SURVEY FOR EGGS OF GEOHELMINTHS IN SCHOOL PLAYGROUNDS AND PALMS OF PUPILS IN BWARI AREA COUNCIL, ABUJA, NIGERIA.

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DECLARATION

I declare that this thesis entitled SURVEY FOR EGGS OF GEOHELMINTHS IN SCHOOL PLAYGROUNDS AND PALMS OF PUPILS IN BWARI AREA COUNCIL, ABUJA, NIGERIA was carried out by me in the department of Veterinary Public Health and Preventive Medicine under the supervision of Professor I. Ajogi, Dr E.C. Okolocha and Dr O.O. Okubanjo. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for the award of another degree or diploma at any University.

Chigozie Onyeka CHUKWUDIKE ---------------------------- ---------------------

Signature Date

CERTIFICATION

This thesis entitled "SURVEY FOR EGGS OF GEOHELMINTHS IN SCHOOL PLAYGROUNDS AND PALMS OF PUPILS IN BWARI AREA COUNCIL, ABUJA NIGERIA, by Chigozie Onyeka CHUKWUDIKE meets the regulations governing the award of the degree of Master of Science in Veterinary Public Health and Preventive Medicine, Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to the Almighty God who provided all I needed throughout the course of this study.

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ABSTRACT

Helminth infestation has remained a public health problem in the tropics and subtropics. This study was conducted in Bwari Area Council, Abuja FCT, to determine the level of contamination in soils of pre-primary and primary schools' playgrounds and palms of pupils by zoonotic helminths. Twenty schools were randomly selected from 10 wards comprising of 10 each of private and public owned pre/primary schools in Bwari Area Council. Fifty grams of soil were collected from each of the randomly selected playgrounds. The samples were transported to the Helminthology Laboratory of Department of Veterinary Parasitology and Entomology, Ahmadu Bello University, Zaria where floatation technique, direct smear method and sedimentation techniques were used to recover helminth eggs. The eggs were counted using McMaster. Of the 400 soil samples that were analyzed, 6607 parasite eggs were observed out of which 4,836 were helminth eggs while 400 swab samples collected from the pupils palm had a prevalence rate of 11(4.2%). The distribution of helminthe eggs from the playground was found to be; *Taeniid* eggs 1480(30.6%), *Toxocara* eggs 863(17.8%), *Fasciola* eggs 179(3.7%), *Strongyle* eggs 169(3.5%), *Hookworm* eggs 1260(26.1%), *Schistosome* eggs 3(0.06%), *Trichuris* eggs 482(9.9%), *Strongyloides* eggs 400(8.3%), beside helminth eggs, *Coccidian* oocysts 1065(16.1%) and Mite eggs 863(13.1%) were also recorded. A dry and rainy period prevalence rate of helminths showed that 3,592 (74.3%) was recorded during the rainy season while 1,244 (25.7%) was recorded during the dry season respectively. There was a significant association between the occurrence of helminth eggs and the season of the year (χ^2 = 203.1, $P < 0.05$). More helminth eggs were observed from Public schools 3,596 (74.4%) than that of private schools 1,280 (26.5%). There was however, no significant

association between the occurrence of helminth eggs and the schools (χ^2 = 0.6434, P > 0.005). There was a significant association between the occurrence of helminth eggs and soil type, (χ^2 = 6.562, P = 0.0376). There was no significant association between sex and helminth eggs found on pupil's palm (χ^2 = 0.07910, P =0.7785), although prevalence rate was higher in male 46(36.5%) than in female 57(45.9%) children. There was also a significant association (χ^2 = 324.8, P= 0.0001) between the occurrence of helminth eggs observed from pupil's palms and those observed from school's playgrounds. However, there was no significant association between age and helminth eggs obtained from pupils palms (χ^2 = 1.909, P = 0.592, df = 3). Prevalence rate of helminth eggs was also higher among pupils within ages 0-5yrs 46(41.82%). Questionnaire analyses show that the awareness level of the respondent's to soil-transmitted helminth was 37.6% out of 250 respondents. In this study, there was a significant association between children that played with animals 103 (41.2%) and those that had helminth infection (χ^2 = 30.238, P = 0.000), there was also a significant association between children that played with soil and those that had helminthic disease (χ^2 = 14.704, P = 0.000). This study also revealed that there was a significant association between ownership of pet/domestic animals and those that had helminthic infection (χ^2 = 41.870, P = 0.000).. In this Study, there was no significant association between knowledge of soil transmitted helminth and level of educational attainment, (χ^2 = 13.393, P = 0.02000). However, there was also no significant association between the risk factors of soil-transmitted helminth and the children that had helminthic infection, (χ^2 = 2.251, P = 0.895). This study revealed that soils of pre-primary and primary school's playground and palms of the pupil in Bwari Area Council were contaminated with helminth eggs. School based chemotherapy and de-worming of people at risk, public enlightenment programmes should be encouraged to reduce helminthic infection to a control level.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

Appendix

LIST OF ACRONYMN

_ve	Negative
+ve	Positive
AIDs	Acquired Immuno-Defifiency Syndrome
CDC	Centre for Disease Prevention and Control
DALY	Disability Adjusted Life Years
DDT	Dichloro-Dipheny-Trichloroethane
EE	Eosinophilic Enteritis
EPGs	Eggs per Grams
FCT	Federal Capital Territory
L.G.A	Local Government Council
LF	Lymphatic Filariasis
NDTs	Neglected Tropical Diseases
^{O}C	Zero Degree Centigrade
OR	Odds Ratio
R_O	Basic Reproductive Number
SEM	Standard Error of the Mean

SPSS	Statistical Package for Social Sciences
STH	Soil Transmitted Helminth
TDS	Trichuris Dysentery Syndrome
UNICEF	United Nations International Children’s Emergency Fund
VLM	Visceral Larva Migrans
WHO	World Health Organization
$ZnSO_4$	Zinc Sulphate Solution

CHAPTER ONE

INTRODUCTION

1.1 Background of Study:

The term "helminth" refers to a variety of worms that live as parasites in both human and animal bodies. Helminthology is the study of diseases caused by helminth parasites, (WHO, 2004). Helminth infections occur when infective form of worms (eggs, larvae etc) enters mature, lay eggs and feed on man or animal. Helminth parasites are parasitic worms from the phyla Nemathelminthes (roundworms) and Platyhelminthes (flatworms); together, the zoonotic ones comprise the most common infectious agents of humans in developing countries (WHO, 1997). They live and feed on living hosts, receiving nourishment and protection while disrupting their hosts' nutrient absorption, thereby causing weakness and diseases (WHO, 1997).

Some of these helminths are transmitted through the soil (geohelminths). Soil-transmitted helminths refer to the intestinal worms infecting humans that are transmitted through contaminated soil, (CDC, 2010). The soil-transmitted helminths (STH) are one of the world's most important causes of physical and intellectual growth retardation in children. Yet, despite their educational, economic, and public-health importance, they remain largely neglected by the medical and international community.

The parasites that cause helminth infections are naturally present in the environment. However, high prevalence of intestinal parasitic infections in certain parts of the world is closely related to poverty and poor environmental hygiene such as lack of safe water supply, contamination of the environment by both human and animal wastes and poor environmental or personal hygiene (WHO, 1997).

Helminth infection has remained a public health problem in the tropics and subtropics. Because of their high mobility and lower standards of hygiene, school-age children are particularly the population most at risk of these parasites (WHO, 2002).

One estimate has put 120 to 215 million cases of morbidity due to *Ascaris lumbricoides,* 90 to 130 million due to hookworm and 60 to 100 million due to *Trichuris trichiura* infections (Chan *et al.,* 1994a). Children may also be particularly susceptible to the adverse effects of helminth infections due to their incomplete physical development and their greater immunological vulnerability (WHO, 2002). For instance, unclean hands played a vital role in the transmission of ascariasis among school children. Toddlers also have high positive rates of soil-transmitted helminths (STHs), because of the dirty environment in which they play and because contaminated hands by soil were dipped into the mouth quite often, Etim *et al.,* (2002).

These infections are widespread in Africa with high prevalence rate in Nigeria, Ivory Coast, Angola, New Guinea, Zimbabwe and Kenya (Muniz, 2008). Soil contamination with helminth eggs has been reported in different countries worldwide (Alanso *et al.,* 2001; Mizgajska, 2001). In Nigeria, studies on the evaluation of soil transmitted helminths (STH) infections in different localities include those of Mohammed (2010) whichnoted a prevalence rate of 62.3% in recreational parks and gardens, Abuja. Maikai *et al.* (2008) which noted a prevalence rate of 62% of helminthes in Kaduna, Nigeria. Nwosu and Anya (1980) which noted that *88%* of hookworm infestations in Southern Nigeria were due to

Necator americanus, while about 12% were due to *Ancylostoma duodenale.* Sam-Wobo *et al.* (2004) reported prevalence levels of 17.8 to 87% in various communities in Ogun State, South - west Nigeria, which was ascribed to the high biotic potential of the worm as well as the ability of eggs to withstand adverse conditions.

Soil-transmitted helminth infection is found mainly in areas with warm and moist climates where sanitation and hygiene are poor, they also occur in temperate zones during warmer months. These soil-transmitted helminths (STHs) are considered Neglected Tropical diseases (NTDs) because they inflict tremendous disability and suffering yet can be controlled or eliminated, (CDC, 2010). Thus soil contamination' is the most direct indicator of the risk of human infection (Mizgajska, 2001).

1.2 Statement of Research Problem

Parasites, especially helminths, are of great importance to the well-being and development of man, particularly to the many children of the world in whom they constitute a formidable health problem (Savioli *et al.,* 1992). Affected children often suffer serious illness, nutritional defects, cognitive impairments, and occasional death (Ahmed *et al.,* 2003). Children between the ages of three and twelve years are known to often acquire helminth infections, usually with high intensity value (Awogun, 1982; Ferreira *et al.,* 1994). The prevalence and intensity of the helminths are associated with the risk of morbidity and tend to be highest in school-aged children (Brooker *et al.,* 1999). Heavy infestations can cause a range of health problems, including abdominal pain, diarrhea, blood and protein loss, intestinal obstructions, vomiting; weakness, rectal prolapse, physical cognitive growth retardation, and sometimes death may occur (CDC, 2010). Companion animals play a significant role in the transmission of zoonotic diseases worldwide (Schent, 1994). The role of dogs in the transmission of zoonotic helminth diseases cannot be over-emphasized because of the close contact they maintain with humans and other animals.

Intestinal parasites in these pet animals are common pathogenic agents encountered in animal health workers and children. The close association between children and puppies play a significant role in the transmission of such parasites because the prevalence of the infection is mostly higher in young puppies even though all ages are affected, (Ramirez-Borrios *et al.,* 2004).

In sub-Saharan Africa and elsewhere, helminthosis frequently co-exists with malaria, HIV/AIDS, tuberculosis, and elephantiosis. Such co-existence have additive effects, such as severe anemia and synergistic effects, such as increased transmission of the malaria-causing parasite, HIV, and/or increased susceptibility to infection with these pathogens, as well as cause an exacerbated progression of these two killer diseases, (Fincham *et al.,* 2003). The migration of *Ascaris* larvae through the respiratory tract can also lead to temporary asthma and other respiratory symptoms, (John *et al.,* 2006), while the natural movement of worms and their attachment to the intestine may be generally uncomfortable for their hosts. In addition to the low-level costs of chronic infection, helminth infection may be punctuated by the need for more serious, urgent care; for example, the World Health Organization found that worm infection is common reason for seeking medical help in a variety of countries, with up to 4.9% of hospital admissions in some areas resulting from the complications of intestinal worm infections and as many as 3% of hospitalizations attributable to ascariosis alone. Estimates of annual deaths from soil-transmitted helminth infections vary widely, from 10,000, to 65,000, respectively (WHO, 1997).

Geo-helminth eggs have been identified in primary school playgrounds in Kaduna State (Maikai *et al.,* 2008). Over 130 countries worldwide are reported to be endemic with soil-transmitted helminths (WHO, 2008). In Nigeria and other developing countries where there is a uncontrolled population of stray dogs and inadequate veterinary care, there is likelihood of a high degree of soil contamination by helminth eggs. The Nigerian environment in which most of the country's children live is poor in hygiene and conducive for the development of the parasites (Ogo *et al,* 2004; Ajayi *et al.,* 2006).

In Nigeria, in spite of Government's effort in providing clean drinking water (especially in urban areas) and the mounting of regular sanitation exercises, the prevalence of these parasites still remains high especially in children. Lack of adequate attention to helminthic disease accounts for the high incidences in children especially in Nigeria where about 70% of school children are enrolled in primary school (WHO, 2008). Helminthic infestation poses serious problems where diseases, ignorance, poverty and inadequate health care are interwoven (Chigozie *et al.,* 2007).

There is paucity of information on presence or otherwise geo-helminth eggs in pre/primary school playgrounds and palms of pupils in Bwari. The investigation of Mohammed (2010), on helminth eggs in Recreational Parks and gardens in F.C.T. Also, the study of Maikai *et al.,* (2008) on Playgrounds and Living Environment was done in Kaduna, and did not include collection of swabs from palms of pupils. Thus, there is lack of documented information on the presence or otherwise of eggs of geo-helminth eggs in pre/primary school playgrounds and palms of pupils in Bwari Area Council.

1.3 Justification

School children love playing with soil. They are therefore at high risk of infection if such soils are contaminated with geo-helminth eggs. The poor sanitary conditions of environments in pre/primary school's playgrounds, coupled with indiscriminate excretion by man/animals lead to faecal contamination of school's playgrounds soils, food, and water with consequent maturation of eggs of zoonotic helminths (Rai *et al.,* 2005).

The study of Mohammed (2010) which reported a prevalence of 68% for *Toxocara* eggs was conducted on samples from recreational parks and gardens in the FCT, which excludes the Bwari Area Council. Also, the study of Maikai *et al. (*2008) on helminth eggs in Playgrounds of Primary Schools was done in Kaduna, and did not involve collection of swabs from pupils' palms. Ogwurike *et al.* (2010), did a comparative study of helminthiasis among pupils of private and public schools in Jos North L.G.A Plateau State but did not collect soil samples from pre-primary and primary school's playground. Chigozie *et al.* (2007), worked on soil-transmitted helminth infection in school children in South-Eastern Nigeria but did not sample pupil's palms.

In Bwari Area Council of the F.C.T, there is no information on presence or absence of geo-helminths in the palms of pupils and pre-primary and primary school playground soils. The current study therefore seeks to investigate the soils of playgrounds and palms of pupils in the pre-primary and primary schools in Bwari Area Council for the presence of geo-helminth eggs. The findings will provide useful information to the pupils, parents, teachers, school administrators and the general public on the need for precautionary measures against infection with eggs of geo-helminth eggs.

1.4 Aim of the Study

The aim of this study is to determine the level of contamination of soils and palms of pupils by Geo-helminth eggs in the soils of some randomly selected pre-primary and primary schools' playgrounds in Bwari Area Council, Abuja F.C.T, Nigeria.

1.4.1 Objectives

1. To determine the prevalence of geo-helminth eggs in the palms of the pupils and soils of play grounds in randomly selected pre-primary and primary schools in Bwari Area Council of Abuja FCT, Nigeria.
2. To determine the soil factors that affect the distribution of the geo-helminth eggs in the palms of the pupils and soils of the selected pre-primary and primary school playgrounds.
3. To determine the risk-factors associated with the transmission of geo-helminth eggs in the selected pre-primary and primary schools.
4. To determine the association between occurrence of geo-helminth eggs and seasons of the year in selected pre-primary and primary schools.

1.4.2 Research questions

1. What is the prevalence of geo-helminth eggs in palms of the pupils, and in some randomly selected pre-primary and primary school playgrounds in Bwari Area Council?
2. What are the soil factors that affect the distribution of geo-helminth eggs in the soils of these selected playgrounds?

3. What are the risk-factors that are associated with the transmission of geo-helminth eggs in these selected playgrounds?

4. What is the association between occurrence of geo-helminth eggs and seasons of the year in the study area?

CHAPTER TWO

LITERATURE REVIEW

2.1 Intestinal Helminths

The term "helminth" was derived from the Greek word "helmins" (worm). Helminths are worm-like organisms that live and feed off living hosts. Intestinal helminths are a type of intestinal parasite that reside in the human and animal gastrointestinal tract. They represent one of the most prevalent forms of parasitic association. The intestinal helminth parasites that parasitize the domesticated and wild animals and humans are categorized into 3 groups: Cestodes (tapeworms) are of the Phylum Platyhelminthes and belong to the class Cestoda, trematodes (flukes) belongs to the phylum Platyhelminthes and class Trematode and Nematodes (roundworms), which are members of the phylum Nemathelminthes. Although the parasites that cause helminth infections are naturally present in the environment, high prevalence of intestinal infection is closely related to poverty, poor hygiene and lack of education (WHO, 1997).

Scholars estimate that over a quarter of the world's population is infected with an intestinal worm of some sort, with roundworm, hookworm, and whipworm infecting 1.47 billion people, 1.05 billion people, and 1.30 billion people, respectively. Furthermore, the World Bank estimates that 100 million people may experience stunting or wasting as a result of infection (World Bank, 1993). Because of their high mobility and lower standards of hygiene, school-age children are particularly vulnerable to these parasites (WHO, 2002). Children may also be particularly susceptible to the adverse effects of helminth infections due to their incomplete physical development and their greater immunological vulnerability. It is to be expected that children experiencing abdominal pain, nausea and digestive disturbances due to helminth infection will probably have a reduced attention span when present in school, and may even miss a significant amount of schooling due to chronic illness (WHO, 2002).

2.2 **Historical Perspectives**

Helminths have plagued humans since before the era of our earliest recorded history. The eggs of intestinal helminths can be found in the mummified feces of humans dating back thousands of years (Cox, 2002), and we can recognize many of the characteristic clinical features of helminth infections from the ancient writings of Hippocrates, Egyptian medical papyri, and the Bible. These same helminthiases markedly altered the course of modern twentieth century world history (Cox, 2002; Hotez, 2008), especially in China during the Cold War, when the schistosome was known as "the blood-fluke that saved Formosa" because acute schistosomiasis sickened Mao's troops and aborted their amphibious assault of Taiwan (historically known as Formosa) just long enough for American ships to enter the Straits of Taiwan (Hotez, 2002).

Humans are infected by many types of helminths. The nematodes (also known as roundworms) include the major intestinal worms (also known as soil-transmitted helminths) and the filarial worms that cause lymphatic filariasis (LF) and onchocerciasis;

whereas the platyhelminths (also known as flatworms) include the flukes (also known as trematodes), such as the schistosomes, and the tapeworms (also known as the cestodes), such as the pork tapeworm that causes cysticercosis.

The most common helminthiases are those caused by infection with intestinal helminths, ascariasis, trichuriasis, and hookworm, followed by schistosomiasis. Practically speaking, this means that the inhabitants of thousands of rural, impoverished villages throughout the tropics and subtropics are often chronically infected with several different species of parasitic worm; that is, they are polyparasitized (Hotez, 2007).

2.2.1 Global distribution and prevalence

Soil-transmitted helminth (STH) infections rarely cause death. Instead, the burden of disease is related less to mortality than to the chronic and insidious effects on the hosts' health and nutritional status (Stephenson *et al,* 2000). Hookworms have long been recognized as an important cause of intestinal blood loss leading to iron deficiency and protein malnutrition. The iron deficiency anemia that accompanies moderate and heavy hookworm burdens is sometimes referred to as hookworm disease (Hotez *et al.,* 2004). When host iron stores are depleted, the extent of iron deficiency anemia is linearly related to the intensity of hookworm infection (Stoltzfus *et al.,* 1997). Because of their underlying poor iron status, children, women of reproductive age, and pregnant women are frequently the ones most susceptible to developing hookworm anemia (Brooker *et al.,* 2004a). Iron deficiency anemia during pregnancy has been linked to adverse maternal-fetal consequences, including prematurity, low birth-weight, and impaired lactation (WHO, 2002).

Chronic STH infections resulting from *Ascaris, Trichuris,* and hookworm can dramatically affect physical and mental development in children (WHO 2002). Studies have also shown that the growth and physical fitness deficits caused by chronic STH infections are sometimes reversible following treatment with anthelmintic drugs. The effects on growth are most pronounced in children with the heaviest infections, but light infections may also contribute to growth deficits if the nutritional status of the community is poor (Stephenson *et al.,* 2000).

Stoll (1999) published a landmark paper entitled "This wormy world," in which he set out to estimate the number of people infected with helminths worldwide (Stoll, 1999). Over the last 60 years, several estimates have confirmed Stoll's initial observation that hundreds of millions of people harbor parasitic worms (Ottesen, 2000).

It is estimated that approximately one-third of the almost three billion people that live on less than two US dollars per day in developing regions of sub-Saharan Africa, Asia, and the Americas are infected with one or more helminth (Hotez *et al.,* 2006).

2.3 Taxonomy

Helminths are bilaterally symmetrical metazoan belonging to the Phylum Nemathelminthes which are unsegmented, possess an alimentary system with a body cavity, and Plathyhelminthes which are segmented, flattened, cylindrical, bilaterally symmetrical without body cavity. They consist of three classes namely; Nematoda or round worm, Cestoda or tapeworm and Trematoda or fluke (fig 2.1). Cestodes are flat, tape or ribbon-like and segmented with hooks and suckers, sex is hermaphroditic. Trematodes are flat, leaf-like and unsegmented, have suckers, mouth but no anus. Sex is hermaphroditic, except *Schistosoma* spp*,* reproduction is oviparous and through multiplication within larval forms. Nematodes are cylindrical, unsegmented, have a mouth, no hook nor suckers, have an anus. Both male and female have separate sexes. Reproduction is oviparous and larviparous.

KINGDOM ANIMALIA

SUBKINGDOM METAZOA

PHYLUM NEMATHELMINTHES PLATHYHELMINTHES

CLASS NEMATODA (round worm)

CESTODA (tape worm) TREMATODA (fluke)

	NEMATODA (round worm)	CESTODA (tape worm)	TREMATODA (fluke)
Examples	Ascaris *lumbricoides*	*Diphyllobathrium species*	*Clonorchis sinensis*
	Ancylostoma duodenule	*Hymenolopis species*	*Fasiola hepatica*
	Enterobium vermicularis	*Taenia species*	*Fasciolopsis buski*
	Necator Americanus		*Paragonimus westermani*

Strongyloids stercoralis *Schistosoma species*

Trichuris trichuria

Toxocara species (Catis & Canis)

Capillaria species

Trichosomoides species

Gnathostoma species

Filaria species

Fig 2.1: Taxonomy of helminthes Source: (Cheesbrough, 2000)

2.4 **Epidemiology and Burden of Soil Transmitted Helminth Infection**

The greatest number of soil-transmitted helminth infections occur in tropical and sub-tropical regions of Asia, especially China, India and Sub-Sahara Africa. In 2002, an estimated 1.5 billion, 1.3 billion, and 1.1 billion people respectively were infected with *Ascaris,* hookworm, and *Trichiuris,* respectively. Aboutl-2 billion soil-transmitted helminth infections results in severe morbidity, which are associated with the heaviest worm burden (Hotez *et al.,* 2003). Climate is an important determinant of transmission of these infections, with adequate moisture and warm temperature essential for larval development in the soil (Brooker *et al.,* 2006). Equally important determinants are poverty and inadequate water supplies and sanitation (de Silver *et al.,* 2003), In such conditions, soil transmitted helminth species are commonly co-endemic.

