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IMPACT AND FACTORS ASSOCIATED WITH GASTRO-INTESTINAL PARASITIC INFECTIONS AMONG PUPILS IN THIKA DISTRICT, KENYA

TERESIA WAMBUI NGONJO (B.ED SCIENCE)

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OCTOBER 2009

DECLARATION

I, Teresia Wambui Ngonjo declare that this thesis is my original work and has not been presented for a degree in any other university or any other award

Signed______________ Date 11-11-2009

SUPERVISORS APPROVAL

This thesis is submitted for examination with our approval as university supervisors

DR MICHAEL GICHERU
DEPARTMENT OF ZOOLOGICAL SCIENCES
KENYATTA UNIVERSITY

Signed______________ Date 11-11-2009

DR. CHARLES MWANDAWIRO
KENYA MEDICAL RESEARCH INSTITUTE
EASTERN AND SOUTHERN AFRICA CENTRE OF
INTERNATIONAL PARASITE CONTROL (ESACIPAC)

Signed______________ Date 12-11-2009

DEDICATION

I dedicate this thesis to my parents, Kanyiri, J, and Waithera, B; for their encouragement; my husband, Ngonjo, S. for his undying love and support; and children, Gacheru, V, Wangui, M.Pand Waithera, C.C. for their patience.

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ABBREVIATIONS AND ACRONYMS

ESACIPAC	Eastern and Southern Africa Centre of International Parasite Control
CDC	Centre for disease control
CBS	Central bureau of statistics
DVBD	Division of vector borne diseases
EPG	Eggs per gram
FRESH	Focusing resources on effective school health
GOK	Government of Kenya
HAZ	Height-for- age Z score
H/A	Height-for-age
KEMRI	Kenya Medical Research Institute
Mg	Milligrams
SD	Standard deviation
SPSS	Statistical package for social sciences
STH	Soil transmitted helminthes
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
USA	United States of America
W/A	Weight-for-age
WAZ	Weight-for- age Z Score

WHO	World health organization
WHZ	Weight-for-height Z Scores
W/A	Weight –for age
US NCHS	United State National Centre for Health Statistics
μm	Micrometers
Z	Z scores

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ABSTRACT

Intestinal parasitic infections are amongst the most common human infections worldwide. It is estimated that some 3.5 billion people are affected, and that 450 million are ill as a result of these infections, the majority being children. These parasites remain a major health problem in many developing countries. The study set out to investigate the factors that influence intestinal parasitic infections and their effect on growth status of school going children. The study was conducted in four public primary schools namely, Athena (peri-urban), Kathambara (rural), Kianjau (slum) and St.Patrick (urban) all in Thika district, Kenya. The stools were collected from children and examined for helminthiasis by kato-katz technique. Protozoa were examined using formol ether concentration method and fresh saline smears. Anthropometric measurements of weight and height of subjects were taken to determine the relationships of intestinal parasitic burden and degree of stunting, wasting and malnutrition. Information on family background of the study subjects was obtained through a standard pre-tested questionnaire. Chi square and one way Anova tests were used for comparing infection by sex, age, the risk factors of intestinal parasitic diseases and to compare mean heights and weights between children in the four schools. Prevalence of intestinal helminthes in children of peri-urban, rural, slum and urban schools were 38.9%, 48.9%, 48.9% and 31% respectively. Prevalence of intestinal protozoa of pupils in peri-urban, rural, slum and urban schools were 46.3%, 38.9%, 34.8% and 28.7% respectively. *Ascaris lumbricoides* infection was significantly higher in slum and rural than in peri-urban and urban schools (χ^2=14.425, df=3, $p<0.05$). Hookworm infection was significantly higher in the rural and peri-urban schools than in urban and slum schools (χ^2=15.268, df=3, $p<0.01$). *Entamoeba histolytica* was significantly higher in rural and slum schools than in peri-urban and urban schools. (χ^2=9.29, df=3, $p<0.05$). In the slum school, *Ascaris lumbricoides* infection was significantly associated with the failure to wash hands before meals (χ^2=13.674, df=1, $p<0.01$), type of toilet slab (χ^2=6.298, df=1, $p<0.05$), and toilet sharing (χ^2=5.84, df=1, $p<0.05$). In the rural school, *Ascaris lumbricoides* infection was significantly associated with source of drinking water (χ^2=8.902, df=3, $p<0.05$), and failure to wash hands after toilets (χ^2=7.191, df=1, $p<0.05$). In the rural school, *Entamoeba histolytica* infection was significantly associated with eating of tubers (χ^2=18.37, df=1, $p<0.001$). Nutritional parameters were all significantly different in children of the four schools, stunting (low height for age), (χ^2 =9.41, df=3, $p<0.05$); wasting (low weight for height), (χ^2=19.47,df=3.$p<0.001$) and malnultrition (low weight for age) (χ^2=11.97,df=3, $p<0.001$). The results of this study indicate that the prevalence of intestinal parasites in the study area is high. This could impact negatively on the intellectual, psychological and physical development of the school going children. The results will help in intensifying efforts towards achieving the global control efforts to reach 75% of children with intestinal parasites by year 2010. The results of this study will be used in designing of community specific control strategy in Thika district deworming programmes.

CHAPTER ONE: INTRODUCTION

1.1 Background information

Intestinal parasitic infections are amongst the most common infections worldwide. It is estimated that some 3.5 billion people are affected, and that 450 million are ill as result of these infections, the majority being children (WHO, 1998). Studies estimate that 1,277 million people worldwide are infected with hookworm (*Necator americanus* and *Ancylostoma duodenale*), 1273 million with *Ascaris lumbricoides*, 902 million with *Trichuris trichiura* and 200 million with schistosomiasis (Savioli *et al*., 1997). These infections are regarded as serious public health problem, as they can cause iron deficiency anaemia, growth retardation in children and other physical and mental health problem (Nokes *et al*., 1992; Adam *et al*., 1994; Stoltzfus *et al.,* 1996; Stephenson *et al* 1993).

School age children are the group at high risk for intestinal parasitic infections (Stephenson *et al*., 1993). Helminthiasis has potential consequences on physical, psychological and intellectual development of children and contributes a great cost burden to the health care system (Stephenson *et al.,* 1993). Direct association has been established between school performance and intestinal helminthic infections (Sternberg *et al*., 1997; Levav *et al.,* 1995). Children with high multiple infections have been indicated to have poor school performances than uninfected children or those infected with a single species of the intestinal helminthes (Kvalsvig *et al.,* 1991). In Kenya intestinal worm infection is ranked fifth major cause of outpatient hospital attendance after malaria, bronchopneumonia, dysentery and skin diseases (GOK, 2001a). Studies done in Western Kenya showed that, the mean school prevalence for infection with any of the soil transmitted helminthes (STH) was 63% with hookworm (42.5%), *Ascaris lumbricoides* (22.9%)

and *Trichuris trichiura* 17.9% (Handzel *et al.,* 2003). In Mwea, central Kenya, prevalence before treatment was 47.4% for *Schistosoma mansoni*, 16.7% for *Necator americanus*, 1.6% for *Ascaris lumbricoides* , and 0.8% for *Trichuris trichiura (*Kihara *et al.,* 2007*).* Studies on intestinal parasites conducted in two communities, Miu and Kitengei in Machakos District, Kenya (Chunge *et al.*, 1995) revealed that more than 60% of the subjects were infected with more than one of the intestinal parasites. The magnitude and similarity of parasitism in these two communities is notable, slightly higher than the 60% found in Kiambu District, Kenya (Chunge *et al.,* 1991a).

Among the many species of intestinal protozoa, *Entamoeba histolytica* and *Giardia lamblia* are potentially pathogenic and in many parts of the world either or both organisms constitute a public health problem (WHO, 1980). *Entamoeba histolytica* is one of the six amoeba of the genus *Entamoeba* that infects humans. Infection is distributed world wide, with a high prevalence in tropical countries (Garcia *et al.*, 1988). The prevalence of *Entamoeba histolytica* infections differs from one geographic area to another , and severity varies from one case to another (Walsh *et al.*,1988). Rapid urbanization, especially in tropics is often associated with increased poverty, poor housing and unsanitary conditions (Wilson *et al.,* 1998). *Giardia lamblia* and *Entamoeba coli* can be transmitted orally by drinking infected water and both are environmental contaminants of the water supply. The water supply is really an important risk factor for Giardiasis and several large outbreaks of giardiasis have resulted from the contamination of municipal water supplies with human wastes (Wilson *et al.*, 1998). The ingestion of contaminated water is a common problem in Turkey countrywide due to the lower quality of water and faulty sewage lines. The problem is greater in the rural areas that do not have a municipal water network and sewage system (Ozar *et al.*, 1999). Prevalence of parasitic infections among two different groups of persons in rural and urban areas respectively on island of Bioko (Equitorial Guinea) were *Entamoeba histolytica* (14.9% and 32.7%), *Entamoeba coli* (10.2% and 11.1%), *Giardia lamblia* (7.2 and 8.6%) respectively. Intestinal parasitic infections are a public health concern in Kenya. Although these infections occur in all age groups, the problem is predominant among the worlds estimated 400 million school children. This contributes to childhood growth retardation. Intestinal parasites infections occur in both rural and urban populations, necessitating regular deworming especially in school going children who are more vulnerable (Kamnuvi *et al*., 1983). Study done on parasite related diarrhoea, Mombasa Kenya found that *Entamoeba histolytica* and *Giardia lamblia* causes diarrhoea but were present in equal frequency in diarrhoeal, semi-formed and formed stools., except the trophozoites of *Entamoeba histolytica* (Yoshiki *et al*., 1993).

Gastro-intestinal infections occur almost in every part of the country with higher infection rates in areas where water is stagnant. Geographic distribution of schistosomiasis and soil transmitted helminthes (STH) in Western Kenya indicated nearly two-thirds of children tested were infected with one or more STH. This calls for the need to map a detailed epidemiology of gastro-intestinal parasitic infections as this may help in designing control strategies, in areas of high transmission. Although many studies regarding intestinal parasites focus on establishing the prevalence and intensity of these infections in different populations, fewer studies have examined the social-cultural factors that affect transmission of intestinal parasite. Some studies have shown that the lack of education, lack of latrines, occurrence of diarrhea, lower socio-economic status, inadequate disposal of human excreta and sanitation in households are related to parasitoses (Holland *et al*., 1988).

1.2 Problem Statement

Thika is a highly populated and ideal urban centre, surrounded by slum and rural communities. Many people are settled in the urban and periphery of the town (peri-urban) to provide labour in the industries. These people live in different environments with different lifestyles, such as rural, urban, slum and peri-urban. Most of gastro-intestinal parasites are transmitted through soil and faecal contamination. Although these parasites are known to cause problem in growth, their impact on children in this study area is not documented. There is need to compare prevalence of the gastro-intestinal parasites in the stated areas and factors that perpetuate their transmission and the effect on pupils are not well documented.

1.3 Justification

Distribution of parasitic infection in a community has been found to vary in different regions due to underlying socio-economic, behavioural and environmental factors. Intestinal parasites impact negatively on health of young children. There is need to establish prevalence's of intestinal parasitic infections in pupils in the urban, peri-urban, slum and rural settings of the study areas. Factors that may influence transmission of gastro-intestinal parasites need to be identified for proper designing of effective community control strategies in the different areas. Nonetheless, use of pupils deworming programmes as entry point into school health and nutrition is easily done by teachers and is seen as a more viable step in the control of infectious diseases. Integration of several control programmes through schools has been advocated for many years and even the World Health Organization endorses this as the right strategies.

The study will form baseline survey that provide basis for development of control programmes at national, regional and district levels. Establishing prevalence of intestinal protozoa, intensity of soil-transmitted helminthes (STH) in relation to nutritional status of school children may influence the Ministry of Health and Ministry of Education to incorporate school health and nutrition into the education systems in the country. There is need to establish the prevalences of parasitic infections, identify associated socio-demographic, behavioral and environmental factors in order to strategize on how to put the best interventional measures. Intestinal parasitic infections can only be definitely controlled by improvement in sanitation and living conditions, but in the short term these measures can scarcely be implemented due to lack of resources. Establishing prevalence and determining whether gastro-intestinal parasites affect the growth status of pupils in Thika district may call for integrated health and nutrition intervention. This may lead to improved learning and equity among children attending free primary education.

1.4 Research Questions

(a) What is the prevalence of gastro-intestinal parasitic infections among school going children in peri-urban, rural slum urban schools in Thika district ?.

(b) What is the impact of the intestinal parasitic infections on the growth status of children?

(c) What are the factors that contribute to the transmission of intestinal parasitic infections in peri-urban, rural, slum and urban schools in Thika district?

1.5 Hypothesis

(a) There is no difference in prevalence and intensity of intestinal worms in peri-urban, rural, slum and urban schools school age children in Thika district.

(b) There is no relationship between gastro-intestinal parasites and anthropometric indices of school going children in peri-urban, rural, slum and urban schools in Thika district.

1.6 General Objective

To determine the impact and factors associated with gastro-intestinal parasitic infections among pupils in Thika district

1.6.1 Specific Objectives

(a) To determine prevalence and intensity of intestinal worm infections in school children of peri-urban, rural, slum urban schools of Thika district

(b) To determine prevalence of intestinal protozoa infections in children of peri-urban, rural, slum , urban schools of Thika district

(c) To establish the environmental factors that influences the prevalence and intensities of intestinal parasites in peri-urban, rural, slum urban schools of Thika district.

(d) To determine the anthropometric parameters in school age children in peri-urban, rural, slum and urban schools in Thika.

CHAPTER TWO: LITERATURE REVIEW

2.1 Intestinal Helminthes and Schistosomiasis

Intestinal helminthiasis is caused by parasitic members of the class Cestoda, Trematoda and phylum Nematoda. These include *Ascaris lumbricoides*, the large roundworm that causes ascariasis; *Enterobius vermacularis*, the pinworm that causes enterobiasis; *Ancyclostoma duodenale* and *Necator americanus*, two types of hookworms that cause ancyclostomiasis; *Trichuris trichiura*, the whipworm that causes trichuriasis. Others include *Stronglyloides stercoralis* that causes strongyloidiasis; and *Trichinella spiralis* that causes trichineliasis (WHO, 1987). The most common of these are *Ascaris lumbricoides, Trichuris trichiura*, hookworm (*Ancyclostoma duodenale* and *Necator americanus*) (Chamlong, 1983; Muchiri *et al.,* 2001; Brooker and Michael, 2000). The cestodes that cause significant human disease include *Taenia solium*, *Taenia saginata* and *Hymenolepis nana* (Kaethe, 1992) and the trematode that cause significant infection is *Schistosoma mansoni* (Bundy *et al*., 1987).

2.2 Prevalence of Intestinal Helminthes in school children in Thika District

Human intestinal helminthes infections were predicted to be among the most widespread parasitic infections in the world (WHO, 1984). This has not changed much because in tropical and sub-tropical region, the prevalence of intestinal helminthic infections ranges from 25% to 90% among school age children (Olsen, 1998). Schistosomiasis and soil transmitted helminthes are responsible for extensive morbidity and mortality in sub-saharan Africa (Chistul *et al*., 2000). It is estimated that worldwide more than 200 million persons are infected with schistosomes with 85% of the cases occurring in Africa. Trichuriasis is a tropical disease of children (5 to 15 yrs) in rural Asia (65% of the 500-700 million cases). It is, however, seen in the two Americas, mostly in the South and is concentrated in families and groups with poorer sanitary habits. *Enterobius vermacularis* is by far the commonest helminthic infection in the US (18 million cases at any given time). The worldwide infection is about 210 million. It is an urban disease of children in crowded environment (schools, day care centers, etc.). Adults may get it from their children. Hookworms parasitize more than 900 million people worldwide and cause daily blood loss of 7 million liters. Ancylostomiasis is the most prevalent hookworm infection and is second only to ascariasis in infections by parasitic worms. *Necatar americanus* (new world hookworm) is most common in the Americas, central and southern Africa, southern Asia, Indonesia, Australia and Pacific Islands. *Ancylostoma duodenale* (old world hookworm) is the dominant species in the Mediterranean region and northern Asia.

In 1999 reported cases of out patient attendance related to worms were 624, 273 (GOK, 2001a) in Kenya. This is about 0.02% of country's population, but actual figures based on research are high ranging from 10 to 90% (Muchiri *et al.,* 2001; Brooker *et al.,* 2000b) indicating that many cases go unreported. Prevalence of helminthic infection among healthy children in Kisumu aged between four and five years was found to be 60% (Oslen, 1998). Cases of multiple infections also exist. From a study carried out in Busia, 5.9% of school children were harboring four different species of intestinal helminthes, which is *Ascaris lumbricoides*, hookworm, *Trichuris trichura* and *Schistosoma mansoni* while 26% of children had all three geohelminths (Brooker *et al.*, 2001). In Mwea central Kenya, Prevalence of soil transmitted helminthes was between 0.2% and 28.5% (Kihara *et al.*, 2007).

2.3 Transmission of Intestinal Worms Infections and Schistosomiasis

Transmission of intestinal helminthic infections in edemic areas is dependent on many factors including species of intestinal helminth, seasonality of transmission and infection rate (Muchiri *et al.,* 2001). Children are highly at risk of these parasitic infections because their level of hygiene and sanitation are low or poor (Anderson *et al*., 1985). Different modes of transmission exist; for example *Ascaris lumbricoides, Trichuris trichura* and hookworm are soil transmitted (Crompton, 1999). Three major life cycles for intestinal nematodes exits; that is direct, indirect and percutaneous (Freedman, 1992). Direct life cycle involves transmission from soil into the digestive system where maturation of the worm occurs. Indirect life cycle is similar to direct life cycle, but involves migration of the larvae through the circulatory and respiratory system before final migration into the digestive system where maturation occurs for example, *Ascaris lumbricoides*. Percutaneous life cycle involves embryos hatching outside the body where they grow and develop as infective larvae. The larvae re-enter the definitive host by burrowing through the skin, for example hookworm.

2.4 Life cycles of Intestinal Parasites

2.4.1 Life cycle of *Ascaris lumbricoides*

The infection occurs by ingestion of food contaminated with infective eggs which hatch in the upper small intestine. The larvae (250 x 15 micrometers) penetrate the intestinal wall and enter the venules or lymphatics. The larvae pass through the liver, heart and lung to reach alveoli in 1 to 7 days during which period they grow to 1.5 cm. They migrate up the bronchi, ascend the trachea to the epiglottis, and pass down the oesophagus to the small intestine where they mature in 2 to 3 months. A female may live in the intestine for 12 to 18 months and has a capacity of producing 25 million eggs at an average daily output of 200,000 eggs per day. The eggs are excreted in faeces, and under suitable conditions (21° c to 30° , moist, aerated environment) infective larvae are formed within the egg. The eggs are resistant to chemical disinfectant and survive for months in sewage, but are killed by heat (40° c for 15 hours). The infection is commonly man to man. Auto infection can also occur in certain situations (Fig. 2.1).

2.4.1.1 Pathology of *Ascaris lumbricoides*

Symptoms are related to the worm burden. Ten to twenty worms may go unnoticed except in a routine stool examination. The commonest complaint is vague abdominal pain. In more severe cases, the patient may experience listlessness, weight loss, anorexia, distended abdomen, intermittent loose stool and occasional vomiting. During the pulmonary stage, there may be a brief period of cough, wheezing, dyspnea and discomfort. Most symptoms are due to the physical presence of the worm in the abdomen. Diagnosis is based on identification of eggs (40 to 70 micrometers by 35 to 50 micrometers) in the stool.

2.4.1.2 Treatment of *Ascaris lumbricoides*

Mebendazole, 200 mg per kg body weight, for adults and 100 mg per kg body weight for children, for 3 days is effective. Good hygiene is the best preventive measure. Kihara *et al.* (2007) observed that albendazole has cure rates of 100% for Ascariasis. Excessive clustering of eggs of *Ascaris lumbricoides* and *Trichuris trichiura* suggest that concurrent infection with these species occurs at a greater frequency than would be expected by chance (Brooker *et al.*, 2000).

