PREVALENCE OF SOIL-TRANSMITTED HELMINTHS INFECTIONS AMONG SCHOOL CHILDREN IN BONDO DISTRICT, NYANZA PROVINCE, KENYA 2007

Dan William O. Owiti

A Thesis Submitted In Partial Fulfillment For The Degree Of Master Of Science In Laboratory Management And Epidemiology In The Jomo Kenyatta University Of Agriculture And Technology

2008

Declaration

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

Signature………………………………… Date………………………….

Dan William O. Owiti

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

Signature………………………………… Date…………………………...

Dr. Joe Oundo, PhD

FELTP, Kenya

Signature………………………… Date………………………….

Dr. M. Kariuki Njenga., PhD

FELTP, Kenya

Signature……………………… Date………………………...

Dr. Helen Kutima, PhD

JKUAT, Kenya

Dedication

This thesis is dedicated to the memory of my late father, the late Pastor William Owiti Anditi who was my inspiration for the period he lived his full life on earth before being called by the Lord God as his servant. The late Pastor Owiti will be remembered for having overseen the construction and completion of the Voice of Salvation and Healing Church (VOSH) under the leadership of Reverend Silas Owiti. VOSH is situated in Ondiek estate in Kisumu City approximately 350 Km to the West of Nairobi City. VOSH now has thousands of Christian faithful followers.

Acknowledgements

First and foremost I would like to mention that the success of this research project, which finally culminated in the publishing of this thesis, is as a result of efforts and participation of many persons and institutions. It is, therefore, not possible to acknowledge every body. However, a few of such persons and institutions deserve my appreciation following the role they played during the study period.

I would like to extend my greatest appreciation to my supervisors Dr. Joe Oundo, Dr. Kariuki Njenga and Dr. Helen Kutima. I note with great pride that I benefited a great deal from their guidance, suggestions, criticism and corrections during the entire period of the study. Indeed they sacrificed their scarce valuable time out of their tight professional and personal schedules to come to my assistance whenever I needed it.

I am greatly indebted to the Ellis Foundation through the Centres for Disease Control and Prevention of the United States of America (USA) Government for financial sponsorship during the whole period of the study. I am also grateful to my employer, Ministry of Health (MOH) for having accepted to release me to undertake the training. I would also wish to thank the Ministry of Science and Technology (MOST) for having given authority for me to conduct this study. Similarly I am grateful to the Ministry of Education (MOE) officials right from the headquarters in Nairobi to the field in Bondo District where the study was carried out. I recognize with great appreciation their support and assistance in providing the necessary information and coordinating activities during the study period. I also wish to thank the local Provincial administration in Bondo District for their support.

This study was conducted among school children in twenty selected primary schools in Bondo District. I would like to thank all the children who participated in the study for without them this study would not have been possible. My special gratitude goes to all the teachers of the schools which participated in the study. At the Bondo District Hospital where the sample analysis was done, I would like to thank Mr. Tobias Osewe, Mr. Ben Otunge and Mr. Edward Nyagero who gave their technical expertise in the analysis of the stool samples. I would also like to thank the Medical Officer of Health (MOH), Bondo District for his support and having agreed to release his officers to accompany me to the field. I also sincerely thank Mr. Agak Kwanya, the Nyanza Provincial Division of Vector-Borne Disease (D.V.B.D) officer, for having released a vehicle from Kisumu to Bondo for the field work. Last but not least I am most grateful to Dr. Dunston Mukoko of D.V.B.D, Nairobi for having kindly edited this work.

I also wish to thank all my classmates with whom we shared our academic lives during the two years of study. Finally my very special thanks go to my dear wife Mrs. Martha Adhiambo Owiti who was always available to offer her moral support whenever needed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

CDC	Centres for Disease Control and Prevention
DVBD	Division of Vector-Borne Diseases
FELTP	Field Epidemiology and Laboratory Training Programme
MOE	Ministry of Education
MOH	Ministry of Health
MOST	Ministry of Science and Technology
SG	Specific Gravity
STHs	Soil-Transmitted Helminthes
STHIs	Soil-Transmitted Helminthes Infections
TDS	Trichuris Dysentery Syndrome
USA	United States of America
VOSH	Voice of Salvation and Healing Church
WHO	World Health Organization

Abstract

A study to determine the prevalence of soil-transmitted helminth (STH) was conducted among 418 school children in 20 primary schools in five divisions (Maranda, Madiany, Rarieda, Nyang'oma and Usigu) of Bondo district, Nyanza Province, Kenya. In a cross-sectional survey stool samples were obtained from children aged 5-15 years and examined for the presence of eggs of helminthes, from September to November 2007. The stool samples were examined using the direct method and Formol-Ether concentration. The overall prevalence of STH in the district was found to be 18.4%. *Ascaris lumbricoides* had the highest prevalence at 8.6% followed by Hookworms 5.7%, *Trichuris trichuria* 3.7% and *Strongyloides stercoralis* 0.2% respectively. The study revealed that Maranda division had the highest prevalence of the helminthes infections. The high prevalence of worm infection in Maranda seems to be associated with the division's dependency on water pan as a source of water for domestic use. Children belonging to the age group of 5-7 years were more infected with STHIs than those of older age groups. It is recommends that further study be done to find out why dependency on water pan as a source of water for domestic use is a risk factor in Maranda.

CHAPTER ONE

1.0 Introduction

1.1 Background to study

Soil-transmitted helminthes infections (STH) estimated to affect approximately 1 billion persons are among the most common and widespread infections (Stephenson, 2002). Intestinal helminths are particularly widespread within the tropical and sub-tropical regions of the world. Africa alone was estimated to have 132 million cases of hookworm by 1991 (Pawlowski *et al,* 1991), but the cases are now estimated to be over 200 million (WHO, 2002). In terms of morbidity and mortality, intestinal worms are among the top 17 infections (Walsh and Warren, 1979).The contribution of intestinal worm infections to mortality and morbidity however are probably underestimated because of under-reporting (Cooper *et al,* 1986). More recent global studies estimate the overall prevalence and distribution of soil-transmitted helminth at 2 billion people, 350 million of the infections associated with *Ascaris lumbricoides* morbidity, 220 million with *Trichuris trichuria* and 150 million with hookworm morbidity (WHO, 2002).

Global estimates suggest that STHs and schistosomosis are among the most common infections in the world. According to recent estimates by the World Health Organization (WHO) *Ascaris lumbricoides* infect approximately 1.45 billion persons, hookworms (*Necator americanus and Ancylostoma duodenale*) 1.3 billion persons and *trichuria* over 1 million people (WHO, 2002). The annual mortality is estimated to be 60,000 due to *Ascaris lumbricoides,* and 10,000 due to hookworms and *Trichuris trichuria* respectively (WHO, 2002). The three major species of schistosomes in man infect 200-270 million persons (Crompton and Nesheim 1982; Doumenge and Mott 1984; WHO, 1998). This includes 78 million infections with *Schistosoma haematobium*, 57 million *Schistosoma mansoni* and 69 million *S. japonicum*. Worldwide up to 600 million people are at risk of infection with schistosomosis (WHO, 1998). Current estimates of total number of individuals with morbidity due to *Schistosoma mansoni* in sub-Saharan Africa is 393 million at risk and 54 million infected (WHO, 1999). In 1998 WHO estimated that schistosomosis and soil-transmitted helminthes were responsible for more than 40% of burden of disease due to tropical diseases (WHO, 1999). Not only are the absolute numbers of persons infected with the helminthes staggering but the prevalence of these infections is also high compared to other infectious diseases in the developing world (Pawlowski, 1984).

Intestinal helminthes infections are known to cause protein energy malnutrition and iron deficiency anaemia, which globally affect 2.15 billion people of whom 51%, are pregnant women in sub-Saharan Africa alone over 206 million people suffer from anaemia with 52% of those infected being pregnant women (WHO, 2002)

Among children aged 5 years and below, intestinal helminthes infections cause malnutrition and anaemia which are the two major causes of mortality (Wamae *et al*, 1998). These infections also cause growth retardation in children and other physical and mental health problems. These infections are problems despite the fact that they are relatively easy to control. Evidence suggests that treating school children increases their height and weight, improves iron stores and reduces iron-deficiency anaemia (Sackey *et al*, 2003; Easton, A, 1999; Oberhelman *et al*, 1998).

The impact of these parasites on public health has been grossly under estimated, partly because although they cause considerable morbidity, mortality is very low (WHO, 1990). The latest figures show the annual mortality for *Ascaris lumbricoides* as 60,000 people, for *Trichuris trichuria* as 10,000 people and for hookworms as 65,000 people (WHO, 1998c, WHO, 2002). In Kenya, a review of stools examined at Kenyatta National Hospital (Chunge *et al*., 1985) between 1972 and 1976 showed the following important parasites in terms of prevalence: Hookworms (9.7%), *Ascaris lumbricoides* (4.7%), *Trichuris trichuria* (4.3%) and *Strongyloides stercoralis* (0.3%). But specific studies that have focused on the epidemiology of helminthes have been carried out in Nyanza and Coast Provinces (Hall *et al,* 1999). In western Kenya, studies have shown that hookworm is the most common helminth, followed by *Trichuris trichuria and Ascaris lumbricoides* (Kinoti 1997; Brooker *et al.* 1971; Pamba 1980; Chunge *et al.* 1985; Geissler *et al.* 1997; Brooker *et al*, 2000).

To control these parasites together with other intestinal ones, the WHO, has developed guidelines which suggest consideration of three coordinated actions: improved sanitation, chemotherapy and health education (Curtale *et al*; 1998).

Generally the high prevalence of intestinal parasites in any population is related to parasitic contamination of soil and water sources in related to deficient sanitary and specific socio-cultural conditions (Gamboa *et al,* 2003). The implementation of programmes on health education, personal hygiene, communal sanitation and eventual treatment of infected people would thus largely contribute to the control of this health problem (Celiksoz, *et al*, 2005).

1.2 Justification

Although studies on prevalence of intestinal helmithes infections have been conducted in Bondo District in the recent past, none has focused on evaluating the epidemiological profile. The magnitude of STHI's as a problem among school children of age group 5-15 years in this district has not been documented, yet this is the most vulnerable group. This study was, therefore, meant to elucidate the possible association of STHI's with demographic, socio-economic and other risk factors among residents in this community. The results and subsequent recommendations will be applied in an attempt to improve the public health of the people of Bondo.

1.3 Hypothesis

1.3.1 Null Hypothesis

The prevalence of soil-transmitted helminthes infections among school children in Bondo district is not higher than 21%.

1.3.2 Alternate Hypothesis

The prevalence of soil-transmitted helminths infections among School children in Bondo district is higher than 21%.

1.4 Objectives

1.4.1 General objective

To determine the prevalence, socio-demographic factors and risk factors associated with intestinal soil-transmitted helminth infections among school children in a rural community in Kenya, 2007

1.4.2 Specific objectives

1.4.2.1 To determine the prevalence of STHIs among school children by age, sex and administrative divisions in Bondo District, Kenya.

1.4.2.2 To determine the socio-demographic factors associated with transmission of STHIs among school children in Bondo District, Kenya.

1.4.2.3 To determine the risk factors associated with transmission of STHIs among school children in Bondo District, Kenya.

Chapter Two

2.0 Literature review

2.1 Classification and general characteristics of intestinal soil- transmitted helminthes (STHs)

Ascaris lumbricoides, Strongyloides stercoralis, Hookworms (*Ancylostoma duodenale and Necator americanus*), *Enterobius vermicularis and Trichuris trichuria* belong to the animal kingdom, phylum Nematohelminthes and class Nematoda. They are dioecious, posses a smooth body cuticle and the posterior end of all males are curved. They are all elongated, unsegmented and have no appendages. These nematode parasites have a complete digestive system, a very rudimentary nervous system and excretory system. They have a body cavity in which a reproductive system is suspended (Muller, 1975).

The fertilized eggs of Ascaris are yellow brown and the shell is covered by an uneven albuminous coat. They are oval or round in shape and measure 60x40µm. They contain a central granular mass which is the unsegmented ovum. The unfertilized eggs are darker in colour and have a more granular albuminous granular covering than fertilized eggs. They are more elongated than fertilized eggs measuring a bout 90x45 µm.

The eggs of hookworms ((*Ancylostoma duodenale and Necator americanus*) are similar in morphology. They are colourless with a thin shell which appears as a black line around the ovum. They are oval in shape, measuring a bout 65 x 40 µm. The eggs contain an ovum which appears unsegmented. In faeces more than 12 hours old, larvae may be seen inside the egg.

Trichuris eggs are yellow brown in colour and measures a bout 50 x 25 µm. They have a characteristics barrel shape with a colourless protruding mucoid plug at each end. They contain a central granular mass which is the unsegmented ovum.

Strongyloides stercoralis are actively motile except in formal preparations when they mobilized larvae can be identified by their forms. They are large, measuring 200-300 µm x 15 µm and are unsheathed. They can be distinguished from hookworm larvae by their shorter buccal cavity.

The eggs of *Enterobius vermicularis* are colourless and have a clear shell. They are oval in shape and usually flattened on one side. They measure a bout 55 x 30 µm. The eggs contain larva.

2.2 *Ascaris lumbricoides* (Roundworms)

2.2.1 Geographical distribution

It is estimated that more than 1.5 billion people are infected with STHIs worldwide (WHO, 1993) of which *Ascaris lumbricoides* is the most common and important. This helminth is cosmopolitan and its distribution is largely determined by local habits in the disposal of feaces because its eggs reach the soil in human feaces and so contaminate the environment (Crompton, Neishein and Pawlowski, 1989, Crompton and Pawlowski, 1985)

2.2.2 Life cycle and mode of transmission

Ascaris lumbricoides is the largest of the common nematodes that infest humans. Its life is relatively simple and involves the egg, four larval stages and, immature worms and adult worms of both sexes. The adult worm lives in the small intestine (Muller, 2002). The female adult worms measure 20-35cm in length and about 3-6mm in diameter, while the males are smaller and measure 15-31cm in length and 2-4mm in diameter (Beaver *et al*, 1984). Female worms produce eggs which are excreted in the faeces of the host. One female *Ascaris lumbricoides* can discharge an average of 200,000 to 240,000 eggs per day with the range being 134,000 to 360,000 (Cram, 1926). However, only two eggs per female worm are needed to infect man and develop into adult male and fertile female worms in order for the proportion of *Ascaris lumbricoides* in a given population to remain reasonably stable (Croll *et al*, 1982).

Humans contract *Ascaris* by ingestion of embryonated eggs. This commonly occurs through faecal contamination of food, water or other beverages, eating utensils or fingers. Cooked food is usually safe but can become contaminated after cooking. Consumption of soil by pregnant women, young children and others may lead to infection.

The eggs are passed in faeces in a un-embryonated state. In the presence of sufficient oxygen, moisture and warmth, the larva develops inside each egg in about two to three weeks and becomes infective one week later. The eggs are broad and ovoid and measure 45-70 x 35-50µm; they have a tough protein coat and prior to embryonation, are extremely resistant to drying or to destruction by various chemicals. They have been known to remain in soil for up to six years in Germany and 14 years in Russia (Mueller, 1953). However the majority of them are thought to be destroyed after passage in faeces in the environment. Eggs are deposited on heavy clay soils in moist, shady location with temperatures of 22ºC to 32ºC typical of tropical climates; develop rapidly into infective-stage larvae (Beaver *et al*, 1984).