The risk of infection in travelers is low. Since adult worms do not multiply in the body, travelers who are diagnosed with intestinal worms generally have few worms. Sporadic exposure to infection is less likely to produce symptomatic disease. Because eggs must pass through a developmental phase in soil before becoming infective or releasing infective larvae, soil-transmitted helminth infections are not transmitted from person to person. It is well established that indiscriminate disposal of human faeces, poor personal hygiene and inadequate water supply contribute to high levels of STH infections. This is of prime importance in health of many populations in third world countries where illiteracy, poverty and associated poor environmental sanitation practices have been implicated in the heavy burden of helminthiasis among children (Bundy, 1995). The relative contribution of environmental climatic and behavioural factors in the transmission of intestinal helminthic infections has been evaluated (Crompton, 1999).

Public health importance of STH infections ranks the highest in morbidity rate among school aged children who often present with heavy infections. These children are vulnerable to nutritional deficiency (Bethony *et al.,* 2006). The infections have been shown to have a negative impact on the physical fitness and cognitive performance of the pupils which have led to calls for school-based periodic deworming programs (Chigozie *et al.,* 2007). Intestinal obstruction, anaemia, malnutrition, dysentery, vomiting and colitis are the major complications associated with STH infections (Cooper, 1991). The high medical, educational, and economic burden of helminth infections, together with their co-endemicity with malaria and AIDS, provides an important rationale for launching a global assault on parasitic worms (Hotez *et al.,* 2007).

Because morbidity from these infections and the rate of transmission are directly related to the number of worms harboured in the host, intensity of infection is the main epidemiological index used to describe soil-transmitted helminth infection (Raso *et al.,* 2004). Intensity of infection is measured by the number of eggs per gram of faeces, generally by the Kato-Katz faecal thick-smear technique. For *Ascaris lumbricoides* and *Trichuris trichiuria,* the most intense infections are in children aged 5-15 years, with a decline in intensity and frequency in adulthood. Whether such age dependency indicates changes in exposure, acquired immunity, or a combination of both remains controversial. Although heavy hookworm infections also occur in childhood, frequency and intensity commonly remain high in adulthood, even in elderly people (Galvani, 2005). Soil-transmitted helminth infections are often referred to as being "over dispersed" in endemic communities, such that most worms are harbored by a few individuals in an endemic area.

There is also evidence of familial and household aggregation of infection with the relative contribution of genetics and common household environment debated (Chan *et al.,* 1997). Estimates of annual deaths from soil-transmitted helminth infection vary widely, from 12, 000 to as many as 135,000. Because these infections cause more disability than death, the worldwide burden, as for many neglected tropical diseases, is typically assessed by disability-adjusted life years (DALY). Since the first disability-adjusted life years (DALY) estimates were provided, there has been much variability in quoted estimates, partly because of different emphasis on the cognitive and health effects (WHO, 2004). The lower estimates assume that most hookworm cases do not result in severe anemia or pronounced protein loss by the host, whereas the higher estimates show the long-term results of infection such as malnutrition and delayed cognitive development, especially in children.

For these reasons, school-aged children have been the major targets for anthelmintic treatment, and the scale of disease in this age group was pivotal in leveraging support for school-based control (Bundy, 2004).

There is evidence to support the high disease-burden estimates from soil-transmitted helminth infections, and highlight the importance of hookworm as a threat to maternal and child health. For example, cross-sectional evidence from Africa and Asia shows that 30-54% of moderate to severe anaemia in pregnant women is attributable to hookworm, and intervention studies suggest that antenatal anthelmintics substantially increase maternal haemoglobin concentrations as well as birth weight and infant survival (Christian *et al.,* 2004). In childhood, hookworm contributes to moderate and severe anaemia in school-aged children, and there is increasing recognition of a similar contribution in pre-school children. These features of hookworm disease need to be better incorporated into disability-adjusted life years (DALY) estimates. Because hookworms are the most widespread species of soil-transmitted helminth in sub-Saharan Africa, where iron stores are low, this consequence of infection could substantially alter the perception of the public-health importance of hookworm. In light of their nutritional and educational effects, soil-transmitted helminth infections clearly need to be re-assessed, as has lately been done for schistosomiasis (King *et al.,* 2005).

For all human soil-transmitted helminths studied to date, which so far includes *Ascaris, Trichuris,* both hookworms*, Enterobius,* and *Strongyloides,* worm burden exhibit a highly over-dispersed distribution so that most individuals harbor just a few worms in their intestines while a few hosts harbor disproportionately large worm burdens. As a general rule, approximately 70% of the worm population is harbored by 15% of the host population. These heavily infected individuals are simultaneously at highest risk of disease and the major source of environmental contamination. In the case of *Ascaris* and *Trichuris* infections, overdispersed distributions also exhibit age dependency, with a peak in the child-age class, but with a subsequent decline among adults. Maximum prevalence of both *Ascaris* and *Trichuris* infections is usually attained before 5 years of age (Bundy *et al.,* 1995).

Most helminth infections, if left untreated, result in multi-year, chronic inflammatory disorders that cause both concurrent and delayed-onset pathology to the afflicted human host (King, 2008). In addition to the overt and dramatic effects of blindness and elephantiasis in individuals with onchocerciasis and lymphatic filariasis (LF), respectively, it is now appreciated that chronic helminth infections are also linked to more insidious persistent health conditions such as anemia, growth stunting, protein-calorie undernutrition, fatigue, and poor cognitive development (Bethony *et al.,* 2006.). These seemingly subtle and often overlooked morbidities are very important because of the high prevalence of helminthiases in the rural developing world, in which any health impairment is substantially magnified in terms of degradation of individual patient performance status (King and Dangerfield-Cha, 2008).

Initially, in childhood, it is the presence of helminth infection and the intensity of infection that determine the risk for disease formation. It is also true that for many of the tissue-invasive helminths, such as the schistosomes and filariae, tissue damage can continue into later adult life, with disease persisting and even increasing long after the infection is cleared. As such, measures of infection prevalence do not capture the prevalence of infection-associated disease, particularly in adult life. Conditions such as elephantiasis, which occurs in individuals with lymphatic filariasis (LF), visual impairment, which occurs in individuals with onchocerciasis; periportal fibrosis and hypertension, which occur in individuals with intestinal schistosomiasis; biliary obstruction, cholangitis, and cholangiocarcinoma, which occur in individuals with food-borne trematodiasis; and urinary obstruction and bladder cancer, which occur in individuals with urinary schistosomiasis, are potentially the most life-threatening consequences of helminth infections. Although most likely to contribute to hospitalization and to cause mortality, these advanced outcomes are rare when compared to the disease burden of the average patient, which is characterized by the subacute morbidities detailed earlier.

The temporal lag between initial high-intensity childhood infection and the delayed onset of "classical" parasite-associated pathologic findings have led to a serious under-appreciation of the day-to-day burden of helminthic diseases. In international health assessments based on the disability-adjusted life year (DALY) metric, DALY calculations are weighted to stress diseases prevalent among adults in the 20-40 age group, and therefore diseases arising primarily in childhood carry far less weight (Anand and Hanson, 1997). In the current Global Burden of Disease (GBD) assessments by the WHO, it is not clear whether prevalence of infection per se was used to gauge the disease burden of helminths or the more appropriate duration of infection- associated pathology, which is often irreversible. The DALY disability weights assigned to specific helminth infections were developed by non-patient committees based on disease scenarios that did not reflect what is now appreciated as the full spectrum of helminth infection- associated pathology (Murray *et al.,* 1996). Although efforts are underway to revise the GBD assessments, it is important that not to underestimate the substantial disease burden of more than one billion individuals worldwide who are affected by helminth infections.

A new focus for assessing the health-burden related to helminthic diseases has been the adoption of patient-based quality-of-life (QoL) interview techniques for assessing disease burden across many international settings (Jia *et al,,* 2007). Although health-related QoL is in some sense a cultural construct, and subjective adaptation to physical impairments is likely to vary from region to region, certain universal features of disease impact can be identified. Implementation of QoL assessment for most prevalent diseases, and the subsequent use of quality-adjusted life years (QALYs) for comparison of disease impacts, is likely to provide the most useful comparison of disease burdens across different societies and their economies.

2.4.1 Epidemiological factors affecting presence of helminth parasites

With the exception of *Strongyloides stercoralis,* helminths do not replicate within the human host. This fundamental aspect of helminth biology establishes a set of transmission dynamics quite different than those for viruses, bacteria, fungi, and protozoa. Prevalence is commonly combined with worm burden (also referred to as the "intensity of infection"), which is commonly measured by the number of eggs per gram (EPG) of feces for intestinal helminths and schistosomes (Anderson, 1982). Based on EPG and their association with morbidity, individuals are classified into categories of light, moderate, and heavy infection by the WHO (Montresor *et al.,* 1998). Furthermore, in the case of soil-transmitted helminths, the WHO recommends use of both prevalence and intensity of infection to classify communities into transmission categories -category I (high), category II (medium), and category III (low). These transmission categories are assigned according to both the number of heavily infected people in the community (greater or less than 10%) and the prevalence of infection (greater or less than 50%). For example, a community with greater than 50% prevalence but less than 10% heavy infection would be considered a category II transmission community (WHO, 2002).

The WHO uses this information in algorithms to determine the type of mass treatment a community should receive. It important to note that the quantitative assessment of worms provides no information on whether the infection represents either a recent or long-term infection nor does it indicate either the length or extent of exposure to infection (i.e. an individual residing near a source of transmission for many years may not necessarily have high egg count despite extensive exposure). There are several key determinants underlying the epidemiology of helminth infections.

2.4.1.1 Effects of Environment, Climate, water and Season on helminth/eggs

Climate and topography are crucial determinants of the distribution of helminth infections (Brooker, 2007). Helminths transmitted by vectors are limited to landscapes in which host and vector come together in the same habitat, resulting highly focal distribution. For example, the distribution of schistosomiasis reflects the biotic and abiotic features (i.e., climatic, physical, and chemical factors) that affect the survival and development of the snail vector. In the case of onchocerciasis, the distribution and incidence of the disease are limited by biogeographic variations favorable to exposure to the blackfly vectors (Bockarie and Davies, 1990). Soil- transmitted helminths are highly affected by surface temperature (Brooker *et al.,* 2003), altitude, soil type, and rainfall.

Adequate warmth and moisture are key features for each of the STHs. Wetter areas exhibit increased transmission, and in some endemic areas, helminth infections exhibit marked seasonality (Brooker and Michael, 2000). Recent use of geographical information systems and remote sensing has identified the distributional limits of helminths on the basis of temperature and rainfall patterns. For schistosomiasis, specific snail intermediate hosts prefer certain types of aquatic environments. Construction of dams is known to extend the range of snail habitats, thereby promoting the re-emergence of schistosomiasis.

2.4.1.2 Effects of age dependency on helminth infestation

Much epidemiologic research has focused on heterogeneity in the intensity of helminth infection by age. Changes in the average intensity of infection with age tend to be convex, rising in childhood and declining in adulthood. For *Ascaris lumbricoides* and *Trichuris trichiura,* the heaviest and most frequent infections are in children aged 5-15 years, with a decline in intensity and frequency in adulthood (Gilles, 1996). Similarly, for all the major schistosomes, the heaviest and most frequent infections are in older children aged 10-15 years (Woolhouse *et al.,* 1991). In contrast, hookworm frequently exhibits a steady rise in intensity of infection with age, peaking in adulthood (Bethony *et al.,* 2002). Similarly, the pathologic events that occur with filarial infections also predominate in adulthood.

Some of the strongest evidence for protective immunity to human helminth infection has come from epidemiological observations of a "peak shift" in prevalence and intensity of infection with age. Briefly, if age-infection data are compared across host populations, the peak level of infection intensity (e.g., EPGs for intestinal helminths) is higher and occurs in younger individuals when transmission is also higher, but the peak intensity of infection is lower and occurs in older individuals when transmission is lower. This shift in the peak level of infection intensity and the age at which this peak occurs is consistent with mathematical models that assume a gradually acquired protective immunity, an interpretation supported by experimental studies in animals (Woolhouse, 1989).

2.4.1.3 Relationship between helminths and poverty, sanitation & urbanization

Helminths depend for transmission on environments contaminated with egg-carrying feces. Consequently, helminths are intimately associated with poverty, poor sanitation, and lack of clean water. The provision of safe water and improved sanitation are essential for the control of helminth infection. Although the STH and schistosome infections are neglected diseases that occur predominantly in rural areas, the social and environmental conditions in many unplanned urban slums and squatter settlements of developing countries are ideal for the persistence of *A. lumbricoides* (Crompton and Savioli, 1993).

In common with many other parasitic infections, STH infections flourish in impoverished areas characterized by inadequate sanitation and overcrowding. It is commonly assumed that *A. lumbricoides* and *T. trichuria* are more prevalent in urban areas, whereas hookworm is more often found in rural areas (Crompton & Savioli, 1993). By contrast, hookworm appears to be equally prevalent in both urban and rural settings. The precise reasons for the urban-rural dichotomies for *A. lumbricoides* and *T. trichiura* are as yet unclear. Differences in prevalence of *A. lumbricoides* and *T. trichiura* in urban and rural areas may reflect differences in sanitation or population density; socio-economic differences may also play an important role. It is clear that further investigations are needed to resolve these issues. However, comparable data on STH infections in urban and rural settings are remarkably few and those that do exist indicate a more complicated picture. Studies which surveyed similar age groups and socio-economic areas indicate that the prevalence of *A.*

lumbricoides and *T. trichiura* differ between urban and rural communities, but in no systematic manner.

Urbanization often accompanies social and economic development, with better opportunities for education, adequate living standards and higher incomes. However, overcrowding and lack of adequate water and sanitation of urban slum communities may increase transmission of STH infections. Investigation of the impact of increased urbanization on STH infections together with assessment of the effectiveness of urban helminth control measures in low-income settings is clearly warranted as increased urbanization may promote the transmission of STH infections, especially *A. lumbricoides* and *T. trichiura.*

2.4.1.4 Effects of Behavior, Household clustering and Occupation on helminth infection

Specific occupations, household clustering, and behaviors influence the prevalence and intensity of helminth infections (Bethony *et al.,* 2001), particularly for hookworm, in which the highest intensities occur among adults (Brooker, *et al.,* 2004b). Engagement in agricultural pursuits, for example, remains a common denominator for hookworm infection. Behavioral and occupational factors, through their effect on water contact, soil contact, interact with environmental factors to produce variation in the epidemiology of soil helminths. Evidence for household clustering of infected individuals exists for most diseases caused by infection with a helminth, including ascariasis, trichuriasis, and strongyloidiasis. This clustering can persist through time, as shown by familial predisposition to heavy infection with *Ascaris lumbricoides* and *Trichuris trichiura* in Mexico. Household aggregation of lymphatic filarial infection (individuals with LF and/or microfilaraemia) has been described in India and Polynesia (Forrester *et al.,* 1988). In one study on schistosomiasis, shared household accounted for 22% of the variance in *S. mansoni* egg counts. There is also some evidence for a similarity in antibody isotype level among family members for crude schistosome antigen extracts, reflecting the degree to which this phenotype might be influenced by genetic factors (Bethony *et al.,* 1999).

2.4.1.5 Effects of polyparasitism on helminth infection

Finally, an increasing number of studies of helminth epidemiology have shown that it is common for individuals to be infected with more than one species of helminth (Fleming, 2006). There is also evidence suggesting synergism and antagonism in concurrent intestinal nematode and schistosome infections as well as filarial nematode and soil-transmitted helminth infections. A number of epidemiological studies have indicated that individuals infected with multiple species of helminth often harbor heavier infections than individuals infected with a single helminth species. An important consequence of simultaneous infection with the parasites that cause hookworm, schistosomiasis, and malaria is severe anemia. It has also been speculated that helminth infections may adversely influence host immune responses to the malaria-causing parasite and other pathogens (Druilhe and Sokhna, 2005).

2.4.2 Prevalence rate of helminth infection in the world

Hundreds of millions of people in the world mainly in developing countries, even today, are infected with soil-transmitted helminths (STH) with a significant amount of morbidity and mortality (WHO, 1997). In some areas, nearly 100% of people are infected (van-Niekerk *et al,* 1979). One estimate has put 120 million to 215 million cases of morbidity due to *Ascaris lumbricoides,* 90 million to 130 million due to hookworm and 60 million to 100 million due to *Trichuris trichuria* infections (Chan *el al,* 1994) with an annual death numbers of 60,000, 65,000 and 10,000, respectively (WHO, 1997). In addition, helminths of animal origin also pose a potential zoonotic health problem. In the developing world, soil contamination rate reportedly range from 20% to 64% (Uga *et al,* 1997). A relatively stable soil contamination rate with *Ascaris* eggs throughout the year attributed to open and indiscriminate defecation has also been reported (Peng *et al.,* 1996).

Contamination of soil with parasite eggs, thus, constitutes a most important risk factor for STH as well as for zoonotic helminth infections. In the industrialized countries, where STH prevalence is very low, investigators have focused their study on zoonotic helminth parasites such as *Toxocara* eggs contamination of sandpits in public parks including the measures to prevent their contamination and extermination of the eggs already present in the sandpits (Uga and Kataoka, 1995b; Mohamed, 2010). Approximately 70% of the health problems in Nepal, a country in South Asia are infections. Of them, STH infection alone is most important (Rai *et al.,*1994) and has been found to significantly affect on the nutritional status of Nepalese (Rai *et al.,* 2000).

2.4.3 **Prevalence rate of helminthosis in Africa**

In areas where annual rainfall falls below 1400mm and temperatures exceed 37-40 °C, there is usually an absence of transmission as demonstrated by studies in Chad (Brooker *et al.,* 2002). *Ascaris* and *Trichuris* are widespread in Ethiopia but with prevalence rates varying considerably: rates are lowest in the low and dry areas of the country than in the more humid highlands. In East Africa, prevalence rates tend to be lower in the relatively drier and less humid coastal areas than elsewhere. In the hot dry areas of Somalia for instance, prevalence is <5%, whereas in the more humid southern areas the prevalence of *Ascaris* is 14-33% and the prevalence of *Trichuris* is 59- 79%. In coastal areas of Kenya prevalence is typically 20-30%, and similar prevalences are also found in coastal Tanzania.

In contrast, prevalence exceeding 50% is common in the heavily populated areas east of Lake Victoria in Kenya (Brooker *et al.,* 2000) and southern areas of Uganda (Kabatereine *et al.,* 2006). *Ascaris* and *Trichuris* are also common on Madagascar, but prevalence varies throughout the island with prevalence highest in the rainforest areas.

The prevalence of soil-transmitted helminth infections tends to be low in much of the Middle East and North Africa, probably because the hot, dry climatic conditions that prevail in much of the region are unsuitable for survival of eggs and larvae. In Algeria, 1.5% of 11,601 individuals living in and around Algeria were found to have ascariasis, while only 2.8% had trichuriasis, and none had hookworm (Bachta *et al.,* 1990). A study that compared prevalence rates in two household surveys (the first undertaken in the mid-1980's and the second in the mid-90s) in Sao Paulo City, Brazil, found a significant decline in the prevalence of both ascariasis and trichuriasis (Ferreira *et al.,* 1994). Both infections were found in less than 5% of the study population in the second survey. The decline in prevalence was attributed to improved family income, maternal schooling, housing, sanitation and access to health care.

2.4.4 Prevalence rate of helminth infection in Nigeria

In Nigeria, studies on the evaluation of soil-transmitted helminth (STH) infections in different localities include those of Adeyeba and Akinlabi (2002), Etim *et al.* (2002), Nock *et al.* (2003), Maikai *et al.* (2008).

Nwosu and Anya (1980) noted that 88% of hookworm infestations in Southern Nigeria are due to *Necator americanus,* while about 12% are due to *Ancylostoma duodenale.* Sam-Wobo *et al.* (2004) reported prevalence levels of 17.8 to 87% in various communities in

Ogun State, South - West Nigeria, which was due to high biotic potential of the worm as well as the ability of eggs to withstand adverse conditions. Maikai *et al.,* (2008) noted a 62% prevalence of helminth eggs in primary schools and residential areas in Kaduna state. Ogwurike *et al.* (2010) noted an 82.56% prevalence rate of helminth infection amongst pupils of both public and private schools in Jos Plateau state.

Investigation in dogs within Zaria, Kaduna State of Nigeria by Ajanusi and Gunya (1998) showed *Ancylostoma* species to have the highest prevalence (30%) followed by *Diphylidium* spp (19.4%), *Toxocara* species (17.5%) and *Taenia* species (9.4%). The study revealed that infection with intestinal helminthe is endemic for dogs in Zaria area. In Calabar, Etim and Akpan (1999), examined 160 soil samples and reported prevalence rates of 37.5%, 17.5% and 5% for *Ascaris lumbricoides,* hookworm and *Trichuris trichiura* eggs respectively. Ajanusi and Asiribo (2004) carried out a ten-year analysis on the effect of age, sex and season on the prevalence of *Ancylostoma* and *Toxocara* in dogs in Zaria. They came up with the conclusion that the number of dogs with single infection was significantly higher than those with mixed infections and that male dogs were more affected, and that *Toxocara* infection was highest in puppies.

In an investigation on the environmental and socio-cultural variables influencing the distribution of helminth eggs in 608 soil samples from 14 playgrounds that differred in socio-economic status in Kaduna metropolis. Maikai *et al.,* (2008), reported prevalence rate of helminth eggs in this order; *Toxocara* species (50.4%), *Taenia* species/*Echinococcus* species (36.9%), *Dipylidium caninum* (26.3%), *Ancylostoma species* (9.0%), *Ascaris* species (7.2%), *Trichnris* species (3.7%) and *Ascaridia* species *(1.9%).*

In a study conducted to determine the relationship between helminthic infection and nutritional status in pre-school rural children in Nigeria by Tarmramat and Olowu (2008) eggs of *Ascaris lumbricoides* was reported to be the commonest seen in 38.1% of the cases.

In a comparative study of helminthiasis in 2,000 pupils of private and public primary schools in Jos North Local Government Area of Plateau State, Nigeria, Ogwurike *et al.* (2010) reported prevalence rates (%) of 14.6, 7.7, 5.3, 2 and 1.7 for eggs of hookworm, *Ascaris, Strongyloides, S. mansoni* and *T. trichiura* respectively, the overall prevalence being 31.6%. The overall prevalence in the 1000 public primary school pupils examined was 46.6% compared to 16.6% in pupils from the private schools examined.

The burden of the disease regarding mortality is difficult to estimate in Nigeria due to poor health infrastructures (Olaniyi *et al.,* 2007). However, many evidence in Nigeria show association between *ascaris* and some acute complications such as intestinal obstructions, appendicitis, and peritonitis (Holland *et al.,* 1996) but many deaths and morbidity occur outside health facilities without clinical examinations and reports. Though the nutritional impact of STH infections is yet to be researched in Nigeria (Olaniyi *et al.,* 2007), available evidence globally associate hookworms with anaemia and iron deficiencies, ascariasis with growth stunting and trichuriasis with decreased school performance is more severe among children and pregnant women. These may have significant contribution to high diarrhea and infant and maternal mortalities in Nigeria. This therefore raises concern on the implications of neglecting STH infections in Nigeria especially on children, pregnant women and the country at large.

2.5 Risk Factors of Helminthosis

Risk factors of helminthiasis may be associated with the following;

- Poverty
- Behaviour, Occupation and socio-economics
- Ethnicity and Culture
- Poor living conditions
- Poor sanitation and water supply
- Family and Housing
- Environmental risk factors (Urban versus Rural Environments)
- Poor quality of soil and climate (high humidity and temperature)
- Poor personal hygiene
- Certain practices - e.g. use of human fertilizer
- Poor health awareness and literacy

2.5.1 Environmental risk factors (urban versus rural environments)

Helminths commonly occur both in urban environments, especially urban slums, and in rural areas. In some instances the prevalence of *Ascaris* infection is actually greater in urban environments (Phiri *et al.,* 2000). In contrast, high rates of hookworm infection are typically restricted to areas where rural poverty predominates (Albonico *et al.,* 1997). The urban-rural dichotomy between Ascaris-Trichuris versus hookworm infections can be partly understood by fundamental differences in the life cycles of these soil-transmitted helminths.