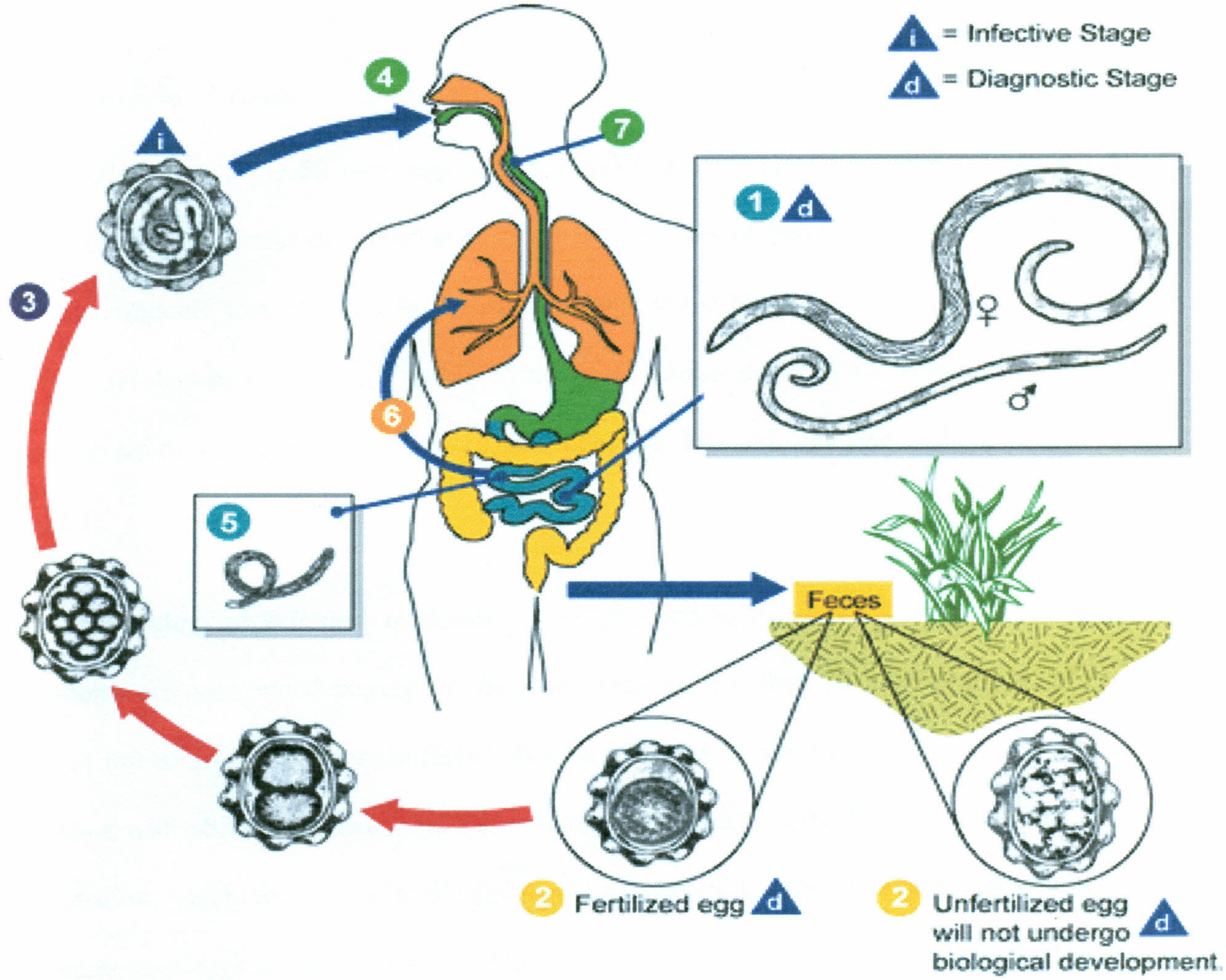

Figure 2.1: Life cycle of *Ascaris lumbricoides* (CDC, 2000)

a. Adult worms live in the lumen of all the small intestines. A female may produce upto 240,000 eggs per day, which are passed with the faeces.
b. Fertile eggs embryonate and become infective after 18hours to several weeks depending on the environmental conditions (optimum; moist, warm, shaded soil).
c. After infective eggs are swallowed, the larvae hatch, invade the intestinal mucosa, and are carried via the portal, then systemic circulation to the lungs.
d. 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.
e. Upon reaching the small intestines, they develop into adult worms.
f. Between 2 and 3 months are required from ingestion of the infective eggs to oviposition by the adult female. (CDC, 2000)

2.4.2 Life cycle of *Trichuris trichiura*

The female organism is 50 mm long with a slender anterior (100 micrometer diameter) and a thicker (500 micrometers diameter) posterior end. The male is smaller and has a coiled posterior end. The eggs are less resistant to desiccation, heat and cold than ascaris eggs. The embryo is killed under desiccation at 37° C within 15 minutes. Temperatures of 52° C and -9° C are lethal. *Trichuris trichiura* produces 3000 to 10, 000 eggs per day and may live as long as 5 to 6years (Fig.2.2).

2.4.2.1 Pathology of *Trichuris trichiura*

Symptoms are determined largely by the worm burden: less than 10 worms are asymptomatic. Heavier infections (massive trichuriasis) are characterized by chronic profuse mucus and bloody diarrhoea with abdominal pains and oedematous prolapsed rectum. The infection may result in malnutrition, weight loss and anaemia and sometimes death. Diagnosis is based on symptoms and the presence of eggs in faeces. (CDC, 2000).

2.4.2.2 Treatment of *Trichuris trichiura*

Mebendazole, 200 mg per kg body weight, for adults and 100 mg per kg body weight for children, for 3 days is effective. Accompanying infections must be treated accordingly. Improved hygiene and sanitary eating habits are most effective in control.

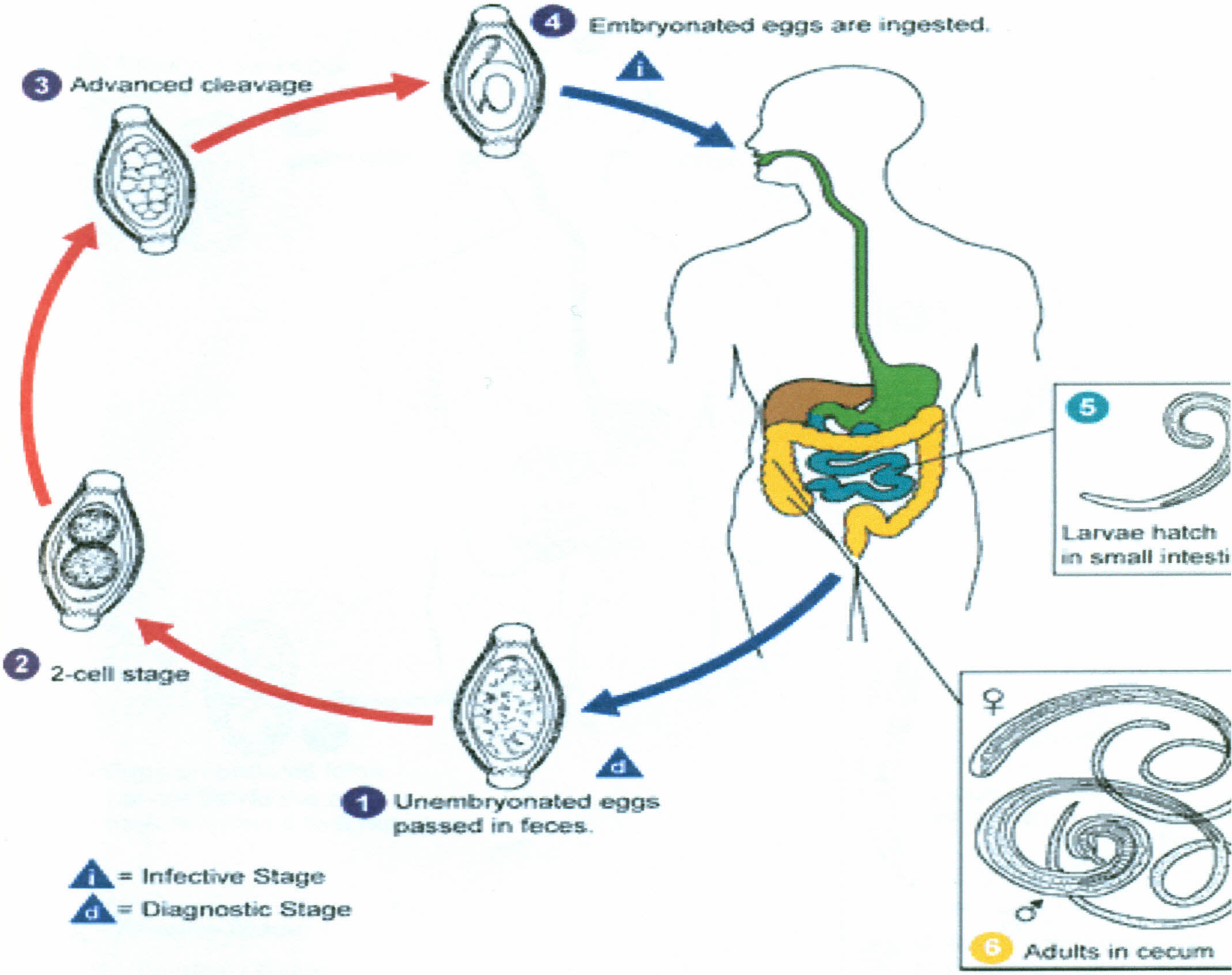

Figure 2.2: Life cycle of *Trichuris trichiura* (CDC, 2000)

a. The *Trichuris trichiura* eggs are lemon or footballs shaped and have terminal plugs at both end.
b. Eggs develop slowly even when kept moist and warm, they require 3-6 weeks.
c. Eggs undergo cleavage.
d. Infection occurs by ingestion of embryonated eggs in soil.
e. The larva escapes the shell in the upper small intestine and penetrates the villus where it remains for 3 to 10 days.
f. Upon reaching adolescence, the larvae pass to the cecum and embed in the mucosa. They reach the ovipositing age in 30 to 90 days from infection, produce 3000 to 10,000 eggs per day and may live as long as 5 to 6 years. Eggs passed in faeces embryonate in moist soil within 2 to 3 weeks (Fig, 2.2) (CDC, 2000).

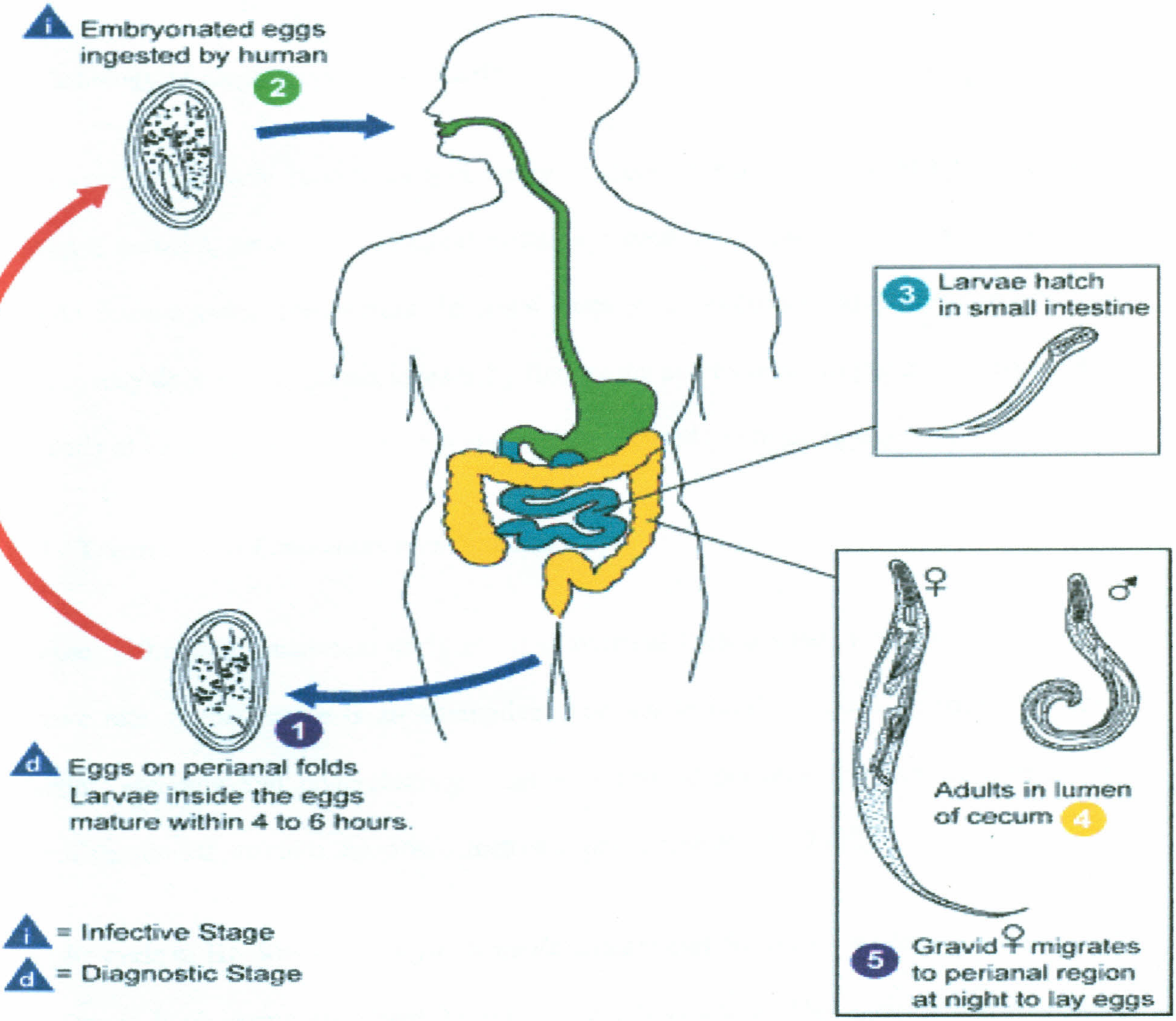

Figure 2.3: Life cycle of *Enterobius vermacularis* (CDC, 2000)

a. The female worm measures 8 mm x 0.5mm; the male is smaller. Eggs (60 micrometers x 27 micrometers) are ovoid but asymmetrically flat on one side. 2
b. Infection occurs when embryonated eggs are ingested from the environment, with food or by hand to mouth contact.
c. The embryonic larvae hatch in the duodenum and reach adolescence and upper ileum.
d. Adult worms descend into lower ileum, cecum and colon and live there.
e. The gravid females, containing more than 10,000 eggs migrate, at night, to the perianal region and deposit their eggs there. Eggs mature in an oxygenated, moist environment and are infectious 3 to 4 hours later. Man-to-man and auto infection are common. Man is the only host (Fig, 2.3); (CDC, 2000).

2.4.3 Pathology of *Enterobius vermacularis*

Enterobiasis is relatively innocuous and rarely produces serious lesions. The most common symptom is perianal, perineal and vaginal irritation caused by the female migration. The itching results in insomnia and restlessness. In some cases gastrointestinal symptoms (pain, nausea, vomiting) may develop. Diagnosis is made by finding the adult worm or eggs in the perianal area, particularly at night. Scotch tape or a pinworm paddle is used to obtain eggs.

2.4.3.1 Treatment of *Enterobius vermacularis*

Two doses (10 mg/kg; maximum of 1g each) of Pyrental Pamoate two weeks apart give a very high cure rate. Mebendazole is an alternative. The whole family should be treated, to avoid reinfection. Bedding and underclothing must be sanitized between the two treatment doses. Personal cleanliness provides the most effective in prevention (CDC, 2000).

2.4.4 Life cycle of Hookworm (*Ancylostoma duodenale* and *Necatar americanus*)

Adult female hookworms are about 11 mm x 50 micrometers. The anterior end of *Necatar americanus* is armed with a pair of curved cutting plates whereas *Ancylostoma duodenale* is equipped with one or more pairs of teeth. Hookworm eggs are 60 micrometers x 35 micrometers. Hookworms are not capable of a free-living or auto-infectious cycle (Fig 2.4). Furthermore, *Ancylostoma duodenale* can infect also by oral route (CDC, 2000).

2.4.4.1 Pathology of hookworm

Symptoms of hookworm infection depend on the site at which the worm is present and the burden of worms. Light infection may not be noticed. Dermal infection show local erythema, macules, papules (ground itch) that cutaneous invasion and subcutaneous migration of larva. Pulmonary site results to bronchitis, pneumonitis and, sometimes, eosinophilia. This is due to migration of larvae through lung, bronchi, and trachea. Gastro- intestinal infection cause anorexia, epigastric pain and gastro-intestinal hemorrhage. This is due to attachment of adult worms and injury to upper intestinal mucosa. Hematologic infection causes iron deficiency, anemia, hypoproteinemia, edema, and intestinal blood loss (CDC , 2000).

2.4.4.2 Treatment of hookworm

Single dose of 400mg of albedazole is effective to treat hookworm infections. Kihara *et al.* (2007) observed that albendazole prevalence reduced to 0.8% for *Necator americanus.*

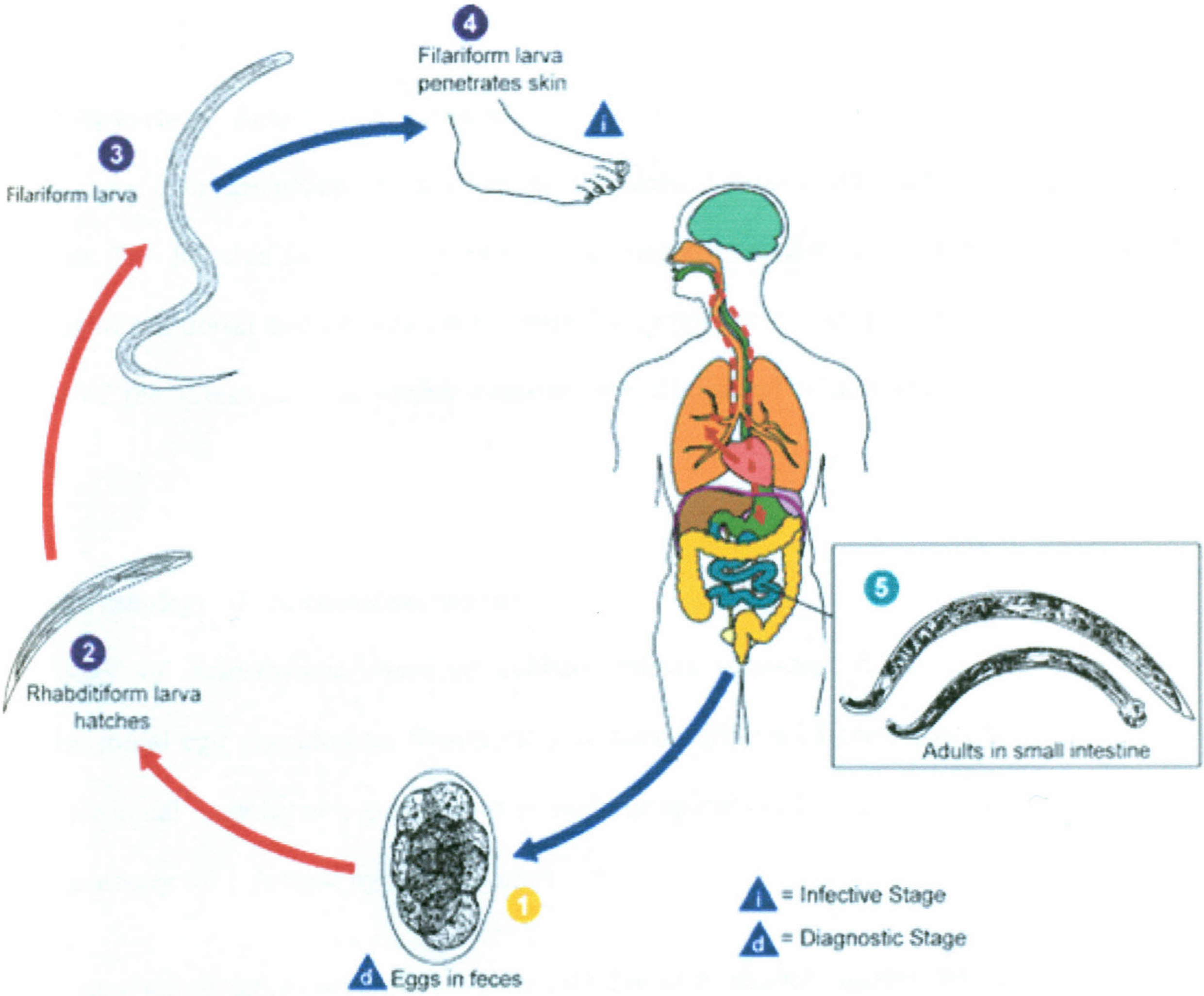

Figure 2.4: Life cycle of hookworm (CDC, 2000)

a. Eggs are passed in the faeces and do not develop further until exposed to air.
b. The rhabditum larvae hatches penetrate the skin of man,
c. Rhabditum larvae develops into filariform
d. Filariform larvae penetrates the skin until they enter lymph or blood vessels in the venous circulation and pass through the right heart to lungs, where they penetrate into the alveoli. From there, the adolescent parasites ascend to the glottis, are swallowed, and reach the upper part of the small intestine.
e. They develop into adults in the small intestine. Ovipositing females develop in 28 days from infection. The eggs in the intestinal mucosa hatch and develop into rhabditiform larvae in man (Fig,2.4); (CDC, 2000).

2.4.5 Life cycle of *Schistosoma mansoni*

Schistosoma mansoni occurs more often in the superior mesenteric veins draining the large intestine. The females (size 7 to 20 mm; males slightly smaller) deposit eggs in the small venules of the portal and perivesical systems. The eggs are moved progressively toward the lumen of the intestine *Schistosoma mansoni* are eliminated with faeces (Fig 2.5); (CDC, 2000).

2.4.5.1 Pathology of *Schistosoma mansoni*

Pathology of *Schistosoma mansoni* schistosomiasis includes: Katayama fever, hepatic perisinusoidal egg granulomas, Symmers' pipe stem periportal fibrosis, portal hypertension, and occasional embolic egg granulomas in brain or spinal cord. Human contact with water is thus necessary for infection by schistosomes.