Development is much slower at low temperatures and can take up to 45 to 55 days at 16 -18ºC (Pawloski and Arfa, 1984b). Prolonged exposure to ultra violet rays from sunlight kills *Ascaris* eggs (Fitzgerald and Ashley, 1977). *Ascaris* eggs are coated with a mucopolysaccharide protein that renders them adhesive to a wide variety of environmental surfaces; this feature accounts for their adhesiveness to everything from door handlers, dust, fruits and vegetables, paper money and coins (Crompton, 1989; Kagei; 1983). This could partly explain why Maranda Division, which is a peri-urban setting, had the highest prevalence of *Ascaris* infection.

Embryonated eggs ingested by the host hatch in the small intestine and liberate larvae which burrow through the mucosa and are carried to the liver via the enterohepatic circulation. The larvae develop further and roam about in the liver for about 5 days, then proceed via the blood vessel to the right side of the heart and on to the lungs. They continue to grow into the lungs for 9-15 days, finally break up into the alveoli, pass up the trachea, and are either swallowed or sometimes spat out by the host.

The swallowed larvae are apparently not affected by the gastric juice in the stomach and most survive to reach the small intestine where they grow to become juvenile and then to mature adult worms of both sexes which mate to produce fertilized eggs. Many of the larvae are lost in inappropriate tissues and do not survive to become adult worms. The entire cycle from the ingestion of eggs to production of fertilized eggs by mature *Ascaris lumbricoides* take two to three months (Cooper, 1986).

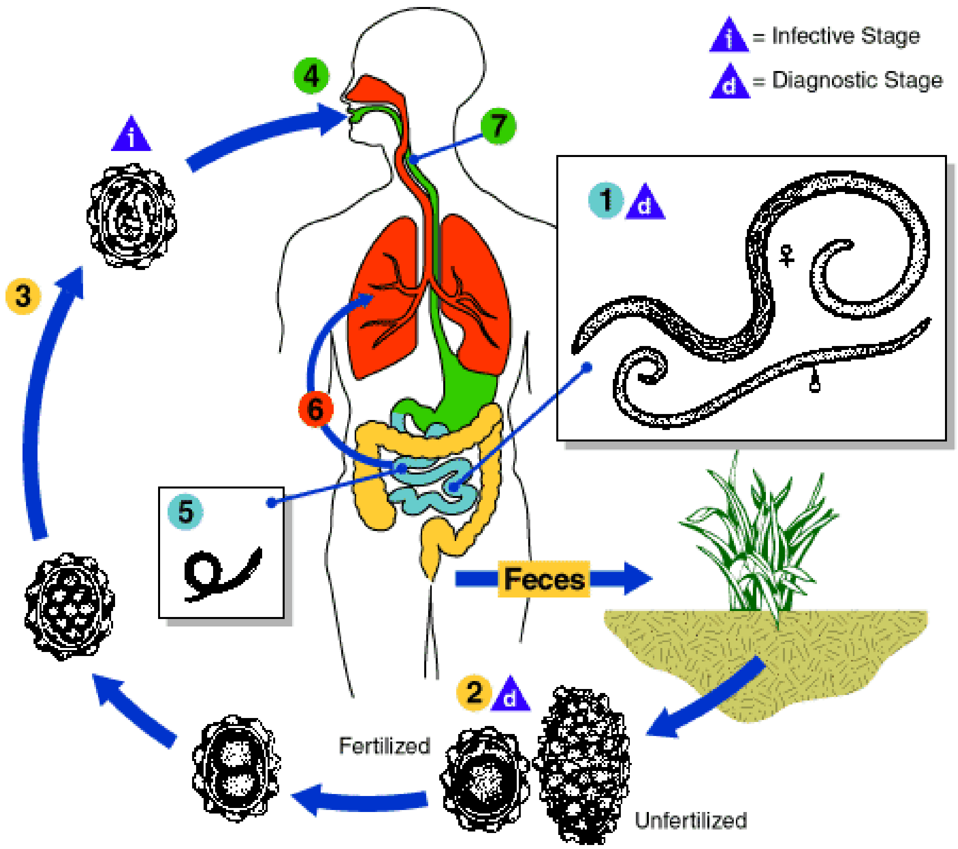

Figure1: Life cycle of *Ascaris lumbricoides*

2.2.3 Clinical features and pathology

Ascaris infections are classified by their clinical expression into four different groups (De Siliva *et al*, 1997). During early infections, the invasive larval stages of *Ascaris* will elicit a host eosinophilic inflammatory response in the liver (hepatitis) and lung (Loeffler's pneumonitis). In the next phase larval migration is known to be associated with a distinctive type of pneumonitis known as Loeffler's Syndrome. Adult and larval *Ascaris* release extremely potent, volatile allergens (Coles, 1985, Kennedy, 1992).These may initiate the asthma like symptoms sometimes associated with *Ascariasis.* The most severe manifestations of *Ascaris* occur as a consequence of the third phase when either physical obstruction in the intestinal tract by a bolus of adult worms or because of adult parasite migrations into the biliary tree.

Among the factors associated with acute obstruction are high fever, acute diarrhea, peppery foods, inhalant anesthesia and other physiological stresses (O'Hanley and Pool, 1995). Of greater global health impact than acute obstructive ascariasis are the nutritional consequences of chronic ascariasis, including increased faecal nitrogen loss, reduction in the ability to digest lactose and diminished vitamin A utilization. In the fourth clinical expression it has been suggested that ascariasis may modulate the immune response to other infections. For example, infection with *Lumbricoides* alone or in conjunction with *americanus* was found to be associated with a protective adjusted odds ratio when cases of cerebral malaria were compared with mild controls (Nacher *et al* 2000; 2002a). However, in a prospective study on Thai villagers, the same investigators found that helminthes-infected subjects were more likely to develop falciparum malaria (Nacher *et al*, 2002b). Infection with *Lumbricoides* has also been found to diminish the magnitude of the vibriocidal antibody response as well as the cytokine response to a live oral cholera vaccine (Cooper *et al* 2000; 2001).

2.2.4 Control

2.2.4.1 Prevention

The prevention of *Ascaris* infection can be achieved first by ensuring that soil is not faecally contaminated. This is made possible by providing and using adequate latrines among communities. The use of untreated human faeces as fertilizer in farms should be avoided and treatment of infected individuals as part of a control programme, especially children should be undertaken. Proper washing of hands before eating prevents the *Ascaris* from being ingested. Eating of uncooked vegetables, green salads and fruits which may be contaminated with *Ascaris* eggs from infected soil should be avoided. This reduces the risk of a person getting *Ascaris* infection. Public health education should be mounted among communities.

2.2.4.2 Treatment

Ascariasis is treated with administration of various anti-helminthics drugs. These include Albendazole (Zentel), Mebendazole, Combatrin (Pyrantel pamoate) and Levamisole. Albendazole is 100% effective at a single oral dose of 400mg for all individuals except pregnant women and children below 5 years. Mebendazole is used at a standard single doze of 400mg and it is 100%

effective against *Ascaris.* Combatrin is given as a single dose but it possibly encourages obstruction by paralysed worms. Levamisole is given at 150-250mg. Intestinal obstruction in children caused by *Ascaris* can usually treated conservatively with intravenous fluids. In mixed infections Ascariasis is treated first with a specific anti-helminth followed by administration of a broad spectrum anti-helminth drug. This is to a void the adult worms from migrating causing other complications elsewhere in the body.

In areas where Ascariasis is common, the directly attributable benefits of mass chemotherapy may be minimal. It can however facilitate the entry of other health care programmes in children, because deworming for ascariasis is often much desired and appreciated by the community (Bundy, 1990). In areas with Vitamin A deficiency and endemic ascariasis, Vitamin A supplementation can be combined with deworming: anti-helminthics do not impair Vitamin A absorption but the worms may interfere with Vitamin A uptake by reducing fat absorption.

2.3 *Ancylostoma duodenale and Necator americanus* (Hookworms)

2.3.1 Geographical distribution

Ancylostoma duodenale is native to parts of southern Europe, North Africa, Northern Asia and parts of Western South America while *Necator americanus* is found in Central and Southern Africa, Southern Asia, Australia and the Pacific Islands.

2.3.2 Life cycle and mode of transmission

Adult hookworms usually live in the upper small intestines where females deposit eggs into the intestinal lumen. *Ancylostoma duodenale* has been estimated to produce an average of 20,000 eggs per female worms per day and *Necator americanus* about half that number. Egg production can be related to several factors including age of infection, the nutritional status of the host and the number of worms present. The immunological response to the infection by the host may also affect the egg production (Schad & Banwell, 1984).

Eggs leave the host through faeces and if the conditions are favourable will hatch within 24 hours. Ideal conditions are aerated, moist soil and a temperature range of 23 – 33^0C (Gilman, 1982). Eggs of the two hookworm species are similar and difficult to distinguish. They are thin shelled, transparent; ovoid with round ends and measure 64-70 x 36-42µm.The eggs hatch into the first stage or rhabdtiform larvae which feed on bacteria and faecal matter. For approximately 7 days, the larvae grow, moult once and then moult again after following further growth. This third stage or filariform larvae is ineffective, non feeding and capable of active vertical movement in the soil and on vegetation. These larvae are very sensitive to desiccation and the mortality rate is 90% in their first weeks of life (Gilman, 1982). Larvae are attracted to a potential host by warmth and carbon dioxide. Both species of hookworm can penetrate the skin effectively and usually between the toes or hands. Following penetration, the larvae migrate within the circulatory system to the lungs where they enter the alveoli and then migrate to the pharynx where they are swallowed or pass through the oesophagus into the stomach. Maturation is completed in the small intestine and the eggs of *Ancylostoma duodenale* first appear in feaces between 43 and 105 days and those of *Necator americanus* between 40 and 60 days after initial infection (Schad and Banwell, 1984).

Both *duodenale* and *americanus* have been recorded to be fairly long-lived, for *duodenale*, a maximum of six to seven years and a maximum of worm egg output of 12 to 18 months. The absolute longevity of *Necator americanus* was reported to be five to six years. The adult worms are somewhat stout, cylindrical nematodes, off-white or rusty red in colour. *Ancylostoma duodenale* is the larger of the two species, females measuring 5-10 mm and 10-18 mm for the males. *Necator americanus* females measure about 10 mm and males 5-9 mm in length. Both parasites have a well developed sub-globular buccal capsule. In *Ancylostoma duodenale* this bares two pairs of teeth and in *Necator americanus* a pair of semicircular cutting plates. Eggs of the two worms are difficult to distinguish unless precise measurements of a series of eggs are made or epidemiological data on geographical location.

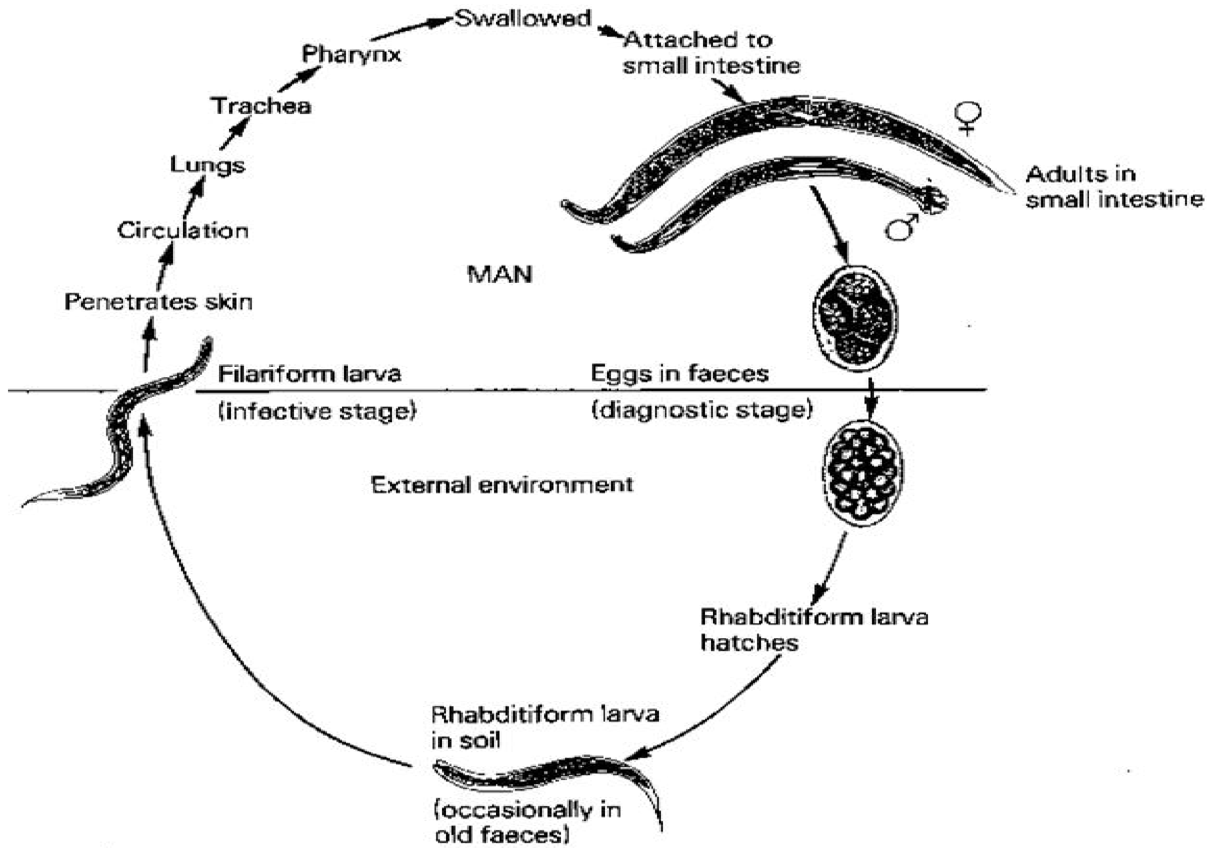

Figure2: Life cycle of hookworm

2.3.3 Clinical features and pathology

Human hookworm infection is a soil-transmitted intestinal helminthiasis caused by either *americanus* or *duodenale.* The pathology associated with hookworm infection are those that are associated with the presence of the adult parasite in the intestine and those associated with the penetration of and migration of the larval worm within the skin. Poor iron intake and iron deficiency anaemia are the hallmarks of hookworm disease. Poor iron status and iron deficiency anemia are the hallmarks of hookworm disease. The course and outcome of pregnancy, growth, and development during childhood and the extent of worker productivity are diminished during hookworm disease (Oberhelman, 1998).

2.3.4 Control

2.3.4.1 Prevention

Personal prevention against hookworm infection is provided by wearing of protective attires. Wearing of adequate protective footwear prevents infective larvae from penetrating the skin of the feet. Prevention of hookworm infection can be avoided by ensuring that soil is not faecally contaminated. This is made possible by providing and using adequate latrines among communities. The use of untreated human faeces as fertilizer in farms should be avoided and treatment of infected individuals as part of a control programme is essential should be undertaken. Public health education should be mounted among communities. This should aim at imparting basic personal health hygiene knowledge to the communities.

2.3.4.2 Treatment

Hookworm infections are treated by administration of the following anti-helminthes: Albendazole, Mebendazole, Levamisole and Combatrin. Albendazole given at a single doze of 400mg for all ages above 2 years is 60-90% effective against hookworm infections. A single dose of 500 mg of Mebendazole for all ages above 2 years or 100 mg given twice daily for 3 days is 20-90% effective against hookworm infections.