The infective stages of helminths are embryonated eggs having enormous capacity for withstanding the environmental extremes of urban environments. Viable helminth eggs have been recovered from soil samples for more than 10 years after having been first deposited (Crompton, 1989). In addition to ascaroside, *ascaris* eggs are coated with a mucopolysacccharide that renders them adhesive to a wide variety of environmental surfaces; this feature accounts for their adhesiveness to everything from door handles, dust, fruits and vegetables, paper money and coins, etc. (Crompton, 1989). The "five fs" of parasitology, fingers, feces, fomites, flies and food might have originated with helminths in mind. Transmission through the ingestion of most helminth eggs adhering to vegetables is a major route of transmission.

The social and environmental conditions in the unplanned slums of developing countries are ideal for the persistence of *A. lumbricoides* and *T. trichiura.* Many surveys have shown a high prevalence of these infections in children of slums, shanty towns and squatter settlements (Crompton and Savioli, 1993). The degree of contamination by faeces is more likely to be the major factor in the severity of soil contamination by helminth eggs (Uga, 1993). Stray animals play a significant role in such environmental contamination (Paul *et al.,* 1988). Humans also contribute to such environmental contamination by defeacating in the soil (Duniya, 2000). Canine faecal material can last up to 41 months within the natural environment (Guarnera *et al.,* 2000).

2.5.2 **Soil risk factors in transmission of helminth infection**

Ascaris eggs develop best in less permeable clay soils, with survivability increasing with their soil depth (Crompton, 1989). Clay soils are believed to prevent egg dispersal by water (Mizgajska, 1997). The vulnerability of *Ascaris* eggs to direct sunlight may account for part of this observation. Unlike Ascaris and *Trichuris* eggs, hookworm eggs hatch in the soil and give rise to first-stage larvae, which moult to infective larval stages only under precise conditions.

Egg development in the soil is dependent upon a number of factors including temperature (optimal development at 20-30 ^{0}C), and adequate shade and moisture. Mathematical models based on laboratory data show that *A. duodenale* eggs hatch sooner than *N. americanus* eggs, but at a marginally slower rate. Well-aerated, non-adhesive sandy soils (0.5 mm to 2 mm) are particularly conducive to promoting hookworm egg hatching, larval development, and larval migration (Beaver, 1975). Such soil is sometimes known as 'sandy loam'. Changing environmental conditions, specifically deforestation and subsequent silting of local rivers may cause deposition of sandy loam top soils and increased soil moisture that might promote the emergence of endemic hookworm (Lilley *et al.,* 1992). Even though some physical properties of soil (e.g humidity, oxygenation, compactness) influence egg survival within the environment, there is no direct relationship between soil texture (percentage of gravel, sand, clay, silt) and the prevalence of helminth eggs (Mizgajska, 1997). Soil pH and high or low levels of nitrogen and other exchangeable cations affect the prevalence of helminth eggs in the soil (Sam-Wobo and Mafiana, 2004).

2.5.3 Climate risk factor of soil transmitted helminth

Adequate warmth and moisture are key features for each of the soil-transmitted helminths, *Ascaris* and *Trichuris* eggs are hardier than hookworm L3 and therefore survive drier climates better. However, even for *Ascaris* and *Trichuris*, the rates of infection are low in arid climates. At low humidity (atmospheric saturation less than 80%), human *Ascaris* ova do not embryonate; there appears to be no upper lethal limit on relative humidity (Brooker and Michael, 2000). This probably accounts for the low rates of infection in Chad and Mali, where tropical conditions in combination with poverty would ordinarily result in high endemicity (Crompton, 1989). For hookworm, moisture is especially critical. The infective third-stage larvae (L3) migrate along films of moisture. The presence of moisture will therefore allow L3 to travel vertically in the soil, particularly at night. Since the presence of vegetation tends to prevent evaporation and conserve soil moisture, this feature has been used as a useful proxy measure of soil moisture (Brooker and Micheal, 2000).

Around vegetation, L3 will migrate to a height of 30-40 cm in 24-48 hr, if the film of moisture extends this far. L3 are susceptible to dessication and will migrate up and down vertically in response to changing moisture conditions, until the lipid reserves of these non-feeding stages are exhausted (Hotez, 2002). It has been suggested that total rainfall in an area and its seasonal distribution may also help explain observed patterns of infection: wetter areas are usually associated with increased transmission of all three major soil-transmitted helminth infections (Brooker and Michael, 2000). A study of the prevalence of helminth infections along the coastal plains of South Africa found transmission of *A. lumbricoides* to correlate with variables based on annual data, particularly rainfall and temperature (Appleton *et al.,* 1999).

Studies from West Africa suggest that a minimum of 1400 mm annual rainfall is necessary for the prevalence of *A. lumbricoides* to exceed 10%. However, recent work in Uganda demonstrated that moderate to high prevalence can occur in areas with an annual rainfall between 800-1400 mm. This difference illustrates how relationships between prevalence of infection and ecological variables may be local, so it will be important to investigate such relationships in different ecological zones. Altitude probably affects soil helminth transmission through the associated changes in temperature and humidity. It has been postulated that the unique ability of *A. duodenale* L3 to undergo arrested development in the human host, may allow this species to survive during the cold winter months.

2.5.4 Behavior, occupation and socio-economics as risk factors on soil transmitted helminth

Specific occupations and behaviors influence the prevalence and intensity of soil-transmitted helminth infections. Because of the high rates of hookworm infection among adults, occupation probably has a greater influence on hookworm epidemiology. Engagement in agricultural pursuits remains a common denominator for human hookworm infection. Heavy infections in Sichuan Province, China and in Vietnam, for instance, are attributed to widespread use of feces as night soil fertilizer (Humphries *et al.,* 1997; Hotez, 2002), whereas in other parts of Asia (e.g. Hainan) and other parts of the world, high rates of hookworm occur despite the absence of Night soil use. Hookworm has been noted to target families who are involved in agricultural pursuits. The Chinese nationwide survey of 1988-1992, for instance, found the highest prevalence among vegetable growers and farmers (Hotez *et al.,* 2002). In China, hookworm rates are the highest among families that harvest sweet potato and corn (Sichuan Province), but also tobacco, cotton, soybeans, and rapeseed. In India, Bangladesh, and Sri Lanka high rates of infection are observed among workers and their families in the tea gardens, while high rates in Latin America occur among banana growers and on the coffee fincas. Plantation- style agriculture is a particular set-up for endemic hookworm infection.

Along with malaria, and its associated genetic polymorphisms, hookworm is considered one of the major so-called "agriculture-related anaemias". Hookworm is generally not considered a water-borne infection. In at least one instance in the Niger Delta of Nigeria, this mode of transmission was linked to high rates of infection among fishermen (Udonsi, 1988; Udonsi and Amabibi, 1992). Several studies have investigated the effect of socio-economic status in both rural areas and urban areas, and a recurrent finding of studies is that there is no consistent association. For example, work in Madagascar show that *Ascaris* worm burden is more influenced by ethnicity and sex than socioeconomic factors. This is in contrast to studies in Panama, which show significant associations. In the urban setting of Lubumbashi, Zaire, factors related to poor sanitation were important in areas of low socio-economic status, but not high socioeconomic status. The role of sanitation has traditionally been noted to have a major influence on the prevalence and intensity of soil- transmitted helminthes and will be discussed under control.

Also important is the density of people in the house and household clustering. The impact of shoes and other footwears on interrupting hookworm transmission has probably been overestimated, given that *N. americanus* infective larvae penetrate all aspects of the skin and *A. duodenale* larvae are orally infective. In Hainan, shoes were observed to have no impact on preventing transmission and may have even been a risk factor (Bethony *et al.,* 2002).

2.5.5 Ethnicity and culture as risk factors on soil transmitted helminthes

In a few well-documented instances, an apparent relationship between prevalence, worm burden and ethnicity have been described. This includes higher rates of *Ascaris* infection among more sedentary Bantus compared to Pygmies in the Central African Republic, as well as higher rates of infection in Malay or Indian people of Malaysia compared to the Chinese (Crompton, 1989). In India, (Nawalinski and Chad 1974) found a greater prevalence of hookworm among Muslims compared to Hindus despite their observation that both groups live in proximity to each other and that their behavior with respect to risk factors ordinarily attributed to soil- transmitted helminth infections did not appreciably differ.

2.5.6 Family and housing as risk factors of soil transmitted helminth

Ascaris prevalence and worm burdens have been noted to be higher among children from large families (Prakash *et al.,* 1980). The order in which a child is born into a large family may also affect his likelihood of becoming infected (Adekunle *et al.,* 1986). In Panama, houses made from wood and bamboos are associated with significantly higher rates of soil-transmitted helminth infections than concrete houses (Holland *et al.,* 1988).

2.5.7 Food as risk factor of soil transmitted helminth

Although not classically considered food-borne illnesses, *Ascaris eggs* and *hookworm* larvae will adhere to vegetables. A survey from Japan found that at one time *Ascaris* eggs were present on 1178 of 2750 items of vegetables sold in 40 Tokyo shops (Kobayashi, 1980). Children living in an area of Marrakesh, Morocco where raw sewage is used for agricultural irrigation were shown to have significantly higher prevalence of *Ascaris* and *Trichuris* infections when compared to a group of children where this was not a common practice (Bouhoulm and Schwartzbrod, 1997).

2.6 Population at Risk of Soil Transmitted Helminths (STH)

2.6.1 School-age children as a high-risk population

School-age children typically have the highest intensity of worm infection of any age group, and chronic infection negatively affects all aspects of children's health, nutrition, cognitive development, learning, and educational access and achievement (World Bank, 2003). Regular deworming can cost-effectively reverse and prevent much of this morbidity. Furthermore, schools offer a readily available, extensive, and sustained infrastructure with a skilled workforce that is in close contact with the community. With support from the local health system, teachers can deliver the drugs safely. Teachers need only a few hours of training to understand the rationale for deworming and to learn how to give out the pills and keep a record of their distribution. School-based deworming also has major externalities for untreated children and the whole community: By reducing transmission in the community of *Ascaris* and *Trichuris* infections, deworming substantially improves the health and school participation of both treated and untreated children, both in treatment schools as well as neighboring schools (Miguel and Kremers, 2003).

2.6.2 Other at-risk populations

Pre-school children (one to five years of age) are also vulnerable to the developmental and behavioral deficits caused by iron deficiency anemia, and recent analyses indicate that hookworm is an important contributor to anemia in this age group (Hotez *et al.,* 2004). Women of reproductive age (15 to 49 years of age) are particularly susceptible to iron deficiency anemia because of iron loss during menstruation and because of increased needs during pregnancy (Bundy *et al.,* 1995). In certain circumstances, male worker populations can also be at increased risk (Guyatt, 2000).

TRANSMISSION

1. Infective eggs ingested in food, from contaminated hands or penetrate the skin

ENVIRONMENT

5. Egg become infective (embryonated) in soil

6. Develop into infective larvae for some weeks (1-2wks). Larvae contaminate soil.

HUMAN HOST

2. Larvae migrate pass the trachea and are swallowed.

3. Become developed and matured worms in the intestine (attach to the wall and suck blood).

4. Eggs produced and passed in feaces or become filariform

Fig 2.2: General life cycle of soil-transmitted helminthes

(Source: Cheesbrough, 1998)

2.7 General Life Cycle of Soil Transmitted Helminths

Helminths' life cycles are very different from that of bacteria and protozoan, which are well- known microbes in the sanitary field. The *Ascaris lumbricoide's* life cycle illustrates these differences well. Wastewater or sludge containing *Ascaris* eggs and used for agricultural works pollute crops. These eggs are not normally infective and to become so they need to develop a larva (embryonated egg). The larva develops in the normal temperature and moisture of soil and crops in around 10 days. If a person ingests 1 to 10 *Ascaris* eggs, by consuming polluted crops for instance, the eggs travel to the intestine adhering to the duodenum. There, the larva begins to develop producing an enzyme that dissolves the shell. When the eggs hatch, the larva leaves the egg, crosses the intestine wall and enters the blood stream. Through the blood *Ascaris* is transported to the heart, lungs and bronchal tubes. The larva remains in the lungs for approximately 10 days before travelling to the trachea from where it is ingested and returned once again to the intestine.

During its journey, many larvae are destroyed, as they are lost in tissues unsuited to their development, but in other cases the larva forms cysts (in the kidneys, bladder, appendix, pancreas or liver) producing damage and requiring surgical removal. Back in the intestine, 2-3 months after its departure, *Ascaris* reaches its adult phase, and, if female, produces up to 27 million eggs. Eggs are passed to the faeces in the unembryonated state and the life cycle begins once again.

Other helminths have an intermediate host, like *Schistosoma* spp. Schistosoma causes schistosomiasis, a common disease in 54 African and some Asian countries. Schistosoma belong to the Trematode group and those infecting humans are colloquially known as blood flukes. During their life cycle schistosome mature eggs are discharged with faeces into the water. The eggs hatch in response to the temperature and light to release the small free swimming larva miracidia. The miracidia penetrate different classes of fresh snails that serve as intermediate host. In around 4 weeks the miracidia develop via a complex sporocyst scheme to the larva cercarial stage forming a single miracidium and thousands of cercariae are produced. The cercariae are once again excreted to water bodies, infecting humans that come into contact with them by penetrating the skin or by consuming the flesh of polluted fish living in the polluted water (which also serve as hosts). Inside humans, cercariae develop into sexually mature adults migrating to the lungs (in 3-4 days). After penetration of the pulmonary capillaries the worms are carried into the blood stream: In the hepatic circulation schistosomes mature to adults and in pairs they migrate to the mesenteric veins (*S. japonicum* and *S. mansoni*) or to the vesical plexus *(S. haematobium).* After 35 days *(S. japonicum, S. mansoni*) or 70 days *(S. haematobium*) the mature eggs are excreted in faeces and/or urine to begin the cycle once again. Hookworm eggs hatch in the soil, releasing larvae that mature into a form that can actively penetrate the skin. People become infected with hookworm primarily by walking barefoot on the contaminated soil.

As is common for infectious diseases, the transmission of STH infections can be summarized by the basic reproductive number (Ro). This is defined as the average number of female offspring produced by one adult female parasite that attain reproductive maturity, in the absence of density- dependent constraints (Anderson 1982). Ro values of between 1 and 6 are estimated, with rates intrinsically highest for *T. trichiura* and lowest for hookworm. In practice, epidemiological studies fail to differentiate between the main hookworm species, *A. duodenale* and *N. americanus,* which will have different epidemiological and ecological characteristics.

Increase in Ro gives rise to increase in infection prevalence (percentage of individuals infected) and infection intensity (number of worms per human host). The dynamic processes involved in STH transmission, such as free-living infective stage development and survival, depend on the prevailing environmental conditions (Anderson, 1982). For example, free-living infective stages present in the environment develop and die at temperature- dependent rates. Maximum survival rates of hookworm larvae, as indicated by proportion of larvae surviving, occur at 20-30 °C. Experimental studies suggest that maximum development rates of free-living infective stages occur at temperatures between 28°C and 32°C, with development *of A. lumbricoides* and *T. trichiura* ceasing below 5 and above 38°C (Beer, 1976), and development of hookworm larvae ceasing at 40°C (Udonsi and Atata, 1987). It is suggested that *A. lumbricoides* eggs are more resistant to extreme temperatures than *T. trichiura* eggs. Soil moisture and relative atmospheric humidity are also known to influence the development and survival of ova and larvae: higher humidity is associated with faster development of ova; and at low humidity (<50%) the ova of *A. lumbricoides* and *T. trichiura* do not embryonate (Otto, 1929).

Field studies show that the abundance of hookworm larvae is related to atmospheric humidity (Nwosu and Anya, 1980). These differing rates of development and survival will influence parasite establishment in the human host and hence the infection levels. Thus, a climate-induced increase in the rate of establishment, while holding parasite mortality constant, causes the parasite equilibrium to rise (Bundy and Medley, 1992). Although seasonal dynamics in transmission may occur, such fluctuations may be of little significance to the overall parasite equilibrium within communities. This is because the life-span of adult worms is typically much longer (1-10 years) than the periods in the year during which R_0 is less than unity, and R_0 will on average will be greater than one, maintaining overall endemicity (Anderson, 1982). For all these reasons, spatial variability in long-term synoptic environmental factors will have a greater influence on transmission success and patterns of STH infection than seasonal variability in a location.

2.8 Clinical Signs and Symptoms of Helminths

Most infections are asymptomatic, especially when few worms are present. Chronic worm infestation is associated with iron deficiency anaemia, and weakness. Heavy infections with intestinal helminths almost never occur in travellers, heavier infections can cause a range of symptoms including intestinal manifestations (diarrhoea, abdominal pain), general malaise and weakness, and impaired cognitive and physical development. Heavy and chronic infestation of *Trichuris* with co-infection of *Entamoeba histolytica* can cause dysentery and resemble hookworm disease, acute appendicitis. People with light infections usually have no symptoms. Morbidity is related to the number of worms harboured. In developing countries, moderate to heavy *Ascaris* infections can impair the nutritional status of children.

The most serious complication is intestinal obstruction, usually of the small intestine. Children may show irritability, failure to thrive, precipitation of protein energy malnutrition and pot belly, occasionally patients may give a history of passing worms in stools in which case description of worms may also be available to arrive at specific diagnosis, oral expulsion of round worm is also sometimes seen. Pulmonary symptoms occur in a small percentage of patients when *Ascaris* larvae pass through the lungs. These symptoms include cough, fever, and chest discomfort. Hookworm infection can lead to anemia and protein deficiency due to blood loss. *Trichuris* infection can cause blood loss as well as dysentery and rectal prolapse. However, travelers are almost never at risk for these more severe manifestations of intestinal helminths. Hookworms cause chronic intestinal blood loss that can result in anaemia.

The most severe manifestation of heavy infection among children is the *trichuris* dysentery syndrome (TDS), which is associated with chronic dysentery, rectal prolapse, anemia, and growth stunting (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 (Drake *et al,* 2000). These deficits sometimes reverse following anthelminthic therapy, particularly when treatments are linked to psychological support (Stephenson *et al,* 2000). The mechanisms by which Trichuris causes neuropsychiatric deficits in childhood are unknown, but their adverse impact on educational achievements and downstream success in adult life are potentially profound. They also add significantly to the burden of disease caused by *Trichuris*, although assigning quantitative values to this feature is difficult.

2.8.1 Nutritional effects of helminthes

Soil-transmitted helminths impair the nutritional status of the people they infect in multiple ways. The worms feed on host tissues, including blood, which leads to a loss of iron and protein. The worms increase malabsorption of nutrients. In addition, roundworm may possibly compete for vitamin A in the intestine. Some soil-transmitted helminths also cause loss of appetite and therefore a reduction of nutritional intake and physical fitness. In particular, *T. trichiura* can cause diarrhoea and dysentery. The nutritional impairment caused by soil-transmitted helminths is recognized to have a significant impact on growth and physical development.

2.9 Common Examples of Intestinal Helminths (geo-helminths)

In the screening of soil samples collected from the environment, eggs of the following geohelminths were recovered in varying prevalences: *Toxocara* species, *Ancylostoma* species, *Dipylidium cariium* and *Taeniid* (Mizgajska, 2001; Ruiz de Ybanez *et al.,* 2004). Others include *Ascaris, Trichuris* and *Ascaridia* species.

2.9.1 Trichuris species

This is also known as "whip worm" because of the whip-like form of the body. Two species of particular interest are *Trichuris vulpis* and *T. trichiura.* The later being a common parasite of humans reported to infect up to 800 million people (Cooper and Bundy, 1988). Most *Trichuris* infections are probably asymptomatic, but in long time infection, heavy worm load can develop (Harold *et al,* 2000). The eggs of *Trichuris* and *Ascaris* are often found together because both require high humidity and access to oxygen for embryonation (Smyth, 1994). Whipworm eggs incubate in the soil. When swallowed, they travel to the colon. Trichuris causes host injury both through direct effects by invading the colonic mucosa and through the systemic effects of infection.

2.9.2: *Ascaris* species (round worm)

Ascaris worms are large and in heavy infections, especially in children, worm masses can cause obstruction or perforation of the intestine and occasionally obstruction of the bile duct and pancreatic duct. Other complications include liver abscesses and appendicitis caused by migrating worms. Worms can pass through the anus or vomited. In 1995, WHO estimated that there were 250 million persons infected with *A. lumbricoides* and 60,000 persons died from ascariasis (Cheesbrough, 2000).

A frequent mode of transmission is through fresh vegetables grown in fields manured with human faeces ('night soil'). Infection may be transmitted through contaminated drinking water. Children playing about in mud (soil) can transmit eggs to their mouth through dirty fingers. Where soil contamination is heavy due to indiscriminate defecation, the eggs sometimes get airborne along with wind-swept dust and inhaled. The inhaled egg gets swallowed and hatch to larvae on reaching the duodenum (Paniker, 2002).

Ascarid eggs can remain viable for over three months in shaded places but are rapidly killed by dry, hot weather, even when they are 15cm deep under the soil exposed to sunlight. Earthworms can transmit the infection mechanically. Ascaris was probably the first etiologic agent of infection ever described in humans with descriptions of the parasite going back to ancient times, and the first scientific description dating back to 1683

(Crompton, 1989). Mature female *A. lumbricoides* worms produce 100,000-200,000 fertilized or unfertilized eggs per day. The detection of *Ascaris* eggs in fresh or fixed stool samples examined by bright field microscopy remains the most reliable means of identifying cases of ascariasis for both individual patients and community surveys.

Fertilized eggs are medium-sized, measuring between 45-75pm in length 35-50pm in width, eggs are oval-shaped to round thick, rough albuminous outer wall with very thick colorless middle layer. Inner layer contains a thin yolk membrane. Egg is golden brown colour with colourless or pale yellow content. Egg is unsegmented with rough granules. Unfertilized egg is generally have layer (88-94mµ length by 39-44mµ), narrow and more elongated; egg content is full of large, round refractile granules.

2.9.3: Toxocara species (round worm)

Toxocara is a natural parasite of dogs (canidae) and cats (felidae) respectively which can cause aberrant infection in humans leading to visceral larva migrans (VLM). The three important species of particular interest are *Toxocara canis, Toxocara leonina* and *Toxocara cati* (Harold *et al.,* 2000). Older animals are infected by ingestion of mature eggs in soil or of larva by eating infected rodents, birds or other paratenic hosts. Eggs are shed in feces and become infective in 2-3 weeks. Human infection is by ingestion of eggs. (Paniker, 2000).

There are four modes of infection of the disease in animals. The most basic (seen in puppies up to 3 months) is through the ingestion of *T. canis* eggs containing the L_2 (second larval development stage) from the environment. In the canine host, the larvae emerge in the intestine and burrow through the epithelial wall to migrate to the lungs, as is the case with other *ascarid* parasites in general (Schacher 1957). From the lungs, L2 molts into L3 climb the trachea, enter the oesophagus and return to the intestinal tract to mature as adult worms. By the sixth month of ages in a puppy, this development ceases at L2. Instead of molting into L3, the L2 travels to a wide range of organs such as muscle, liver, brain, eye as well as gastrointestinal wall. Another mode of infection is the trans-placental route, during pregnancy, L2 become mobilized three weeks to parturition and migrate to the lungs of the foetus where it molts to L3 just before birth. L3 then migrate in the newborn to the trachea, gets swallowed and mature to adult from ‘the intestinal wall within the sixth month of whelping. Where larva migrates to the eye, it causes a condition referred to as ocular larva migrans (Schantz 1989). There is also evidence of central nervous system invasion (Magnaval *et al.,* 1997).