The symptoms of schistosomiasis are primarily due to a reaction against the eggs and include splenomegaly, lymphadenopathy and diarrhoea. In the bladder, they produce granulomatous lesions, hematuria and sometimes urethral occlusion. Most bladder cancers in endemic areas are associated with chronic infection. In the intestine, they cause polyp formation which, in severe cases, may result in life threatening dysentery. In the liver, the eggs cause periportal fibrosis and portal hypertension resulting in hepatomegaly, splenomegaly and ascites (CDC, 2000).

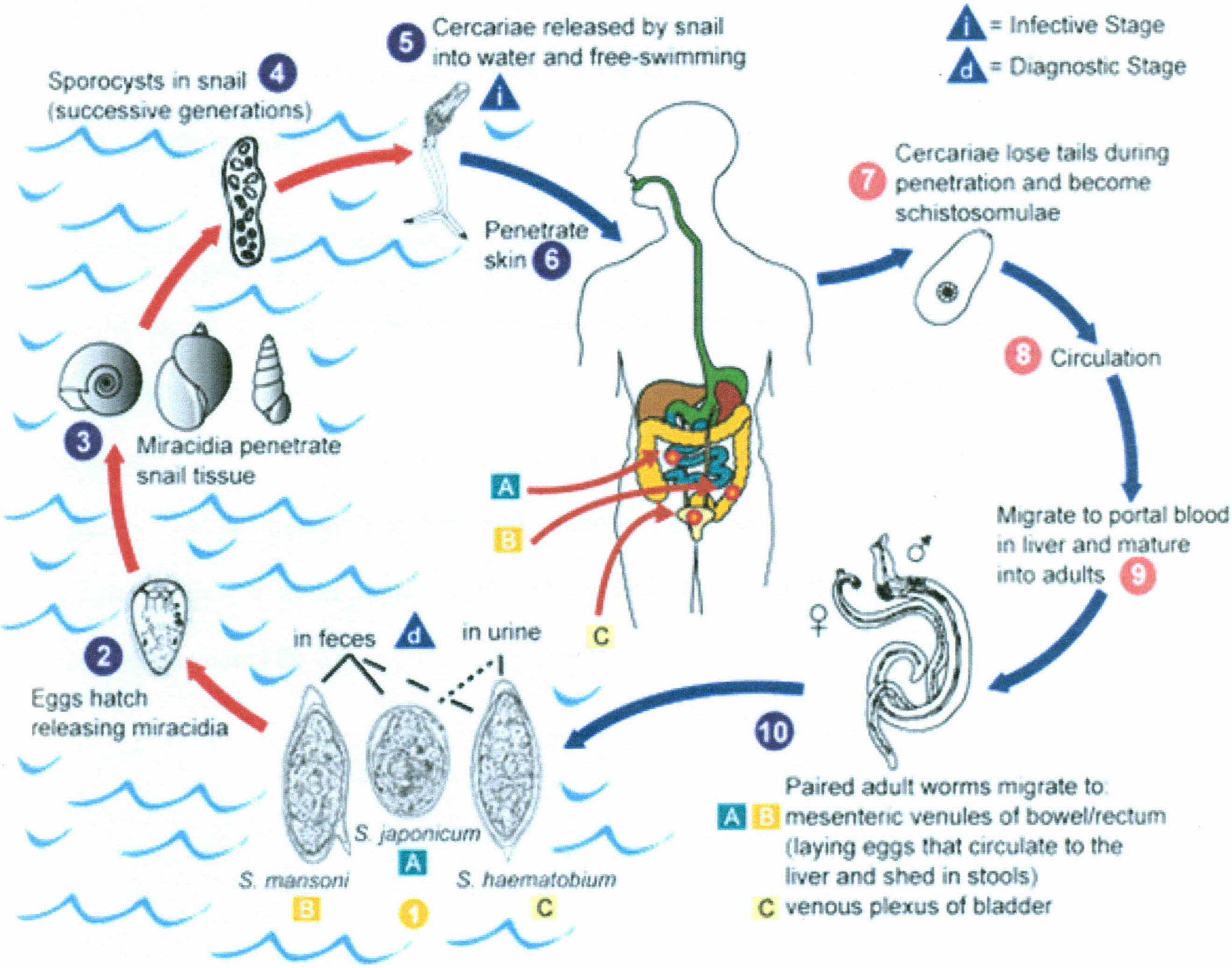

Figure 2.5: Life cycle of ***Schistosoma mansoni*** **(CDC, 2000)**

a. Eggs are eliminated with faeces or urine.

b. Under optimal conditions the eggs hatch and release miracidia.
c. Miracidia swims and penetrates specific snail intermediate hosts.
d. The stages in the snail include 2 generations of sporocysts
e. Upon release from the snail, the infective cercariae swim.
f. Cercariae penetrate the skin of the human host and shed their forked tail, becoming schistosomulae. Cercariae shed their forked tail, becoming schistosomulae .
g. The schistosomulae migrate through several tissues and stages to their residence in the veins.
h. Schistosomulae migrates to portal blood in the liver and matures into adults.10.
i. Adult worms in humans reside in the mesenteric venules in various locations, which at times

2.4.5.2 Treatment of *Schistosoma mansoni*

Praziquantel is effective against all species. Contaminated water should be avoided. Control measures include sanitary disposal of sewage and destruction of snails. No vaccine is available.

2.4.6 Life cycle of *Hymenolepis nana*

Hymenolepiasis is caused by two cestodes (tapeworm) species, *Hymenolepis nana* (the dwarf tapeworm, adults measuring 15 to 40 mm in length) and *Hymenolepis dimnuta* (rat tapeworm, adults measuring 20 to 60 cm in length). *Hymenolepis diminuta* is a cestode of rodents infrequently seen in humans and frequently found in rodents. Eggs of *Hymenolepis nana* are immediately infective when passed with the stool and cannot survive more than 10 days in the external environment (fig 2.6).

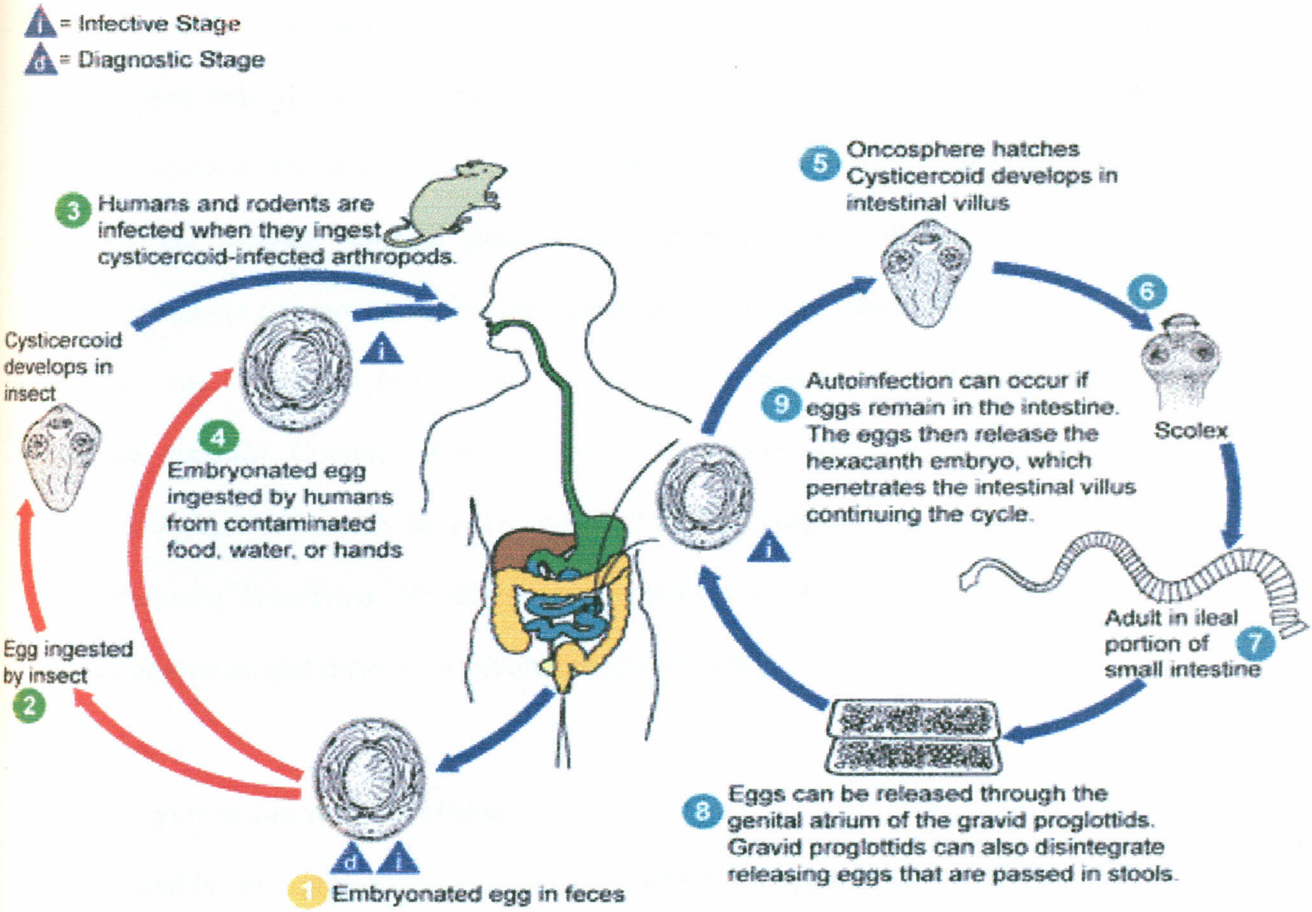

Figure 2.6: Life cycle of *Hymenolepis nana* (CDC, 2000)

a. When eggs are ingested by an arthropod intermediate host
b. (Various species of beetles and fleas may serve as intermediate hosts), they develop into cysticercoids, which can infect humans or rodents upon ingestion
c. Develop into adults in the small intestine when eggs are ingested
d. (In contaminated food or water or from hands contaminated with faeces), the oncospheres contained in the eggs are released.
e. The oncospheres (hexacanth larvae) penetrate the intestinal villus and develop into cysticercoid larvae.
f. Upon rupture of the villus, the cysticercoids return to the intestinal lumen, evaginate their scoleces, attach to the intestinal mucosa
g. Develop into adults that reside in the ileal portion of the small intestine producing gravid proglottids
h. Eggs are passed in the stool when released from proglottids when proglottids disintegrate in the small intestine. An alternate mode of infection consists of internal autoinfection

2.5 Intestinal Protozoa

The protozoa that cause gastro-intestinal infection include amoebae, flagellates and ciliates. They are transmitted through fecally contaminated food, water or other materials. The most common intestinal protozoa are *Entamoeba coli, Iodamoeba bustchlii* (non-pathogenic*),* *Entamoeba histolytica,* and *Giardia lamblia. Balantidium coli* is the only ciliated protozoa that infect humans. A number of amoebae affect the human gastrointestinal tract and may cause diagnostic confusion. These include *Entamoeba hartmanni*, *Entamoeba coli, Endolimax nana,* and *Iodamoeba butschlii*. Common intestinal flagellates include *Dientamoeba fragilis, Blastocystis hominis and Giardia lamblia.* In 1987, over 500 million people were estimated to be infected with *Entamoeba histolytica*, 50 million had extensive symptoms, including colitis or extra intestinal abscesses, and there were 100,000 deaths worldwide (WHO, 1987).

2.5.1 Life cycle of Intestinal Protozoa

Giardia lamblia is a protozoa parasite that colonizes the upper portions of small intestine. It exhibits a typical feacal -oral transmission cycle. The infection is acquired through the ingestion of cysts. Factors leading to contamination of food or water with faecal material are correlated with transmission. Giardiasis is prevalent in children in institution and day care centre. In developing countries, poor sanitation contributes to higher levels of giardiasis, and water-borne outbreaks due to inadequate water treatment. However, person to person transmission and risk factors are close human contact combined with unhygienic conditions. The ingested cyst passes through the stomach and encystations takes place in the duodenum. Excystation can be induced in vitro by a brief exposure of the cysts to acidic conditions or other source of hydrogen ions. This conditions mimics those of the stomach and probably functions as an environmental cue for the parasites. Flagellar activity begins within 5-10 minutes following the acid treatment and the trophozoites emerge through a break in the cysts wall. The trophozoite will undergo cytokinesis (cell division without nuclear replication) within 30minutes after emerging from the cyst resulting in two binucleated trophozoites. The trophozoites are predominately found attached to epithelial cells of small intestines and rarely found in stools, except in cases of severe diarrhea. This attachment is mediated by the ventral disc .The trophozoites absorb nutrients from the intestinal lumen via pinocytosis (http:www.tulance.edu/protozoology/intes.html, 9/2008).

2.5.2 Pathology of *Giardia lamblia*

The first signs of acute giardiasis include nausea, loss of appetite and an upper gastro-intestinal uneasiness. These signs are followed by a sudden explosive, watery diarrhea. Stools associated with giardiasis are generally loose, bulky, frothy and greasy with absence of blood or mucus. An acute infection will persist and lead malabsorption, steatorrhea (excessive loss of fat in faeces), debility (loss of strength) and weight loss. Chronic stage presents intestinal abdominal distention and flatulence.

2.5.2.1 Treatment of *Giardia lamblia*

Infected individuals should be treated with metronidazole which has cure rates of 85%. The recommended dosage is 750mg three times a day for five days. For children 15mg/kg in three doses is recommended. Control measures to prevent or *Giardia* infection include health promotion and education aimed at improving personal hygiene, and emphasizing hand washing, sanitation and food handling. Public health measures to protect water supplies from contamination are required to prevent epidemics and to reduce (http:www.tulance endemicity.edu/protozoology/intes.html, 9/2008).

2.5.3 Life cycle of *Entamoeba histolytica*

Several members of the genus *Entamoeba* infect humans. Among these only *Entamoeba histolytica* is considered pathogenic and the disease it causes is called amebiasis or amebic dysentery. *Entamoeba dispar* is morphologically identical to *Entamoeba histolytica* and the two were considered to be the same species. However, genetic and biochemical data indicate that the non-pathogenic *Entamoeba histolytica* is a distinct species.

Entamoeba histolytica exhibits a typical feacal-oral life cycle consisting of infectious cysts passed in the faeces and trophozoites which replicate within the large intestine. The infection is acquired through the ingestion of cysts. Contaminated food and water are probably the primary sources of infection. The higher prevalence in areas of lower socio-economic status is likely due to poor sanitation and a lack of indoor plumbing. A high prevalence of *Entamoeba histolytica* infection is observed in institutions, such as mental hospitals, orphanages and prisons, where crowding and problems with faecal contamination are contributing factors.

Upon ingestion the cysts pass through the stomach and excysts in the lower portion of the small intestine. Encystation involves a disruption of the cyst wall and quadranucleated ameba emerges through the opening. The ameba undergoes another round of nuclear division followed by three successive rounds of cell division to produce eight small uninucleated trophozoites. These immature trophozoites colonize the large intestines, where they feed on bacteria and cellular debris. They undergo repeated rounds of binary fission.

2.5.4 Pathology *Entamoeba histolytica*

Entamoeba histolytica frequently lives as a commensal within the large intestine with no overt manifestations. However, trophozoites can invade the colonic epithelium and produce ulcers and dysentery. This is invasive diseases and can also progress to a systemic, extraintestinal infection. Amebic ulcers can also become secondarily infected with bacteria. *Entamoeba histolytica* infection occasionally leads to the formation of an amebic granuloma which can be confused with a tumour. Liver abscess occurs due to direct transport of trophozoites from large intestines to the liver via hepatic portal vein.

The pathogenesis of *Entamoeba histolytica is* not well understood. One approach to understand the pathogenesis is to compare possible virulence factors between the two closely species. *Entamoeba dispar* has never been associated with a symptomatic invasive disease and infection does not illicit serum antibodies. In contrast, anti-ameba humoral responses are observed in both asymptomatic and symptomatic *Entamoeba histolytica* infections. The development of invasive disease could be due to quantitave or qualitative aspects of the host immune response. The nature of protective immune response is not clear. Innate or nonspecific immunity, as well as acquired immunity are probably both important for the prevention of invasive disease. (htt:www.tulance.edu/protozoology/intes.html.9/2008).

2.5.5 Prevalence of Intestinal Protozoa

Most intestinal protozoan infections in the world are caused by *Entamoeba histolytica, Entamoeba* coli, *Endolimax nana* and *Giardia lamblia* (WHO, 1996). Giardiasis is found most frequently in children or in groups that live in close quarters. It is a common cause of travelers' diarrhoea and is worldwide in distribution. A number of outbreaks in the USA have been attributed to resort or municipal water supplies, in states such as Oregon, Colorado, Washington, New Hamsphire ands New York (Shaw *et al.,* 1997). The prevalence rates for individual protozoa are generally higher than those reported from other studies in Kenya (Iseki *et al.,* 1983). Iseki *et al,* (1983) carried out an extensive prevalence survey of intestinal protozoa in different areas of Kenya and tabulated results according to age-groups. They concluded that intestinal protozoa are widespread in Kenya and suggested the need for control measures.

Trichomonas hominis has been implicated as a possible cause of chronic diarrhea in children (Mutanda *et al*., 1986). Suggestions have also been made that *Blastocystis hominis* (generally thought to be a fungus), may also contribute to intestinal disturbances (Le Bar *et al*., 1985). Chunge *et al.* (1995) showed that prevalence of *Entamoeba histolytica* in Machakos district to be over 35%. Chunge *et al.* (1987) conducted an extensive prevalence survey of intestinal protozoa in Kiambu district, central Kenya, which showed 81.3% of the population was positive for at least one intestinal parasite, and 76.6% were positive for intestinal protozoa.

2.5.6 Transmission of Intestinal Protozoa

Gastro-intestinal protozoa are mainly transmitted through cysts, which survive up to eight days outside the body in the soil if not desiccated. When they get into drinking water or moist foods such as raw vegetables, they are in a position both from the standpoint of length of life and of opportunities to get into human alimentary canal. Even when a purified water system prevails, accidents may lead to widespread outbreaks of waterborne infections because it is documented that there is an association parasitic infection and quality of drinking water (Roche *et al.,* 1999). *Entamoeba histolytica, Endolimax nana, Giardia lamblia* and *Entamoeba coli* can be transmitted orally by drinking infected water and are environmental contaminants of water supply. Several large giardiasis outbreaks have resulted from the contamination of municipal water supplies with human waste (Wallace *et al,* 1998). With regard to *Entamoeba histolytica* infections, majority are asymptomatic (Wijers *et al.*, 1972). A Study in Nigeria showed that children with symptomatic amoebiasis most likely acquired infection from their asymptomatic mothers (Mnochiri, 1965). Chlorination of water in most cities prevents sewage-tainted supplies from causing typhoid or other bacterial infections, but it has no effect on protozoan cysts. Exposure of one's food to careless food handlers is dangerous. Filth flies are capable of passing viable cysts in their vomitus up to an hour after ingesting them, and in their faeces for over four hours.

2.6 Epidemiological Factors Affecting Transmission of Intestinal Parasites

Gastro-intestinal parasites, which do not multiply inside their host, are distributed in tropical and sub-tropical regions in a manner that is always an exact mirror of prevailing socio-economic and sanitary conditions (Freedman, 1992). The exposure event is related to host's behaviour and household environment, which are further influenced by the cultural and economic circumstances of the community (Knightlinger *et al.*, 1998). In the tropics toilet construction and use has been suggested as an effective control measure (Cheesbrough, 1998). However, this calls for further research as it has been found not to be very protective especially when the environment is faecally contaminated (Haswell – Elinkins *et al.,* 1989). Available toilets may not be easy to clean or water table is high as in Bondo District of Kenya (Muchiri *et al.*, 2001) or even when toilet is provided and not used (Faecham, 1983). Household size, crowding, and the use of construction materials are associated with worm intensity (Forrester *et al.*, 1988). Environmental factors that include rainfall, soil, temperature humidity, soil type and altitude play a major role in the epidemiology of intestinal parasites (Brooker and Michael, 2000). Intestinal cestodes infections are generally high due to difficulty in carrying out adequate inspection of beef carcasses (Kaethe, 1992).

Geographical factors such as presence of natural features like lakes and man made dams may also influence distribution of intestinal helminthes. In Busia, Kenya proximity of schools to lake Victoria increased infections of *Schistosoma mansoni* (Brooker *et al.*, 2000). Risk factors enhancing exposure to intestinal parasite eggs and cysts that have been implicated in the previous field studies will include defaecation practices (Haswell-Elkins *et al.*, 1989; Kan *et al.,* 1989), occupational necessity (Chandiawana *et al.,* 1989; Ciesielski *et al.*, 1992), housing conditions and geophagia (Wong *et al.,* 1988). Each of the above factors can be exaggerated by socio economic status, with those in deepest poverty having the most worms (Holland *et al.*, 1988).