A single dose of 3 mg per body weight of Levamisole is more effective against *Ancylostoma* than against *Necator* (20-60%). A daily dose of 10 mg per body weight given for 3 days of Combatrin is more effective against *Ancylostoma* than against *Necator* (20-90%).

Mass chemotherapy appears to give maximal returns in terms of improved health in areas where hookworm is a major problem and albendazole is used regularly, along with iron supplements; in children it improves physical growth and iron stores, and in pregnant women it reduces the prevalence of iron-deficiency anaemia (Handzel, 2003).

2.4 *Trichuris trichuria* (Whipworms)

2.4.1 Geographical distribution

Trichuris trichuria predominates in some parts of South East Asia, Africa and the Caribbean (Stephenson, *et al*, 1989).

2.4.2 Life cycle and mode of transmission

The life cycle of *Trichuris* is simple. Most stages of development occur in the caecum of the host, from the first cuticular molt of the larva to adulthood and sexual reproduction. Female adults shed an average of 3,000 to 20,000 eggs per day. The eggs are not embryonated when passed out in stool and therefore are not infective. In the soil and with ambient temperatures and humidity, embryonic development starts with the first larval stage. This stage takes between 15 to 30 days and development may abort or be inhibited by direct sunlight or desiccation. The larva hatches when the eggs are ingested by the host. The larva then penetrates the intestinal villi where it remains temporarily and later migrates to the caecum where it burrows and undergoes cuticular moults to maturity. This development to adult will take 30 to 90 days and after copulation the female will start to lay eggs. The eggs are barrel shaped and have transparent polar plugs. They measure 50 to 54µm in length and 22µm width. In heavy infection worms can be found in the posterior level of the ileum or on the walls of the appendix. The length of the adult worm varies from 3-5cm and females are larger than males.

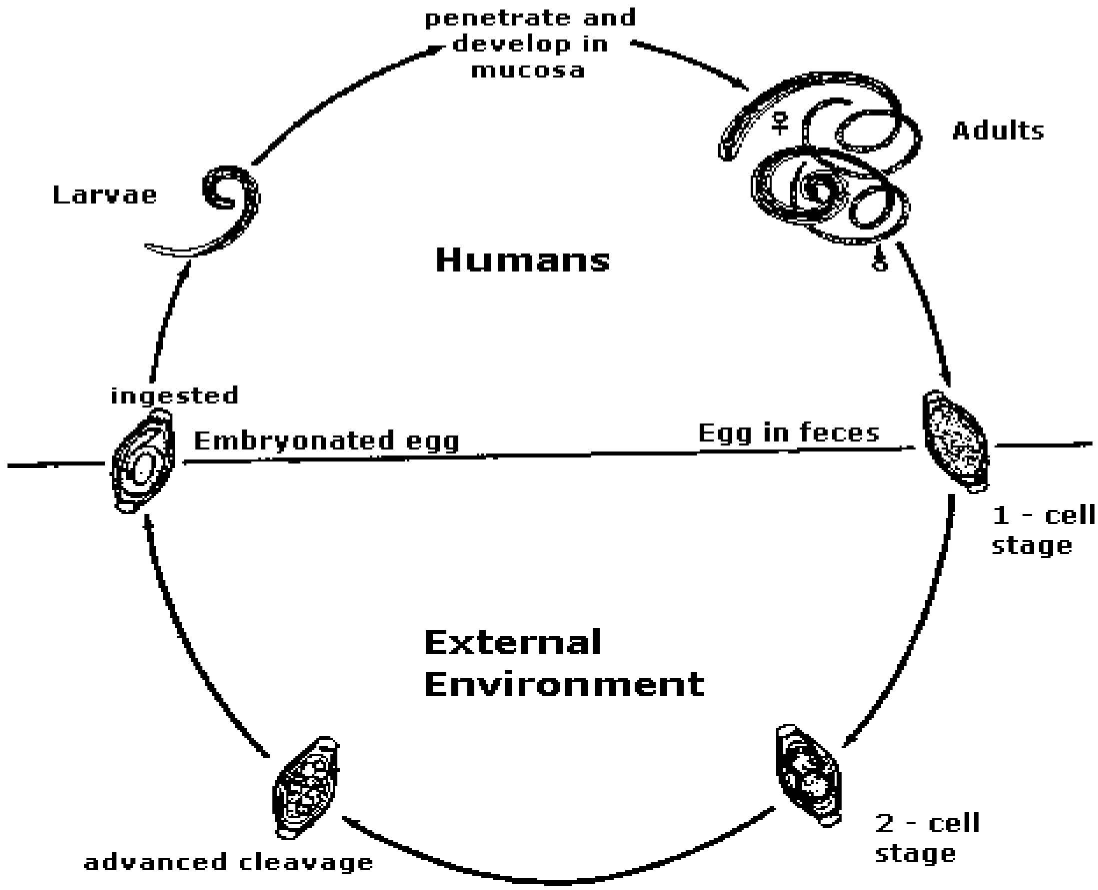

Figure3: Life cycle of trichuris trichuria

2.4.3 Clinical features and pathology

Trichuris causes host injury both through direct effects by invading the colonic mucosa and through the systemic effects of infection. The caecum is the preferential site for invasion although heavy infections will extend throughout the colon and even distally to the rectum (Hotez, 2000).

Several investigators have pointed out the clinical similarities of the pediatric colitis caused by *Trichuris* infection and more established causes of inflammatory bowel disease such as Crohn's disease and ulcerative colitis.

These clinical features include impaired growth, anaemia of chronic disease and even finger clubbing (Cooper, 1995; Hotez, 2000). The most severe manifestation of heavy infection among children is the Trichuris dysentery syndrome (TDS), which is associated with chronic dysentery, rectal prolapse, anaemia and growth stunting (Cooper and Bundy, 1988; Cooper, 1995; Stephenson *et al*, 2000). Growth stunting is sometimes reversible with specific anthelminthic treatment and supplemental oral iron. Intellectual and cognitive impairments and delays are also associated with chronic heavy infections (Sternberg et al, 1997; Drake *et al*, 2000). Overall, the health consequences of *Trichuris* infection in a given community are vastly under-reported (Cooper *et al*, 1986).

2.4.4 Control

2.4.4.1 Prevention

The prevention of Trichuriasis infections is highly dependant on personal protection. To avoid ingestion of eggs thorough washing of vegetables and salads before they are eaten raw should be done. Individuals should also wash their hands before eating and after defecating. Proper disposal of faeces as a result of use of adequate latrines improves sanitation and guards against communities ingesting eggs from faecally contaminated soil. Avoiding the use of untreated human faeces as fertilizers among farming communities reduces the risk of individuals being exposed to *Trichuris* infections.

Targeting and treating individuals as part of a control programme is effective in reducing the worm burden in the community and hence lowering the transmission rate. Public health education should be mounted among communities. This should aim at imparting basic personal health hygiene knowledge to the communities.

2.4.4.2 Treatment

Treatment of *Trichuriasis* is entirely by chemotherapy. Albendazole is given at a single oral dose of 200 mg but for symptomatic should be given each day for 3 days. It is not recommended for pregnant women or infants under 1 year old (Savioli, 1999). Mebendazole at a single oral dose of 400-500 mg is equally effective. Oxantel pamoate with pyrantel, at 10-15 mg per body weight, has the advantage that it doesn't cause ectopic migration of *Ascaris.*

Where trichuriasis is a major problem, single dose chemotherapy may take some time to reduce prevalence. Reduction of heavy infections however will reduce the incidence of *Trichuris* dysentery syndrome (TDS), probably benefit the learning abilities of affected schoolchildren, and may reduce anaemia and stunting. In general, children should be treated as early as possible, and in areas of very high prevalence, thrice-yearly mass chemotherapy probably improves health better than twice-yearly treatment

2.5 *Strongyloides stercoralis*

2.5.1 Geographical distribution

Strongyloides stercoralis has a worldwide distribution and is found in many tropical and subtropical countries including those of Africa, Asia and South America (Cheesbrough, 1987).

2.5.2 Life cycle and mode of transmission

Strongyloides stercoralis is transmitted either by infective filariform larvae penetrating the skin or by autoinfection with rhabditiform larvae developing into filariform larvae in the intestine followed by penetration of the gut wall. It is also transmitted by autoinfection with rhabditiform larvae developing into filariform larvae in faecal matter on peri-anal skin followed by penetration of the skin. Transmammary transmission of *Strongyloides* can also occur. Following penetration, the larvae enter small blood vessels and follow a heart-lung migration during which they develop. After up the trachea, the larvae are coughed and swallowed. The larvae mature in the intestinal tract. It is thought that mating between male and female worms is not essential for reproduction of the parasite as males have been rarely found in humans.

Female worms become embedded in the wall of small intestine while the male worms are expelled. Very soon after the eggs are laid the rhabditiform larvae hatch out in the intestine. They either develop in the intestine into infective larvae or penetrate the intestinal wall or they are passed out in the faeces. This phase of development which occurs in the human host is referred to as the parasitic or direct life cycle. The rhabditiform larvae which are expelled in the faeces are capable, under suitable conditions, of developing into infective larvae in the soil within 3-4 days. The larvae can remain infective in the soil for several months.

The next phase of development occurs in the external environment and is referred to as indirect or heterogonic life cycle. Given a favourable climatic conditions, *Strongyloides stercoralis* can follow a free-living existence for several generations. Instead of the rhabditiform larvae in the soil developing into filariform larvae they are able to develop directly into mature egg-producing worms in the soil. Rhabditiform larvae that hatch in the soil may grow into infective filariform larvae and require a human host in which to become mature worms.

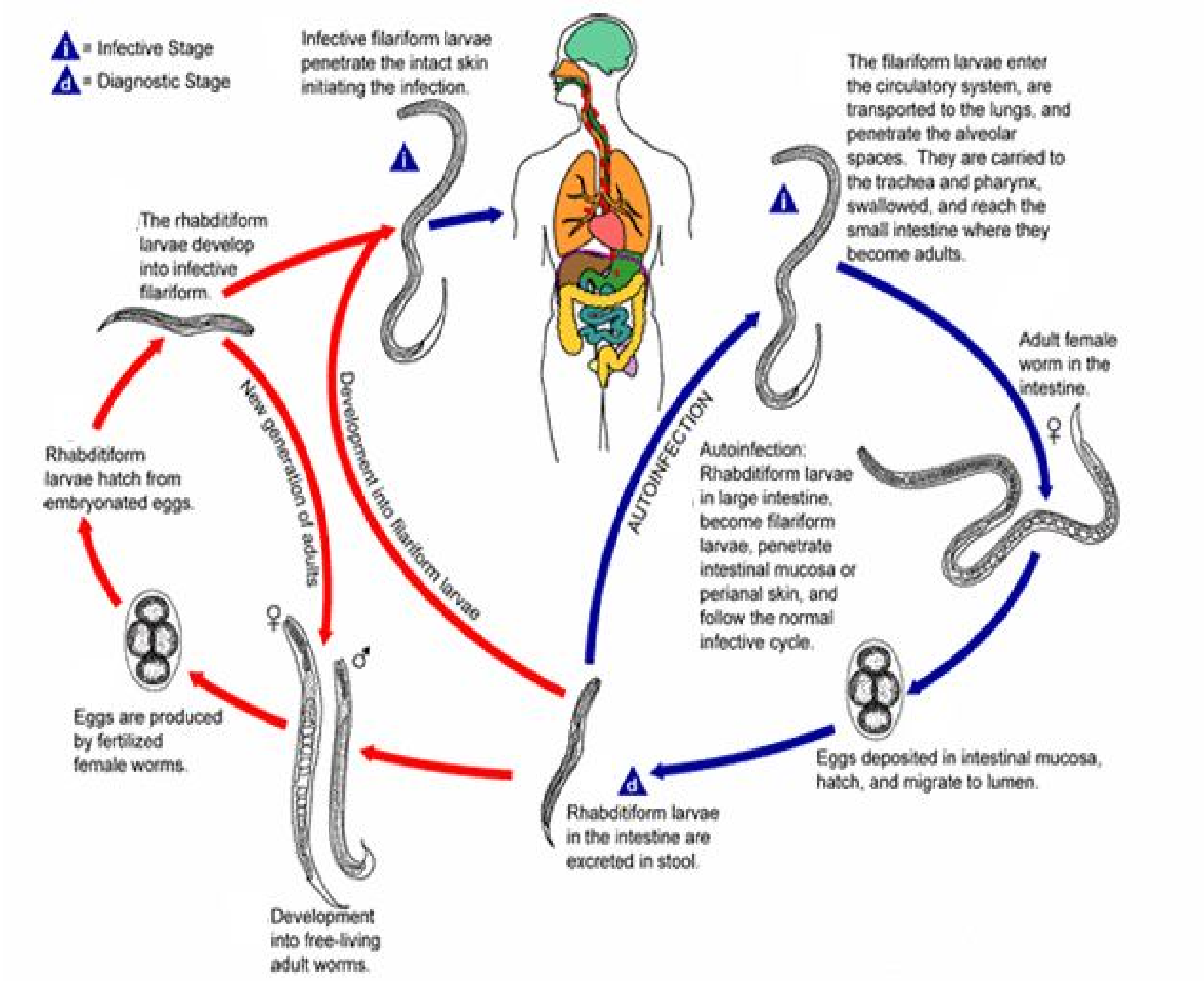

Figure 4: Life cycle of *Strongyloides stercoralis*

2.5.3 Clinical features and pathology

In light infections usually the penetration of the skin by filariform larvae is a symptomatic in non-sensitized persons. In heavier infections a rash often appears at the site of entry ('ground itch') and there may be severe pruritis.

Where autoinfection is occurring there may also be peri-anal and perineal ulceration. In the immunosuppresed persons autoinfection with *Strongyloides stercoralis* can become overwhelming and sometimes fatal. In such infections, larvae can be found in most tissues and serous cavities of the body.

During the larval migration in the circulatory system, the larvae that reach the lungs and pass into the alveoli can cause a pneumonitis similar to Loeffler's syndrome in *ascariasis*

The adult females live in the depths of the crypts of the ileum and lay their eggs there. Larvae hatching from deposited eggs burrow through the lumen and cause superficial catarrhal damage to the mucosa, often with excessive production of mucus.

2.5.4 Control

2.5.4.1 Prevention

Personal prevention of *Strongyloides* infection is aided by the wearing of footwear. This prevents the entry of larvae into the foot. Provision and use of adequate latrines and avoiding the use of untreated human faeces as fertilizer prevents soil from becoming faecally polluted the larvae. Targeted chemotherapy of those groups most at risk may prove to be of use (Conway *et al*, 1995).

2.5.4.2 Treatment

Thiabendazole is the drug of choice though it has side effects which include nausea, dizziness and anorexia. Given orally twice a day for 3-7 days, 25 mg per body weight this drug has a cure rate of a bout 80%. Mebendazole, if given at 100-200 mg twice daily for 3 days is probably effective against adult worms but not against migrating larvae. Albendazole when given at 400 mg twice daily for 3 days has cure rates of 50-85%. Recently ivermectin has also been registered for use against *Strongyloides stercoralis* in humans. This when given as a single dose of 0.2 mg per body weight once a week for 4 weeks has over 80% cure rates against adults and larvae of Strongyloides in uncomplicated cases.