2.9.4: Taenia species

Tania species are members of the phylum Platyhelminthes, and class Cestoda and are often referred to as cestodes or "tapeworms". The cestodes possess many basic structural characteristics of flukes, but also show striking differences. Whereas flukes are flattened, elongated and consist of segments called proglottids. Tapeworm varies in length of 2-3mm to 10mm and may have three to several thousand segments.

Tapeworms are hermaphrodites (monoecious) and every mature segment contains both male and female sex organs. The embryo inside the egg is called the *oncosphere* (meaning 'hooked ball') because it is spherical and has hooklets. Humans are the definitive host for most tapeworms which cause human infection. An important exception is the dog tapeworm *Echinococcus granulosus* for which dog is the definitive host and man the intermediate host. For the pork tapeworm *Taenia solium,* man is ordinarily the definitive host but its larval stages also can develop in the human body. Clinical disease can be caused by the adult worm or the larval form. In general, adult worm causes only minimal disturbance, while the larvae can produce serious illness, particularly when they lodge in critical areas like the brain or the eyes (Paniker, 2002). A characteristics feature of the adult tapeworm is the absence of an alimentary canal; substances enter the tapeworm through tegument. The tapeworm however differs from flukes in the mechanism of egg deposition.

Tapeworm infection is the most common helminth infection in humans with both man and animals acting as definitive or intermediate hosts (Soulsby, 1986). About seven species of *Taenia* are found in the domestic dog which may infect it singly or in multitudes. It includes: *Taenia hydatigena, T. pisiformis, E. granulosus, T. serialis, T. multiceps, T. ovis* and *T. multilocularis.* The most common adult tape worms of man are *T. saginata* or *T. solium* (Soulsby, 1987; Smyth, 1994). *T. saginata* is cosmopolitan most especially where hygiene may be poor or raw or insufficiently cooked meat is consumed (Smyth, 1994). Cysticercosis or neurocysticercosis is the most common parasitic infection of the central nervous system of man (Garcia *et al.,* 2002). Clinical signs of *Taenia* infection include; increased appetite, headache and abdominal pains.

Diagnosis of cestodes infection in man is by isolation of eggs in feaces, though the presence of eggs or proglottids in feaces does not necessarily mean the infection with cysticercus, patients should be evaluated since auto infection can result via fecal oral route. Diagnosis can be through neuroimaging using CT scan or MRI.

2.9.5: Ancylostoma species

Hookworms are nematodes belonging to the family Ancylostomatidae .Human hookworm infection is a soil-transmitted intestinal helminthiasis caused by either *Necator americanus* or *Ancylostoma duodenale.* Intestinal infections with the canine hookworms *Ancylostoma* *ceylanicum* and *Ancylostoma caninum* rarely occur as a consequence of zoonotic transmission (Prociv and Croese, 1996). Hookworms are among the most ubiquitous infectious agents of humankind; some estimates suggest that as many 1.2 billion people are infected worldwide (Chan *et al.,* 1994). The infection is found wherever rural poverty and poor environmental sanitation occurs in a tropical or subtropical climate and adequate moisture.

A. duodenale also has the unique ability to undergo arrested development in humans and may, under certain conditions (Schad *et al.,* 1973; Schad, 1990), enter human mammary glands during pregnancy prior to lactogenic transmission (Hotez, 2000; Yu *et al.,* 1995). *A. duodenale* is considered to be the more "opportunistic species" because of its ability to survive in more extreme environmental conditions, its oral infectivity, greater fecundity and higher virulence (greater blood loss) (Hoagland and Schad, 1978).

Adult hookworms cause chronic blood loss. It has been estimated that a single *A. duodenale* worm ingests about 150) (0.15ml) of blood per day and a *N. Americanus* worm about 30jal (0.03ml) (Cheesbrough, 2000). A single female *A. duodenum* worm may lay about 25,000 to 30,000 eggs a day and some 18 to 54 million during its life time. When a person walks bare-footed on soil containing the filariform larvae, they penetrate the skin and enter the subcutaneous tissue where they break up capillaries of the lung (Paniker, 2002). Some species of zoonotic importance include *Ancylostoma caninum* (affects dogs, wild canidae and sometimes man) and *A. duodenale* (occurs in man and certain wild carnivores and pig) (Soulsby, 1986). The eggs can develop into infective stage larvae in the soil in as little as five days (Bowman, 1999).

Cutaneous contact with the infective stages of canine hoookworms can lead to cutaneous larva migrans (CLM) in humans. *A. braziliense* and *A. canium* are the causal agents of CLM in tropical and sub-tropical parts of the world (Harold *et al.,* 2000). Infection with *A. canium* can also result in eosinophilic enteritis (EE) (Traub *et al.,* 2004).

2.9.6 Schistosoma *haematobium*

Schistosoma haematobium is endemic in 54 countries, mainly in Africa, and the Mediterranean. It is also found in several Indian Ocean islands and small islands off the coast of East and West Africa. *Schistosoma haematobium* is transmitted by cercariae penetrating the skin when bathing, washing clothes, fishing or engaged in agricultural work or other activity involving contact with contaminated water. In most endemic areas, a large proportion of children and teenagers become infected and reinfected. The female lays eggs in the venules (small veins) of the bladder. Human is the only natural intermediate host, snail is the definitive host. The estimated egg output of *S. haematobium* is 20-200 eggs per day. Many of the eggs penetrate through the mucosa into the lumen of the bladder and are passed in the urine.

Eggs can be found in the urine from about 12 weeks after infection. Each egg contains a fully developed miracidium. About 20% of eggs remain in the wall of the bladder and become calcified. *S. haematobium* eggs can also be found in the ureters, rectal mucosa, reproductive organs and liver. The clinical disease is related to the stage of infection, previous host exposure, and worm burden and host response. Cercarial dermatitis (Swimmer's Itch) following skin penetration, results in a macula-papular rash and can last

36 hours or more. Heavy infections in males may involve the penis resulting in scrotal lymphatics being blocked by the eggs (Cheesbrough, 1998).

2.9.6 *Fasciola* Species

Fasciola gigantica is a parasitic flatworm of the class Trematoda, which causes tropical fascioliasis. It is regarded as one of the most important single platyhelminth infections of ruminants in Asia and Africa. Estimates of infection rates are as high as 80-100% in some countries. The infection is commonly called fasciolosis. *Fasciola gigantica* causes outbreaks in tropical areas of southern Asia, Southeast Asia, and Africa. The geographical distribution of *F. gigantica* overlaps with *Fasciola hepatica* in many African and Asian countries and sometimes in the same country, although in such cases the ecological requirement of the flukes and their snail host are distinct. Infection is most prevalent in regions with intensive sheep and cattle production. In Egypt *F. gigantica* has existed in domestic animals since the times of the pharaohs.

The life cycle of *Fasciola gigantica* is as follows: eggs (transported with feces) → eggs hatch → miracidium → miracidium infect snail intermediate host → (parthenogenesis in 24 hours) sporocyst → redia → daughter redia → cercaria → (gets outside the snail) → metacercaria → infection of the host → adult stage produces eggs.

Fasciola gigantica is a causative agent (together with *Fasciola hepatica*) of fascioliasis in ruminants and in humans worldwide. The parasite infects cattle and buffalo and can also be seen regionally in goats, sheep, and donkeys. The eggs of *Fasciola hepatica* are operculated and average 140 µm in length and 75 µm in width.

2.9.8 *Strongyloides stercoralis*

Strongyloides stercoralis has a world-wide distribution. It is endemic in many tropical and subtropical countries including those of Africa, Asia and South America. Infection with *S. stercoralis* can occur by infective filariform larvae penetrating the skin and by autoinfection (self-infection) with rhabditiform (first stage) larvae developing into infective filariform larvae in the intestine or on perianal skin followed by penetration of the intestinal wall or perianal skin. Autoinfection enables untreated infections to persist for many years. During migration of the larvae, allergic and respiratory symptoms may occur. Most infections are without serious symptoms. Heavy infections (especially common in children) can cause dysentery, malabsorption, steatorrhoea, and dehydration with electrolyte disturbance. Abnormal pain is common and occasionally finger clubbing. The rhabitiform larvae passed in stools develop in moist soil into free-living males and females which also mate in soil.

2.10 Resistance of Geo-helminth Eggs

Helminth eggs are considered to be the most resistant biological particles in the sanitary engineering field. This resistance is due to their shell, which is comprised of several layers (3-4 depending on the genera). There is an external irregular lipoprotein layer bounded by a trilaminate membrane, a middle chitinous variable thick layer formed with proteins and an inner lipoidal layer (Jaskoski, 1951). The middle layer, divided by some authors into several ones, serves to give structure and mechanical resistance to the eggs. The protein layer is an important barrier preventing the passage of material through the shell. The innermost one, which dissolves in organic solvents, is known as the vitelline or ascaroside layer, and also confers resistance. It is particularly resistant to salts and chemicals which are lethal to other microorganisms. This layer is also useful for protecting eggs from desiccation, strong acid and bases, oxidants and reductive agents as well as detergent and proteolytic compounds. The permeability of the shell is limited to the passage of respiratory gases and lipid solvents, although water may move slowly through it. Changes in the permeability of the shell occur during hatching owing to the breakdown of the lipid layer (Williams *et al,* 1973). It is at this stage that it is easiest to inactivate helminth eggs.

2.11 Factors Affecting the Rate of Detection of Geo-helminth Eggs in the Environment

Intestinal parasitic infections associated with soil have been traced to factors that promote the perpetuation of such infections. These factors include: faecal pollution of the environment (Wong *et al.,* 1994), poor hygienic practices (Mason and Patterson, 1994), contact with animals (Minvielle *et al.,* 1993) and improper waste disposal (Oberg *et al.,* 1993). These factors seem to be common among people in developing countries where the economy is poor resulting in a low socio-economic and educational status and so they are often exposed to parasitic infections (Ukoli, 1992; Motarjemi *et al.,* 1993).

Other factors include climate/physical factors (e.g. rainfall, temperature, humidity, ultra-violet rays/sunlight), vegetation, chemical factors (ammonia, salt, acids etc.) and biological factors (fungi, protozoan, invertebrates and faecal materials). Similarly, factors associated with sampling and laboratory procedures greatly influence the results of investigation on soil contamination. These include selection of sampling sites, number and volume of samples, depth of sampling, season of examination, method of egg recovery, type of soil examined, preservation of samples and laboratory skills (Mizgajska, 2001).

2.11.1 Biological factor:

The biological factors that have been shown to affect parasite eggs include fungi and various invertebrates. The ovicidal fungi are capable of attacking and destroying *Ascaris* *lumbricoides* eggs under experimental conditions during several days or weeks. The rapidity of the ovicidal effect is dependent particularly on the species of ovicidal fungus and type of ovicidity. (Lysek and Bacovsky, 1979).

2.11.2 Chemical factors affecting helminth egg Survival

2.11.2.1 Soil pH

Parasitic eggs are considered to be highly resistant to extreme pH values. The effects of pH on the survival of helminth eggs were investigated by incubating parasite eggs in phosphate buffers at a range of pH at room temperature, 27°C and 37°C (Kiff and Lewis-Jones, 1984). Acid pH levels inhibited normal development *of Ascaris suum* eggs at all temperatures, but highly alkaline buffers allowed development to the infective larval stage. Others demonstrated that *in vitro* hatching ability but not viability of *Taenia* eggs was completely destroyed at pH 12. However, both human and animal hookworm species will successfully hatch and develop to the infective stage over the pH range 4.6-9.4. The ecological significance of this is that faeces and soil, while providing the optimum pH for hatching, may also provide the nutrients and electrolytes required for further development of the larvae to the infective stage. The optimal pH for *N. americanus* eggs hatching was found 6.0 (Udonsi and Atata, 1987).

2.11.2.2 Chemical Substances

A search of the literature revealed several references concerning the resistance of *Ascaris* eggs to chemical substances (Fairbaim, 1957; and Morishita, 1972). It has been reported that *Ascaris* eggs will develop to the infective stage in a wide range of relatively toxic solutions such as 14% hydrochloric acid, 9% sulphuric acid, 8% acetic acid, 0.4% nitric acid, 0.3% carbonic acid, 0.5% sodium hydroxide, 1% mercuric chloride, and 4% formaldehyde. The resistance of these eggs to toxic substances is mainly due to the relatively impermeable inner membrane of the shell, which is lipoid in nature. This lipoid membrane is, however, altered by many organic solvents, including chloroform, ethyl ether, alcohol, phenols, and cresols. It is permeable to respiratory and certain noxious gases; e.g., methyl bromide, hydrogen cyanide, hydrozoic acid, ammonia, and carbon monoxide, which can kill the developing embryo. However, the charged forms of these gases will not penetrate the lipoid membrane (Fairbairn, 1957).

Dichloro-diphenyl-trichloroethane (DDT) is a relatively efficacious insecticide, which is classified as a "contact poison". DDT powder used at full strength and in direct contact with *Ascaris summ* eggs exerted no perceptible effect on their development (Seamster, 1950). Sulfanilamide, a commonly used bacteriostatic substance, was observed to produce no apparent effect on the development of *Ascaris* eggs. Eggs were killed in at least 3 days by exposure to fumes of concentrated ammonium hydroxide. *Ascaris* eggs from which the chitinous shell had been removed by treatment with sodium hypochlorite, hatched much faster than those in which this shell was present (Fairbaim, 1961). The digestion of a hole in the shell was, therefore, a rate-limiting step in the enzymatic response to stimulation. However, if embryonation was carried out in 1% formalin or in 2% sodium dichromate, hatching in 3 hours was reduced to 25% and *2%,* respectively.

Possibly these reagents, which like dilute acid are excellent inhibitors of microbial growth, reacted chemically with the shell to make it resistant to digestion by chitinase or other enzymes. In all of these solutions embryonation itself appeared to be normal. Formalin, and potassium dichromate solutions, have been used very generally as media for the embryonation of nematode eggs, because they are effective germicides but do not hinder development. If, in nematodes besides *Ascaris,* these disinfectant solutions also make the eggs difficult or impossible to hatch, they are obviously unsuitable for use in the study of infectivity and related biological problems. Ozone and chlorine have been found to be capable of killing *Shistosoma mansoni* eggs when present at levels of 4.0 mg/1 and 40 mg/1, respectively (Mercado-Burgos *et al.,* 1975). However, ozone appears to have no effect on the eggs of *Ascaris* or *Hymenolepis* (Reimers *et al.,* 1989), and routine doses of chlorine in wastewater have no effect on parasite eggs (Liebmann, 1964).

2.11.2.3 Oxygen Requirements

Lack of oxygen suppresses the overall metabolism of many nematodes and influences a number of different activities. In *Ascaris* eggs the rate of development is suppressed by low oxygen concentration (Lee and Atkinson, 1976). However, unembryonated eggs will survive for several weeks at room temperature in anaerobic conditions (Brown, 1928), but the development will be inhibited. The super saturation of water with oxygen does not hasten *Ascaris* egg development. Oxygen pressures do not increase embryonic development and when sufficiently great (>506 mm) they prove lethal to the developing embryo in the very early stages of development. The amount of oxygen consumed by a single egg was very small. It is quite likely that *Ascaris* eggs have become adapted to developing in nature in a medium, which is not fully oxygen-saturated, with the result that higher oxygen tensions are not necessary for normal development.

The oxygen requirements of *Trichuris* eggs are not essentially different from those of *Ascaris* eggs. Carbon dioxide given off, if allowed to remain in close contact with the eggs, will retard their development. No nitrogen is given off during development of *Trichuris* embryos (Nolf, 1932).

2.11.3 Climatic factors

There is a higher diversity of parasites in moderate, tropical and subtropical climates where humidity and temperature conditions are appropriate for their development (Cordero del Campillo and Rojo, 1999). Season at which soil is examined if influenced by the climate. Comparism of soil contamination before and after warmest months differ (Mizgajska, 2001). Egg viability is lower in the dry-hot season due to high temperature (Ruiz de Ybanez *et al.,* 2001). Hence, *Toxocara* eggs are physically destroyed by higher temperatures and sunshine (Mizgajska, 2001). The eggs have also been demonstrated by Levine (1968), to survive over winter on the surface of the soil. The eggs die at 37°C when exposed to sunshine. The development of larvae in the environment depends upon warm temperature and adequate moisture. In most tropical and sub-tropical countries, temperatures are permanently favourable for larval development in the environment. Exceptions to this are the highland and mountainous regions throughout the world, and the winters of southern Africa and Latin America where temperatures may fall below those favourable for the development of *Haemonchus* larvae.

The ideal temperature for larval development of many species in the microclimate of the tuft of grass or vegetation is between 22 and 26 °C. Some parasite species will continue to develop at temperatures as low as 5 °C, but at a much slower rate. Development can also occur at higher temperatures, even over 30 °C, but larval mortality is high at these temperatures. The ideal humidity for larval development in this microclimate is 100%; the minimum humidity required for development is about 85% (Mizgajaska, 2001).

The survival of larvae in the environment depends upon adequate moisture and shade. Desiccation from lack of rainfall kills eggs and larvae rapidly and is the most lethal of all climatic factors. Larvae may be protected from desiccation for a time by the crust of the faecal pat in which they lie or by migrating into the soil. Infective larvae may survive for up to 6 weeks or even longer in the manure pats, which act as a reservoir of infections during dry periods. The development of infective larvae ingested by an animal during adverse environmental conditions may be temporarily arrested in the abomasal or intestinal mucosa. This suspension of development helps some nematode parasites survive the dry seasons. Of the three larval stages in the environment (L_1 L_2, and L_3) it is the L_3 which has a protective sheath that is the most resistant to variations in moisture, temperature and sunlight (Mizgajaska, 2001).

2.11.4 Socio-economic factors

Soil-transmitted helminths are one of the world's most important causes of physical and intellectual growth retardation. Yet, despite their educational, economic, and public-health importance (panel), they remain largely neglected by the medical and international community. This neglect stems from three features: first, the people most affected are the world's most impoverished, particularly those who live on less than US$2 per day; second, the infections cause chronic ill-health and have insidious clinical presentation; and third, quantification of the effect of soil-transmitted helminth infections on economic development and education is difficult. Low level of education and poor socio-economic condition of the people are risk factors for the transmission of soil-transmitted helminthes, and children in these categories are more predisposed. Some cultural practices of use of water for cleaning after defecation, eating from a "common bowl practiced in some rural setting" were identified by Akogun, (1989) as a risk factor for the infections in Nigeria.

Over the past 5 years, however, the world-wide community has begun to recognize the importance of these infections after revised estimates showed that their combined disease burden might be as great as those of malaria or tuberculosis (Chan, 1997). Studies have also highlighted the profound effect of soil-transmitted helminth infections on school performance and attendance and future economic productivity (Miguel and Krener, 2003).Such infections might also increase host susceptibility to other important illnesses such as malaria, tuberculosis, and HIV infection (Finchan, 2003). In 2001, the World Health Assembly passed a resolution urging member states to control the morbidity of soil-transmitted helminth infections through large-scale use of anthelmintic drugs for school-aged children in less developed countries.

2.12 Diagnosis of Soil-transmitted helminths

Diagnosis is made by identifying the eggs of soil-transmitted helminths in the microscopic examination of a stool specimen. Adult *Ascaris* worms may occasionally be coughed up or found in stool or vomit. In their definitive host, each adult female whipworm or hookworm produces thousands of eggs per day, and each female *Ascaris* worm produces upwards of 200,000 eggs daily. Because many soil-transmitted helminth infections present without specific signs and symptoms, the clinician typically needs some index of suspicion, such as local epidemiology or country of origin, to request a faecal examination. In some cases, especially of hookworm infection, persistent eosinophilia is a common presenting finding. Several egg concentration techniques-e.g., formalinethyl acetate sedimentation-can detect even light infections. The Kato- Katz faecal-thick smear and the McMaster method are used to measure the intensity of infection by estimating the number of egg counts per gram of faeces. Ultrasonography and endoscopy are useful for diagnostic imaging of the complications of ascariasis, including intestinal obstruction and hepatobiliary and pancreatic involvement (Santos, 2005).

2.12.1 Different diagnostic methods

2.12.1.1 Floatation method

The media used in this diagnostic method are Zinc sulphate solution, sucrose solution or Zinc sulphate/sucrose mixture. Zinc sulphate sucrose floatation is used for the concentration of nematode and cestode eggs, (Cheesbrough, 2000).

2.12.1.2 Sedimentation

This is the ideal method for concentration of all types of eggs and oocysts. It is especially used in the recorvery of trematode eggs in faeces. Formol-ether concentration method has been the most widely used sedimentation method (Paniker, 2002).

2.12.1.3 Direct Smear

This is a qualitative method of feacal examination. Because of the small amount of faeces involved, it is unlikely to be rewarding except in fairly heavy infections.

2.12.1.4 Egg Count

A semi-quantitative assessment of the worm burden can be made by estimating the number of eggs passed in stools. This is done by egg counts and by relating the counts to the number of worms present by assuming the number of eggs passed per worm per day. However, these are at best approximations and only a rough indication of worm burden can be obtained. Egg counts help to classify helminth infections as heavy, moderate or light infection. Egg counts can be done by different methods. The standard wet mount gives rough indication of the number of eggs. Ordinarily, 1-2 mg of feces is used for preparing a wet film and if all the eggs in the film are counted, the number of eggs per gram of feces can be assessed.

2.12.1.5.1 The modified Kato thick smears

These are not useful for routine-examination, but are valuable in surveys for intestinal helminth eggs. The method described by Kato and Miura in 1954 is known as the Kato thick smear technique. About 50 mg feces is taken on a slide and covered with a special wettable cellophane coverslip soaked in glycerine containing aqeous malachite green. The preparation is left for about an hour at room temperature, in which period the glycerine clears the feces enabling the helminth eggs to be seen distinctly under low power magnification. This method is however not useful for detection of protozoa or helminth larvae (Paniker, 2002).

2.12.1.5.2 Modified Mcmaster technique

McMaster's egg counting chamber can be used. Here eggs in 2g of stool are concentrated by salt floatation on the squared grid on the roof of the chamber, which can be counted.

Egg Count/gram = Sum of counts from the two wells x 20.

2.12.1.5.3 Stoll's dilution technique

In Stoll's dilution technique, 4g of feces is mixed thoroughly with 56 ml of NaOH, using beads in a rubber-stopper glass tube. Using a pipette, transfer exactly 0.75 ml of the sample to a slide, apply cover glass and count all the eggs present. The number multiplied by 200 gives the number of eggs per gram of feces. This figure requires to be corrected for the consistency of feces, by multiplying by 1 for hard formed feces, by 2 for mushy formed feces, by 3 for loose stools and by 4 for liquid stools. Watery stools are unfit for counting.

2.13 Prevention and Control of Helminth Infection

a. Control strategy

A well structured control strategy needs to be based on: (a) local and accurate data concerning the epidemiology, (b) definition of targets, (c) definition of appropriate chemotherapy and health education campaigns, (c) sanitation, (d) monitoring and (e) evaluation programmes (Albonico, 1999). The world health organization (WHO) has recommended three interventions to control morbidity due to STH infections: regular drug treatment of high-risk groups for reduction of the worm burden over time, health education and sanitation supported by personal hygiene aimed at reducing soil contamination (WHO, 2005).

There are two types of basic control programs: (a) those oriented to treating patients (chemotherapy) and (b) those oriented to cutting the oral-faecal exposure (sanitation). In practice, both are needed. Control programs based on sanitation aim to reduce or interrupt transmission, prevent re-infection and gradually reduce worm loads (Bundy *et al.,* 1994). But to be effective in a short period of time they need to be combined at their first stage with chemotherapy. Long term control programmes need to add elements to improve the economic conditions of a region, to ensure a reliable and permanent sanitation system

(Personal and Environmental sanitation) and have permanent health education programmes. Unfortunately, in most developing countries chemotherapy is the only programme applied for economical and practical reasons based mainly on short-term analysis.