2.7 Control of Intestinal Helminthic Infections

Globally, school based drug treatment campaigns have either been planned or initiated as a means of controlling intestinal helmithiasis (Colley, 2000). Through several partnership such as Focusing Resources on Effective School Health (FRESH), by United Nations Educational, Scientific and Cultural Organisation (UNESCO), United Nations Children's Fund (UNICEF), World Health Organisation (WHO), Education International and the World Bank the campaign supporting the distribution of anthelminthics through school has been effective. This would go a long way in improving the health and nutrition of school children and contribute to the global for "Good Health and Education for All". The advent of broad-spectrum anthelminthic drugs that are cheap, safe and simple to deliver, intestinal helminth control has now become a viable option. In addition periodic adminstration of an antihelminthic drugs should be targeted to pre-school and school children is highly recommended to allow a normal growth spurt and stunt prevention (Andrade *et al.,* 2001), and to allow children benefit from schooling (Kvaslvig *et al*., 1991). This also helps to stop transmission cycle as it significantly reduces infection and parasitic burden of infected individuals (Jackson *et al*., 1998) and is in line with global control strategy for soil transmitted helminth (STH) an schistosomiasis (Colley, 2000). Further the strategy has received a boost from global control strategy of lymphatic filariasis, which uses diethyl carbamazine (DEC) or Ivermectin in combination with albendazole (Albonico *et al*., 1998).

However, the success in the control of intestinal helminthic infections has been partially thwarted by high post treatment rates of re-infections. The solution to declining benefit of treatment campaigns has been suggested by intergrating several control measures that are well planed and carefully excuted Public health measures include improved health education, improved water supply, sanitation (Magambo *et al.*, 1998) and control of vectors such snail (Cheesbrough,1998). In Kenya, such large-scale chemotherapeutic control programmes were carried out in Busia District involving 75 schools (Brooker *et al.*, 2000) and in Bondo District (Muchiri *et al.*, 2001). Societal challenges including sanitation and public, adequate housing, sustained funding and interest were identified as draw backs to the success of such programmes (Colley, 2000).

2.8 Growth Status 0f School Children

Weight –for-height (W/H) measures body weight relative to height and is used as an indicator of current nutritional status (WHO, 1995). Low W/H relative to child of the same sex and age in a reference population is referred to wasting (WHO, 1995). Wasting may be due to the consequence of starvation or severe disease (in particular diarrhea). Height –for- age (H/A) reflects cumulative linear growth. Height –for- age deficit indicate past or chronic inadequacies nutrition. Low H/A relative to a child of same sex and age in the reference population is referred to as stunting. Weight-for-age (W/A) reflects body mass relative to age. Weight-for-age relative to a child of the same sex and age in the reference population is lightness while the term underweight is used to refer to severe deficits in W/A (WHO, 1995). The international reference standard (US National Center for Health Statistics) NCHS/WHO reference data will be used (WHO, 1995).

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study Design

This was a cross-sectional descriptive study involving public primary school children. It involved four schools. One was in urban, another in urban slum area, one in outskirts of the town (peri-urban) and one in rural area. School children in the four study populations were from families of different lifestyles and socio-economic status.

3.2 Study area

The study was carried out in Thika District, Central Province of Kenya. The District covers an area of 1,960.2 square kilometers. The district borders Nairobi City to the south, Kiambu District to the west, Maragwa District to the north and Machakos District to the east. There are six administrative divisions namely Thika municipality, Kakuzi, Gatanga, Kamwangi, Gatundu and Ruiru (Appendix 6 and Appendix 7). It lies at an altitude of 1060 to 3550 meters above the sea level. Thika is an industrial town that has very high population settled in the urban and periphery of the town to provide labour in the industries. Some people in the rural areas close to the town live as squatters in the coffee and flower plantations. Though the municipal council has provided clean water in the municipality, sewerage lines have not been put in place in areas around Kiandutu slums. The population of as per 1999 census is 701,664 people (GOK, 2001b). The district is densely populated but with diverse distribution varying from one division to the other and from region to region. Gatundu, Thika Municipality and Gatanga Divisions are most densely populated and lower parts of Ruiru and Kakuzi with least density. The district has a bi-modal rain pattern, with long rains occurring in the months of March and May and short rains in the months of October and November. Average rainfall ranges between 965mm and 2130mm. The eastern part is semi-arid region and receives low rainfall of 116mm and 965mm with mean temperature of 20° C. The kind of agriculture in this area is subsistence farm with big farms under large-scale agriculture of pineapple, coffee and cattle ranch.

3.3 Ethical Consideration

Research permit was obtained from Ministry of Water and Sanitation (Appendix 4) and Ministry Education (Appendix 5). Written consent was obtained from individual children and/ or parents, teachers to allow the school children to be part of the study. Children were examined and treated with albedazole 500mg (single dose) free of charge. Meeting was held with parents, head teacher and the administrator to explain the purpose of the study. It was made clear that the participation is voluntary and individual consent was sought from individual /parents through signing of an informed consent form.

3.4 Study Population

Standard three and four school age children of Athena (Peri-urban), Kathambara (Rural), Kianjau (Slum), and St. Patrick (Urban) public primary schools formed the study group. Pupils from schools that may have had mass deworming were not be included. Those who had been dewormed within the last three months and those who are below class three and above class four were not ~~be~~ included. A list of registered pupils in class three and four was obtained from head teacher in each school and age confirmed from the parent when obtaining the informed consent.

3.5 Sample Size Determination

Sample size was determined by use of the following formula by Fishers *et al* (1998).

$$n = \frac{z^2(1 - \alpha)\, pq}{d^2}$$

Where p = prevalence of intestinal parasitic infections in the study area.

The prevalence of intestinal parasitic infection in Kiambu district, Kenya is about 60% (Chunge *et al*., 1991). $Z = 1.96$ $P = 60\% = p = 0.6$ $q = 1 - 0.6 = 0.4$ $d = 0.05$

$$n = \frac{1.96^2(1 - 0.05)\ 0.6 \times 0.4}{(0.05)^2}$$

$n = 350$ n = sample size

z = standard normal deviation which corresponds to 95% confidence interval.

d = the degree of accuracy.

However to avoid the sampling bias and to cater for attrition, where there was low enrolment (Class three and four), those who consented were all recruited in the study and in total 377 children were sampled

3.6 Sampling Technique

Stratified sampling technique involved each study population formed the strata. Balloting was done to sample a school per strata, (peri- urban, rural, slum and urban) areas. Ninety to one hundred pupils were randomly be chosen from each class three and each class four in each school list using a random number generator. An approximate 377 hundred pupils formed the study population.

3.7 Collection and examination of Stool Samples

This was done by use of modified Kato Katz technique using 41.7 mg templates and cellophane cover slips soaked for 24 hours in a malachite green solution (WHO, 1987). Each child was provided with a polypot labeled with a unique identifier code for collection of stool. Stool sample was passed through 250μm metal sieve to remove fibrous material. The stools were analyzed within 24hours after collection to avoid hatching of ova especially hookworm. Stool was analyzed using Kato-Katz technique (Appendix 2) (WHO, 1987). Fresh stool samples were examined for intestinal helminthes eggs (Appendix 3), and were preserved with 10% formalin until they were examined for protozoa because trophozoites become destroyed if kept for long and fail to get fixed unless preserved. Formol ether concentration method. Fresh saline smears were also used for examination and iodine solution for staining the cysts of protozoa (Ebrahim *et al.,* 1997). Stool samples were emulsified in formal water, the suspension was strained to remove large faecal particles, ether was added and mixed suspension was centrifuged. Cysts, eggs and larvae were fixed, sedimented, faecal debris separated in a layer between the ether and formalin solution and fat dissolved in the ether.

3.8 Determination of Growth Status

This was done by measuring weight, height and comparing with age of the pupil (WHO, 1986). Wasting, stunting, and manultrition were defined as z scores values less than -2 SD (Standard Deviation), which is below what is expected on the basis of the international growth reference scale (Dean *et al.,* 1994). This examination determined whether there were cases of malnutrition, stunted growth, wasting.

3.9 Determination of socio-economic, behavior and environmental indicator of transmission

Standard pretested structured questionnaires interview were used. The questionnaire checked on the exposure event as related to the child's behaviour and household environment, which were further influenced by cultural and economic circumstances of the community (Appendix 1).

3.9.1 Data Analysis

Collected data was entered using Excel spread sheet; later converted into SPSS for windows version 12.0 for analysis. The analysis methods used were Chi-square to analyse categories for proportions and prevalences; One way Anova for intensities of infection and mean body weights and heights between schools. Comparison of nutritional status of the children to the NCHS reference population was performed using Epi –Info Version 6 (Dean *et al.*, 1995).

CHAPTER FOUR: RESULTS

4.1 Demographic Characteristics of Study Population

4.1.1 Distribution of the Study Population by School/Study Area

A total of 377 pupils in the four public primary schools namely Athena (Peri-urban), Kathambara (Rural), Kianjau (Slum), and St. Patrick (Urban) were examined for Gastro-intestinal parasites (GIP) both helminthes and protozoa. The study population was taken from four schools representing four different enviroments. These were Athena (peri-urban) that had more children 108 (28.6%), Kathambara (rural) with 90 (23.9%) children, Kianjau (slum) with 92 (24.4%) and St Patrick (urban) with the lowest population of 87 (23.1%), (Table 4. 1).

Table 4.1 Distribution of the Study Population by School/Study Area

School/description	Number examined	Percentage (%)
Athena (Peri-urban)	108	28.6
Kathambara (Rural)	90	23.9
Kianjau (slum)	92	24.4
St. Patrick (Urban)	87	23.1
Total	**377**	**100**

4.1.2.1 Distribution of the study population age group by sex

Among the 377 pupils, 212 (56.2%) pupils were females while 165 (43.8%) were males. It was apparent that the females were enrolled more in 6-8 years and 9-11 years age groups than boys. The males were however more in 12-14 years age-group (Table 4. 2). These may be due to the trend that some girls drop out of school due to cases of pregnancy.

Table **4.2 Distribution of the Study Population Age Group by Sex**

	Frequency					
Age- group	**Male**	**%**	**Female**	**%**	**Total**	**%**
6-8years	7	31.8	15	68.9	22	5.8
9-11years	101	40.9	146	59.1	247	65.5
12-14 years	55	53.4	48	46.6	103	27.4
>=15	2	40	3	60	5	1.3
Total	165	43.8	212	56.2	377	100

4.1.2.2 Distribution of the Study Population Age Group

The age ranged between 7.25 and 16.58 years (7-17years) with a mean of 10.85 years, median of 10.5years and mode of 10.42 years. The age was normally distributed. The age of the study groups was categorized in 4 age groups as 6-8 years, 9-11 years, 12-14 years and above 15years to suit the distribution of infection of GIP, (Table 4. 3). Most of the pupils were in age group 9-11 years (65.5%) followed by group 12-14years (27.3%). Those that were in 6-8years were 22 and above 15 years of age were 5 (Table 4.3).

Table 4.3 Distribution of Study Population by Age

Age group	frequency N	Percentage frequency (%)
6-8 years	22	5.83
9-11 years	247	65.52
12-14years	103	27.32
≥15 years	5	1.33
Total	**377**	**100**

4.1.3 Anthropometric Characteristics of the study Population

The body weight ranged between 16 to 58 kilograms with a mean of 29.35% and standard deviation 7.12 for the whole population of 377 pupils. The population weight was normally distributed around the mean. The rural school had the highest mean body weight of pupils (32.06 kg) followed by urban with (30.44kg). Pupils from the slum school had mean body weight of 27.89kg while the peri –urban had a mean of 27.46kg (Table 4.4). The mean weight in kilograms of the four schools were significantly different (P<0.001; F=9.416, ANOVA). The mean body weight of children in peri –urban school was significantly different from those in urban school and rural schools. The mean body weight of children in rural schools was different from mean in peri-urban and slum but not in urban school, (Table 4.4).

Table 4. 4 Weight distribution by school in kilogram

School	N	Mean body weight for each school (kg)	Standard deviation
Athena (peri-urban)	108	27.46	6.85
Kathambara(rural)	90	32.06	7.07
Kianjau (slum)	92	27.89	7.49
St. Patrick (urban)	87	30.44	6.05

4.1.4 Height Distribution by School in Centimeters

The height of pupils ranged between 109-168cm with a mean height of 133.87cm and standard deviation of 9.26.The height was perfectly distributed around the means. The rural school had pupils with the highest mean height of 135.8cm followed by urban 134.99, 132.99 for peri-urban and the lowest height observed in slum with 131.99cm. The mean height of the children in the four schools were significantly different ($P<0.05$; $F=3.365$, ANOVA). The mean height of pupils in peri-urban school was not different from that of pupils of other schools. The mean height of pupils in the rural school was nearly significant compared to pupils of pupils in the slum school (Table 4.5).

Table 4.5 Height Distribution by School in Centimeters

School	N	Mean height	Standard deviation
Athena (peri-urban)	108	132.99	8.87
Kathambara(rural)	90	135.79	9.36
Kianjau (slum)	92	131.99	10.41
St. Patrick (urban)	87	134.99	7.85
Total population	377	133.94	9.123

4.2.1 Environmental and Socio-Demographic Factors of the study population

Most mothers had primary school and below level of education (56.7%) followed by post primary and secondary education (37.8% and 4.8 respectively). Only 0.6% and 4.8% of mothers with no education and post primary education respectively. About 0.6% of the mothers had no education. Fathers who had no education were 14.2%, secondary education (45.5%) and primary and below (33.1%). Only 7.2% of children's father had post secondary education, (Table 4.6). Mother education was significantly different in the school categories, ($\chi^2=162.287$; df=3; $p < 0.01$). The urban school had mothers' education in post primary and beyond while the peri- urban, rural and slum has majority of the children mothers reached below primary level, (Table 4. 6).

Majority of study subjects had father as the head of the household (80.8%) and 18.7% had single mothers (Table 4.6). The household head (whether mother or father) significantly differed in the school categories. There was higher percent of mother being the household head in rural school than in the urban, Peri-urban and slum schools areas, ($\chi^2=15.62$; df=3; $P<0.05$)). In the Peri urban school, 14 (14.6%) of the children had mother as the household head and 80 (83.3%) with father as the head of the house. In the rural school, 54 (67%) had father and 25 (31%) had mother as the head of the house. The slum school had 69 (83.1%) of the study subjects with father as the head of the house while 14 (16.9%) were children with mother as the head of the household. The urban school had most of the children from families with the father as the head of the house, 74 (88.1%) and only 10 (12%) with mother as the head of the household. The urban school had 74 (88.1%) and 10 (11.9%) of the children with father and mothers as the head of the household respectively.

Most mothers were in small businesses like green grocers, hawkers and second hand good dealers (38.5%) and 37.9% casual labourers, 12% were peasant farmers, 5.5% formally employed and 5.5% had at least an occupation. Fathers with no occupation were 1.2%, peasant farmers 7.3%, small business 20.6%, self employed 11.3%, and 7.8 with formal employment, and 36% casual labourers . Mother occupation significantly differed in the four study areas, ($\chi^2=198.8$; df=3; $P<0.001$). Peasant farming was common in the rural area (30.2%) followed by Peri-urban

(7.5%), urban (6%), and slum 1.2%) respectively. Self employment was highest in the urban area (65.5%), slum with 45.8%), peri-urban with (37.5%) and rural with (3. 8 %).

Table 4.6 **Socio-Demographic Factors of Study Population**

Socio-demographic characteristic	Frequency									
	Total N=377	%	P/Ur ban N=96	%	Rural N=80	%	Slum N=81	%	Urban N=84	%
Head /of household										
Mother	63	(18.7)	14	(14.6)	25	(31.3)	14.	(16.9)	10	(11.9)
Father	277	(80.8)	80	88.3)	54	(67.5)	69	(83.1)	74	(88.1)
Others	3	(0.8)	2	(2.1)	1	(1.3)	_		_	
Mother Education	Total N=312	%	P/Urban N=93	%	Rural N=71	%	Slum N=65	%	Urban N=83	%
No formal education	2	(0.6)	_	_		_	2	(3.1)	_	_
Primary /below	177	(56.7)	42	(45.2)	70	(88.6)	56	(86.2)	9	(7.2)
Post/primary/secondary	118	(37.8)	44	(47.3)	1	(1.4)	7	(10.8)	66	(79.5)
Post secondary	15	(4.8)	7	(7.7)	_	_	_	_	8	(9.6)
Father Education	Total N=332	%	P/Urban N=93	%	Rural N=71	%	Slum N=65	%	Urban N=83	%
No formal education	47	(14.2)	11	(11.7)	20	(26.3)	10	(12.7)	6	(7.2)
Primary/below	110	(33.1)	11	(11.7)	41	(53.9)	57	(72.2)	1	(1.2)
Postprimary/secondary	151	(45.5)	64	(68.1)	15	(19.7)	12	(15.2)	60	(72.3)
Post secondary	24	(7.2)	8	(8,5)	_		_		16	(19.3)

Most mother were casual labourers in the rural area (87.5%), followed by mothers from slum area (36%), peri urban at (20.8%) and urban at (12%) respectively. Among the four study areas, formal employment was highest in the urban (15.5%), peri-urban (5.2%), slum (1.2%) and none in the rural area, (Table 4.7). Father occupation differed in all school areas, (; $\chi^2=144.7$; df=3; $p<0.001$). While people in the rural area were mainly in farm labour (61.3%), people in the urban (48.8 %), peri-urban (32.3%), and slum (42.8 %) were involved in self employment, (Table 4.7).

Table 4.7 Socio-demographic and Parents Occupation

Socio-demographic characteristic	**Frequency**									
Mother/occupation	**Total**		**P/Urban**		**Rural**		**Slum**		**Urban**	
	N=343	**%**	**N=93**	**%**	**N=71**	**%**	**N=65**	**%**	**N=83**	**%**
No occupation	**19**	(5.5)	**6**	(6.3)	**1**	(1.3)	**12**	(14.5)	_	_
Peasant farmer	**41**	(12)	**6**	(7.5)	**29**	(30.2)	**1**	(1.2)	**5**	(6)
Small business	**132**	(38.5)	**36**	(37.5)	**3**	(3.8)	**38**	(45.8)	**55**	(65.5)
Self employed	**2**	(2)	_	_	_	_	**1**	(1.2)	**1**	(1.2)
Casual Labourer	**130**	(37.9)	**20**	(20.8)	**70**	(87.5)	**30**	(36.1)	**10**	(11.9)
Form-employment	**19**	(5.5)	**5**	(5.2)	_	_	**1**	(1.2)	**13**	(15.5)
Father occupation	**Total**		**P/Urban**		**Rural**		**Slum**		**Urban**	
	N=344	**%**	**N=96**	**%**	**N=80**	**%**	**N=85**	**%**	**N=84**	**%**
No occupation	**4**	(1.2)	_	_	**1**	(1.3)	**3**	(3.6)	_	_
Peasant farmer	**25**	(7.3)	**18**	(18.8)	**3**	(3.8)	**1**	(1.2)	**3**	(3.6)
Small business	**71**	(20.6)	**20**	(20.8)	**2**	(2.5)	**16**	(19)	**35**	(41.7)
Self employed	**39**	(11.3)	**11**	(11.5)	_	_	**21**	(23.8)	**6**	(7.1)
Labourer	**124**	(36)	**27**	(25.1)	**49**	(61.3)	**32**	(31.1)	**16**	(19)
Formal/employment	**27**	(7.8)	**8**	(8.3)	**2**	(2.5)	_	_	**17**	(2.2)
N/A	**54**	(15.7)	**12**	(12.5)	**23**	(28.8)	**12**	(14.3)	**7**	(8.3)

4.2.1.1 Behaviour Characteristics for the Study Population

Among the study subjects, 18.7% had no habit of wearing shoes when going to school, while 81.3% wore shoes when going to school. The behaviour of wearing shoes to school significantly differed in the four schools, (χ^2=36.89; df=3; p<0.001). Children who had the habit of wearing shoes to school from the rural area were only 59% as compared to 86.6% in slum, 85% in per-urban and 93% in urban. Wearing shoes to the farm was not a common behavior (39.6%) compared to those who did not (64.4%), however, this habit differed significantly among the four schools, (χ^2=9.03; df=3; p<0.05). Children from the rural school had the least percent of those who wear shoes to the farm (28%) as compared to 38% in peri-urban, 42% in urban and 51% in slum. Wearing shoes to the playfield was not significant in the study subjects, (χ^2=2.273; df=3; p=0.518). Most children did not wear shoes when in the playfield (69.5 %) as compared to those who did (30.5%).

Almost all the study subjects had a habit of eating raw foods(cassava, sweet potatoes and tubers) from the farms (93.3%) while only 6.7 % did not. This habit was however not significant among the school categories, (χ^2=0.977; df=3; p=0.807). Two hundred and sixty seven (78.4%) of the children regularly practiced hand washing before meals. This behaviour differed significantly among the four schools children, (χ^2= 10.555; df=3; p<0.05). The hand washing habit before meals was highest in peri- urban (86.5%), followed by urban (83.3%), rural (74%) and poorly performed in the slum school (69%). Two hundred and twenty four (65.5%) practiced hand washing after visiting toilets, however, 112 (32.7%) did not practise the same. The habit differed significantly among schools, (χ^2=35.702; df=3; P<0.001). This habit was common in peri-urban school children (78%), followed by urban children (75%), rural (67.5%) and poorly practiced by slum children with only 39%, (Table 4.8).