2.6 *Enterobius vermicularis* (Pinworms)

2.6.1 Geographical distribution

Enterobius vermicularis is another helminth which is a ubiquitous parasite and is more common in the temperate regions of Western Europe and North America but is relatively rare in the tropics.

2.6.2 Life cycle and mode of transmission

The mature adults are found in the lumen of caecum, appendix and colon. The gravid female migrates to the peri-anal and perineum areas or either and lay eggs containing immature larvae or embryos on the skin folds of these regions**.** Embryonation or complete development of the larvae is stimulated by the presence of oxygen or optimal temperature. The eggs become infective several hours after they are passed out of the uterine of the gravid females. This embryonated larva containing the first stage rhabdtiform larvae when ingested hatch in the small intestine and penetrate the mucosa and undergo some growth. After sometimes the immature larvae migrate to the caecum, appendix and the colon and then copulate. The fertilized gravid female then migrates to the anal region to oviposit and this occurs at night when the host is a sleep.

2.6.3 Clinical features and pathology

The majority of infection with *Enterobius vermicularis* is asymptomatic, although in some cases the emerging females and the sticky masses of eggs that they produce may cause irritation of the perianal region, which in some cases may be severe. As the females emerge at night this may cause sleep disturbances and scratching of the affected perianal area, transferring the eggs to the fingers and under the finger nails. This aids autoinfection and to other hosts.

Little internal pathology can be directly attributed to the presence of *Enterobius,* apart from a mild inflammation. Possibly *Enterobius vermicularis* is the cause of appendicitis-like symptoms (pseudo-appendicitis) or, on the other hand, worms may leave an appendix that is inflamed (Addis and Juranek, 1991). In about 20% of infected young girls gravid female worms migrate into the vagina and uterus, occasionally evoking an endometritis (Sun *et al*, 1991).

2.6.4 Control

2.6.4.1 Prevention

Eggs of *Enterobius vermicularis* are infective very soon after being laid. As a result an entire family or community such as in a school often become infected after handling bedding and other articles which have been contaminated. Hygienic measures are of importance in the control of this parasite.

These include frequent washing of hands and changing and washing of sheets and garments every morning during an outbreak. The area around the anus should be washed every morning after waking up. Dust should not be allowed to collect as the eggs are very light and easily become airborne. There should be good ventilation in sleeping rooms and all members of a family infected should be treated.

2.6.4.2 Treatment

Enterobius is susceptible to a wide range of anthelminthics. However where the cost of drugs is prohibitive, it isn't worthwhile to treat symptomless cases. The standard treatment is Albendazole as a single dose of 400 mg, or a divided dose of 200 mg twice a day, usually gives 100% cure rates in children over 2 years and adults. But the drug is contra-indicated for pregnant women. Combatrin given in a single dose of 10 mg per body weight or with a repeat dose 1 week later is also effective against *Enterobius.* Ivermectin given at a single dose of 50-200 mg per body weight or two doses of 100-200 µg per body weight is 85% effective against *Enterobius* infections.

2.7 Laboratory diagnosis of STHIs

There are a number of laboratory methods in use for the diagnosis of STHs. However, microscopic techniques remain to be the most reliable ones for the detection of the various stages of these parasites in human faeces. Other special methods also exist for identifying or differentiating some stages of specific helminthes. The microscopic techniques include the following:

2.7.1 Direct stool examination

This method of stool examination employs the use of normal saline, Eosin or Lugol's Iodine as emulsifying agents. Normal saline is useful for the demonstration of larvae with Lugol's Iodine being used for easy identification of the ova of the parasites (Cheesbrough, 1987).Specifically this method is useful in the identification of ova of *Ascaris*, hookworm, *Enterobius* and those of *Trichuris.* It is also useful in the identification of larvae of *Strongyloides.* The main disadvantage of this method however is its low sensitivity especially when the worm infection is low. The method also exposes laboratory workers to risks of infection when stool samples are handled before fixation and without wearing gloves. The other disadvantage of this method is that stool samples must be examined within a few hours of collection if not preserved. In old samples mixed with soil, hookworm larvae could have hatched from eggs and will therefore require differentiation from *Strongyloides* larvae.

2.7.2 Concentration techniques for stool examination

The concentration techniques used for identification of helminthes include Formol-Ether, Saturated Sodium Chloride Floatation methods, Zinc Sulphate and Baermann's techniques.

2.7.2.1 Formol-Ether Concentration Technique

The Formol-Ether technique is a suitable method for concentrating most of the helminths eggs. This technique is based on the principle that the parasites are sedimented by centrifugation. The Formol-saline fixes the parasites and emulsifies the stool while ether dissolves the faecal fat and separates the faecal fat from the sedimented parasites. The technique is recommended for identification of eggs of *Ascaris*, Hookworm, *Trichuris* and larvae of *Strongyloides*. The technique has the following advantages: the degree of recovery of the parasites is greater as large amount of stool is used, it is safe since the specimens are fixed, it is suitable for both fresh and old samples, the number of parasites can be reported both qualitatively and quantitatively and it enables a large number of samples to be examined at the same time. However this technique has the following disadvantages: it is unsuitable for use in the field as electricity is required for centrifugation and because most unfertilized eggs of *Ascaris* are not recoverable as they are trapped in the debris during processing.

2.7.2.2 Zinc Sulphate Floatation Technique

The principle of this technique is that the 33% $ZnSo_4$ (w/v) of specific gravity (S.G) 1.180-1.200 used is a heavy metal with high S.G that enables lighter parasites to float on it and hence recovered easily. In this technique faeces is emulsified in the solution and the suspension is left undisturbed for the eggs to float to the surface where they are collected on a cover slip. The technique is highly recommended for recovery of eggs of *Trichuris trichuria*. The advantages of this technique are that it is most suitable for diagnosis when large number of parasites is required and that it yields cleaner concentrates for microscopic examination. However this method has some disadvantages which include: it can cause infection since the samples are examined unfixed, it is cumbersome to perform and it is expensive since electricity and a centrifuge are required.

2.7.2.3 Saturated Sodium Chloride Floatation Technique

The method and principle of this technique are similar to those of Zinc Sulphate floatation technique except that saturated sodium chloride solution of S.G 1.200 is used. It is useful for identification of eggs of *Ascaris* and hookworm.

2.7.2.4 Baermann's Concentration Technique

This technique is used to concentrate the larvae of *Strongyloides stercoralis*. 10 gm of faeces is spread on a six-layered gauze pad on a coarse sieve with a wooden applicator stick and placed in a sedimentation flask that has been filled 25 mm below the rim with 1% saline or water. The preparation is then left to incubate for 2 hours after which 5 ml of the bottom sediment is removed with a Pasteur pipette and transferred to a 5 cm Petri dish. This is examined under a dissecting microscope for first-stage larvae. If no larvae are found, the flask is left overnight at room temperature and re-examined; then a drop of iodine is added and the larvae examined on a microscope slide to differentiate them from hookworm larvae. The advantages of this technique are that it gives a good concentration of live *Strongyloides* larvae and it is also useful for treatment follow up. However its main disadvantage is that it is a cumbersome technique for routine work.

2.7.3 Special Techniques

2.7.3.1 Harada-Mori Culture Technique

This technique is based on the principle that the capillary flow of water upwards through the paper and faecal film keeps faeces moist and carries soluble elements of faeces to the top of the paper to either volatilize or accumulate in a dark spot. The larvae on reaching the infective stage move to the water pool where they are recovered after incubation. The technique is used for differentiation of the two species of hookworm larvae (*Ancylostoma duodenale* and *Necator americanus*) and for the recovery of *Strongyloides* larvae

2.7.3.2. Scotch-tape Swab Test

This test is used for recovery of eggs of *Enterobius vermicularis.* An adhesive tape (Cellotape or Scotch-tape) is stuck by one end to a microscope slide and turned back over a tongue depressor or finger to make a swab. The sticky tape is rubbed over the anal region and stuck to the slide. The swab is taken first thing in the morning and the slide examined under low power objective (x10) of the microscope. If there are no eggs seen the test should be repeated after 7 days before a negative diagnosis can be made.

Chapter Three

3.0 Materials and methods

3.1 Study area

The study was conducted in Bondo District in Nyanza Province, Western Kenya near Kisumu City. It is situated at the northern tip of Lake Victoria, the largest fresh water lake in Africa. The District lies between equator to the North 0^0 25 latitude to the South and between E34^0 and E$34^0$33. The district covers a land surface of 986.8km^2 and 194km^2 of Lake Victoria waters. Its annual range of rainfall is from 800-1600mm and the pattern is bimodal. The long rains occur from March to June with the peak period being April and May. The short rains occur from October to December. The district has an average daily temperature of 24^0C (min 15^0C and max 30^0C), and the experiences district a relative humidity of between 60% and 70%. The district is administratively divided into five divisions; Maranda (205Km^2), Madiany (221.2Km^2), Rarieda (178.4Km^2), Nyang'oma (188Km^2) and Usigu (194.2Km^2). However, Rarieda division has since been made a district. In 2006 the population growth rate was recorded at 1.8%. The district has a total of thirty three (33) health facilities. Morbidity due to soil- transmitted infections in the same year ranked 6^{th} at 7063 cases followed by intestinal worms at 6366 cases recorded after sexually transmitted diseases, Diarrhoeal diseases, skin diseases, Respiratory diseases and Malaria in that order.

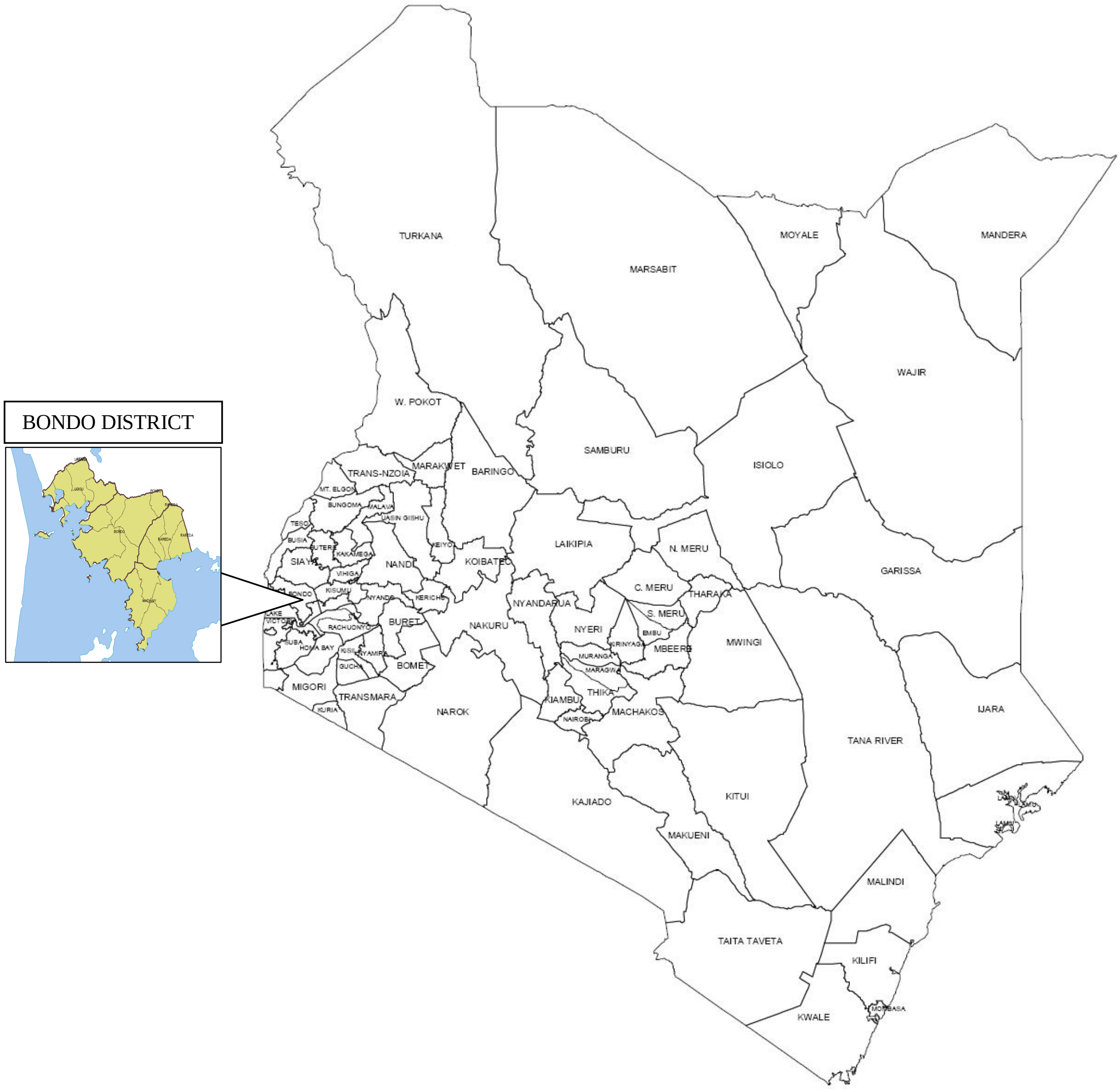

Figure 5: Map of Kenya showing location of Bondo District

3.2 Study design

During the study period Bondo district had a total of 246 public primary schools in the 5 divisions with each division having an average of 49 schools. The schools were stratified by divisions. The selection of schools was done by simple random sampling. In every division each school was given a number from number 1-49. The number and name of each school was then written on small pieces of papers. The papers were then folded, mixed and four papers picked at random to select the schools to be included in the study. The choice of 4 schools per division was made so that a representative study population sample could be attained for the whole district. A schedule of visits to the selected schools was then made (Appendix 1). In each school 20 children who met the inclusion criteria were recruited into the study. The choice of 20 children per school was made so that a total of 400 children could be recruited from all the 20 schools selected in the entire district since the minimum sample size was 396. However there was over participation in some schools as a total of 418 children participated in the study.

The study subjects were recruited by systematic random sampling. This was done by the arranging the children to line up in one queue according to their classes. Each child from the 1st on the queue was asked to pronounce his/her position on the queue up to the 9th child on the queue who was recruited into the study. This process was repeated until the desired number of 20 children per school was obtained. A pre-tested questionnaire (Appendix 2) was administered to each study subjects with the assistance of their school teachers. The questionnaire required them to give their socio- demographic, clinical and risk factors information.

3.3 Study population

The study subjects were randomly selected from school children of ages 5-15 years from selected schools in all the divisions in the district. The total population of children of this age group in the district in 1999 was 75,979 (CBS, 1999). At a projected growth rate of 3.5% per year, the population of the same age group in 2007 was estimated at 97,000. Out of these, 76.4% (74,074) were attending school in 2006 (MOE, 2007).

3.3.1 Inclusion criteria

- School going children of ages 5-15 years who were residents of Bondo District and from randomly selected schools were recruited in the study.
- Children who had had no anthelminthic treatment in the last six (6) months before commencement of the study
- Children who were not undergoing treatment for worms at the time of the study.
- Children who assented or whose teachers consented

3.3.2 Exclusion criteria

- Children who had had antihelminthic treatment during the preceding six (6) months
- Children who were receiving antihelminthic treatment at the time of the study
- Children who declined to assent to participate in the study
- Children whose teachers declined to give consent.