2.13.1 Chemotherapy

These programmes consist of the mass treatment of a large segment of population with drugs. The choice of an appropriate antihelmintic drug depends on (a) its safety record; (b) its therapeutic effect (cure rate or efficacy), (c) its spectrum activity; (d) local health policy; and (e) financial considerations. A key issue for the optimal use of an anthelmintic drug is to decide when and how frequently to treat the population of concern. Common drugs used are albendazole, pyrantel, mebendazole, tiabendazole, niclosamide, pyrantel pomoate and lavamisole. From an economic point of view, targeted population chemotherapy programmes are half the price of universal ones. The fact that long-term chemotherapy programmes are not efficient is often overlooked, as when stopped, if proper sanitation systems have not been put in place, individuals' vulnerability to worms increases, both in terms of infectivity (predisposition to catching the diseases) and intensity (number of worms developed per individual).

2.13.2 Health education and communication

Health education is aimed at reducing transmission and reinfection by improve health and increase hygiene awareness and to change health-related behavior in the population. For diseases related to poverty, such as STH infections e.g. schistosomiasis, the aim is to reduce contamination of soil and water by promoting the use of latrines and hygienic behavior, the suggested solution might not be available or might be too expensive to adopt. Deprived communities understand the importance of the safe disposal of fecal matter and of wearing shoes, but poverty often hinders the construction of latrines and the purchase of shoes. The prevalence of STHs in the community can be used as an indicator of the conditions of living, environmental sanitation, level of education and the socioeconomic status of the community. Providing information on the disease and the possible adoption of preventive measures frequently results in an increase in knowledge but not necessarily in behavioral change.

Educational materials (posters, leaflets, radio and video messages) have been traditionally used to transmit and disseminate health-related messages, (Bull, 2001). Reduction in the fecal contamination of soil can be achieved by recommending the use of latrines, developing self-protection from reinfection, and promoting personal/ family hygiene measures such as washing hands and proper food preparation. The knowledge of, and motivation for, behavioral change must be sustained by making available proper facilities for excreta disposal. Frequently, in STH-endemic areas, latrines are not available or are not in sufficient numbers to meet the needs of the population. Promotions of latrine maintenance and use, washing of hands and proper food handling have benefits that go beyond the control of STH infections.

From this perspective, it is reasonable to include health education in all STH-control programs, wherein the health education message can be provided in a simple and inexpensive way. Health education messages can be delivered by teachers in schools, thereby fostering changes in health-related behavior in children, which in turn involves their parents and guardians. The marketing of health education in order to create increased health awareness and changes in habits of defecation are important when aiming to reduce STH infections (Lansdowne, 2000).

2.13.3 Improved sanitation and personal hygiene

Improved sanitation is aimed at controlling transmission by reducing soil and water contamination. Human STHs are fecal-borne infections, and transmission occurs either directly (hand-to-mouth) or indirectly (through food and water). Sanitation in the context of economic development is the only definitive intervention that eliminates these infections, but to be effective, it should cover a high percentage of the population. Soil transmitted helminth (STH) infections are never a public health problem where hygiene and sanitation standards are appropriate. Improvement of sanitation standards always has a repercussion on infection and reinfection levels (Barreto *et al.,* 2007).

Agglomeration and the type of excreta-disposal facility were the only significant predictors of re-infection in studies conducted in the West Indies, showing that the prevalence of STH infections was significantly lower in areas with better sanitation. Similar results were obtained in the plantation sector of Sri Lanka, in urban slums of Bangladesh and in a study in Salvador, Brazil, suggesting that sewerage and drainage can have a significant effect on STH infections, reducing transmission occurring in the public domain (Moreas *et al.,* 2004). In Zimbabwe, despite the marked increase in the number of latrines, no relationship was found between hookworm re-infection intensities and the availability of latrines in individual farms. A study in the Senegal demonstrated that, despite high coverage of the program of provision of latrines, the majority of the children in a village, interviewed with a questionnaire, claimed to defecate elsewhere Sow, *et al.,* (2004).

Sanitation is inadequate in most cities in developing countries, with major effects on STH infections. In this situation, piped sewers are an appropriate solution, and it is questionable as to whether efforts should focus on systems based on onsite solutions, such as latrines. In a metaanalysis study, data suggested that sewerage typically has a positive effect on enteric infectious disease burden. Environmental factors such as water supply for domestic and personal hygiene, sanitation and housing conditions; and other factors such as socioeconomic, demographic and health-related behavior are known to influence this infection. Two principal factors in maintaining endemicity of these helminths are favorable qualities of the soil and the frequent contamination of the environment by human feces. Their transmission within the community is predominantly related to human habits with regard to eating, defecation, personal hygiene and cleanliness.

Sanitation factors such as the reliability of water supply, frequency of rubbish collection and proximity to overflowing or visible sewage are not under the control of individual households. These do not reflect personal hygiene, and their significance suggests that the impact of environmental sanitation on health could have been greater if the governmental systems had been properly operated and maintained. Improved disposal of excreta offers a more sustainable method of control, among many other benefits. Since domestic risk factors assume greater importance after public domain transmission is controlled, the environmental sanitation creates opportunities for synergy with other inputs, such as hygiene promotion, which are aimed at such domestic risk factors (UNICEF, 1999).

The effect of improved sanitation is slow to development and may take decades to achieve a measurable impact. Often, the high costs involved prevent the provision of sanitation to the communities most in need, and sanitation does not become effective until it covers a high percentage of the population. Moreover, when used as the primary means of control, it can take years or even decades for sanitation to be effective (Asaolu and Ofoezie, 2003).

2.13.4 Treatment

The drugs most commonly used for the removal of soil-transmitted helminth infections are mebendazole and albendazole. These benzimidazole drugs bind to nematode [3-tubulin and inhibit parasite microtubule polymerisation, which causes death of adult worms through a process that can take several days. Although both albendazole and mebendazole are deemed broad-spectrum anthelmintic agents, important therapeutic differences affect their use in clinical practice. Both agents are effective against *Ascaris* in a single dose (Lacey, 1990). However, in hookworm, a single dose of mebendazole has a low cure rate and albendazole is more effective (Albico, 2002). Conversely, a single dose of albendazole is not effective in many cases of trichuriasis. For trichuriasis and hookworm infection, several doses of benzimidazole anthelmintic drugs are commonly needed. Another important difference between the two drugs is that mebendazole is poorly absorbed from the gastrointestinal tract so its therapeutic activity is largely confined to adult worms (Adams, 2004). Albendazole is better absorbed, especially when ingested with fatty meals, and the drug is metabolised in the liver to a sulphoxide derivative, which has a high volume of distribution in the tissues.

For this reason, albendazole is used for the treatment of disorders caused by tissue migrating larvae such as visceral larva migrans caused by *Toxocara canis.* Systemic toxic effects, such as those on the liver and bone marrow, are rare for the benzimidazole anthelmintic drugs in the doses used to treat soil-transmitted helminth infections. However, transient abdominal pain, diarrhoea, nausea, dizziness, and headache commonly occur.

Because the benzimidazole anthelmintic drugs are embryotoxic and teratogenic in pregnant rats, there are concerns about their use in children younger than 12 months and during pregnancy (Dayan, 2003). Overall, the experience with these drugs in children younger than 6 years is scarce, although evidence suggests they are probably safe. A review of the use of the benzimidazole anthelmintic drugs in children aged 12-24 months concluded that they can be used "if local circumstances show that relief from ascariasis and trichuriasis is justified". Both pyrantel pamoate and levamisole are regarded as alternative drugs for the treatment of hookworm and *Ascaris* infections, although the former is not effective for the treatment of trichuriasis and they are administered by bodyweight (Montresor and Crompton 2003).

2.13.4.1 Anthelminthic treatment

Regular drug treatment represents the main approach for infection control in areas where infections are intensely transmitted, where resources for disease control are limited and where funding for sanitation is insufficient. Drug treatment can be administered in the community using alternative approaches;

i. *Universal treatment.* The entire community is treated, irrespective of age, sex, infection status, and other characteristics.

ii. *Targeted treatment.* Treatment is offered to targets population groups, which may be defined by age, sex, or other social characteristics, irrespective of the infection status.

iii. *Selective treatment.* Treatment targets individual-level application of anthelmintic drugs, which is selected on the basis of either diagnosis or a suspicion of current infection, where selection is based on diagnosis to detect the most heavily-infected people who will be most at risk of serious morbidity and mortality. The selection of the delivery strategy and the frequency of treatment are based on the analysis of available epidemiological data (Albonico *et al.,* 2006).

In accordance with the WHO, the recommended drugs for for use in public health interventions to control STH infections are:

a. Albendazole (400mg) tablets given in a single dose, reduced to 200mg for children between 12 and 24 months;

b. Levamisole (40mg) tablets given in a single dose by weight (2.5mg/kg). The drug Levamisole at a dose of 80mg has been successfully used in primary school-age children;

c. Mebendazole (500mg) tablets given in a single dose;

d. Pyrantel pamoate (250mg) tablets given in a single dose by weight (lOmg/kg). A combined preparation of pyrantel-oxantel has been proved to be more effective than pyrantel alone in treating *T. trichiura* infection (WHO, 2004).

Evidence suggests that mass delivery of deworming is preferable on efficacy, economic and equity grounds for approaches that require diagnostic screening. School-based deworming also offers major advantages for untreated children and the whole community by reducing disease transmission in the community as a whole (Bundy *et al.,* 1990).

Frequency of regular treatment should vary according to the intensity of transmission and rates of re-infection. These factors must be considered in relation to the resources available and the cost involved in drug purchase and distribution. The STH infections can be classified as being of light, moderate or heavy intensity according to the thresholds established by the WHO, based on the number of STH eggs per gram of feces. Helminths in different areas of the world have different levels of egg output, so the thresholds proposed by the WHO are not rigid and should be adjusted for the local situation.

The World Health Assembly in 2001 endorsed a strategy for the prevention and control of schistosomiasis and soil-transmitted helminthiasis in high-transmission areas. In the short term, morbidity will be reduced by access to drugs (praziquantel and broad-spectrum anthelminthics) and good case management in all health services; regular treatment of at least 75% of school-age children by 2014; targeting other high-risk groups (young children, women of child bearing age and occupational groups) through existing public health programs and channels. For long-term sustainability, environmental health will require access to safe water and sanitation and improved hygienic behavior through health education (WHO, 2002). Overall, however, anthelmintic treatment significantly improves physical and cognitive outcomes in the following ways:

- *Pre-school children.* Periodic distribution of anthelmintics has a positive effect on motor and language development and reduces malnutrition in very young children (Stoltzfus *et al.,* 2004).
- *School-age children.* Treating school-age children has a considerable effect on their nutritional status (Stoltzfus *et al.,* 2004), anemia, physical fitness, appetite, growth (Stephenson *et al.,* 2000), and intellectual development (Drake *et al.,* 2000).
- *Women of reproductive age.* Studies of pregnant women conducted in Nepal indicate that albendazole treatment improved maternal hemoglobin as well as birth-weight and child survival (Christian *et al.,* 2004).

2.14 Prevention and Control of Soil-Transmitted Helminths

2.14.1 Vaccines for soil-transmitted helminths

Vaccine development has driven the field of immunology since it incorporates the selection and presentation of benign antigens or attenuated pathogens to stimulate an acquired protective response. Vaccination has proven to be the most cost-effective and efficient procedure for disease management. The need to control chronic and emerging diseases and bio-security concerns stimulate demand for new vaccines, (Joseph *et al.,* 2007).

Helminths are exquisitely adapted to evading and modulating the mammalian immune response; and interestingly, similar evasion mechanisms can be shared among distantly related species. This begs the obvious question of whether this ability can ever be exploited for therapeutic purposes (Cooper, 2003).

Early enteric exposures to STH infections in infancy may provide important maturational and regulatory signals for the developing immune response that allows it to control allergic inflammation directed against both parasitic and environmental aeroallergens. Typically, STH infections are chronic in endemic areas, and, as with other helminth parasites, it is likely that geo-helminths have developed ways of modulating the host immune response to permit adult development and survival. Likewise, the human host may have developed mechanisms to limit the pathology associated with the long-term presence of these highly allergenic parasites (Cooper, 2006).

Many aspects of vaccine design and implementation are driven by advancing molecular technology and the basic information of host/pathogen interactions that target pathogen vulnerability and reduced host pathology. Experimental vaccine development under controlled conditions in the laboratory requires field testing to isolate important modulating factors. An underlying parasitic infection is a profound, albeit reversible, modifier of vaccine efficacy. It is critical to develop vaccination and challenge studies on the relevant host species and to extend the work to field trials in order to ensure the success of vaccination through an integrated strategy for the control of STH disease (Joseph *et at,* 2007).

2.14.2 Remote sensoring

Studies have investigated spatial patterns of STH infections and other helminths. These studies have focused on the use of Remote sensoring data to identify ecological correlates of infection and develop statistical models of disease risk (Brooker *et al.,* 2003). Geographical distributions are continually updated as new epidemiological data are collected, and as intervention reduces the prevalence of infection. Analysis of the cost-effectiveness of the tools, which is germane to their long-term and sustainable use, is currently underway. Experiences in Uganda demonstrated the usefulness of remote sensoring (GIS or RS) as geographic decisionmaking tools for implementing helminth control on both national and local scales (Kabatereine *et al.,* 2006).

An important emerging trend is that national governments are beginning to use this approach for designing and developing sustainable national programs. GIS/RS has been employed by governments to plan and conduct nation-wide rapid epidemiological assessments of STHs and schistosomiasis in Chad and Eritrea, and to design and implement national parasite- control programs, in both cases as part of national development programs with World Bank assistance. The results from the survey helped the government plan the country's school-based control program, and resulted in significant cost savings for the program since it identified the need to target far fewer schools than had first been anticipated. The sampling methodology proved to be substantially less expensive and more practical than traditional approaches developed without the benefit of GIS/RS. The national survey revealed that infection was highly focal and that deworming interventions could be precisely targeted, with significant savings in financial and technical resources (Brooker *et al.,* 2002).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

This study was conducted in Bwari Area Council of F.C.T. Abuja is the capital of Nigeria. It is located north of the confluence of the Niger and Benue rivers at the centre of the country. Abuja is locted within Latitude 9°4 N and longitude 7°29 E (http:/www.fct.gov.ng/). Abuja has an estimated population of I million inhabitants. Bwari Area Council is one of the six Area Councils under the Federal Capital Territory Administration. Bwari Area Council is made up of 10 wards which includes Bwari-Central, Kuduru ward, Shere ward, Dutse ward, Ushafa ward, Byazhin ward, Kubwa ward, Usman ward, Kawu ward and Igu ward, (Emmanuel, 2007) (Fig. 3.1) . According to the 2006 census, Bwari Area Council had the population of 229,274 people. There are two distinct seasons in Abuja; the rainy season which is observed between April to October and dry season which comes up from November to March.

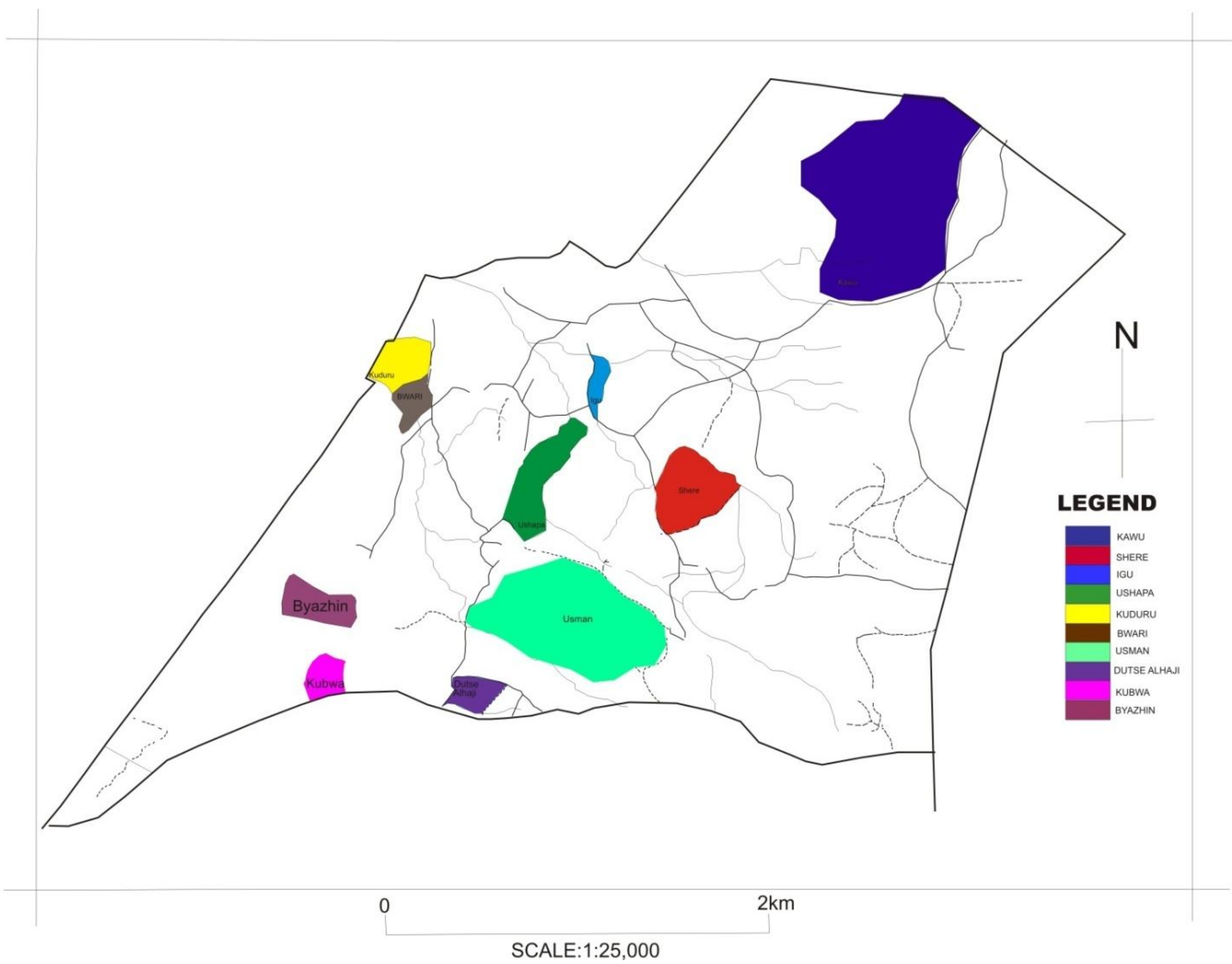


Fig. 3.1 Map of Abuja showing Sampling location

3.2 Study Design

A cross-sectional study design was carried out. Soil samples were collected from the randomly selected school play grounds of the 10 wards that make up Bwari Area Council. The schools were identified, listed and randomly selected. Soil samples were collected from schools in each ward. Analyses of soil samples were carried out to determine the pH, soil types, and soil texture. A sample collection form was used during sample collection to record the schools, estimated area of the playgrounds, fenced or not fenced, level of sanitation, topography, vegetative coverings, presence of stray animals, and detection of fecal matter (Appendix IX). The average climatic datas such as temperature and rainfall for each month of study were obtained from the Meteorological Station located in Abuja (See Appendix XII).

3.3 Sample Size

The sample size of the soil was determined by using the formula outlined by Mungo (2008);

$$N\text{-}\ z^2pq/d^2$$

Where, q= 1-p, N= sample size, p= anticipated prevalence (65% from pilot study conducted), Z= desired confidence, d= allowable error

$$N=1.96^2X0.6500X0.38/\ (0.05)^2= 379.55$$

The sample size was increased to 400 for convinience. This sample size was used for both the smear samples collected from the pupils' palms and soils collected from the playgrounds. The total sample size was therefore 800 samples.

3.4 Collection of Soil Sample

The pre-primary and primary school playgrounds in Bwari Area Council of Abuja F.C.T were visited one after the other and samples were collected for six months (400 samples; twice a week), 67 samples were collected each month, and 17 samples were collected each week two times from two different schools (private and public). Consent was sought from the Heads of the different schools. Sample collection was done during the dry season, (January to March, 2013) and the wet season, (April to June, 2013). Pre-primary and primary school playgrounds in Bwari Area Council of F.C.T were randomly selected using simple random sampling technique to obtain the required number of sites. The different sites for sample collection were identified and numbered. To estimate an area to be sampled, a rope was used to measure out 10 square meters to estimate the length and breadth of an area. A stick was used to peg every 10 metres. Interval of 10 meters was used as interval points.

The points of soil sampes collection were marked as point 1, 2, 3 and so on. A ruler was used to measure 3cm on the trowel from its tip, to aid in measuring depth for soil collection. With the aid of the trowel, l00g of soil samples were collected both from the surface and 3 cm deep into the soil and put into labeled polythene bags. Another l00g of soil was randomly collected from five points out of the selected areas (Four ends and the Centre point), and put in three separate labeled sealed polythene bags for soil and helminth egg analyses as described by Mohammed (2010). The sealed bags were transported immediately to the Helminthology laboratory of the Department of Veterinary Parasitology and Entomology, Ahmadu Bello University, Zaria and kept in the refridgerator at 4°C until examination.

3.5 Consent from Parents and Collection of Swab Samples from the Palms of Pupils

Samples were obtained using simple random sampling technique. In each class of an average of 25 pupils, samples were obtained from the pupils. This was done by writing "yes" on sheets of papers and "No" on the remaining papers, specified number of sheets. Each pupil that picked "yes" in every class was given a letter to take to his/her parents seeking their consent and cooperation to collect swab sample from the pupils palm. Sterile swab sticks dipped in normal saline was used to swab the two palms of each pupil.

Samples were collected before and after break-period. The name, age, class and school of the pupil was recorded on each swab stick. The swab stick was used one per pupil, returned back to the sterile swab tubes containing some drops of normal saline and carefully covered. All collected swabs were taken to the Helminthology laboratory of Department of Veterinary Parasitology and Entomology, Ahmadu Bello University, Zaria for analyses.

3.6 Questionnaire

A copy of structured questionnaire was given to the pupil to be filled by their parents; the upestionnaire sought to obtain information regarding sex, age and residence of pupils, parent's/guardian's level of education, level of hygiene and level of awareness of geohelminth pwasites and so on. (Appendix VIII).

3.7 Laboratory Analysis of Samples

In the Laboratory, eggs were recovered using formal-ether sedimentation for concentration of trematodes eggs and Zinc Sulphate Sucrose floatation for concentration of Nematode and cestode eggs as described by Cheesbrough (2000).

The floatation method was carried out thus; 50 grams of soil from each of the 100g collected at each point was transferred into a 250ml beaker containing 150ml of floatation medium, stirred with a glass rod. It was thoroughly mixed and then filtered through layers of gauze into another 250ml beaker. The filtrate was transferred into 30ml centrifuge tube via the funnel. The funnel was removed and the tube filled to the brim to form a convex meniscus it was then covered with cover slide and allowed to stay for 2-5 minutes before examination under xl0 magnification. The solution was mixed very well and the wells of the McMaster slide were filled, one at a time, using Pasteur pipette and rubber teat. The two wells of the slide were filled and left on the bench for 5 minutes before counting to allow setting. Air bubbles were excluded from the wells. All the eggs within the ruled areas of the two wells were counted using xl0 objective.

Egg Count/gram = Sum of counts from the two wells x 1.

Direct smear (examination) method was also used to recover eggs on swab sticks collected from the pupils' palms, as described by Arora and Arora, (2010). Using the swab stick, emulsify the smear sample in a small drop of saline on a slide and with cover slide to avoid formation of air bubbles. The entire preparation is examined under low power of the microscope and the number of eggs is counted and then calculated.