Table 4.8 Behaviour Characteristics of Study Population

Behaviour characteristic	Total		P/Ur ban		Rural		Slum		Urban	
	N	%	N	%	N	%	N	%	N	%
Wear shoes to school										
No	**64**	(18.7)	**14**	(14.6)	**33**	(41.3)	**11**	(13.3)	**64**	(7.1)
Yes	**279**	(81.3)	**82**	(85.4)	**47**	(58.8)	**72**	(86.7)	**78**	(92.7)
Wear shoes to farm										
No	**206**	(64.4)	**59**	(62.1)	**57**	(72.2)	**41**	(49.4)	**49**	(58.3)
Yes	**135**	(39.9)	**36**	(37.9)	**22**	(27.8)	**42**	(50.6)	**35**	(41.7)
Wear shoes to playfield										
No	**237**	(69.5)	**61**	(63.5)	**57**	(72.2)	**59**	(71.1)	**60**	(72.3)
Yes	**104**	(30.5)	**35**	(36.5)	**22**	(27.8)	**24**	(28.9)	**23**	(27.7)
Eat raw tubers/fruits										
No	**23**	(6.7)	**8**	(8.3)	**5**	(6.3)	**6**	(7.2)	**4**	(4.8)
Yes	**320**	(91.7)	**88**	(91.7)	**75**	(93.8)	**77**	(92.8)	**80**	(95.2)
Wash hands before meals										
No	**74**	(21.6)	**13**	(13.5)	**21**	(26.3)	**26**	(31.3)	**14**	(16.7)
Yes	**269**	(78.4)	**83**	(86.5)	**59**	(73.8)	**57**	(68.7)	**70**	(83.3)
Wash hands after toilets										
No	**112**	(32.7)	**21**	(27.8	**26**	((32.5)	**48**	(58.5)	**20**	(24.1)
Yes	**221**	(78.2)	**75**	(78.2)	**54**	(67.5)	**34**	(41.5)	**63**	(75.9)

4.2.1.2 Water source for the study population

Piped water supply was the major source 206 (65.2 %,) for domestic purposes, while 110 (34.8%) used water from wells. Forty one (13.5%) of the children came from households where spring water was used, 53 (17.4%) from rivers, and 3(0.01%) from ponds/ dams. However, majority of them 207 (68.1%) also used rain water for domestic purposes. The source of drinking water based on piped and well water was significantly different in the four areas, (χ^2=47.73; df=3; p<0.001). Piped water supply was common in the urban area (82%) followed by peri-urban and slum both with 61%, and lowest in the rural area at 34%. The alternative water sources were surface and rain water which differed significantly among the four school location, (χ^2=102.9; df=3; p<0.001). Other sources of drinking water in the peri-urban school were mainly rain water at 45%, and spring (18%). In the rural school area, other sources of water were rivers at 36%, rain water 30%, and spring at 21%. Both urban and slum had rain water as the alternative source of water at 86% and 82% respectively.

Two hundred and eight (60.6%) of the children came from families where they did not practise boiling drinking water, however, 135 (39.4%) did practice boiling of drinking water. This practice significantly differed across the four school locations, (χ^2=64.77; df=3; p<0.001). This was highly practiced more in the urban (69%), followed by peri-urban (49%). Boiling of drinking water was not a popular habit in rural (17.5%), and slum area (19%) (Table 4.9).

Table 4.9: **Water Sources of Study Population**

Water/ sanitation	Frequency									
Source of drinking water	**Total** N	(%)	**P/Ur ban** N	(%)	**Rural** N	(%)	**Slum** N	(%)	**Urban** N	(%)
Piped	**206**	(65.2)	**59**	(70.2)	**27**	(39.1)	**51**	(63)	**69**	(84.1)
Well	**110**	(34.8)	**25**	**(29.8)**	**42**	(60.9)	**30**	(37)	**13**	(15.9)
Other sources of water/surface										
Spring	**41**	(13.5)	**17**	(22.7)	**17**	(24.3)	**5**	(6.4)	**2**	(2.5)
River/stream	**53**	(17.4)	**12**	(16)	**29**	(41.4)	**5**	(6.4)	**7**	(8.6)
Pond/dam	**3**	(0.01)	**3**	(4)	-		-		-	
Rain water	**207**	(68.1)	**43**	(57.3)	**24**	(34.3)	**68**	(87.2)	**72**	(88.9)
Boiling of drinking water										
No	**208**	(60.6)	**49**	(51)	**66**	(82.5)	**67**	(80.7)	**26**	(31)
Yes	**135**	(39.4)	**47**	(49)	**16**	(17.5)	**16**	(19.3)	**58**	(69)

4.2.1.3 Toilet Characteristics of the Study Population

Two hundred and eighty eight (84%) of the pupils had households with pit latrines, 17 (5%) flush toilets and the remaining 38 (11.1%) occasionally defeacated in open fields. Type of toilet was significantly different in the four school locations, (χ^2=41.01; df=3; $p<0.001$). Pit latrines were the commonest toilet in all the study areas. In the urban school, 95% of children came from families with pit latrines, 93 % in the peri-urban, 77% in the slum and 68% in the rural school. About 27% of children in the rural and 13% in the slum did not have latrine facility and used open fields and bushes. Latrines in the study population had wood floor 174 (56.6%) while 135 (43.7%) concrete floor. The type of toilet slab differed significantly, (χ^2=110.5; df=1; $p<0.001$).

Concrete slab was common in the urban at 77%, Peri urban at 44%, rural 24%, and slum 11%. The wooden slab was the alternative slab, with slum having 74%, followed by peri-urban 54%, rural 51% and urban 23%. Toilet sharing was common among the households of the study subjects 290 (84.5%) while 53 (15.5%) did not share. Toilet sharing was significant in the four school locations, (χ^2=18.36; df=3; p<0.001). The urban area had the highest rate of toilet sharing (97%), followed by slum and peri urban (83%), slum (83%) and rural with the lowest rate (74%). One hundred and seventy one (58.4%) of the children came from households where toilet sharing was between 5-9 families, 85 (29%) shared ten and above families, and 37 (12.6%) less than five families. The number of families that had the habit of sharing toilets differed significantly among school locations, (χ^2=119.65; df=3; p<0.001).

In peri-urban 5-9 families shared toilets (73%), 69.5% in urban area, 55.5% in rural area and 31.4% in the slum area. Sharing of toilets by over 10 families was highly reported in the slum school (67%), followed by rural school (42%), peri-urban (11%) and 5% in urban school. Only 78 (22.8%) of children reported experiencing toilet overflow during rains while 264 (77.2%) did not. However, cases of toilet overflow differed significantly in the four localities, (χ^2=39.39; df=3; p<0.001). The toilet overflow was least common in the urban area at only 3.6% compared to 19%, 25% and 44% in the rural, peri-urban and slum schools respectively, (Table 4.10).

Table 4. 10: **Toilet Characteristics of Study Population Per School.**

Toilet **characteristics**	**Frequency**									
Toilet type	**Total**		**P/Ur ban**		**Rural**		**Slum**		**Urban**	
	N	**(%)**	**N**	**(%)**	**N**	**(%)**	**N**	**(%)**	**N**	**(%)**
None	**38**	(11.1)	**3**	(3.1)	**22**	(27.5)	**11**	(13.3)	**2**	(2.4)
Flush	**17**	(5.0)	**4**	(4.2)	**3**	(3.8)	**8**	(9.6)	**2**	(2.4)
Pit latrine	**288**	(84)	**89**	(92.7)	**55**	(68.8)	**64**	(77.1)	**80**	(95.2)
Toilet slab										
Wood floor	**174**	(56.3)	**52**	(55.3)	**41**	(68.3)	**62**	**(87.3)**	**19**	(22.6)
Concrete	**135**	(43.7)	**42**	(44.7)	**19**	(31.7)	**9**	**(12.7)**	**65**	(77.4)
Toilet sharing										
No	**53**	(15.5)	**16**	(16.7)	**21**	**(26.3)**	**14**	(16.9)	**2**	(2.4)
Yes	**290**	(84.5)	**80**	(83.3)	**59**	**(73.8)**	**69**	(83.1)	**82**	(97.6)
Number of families sharing toilets										
<5	**37**	(12.6)	**13**	(16)	**2**	(3.3)	**1**	(1.4)	**21**	(25.6)
5-9	**171**	(58.4)	**59**	(72.8)	**33**	(55.5)	**22**	(31.4)	**57**	(69.5)
≥10	**85**	(29)	**9**	(11.1)	**25**	(41.7)	**47**	**(67.1)**	**4**	(4.9)
Toilet Overflow										
No	**264**	(77.2)	**72**	(75)	**65**	(81.3)	**46**	(56.1)	**81**	(96.4)
Yes	**78**	(22.8)	**24**	(25)	**15**	(18.8)	**36**	(43.9)	**3**	**(3.6)**

4.2.2 Prevalence of Intestinal Parasitic Infections

Overall prevalence of helminthic infections was 38.9%, 48.9%, 48.9% and 31% for Peri-urban, rural, slum, and urban school respectively (Table 4.11). It was observed that rural and slum schools had equal prevalence of 48.9 %, followed by peri-urban with 38.9% and urban 31%.

Table 4. 11: Overall Prevalence of Parasitic Worm infections by schools

School	N	Number positive	Prevalence in %
Athena (peri-urban)	108	42	38.9
Kathambara(rural)	90	44	48.9
Kianjau (slum)	92	45	48.9
St. Patrick (urban)	87	27	31
Total population	**377**	**158**	**42**

4.2.3 Prevalence of Intestinal Protozoa Infections

Overall prevalence of protozoan infections was 46.3%, 38.9%, 34.8% and 28.7% for Peri- urban, rural, slum and urban school respectively (Table 4.12). The peri- urban school had the highest prevalence of 48.3%, and the urban school had the lowest of 28.7%.

Table 4.12: Prevalence of Gastro-intestinal Protozoa in the Four Schools

School	N	Number positive	Prevalence in %
Athena (peri-urban)	108	50	46.3
Kathambara(rural)	90	35	38.9
Kianjau (slum)	92	32	34.8
St. Patrick (urban)	87	25	28.7
Total population	**377**	**142**	**38**

4.2.4 Overall Prevalence of Helminithic Infections

There were six helminthes observed in the study group. The overall prevalence of *Ascaris lumbricoides* was 19.6% and 13.3% for hookworm, 6.1 % for *Trichiuris trichiura*; and 2.7% for *Schistosoma mansoni.* The prevalence of *Enterobius vermacularis* and *Hymnolepis nana* were 2.9% and 7.2 respectively, (Table 4.13).

Table 4.13: Overall Prevalence of Gastro-Intestinal Helminthes

Helminthes	**Number positive**	**N**	**Prevalence (%)**
A.lumbricoides	74	377	19.6
T.trichura	23	377	6.1
Hookworm	50	377	13.3
S.mansonii	10	377	2.7
E.vermacularis	11	377	2.9
H.nana	27	377	7.2

Ascaris lumbricoides infection was significantly different in children of the four schools, (χ^2=14.425, df=3; p<0.01). The highest prevalence rate was observed in slum school (Kianjau) (27.2 %), Kathambara (rural) 26.7%, St. Patrick 14.9%, and peri-urban 10.2%. Hookworm infection was significantly different in children of the four schools, (p<0.01, χ^2=15.268, df=3). The highest prevalence rate was observed in rural school (Kathambara) (20 %), peri-urban (Athena) 19.4 %), St. Patrick (Urban) 6.9%, and slum (Kianjau) 5.4%. *Enterobius vermacularis* infection was significantly different in children of the four schools, (χ^2=10.77; df=3; p<0.05). The helminthes with the highest prevalence rate in peri urban (Athena) school was hookworm (19.6%), *Ascaris lumbricoides* (10.2%), *Enterobius vermacularis* (7.4%), and *Schisotosoma* *mansoni* (0.9%). There was no presence of *Hymenolepis nana* in Athena school. Prevalence of hookworm was 20% and *Trichuris trichiura* had 4.4%. Both *Enterobius vermacularis* and *Hymenolepis nana* had 1.1%. The slum school (Kianjau) had highest prevalence of *Ascaris lumbricoides* 27.2%, *Hymenolepis nana* (17.4%). Hookworm and *Schistosoma mansoni* were 5.4%, while *Trichuris trichiura* was 1.1%. The urban school (St. Patrick) had *Ascaris lumbricoides* prevalence of 14.9% followed by hookworm (6.9%), *Trichuris trichiura* and *Hymnolepis nana* with 5.7% each, *Schistosoma mansoni* was (3.4%) while *Enterobius vermacularis* was (1.1%) (Table 4.14).

Table 4.14: **Prevalence of Helminthes Infection Per Schools**

	Helminthes infection					
School	***A.lumbricoides***	***Trichuris trichiura***	**Hookworm**	***S.mansoni***	***E.vermacularis***	***H.nana***
Athena (peri/urban						
No. examined	108	108	108	108	108	108
No.Positive	11	10	21	1	8	0
Prevalence in %	**10.2**	**9.3**	**19.4**	**0.9**	**7.4**	**0**
Kathambara(rural)						
No. examined	90	90	90	90	90	90
No.Positive	24	3	12	1	1	6
Prevalence in %	**26.7**	**4.4**	**20.0**	**1.1**	**1.1**	**6.7**
Kianjau (slum)						
No. examined	92	92	92	92	92	92
No. Positive	25	4	5	5	1	16
Prevalence in %	**27.2**	**4.3**	**5.4**	**5.4**	**1.1**	**17.4**
St. Patrick (urban)						
No. examined	87	87	87	87	87	87
No.Positive	13	5	6	3	1	5
Prevalence in %	**14.9**	**5.7**	**6.9**	**3.4**	**1.1**	**5.7**

4.2.5 Mixed Infections of Intestinal Worms

Among the study subjects, *Ascaris lumbricoides* and hookworm mixed infections formed the highest percent of 20.7%, hookworm and *Hymenolepis nana* (17.7%) , followed by 13.8% for *Ascaris lumbricoides* and *Schistosoma mansoni,* hookworm and *Trichuris trichiura,* and then same percent for *Ascaris lumbricoides* / hookworm / *Trichuris trichiura* and *Hymnolepis nana.* hookworm and *Trichuiris trichiura,* (Table 4.15).

Table 4.15: Mixed Infections of Intestinal Worms

Mixed infections of intestinal worms	**%**
Ascaris lumbricoides , hookworm	**20.7**
Hookworm ,*Hymenolepis nana*	**17.7**
Ascaris lumbricoides, Schistosoma mansoni hookworm *Trichuris trichiura*	**13.8**
Ascaris lumbricoides, hookworm , *Trichuiris trichiura ,Hymnolepis nana*	**13.8**
Ascaris lumbricoides, Trichuris trichiura	**10.3**

4.2.6 Overall Prevalence of Gastro-intestinal Protozoa in the Study Population by Species

The overall prevalence of intestinal protozoa was 37.8% (142/377). Protozoa observed in this study population were *Entamoeba histolytica* (14.6%*), Entamoeba coli* (18.8%), *Giardia lamblia* (6.9%) and the lowest *Iodamoeba bustchili* 5.8% (Table 4.16).

Table **4.16 Overall Prevalence of Gastro-intestinal Protozoa**

Protozoa	**Number positive**	**N**	**Prevalence in %**
E.histolytica	55	377	**14.6**
E.coli	61	377	**16.2**
G.lamblia	26	377	**6.9**
I.bustchili	22	377	**5.8**

4.2.7 Prevalence of Gastro-intestinal Protozoa by Schools

Entamoeba histolytica infection was significantly different between the school children of the study areas, (χ^2=18.652; df=3; $p<0.001$). It was highest in the rural school (Kathambara) (22.2%), slum (Kianjau) (19.6%), Peri urban (Athena) and urban (St.Patrick) school 14.8% and 1.1% respectively. There was no significance difference of *Entamoeba coli* infection between children of the four schools, (χ^2=4.691;df=3; p=0.196). However it was highest in peri urban school (24.1%), followed by rural (21.1%), urban and slum schools 16.1% and 13% respectively. *Giardia lamblia* infection was not significant between children of the four schools, (χ^2=0.661;df=3; p=0.882). Peri urban school (8.3%), followed by urban (6.9%), rural and slum schools had 6.7% and 5.4% respectively. *Iodamoeba bustchilii* infection though generally low, there was significant difference between children of four schools, (χ^2= 9.293; df=3; $p<0.05$). Peri urban school had (10.2%), urban (8.0%), rural and slum schools had 3.3% and 1.1% respectively (Table 4.17).

Table **4.17 Prevalence of Gastro-intestinal Protozoa by School**

	Protozoa infection			
Protozoa	***E. histolytica***	***Entamoeba coli***	***G. lamblia***	***I.bustchelii***
Athena (peri/urban)				
No. examined	108	108	108	108
No. Positive	16	26	9	11
Prevalence in %	**14.8**	**24.1**	**8.3**	**10.2**
Kathambara(rural)				
No. examined	90	90	90	90
No.Positive	20	19	6	3
Prevalence in %	**22.2**	**21.1**	**6.7**	**3.3**
Kianjau (slum)				
No. examined	92	92	92	92
No.Positive	18	12	5	1
Prevalence in %	**19.6**	**13**	**5.4**	**1.1**
St. Patrick (urban)				
No. examined	87	87	87	87
No.Positive	1	14	6	7
Prevalence in %	**1.1**	**16.1**	**6.9**	**8.0**

4.2.8 Intensity of Helminthes Infection

The intensity of *Ascaris_lumbricoides* infection between the four schools was significantly different, ($P<0.01$; F=4.22; ANOVA). The intensity was significantly different between rural and slum schools. The mean intensity in peri-urban and urban schools were not significantly different with the rest of schools. To normalize the data for analysis, all eggs per gram (EPG) were transformed to log 10 to give the geometric mean. The mean intensity of *Ascaris lumbricoides* were 2.72, 3.41, 2.49, 3.06, and for Peri-urban, rural, slum, and urban school respectively. The rural school children had the highest mean intensity. *Trichuris trichiura* had low prevalence and low intensity in the study subjects. The maximum intensity was 360 eggs/gram with majority of infection below 100 eggs/gram. The mean intensity of hookworm infection was 2.3, 2.3, 1.9 and 1.8 for peri-urban, urban, rural, slum, and urban school respectively.

4.3 Socio-Demographic and Enviromental Factors Influence for Intestinal Helminthic Infections

4.3.1 Relationship Between Environmental and Socio-Demographic Factors and Ascaris lumbricoides Infection

Socio–demographic characteristic of the study population included household head, both parents education and occupation. *Ascaris lumbricoides* infection was not significantly associated with social demographic factors in the all the four schools, p>0.05. Overall, the infection *Ascaris lumbricoides* was not significantly associated with habit of wearing shoes. In specific schools, all behavioural characteristics in the peri-urban were not associated with *Ascaris lumbricoides* infection ; wear shoes to school (χ^2=1.696; df=1; p=0.348), Wear shoes to playfield, (χ^2=0.181; df=1; p=0.726); Wear shoes to farm, (χ^2=1.563; df=1; p=0.279); Eat raw tubers/fruits, (χ^2=0.1; df=1; p=0.559), Wash hands before meals (χ^2= 0.639; df=1; p=0.351) ,Wash hands after toilet visits (χ^2= 0.0.673; df =1; p=0.679). In the slum school, children who fail to wear shoes to school (χ^2=6.767; df=1; p=0.015) and those fail to wash hand before meals (χ^2=13.674; df=1; p=0.001) were associated with *Ascaris lumbricoides* infection. This was unlike those children who practise wearing shoes to farm, (χ^2=1.609; df=1; p=0.205); Eat raw tubers/fruits, (χ^2=4.10; df=1; p=0.064), Wash hands after toilet visits (χ^2= 3.412; df =1; p=0.065). Overall, wearing shoes to the farm was not associated with *Ascaris lumbricoides* infection, (χ^2=1.255; df=1; p=0.263). Wearing of shoes to playfields was also not related to *Ascaris lumbricoides* infection, (χ^2=1.120; df=1; P=0.290). There was no significant relationship between *Ascaris lumbricoides* infection and eating of raw foods and tubers from the farms, χ^2=1.423; df=1; P=0.233).

Overall, failure to wash hands before meals contributed significantly to *Ascaris lumbricoides* infection, (χ^2=23.545; df=1; P<0.01). Children who did not wash hands before meals had nearly three times (41%) as much risk of *Ascaris lumbricoides* infection than those who did (15%). Those who did not have the habit of washing before meals and were infected were 35.7% against 11% those who wash hands and had infection. In the slum school, *Ascaris lumbricoides* infection was significantly associated with the habit of washing hands before meals, (χ^2=13.674; df=1; p<0.01). Children who did not practice washing hands before meals had 1.36 higher chances of *Ascaris lumbricoides* infection than those who wash hands. In urban school, *Ascaris lumbricoides* infection was significantly associated with the habit of washing hands before meals, (χ^2=5.26; df=1; p<0.05). Similarly, the overall prevalence of *Ascaris lumbricoides* infection was twice as high (30.4%) among children who did not wash hands (14.7%) after visiting toilets, (χ^2=14.47; df=1; P<0.01). For specific schools, in the rural school, only the habit of washing hands after toilets showed association with *Ascaris lumbricoides* infection, (χ^2=7.191; df=1; p<0.05). The percent of those who practiced washing hands after toilets and were infected was higher (68%), as compared to those who washed and were not infected (22%).