3.3.3 Ethical considerations

Prior to the commencement of the study the study proposal was presented for registration by the Board of Postgraduate Studies of Jomo Kenyatta University of Agriculture and Technology, approval was also sought and obtained from the Ministry of Science and Technology (Appendix 3). At the local level permission was also sought and obtained from the District Education Officer, and the District Medical Officer of Health, Bondo. The purpose and the benefits of the study were explained to the selected study subjects and their teachers. Assent was sought and obtained from the study subjects.

Consent was then given by the study subjects' teachers who signed the consent forms before the study began (Appendix 4). No child was forced or coerced or intimidated in any way to participate in the study. Anonymity of the study subjects were achieved by coding and confidentiality was also observed. All children who participated in the study were de-wormed after taking stool samples by administering 1 tablet of Albendazole (400 mg) to them in their respective schools by one of the District Hospital's Nurse.

3.4 Sample size

From the previous studies conducted in the area (Thiongo *et al.*, 2001) the prevalence of hookworms, *Trichuris trichuria* and *Ascaris lumbricoides* infections were found to be >36%, 21% and 16.5% respectively. The population size of the study subject was found to be 74, 074 (MOE, 2007). The sample size calculation was done using statcal software in the Epi-info programmes version 3.4.3 of 2007. The following figures were used to arrive at the sample size:

Population size =74,074

Expected frequency = 21%

Worst acceptable =17%

Confidence level= 95%

From statcal this calculation gives a sample size of 396. However the total number of children who took part in the study was 418.

3.5 Sample collection

Each study subject was provided with appropriately labeled polypot stool container for the collection of stool specimen. The labels had the subject's name, date of sample collection, identification number and the name of the school. The study subjects were also provided with an applicator stick. They were instructed on how to collect and put stool in the polypots at the school toilet. The collected stool was then delivered to the investigating team which was at hand. The samples were packed in a cool box with ice packs and transported by a vehicle to the Division of Vector Borne Disease's (DVBD) laboratory at the District Hospital for examination. This was after assent/consent of the study subjects were sought either from them directly or from their teachers before the study began. The teachers signed the consent forms on behalf of the study subjects. No visits were made to the children's homesteads for their parents consent because this was a school based study

3.6 Procedure for stool examination

On receipt of the stool samples at the laboratory, the details of each subject was verified and entered in the laboratory report form. The samples were examined within 6 hours so that the viability of the various stages of the worms could be maintained. The stool samples were examined using the direct stool examination procedure or method (Appendix 6) (Cheesbrough, 1987). Briefly, this was done by putting bean sized amount of the sample on a microscope glass slide and adding a drop of normal saline and a drop of Lugols'Iodine. The slide was then covered with a cover slip and examined under X10 and X40 magnifying objectives of Olympus microscope (Germany). Any observation made was then recorded on the subject's laboratory report form (Appendix 5).

The samples were further examined by the Formol- Ether concentration technique (Cheesbrough, 1987). This was done by first emulsifying a small amount of (bean sized) the sample in about 7ml of 10% Formol saline in a mortar. Four milliliters (4ml) of the Formol saline was added and the mixture shaken for about 20 seconds. The emulsified stool was sieved and the suspension collected in a beaker. The suspension was transferred to a centrifuge tube and 5ml of ether added. The sample was then centrifuged at 3,000 revolutions per minute (3,000 rpm) for 1minute. Using a spatula the layer of the faecal debris was broken from the side of the tube and the tube rapidly inverted to discard other contents to remain with the sediment. Using a wooden applicator stick, the sediment was mixed and transferred to a slide, cover slip used to cover it and examined under X10 and X40 magnifying objectives of Olympus microscope and any observation reported (Appendix 5).

3.7 Data entry, cleaning and analysis

Data was entered, cleaned and analyzed in Epi-info statistical software version 3.4.3 of 2007. Odds Ratio was used as a measure of association between exposure variables and outcome. P-value was used to determine the statistical significance between risk factors and outcome.

Chapter Four

4.0 Results

4.1 Overall prevalence of STHIs among school children in Bondo District, 2007

From this study of the 418 school children examined for STHIs during the study period, 77 children were infected with worms giving a prevalence of 18.4%. The prevalence of the individual helminthes among the study population was found to be as follows: *Ascaris lumbricoides* 36 (8.6%), Hookworm 24(5.7%), *Trichuris trichuria* 16(3.8%) and *Strongyloides stercoralis* 1(0.2%). All these were single infections. 46 (11%) of the males were infected with the worms as compared to 31 (7.4%) females. Maranda division had the highest prevalence for all the worms at 38 (34.9%).

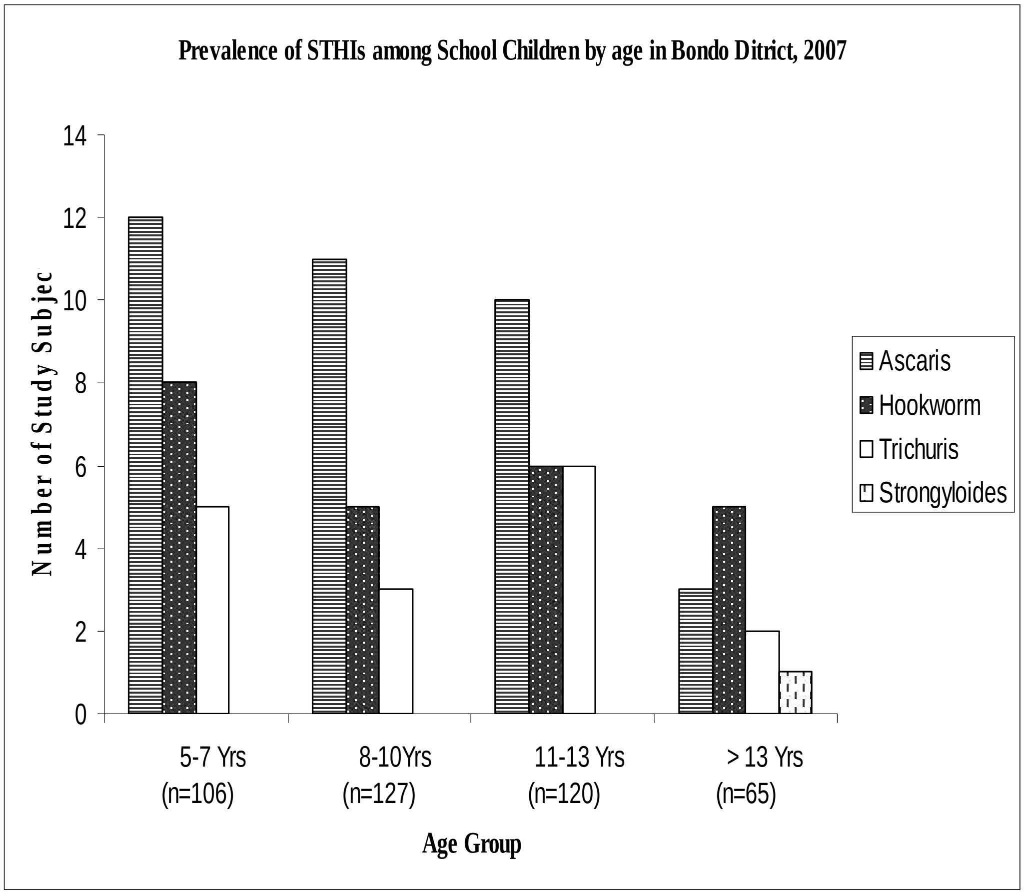

Figure: 6 Prevalence of STHIs among school children by age in Bondo District 2007

Figure 6 above shows the prevalence of STHIs among school children by age from 5-15 years. Ascaris was the most predominant infection among all age groups except children who were above 13 years. Hookworm infection was more prevalent among children who were above 13 years. One isolated case of

Strongyloides infection was found in only one child who was above 13 years. Generally the prevalence of STHIs is high among children of lower age groups and decreases with advancing age. *Ascaris* infection was the most prevalent of all the worms. Children most infected with *Ascaris* belonged to the age group 5-7 years. The lowest prevalent STHIs was *Strongyloides*

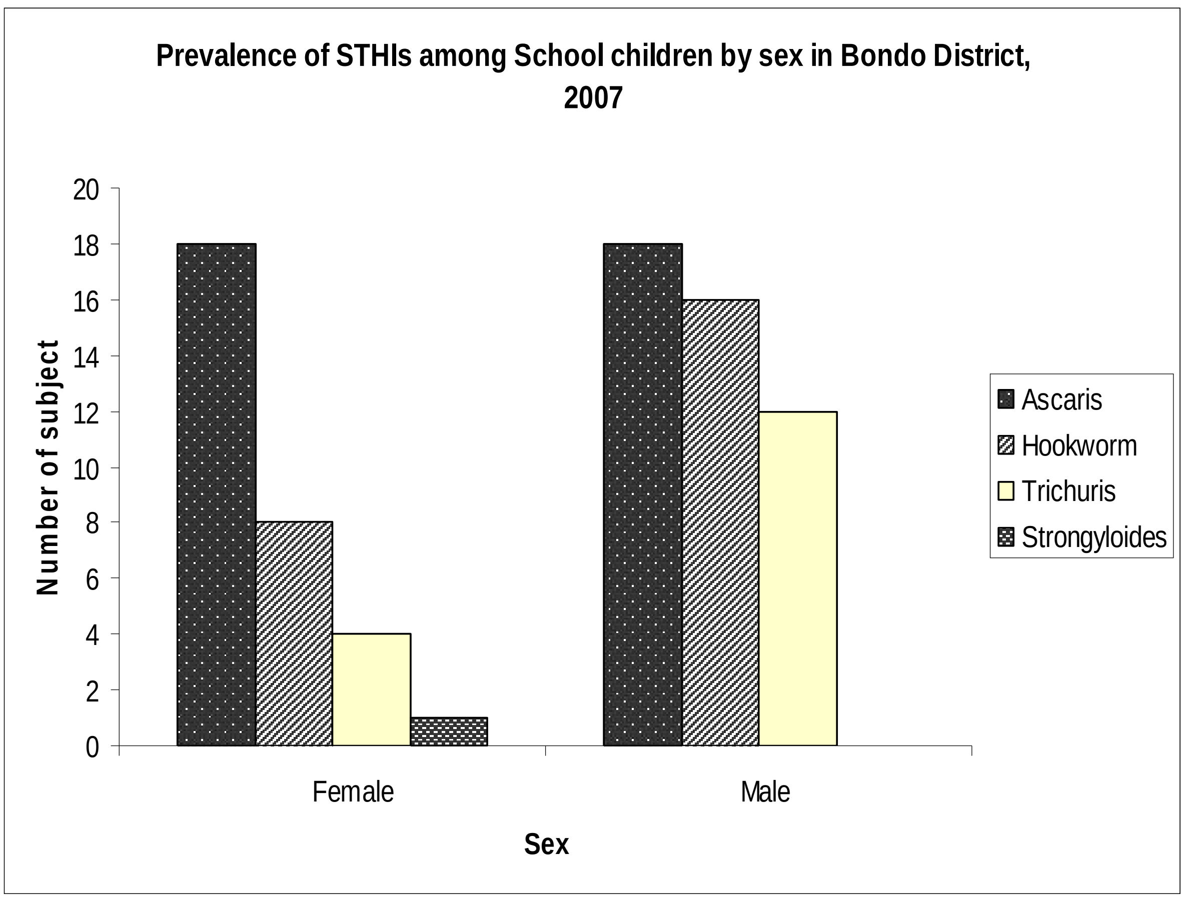

Figure 7: Prevalence of STHIs among school children by sex in Bondo District, 2007

Figure 7 above shows prevalence of STHIs among children by sex. Both sexes are infected with the three (3) predominant worms (*Ascaris, Hookworm and Trichuris*) though males appear to be more infected than females. Both sexes appear to be equally infected with *Ascaris.* Males are more infected with hookworm and *Trichuris* than females. The only Strongyloides case was found in a female.

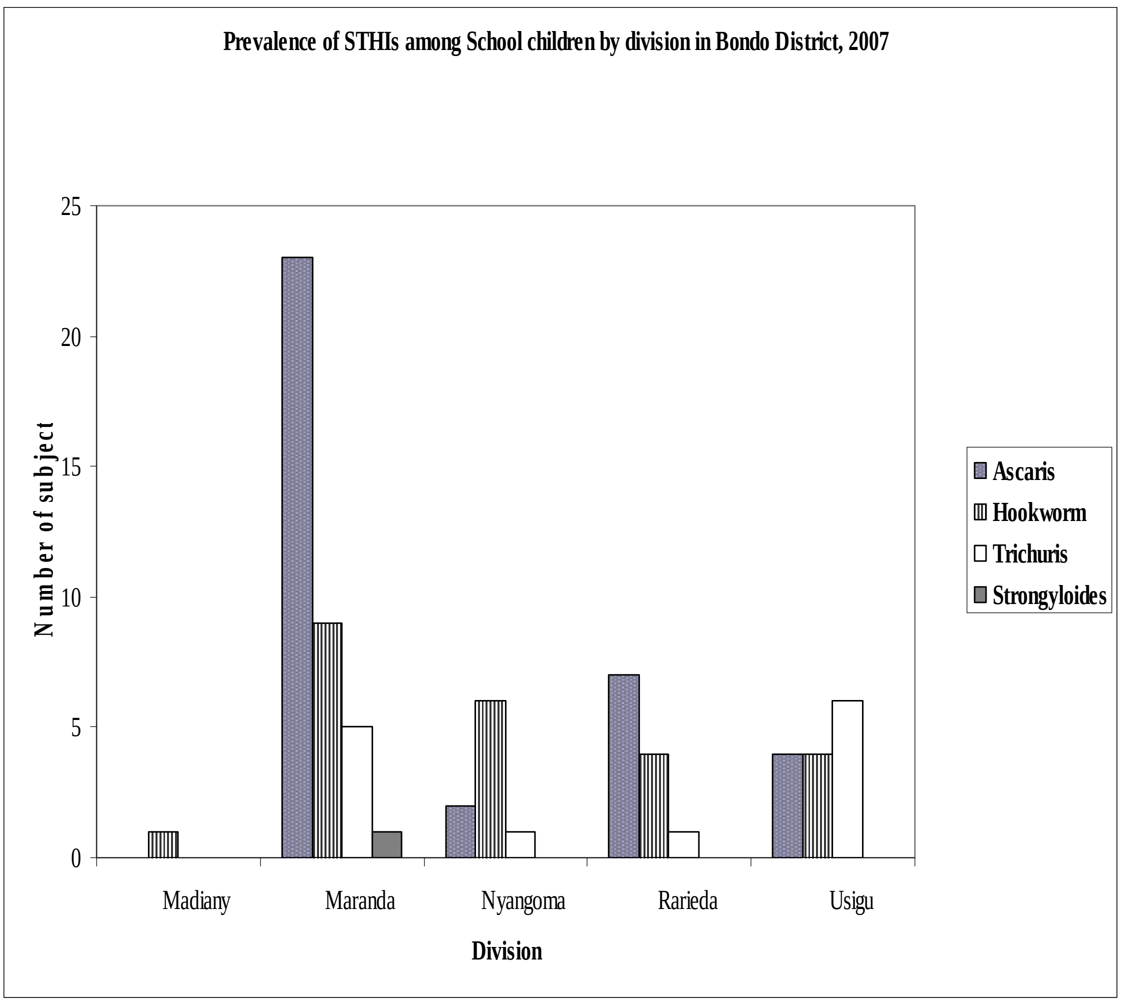

Figure 8: Prevalence of STHIs among schoolchildren by administrative divisions in Bondo District, 2007

The table above shows the prevalence of STHIs among school children by administrative divisions. The prevalence of STHIs in Bondo district is not homogeneously distributed. Maranda division had the highest prevalence of all the worms except *Trichuris*. Madiany division had the lowest prevalence with only Ascaris found. Strongyloides infection was only found in Maranda division.