3.7.1 Identification and counting of helminth eggs

Identification of helminth ova was made based on the characteristics and morphologies described by Soulsby (1982), using floatation and sedimentation methods respectively as described in 3.7 above.

3.7.2 Determination of intensity of infection

Light infection from 20 - 200 eggs per field was denoted using a positive sign (+) (l-10 eggs x20*)*

Moderate infections from 220 - 400 eggs per field (++) (11-20 eggs x 20)

Heavy infections from 420 - 600 eggs per field (+++) (21-30 eggs x 20)

No infection was recorded using a minus sign (-) As described by Duniya, (2000).

3.8 Data Analysis:

Analysis of data was carried out using the Statistical Package for Social Science (SPSS) version 17. Chi-square test was used where appropriate to test for association between the presence of geo-helminth eggs on the palms of the pupils and the soil samples from the different sites (playgrounds), association between private and public schools, association between the occurrence of geo-helminth eggs and periods of the year, association between occurrence of helminth eggs and pre/primary schools, association between the occurrence of geo-helminth eggs and soil factors of soil samples from the various schools, association between the occurrence of geo-helminth eggs and seasons of the year. Odds ratio was also used to determine the occurrence of geo-helminth eggs in soil samples of pre-primary school's playgrounds of both public and private schools. (P values < 0.05 will be considered significant).

CHAPTER FOUR

RESULTS

4.1 Prevalence of Geo-helminth Eggs in Soils of Some Selected Pre-Primary and Primary School Playground in Bwari Area Council, Abuja.

Overall, 6607 eggs were obtained from 400 soil samples collected from some selected pre-primary and primary school playgrounds in Bwari Area Council out of which 4836 were geo-helminth eggs. The overall Prevalence rate of geo-helminth eggs found in pre-primary and primary school playgrounds in Bwari Area Council was 62.5%. *Taeniids eggs* (plate i) were 1480(30.6%) with a mean of 74.0 ± 13.07. *Toxocara* eggs (plate ii) were 863(17.8%) with a mean of 43.15 ± 6.67, Hookworm eggs (plate iii) were 1260(26.1%) with a mean of 63.0 ± 8.98, *Trichuris* eggs (plate iv) were 482(10.0%) with a mean of 24.10 ± 7.50, *Schistosome haematobium eggs(plate v) were* 3(0.1%) with a mean of 0.15 ± 0.15.

Plate I: *Taeniid* egg

Plate II: *Toxocara* egg

Plate III: *Hookworm eggs*

Plate IV: *Trichuris egg*

Plate V: *S. haematobium egg*

Besides helminth eggs, coccidian 1065(16.1%) and mite eggs 863(10.6%) were also observed (Appendix I). The prevalence rate of geo-helminth eggs obtained from both public and private schools were as follows; schools A = 8.5%, B = 11.8%, C = 9.2%, D = 16.1%, E = 11.1%, F - 7.5%, G = 11.2%, H = 10.0%, I = 8.9%, J = 5.6%. K = 4.8%, L = 8.1%, M = 6.5%, N = 11.3%, O = 11.3%, P = 9.7%, Q = 9.7%, R = 16.1%, S = 9.7%, and T = 12.9% respectively (Appendix X).

4.2 Occurrence of Geo-helminth Eggs in Public Schools of Some Selected Pre-Primary and Primary School Playgrounds in Bwari Area Council, F.C.T

Table 4.2 shows the occurrence of geo-helminth eggs in some selected pre-primary and primary school playgrounds. Out of 3596(74.35%) helminth eggs with a mean of 359.6 ± 70.33 observed from the Public schools, 1180(32.8%) *Taenia* eggs with Mean of 118.0 ± 14.13. *Toxocara eggs* 603 (16.8%) with Mean of 60.30 ± 8.80. *Fasciola* eggs 179(4.97%) with Mean of 17.90 ± 6.89. *Strongyles* eggs 169(4.7%) with Mean of 16.90 ± 8.18. Hookworm eggs 880(24.5%) with Mean of 88.0 ± 11.23. *Trichuris eggs* 342(9.5%) with Mean of 34.20 ± 13.02. *Strongyloides* egg 240 (6.67%) with Mean of 24.00 ± 7.78. *Schistosoma haematobium* eggs 3(0.08%) with Mean of 0.30 ± 0.30, besides helminth eggs, Mite (12.9%) and Coccidian eggs were also observed (24.15%) (Table 4.2).

4.3 The Occurrence of Geo-helminth Eggs in Some Selected Private Pre-Primary and Primary School Playgrounds in Bwari Area Council

Table 4.3 shows the occurrence of geo-helminth eggs in some selected private schools of pre-primary and primary school playgrounds. Out of a total of 1,240(25.64%) helminth eggs observed in private schools with mean of 112.00 ± 39.62, t*aenia* eggs 300 (24.1%)

with Mean of 30.0 ± 9.56. *Toxocara* eggs 260 (20.9%) with Mean of 26.00 ± 6.70. *Hookworm* eggs were 380 (30.6%) with Mean of 38.0 ± 8.67, *Trichuris* eggs were 140 (11.29%), Strongyloides egg 160(12.9%) with Mean of 16.00 ± 9.33. Besides helminthes eggs, mite eggs (14.25%) and Coccidian eggs (11.95%) were also observed (Table 4.3).

Table 4.I The Occurrence of Geo-helminth Eggs in Some Selected Pre-Primary and Primary School Playgrounds in Bwari Area Council, FCT

Type of Egg	No of eggs recovered	Percentage (%)	Mean ± SEM of geo-helminth eggs
Taeniids	1480	30.6	74.0 ± 13.07
Toxocara	863	17.8	43.15 ± 6.67
Fasciola	179	3.7	8.95 ± 3.39
Strongyle	169	3.5	8.84 ± 4.43
Hookworm	1260	26.1	63.0 ± 8.98
S. haematobium	3	0.06	0.15 ± 0.15
Trichuris	482	9.96	24.10 ± 7.50
Strongyloides	400	8.3	20.00 ± 5.78
Total	4836	100	242.19 ± 49.97

n = 4836

Table 4.2 Occurrence of Geo-helminth Eggs in Public Schools of Some Selected Pre-Primary and Primary School Playgrounds

S/n	Helminths	No of eggs found	Percentage (%)	Mean ± S.E.M of geo-helminth eggs
1.	Taenia	1180	32.8	118.0 ± 14.13
2.	Toxocara	608	16.8	60.30 ± 8.80
3.	Fasciola	179	4.97	17.90 ± 6.89
4.	Strongyles	169	4.7	16.90 ± 8.18
5.	Hookworm	880	24.5	88.0 ± 11.23
6.	*S. haematobium*	3	0.08	0.30 ± 0.30
7.	Trichuris	342	9.5	34.20 ± 13.02
8.	Strongyloides	240	6.7	24.00 ± 7.78
9.	Total	3596	100	359.6 ± 70.33

n = 3596

Table 4.3 Occurrence of Geo-elminth Eggs in Some Selected Private Pre-Primary and Primary School Playgrounds

S/n	Helminths	No of eggs found	Percentage (%)	Mean ±S.E.M of geo-helminth eggs
1.	Taenia	300	24.1	30.00 ± 9.56
2.	Toxocara	260	20.9	26.00 ± 6.70
3.	Hookworm	380	30.6	38.00 ± 7.33
4.	Strongyloides	160	12.9	16.00 ± 9.33
5.	Trichuris	140	11.29	14.00 ± 6.70
	Total	1240	100	112.00 ± 39.62

n = 1240

4.4 Occurrence of Geo-helminth Eggs in Some Selected Public School Playground Soils

Table 4.4 Occurrence of geo-helminth eggs in the public school playgrounds. Out of 3596 helminth eggs obtained from 304 soil samples collected from the public schools, 306(8.5%) helminth eggs was observed from 32 soil samples collected from school A, 425(11.8%) eggs were observed from 28 soil sample collected from school B, 332(9.2%) helminth eggs were observed from 30 soil samples collected from school C, 580(16.1%) eggs from 30 soil samples collected from school D, 400(11.1%) eggs from 30 soil samples collected from school E. 269(7.5%) eggs from 30 soil samples collected from school F, 403(11.2%) eggs from 32 soil samples collected from school G, 360(10.0%) eggs from 30 soil samples obtained from school H, 321(8.9%) eggs from 32 soil samples collected from school I while 200(5.6%) eggs were observed from 30 soil samples collected from school J. However, there was a significant association ($P < 0.005$) between the occurrence of geo-helminth eggs in the soil and the soil in the public schools sampled.

4.5 Occurrence of Geo-helminth Eggs in Some Selected Private School Playgrounds

Table 4.5 shows the occurrence of geo-helminth eggs in some selected private school playgrounds. Out of 1240 geo-helminth eggs recovered in 96 soil samples collected from the Private schools, 60(4.8%) geo-helminth eggs were observed from 8 soil sample collected from school K, 100(8.1%) geo-helminth eggs were observed from 8 soil samples collected from school L, 80(6.5%) geo-helminth eggs were observed from 10 soil samples from school M, 140(11.3%) geo-helminth eggs were observed from 10 soil samples from school N, 140(11.3%) geo-helminth eggs were observed from 10 soil samples collected from school O, 120(9.7%) geo-helminth eggs were observed from 10 soil samples collected from school P and 120(9.7%) geo-helminth eggs from 10 soil samples collected from school Q. The number of geo-helminth eggs recovered from school R was 200(16.1%) while 120(9.7%) from 10 soil samples were recovered from school S and 160(12.9%) was recovered from school T. However, there was no significant association ($P>0.005$) between the occurrence of geo-helminth eggs and the soil samples from private schools.

4.6 Occurrence of Geo-helminth Eggs in the Soils of Both Public and Private School Playground Soil

Table 14.6 shows the association between the occurrence of geo-helminth eggs and the soil samples of both public and private schools. There was no significant association ($P>0.005$) between the occurrence of geo-helminth eggs and the soil in the schools. Out of 400 soil samples collected, 250(62.5%) were positive for geo-helminth eggs. 191(76.4%) of the 304 soil samples from public schools were positive for geo-helminth eggs, while 59(23.6%) of the 96 soil samples from private schools were positive for geo-helminth eggs.

Table 4.4 Occurrence of Geo-helminth Eggs in Public School Playground Soils

Sch	soil samples collected	No of samples +ve	No +ve for eggs (grams)	Percentage (%)
A	32	16	448	8.5
B	28	14	525	11.8
C	30	18	475	9.2
D	30	22	760	16.1
E	30	24	520	11.1
F	30	18	349	7.5
G	32	16	566	11.2
H	30	20	500	10.0
I	32	22	424	8.9
J	30	26	360	5.6

Total	304	196	4927	100

n = 4927

Table 4.5 Occurrence of Geo-helminth Eggs in Some Selected Private School Playground Soils

Sch	Soil sample collected	No of samples positive	No +ve for helminth eggs	Percentage
K	10	5	120	4.8(%)
L	10	4	100	8.1(%)
M	8	2	80	6.5(%
N	8	6	140	11.3(%)
O	10	6	220	11.3(%)
P	10	4	140	9.7(%)
Q	10	5	180	9.7(%)
R	10	6	300	16.1(%)
S	10	8	180	9.7(%)

T	10	8	220	12.9(%)
Total	96	54	1680	100

Table 4.6 Comparism Between the Occurrence of Geo-helminth Eggs in the Soils of Both Public and Private School Playgrounds

Schools	No of soil sample collected	No +ve for geo-helminth eggs (%)
Public	304	191(76.4%)
Private	96	59(23.6%)
Total	400	250 (62.5%)

(χ^2 = 0.05848, df = 1, P = 0.8089)

4.7 Comparism between the Occurrence of Geo-helminth Eggs in the Soil Samples of Some Selected Pre-Primary and Primary School Playground

Table 4.7 shows the relationship between the occurrence of geo-helminth eggs in soil samples of both pre-primary and primary school playground. Out of the total number of 400 soil samples collected, 20 samples were collected from pre-primary school out of which 16 (6.4%) samples were positive for geo-helminth eggs while 234(62.5%) of the 380 samples collected from primary schools were positive for geo-helminth eggs. However there was no significant association between the occurrence of geo-helminth eggs and the soil samples from the two playground ($\chi^2 = 2.751$, P = 0.0972).

4.8 Occurrence of Geo-helminth Eggs in Soils of Some Selected Pre-Primary School Playgrounds of Public and Private Schools

Table 4.8 shows the association between the occurrence of geo-helminth eggs in soil sample of some selected Pre-primary playgrounds of both public and private schools. The total soil samples collected from the pre-primary schools were 20 out of which 12(60%) was positive for geo-helminth eggs. Out of the 15 samples collected from the public schools, 10(66.67%) was positive with geo-helminth eggs. While 2(40%) out of the 5 samples collected from private schools were positive with geo-helminth eggs. There was however, no significant association between the occurrence of geo-helminth eggs and soil samples of pre-primary school (OR = 3.00, P = 0.3473).

Table 4.7 Comparism Between the Occurrence of Geo-helminth Eggs in the Soil Samples of Pre-Primary and Primary School Playground

Schools	No of soil samples collected	No +ve for geo-helminth eggs (%)
Pre-primary	20	16 (6.4)
Primary	380	234 (93.6)
Total	400	250 (62.5)

$\chi^2 = 2.751$ df = 1 P = 0.09872

Table 4.8 Occurrence of Geo-helminth Eggs in Soils of Some Selected Pre-Primary School playgrounds of Public and Private Schools

School	No of soil sampled	No +ve for geo-helminth eggs (%)
Public	15	10 (66.67)
Private	5	2 (40)
Total	20	12 (60)

P = 0.3473 Odds ratio = 3.00 (Cl = 0.3722 to 24.18)

4.9 Seasonal Prevalence of Geo-helminth Eggs in Soils of Some Selected Public and Private School Playgrounds, Bwari Area Council

Table 4.10 shows the association between the occurrence of geo-helminth eggs and seasons. The total number of soil samples collected was 400 with 250 (62.5%) positive for geo-helminth eggs. Out of 200 samples collected during the rainy season, 194(77.6%) was positive for geo-helminth egg. While 56(22.4%), out of 200 samples colleted during the dry season were positive with helminth eggs. There was a significant association between the occurrence of geo-helminth egg and season ($\chi^2 = 203.1$, P = 0.0001).

4.10 Occurrence of Geo-helminth Eggs Based on pH of the Soil in Some Selected Schools

Table 4.10 shows the association between the occurrence of geo-helminth Eggs the soil pH. The total number of soil samples collected was 400 with 250(62.5%) positive eggs. Out of

202 samples that was slightly alkaline, 115(46%) were positive for geo-helminth eggs, while out of 170 samples that was alkaline, 117(46.8%) was positive with eggs. Furthermore, out 0f 10 samples that was acidic, 5(2%) was positive for geo-helminth eggs. While out of 18 samples that are slightly acidic, 13(5.2%) was positive for geo-helminth eggs. However, there was no significant association between the occurrence of geo-helminth eggs and the soil pH (χ^2 = 6.966, P = 0.0730). Schools A, B, C, E, F, G, N, T were observed to have soil slightly alkaline with pH values ranging between 7.1-7.8, schools D, H, I, J, L, O, P, R soil were observed to be alkaline and raged between pH value of 8.0 – 8.6, school K was observed to be Acidic with pH value of 6.0, while school M and S were observed to be slightly acidic with pH value of 6.1 – 6.2 (See Appendix 9).

Table 4.9 Seasonal Prevalence of Geo-helminth Eggs in Soils of Some Selected Public and Private School Playgrounds, Bwari Area Council

Periods of the yr	No of soil sample collected	No +ve for geo-helminth eggs (%)
Raining	200	194(77.6)
Dry	200	56(22.4)
Total	400	250(62.5)

χ^2 = 203.1, df = 1, P = 0.0001 (Significant)

Table 4.10 Occurrence of Geo-elminth Eggs Based on pH of the Soil in Some Selected Schools

PH	No of soil sampled	No +ve for geo-helminth eggs (%)
Slightly alkaline	202	115(46)
Alkaline	170	117(46.8)
Acidic	10	5(2)
Slightly acidic	18	13(5.2)
Total	400	250(62.5)

n = 250

4.11 Occurrence of Geo-helminth Eggs Based on Soil Types of Some Selected Pre-primary and Primary School Playgrounds

Table 4.11 shows the association between the occurrence of geo-helminth eggs and soil types in some selected pre-primary and primary school playground. Out of 282 mixture of loamy and sandy soil collected, 165(58.5%) was positive for geo-helminth eggs. While out of 30 mixture of sandy and clay soil samples collected, 21 (70%) was positive for geo-helminth eggs. Out of 88 sandy soil samples collected, 64(72.7%) was positive for geo-helminth eggs. However, there was a significant association between the occurrence of geo-helminth eggs and the soil type sampled (χ^2 = 6.562, P = 0.0376).

4.12 Comparism Between Sex and Geo-helminth Eggs Found in Palms of Pupils

Table 4.12: shows the comparism between sex and geo-helminth eggs found in palms. The total number of Respondents was 250 out of which 11(4.4%) were not found with geo-helminth eggs in their palms while 239(95.6%) were found with helminth eggs in their palms. Out of 126 respondents whose children were male, 6(4.7%) had geo-helminth eggs in their palms. Out of 124 respondents whose children were female, 5(4.0%) were found with geo-helminth eggs in their palms. However, there was no significant (P>0.05) association between sex of the children and the presence of geo-helminthic eggs on their palms. Both sex had fairly equal number of geo-helminth eggs on their palms.

Table 4.11 Occurrence of Geo-helminth Eggs Based on Soil Types of the schools

Soil type	No of soil sampled	No +ve for geo-helminth eggs (%)
Loamy and sandy (mixed)	282	165(58.5)
Sandy clay	30	21(70)
Sandy	88	64(72)
Total	400	250(62.5)

(χ^2 = 6.562, df = 2, P = 0.0376)

Table 4.12 Comparism Between Sex and Geo-helminth Eggs Found in palms of pupils

Sex	Geo-helminth eggs found in palms +ve	Total
Male	6(4.8)	126
Female	5(4.0)	124
Total	11(4.4)	250

($\chi^2 = 0.07910$, df = 1, P = 0.7785)

4.13 Comparism between Age and Geo-helminth Egg Found in Palms of Pupils

Table 4.13 shows the comparism between age and geohelminth egg found in palms. Total number of respondents was 250 out of which 10(4%) of their children had geo-helminthic eggs found in their palms while 240(96%) of their children do not have geo-helminth eggs found in their palms. Out of 73 respondents whose children fall within ages 0-5 yrs, 6(8.2%) had geo-helminth eggs in their palms. Out of 73 respondents whose children fall within ages 5-10yrs, 4(5.5%) had geo-helminth eggs found in their palms. Of the 28 and 39 children that fell within the 11-15yrs and above 15years age brackets respectively, none (0%) had helminth egg in their palm swabs. However, there was no significant association (χ^2 = 3.814, P = 0.282) between age and geo-helminth egg found in pupils' palms.

4.14 Comparism Between Geo-helminth Eggs Observed from School Playgrounds and those Observed from Pupil's palms

Table 4.14 shows the comparism between geo-helminth eggs observed from school playgrounds and those observed from pupil's palm. Out of 800 samples collected from both school's playgrounds and pupil's palms, 261(33) were positive for geo-helminth eggs comprising of 250(95.7) representing soil samples collected from school's playgrounds and 11(4.2) representing smear samples collected from pupil's palms. However, there was a significant association (χ^2 = 324.8, P = 0.0001) between geo-helminth eggs observed in the school's playgrounds and those observed from the pupils palms.

Table 4.13 Comparism Between Age and Geo-helminth Egg found in Palms of Pupils

Age	Geo-helminth eggs found in palms (%)	Total
	+ve	
0 – 5yrs	6(5.1)	110

5 – 10yrs	4(5.5)	73
11 – 15yrs	0	28
15yrs & above	0	39
Total	10(4)	250

(χ^2 = 3.814, df = 3, P = 0.282)

Table 4.14 Comparism Between Geo-helminth Eggs Observed from Pupils Palm in Both Public and Private Schools

Schools	No of respondents	No +ve for helminth eggs (%)
Public	125	9(3.0)

Private	125	2(2.1)
Total	250	11(100)

(P = 0.0597 OR = 4.772 CI = 1.009 to 22.56)

4.15 Comparism Beteen Geo-helminth Eggs Observed from Pupils Palms in Pre-primary and Primary Schools

Table 4.15 shows the comparism between geo-helminth eggs observed from pupils' palm from pre-primary and primary schools. The total number of respondents was 250. Out of

125 respondents from pre-primary schools, 7(35.0%) geo-helminth eggs were observed from their palms while out of 125 respondents from primary schools, 4(1.1%) helminth eggs were observed from their palms. However, there was no significant association (P = 0.5395, OR = 0.5573, CL = 0.1589 to 1.954) between helminth eggs observed from pupils palms in both pre-primary and primary schools.

4.16 Comparism Between Gender and Prevalence of Helminthic infection in Pupils

Table 4.16 shows the comparism between gender and prevalence of helminthic infection in some selected pre and primary school pupils. The total number of respondents was 250 out of which 126 were male representing 50.4% while 124(49.6%). Out of 250 respondents, 103(41.2%) said yes to geo-helminthic infection while 147(58.8%) said no to geo-helminthic infection. Out of 126 respondents that were male, 46(36.51%) had geo-helminthic infection. Out of 124 respondents that were female, 57(45.97%) of the pupils had geo-helminthic infection. However, there was no significant association between gender and prevalence of geo-helminthic infection in pupils (χ^2 = 2.309, P = 0.129).

Table 4.15 Comparism Between Geo-helminth Eggs Observed from Pupils Palms in Pre-primary and Primary Schools

Schools	No of respondents	No +ve for geo- helminth eggs (%)
Pre-primary	125	7(35.0)

Primary	125	4(1.1)
Total	250	11(100)

(P = 0.5395 OR = 0.5573 CI 0.1589 to 1.954)

Table 4.16 Relationship Between Gender and Prevalence of Helminthic infection in Some Selected Pre-primary and Primary pupils in Bwari Area Council, FCT

Gender	Frequency of occurrence of helminth infection in sch. Pupils	Total

	+ve	
Male	46(36.51%)	126
Female	57(45.97%)	124
Total	103(41.2%)	250(100%)

(χ^2 = 2.309, df = 1, P = 0.129)

4.17 Respondent's Knowledege of Soil-Transmitted Helminth and Level of Educational Attainment

Table 4.17 shows the association between knowledge of soil-transmitted helminthes and level of Educational attainment. Out of 250 respondents, 78(31.2%) had knowledge of soil-transmitted geo-helminth, 29(11.6%) had no knowledge, while 143(57.25%) had no opinion on the question. Relating knowledge to the level of educational attainment, 94 respondents who were educated had knowledge of soil-transmitted helminthes while 156 respondents were educated but did not have knowledge of soil transmitted helminthes. However, there was no significant association between knowledge of soil transmitted helminth and level of Educational attainment, (χ^2 = 13.393, P = 0.02000).

4.18 Comparism Between Age and helminthic Infection in School Pupils

Table 4.18: shows the comparism between age and geo-helminthic disease. The total number of respondents was 250 out of which 103 (41.2%) represents respondents within age bracket that had the infection while 147(58.85) did not have the infection. There was also no significant association (χ^2 = 1.909, df = 3, P = 0.592) between the ages of the children and the frequency of occurrence of helminthic infection. Ages 11-15 and 15yrs & above had a higher percentage of occurrences when compared to 0-5 and 5-10yrs of age.