A higher prevalence of *Ascaris lumbricoides* infection was found in school children whose families used water from wells for drinking and domestic use (27. 3%) compared to those who used piped water (15%). This was statistically significant, (χ^2=9.611; df=1; P<0.01). Specifically, the rural school showed significant association between the use of piped or water from wells with *Ascaris lumbricoides* infection, (χ^2=8.902; df=1; p<0.05). Those who used treated piped water had infection of 15% while those using water from wells 31% were infected. In urban school, there was no significant relationship between *Ascaris lumbricoides* infection, and water sources, piped and well water, (χ^2=1.873; df=2; p=0.392), surface water, (χ^2=1.835; df=3; p=0.607), and boiling of drinking water, (χ^2=0.000; df=3; p=1). In slum school, there was no significant relationship between *Ascaris lumbricoides* infection, and water sources, piped and well water, (χ^2=4.43;df=2; p=0.111), surface water, (χ^2=4.538; df=3; p=0.209), and boiling of drinking water, (χ^2=2.924; df=1; p=0.130). The prevalence rate of *Ascaris lumbricoides* infection was not significantly related to other sources of water, (χ^2=P=0.254). Habit of boiling drinking water was significantly associated with *Ascaris lumbricoides* infection, (χ^2 =8.732; df=1; P<0.01). Those who did not practice boiling drinking water (25.5%) had double higher risk of infection than those who did not (12.6%).

Ascaris lumbricoides infection was significantly associated with the type of toilet, (χ^2=10.998; df=2; P<0.01). School children from families with no toilets had the highest risk of infection at

39.5% followed unexpectedly with those with flush toilets at 29.4% and pit latrine 17.4%. *Ascaris lumbricoides* infection was significantly associated with the type of toilet slab (wood floor and concrete slab), (χ^2=16.005; df=1; P<0.001). School children whose families had wood slab toilets (21.3%) had a higher risk of infection than those with concrete slab (13.3%). Sharing of toilets in situation of communal toilets had significant relationship with *Ascaris lumbricoides* infection, (χ^2=7.090; df=1; P<0.01). From the results, it is apparent that those who shared toilets had a higher risk of infection with *Ascaris lumbricoides* than those who did not share. The number of families sharing toilets had a significant association with *Ascaris lumbricoides* infection, (χ^2 =16.902; df=1; P<0.01). The higher the number of families sharing a toilet the higher the risk of infection (<5=8.1%, 5-9=14.6%, and ten and above=29.4%). There was no significant difference between *Ascaris lumbricoides*, and toilet overflow, (χ^2=0.796; df=1 P=0.332).

For specific schools, in slum school, there was no significant association between type of toilet, sharing of toilet facility, and toilet overflow and *Ascaris lumbricoides* infection (χ^2=5.40; df=3; p=0.145 and (χ^2=0.000; df=1; p=0.991) respectively. However, in the same school the type of toilet slab and toilet sharing were significantly associated with *Ascaris lumbricoides* infection, (χ^2=6.298, df=1; P<0.05); (χ^2=5.84, df=1; P<0.05) respectively. Both in the peri-urban and rural schools, there was no significant association between *Ascaris lumbricoides* infection and toilet slab and sharing, (p>0.05). The urban school did not show any significant relationship between *Ascaris lumbricoides* infection and all the toilet characteristics; type of toilet (χ^2=3.827, df=2; p=0.148), toilet slab (χ^2=2.205; df=1; p= 0.158), sharing of toilets (χ^2=0.375; df=1; p=1), and toilet overflow ($\chi^2=0.570$; df=1; p=1). This could be due to the fact that people in the urban may be receiving health education and practicing proper sanitation methods more than those in the slum area.

4.3.2 Relationship Between Environmental and Socio-Demographic Factor and Infection with *Trichuris trichiura*

Among the socio demographic characteristics of population, only the fathers' occupation that had a significant relationship with *Trichuris trichiura* infection, ($\chi^2=14.427$; df=4; $P<0.05$). For individual schools, there was no significant association between social demographic factors and *Trichuris trichiura* infection. Habit of wearing shoes to school, farm and playfields were not associated with *Trichuris trichiura* infection. Hand washing habits, sources of water, toilet type and other toilet characteristics, boiling of drinking water did not show any significant relationship with *Trichuris trichiura* infection.

4.3.3 Relationship Between Environmental and Socio-demographic Factors and Hookworm Infection.

Among the socio-demographics characteristics of the population, fathers' occupation was significantly associated with with hookworm infection in the children, ($\chi^2=7.64$; df=4; $p<0.05$;). Children whose fathers were peasant farmers had the highest infection risk of 28%, casual labourers (12.2%) and small business at 11.3%. Children whose fathers were self employed and formally employed had the lowest risk. All the other socio-demographics characteristics of population were not significantly associated with hookworm infection ($p>0.05$). The habit of wearing shoes to the farm was not associated with hookworm infection, ($p=0.069$). Habit of wearing shoes to school or to playfield, eating of raw food and tubers, washing hands before meals and after visiting toilets were not associated with hookworm infection.. Source of drinking water and boiling of drinking was not associated with hookworm infection. However, there was association with hookworm infection and surface water source; water from springs, rivers and streams had high risk of infection, ($\chi^2=9.704$; df=3; $p<0.05$). There was no association between hookworm infection and toilet characteristics.

Hookworm infection was not significantly associated with characteristics of the families where pupils came from, behaviour, water sources and toilet characteristics in peri-urban, rural and slum schools, ($p>0.05$). In the urban school, there was no significant association between hookworm infection and behaviour, water sources and, toilet characteristics. However, in socio-demographics characteristics, there was an association between father education and hookworm infection, ($p<0.001$; $\chi^2=17.937$, df=3). The higher the fathers' education (5%) the lower the infection (0%). For *Enterobius vermacularis* and *Hymnolepis nana* the overall prevalences were very low and thus not possible to do statistical analysis on the data.

4.4 Socio-Demographic Factor and Environmental Factors to Intestinal Protozoa infections

4.4.1 Relationship Between Environmental and Socio-Demographic Factors and *Entamoeba histolytica* Infections

Infection with *Entamoeba histolytica* was significantly associated with occupation of childs' mother, ($\chi^2=11.139$; df=3; $p<0.05$;). Children whose mothers were peasant farmers were proportionately more infected (24.4% and 20% respectively) than those whose mothers were formally employed and in small business (10.5% and 9.1% respectively). The habits of wearing shoes to school, farm, playfield, washing hands before meals and after visiting toilets were not associated with *Entamoeba histolytica* infection. Eating raw food and tubers was not associated with *Entamoeba histolytica*, p=0.06. Source of drinking water and surface water source were not significantly associated with *Entamoeba histolytica* infection. However, *Entamoeba histolytica* infection was associated with habit of boiling drinking water, (χ^2=6.289; df=1; p<0.05). Children whose families did not boil water had higher infection rate (18.8%) than those whose families boil water (8.9%). *Entamoeba histolytica* infections were not significantly associated with toilet characteristics.

For specific schools, there was no significant association between *Entamoeba histolytica* infections with socio-demographics characteristics, behaviour, water sources and toilet characteristics in slum and urban schools, p>0.05. In the rural school wearing shoes to school, to the farm, and playfields were not significantly associated with *Entamoeba histolytica* infections, (p>0.05). Washing hands before meals and after toilets were not significantly associated with *Entamoeba histolytica* infections, (p>0.05). However, eating of raw foods, tubers and fruits by, was significantly associated with *Entamoeba histolytica* infections, (χ^2=18.370; df=1; p<0.001;). Those who do not eat raw tubers and fruits from farms and infected were 28% as compared to 72% of those who eat and got infected. In the peri-urban school, wearing of shoes to school, and playfields; washing hands before meals and after toilets, were not significantly associated with *Entamoeba histolytica* infections, (p>0.05). However, wearing of shoes to the farm was associated with *Entamoeba histolytica* infections, (χ^2=4.57; df=1; p<0.05). Eighty seven (87%)

of those who did not wear shoes to the farm got infected as compared who wear and were infected 13%.

4.4.2 Relationship between environmental and socio-demographic factors and *Entamoeba coli* infections

Head of household, parents' education, and parents' occupation were not significantly associated with *Entamoeba coli* infections. In all the four schools, there was no relationship between socio-demographic factors and *Entamoeba coli* infections, $p>0.05$. The habits of wearing shoes to school, farm, playfield, washing hands before meals and after visiting were not significantly associated with *Entamoeba coli.* Among the behaviour characteristics, peri-urban, rural and urban schools, did have any association between wearing shoes to school, to the farm, and to the playfield; eating raw food and tubers, washing hands before meal and after toilets, with *Entamoeba coli* infections, ($p>0.05$). In the slum school, 73% of those who ate raw tubers while working on the farms were infected with *Entamoeba coli* against 27% who did not eat raw tubers and not infected, ($\chi^2=7.596$; df=1; $p<0.05$;). Similarly, in the slum school, there was significant association between washing hands after toilets with *Entamoeba coli* infections, ($\chi^2 =6.55$, df=1; $p<0.05$).

There was 54.5% of those who did not have habit of washing hands after toilets were infected while only 36% of those who washed hands got infected. Surface water source and boiling of drinking water did not have any association with *Entamoeba coli* infections. However, the source of drinking water for the family and *Entamoeba coli* infections were significantly associated, ($\chi^2 =11.878$; df=1; $p<0.01$). Children from families that did not have piped or well water were significantly infected at 40.7% followed by 17% by those with piped water, and 12.7% of well water. As per individual schools, there was no association between the source of drinking water for the family and *Entamoeba coli* infections, ($p>0.05$). Type of toilets used, whether flush, latrine or promiscus was not significantly associated with *Entamoeba coli* infections, ($p=0.059$). *Entamoeba coli* overall infections were not related to the other toilet characteristics. For specific schools, only in the slum school where the type of toilet was significantly associated with *Entamoeba coli* infections, ($\chi^2=6.631$; df=2; $p<0.05$). High *Entamoeba coli* infections were found in 36% of children without toilet facility as compared to 64% with pit latrines and not infected. In the peri-urban, rural and urban schools, there was no relationship between *Entamoeba coli* infections and the toilet characteristics, ($p>0.05$).

4.5 Nutrititional Characteristics of the Study population

4.5.1 Mid-upper-arm Circumference

The mid arm circumference ranged between 12-25cm with a mean of 17.63 and standard deviation 2.11. Children in the peri-urban school had the lowest mean of 16.84cm, followed by slum with 17.78 cm, rural 17.93cm and urban with 18.17cm . The means of mid-arm circumference of children in the four schools were significantly different ($P<0.001$; $F=8.174$, ANOVA). Pupils from peri urban school had mean that was significantly different from all the others three schools. The rural, slum and urban school children were only significantly different with those from peri urban school (Table 4.18).

Table 4.18 Mid-upper-arm circumference

School	N	Mid-Upper-Arm Circumference(cm)	Standard deviation
Athena (peri-urban)	108	16.84	1.80
Kathambara(rural)	90	17.93	1.98
Kianjau (slum)	92	17.78	2.27
St. Patrick (urban)	87	18.17	2.15
Total population	**377**	**Mean MUAC=17.68**	**Mean STD =2.05**

4.5.2 Anthropometric Characteristics of the Study Population

Stunting (Height – for –Age: HAZ) was the predominant parameter manifested 24.7% (93 out of 376), followed by malnutrition (Weight – for –Age: WAZ) 18.1% (68 out of 375), and wasting (Weight –for-Height: WHZ) 6.4% (24 out of 375) (Table 4.19).

Table 4.19 Anthropometric (Nutritional characteristics)

Anthropometric Measure	Z scores	Frequency	% Frequency
Stunting	< -2 z scores	93	24.7
Normal	> = -2 z scores	283	75.3
Wasting	< -2 z scores	24	6.4
Normal	> = -2 z scores	351	93.6
Malnutrition	< -2 z scores	68	18.1
Normal	>=-2 z scores	307	81.9

$$Z=\frac{\text{Weight of the subject-Weight from the reference data}}{\text{Weight from the reference data- 1SD of the reference weight}}$$

(Waterlow *et al*, 1977)

4.5.3 Anthropometric characteristics Per School

Stunting was significantly different in the four schools, ($\chi^2=9.41$; df=3; $p<0.05$). The slum school showed high prevalence of stunting with 30.4%, followed by peri urban with 28.7%, rural with 25.8% and urban with 12.6%. Wasting in children was significantly different across the study areas, ($\chi^2=19.47$; df=3; $p<0.001$). The peri urban school showed high prevalence of wasting with 14.8%, followed by slum with 5.5 %, urban with 2.3% and rural with 1.1% respectively. The rate of malnutrition was significantly different across the study areas, ($\chi^2=11.97$; df=3; $p<0.001$). Malnutrition was high in peri urban with 26.9 %, slum school (20.9%), rural with 13.5%, and urban with 9.2% (Figure 4.3).

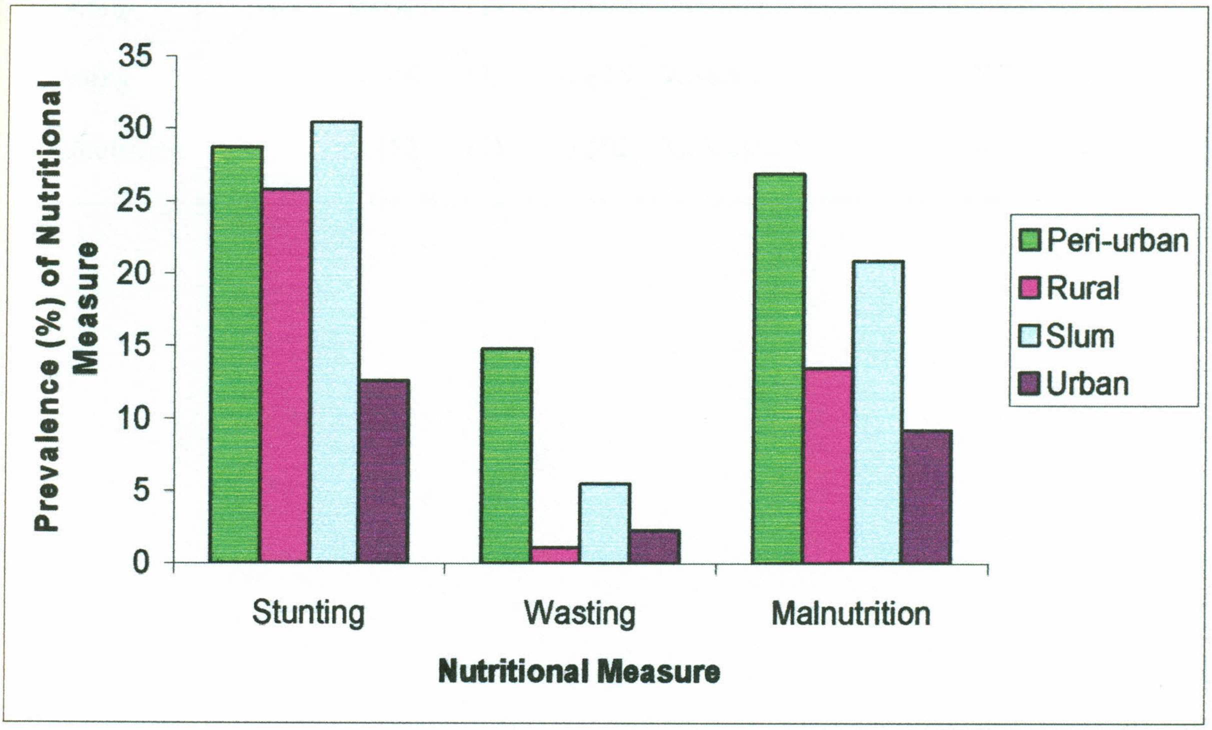

Fig 4.1 Anthropometric Characteristics Per school

4.5.4 Nutritional Characteristics and Intestinal Parasitic Infections

The relationship between anthropometric scores and intestinal helminthic infections were analysed by cross tabulation. The overall prevalence of intestinal helminthic infections was not significantly associated with stunting, wasting and malnutrition ($p>0.05$; Table 4. 20). Similarly, there was no association between the anthropometric scores and helminthes infections in the specific schools ($p >0.05$; Table 4. 21a, Table 4. 21b).

4.20 Nutritional Characteristics and Intestinal Parasitic Infections

Helminthes Infection				**Protozoa Infection**			
Nutritional status	**χ^2**	**(df)**	**P**	**Nutritional status**	**χ^2**	**(df)**	**P**
Stunting	0.000	(1)	0.982	Stunting	15.849	(1)	0.001
Wasting	0.226	(1)	0.635	Wasting	0.000	(1)	0.986
Malnutrition	0.452	(1)	0.502	Malnutrition	0.445	(1)	0.121

Table 4. 21a: Anthropometric characteristics on Overall Worm infections

School			**Helminthes infections**		
Peri/urban(Athena)	**Negative**	**(%)**	**Positive**	**(%)**	**P Value**
Stunting	10	32.3	21	67.7	**0.37 ns**
Normal	32	41.6	45	58.4	
Wasting	5	31.3	11	68.8	**0.497 ns**
Normal	37	40.2	55	59.8	
Malnutrition	10	34.5	19	65.5	**0.569 ns**
Normal	32	40.5	47	59.5	
Rural(Kathambara)					
Stunting	12	52.2	11	47.8	**0.495 ns**
Normal	29	43.9	37	56.1	
Wasting	0	0	1	100	**1.00 ns**
Normal	41	46.6	47	53.4	
Malnutrition	4	33.3	8	66.7	**0.341 ns**
Normal	37	48.1	40	51.9	

ns: Not significant

Table 4. 21b: Anthropometric characteristics on Overall Worm infections

School	Helminthes infections				
Slum (Kianjau)	**Negative**	**(%)**	**Positive**	**(%)**	**P Value**
Stunting	13	46.4	15	53.6	**0.733 ns**
Normal	32	50	32	50	
Wasting	3	60	2	40	**0.677 ns**
Normal	42	48.8	44	51.4	
Malnutrition	9	47.7	10	52.6	**0.923 ns**
Normal	35	48.6	37	51.4	
Urban(St .Patrick)					
Stunting	3	27.3	8	72.7	**1.00ns**
Normal	24	31.6	52	68.4	
Wasting	1	50	1	50	**0.527 ns**
Normal	26	30.6	59	30.6	
Malnutrition	3	37.5	5	37.5	**0.699 ns**
Normal	24	30.4	55	30.4	

ns: Not significant

4.5.5 Anthropometric Characteristics on Overall Protozoa Infections

The overall prevalence of intestinal protozoa infections was significantly associated with stunting, (χ^2=5.443, df=1; $p<0.001$). In specific schools, stunted children in peri-urban were significantly associated with protozoa infections (χ^2=9.4; d=3; $p<0.05$); (Table 4.22a) respectively. However, stunted children from the peri-urban, rural and urban schools did not show any association with protozoa infections (p>0.05; Table 4.22a, Table 4.22b). Wasting (χ^2=0.000; df=1; p=0.986) and malnutrition (χ^2=5.445; df=1; p=0.986) parameters were not significantly associated with protozoa infections (p>0.05; Table 4. 20).

Table 4. 22a Anthropometric Characteristics on Overall Protozoa Infections

	Protozoa infections					
Peri/urban (Athena)	**Negative**	**(%)**	**Positive**	**(%)**	**P value**	**χ^2**
Stunting	10	32.3	21	67.7	**0.05**	**9.4**
Normal	48	62.3	29	37.7		
Wasting	11	68.8	5	31.3	**0.191ns**	**1.710**
Normal	47	51.1	45	48.9		
Malnutrition	14	48.3	15	51.7	**0.493ns**	**0.191**
Normal	44	55.7	44	55.7		
Rural (Kathambara)						
Stunting	11	47.8	12	52.2	**0.109ns**	**0.493**
Normal	2	40	3	60		
Wasting	1	100	0	0	**1.00ns**	**2.565**
Normal	54	61.4	34	38.6		
Malnutrition	5	41.7	7	58.3	**0.200ns**	**0.625**
Normal	50	64.9	27	35.1		

Table 4. 22b Anthropometric Characteristics on Overall Protozoa Infections

			Protozoa infections			
Slum (Kianjau)	**Negative**	**(%)**	**Positive**	**(%)**	**P value**	**χ^2**
Stunting	17	60.7	11	39.3	**0.549ns**	**2.381**
Normal	43	67.2	21	32.8		
Wasting	2	40	3	60	**0.423ns**	**0.288**
Normal	58	67.4	28	32.6		
Malnutrition	11	57.9	8	42.1	**0.476ns**	**0.361**
Normal	48	66.7	24	33.3		
Urban(St .Patrick)						
Stunting	4	36.4	7	63.6	**0.011ns**	**1.584**
Normal	58	76.3	18	23.7		
Wasting	1	50	1	50	**0.495ns**	**0.5071**
Normal	61	71.8	24	28.2		
Malnutrition	4	50	4	50	**0.219ns**	**1.945**
Normal	58	73.4	21	26.6		

4.5.6 Growth Status and Intestinal Parasitic Infections

Stunting, wasting and malnutrition were not significantly associated with *Ascaris lumbricoides* and hookworm infections in the four schools. Among the protozoa, there was statistical significant association between *Iodamoeba bustchili* infection in the stunted children of peri-urban school, (χ^2 =13.648; df=1; $p<0.05$;). In the rural school, *Entamoeba coli* infections were significantly associated with stunted children than the normal, (χ^2 =5.841; df=1; $p<0.05$). All the other nutritional status were not associated with the rest of intestinal parasitic infections.