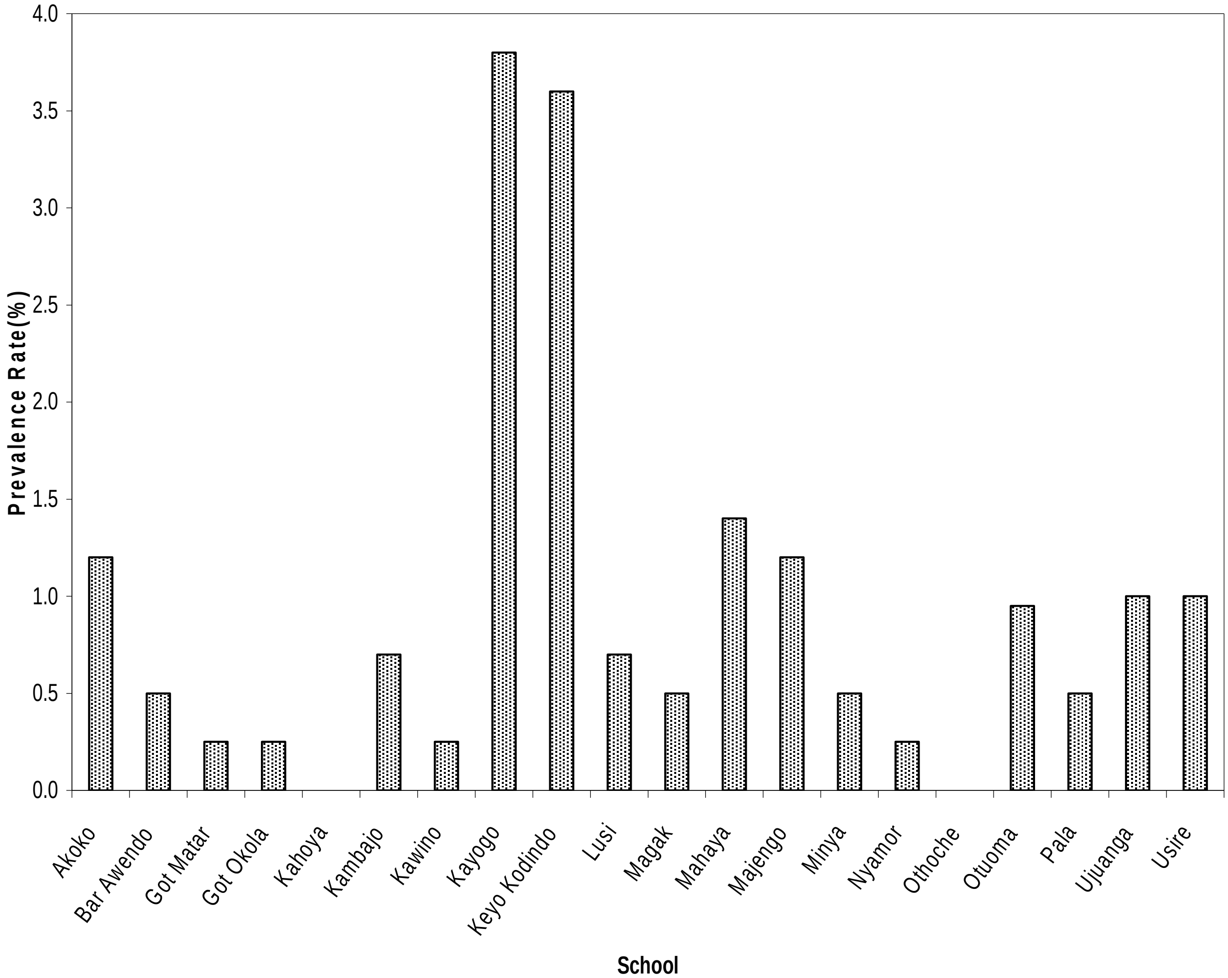

Figure 9: Prevalence of STHIs among school children by schools in Bondo District, 2007

As shown in figure 9 above, of the twenty (20) schools which were included in the study, Kayogo and Keyo Kodindo primary schools had the highest prevalence of helminth infections at 3.6% and 3.5% respectively. None of the four STHs was found in Kahoya and Othoche primary schools.

4.2 Socio-demographic features of the study population

From September to October 2007 a total of 418 subjects took part in this study. Of these 198 (47.4%) were females and 220 (52.6%) were males. The minimum age of the subjects who participated in the study was 5 years and maximum was 15 years. The mean age was 10 years. The median age was 10 years. The standard deviation is 3 while the variance is 8.7. As per the divisions; the number of subjects who participated in the study in the whole district was: Madiany 80 (19.1%), Maranda 109 (26.1%), Nyang'oma 60 (14.4%), Rarieda 80 (19.9%) and Usigu 89 (21.3%)

Of the 418 subjects who participated in the study, 414 (99.0%) were Christians, 2 (0.5%) were Muslims while 2 (0.5%) did not belong to any religion.

4.2.1 Association between socio-demographic factors and transmission of STHIs

Table 1 below shows the association between socio-demographic factors and infection of worms. The factors which were found to have significant association with worm infection were the subject's mothers/guardians low level of education (Primary school level and below), fishing, ownership of a Television set and use of tap water for domestic purposes when univariate analysis was done. The use of tap water for domestic purposes had the strongest association with *Ascariasis* (P- value < 0.001). Ownership of a Television set and use of tap water for domestic purposes did not reduce the risk of getting infected with STHIs among school children.

Table 1: Association between socio-demographic factors and type of worm detected in Bondo District, 2007

Socio-demographic factor	Type of worm	OR	CI	χ^2	P-value
Low education	Ascaris, Trichuris, Hookworm and Strongyloides	2.67	1.35-5.26	8.53	0.003
	Ascaris, Trichuris and Hookworm	2.62	1.33-5.16	8.17	0.004
	Ascaris and Hookworm	2.81	1.29-6.1	7.26	0.007
Fishing	Ascaris, Trichuris, Hookworm and Strongyloides	0.33	0.12-0.96	4.55	0.033
	Ascaris, Trichuris and Hookworm	0.34	0.12-0.97	4.39	0.036
Ownership of a TV	Ascaris, Trichuris and Hookworm	0.32	0.11-0.91	5.01	0.025
	Ascaris, Trichuris and Hookworm	0.32	0.12-0.93	4.83	0.028
Tap water	Ascaris, Trichuris, Hookworm and Strongyloides	0.3	0.09-0.98	4.41	0.036
	Ascaris	6.09	3.0-12.6	33.2	0.000001

Table 2: Clinical symptoms and STHI's among school children in Bondo District, 2007

	Type of worm				
Clinical symptom	Ascaris	Hookworm	Trichuris	Strongyloides	All worms
Abdominal pain (n=32)	3(9.4%)	2(6.3%)	3(9.4%)	0(0%)	8(25%)
Abdominal distension (n=8)	2(25%)	1(4.2%)	0(0%)	0(0%)	0(0%)
Nausea/Vomiting (n=6)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
Lack of appetite (n=1)	0(0%)	0(0%)	0(0%)	0(0%)	3(37.5%)
Intestinal dismotility (n=13)	0(0%)	1(1.7%)	1(7.7%)	0(0%)	2(15.4%)
Salivation during sleep (n=3)	0(0%)	0(0%)	0(0%)	1(0.2%)	0(0%)
Headache (n=8)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
Irritability (n=1)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
Peri-anal itching (n=2)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
History of parasitic infection (n=4)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)

4.3 Clinical symptoms associated with STHIs transmission.

Table 2 above shows the prevalence of STHs among those subjects in the study population who had probable clinical symptoms related to STHIs. Out of the 36 positive *Ascaris* cases, only 5 cases had probable clinical symptoms related to STHI's while of 24 positive cases of hookworm infections, only 4 cases had similar clinical symptoms. Of the 16 cases of *Trichuris*, only 4 cases had clinical symptoms which could be related to STHIs.

Table 3: Association between risk factors and STHIs among school children in Bondo District, 2007

Risk factor	*Ascariasis* OR	*Ascariasis* CI	*Ascariasis* P-value	Hookworm OR	Hookworm CI	Hookworm P-value	*Strongyloides* OR	*Strongyloides* CI	*Strongyloides* P-value	*Trichuris* OR	*Trichuris* CI	*Trichuris* P-value
Ownership of a toilet												
Yes												
No	1.76	0.80-3.85	0.16	0.80	0.35-1.86	0.61	0.80	0.35-1.86	0.61	1.29	0.44-3.80	0.64
Hand washing after relieving												
Yes												
No	0.43	0.18-1.06	0.06	0.82	0.23-2.87	0.76	0.00	U	0.11	1.18	0.23-14.06	0.48
Cleaning of peri-anal area												
Yes												
No	0.57	U	0.45	U	U	0.58	U	U	0.98	0.31	0.04-2.63	0.30
Helping parent/guardian at farm												
Yes												
No	0.76	0.38-1.53	0.44	0.97	0.41-2.28	0.95	U	U	0.63	0.57	0.21-1.55	0.27
If helps at farm, wearing of shoes or gumboots												
Yes												
No	0.51	0.15-1.81	0.22	1.11	0.34-3.61	0.54	0.00	U	0.75	1.01	0.20-5.13	0.63
Washing of fruits before eating												
Yes												
No	1.36	0.65-2.87	0.41	0.59	0.26-1.35	0.21	U	U	0.38	0.46	0.17-1.26	0.12

4.4 Association between risk factors and outcome

Table 3 above shows the results of statistical analysis of the association between risk factors and STHIs. No statistical significance was obtained although hand washing after defeacation almost showed significance (P-value 0.06) with *Ascaris* infection.

Table 4. Determining individual socio-demographic and risk factors for worm infections among school children in Bondo District, 2007

Term	Odds Ratio	95%	C.I.	P-Value
Low education	2.4116	1.2065	4.8203	0.0127
Maranda Division	3.5074	2.0791	5.9168	0.0000
CONSTANT				0.0000

Table 4 above shows the result of the unconditional logistic regression analysis. After primary statistical analysis to establish an association between individual socio-demographic and risk factors and the worm infections failed to reveal any significant association, unconditional logistic regression analysis was done. Some factors were combined and tested for an association between them and/or single or combined possible outcomes (STHI's). The result indicated that low education of the subjects' mothers/guardians was a socio-demographic factor significantly associated with transmission of STHIs for residing in Maranda division. Similarly washing of fruits before eating them and drinking water from water pans were the two risk factors found to have an association with transmission of STHIs for residing in the same division.

4.5 Association between risk factors and outcome for residing in Maranda division

Table 5 below shows association between risk factors and outcome for residing in Maranda division. After multivariate analysis revealed that residing in Maranda division predisposes people to helminthes infection, further analysis was done to establish the risk factors associated with this. The result found that washing of fruits before eating them (P-value 0.01), low education level of mother's/guardian's (P-value 0.03) and use of water from water pans for domestic purposes (P-value < 0.001) in Maranda division were significantly associated with STHIs in this division.

Table 5: Association between risk factors and outcome (Combined worms) for residing in Maranda division – Univariate analysis.

Risk factor	OR	CI	P- value
Low education			
Yes			
No	2.66	1.07-6.58	0.03
Water pan			
Yes			
No	5.60	2.19-14.3	< 0.001
Washing of fruits			
Yes			
No	2.81	1.28-6.13	0.01

Table 6: Association between risk factors and outcome (Combined worms) for residing in Maranda division – Multivariate analysis.

Term	Odds Ratio	95%	C.I.	P-Value
Washing of fruits	0.7272	0.4316	1.2255	0.2316
Low education*	2.7653	1.3835	5.5272	0.0040
Water pan	5.1906	1.9149	14.0695	0.0012
CONSTANT				0.1022

Table 6 above shows the results of unconditional logistic regression analysis done to determine the risk factors associated with STHIs in Maranda division. This analysis was done after the primary analysis in order to control for multiple confounders. The results indicated that low education of the subjects' mothers/guardians (P-value <0.01) and dependency on water from water pans as a source for domestic use (P-value <0.01) had statistically significant association with transmission of STHs in Bondo district. Maranda division had the highest number of mothers/guardians of the study subjects with low level of education (28.8%) compared to Usigu (21.2%), Rarieda (19.5%), Madiany (14.2%) and Nyang'oma (6.2%). All the 19 water ponds found in Bondo district were all located in Maranda division.

Chapter Five

5.0 Discussion

In this study four (4) parasites (*Ascaris lumbricoides,* Hookworm and *Trichuris trichuria* and *Strongyloides stercoralis)* were studied. This was in conformity with a number of previous studies done elsewhere (Ukpai and Ugwu 2003, Nigeria; Adams *et al.* Kenya, 1994; Bethony *et al*, 2006,; Bundy, 1995). During the period of this study, the overall prevalence of STHs among primary school children aged 5-15 years in Bondo District was found to be 77/418 (18.4%). Results of this study are in agreement with a study conducted in Nigeria (Chigozie *et al*, 2007) in which the overall prevalence of 86/510 (16.9%) was recorded.

The results of the current study were unexpectedly low as compared to studies done in many parts of the world in similar rural settings. In a study conducted in Nigeria, a prevalence of 54.7% in children infected with STHs was observed (Egwunyenga *et al*, 2005). This was in contrast to the findings of previous studies conducted in the same area before by Geissler *et al*, (1998) and Thiong'o *et al*, (2001) which found geohelminths to be more prevalent in the study area.

The area has all the factors that favour transmission and maintenance of intestinal helminthes in the community: humid conditions, optimal temperatures for larval development and egg viability and widespread economic deprivation. The overall low prevalence of STHIs in this area could therefore be attributed to school based deworming, a control intervention activity which had been undertaken in some parts of the district several years before the onset of the study by Muchiri *et al* (2001) in 1997 and Handzel, *et al* (2003) in 2001. This therefore means that the school based deworming was an effective control measure. Chemotherapeutic control of intestinal helminthes is based on the principle that killing of the adult worms reduces environmental contaminations and hence rate of transmission, as well as directly treating the disease in individuals (Bundy *et al*. 1990).

The prevalence of the individual helminthes among the study population was found to be as follows: *Ascaris lumbricoides* 36 (8.6%), Hookworm 24(5.7%), *Trichuris trichuria* 16(3.8%) and *Strongyloides stercoralis* 1(0.2%).This finding supports the fact that the most prevalent helminth in the tropics is *Ascaris* (Muller, 2002). However, the results of this study do not agree with the results of previous studies done in the same region. In a study conducted in Usigu division in the same district (Muchiri *et al.*, 2001), the prevalence of the parasites was found to be 61.2% for hookworm, 41.9% for *Ascaris* 31.1% for *trichuris* 31.1%. Another study conducted by Magnussen *et al* (1997) also found the prevalence of Hookworm to be 57%, *Trichuris* 56% and *Ascaris* 17.4%. A further study carried out in Matuga Division, Kwale District, Coast Province, Kenya gave the prevalence of the STIs to be Hookworm 57%, Trichuris 56% and Ascaris 18% (Olsen, 2003). Other studies conducted elsewhere also showed that Hookworm is the commonest helminth, followed by *Trichuris trichuria* and *Ascaris lumbricoides (*Broooker *et al. 1971;* Pamba 1980*;* Chung*e et al.* 1985*;* Kinoti *et al.* 199*7;* Geissler *et al*1997*; Broooker et al*, 2000*;* Handzel *et al* 2003).