Table 4.17 Knowledge of Soil-transmitted Helminths and Level of Educational Attainment

Knowledge of	Level of Educational attainment (%)	Total

Soil helminth	Nonformal	Primary	Secondary	OND/NCE	B.Sc/HND	Post-graduate	
Yes	5(5.32)	2(2.13)	11(11.02)	20(21.28)	53(56.38)	3(3.19)	94
No	9(5.77)	8(5.13)	40(25.64)	34(21.79)	56(35.89)	9(5.77)	156
Total	14(5.6)	10(4)	51(20.8)	54(21.6)	109(43.6)	12(4.8)	250(100)

Table 4.18 Association between Age and Helminthic Infection in School pupils

Age	Frequency of occurrence of helminthic infection (%)		
	+ve	-ve	Total
0 – 5yrs	46(41.82)	64(58.2)	110
6 – 10yrs	30(41.1)	43(58.9)	73
11 – 15yrs	14(50)	14(50)	28
15yrs & above	13(33.3)	26(66.67)	39
Total	103(41.2)	147(58.8)	250

(χ^2 = 1.909, df = 3, P = 0.592)

4.19 Respondent's Response on Occurrence of Helminth Infection Between Pupils that Had Contact with Animals

Table 4.19 shows the occurrence of helminth infestation in pupils that had contact with animals. There was a significant association (χ^2 = 41.870, P = 0.000) between the occurrence of geo-helminthic infection and children that had contact with animals. 59(63.4%) of the 93 children who had reported geo-helminthic infection had contact with animals while 44 out of the 157 that did not report helminthic infection had contact with animals.

4.20 Respondent's Response on Occurrence of Helminth Infection in Pupils that Had Contact with Soil

Table 4.20 shows the occurrence of helminth infestation in pupils that had contact with soil. There was also a significant association (χ^2 = 14.704, P = 0.000) between children that had contact with soil and the occurrence of helminthic infection. 90(48.12%) of the 187 who had contact with soil had helminthic infection while 13 of the 63 that did not have contact with soil had helminthic infection.

Table 4.19 Respondent's Response on Occurrence of Helminth Infection in Pupils that Had Contact with Animals

Contact with animals	Helminthic infection in School pupils (%)	Total
	+ve	
Yes	59(63.4)	93
No	44(28.01)	157
Total	103(41.2)	250

(χ^2 = 30.238, df = 1, P = 0.0000)

Table 4.20 Respondent's Response on the Occurrence of Helminth Infection in Pupils that Had Contact with Soil

Contac with soil	Helminthic infection in sch pupils +ve	Total
Yes	90(48.12)	187
No	13(20.6)	63
Total	103(41.2)	250(100)

(χ^2 = 14.704, df = 1, P = 0.000)

4.21 Ownership of Pet/domestic Animals and Helminthic Infection in School Pupils

Table 4.21 shows the comparism between ownership of pet/domestic animals and helminthic infection in pupils for the past six months. The total number of respondents was 250, out of which 103 (41.2%) had helminthic infection while 147(58.8%) did not have Helminthic infection in pupils for the previous six months of the survey. 69(64.5%) of the 107 children whose parents/guardians owned pets/domestic animals had helminthic infection while, 34(23.78%) of the 43 who did not own pets/domestic animals were reported to have helminthic infection. There was a significant ($P<0.05$) association between ownership of pet/domestic animals and the occurrence of helminthic infection.

4.22 Association Between Risk Factors of Soil-Transmitted Helminth and Children that Had Helminthic Infection

Table 4.22 shows the association between the risk factors of geo-helminth eggs and children that had helminthic infection. The total number of respondents is 250. Out of 50 respondents that said behavior, occupation and socio-economics, 23(46%) of them had helminthic infection while 27(54%) do not have helminthic infection. Out of 36 respondents that said poor sanitation and water supply, 15(41.67%) of their children had helminthic infection. Out of 15 respondents that recorded poor quality of soil, 6(40%) of the children had helminthic infection. Out of 50 respondents that recorded poor personal hygiene. 18(36%) of their children had helminthic disease while 32(64%) do not have helminthic infection. Out of 14 respondents that recorded poor health awareness and literacy, 4(28.57%) of the children had helminthic infection. Out of 70 respondents that said poverty, 31(44.29%) o of the children had helminthic infection while 39(55.72%) do not have helminthic infection. And out of 15 respondents that had no opinion answer, 6(40%) of their children had helminthic infection. However, there was no significant association retween the risk factors of helminthic infection and the children that had helminthic infection, (χ^2 = 2.251, P = 0.895).

4.23 Association between Environmental Factors and Children that Had Helminthic Infection

Table 4.23 shows the association between Environmental factors and the occurrences of heIminthic infection in children. The total number of respondents was 250. Out of 129 respondents a recorded climatic factor, 59(45.74%) of their children had helminthic infection. Out of 72 respondents that recorded soil factor, 25(34.7%) had helminthic infection. And out of 49 respondents that recorded Behaviour, occupation and socio-economics, 19(38.78%) had helminthic infection. However, there was no Significant association between the environmental factors and the pupils that had helminthic infection, (χ^2 = 2.462, P = 0.296).

Table 4.21 Ownership of Pet/domestic Animal and Geo-helminthic Infection in Children

Ownership of pet/domestic animals'	Geo-helminthic infection in children (%)		Total
	+ve	-ve	
Yes	69(64.5)	38(35.5)	107
No	34(23.78)	109(81.3)	143
Total	103(41.2)	147(58.8)	250

(χ^2 = 41.870, df = 1, P = 0.000)

Table 4.22 Risk Factors of Soil-Transmitted Helminth and Children that Had Helminthic Infection

Risk factors	Helminth disease in pupils (%)		Total
	Yes	No	
Behaviour, occupation & Socio-economics	23(46)	27(54)	50
Poor sanitation and Water supply	15(41.67)	21(58.3)	36
Poor quality of soil & climate	6(40)	9(60)	15
Poor personal hygiene	18(36)	32(64)	50
Poor health awareness And literacy	4(28.57)	10(71.43)	14
Poverty	31(44.29)	39(55.72)	70
No Opinion	6(40)	9(60)	15
Total	103(41.2)	147(58.8)	250

(χ^2 = 2.251, df = 6, P = 0.895)

Table 4.23 Relationship Between Environmental Factors and Children that Had Helminthic Infection

Environmental factors	Helminthic infection in pupils (%)		
	YES	No	Total
Climatic factors	59(45.74)	70(54.26)	129
Soil factor	25(34.7)	47(65.28)	72
Behaviour, occupation And socio-economic	19(38.79)	30(61.22)	49
Total	103(41.2)	147(58.8)	250

(χ^2 = 2.462, df = 2, P = 0.296)

Fig. 4.1 shows the parasite eggs observed in both pre-primary and primary schools and their eggs count per gram. The blue shaded area indicates helminth eggs observed from all school, the red shaded areas indicates helminth eggs collected from public schools while the lemon shaded areas indicates helminth eggs collected from private schools. The total number of parasite eggs collected from all schools was 6607(100%), 4927(74.6%) in public schools and 1680(25.4%) in private schools. The highest parasite egg collected was *Taenia eggs* representing 1480(22.4%) in all schools, 1180(23.9%) in public schools and 300(17.9%) in private school respectively. The second largest helminth eggs collected was hookworm eggs representing 1260(19.1%) from all schools, 880(17.9%) from public schools and 380(22.6%) from private schools. The third largest helminth eggs was *coccidian eggs* representing 1065(16.1%) from all schools, 865(17.6%) from public schools and 200(11.9%) from private schools. The least helminth egg was schistosoma haematobium eggs representing 3(0.085%) from public school.

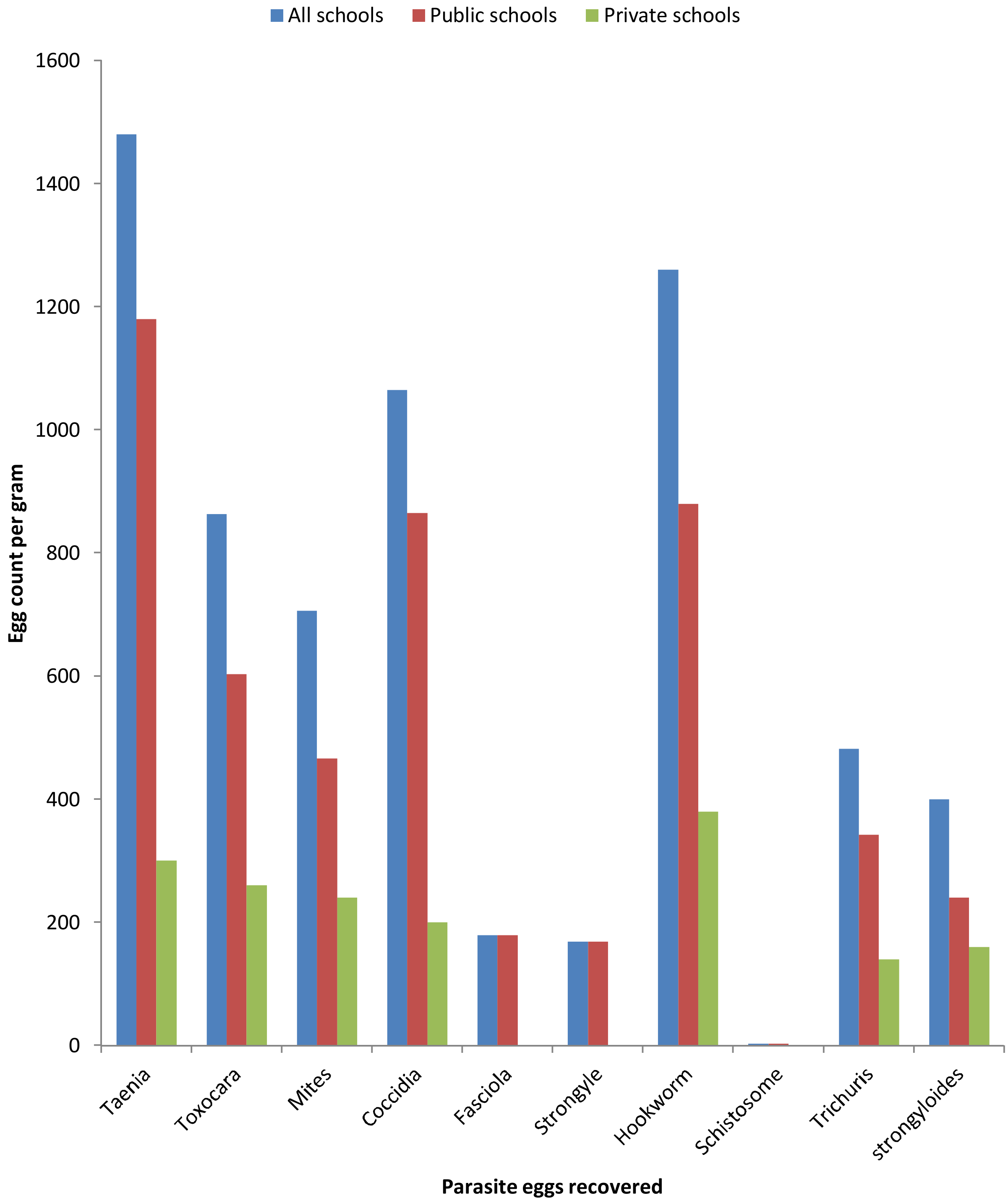


Figure 4.1: Prevalence of Parasite Eggs in Primary and Pre-Primary Schools' Playground of both Public and Private Schools

Fig. 4.2 shows the geo-helminth eggs observed in both pre-primary and primary schools and their eggs count per gram. The blue shaded area indicates geo-helminth eggs observed from all school, the red shaded areas indicates geo-helminth eggs observed from public schools while the lemon shaded areas indicates geo-helminth eggs observed from private schools. The total number of geo-helminth eggs observed from all schools was 4836(100%), 3596(74.4%) in public schools and 1240(25.6%) in private schools. The highest geo-helminth egg collected was *Taenia eggs* representing 1480(30.6%) in all schools, 1180(32.8%) in public schools and 300(29.2%) in private school respectively. The second largest geo-helminth eggs collected was hookworm eggs representing 1260(26.1%) from all schools, 880(16.1%) from public schools and 380(30.6%) from private schools. The third largest geo-helminth eggs was *Toxocara eggs* representing 863(17.8%) from all schools, 608(16.8%) from public schools and 260(20.9%) from private schools. The least geo-helminth egg was *schistosome haematobium eggs* representing 3(0.1%) from public school.

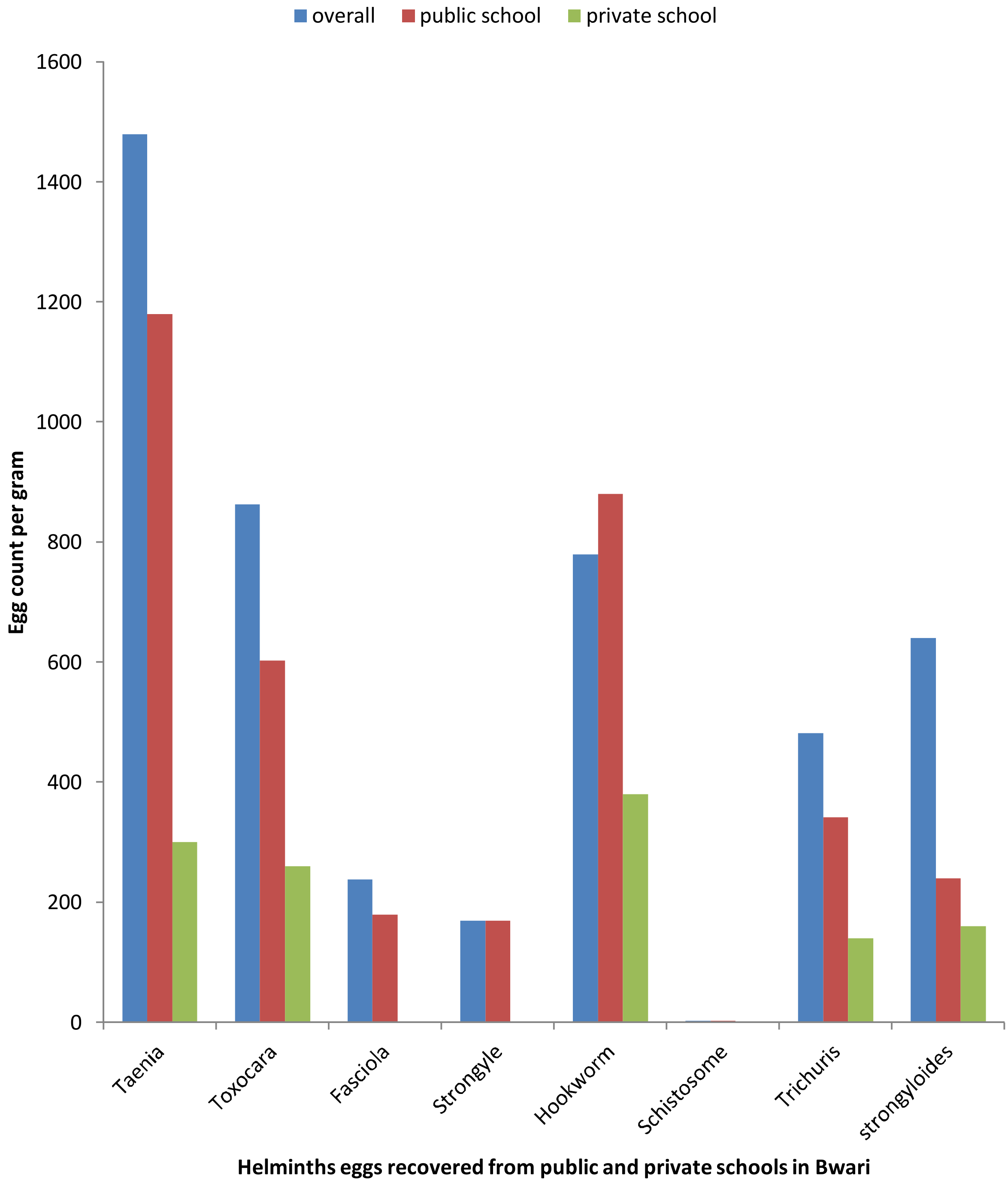


Figure 4.2: Prevalence of Geo- helminth Eggs observed from Primary and Pre-Primary Schools' Playground of Both Public and Private Schools.

Fig 4.3 shows the geo-helminth eggs observed during the rainy season and their eggs count per gram. The areas shaded blue indicates all schools, red indicates public schools while lemon indicates private schools.The total number of geo-helminth collected during the rainy season from all schools was 3592(100%), 2652(73.8%) from public schools and 940(35.4%) from private schools. *Taenia eggs* was the highest generated in all schools 1240(34.5%), 1020(38.5%) in public schools and 220(23.4%) in private schools. The second highest geo-helminth eggs collected was hookworm *eggs* representing 880(24.1%) in all schools, 620(23.4%) in public schools and 260(27.7%) in private schools. The third highest geo-helminth egg collected was *toxocara eggs* 643(17.9%) representing 443(16.7%) from public schools and 200(21.3%) from public schools.

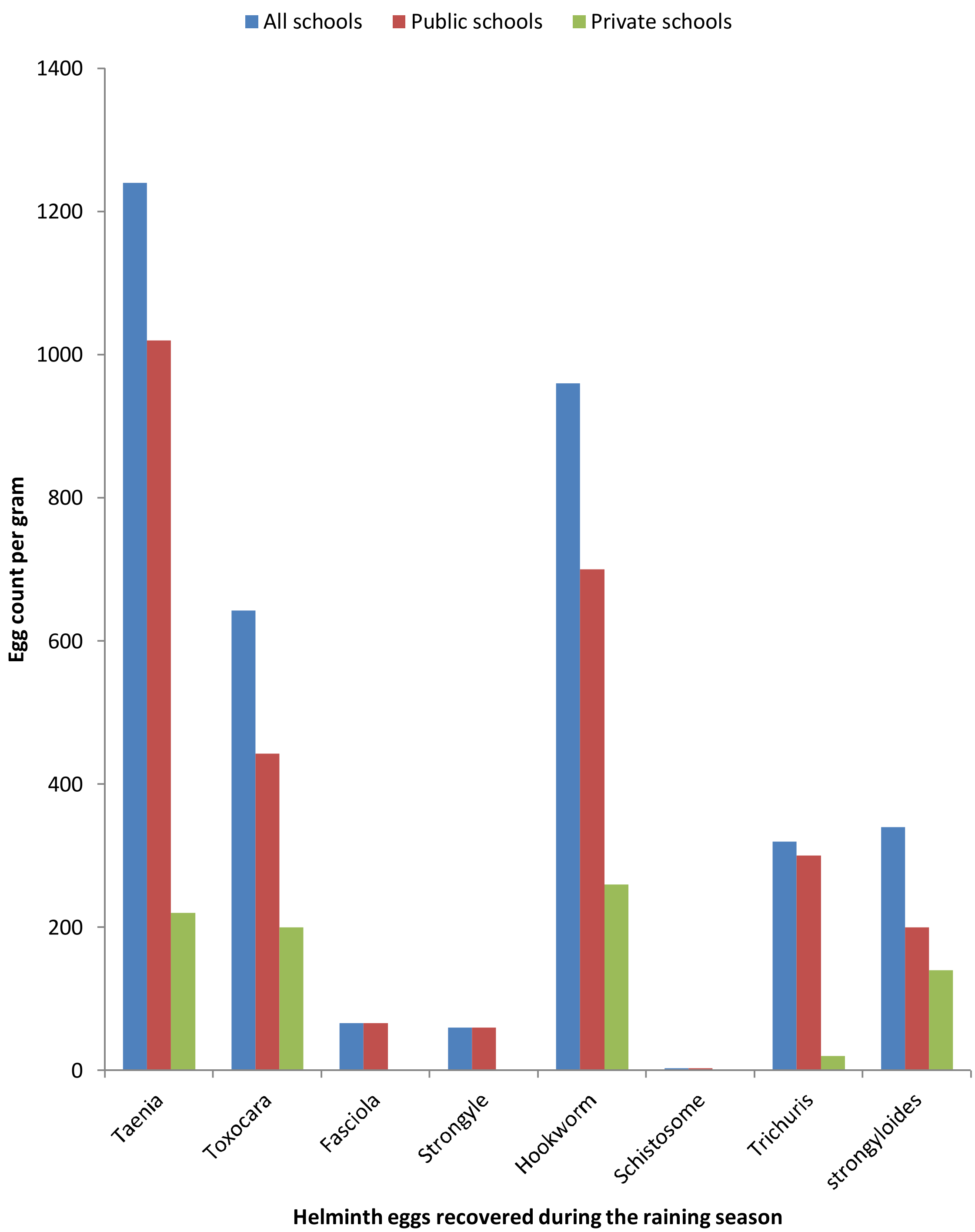
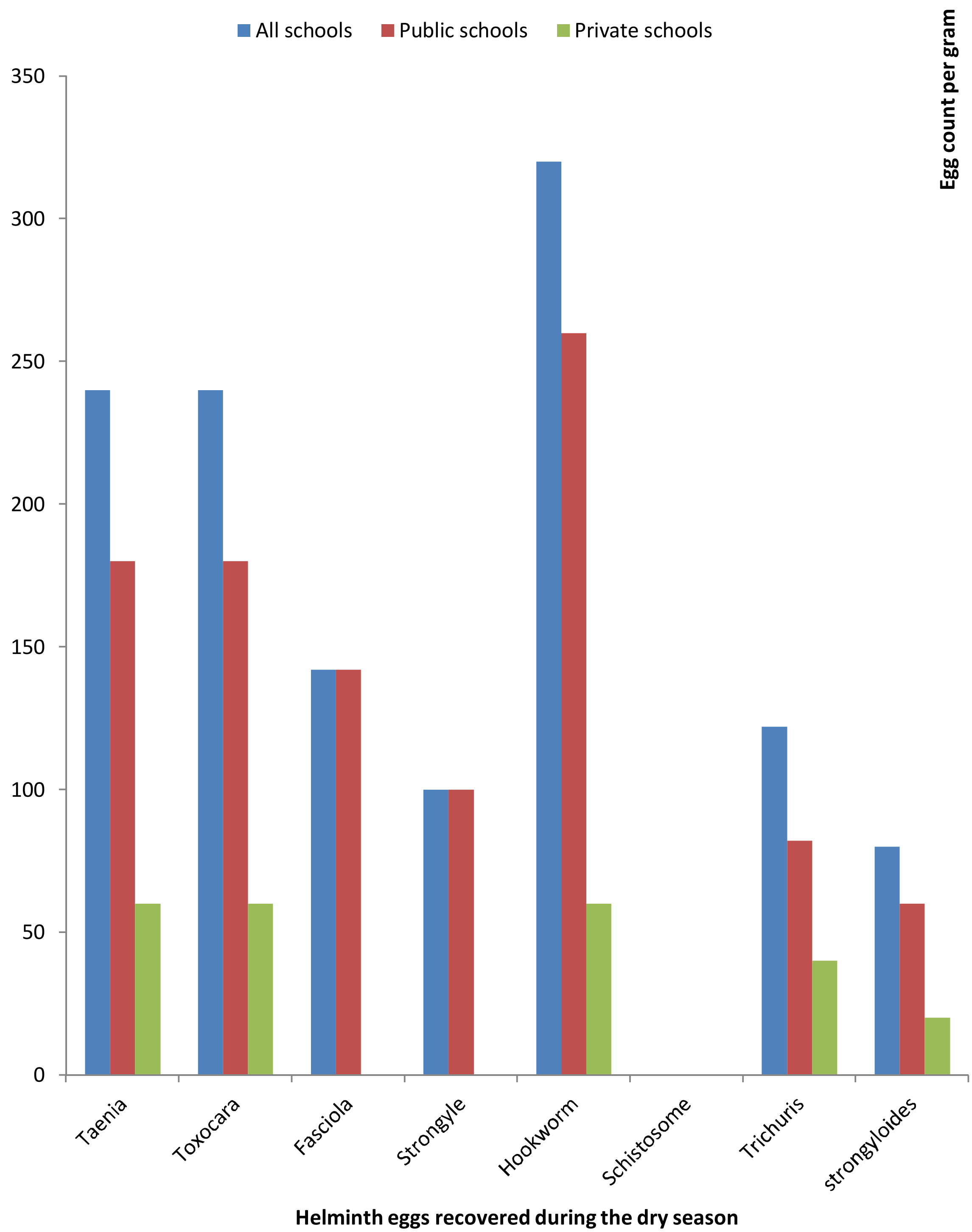


Figure 4.3: Geo-helminth Eggs Observed during the Rainy Season

Fig. 4.4 shows the geo-helminth eggs observed during the dry season. The blue shaded areas represents geo-helminth eggs observed from all school, the red shaded area represents geo-helminth eggs observed from public schools while the lemon coloured area represents geo-helminth eggs observed from private schools. The total number of geo-helminth eggs observed during the dry season was 244(100%) from all schools representing 944(75.9%) from public schools and 300(24.1%) from private schools. The highest geo-helminth eggs observed was *hookworm eggs* 320(25.7%) from all schools, 260(27.5%) from public schools and 120(40%) from private schools. *Taenia eggs* 240 (19.3) and Toxocara eggs 240(19.3) were the second highest. *Strongyle eggs* 80(6.4%) were least geo-helminth egg observed representing 60(6.4%) from public schools and 20(6.7%). Besides geo-helminth eggs, mite eggs and coccidian eggs were also observed.