4.6 Gender and Intestinal Parasitic Infections

4.6.1 Gender and Intestinal Helminth Infections

There was no significant difference in helminthes infection between males and females (χ^2 =0.032; df=1; p=0.648) Table 4.23).

Table 4.23: Gender and Intestinal Helminth infections

		Helminthes		
Gender	**N**	**Number infected**	**Prevalence (%)**	**P value**
Male	165	70	42.4	0.648
Female	212	85	40.1	

4.6.2 Gender and Intestinal Protozoa Infections

There was no significant difference in protozoa infections between males and females (χ^2 =3.04; df=1; p=0.081); (Table 4. 24).

Table 4.24: Gender and Intestinal Protozoa Infections

	Protozoa			
Gender	**N**	**Number infected**	**%**	**P value**
Male	165	54	32.7	**3.04**
Female	212	88	41.5	

4.6.3 Age Groups and Intestinal Helminthic Infections

There was no significant differences across the age groups and helminthes infections in (χ^2 =3.482; df=1; p=0.323) (Table 4.25).

Table 4.25: Age Groups and Intestinal helminthic infections

Age groups	positive	N	Prevalence (%)	P value
6-8yrs	8	22	36.4	**0.323**
9-11yrs	102	247	41.3	
12-14yrs	41	103	39.8	
≥15yrs	4	5	80	

4.6.4 Age Groups and Intestinal protozoa infections

There was no significant association across the age groups and protozoa infections, (χ^2 =2.555; df=1; p=0.465; (Table 4. 26).

Table 4. 26: Age Groups and Intestinal Protozoa Infection

Age group	Positive	N	Prevalence (%)	p
6-8yrs	9	22	40.9	**0.465**
9-11yrs	86	247	34.8	
12-14yrs	45	103	43.7	

4.6.5 Intensity of Soil Transmitted Helminthes Infections Among the Study Subjects

The common infections were *Ascaris lumbricoides,* hookworm, *Trichuris trichiura and schistosoma mansoni.* Among the four helminthes, above 70% of_the infections were light intensity. *Ascaris lumbricoides* had 53 out of 73 positive cases (72.6%) in light intensty, 18 (24.7%) in moderate intensity, and 2 (2.7%) in heavy intensity. *Trichiuris trichiura* had 22 positive cases which were all (100%) in light intensity. There were no cases of infection both in moderate and heavy intensity. Majority of hookworm infections (95.4%) were in light intensity as compared by (2.3%) both for moderate and heavy intensity. *Schistosoma mansoni.* Positive cases were 10; Seven of them (70%) were in light intensity and 3 (30%) were in moderate intensity. There was no case recorded in heavy intensity. There was no significant difference between the four schools and the level of intensity of the four helminthes, (p>0.05, Table 4. 27).

Table 4. 27: Intensity of helminthes infection

Level of infection intensity (EPG)	**frequency**	**percentage**
A. lumbricoides	**N=73*)***	
Light (1-4999	53	72.6
Moderate (5000-49,999)	18	24.7
Heavy (>=50,000)	2	2.7
T.trichuris	N=22	
Light (1-1999)	22	100
Moderate (1000-9999)	0	0
Heavy (>=10,000)	0	0
Hookworm	**N=44**	
Light (1-1999)	42	95.5
Moderate (2000-3999)	1	2.3
S.mansoni	**N=10**	
Light (1-99)	7	70
Moderate (100-399)	3	30
Heavy (>=400)	0	0

Level of intensity set by WHO Threshold for light, moderate and heavy infection with *Ascaris lumbricoides, Trichuris trichiura,* Hookworm and Schistosomes (WHO, 1998)

Table 4. 28: Classification of intensity of helminthes as per WHO Guidelines (WHO, 1998)

	S.mansoni	**Hookworm**	***A.lumbricoides***	***T.trichiura***
Light (epg)	1-99	1-1999	1-4999	1-1999
Moderate (epg)	100-399	2000-3999	5000-49,999	1000-9999
Heavy (epg)	>=400	>=4000	>=50,000	>=10,000

CHAPTER FIVE: DISCUSSION

5.1 Demographics of the Study Population

The findings of this study show that females were more in the study group than the males. This could be because there are more enrolment of girls than boys but this usually reverses in the upper primary because of high dropout of girls. This is true for any normal population. Most pupils were in age group 9-11 years (65%) because they enroll in class one at the age of 6 years and the study group were all in class three and four. The mean body weight mean was highest in the rural school followed by urban school. As observed in other studies, majority of children in these two schools could have come from better-off households, with higher socioeconomic status (including purchasing power and schooling profiles than in peri-urban and slum children. (Shuval *et al*., 1981; Eve *et al.,* 1998*).*

5.2 Prevalence and Intensity of Gastro-intestinal Parasites

Overall gastro-intestinal parasitic infections had varied prevalences in the different schools. It was evident that, rural and slum school children had the highest prevalence of helminthes infections. This has been observed in other endemic communities, for examples Busia district in Kenya and south East Madagascar (Forrester *et al.,* 1998; Kightlinger *et al*., 1998; Brooker *et al.,* 2000; Muchiri *et al*., 2001). The study subjects from poor dwellings with lower sanitation and hygiene scores were at high risk of parasitic infections than better off groups (Hoque *et al.,* 1996*).*

The prevalence in the different schools was varied with the rural and slum school having the same worm prevalence (48.9%). The prevalence in this study of slum school was below that of a similar school in the city of Porto Viejo (Ecuador) which was 80% (Andrade *et al.,* 2001*).* The same prevalence found in the rural school was above 0.2 and 28.5%, the range reported for soil transmitted helminthes in Mwea, central Kenya (Kihara *et al.*, 2007). Overall worm prevalence in Peri-urban and urban were 38.9% and 31% respectively. These were above those observed in urban schools in Western part of Turkey (22.4%), (Pinar *et al.*, 2004). The differences in findings among the studies can be explained by variations in geographical, socio-economic conditions and cultural practices of the population under consideration.

Overall worm infection was not influenced by both age group and gender. These results are with those from a study conducted in the central part of Turkey (Topcu *et al.*, 1999). However, an epidemiological study from Madagascar found that girls had a significantly higher prevalence and intensity of ascariasis (Knightlinger *et al.*, 1995) while another study from Guatemala did not find any gender differences with respect to parasitoses (Anderson *et al.,* 1993). These results may indicate that gender may or may not play a role in parasitoses depending on the region and other environmental or behavioural factors.

In this study, overall prevalence of *Ascaris lumbricoides* was found to be dominant; hookworm, *Trichuris trichiura, Schistosoma mansoni,* followed in that order respectively. One generalization nearly made about *Ascaris lumbricoides* infection, is that it is associated with low socio-economic status. This had been clearly demonstrated in two Nairobi Primary schools. The prevalence in Mathare primary school, in a poor area of Nairobi was 82% twice as much the prevalence of 39% found in Bahati primary school, which is located in a prosperous area (Rijpstra, 1975). It was evident that in St. Patrick primary, which is in urban area, where better school is synonymous with better housing and sanitation, socio-economic status of the neighbourhood can result in a lower prevalence of *Ascaris lumbricoides*. However, in rural Machakos in southern central Kenya, two poor sublocations Katitu and Ulaani, the prevalence of *Ascaris lumbricoides* in 1-16 year old was only 3.6% (Kinyanjui, 1973). Thus, in rural communities, where prosperity is often determined mainly by rainfall, which may encourage transmission of *Ascaris lumbricoides* infection, socio-economic status may not necessarily be related to prevalence of the infection.

Hookworm infection was statistically different between schools ($p<0.01$). Peri-urban and rural school children showed higher prevalence than in slum and urban school children. This may be due to the few farming activities done in peri urban and rural areas that could have contributed to the transmission of hookworm eggs and larvae from soils. There are no farming activities both in the slum and urban areas hence low prevalence of hookworm infection in children from those areas. There was statistical difference of *Enterobius vermacularis* between schools. The infection was low though the peri urban school showed a slightly higher rate than the others. Enterobiasis infection is transmitted hand to mouth and person to person directly. The observed prevalence of *Enterobius vermacularis* could also be explained by the highly infectious nature of the parasites. Prevalence of *Hymenolepis nana* was statistically different among the school children in the four schools. In the present study *Hymenolepis nana* was found to be more common among slum children. This findings agree with studies done among school children in Brazil who defecate in open fields, (Quihui *et al*., 2004). It has been suggested *Hymenolepis nana* may cause epidemics in institutions for children, (Mirdha *et al*., 2002). *Hymenolepis nana* infection is therefore an important parasites for public health concern particularly in communities with high prevalence rates of parasites.

The high overall prevalence of protozoan infection (37.8%), substantially higher than that of helminthes for some species, was still probably underestimated because of predominance (80%) of formol-ether examinations unable to detect trophozoites. The results indicate that *Entamoeba coli* was the most common protozoa in the rural area and in peri-urban than in urban, and slum areas. This agrees with the study done in Turkey where *Entamoeba coli* infection was significantly high in rural area than in urban area, (Pinar *et al*., 2004). The rural and slum schools recorded high prevalences of *Entamoeba histolytica* infection than in peri-urban and urban schools. There was statistical difference of *Entamoeba histolytica* infection among school children of the four study areas. The high prevalence of this parasite was closely related to the poor sanitary conditions found in rural and slum areas, (Magambo *et al,* 1998). Prevalences of *Giardia lamblia* observed in children of the four study areas were not significantly different. Among the four schools the highest prevalence of *Giardia lamblia* was 8.3%. This was far below that was found in a village in Kiambu District with prevalence of 36% in the 0-4 age group (Chunge *et al*., 1992); this confirms a sharp decline in prevalence which is typical of endemic situations where age related immunity is presumed to occur (Knight, 1980; Moshadeque *et al*., 1983).

Iodamoeba bustchlii, a non-pathogenic protozoan parasite, occurred at low prevalence in the four schools (between 1.1% - 10.2%). However, Peri-urban and urban had a high prevalence of

Iodamoeba bustchlii unlike the rural and slum schools. A study carried in two primary schools south east of lake Langano, south of Addis Ababa, Ethiopia, reported no positive infection with *iodamoeba bustchlii.* Children from these two schools were living in conditions under similar poor environmental sanitation, low socio-economic status and with no adequate safe water supply like rural and slum children in this study. Thus presence of this non-pathogenic protozoan parasite is not dictated by the above stated factors (Mengistu *et al.,* 2004).

The mean eggs count per gram of faeces (EPG) was lower than the threshold set by WHO for heavy infections (WHO, 1998). However, there were few cases of heavy infections in *Ascaris lumbricoides* and hookworm. All the common helminthes, *Ascaris lumbricoides,* hookworm, *Trichuris trichiura, Schistosoma mansoni* appeared more in light intensity. *Ascaris lumbricoides,* hookworm, and *Trichuris trichiura,* level of intensity was similar to that found in children in Mwea , Central Kenya before treatment, (Kihara *et al,* 2007). In this study, there was no heavy infection in *Schistosoma mansoni* unlike in Mwea which recorded 559, 338, 257 cases before treatment for light, moderate and heavy intensity respectively. This is because *Schistosoma mansoni* is not endemic in the study area and the few positive cases may have been imported from elsewhere, where *Schistosoma mansoni is* endemic. The children experiencing heavy infections in this study group are at high risk of suffering from high degrees of morbidity (Ramdath *et al.*, 1995). The results found in current study may however have been underestimated because the samples were taken in the middle of the dry season when the transmission is low.

5.3 Mixed infections with intestinal worm

Multiple infections co-existed in the study subjects. *Ascaris lumbricoides* and hookworm mixed infections formed the highest percent of 20.7%, hookworm and *Hymenolepis nana* (17.7%), followed by 13.8% for *Ascaris lumbricoides* and *Schistosoma mansoni,* hookworm and *Trichuris trichiura,* and then same percent for *Ascaris lumbricoides*/ hookworm/ *Trichuris trichiura* and *Hymenolepis nana. Ascaris lumbricoides* and *Trichuris trichiura* had 10.3 %. This could be due to the fact that social or behavioural factors that lead to acquisition of one species infection increased the probability of infection with other species. Several investigations suggest that this may have far reaching effect on the health of such an individual as they may suffer from multiple morbidity associated with parasitic infection. (Booth *et al*., 1998; Brooker *et al*., 2000; Tchuem-Tchuente *et al.,* 2003*).* Such children are also known to have poorer academic scores compared with children with a single infection only (Kvalsvig *et al*., 1991). This may have an effect on the type of drug to be used in the control programme. Such a drug must be broad spectrum for soil transmitted helminthes (STH) and effective against all of them so as to reduce the burden of the disease associated with each of the parasites (Aswathi *et al.,* 2003; Muchiri *et al*., 2001; WHO, 1995).

5.4 Intestinal Parasitic Infections Influenced by Socio-Demographic and Environmental factors

The education level of all the parents of the children did not contribute significantly to difference in the levels of parasitic infections. This is an indicator that academic knowledge did not translate into lower worm burdens. The children of literate parents had worm burdens similar to the children of illiterate. The education and occupation of people indicate the socio economic aspect of population. *Ascaris lumbricoides, Entamoeba histolytica* and *Entamoeba coli* infection were not associated with socio-demorgraphic factors (P>0.05). This is contrary to popular believe that socio-economic status can be used as good predictor of intestinal helminthic infections (Henry *et al.*, 1998; Holland *et al.*, 1988*)*. In the specific schools, all the socio-demographic factors had no effect on the prevalence of *Ascaris lumbricoides* infection. However, the occupation of the father contributed significantly to the levels of infections associated with hookworms (p<0.05). Children whose fathers were peasant farmers had highest risk of infection. This could be because hookworm transmission is through penetration of larvae from the soils and children from such families get involved in farming activities.

Mothers' occupation was not associated with hookworm infection (p>0.05). This was similar to the results observed by Knightlinger *et al.,* (1998) that occupation is not a good indicator of intestinal helminthiasis. For specific localities, urban area showed low fathers' education contributing significantly to the level of hookworm infection. This could be explained by correlating the father's education with other variables. The father's education correlated negatively with hookworm suggesting that as education levels increased the level of hookworm infection decreased. This was as a result of several underlying factors. These included the fact that such an educated man married an educated wife, had few children in his household and had regular source of income. This is similar to the results observed by Kightlinger *et al,* (1998) that fathers' educational levels is a good indicator of intestinal helminthiasis.

Overall Infection with *Entamoeba histolytica* was significantly associated with the occupation of the childs' mother ($p < 0.05$) children whose mothers were peasant farmers and labourer were more infected. This could be explained by correlating mothers occupation with other variables. Mothers who are peasant farmers and labourer are those of low socio-economic status and with poor sanitary and environmental conditions. Epidemiological research done in Southen Malawi showed that social and economic situations of individuals are an important cause in the prevalence of intestinal parasites. In additions, poor sanitary and environmental conditions are known to be relevant in the propagations of the infectious agents, (Phirri *et al*, 2000). *Entamoeba histolytica* infection was not associated with socio- demographic, toilet characteristics, water and sanitation. The peri-urban school children behavior of not wearing shoes showed significant relationship with *Entamoeba histolytica* infection unlike in the other areas of the study ($p<0.05$). Those who did not wear shoes could be an indication of low hygiene standards of the family because *Entamoeba histolytica* transmission is through feacal-oral route that involves contaminated food and water. The habit of eating raw tubers from the farm was significantly associated with *Entamoeba histolytica* infection in the rural area ($p<0.001$). Slum and the urban school did not have any significant association with the behaviour characteristic did not have association with *Entamoeba histolytica* infection. *Entamoeba coli* was not associated with the socio-demographic, water and sanitation characteristics in the four localities. However, in behaviour characteristics, rural school children habit of eating raw tubers from farms and failure to wash hands after toilets contributed to *Entamoeba coli* infection. This may be because farming is more in rural area than in peri-urban, slum and urban and also due to poor level of hygiene practice. There was no significant association between *Entamoeba coli* and toilet characteristics in peri-urban, rural and urban school children ($p>0.05$). However, the slum school children showed significant association between *Entamoeba coli* infection and toilet characteristics ($p<0.05$). There was high infection in children with no toilet facilities than those who used toilets. The difference may be due to improper toilet facilities which require individuals to defecate in areas around their homes.

5.5 Intestinal Parasitic infections, Behaviour, Attitudes and Practices

It seems that the habit of regular wearing of shoes had a significant contribution to the low prevalence of hookworm infections. Education on disease transmission and wearing of shoes may contribute to the prevention and control of hookworm and parasites with similar modes of transmission. Hand washing was not a common practice even for most of the children. *Ascaris lumbricoides* infection was associated with failure to wash hands before meals and after visiting toilets. This contributed positively to the transmission levels.

In specific areas, children from slum recorded *Ascaris lumbricoides* infection associated with failure to wash hands before meals and after visiting toilets. This is similar to study done in Ethiopia (Girum Tadesse, 2005) where higher rate of helminthes was reported in children who did not wash hands before meals. Use of water from wells and other surface water led to higher infection of ascariasis than use of piped water; similar to school children in Ethiopia who had high prevalence. *Entamoeba coli* was significantly associated with source of drinking water. This can be transmitted by drinking infected water and environmental contaminants of the water supply. Water and sanitation characteristics were not associated with *Ascaris lumbricoides* infection in peri-urban, urban and slum areas. However, source of drinking water showed association with *Ascaris lumbricoides* infection in the rural children. Those who used water from the well had higher rate of infection than those with piped water. This may be due to the fact that piped water supplied in the peri-urban, slum and urban is from the Thika municipal council, treated and more safe for drinking.

Boiling of drinking water was associated with ascariasis infections. *Ascaris lumbricoides* and infections were associated with the type of toilet ($p<0.01$) and the type of toilet floor ($p<0.001$). Those without latrines had the highest risk of infection of the both parasites. Toilet slab (wood floor and concrete slab) and communal toilets contributed to *Ascaris lumbricoides* infection. In the slum school, wooden slab ($p<0.05$) and latrine sharing ($p<0.05$) were associated with higher *Ascaris lumbricoides* infection. Toilet characteristics from peri-urban, rural and urban areas did not show association with *Ascaris lumbricoides* infection ($p>0.05$). This conforms with study done in Brazil where children from poorer dwellings with lower sanitation and hygiene scores were at higher risk of infection than better of groups (Eve *et al.,* 1998). Wooden latrines in the slum area were poorly made and difficult to clean, fitting the description of Chandiwana *et al.* (1989) as focal points of disease transmission. *Trichuris trichiura* was the only parasites associated with toilet overflow. However, the other intestinal helminthes were not associated with the toilet characteristics. Defecation practices made little differences in the childrens' worm counts in the other helminthes detected. The latrine problem is reinforced by other African studies, where toilet and latrine use are not protective for individuals if the community at large is fecally contaminated (Feachem *et al*., 1983). The quality and use latrines might explain the findings where toilet characteristics were associated with intestinal helminthes.

5.6 Intestinal Parasitic Infections and Anthropometrics Characteristics

In agreement with study in Ethiopia (Asfaw *et al*., 2005), anthropometric scores were found to be independent of the overall rate of intestinal helminthic infections. However studies done in Mexican school children has shown a higher prevalence of overall helminthes infections in stunted children compared to those normally nourished (Quihui *et al.,* 2004). Degree of stunting malnutrition and wasting was high in children from slum and peri urban which could be because of they come from families where the children are not assured of a daily solid meal. This study has analyzed the relationship between anthropometric scores and parasitic infection. The overall prevalence rate of intestinal helminthes infections was not different among children with or without stunting, wasting and underweight. However, the overall prevalence of intestinal protozoa was associated with stunting.

There was an association between *Iodamoeba bustchlii, infections* and stunted children of peri urban school. This organism is a commensal and could be it interferes with absorption hence stunting manifestation may occur. Whereas, urban, and slum schools there was feeding programs, there was none in the peri-urban school. This could be explained by the fact that underweight represents a state of acute malnutrition that can be corrected by food while stunting is an index of chronic malnutrition. Lack of adequate nutrients caused by high intensity infection in a critical period can prevent the normal growth in pre pubertal and pubertal children. In the current study, the intensity of helminthes was low and could be that is why there was no impact on growth status of children. Another contributing factor to growth failure is adverse emotional and social environment existing in families which live in very miserable conditions (Stanhope, 1994).

Due to low number of positive cases, it was not possible to analyze the effect of other intestinal parasitic infections on the anthropometric scores of school children.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

Based on the results of this study, the following conclusions were drawn.

(a) Prevalence and intensity of Gastro-intestinal parasites.

(i) School children from rural and slum areas had equal prevalence of intestinal helminthes infections (48.9%)

(ii) The most prevalent parasites observed in the study were *Ascaris lumbricoides* (19.6%) and *Entamoeba histolytica*. (14.6%)

(iii) All intestinal helminthes were more confined in light intensity and only few cases were in moderate and heavy intensity.