The possible reason for the high prevalence of *Ascaris lumbricoides* is the fact that the infective stages of *Ascaris*, the embryonated eggs have enormous capacity for withstanding the environmental extremes of urban environments (Hotez, *et al.,* 2003). High prevalence of *Ascaris* in the study population may be may also be due to the reintroduction of eggs into the environment through contaminated soil, water and food, with susceptible individuals contracting the infection through either contact or inadvertent ingestion of polluted materials.

The study revealed that the prevalence of *Ascaris lumbricoides* was highest among children of 5-7 years. However the prevalence decreases with advancing age. These results are comparable to a study conducted in Metro Manila, Phillipines among children living in residential institutions, (Baldo, *et al*., 2004). The high prevalence of *Ascaris* among children in the lower age group is due to their habits and personal behaviors. Children of this age group have just been weaned from suckling their mothers but they still continue with the habit of picking and leaking anything they come across. Since the transmission of *Ascaris* is faecal-oral, if a child picks something from the ground that is soil contaminated then the child will become infected. However as the children advance in age they tend to drop these habits and hence the reduction in Ascaris infection in older children.

Among the study group, males were generally more infected with the helminthes at a prevalence of 46/220 (21%) than females at 31/198 (16%) though there was no statistical significance (P-value 0.17, CI 0.42-1.16, OR 0.70). This finding agrees with the results of other studies done elsewhere. In a study carried out by Egwenyenga *et al* (2005) in Nigeria, 60.8% males were found to be infected compared to 47.3% females. In another study done by Chigozie *et al* (2007) in males were more infected than the females (18.3% versus 15.5%). This difference was not investigated but one reason to explain this could be due to the nature of male children's habits. Male children like exploring their environment more than their female counterparts. This therefore exposes them to higher risks of contracting infection from the environment.

In this current study, most of the socio-demographic factors were not significantly associated with STHIs. For example, ownership of a radio set was noted in 85.6% of the study population. There was no significant difference in the prevalence of *Ascaris* infection and this factor. Furthermore, no association was found between the prevalence of all parasites and household's head occupation, type of house, ownership of a television set, water source and type of cooking fuel.

The study showed that people residing in Maranda division were at more risk of contracting *Ascaris* and all helminthes infections generally than people in other divisions in the district. The study revealed that the children's mothers/guardians low level of education (P-value <0.01) and use of water from water pans (P-value <0.01) for domestic purposes were two risk factors that were strongly associated with STHIs in Maranda division. The finding that children's mothers/guardians low level of education is associated with STHIs concurs with findings of a similar study done by Okyay, *et al* in Western Turkey (2004). This association is due to the fact that persons with low level of education are not able to understand the basic personal hygiene principles and as a result they cannot impart knowledge regarding this to their children. Poor personal hygiene practices are known to aid in the transmission of intestinal helminth infections.

Another possible reason is that Bondo Township which is an urban setting is located in Maranda division and as with such settings the transmission of *Ascaris* eggs is enhanced due to the numerous socio-economic activities such as petty businesses and food vending.

The reasons of the finding that use of water from water pans for domestic purposes was associated with STHIs could not be established.

Based on clinical symptoms, the study results agree with a study conducted by Okyay *et al,* (2004) which indicated that most of the complaints had no significant relationship with STHIs. For example only 9.4% of the study population with *Ascaris* infection had abdominal pain- the association between the abdominal pain and the infection having no significant association. Generally clinical symptoms were not associated with worm infection. In this study the complaints may not have been assessed effectively through use of only a questionnaire without physical examination by a clinician.

The finding of no clear association between the studied risk factors and worm infection was unexpected. The study results indicated that 63.2% of the study subjects owned toilets at their homes. There was no significant difference in the prevalence of *Ascaris* and this factor among those who owned and those who did not own toilets.

The study did not find any significant association between other possible risk factors (washing of hands and/or cleaning of perianal area after one relieves himself, helping a parent/guardian at farm, wearing shoes or gumboot while at farm, washing of fruits before eating them and washing of hands before eating) and helminth infections. The study was not able to establish why this was the case yet the risk factors so investigated predispose children to intestinal helminth infections.

5.1 Limitations and assumptions

The following were the limitations encountered during the study:

- Lack of a clinician to physically examine the study subjects to effectively assess the subjects' clinical status
- Recall bias from some of the respondents.
- Information bias from some of the respondents.

The following were assumptions were made during the study

- That the prevalence of STHIs in Bondo district was higher than 21%
- That there was low latrine coverage in the entire district.
- That there was low degree of use of latrines
- That the coverage of safe water supply in the entire district was as low as 4%
- That most latrines were ordinary with very few ventilated improved ones at 10%

5.2 Conclusions

Arising from the results of this study it is concluded that:

- There is an association between use of water from water pans for domestic purposes and transmission of Soil-transmitted helminthes infections.
- There is an association between low education level of the children's mothers/guardians and transmission of Soil-Transmitted helminthes infections.
- The most prevalent helminth infection among school children in Bondo District is *Ascaris lumbricoides.*
- Maranda Division has the highest prevalence of Soil-Transmitted helminthes infections among school children in Bondo District.
- Most of the school children infected with Soil-Transmitted helminthes infections in Bondo District belong to the age group 5-7 years. This could be due to their lack of knowledge of proper hygiene practices and habits.

5.3 Recommendations

- There is a need for an elaborate study to determine why the use of water from water pans as a source for domestic water predisposes residents in Maranda division to STHIs
- Public health education on prevention and control of Soil-transmitted helminthes should be intensified in the community.
- Mass school-based deworming should be continued at regular intervals in the whole district so as to reduce the transmission of the worms in the community.

References

Adams, E.J, Stephenson L.S, Latham, M.C, Kinoti, S.N. (1994), Physical activity and growth of Kenyan school children with Hookworm, *Trichuris trichuria* and *Ascaris lumbricoides* Infections are improved after treatment with Albendazole, *J Nut*, 124: 1199-206

Addis, D.G and Juranek, D.D. (1991), Lack of evidence for a causal association between parasitic infections and acute appendicitis, *Journal of Infectious Diseases* 164; pp 1036- 1037

Beaver P.F. Jung R & Cupp E.W. Helminths and helminth infections in: clinical parasitology 9th Edition (Philadelphia: Lea and Febiger), (1984); pp 240-245 and 253-261

Brooker, S. Peshu, N. Warn, P.A. Mosobo, M. Guyatt, H.L. Marsh, K. (1999) and Snow R.W. The epidemiology of hookworm infection and its contribution to anaemia among school children at the Kenyan Coast. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 93, 240-246

Brooker S, Miguel EA, Moulin S, Luoba AI, Buddy DAP and Kremer, M (2000), Epidemiology of single and multiple species of helminth infections among school children in Busia District, Kenya. East Africa Medical Journal 77, 157-161

Baldo, E.T,Belizario, V.Y, DE Leon, W.U, Kong, H-H, Chung, D. (2004) Infection status of intestinal parasites in residential institutions, in Metro Manila, the Philipines.The Korean Journal of Parasitology, (2004), Vol. 42 No. 2, 67-70

Bundy, D.A., M.S. Wong, L.L. Lewis, and J. Horton. Control of Geohelminthes by Delivery of Targeted Chemotherapy through Schools: Transactions of the Royal Society of Tropical Medicine and Hygiene (1990), 84:521-22

Bethony, J.; Brooker, S.; Albonico, M,; Geiger, S.M.; Loukas, A.; Diemrt, D. and Hotez, P.J. (2006), Soil-Transmitted Helminth Infections: ascariasis, trichuriasis and hookworm. Lancet; 367 (9521): 1521-32

Bundy, DAP. (1990), Control of intestinal nematode infections by chemotherapy: mass treatment versus diagnostic screening. Trans. Med. Hyg. 84, 622-625

Bundy DAP. Epidemiology and transmission of Intestinal helminthes In: *Enteric Infection 2 Intestinal Helminthes*, (1995: 5-24)

Celiskoz, A, Guler N, Guler G, Oztop, A.Y and Degerli, S. (2005), Prevalence of intestinal parasites in three socio-economically different regions of Sivas, Turkey. J Health Population Nutrition Journal 23 (2), 184-191

Central Bureau of statistics (1999), Kenya population and housing censes *Population distribution by administrative areas and urban centre;* (1999), pp137-8, Nairobi, Kenya

Cheesbrough, M. Medical Laboratory Manual for Tropical Countries, Vol. 1, ELBS Tropical Health Technology /Butterworth 1987; pp356 and pp 384

Chigozie, J. U, Eze, K. O, Oyibo, P. G and Azu, N. C. (2007), Soil-transmitted helminth infection in school children South-East Nigeria: The Public Health Impact. World Medicine, Volume 4 Number 1

Chunge, RN, Kamunvi, F. and Kinoti S.N Intestinal parasitoses in Kenya; (1985) A review of intestinal helminthes in Kenya, (1900-1983), East Africa Medical Journal. 62:558

Coles, G.C Allergy and immunapathology of ascariasis in: Ascariasis and its public health significance. (DWT Crompton MC Neshein and ZS Pawlowski eds) London and Philadelphia: Taylor and Francis**. (**1985), pp167-184

Cooper, E.S. Bundy, D.A.P Henry, F.J Chronic dysentery stunting and whipworm infection. Lancet, ii: (1986)**.** 280-1

Cooper E.S. Epidemiology and transmission of intestinal parasites. In: Enteric infections, intestinal helminthes (Editors. MJG Farthing, GT Keusch, D. Wakelin); Chapman and Hall Medical, (1995), pp201-12.

Conway, D.J; Lindo, J.F.; Robinson, R.D. and Bundy, D.A.P. (1995). Towards effective control of Strongyloides stercoralis. Parasitology Today 11, 420-427

Cooper E.S and Bundy DAPS. Trichuriasis is not trivial. Parasitology today; 4, (1988)**,** pp301-5

Cram. E.B. Ascaris in preventive medicine. American Journal of Tropical Medicine and Hygiene 6, (1926), 91-114

Croll, N.A. Anderson, RM, Gyorks T.W and Ghadrian, E. (1982). The population, biology & control of Ascaris lumbricoides in a rural community in Iran. Transactions of the Royal society of Tropical Medicine & Hygiene 76, 187-197

Crompton DWT and Neishem M.C (1982). Nutritional Science and Parasitology: Bioscience 32, 677-680

Crompton, D.W.T and Stephenson L.S (1985), Ascaris in Africa: In: Ascaris and its public health significance, edited by, D.W.T Crompton; M.C Neshein and Z.S. Pawlowski, London: Tailor and Francis

Crompton, D.W.T, Biology of Ascaris lumbricoides, in: Crompton, D.W.T, Neshen, M.C. and Pawloski, Z.S. (Eds) (1989), Ascaris and its prevention and control. London: Taylor and Francis, 9-44

Curtale F, Pezzoti P, Sharbini AL, (1998). Knowledge, Perception and Behaviors of mothers towards intestinal helmithes in the Upper Egypt: Implications for control. *Health Policy plan*; 13:pp423-232

De-silva, H. (1997), Childhood intestinal infection in Sri Lanka. *Galle Medical Jo*urnal 1: pp70-80

De-Silva NR, Sirisena JL, Gunasegaram DP, Ismail MM and de-silva HJ (1999), Effects of Mebendazole therapy during pregnancy on birth outcome. *Lancet* 353, 1145 – 9

Doumenge and Mott (1984), Global distribution of Schistosomosis, CEGET WHO Atlas. World Health Statistics Quarterly 37,186 199

Drake L.J, Jukes, M.C.H, Sternberg, R.J and Bundy, DA.P (2000). Geohelminth infections (Ascaris, Trichuriasis and Hookworm). Cognitive and developmental impacts. Semin Pediatr Dis (2000), 11:245-51

Easton A. (1999), Intestinal worms impair child health in the Philippines. British Medical Journal 18:214

Egwunyenga, O. Andy and Ataikiru, D. Palmer (2005), Soil-transmitted helminthiasis among school aged children in Ethiope East Local Government Area, Delta State, Nigeria. African Journal of Biotechnology Vol. 4(9), pp. 936-941, September (2005)

Espinoza, E.M.M., Perez, H.J.S., Gil, M.D.M.G., Morales, G.V., Ramirez, M.P. **(**2003), Intestinal parasites in children, in highly deprived areas in the border region of Chiapis, Mexico.Salud pulica de mexico/vol. 45, no.5.

Fitgerald, P.R. and Ashley, R.F. (1997), Differential survival of Ascaris ova in waste water sludge: Journal of Water Pollution Control Federation, Washington, 1722-1724

Gamboa, M.I.; Basualdo, J.A.; Carboda, M.A.; (2003), Distribution of intestinal parasite in relation to environmental and socio-cultural parameters in La Plata, Argentina. J.Helmintho; 77:15-20

Geissler, P.W. Mwaniki, D. Thiongo, F. and Friis, H. (1998), Geophagy among primary school children in Western Kenya. Tropical Medicine and International Health 2(7). 624-30

Gilman, R.H. (1982), Hookworm disease: Host pathogen biology. *Review of Infections Disease 4* (A), 824-829

Glickman L.T, Camara A., Glickman N.W McCabe G. P Nematode intestinal parasites in children in rural Guinea Africa, Prevalence and Relationship Geograohagia. Intl Epidemiol (1999), 28: 169-74

Geissler, P.W. Mwaniki, D. Thiongo, F. and Friis, H. (1998), Geophagy as a risk factor for geohelmith infections: a longituidinal study among Kenyan school children. Transaction of the royal Society of Tropical Medicine and Hygiene 92, 7-11

Hall A, Latham MC, Crompton DWT, Stephenson LS and Wolgemuth JC (1984), Intestinal parasitic infections of men in four regions of rural Kenya. Transactions of the Royal Society of Tropical Medicine and Hygiene 76, 728-733

HandzeL T, Karanja D.M.S, Addiss D.G, Hightower A.W, Rosen D.H,Colley D.G, Andove J, Slutsker L and Secor E (2003), Geographic distribution of Schistosomosis and soil-transmitted helminthes in Western Kenya: Implications for anthelminthic Mass Treatment. The American Society of Tropical Medicine and Hygiene

Hotez PJ. (2000), Paedtric geohelminth infections: Trichuriasis, Ascariasis and hook worm infections seminar paediatrics Infectious Diseases; 11:236-44

Hotez PJ., da silva, N., Brooker, S., Albonico, M., Bthony, J., (2003), Soil transmitted helminth infections, the nature, causes and burden of the condition. Working paper No. 3, Disease Control Priority Project Centre Bethseda, Maryland, Forgatey International National Institute. (2003).