(b) Environmental factors and practices influencing prevalence.

(i) Environmental factors and practices differed in their contribution of intestinal parasites transmission in the different localities of the study.

(ii) Washing hands before meals and after toilet visits, and use of latrines contributed to low prevalence of *Ascaris lumbricoides*.

(iiiucation level was not an indicator of infection in all the localities.

(c) Anthropometric parameters in school age children.

(i) Degree of stunting, malnutrition and wasting was high in children from the slum than the, rural, peri-urban and urban areas.

(ii) Gastro-intestinal helminthes infection did not affect the growth of the school children in the study population

6.2 Recommendations

Based on findings of this work, the following recommendations were made

(a) There is need to establish long term measures aimed at lowering the transmission of the intestinal parasitic infection using control measures including treatment of infected individuals, improvement on sanitation and provision of clean water. The impact of each measure would be maximized through a health education program directed to school children and to communities in general in order to reduce the worm burden.

(b) The behaviour of individual children should be studied further to explain the variation in levels of infections.

(c) There is need to determine the effects of intestinal parasites infections on health and academic well being of school children.

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APPENDIX 1: PUPILS QUESTIONNAIRE

This questionnaire is not an examination. Please tell us how really often you do it
Child's name ____________________________ School name ________________
Age ___________________ Sex Male_________________ Female_______________

1. Name of the household head

2. Do you wear shoes when going to school? Yes ( ) No ( )

3. Do you wear shoes when going to the farm? Yes ( ) No ( )

4. Do you wear shoes when playing in the field? Yes ( ) No ( )

5. Do you eat any raw food when working in the farm? Yes ( ) No ( )

If yes specify

Cassava	Yes	( )	No	( )	Carrots	Yes ( )	No	( )
Sweet Potato	Yes	( )	No	( )	Groundnuts	Yes ( )	No	( )
Fruits	Yes	( )	No	( )	sugar cane	Yes ( )	No	( )

Others (specify) ______________________

6. Do you wash hands before eating? Yes ( ) No ( )

7. Do you wash hands after visiting toilets? Yes ( ) No ( )

6. What is the main source of drinking water for members of your household?

Piped water

Piped into dwelling to a public tap	Yes	( )	No	( )
Water from open well	Yes	( )	No	( )
Open well in the compound	Yes	( )	No	( )
Covered well/ Borehole	Yes	( )	No	( )
Covered well in the compound/plot	Yes	( )	No	( )

Surface water

Spring	Yes	( )	No	( )
River/stream	Yes	( )	No	( )
Pond/lake	Yes	( )	No	( )
Dam	Yes	( )	No	( )
Rain water	Yes	( )	No	( )
Bottled water	Yes	( )	No	( )

7. Do you boil drinking water? Yes ( ) No ( )

8. What kind of toilet facility does your household have?
Flush toilets Yes ( ) No ( )
Traditional pit toilet Yes ( ) No ( )
Ventilated improved pit (VIP) Yes ( ) No ( )
No facility/Bush field Yes ( ) No ( )

If it is by use of toilet, observe the following
Type of floor

Wood covered with soil? Yes ( ) No ( )
Concrete slab? Yes ( ) No ( )
Wood Yes ( ) No ( )
9. Do you share this toilet with other households? Yes ( ) No ( )

10. How many other households use this toilet?
Less than 5 ( ) 5-9 ( ) 10 or more ( )

10.Does your toilet ever overflow with water during the rainy season? Yes ( ) No ( )

11. Do you have a child under 5 years in the household? Yes ( ) No ( )

12. How does the mother dispose child wastes?
Thrown outside dwelling Yes ( ) No ( )
Buried in the yard Yes ( ) No ( )
Rinsed away Yes ( ) No ( )
Not disposed of Yes ( ) No ( )

13. How regularly do you cut your nails short? ____________________________

14.What is the occupation of both parents?
Father___________ Mother___________

15. What is the highest level of education attained by parents?

Father		Mother	
No education	( )	No education	( )
Primary	( )	Primary	( )
Secondary	( )	Secondary	( )
Post secondary	( )	Post secondary	( )

16 What is the occupation of parents?
Mother__________________ Father_____________

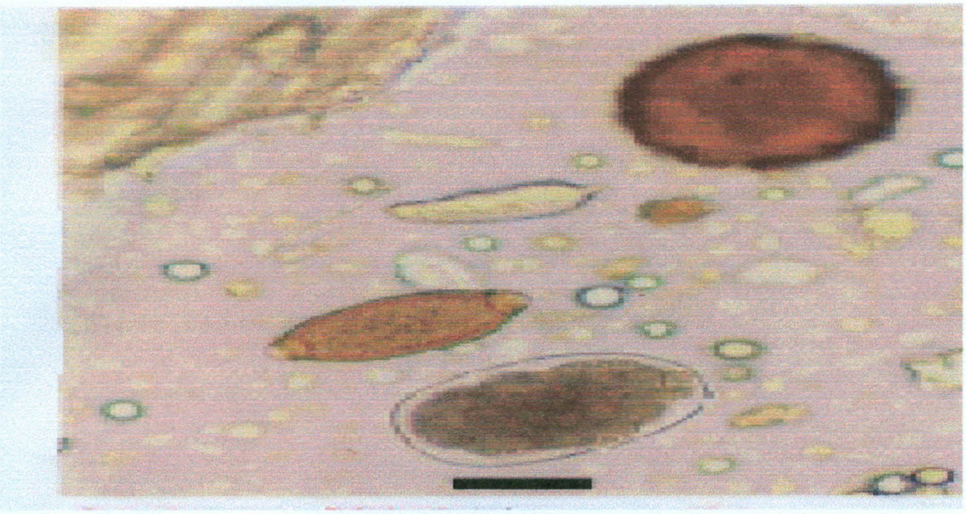
APPENDIX 2: KATO-KATZ TECHNIQUE

Kato thick smear technique

1. Coverslips made from cellophane strips (25x30mm, 40-50µm thick, wettable) were soaked in 50% Glycerine-Malachite green solution for at least 24hours before use. Remember to separate the cellophane strips before you put them into the solution.
2. A smooth faecal sample is needed. Therefore to remove fibrous material, a small amount of specimen is forced through a screen of metal or nylon mesh (mesh size 250 µm).
3. Place template on a microscope slide and using a wooden spatula, completely fill the well in the template with the strained faeces and level the material to the surface of the template.
4. Remove the template carefully; leaving all the faecal material on the slide and none is sticking to the template.
5. Cover the specimen on the slide with soaked cellophane cover slip. If an excess of material is present on the upper surface of cellophane, wipe off the excess with a small piece of absorbent paper.
6. Invert the slide against a smooth surface and spread the faecal specimen evenly under the cellophane by pressing it against the surface.
7. Observe the eggs of hookworm within the first two hours of preparation and observe the other soil transmitted helminth within 24 hours.

8. Leave the specimen in the dark at lest 24 hours before examining for eggs the specimen should be observed under 40-100x total magnification. To obtain the number of eggs per gram of the patient's faeces, the number of schistosome eggs counted in the so specimen is multiplied by 24.

APPENDIX 3: EGGS OF INTESTINAL HELMINTHES



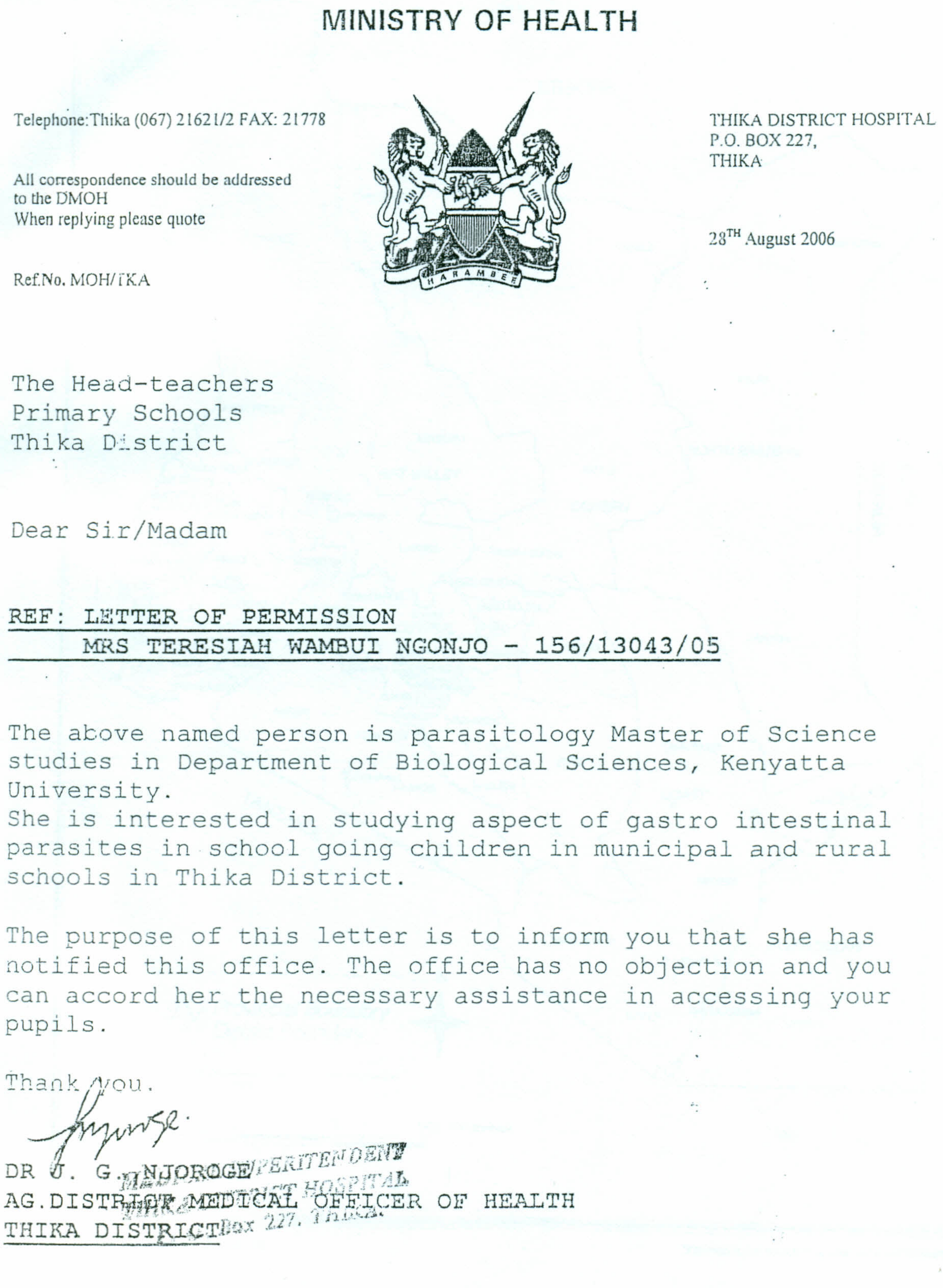
Ascaris (upper) *Trichuris* (middle) Hookworm (lower) in the same microscopic field

ookworm egg found in faeces.

B. Advanced cleavage stage of Hookworm egg.

C. Hookworm egg round and dividing ovum.

APPENDIX 4: MINISTRY OF WATER AND SANITATION CLEARANCE



MINISTRY OF HEALTH

Telephone:Thika (067) 21621/2 FAX: 21778

All correspondence should be addressed
to the DMOH
When replying please quote

Ref.No. MOH/TKA

THIKA DISTRICT HOSPITAL
P.O. BOX 227,
THIKA

28TH August 2006

The Head-teachers
Primary Schools
Thika District

Dear Sir/Madam

REF: LETTER OF PERMISSION
MRS TERESIAH WAMBUI NGONJO - 156/13043/05

The above named person is parasitology Master of Science studies in Department of Biological Sciences, Kenyatta University.
She is interested in studying aspect of gastro intestinal parasites in school going children in municipal and rural schools in Thika District.

The purpose of this letter is to inform you that she has notified this office. The office has no objection and you can accord her the necessary assistance in accessing your pupils.

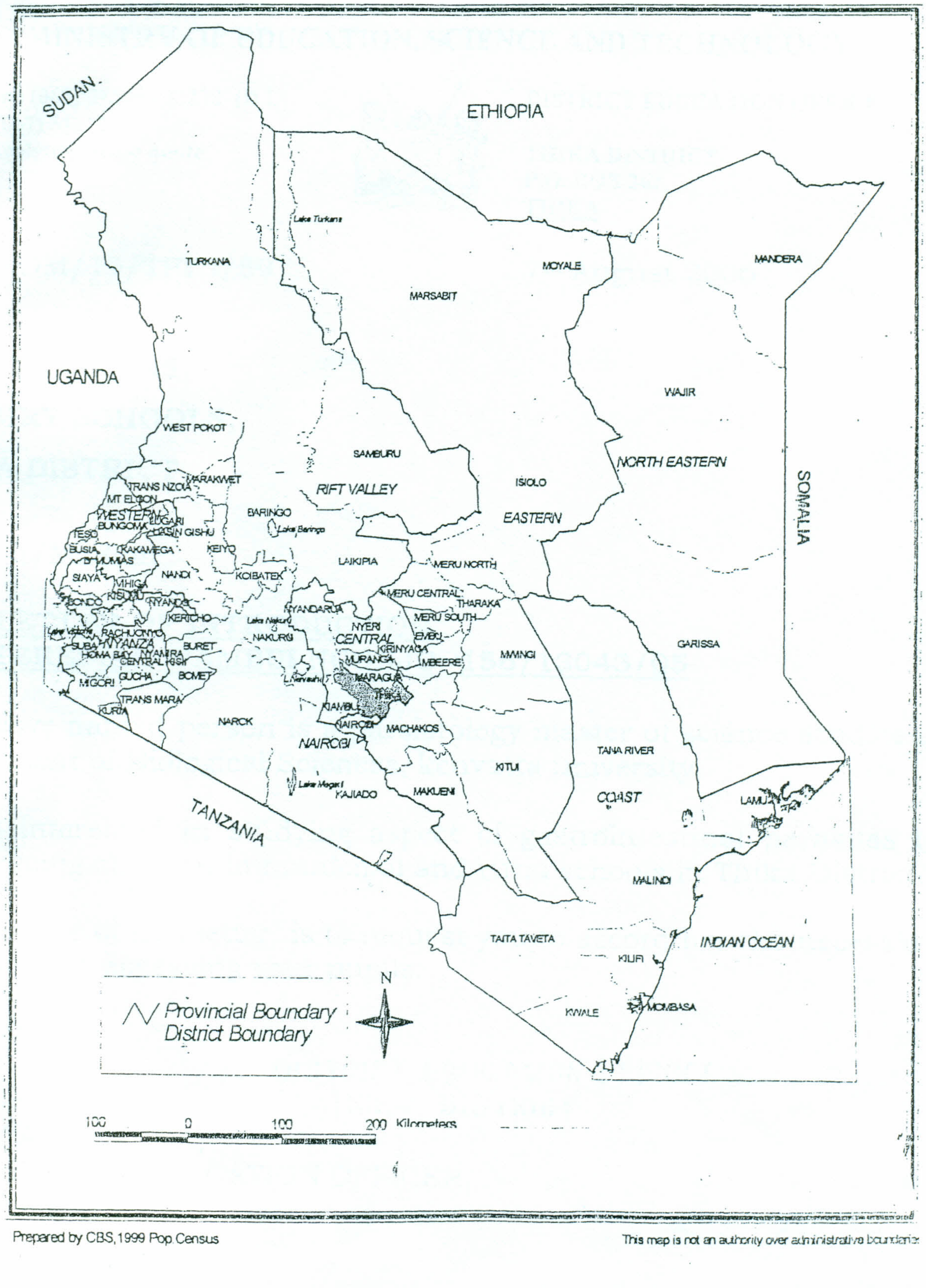
Thank you.

Njoroge

DR J. G. NJOROGE
AG.DISTRICT MEDICAL OFFICER OF HEALTH
THIKA DISTRICT

MEDICAL SUPERITENDENT
THIKA DISTRICT HOSPITAL
Box 227, Thika.

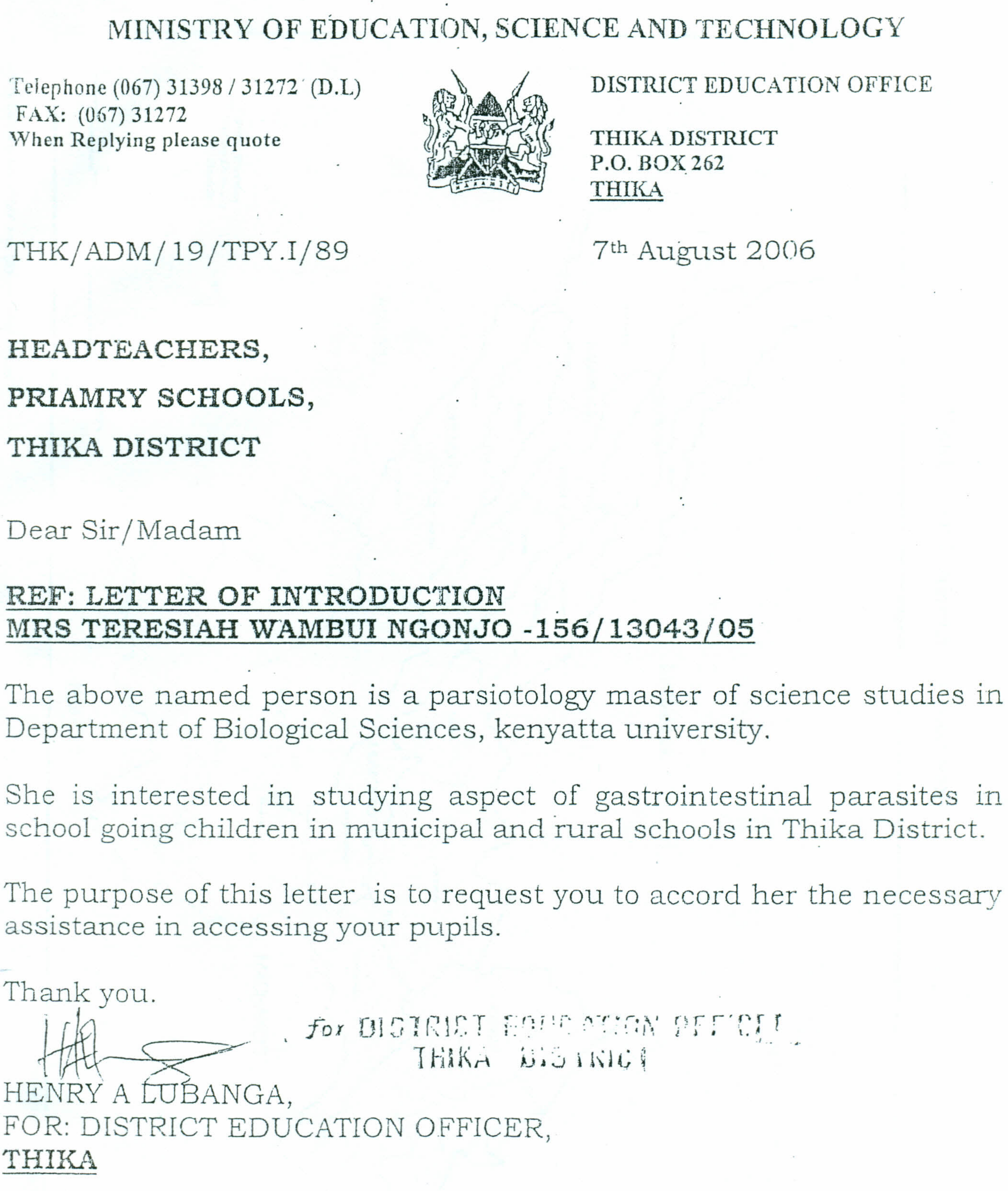
APPENDIX 6: LOCATION OF THIKA DISTRICT IN KENYA



Prepared by CBS,1999 Pop.Census

This map is not an authority over administrative boundaries

APPENDIX 5: LETTER OF INTRODUCTION TO SCHOOLS



MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

Telephone (067) 31398 / 31272 (D.L)
FAX: (067) 31272
When Replying please quote

DISTRICT EDUCATION OFFICE

THIKA DISTRICT
P.O. BOX 262
THIKA

THK/ADM/19/TPY.I/89

7th August 2006

HEADTEACHERS,

PRIAMRY SCHOOLS,

THIKA DISTRICT

Dear Sir/Madam

REF: LETTER OF INTRODUCTION
MRS TERESIAH WAMBUI NGONJO -156/13043/05

The above named person is a parsiotology master of science studies in Department of Biological Sciences, kenyatta university.

She is interested in studying aspect of gastrointestinal parasites in school going children in municipal and rural schools in Thika District.

The purpose of this letter is to request you to accord her the necessary assistance in accessing your pupils.

Thank you.

for DISTRICT EDUCATION OFFICER
THIKA DISTRICT

HENRY A LUBANGA,
FOR: DISTRICT EDUCATION OFFICER,
THIKA

APPENDIX 7: THIKA DISTRICT ADMINISTRATION BOUNDARIES

THIKA DISTRICT (Administrative Boundaries)

This map is not an authority over administrative boun

Prepared by Central Bureau of Statistics; 1999 Population Census