Kagei, N. (1983), Techniques for the measurement of environmental pollution by infective stages of Soil-transmitted helminthes, in: Yokogawa, M. (Ed,) Collected papers on the control of Soil-transmitted helminthes, Vol. 2. Asian Parasite Control Organization, 1983; 27-46

Kennedy, M.W. (1992), Genetic control of the antibody response to parasite allergens. In: Allergy and immunity to Helminths (R Moqbel, ed) London and Philadephia, Taylor and Francis pp 63-80

Kinoti, G.K. (1997), The prevalence of helminth infections in the Kisumu area of Kenya. East Africa Medical Journal 48,490-495

Magnussen, P. Muchiri, E. Mungai, P. Ndovu, M. Ouma, J.H and Tosha, S (1997), A school based approach to the control of urinary Schistosomosis and Intestinal helminth infections in Matuga, Kenya; Impact of a two year chemotherapy programme on prevalence an intensity of infections. Tropical Medicine and International Health Vol. 2 No. 9, 825-831

Makidono, J. (1956), Observation of Ascaris during fluoroscopy. American Journal of Tropical Medicine and Hygiene 5, 699-702

Miller, T.A. (1979), Hookworm infection in man. Advances in Parasitology 17, 315-384

Ministry of Education Headquarters, Nairobi (2007), communication from the chief economist on public primary schools enrolment by Gender and District, (1999 – 2006), in Bondo District.

Muchiri, E.M, Thiong'o, F.W, Magnussen, P, Ouma, J.H. (2001). A comparative study of different Albendazole and Mebendazole regimens for the treatment of intestinal infections in school children of Usigu Division, Western Kenya. The journal of parasitology, vol.87, no.2

Muller R (1975), Worms and disease. A manual of medical helminthology. London: William Heienemman Medical books

Muller, R. (2002), Worms and Human Disease CAB International (2002), Second Edition, CAP 5 pp 152

Nacher, *et al (*2002a*), (*2000*),* M. Singhasivanon, P. Yimsamran, S. Manibunyong, W, Thanyavanich, N. Wuthisen R. Loareeuwan, S. (2002) Intestinal helminthes are associated with increased incidence of Plasmodium falciparum malaria in Thailand. *J. Parasitol*; 88:55-8

O'Hanley, P. Pool, T. (1995), Ascariasis. In: Enteric infection 2, Intestinal Helminths (Eds. MJG Farthing, GT Keusch, D Wakelin) Chapman and Hall Medical, pp 117-28

Okyay, P.; Ertug,S.; Gultekun, B. Onen, O. Beser, E. (2004), Intestinal parasites and related factors in school children, a Western city sample-Turkey, BMC Public Health. (2004), 4:64

Olsen A, Nawiri J and Friis H (2000), the impact of iron supplementation on reinforcement with intestinal helminthes and Schistosoma mansoni in Western Kenya. Transaction of the Royal Society of tropical Medicine and Hygiene 94,493-499

Olsen A, (2003), Experience with school-based interventions against soil-transmitted helminthes and extension of coverage to non-enrolled children: Acta Tropica (2003), 255-266

Oberhelman RA, Guerrero ES, Fernandez ML, Silio M, Mercado, Comiskey N. (1998), Corelation between parasitoses, physical growth and psychomotor development among infants and children from rural Nicaragua. Am J Trop Hyg; 58:472-5

Pamba, H.O, (1980), Hookworm and Ascaris infection in Nyanza Province, Kenya. East African Medical Journal 57, 891-97

Pawlowski, Z.S. and Arfaa R (1984b), Chapter 41- Ascariasis in: Tropical and Geographic Medicine, edited by KS Warren and AAF Mahmoud (New York: Mc Graw Hill), pp 380-385.

Pawlowski, Z.S, Schad GA and Scott DJ (1991), Hookworm infection and Anaemia. Approaches to prevention and control, WHO, Geneva

Sackey ME, Weigel M.M and Armijos RX. (2003), Predictors and nutritional consequences of intestinal parasitic infections in rural Ecuadorian children. J. Trop Paedriatric 49:17-23

Savioli, L. (1999), Treatment of Trichuris infection with albendazole. Lancet (British edition) 353 (9148, 237.)

Schad, G.A and Banwell, J.G (1984), Hookworm, In: Tropical & Geographic Medicine Editions Warren KS & Mahmoud AAF. New York: Mc Graw Hill, pp359-372

Sternberg R.J, Mc Grane, P. Powell, C. (1997), Effect of a parasitic infection on cognitive functioning. J Exp Psychol; 3:67-76

Stephenson L.S. Holland C.V and Cooper, E.S (2000), The public health significance of Trichuris trichuria. Parasitology; 121suppl: 573-95

Stephenson, L.S, National experiences of Ascaris control measures; Ascaris and its prevention and control, edited by DWT Crompton, MC Neshein and ZS Pawlowski, London: Taylor and Francis pp207-222

Stephenson, L.S, Latham MC, Kurz KM, Kinoti, S.N, Brigham H. (1989)**,** Treatment with a single doze of albendazole improves growth of Kenyan school children with hookworm, Trichuris trichuria and Ascaris lumbricoides infection. Am J Med Trop Hyg; 41:78-87

Sun, T., Schwarz, N.S., Sewell, C., Lieberman, P. and Gross, S. (1991), Enterobius egg granuloma of the vulva and peritoneum: review of the literature. American Journal of Tropical Medicine and Hygiene 45, 249-253

Thiong'o, F.W, Luoba A & Ouma, J.H (2001), Intestinal Helminths and Schistosomosis among school children in a rural District in Kenya. *East* African Medical Journal 78, (6) 279-282

Ukpkai, O.M. and Ugwu, C.O. (2003). The prevalence of gastro-intestinal tract parasites in primary school children in Ikwano Local Government Area of Abia State, Nigeria. Nig J Parasitol; 240: 129-36

Walsh and Warren Selective primary health care. Nature: (London) 258, (1979)**,** 113-117,

Wamae, C.N., Mwanza, J., Makama, S., Ministry of Health, Kenya. International Child Survival and Emerging Infections Program Support Activity and Epidemiology of Parasitic Diseases, (1998), National Centre for Infectious Diseases; and an Epidemic Intelligence Service Officer, CDC

WHO Informal consultation on parasitic infections. Geneva. 9-1 July (1990) WHO mimeographed document no. WHO/CDS/IPI/90.1. (1990), 1.

WHO The control of schistosomiasis: Technical Report series 832 World Health Organization. (1993), Geneva Swirtzeland. P.86.

WHO Report of the WHO informal consultation on Schistosomosis control. WHO/CDS/CPL SIP/99.2, (1998), Geneva

WHO Guidelines for evaluation of soil-transmitted helminthiasis and schistosomiasis at a community level (1998c), WHO/CTD/SIP/98.1. Geneva.

WHO Making a difference. World health report. Geneva: World Health Organization; (1999)

WHO Prevention and control of schistomiasis and soil-transmitted helminthiasis: Report of WHO Expert Committee. WHO Technical Report Series 912; (2002), WHO-Geneva.

Zulkifli A, Khairul AA, Atiya AS, Abdullah B, Yano A. The prevalence and intensity of soil-transmitted helminthiasis among pre-school children in Orang Asli resettlement villages in Kelantan; Med J Malaysia. (1999), 54:453-8.

APPENDICES

Appendix 1

<u>Schedule of visits to selected Bondo District primary Schools for helminthes prevalence study – 2007</u>

Day	Date	Division	School
Tuesday	18/09/2007	Madiany	Othoche Kahoya
Wednesday	19/09/2007	Madiany	Lusi Gagra
Thursday	20/09/2007	Rarieda	Mahaya Memba
Friday	21/09/2007	Rarieda	Nyamor Kawino
Monday	24/09/2007	Nyang'oma	Serawongo Magak
Tuesday	25/09/2007	Nyang'oma	Minya Otuoma
Wednesday	26/09/2007	Usigu	Pala Got Matar
Thursday	27/09/2007	Usigu	Majengo Bar Awendo
Friday	28/09/2007	Maranda	Kayogo Keyo Kodindo Kambajo Usire

Appendix 2

Questionnaire

PREVALENCE OF SOIL-TRANSMITTED HELMINTHES INFECTIONS AMONG SCHOOL CHILDREN IN BONDO DISTRICT, WESTERN KENYA, 2007.

(1)Questionnaire Number_____________

(2) Date of Study___________________

(3)School____

(4) Division____

Demographic Information

(5) Name of Child____

(6) Sex M [ ] F [ ]

(7) Date of Birth____________________

(8) Age: Years______ Months__________

(9) Height: M_________ Cm_______

(10) Weight: Kg ______Gm___________

(11) No. of Siblings__________________

(12) Birth order_____________________

(13) Religion: Christian [ ] Moslem [ ] None [ ] Other [ ]

Medical history

(14) Have you been treated for worms in the last six (6) months? Yes [ ] No [ ]

(15) Are you currently taking any drugs for worms? Yes [ ] No [ ]

(16) What complaints do you have?

Abdominal pain	[ ]	Nausea/Vomiting	[ ]
Lack of appetite	[ ]	Abdominal distension	[ ]
Intestinal dismotility	[ ]	Salivation during sleep Headache	[ ]
Irritability in sleep	[ ]	Perianal itching	[ ]
Teeth grinding	[ ]	History of parasitic infection	[ ]

Socio-economic factors

(17) Mother's/ Guardian's education level:

None [ ] Primary [ ] Secondary [ ] Tertiary [ ]

(18) Household's head occupation: Farming [ ] Fishing [ ] Trader [ ] other [ ]

(19) Monthly income: ≤1000/- [ ] 1,000/- [ ] 5,000/- [ ]
5,000/- [ ] 10,000/- [ ] ≥ 10,000/- [ ]

(20) Type of house: Grass thatched [ ] Semi-permanent [ ] Permanent [ ]

(21) Ownership of a Radio set: Yes [ ] No [ ]

(22) Ownership of a Television set: Yes [ ] No [ ]

(23) Water source: Tap Borehole [ ] Rain [ ] River/Stream [ ] Lake [ ]

(24) Cooking fuel: Electricity [ ] Gas [ ] Kerosene [ ] Wood [ ]

Risk factors

(25) Do you have a toilet at home? Yes [ ] No [ ]

(26) If no where do you go to relieve your self?

Bush [ ] River [ ] Lake [ ] Neighbour's toilet [ ]

(27) Do you wash your hands after relieving your self? Yes [ ] No [ ]

(28) If yes, how often? Always [ ] Sometimes [ ] Never [ ]

(29) Do you clean the peri-anal area after you relieve your self? Yes [ ] No [ ]

(30) If yes, how often? Always [ ] Sometimes [ ] Never [ ]

(31) Do you help your parent /guardian at the farm? Yes [ ] No [ ]

(32) If yes, do you wear shoes or gumboot while at the farm? Yes [ ] No [ ]

(33) Do you wash fruits before eating them? Yes [ ] No [ ]

(34) If, yes how often? Always [ ] Sometimes [ ] Never [ ]

(35) Do you wash your hands before eating? Yes [ ] No [ ]

(36) If yes, how often? Always [ ] Sometimes [ ] Never [ ]

Appendix 3

Research Authorization

REPUBLIC OF KENYA

MINISTRY OF SCIENCE & TECHNOLOGY

Telegrams: "SCIENCE TEC", Nairobi
Telephone: 02-318581
E-Mail:ps@scienceandtechnology.go.ke

JOGOO HOUSE "B"
HARAMBEE AVENUE,
P.O. Box 9583-00200
NAIROBI

When Replying please quote

Ref. MOST 13/001/ 37C 577/2

30th August 2007

Dan Owiti
Jomo Kenyatta University
P.O. Box 62000
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on, ***'A Study to Determine the Prevalence of Soil Transmitted Helminthes Infections in Bondo District, Kenya 2007.***

I am pleased to inform you that you have been authorized to carry out research in Bondo District for a period ending 31st July 2008.

You are advised to report to the District Commissioner and the District Education Officer Bondo District before embarking on your research project.

On completion of your research, you are expected to submit two copies of your research report to this office.

M. GATOBU
FOR: PERMANENT SECRETARY

FOR PERMANENT SECRETARY
MINISTRY OF SCIENCE AND

Copy to:

The District Commissioner
Bondo District

Reported for research on 14/9/2007.
DISTRICT COMMISSIONER
BONDO

The District Education Officer
Bondo District

Reported for Research on 13/9/2007

for.
DISTRICT EDUCATION OFFICER
BONDO DISTRICT
P O BOX 580 BONDO

Appendix 4

Consent Agreement for Children

CONSENT FORM FOR THE STUDY ON THE PREVALENCE OF SOIL-TRANSMITTED HELMINTHE INFECTIONS (STHI's) AMONG SCHOOL CHILDREN IN BONDO DISTRICT, 2007

My name is______________________________. I work with the Ministry of Health and I am based in______________________________. We are undertaking a study to determine the prevalence of STHI's among school children in Bondo District. The study will benefit those children found infected with the worms as they will be treated. You may refuse or allow this child to participate in this study.

If you allow this child to participate in this study then we would like to ask you a few questions on his/her behalf regarding this study. We will then provide this child with a stool container in which he/she will put a small amount of stool which we will collect for analysis in the laboratory at the District hospital. The laboratory result will be given to the child later and if found infected with the worm he/she will be appropriately treated.

Please kindly give me your name and append your signature or thumbprint on this form if you consent for the child to take part in the study and if you are willing to be asked questions.

Thank you.

Name:______________________________________

Signature____________________________________

Date: _______________________________________

Consenting for: ________________________________

Questionnaire No. ______________________________

Appendix 5

Bondo District Laboratory Report Form-2007

Questionnaire No.________________Date sample taken_______________________

Name of child__________________ Sex_____________Age___________________

School__________________________Division_____________Location_________

Bondo District Laboratory Report Form-2007

Questionnaire No.______________Date sample taken_______________________

Name of child________________________Sex_____________Age_____________

School________________________Division_____________Location_________

[

Appendix 6

Procedure for Stool Examination by Direct Method

1. The stool sample was macroscopically examined and its colour, consistency and whether adult worms or segments were present noted

2. Using an applicator stick a small amount of stool (bean size) was taken and put on a microscope slide

3. A drop of Normal saline was added onto the stool and the stool emulsified using the applicator stick

4. Another drop of Lugol's Iodine was added onto the stool and further emulsified using the applicator stick

5. The preparation was then covered with a cover slip

6. The slide was transferred onto the microscope stage

7. The preparation was then examined under x 10 and x 40 objectives and any observation made reported on laboratory report form

Appendix 7

<u>Procedure for Stool examination by Formol-Ether concentration technique</u>

1. Using an applicator stick a small amount of stool (bean sized) was taken and put in a mortar with 7ml of Formol saline
2. The stool was emulsified in the Formol saline using a pestle
3. The suspension was strained into a centrifuge tube placed in a funnel through four (4) layers of wet surgical gauze
4. 3 ml of Ether was then added into the centrifuge tube
5. The centrifuge tube was corked with a rubber stopper and the tube shaken for 30 seconds to mix
6. The centrifuge tube was uncorked and transferred into a centrifuge and span at 2000 RPM for 2 minutes for sedimentation to occur
7. The centrifuge tube was removed from the centrifuge and using an applicator stick the plug was carefully dislodged and the supernatant discarded
8. The centrifuge tube was shaken and the sediment transferred onto a microscope slide
9. A drop each of Normal saline and Lugol's Iodine were placed onto the preparation
10. The preparation was then covered with a cove slip
11. The slide was then transferred onto the microscope and examined under X10 and X40 objective and any observation made reported on laboratory report form.