All schools
Public schools
Private schools
Egg count per gram
350
300
250
200
150
100
50
0
Taenia
Toxocara
Fasciola
Strongyle
Hookworm
Schistosome
Trichuris
strongyloides
Helminth eggs recovered during the dry season

Figure 4.4: Geo-helminth Eggs Recovered During the Dry Season

CHAPTER FIVE

DISCUSSION

The overall prevalence of geo-helminth eggs obtained from pre-primary and primary school's playground in this study was 4836(62.5%) while the prevalence of geo-helminth eggs in pupil's palms was 11(4.2%). The prevalence rate of geo-helminth eggs obtained in this study is comparable to that of Maikai *et* al. (2008) who noted a prevalence rate of 62.0% in a similar study in geo-helminth eggs in Kaduna state. This high rate is probably due to indiscriminate defeacting, urinating & dumping of refuse in the playgrounds. However, the rate in this study is lower than that of Mohammed (2010) who noted a prevalence rate of 68.06% soil contamination with *Toxocara eggs* in recreational parks and gardens in Abuja probably because of influx of people that goes to recreational parks with their pets.

The rate of contamination of playgrounds of public schools with geo-helminth eggs was (70.4%) while that of the private schools was (25.6%) school. However, it is lower compared to that of Ogwurike *et al.* (2010) who noted a rate of (82.52%) in public schools and 47.83% in private schools. The prevalence rates noted by Ogwurike *et al.* (2010) was higher than the prevalence noted in this work probably because they noted that pupils from public schools uses pit latrine while pupils from private schools uses bush and open spaces to defecate thereby giving rise to high degree of contamination, by contrast, pupils in this study used water system which reduces the chances of contamination. In this study, the rate of contamination of helminth eggs was higher in public schools compared to private schools probably because environmental sanitation & hygiene was poorer in public schools compared to private schools. Majority of the public schools were not fenced allowing possibility of contaminations arising from indiscriminate defecation by both humans and stray animals.

Uga and Ktaoka (1995) proposed fencing as a way of reducing contamination of sand pits by helminthes eggs. Duniya (2000) noted that heaps of refuse may facilitate contamination of soil (See Appendix XI). The implication of this is that pupils from public schools are likely to have high prevalence rate of helminth infection compared to pupils from private school.

Even though there was no relationship between (χ^2 = 0.6434, P-value = 0.4225), the detection of geo-helminth eggs in public 191(76.4%) and private 59(23.6%). Detection of geo-helminth eggs was probably associated with the population of stray animals like (dogs, goats, cats), heaps of refuse (this also explains the role domestic animals play in feacal contamination of the environment). Unfenced school premises, generally poor sanitation and hygiene in the public school. However, there was no association (χ^2 = 0.05848, P = 0.8089) between the occurrence of geo-helminth eggs and private schools probably due to high level of hygiene and sanitation, properly fenced school playground.

In this study, there was no association (χ^2 = 2.751. P = 0.0972) between the occurrence of geo-helminth eggs in the soil samples of pre-primary and primary school play grounds. This could be due to the fact that most pre-primary school playground had well protected caged fences, moderate sanitation, there was less number of pre-primary playground (5) in this study compared large number of primary school playgrounds (20) because most schools especially the public schools do not have separate pre-primary school playground, by contrast, most of the primary school playgrounds were found to be poor in sanitation and hygiene, large number of primary schools sampled(20), unprotected/non-fenced school environment which gives rise to presence of stray animals which harbours most of these geo-helminth eggs.

Occurrence of helminth eggs was also compared in pre-primary (public) schools and Pre-primary (private) schools using chi-square analysis, the association was found to be no significant, (P-value > 0.005). This could be as a result of the fact that good environmental sanitation and hygiene was observed in private schools compared to the public schools. This implies that there is high contamination of geo-helminth eggs in primary school leading to high rate of helminth infections than in pre-primary schools.

There was a significant association (χ^2 = 2.03.1, P = 0.0001) between the occurrence of geo-helminth eggs and the season of the year. Out of 200(50.0%) samples collected during the rainy season, 56 (22.4%) were positive for geo-helminth eggs. This could be as a result of the fact that moisture prevents dryness, shrinkage and desiccation of both eggs and larvae creating a conducive atmosphere for these helminth to produce plenty number of eggs. According to Childs (1985), ascarids eggs survive in moist and pc areas. The average rainfall (mmHg) for each of the months of sample collection in this work was recorded thus; dry season (January -March) 0, 0.71±0.71, 0.61±0.57 while rainy season (April-June) 1.73±0.57, 7.43±3.00, 7.43±3.00 respectively (Appendix VX). Also, Shiba *et al.* (2000)

noted that soil contamination rate was higher (48.3%) during wet season compared to that observed in the dry season (33.3%) but without significant difference (p>0.05).

In this work, one hundred and fourty nine (74.5%) out of 200 samples collected during the rainy season were positive for helminth eggs while maikai *et al.* (2008) noted 215(58.1%) out of 370(60.9%) samples collected during the rainy period were positive for geo-helminth eggs. Fifty-one (25.5%) out of 200 samples collected during the dry season were positive for helminth eggs in this work while Maikai *et al.* (2008) noted that 162(68.1%) out of 238(39.1%) samples collected during the dry season were positive for geo-helminth eggs and concluded that a higher detection of helminth eggs during the dry harmattan period than in the wet rainy period, could be result of rainfall which may have washed away the eggs. It has been suggested that total rainfall in an area and its seasonal distribution may also help explain observed patterns of infection: wetter areas are usually associated with increased transmission of all three major soil-transmitted helminth infections. The reason for high raining season could be as a result of the fact that raining season favours the multiplication and distribution of helminth eggs by providing optimum condition and condusive environment for their survival. The implication of this is that season affects the distribution of geo-helminth eggs leading to high helminthic infections.

Many of these geo-helminth eggs are not favoured by environmental conditions like extreme temperature during the dry season leading to shrinkage and hatching of the eggs (Figure 4.2 3). The average maximum temperatures (0°C) for each of the months of sample collection (January - June, 2012) were recorded thus; 44.77±0.28, 35.86±0.14, 37.68±0.20, 34.63±0.29, 31.59±0.39 and 30.17±0.29 while the average minimum temperatures (0°C) were recorded thus; 18.46±0.42, 22.68±0.31, 24.24±0.26, 24.61±0.31, 22.25±0.24, 22.25±0.24 respectively. Temperatures of 50°C, 55°C, and 60°C produced complete inhibition of normal development (Kiff and Lewis-Jones, 1984). Low temperatures (8.9°C to 15.6°C) inhibit complete development of the cells inside the eggs. Once eggs are moved to room temperature the development to the motile embryo is accomplished (Seamster, 1950). Egg development in the dependent upon a number of factors including temperature (optimal development at 20-30 ^{0}C adequate shade and moisture (Komiya and Yasuraoka, 1966).

Much geo-helminth eggs were observed from schools where fecal samples and stray animals were sighted, this could be as a result of the fact that they normally pass out through their faeces, more me people do not take ante-helminthic drugs periodically and these stray animals may not undergo treatment against helminthes infection. In contrast to this, Maikai *et al.* (2008), noted that soil samples collected from playgrounds where dogs were sighted had less number of helminth eggs those that dogs were not sighted because, sighting of a dog does not always mean contamination of such sites with helminth eggs especially if such a dog is free from massive load of geo-helminth infections. But in this study the playgrounds where animals were sighted had more helminth eggs probably because animal faeces were found all over these playgrounds which may have passed with the geo-helminth eggs.

In this study, there was no significant association between the occurrence of geo-helminth eggs and the pH values of soil samples from the schools, (χ^2 = 6.966, P-value = 0.0730). Analysis of the occurrence of helminth eggs and soil types shows that the association was not significant (χ^2 = 4.415, P-value = 0.1100). Majority of the soil samples were mixtures of sand/loamy sand/clay and sandy soil. Well-aerated, non-adhesive sandy soils (0.5 mm to 2 mm) are particularly conducive to promoting hookworm egg hatching, larval development, and larval migration (Beaver, 1975). It was concluded that desiccation and heat were both important in killing the eggs, and the results indicated that soil is an important factor in the rate of development and viability of the *Ascaris* and *Trichuris* eggs. The cultures on sand in the sun did not produce any embryonated eggs, while those in the shade did. Those in loam, clay and humus soils became embryonated but *Ascaris* on humus soil-lower in development due to the minimized oxygen (Ogata, 1925), the implications of this at soil favours the development and growth of helminth eggs thereby leading to high helminth infection.In this study, *Taeniid* egg 1480(30.6%) was the highest helminth eggs observed which is lower in prevalence compared to that of Maikai *et al.* (2008) who noted a higher prevalence rate of 28.1% *taenia* in Kaduna. The presence of *taenia* eggs in this study probably could be as a result of ingestion of improperly cooked beef by people of Bwari Area Council, helminth eggs they pass out through indiscriminate defeacation in the playground and other places that eventually leads to the distribution of *taeniids* and other geo-helminth eggs in the playground. Hookworm eggs l260 (26.1%) are the second highest helminth eggs recovered which was in prevalence compared to that of Ogwurike *et al.* (2010) who noted a prevalence rate of 14.9% hookworm eggs in private and public schools in Jos North L.G.A, Plateau state Nigeria.

The high prevalence of hookworm eggs in this study could be as a result of indiscriminate dumping of refuse in the school premises especially of the playgrounds. *Toxocara* 5(53(17.8%) was the third in prevalence to hookworm in this study, which is in prevalence compared to that of Maikai *et al.* (2008) who noted prevalence rate of toxocara 41.5%) in Kaduna metropolis. The number of *Trichuris* 482 (9.96%) observed in this study is insignificant but higher than that of Maikai *et al.* (2008) who noted a prevalence rate of 2.5% *Trichuris* in Kaduna. The presence of *Trichuris* in this work could be attributed to stray dogs found within the school premises, this rate may also be as a result of the high reproductive rate of *Toxocara spp.* and the extreme resistance of the eggs to adverse environmental conditions which may contribute to their accumulation in soils (Mizgajska, 2001).

The least number of helminth egg recovered was *Schistosome haematobium* eggs with a prevalence rate of 0.1% which is lower in prevalence compared to that of Ogwurike *et al.* (2010) who noted a prevalence rate of 2.0% *S. mansoni* in Jos, Nigeria. The presence of *Schistosome eggs* in this work could be as a result of indiscriminate urination in the playground which is a common practice in public schools. *Strongyloides* eggs (8.2%) were recovered which is higher in prevalence compared to that of Ogwurike *et al.* (2010) who noted 5.3% prevalence in Private and public schools in Jos, Plateau state.

The number of *Trichuris eggs 482* (9.96%) obtained in this study was also low but higher in prevalence compared to that of Maikai *et al.* (2008) who noted a prevalence rate of (2.5%) in Kaduna Metropolis and that of Ogwurike *et al.* (2010) who also noted a prevalence rate of 1.7% trichuris. The low rate of *Trichuris* eggs could be as a result of the fact that the environmental condition did not favour them. *Trichuris* eggs are killed at slightly lower temperatures (52°C to 54°C) for a shorter time than *Ascaris* eggs (Nolf, 1932). *Trichuris* eggs required a more highly saturated atmosphere before they could develop than do *Ascaris* eggs, and the former are less resistant to desiccation.

Out of 400 smear samples collected from the pupil's palms, only 10 samples were found positive for helminth eggs. There was no association (χ^2 = 0.07910, P = 0.7285), between sex and helminth eggs found in palms (See table 4.12), however, there is no record of any work done on helminth eggs recovered from pupils palms. There was also a significant association (χ^2= 3.8134, P = 0.282), between age and parasite found in pupil's palm (Table 4.13). Geo-helminth eggs observed from pupils' palms in public school 9(7.2%) is higher in prevalence compared to Geo-helminth eggs observed from private schools 2(1.6%). However, there was no significant association (P = 0.0597, OR = 4.772, CL = 1.009 to 22.56) between geo-helminth eggs observed from pupils' palms in both public and private schools. This could be as a result of the fact that level of sanitation and hygiene is very low in public school compared to private schools in the study area. Helminth eggs observed from pupils palms in pre-primary schools 7(5.6%) were higher in prevalence compared to those observed from primary school 4(3.2%). However, there was no significant association (P = 0.5395, OR = 0.5573, CL = 0.1589 to 1.954) between geo-helminth eggs observed frhools.om pupils' palms in both primary and pre-primary schools. This could be as a result of the fact that most pre-primary school pupils crawls and sucks dirty hands and objects through their hands unlike primary school pupils who observe hygienic practices more.

On the occurrence of helminthic infection in relation to sex, the respective rates of 55.3 and 44.7% in females and males were lower in comparism to the results of Ogwurike *et al.* (2010) who did a comparative study on helminthiasis amongs pupils of private and public primary schools in Jos and noted a lower prevalence rate of 18.11% female and 15.04% in male. The overall prevalence of *Ascaris* infection has traditionally been considered higher among females compared with males, regardless of age (Crompton, 1989b).

In this study, the 41.1% prevalence of helminth infection seen in the 6-10yrs age group was higher compared to Ogwurike *et al.* (2010) who reported prevalence 32.5% in the ages 6-10 years old in private and public schools in Jos, North Local Govt. Area of Plateau state. In this study, ages 0-5 yrs had the highest prevalence 46(41.82%), ages 6-10yrs 30(41.1%), 11-15 yrs 14(50%) has third highest prevalence while age 15yrs & above has the least prevalence 13(33.3%). prevalence of helminth infection rises rapidly once infancy has passed and tends to remain high, intensity rises rapidly peaks during childhood (among 5-15 years-olds), (Crompton, 1993). Association between children that placed with animals and those that had helminthic infection was found to be significant (χ^2= 30.238, P = 0.000), (Table 4.15). There was a significant association between children that played with soil and those that had helminthic infection (χ^2= 14.704, P = 0.000), (Table 4.19).

There was also significant association between ownership of pet/domestic animal and those that had helminthic infection (χ^2 = 41.870, P =0.000), (Table 4.20). There was also a significant association (χ^2 = 324.8, P= 0.0001) between the occurrence of helminth eggs observed from pupil's palms and those observed from school's play-grounds (Table 4.14).

In this Study, there was no significant association between knowledge of soil transmitted helminth and level of Educational attainment, (χ^2 = 13.393, P = 0.02000). There was no significant association between the environmental factors and those children that had helminthic infection, (χ^2 = 2.462, P = 0.296). There was also no significant association between the risk factors of helminthic disease and the children that had helminthic infection, (χ^2 = 2.251, P = 0.895) (Table 4.21, 4.19, 4.18 respectively).

The correlation between the presence of helminth eggs, soil pH and mineral composition of soils of public school's playgrounds shows that there was a significant association between Nitrogen and *strongyle* eggs (p = 0.0316), there was a significant association between nitrogen *S. haematobium* eggs (P = 0.353), there was a significant association between soil pH and *Stronyloides* (P = 0.0130), and there a significant association between *strongyloides* eggs and sodium. There was also a significant association between *schistosome* eggs and organic carbon (P =0.0326), (Appendix viii). This therefore implies that increase in these mineral elements increases the chances of getting the helminth eggs concerned example;

majority of the soils different school's playgrounds have pH ranges from 7.1-8.6 (Appendix vi).

In this study, comparisms of parameters of soils which contained zoonotic geo-helminth between public and private schools in Bwari Area Council, Abuja FCT shows that there was a significant association between helminth eggs from the schools and pH (0.010), there was a significant association between helminth eggs from the schools and organic carbon. There was gnificant association between helminth eggs and sand (0.038) (Appendix ix). This implies that the higher the soil parameter, the higher the chances of getting the helminth eggs .from the soils of the school's playgrounds. Majorities of the school playgrounds have sandy soils (e. schools J, K, L, N, P, S, and T) and mixture of sand with other soils e.g. schools B, C, D, E, F, G, H, I, M, Q, and R respectively (Appendix v).

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study shows that there is high level of contamination of primary and pre-primary School play grounds (62.5%) and low level of contamination of pupil's palms (4%) in Bwari Area Council, Abuja, Nigeria.

Taeniid eggs 1480(30.6%) were more numerous than other helminth eggs in the soils of play ground and palms of the pupils while the least helminth egg recovered was eggs of *schistosoma haematobium* (0.1%). Public school playgrounds 3,596(73.3%) were more contaminated than private schools 1,280(26.3%), However, there was no significant association ($\chi^2 = 0.05848$, $P = 0.8089$) between the schools and the occurrence of helminth infestation in pupils.

Helminth eggs are obtained more during rainy season 194(77.6%) than dry season 56(22.4%) and there was a significant association ($\chi^2= 203.1$, $P=0.0001$) between the occurrence of helminth eggs and season of the year. Infection rate was higher in female than male, however, there was no significant association (χ^2 = 2.309, P = 129) between sex and helminth infestation in pupils. Majority of the respondents do not have knowledge of soil-transmitted helminths, (62.4%).

There was significant association between children that played with soil and those that had helminthic infection (χ^2 = 14.704, P = 0.000). There was significant association (χ^2 = 41.870, P =0.000) between ownership of pet/domestic animal and those that had helminthic infection. There was a significant association (χ^2 = 0.238, P = 0.000) between children that played with animals and those that had helminthic infection which was found to be significant.

There was no significant association (χ^2 = 2.251, P = 0.895). between the risk factors of helminthic infection and the children that had helminthic infection. There was also a significant ssociation (χ^2 = 324.8, P= 0.0001) between the occurrence of helminth eggs observed from pupil's palms and those observed from school's playgrounds (Table 4.14).

There was no association (χ^2 = 0.07910, P = 0.7285), between sex and helminth eggs found in palms. There was also a significant association (χ^2= 3.8134, P = 0.282), between age and parasite found in pupil's palm. There was no significant association (P = 0.0597, OR = 4.772, CL = 1.009 to 22.56) between geo-helminth eggs observed from pupils' palms in both public and private schools. There was also no significant association (P =0.5395, OR = 0.5573, CL = 0.1589 to 1.954) between helminth eggs observed from pupils palms in both pre-primary and primary schools.

6.2 Recommendation

1. Periodic de-worming of pupils should be encouraged in pre-primary and primary schools.

2. Children should as much as possible not play with soil and if they do should wash their hands immediately.

3. School authorities should provide clean toilets for the children

4. Improvement of sanitary facilities and promoting safe disposal of waste. Laws should be enacted against indiscriminate dumping of refuse, defecating and urinating in public places especially in pre-primary and primary schools; stray animal should be banned in communities by eradicating them whenever they are found.

5. There is need to improve on the personal hygiene and environmental sanitation of the populace especially in pre-primary & primary school, school children should endeavour to wash their hands properly with soap after playing, before eating and after visiting the toilet.

6. Public enlightenment policies and programmes should be carried out in a holistic approach.

8. Pre-primary and primary schools should be properly fenced to avoid indiscriminate defecating and urinating within the premises.

REFERENCES

Adams, (2004). Efficiency of albendazole against the whipworm *Trichuris trichiura:* a randomized controlled trial. *South African Medical Journal.* 94: 972–76

Adegba, O.A and Akinlabi (2002). Intestinal Parasitic infections among school children in a rural community South West Nigeria. *Nigeria Journal Parasitol,* 23: 11-8.

Adekunle L.V, Bammeke A.O, Lucas A.O (1986). Family influence on incidence of intestinal parasites among Nigerian children. Journal of Royal Society Health; 106:66-8.

Ahmed, A., Oniye, S.J., and Nock, I.H. (2003). Intestinal parasitoses in relation to growth and academic performance of students in Katsina State, Nigeria. *Journal of Tropical Biosciences*, 3:42-47.

Ajanusi, O.J and Asiribo O.E (2004) A ten-year analysis of canine *hookworm* and *Toxocara canis* infections in Zaria, Nigeria. *Journal of Tropical Bioscience,* 4:23-26.

Ajanusi, O.J and Gunya, Y.G.D, (1998). Helminth infection in Dogs: Relationship between worm burden and laboratory estimation of infection. *The Nigerian Journal of Parasitology,* 19: 59-65.

Ajayi, O.O., John, O.D., Ajayi, J.A., and Ogwurike, B.A (2006). Parasitic load of refuse demps in markets and their environmental health impact in Jos Metropolis, *Nigerian Annals of Natural Sciences,* 6(2):20-27.

Albonico M, Chwaya H.M, Montresor A, Stolfzfus RJ, Tielsch J.M, Alawi K.S, Savioli L, (1997). Parasitic infections in Pemba Island school children. *East African Medical Journal*; 74: 294-8.

Albonico M, Montresor A, Crompton DW, Savioli L (2006). Intervention for the control of soil-transmitted Helminthiasis in the community. *Advanced Parasitol;* 61:48-312.

Albonico M, Ramsan M, Wright V, Jape K, Haji H.J, Taylor M, Salviola L, Bickle Q (2002). Soil-transmitted nematode infections and mebendazole treatment in Mafia Island school children. *Annals of Tropical Medical Parasitology*; 96: 26-717.

Alonso J.M., Stein, M., Chamorro, M.C., Bojanich M.V. (2001). Contamination of soils with eggs of *Toxocara* in a subtropical city in Argentina. *Journal of Helminthology* 75: 165 – 168.

Anand, S., Hanson, K, (1997). Disability-adjusted life years: a critical review. *Journal of Health Economics* 16:685-702.

Anderson R.M (1982). The population dynamics and control of hookworm and roundworm infection In: Anderson Rm, editor. Population Dynamics of Infectious Diseases: Theory and Applications. London: Chapman and Hall Medical; Pp. 67-109.

Appleton CC, Maurihungirire M, Gouws E, (1999). The distribution of helminth infections along the coastal plain of Kwazulu-Natal province, South Africa. Annals of Tropical Medicine & Parasitology 93:859-868.

Arora D.R, and Arora B.B, (2010). Medical Parasitology. CBS Publishers & Distributors, PVT. LTD, India, 3rd Edition Pg 236-238.

Asaolu S.O, Ofoezie I.E. (2003). The role of Health Education and Sanitation in the control of Helminth Infections. *Acta Tropica* 86:283-294.

Awogun, T.A. (1982). The prevalence of intestinal parasitic infections in children living in Ilorin community. *The Nigerian Journal of Parasitology.* 3(1): 61-66.

Bachta E, Zenaidi N, Belkaid M, Tabet-Derraz O. (1990) [Evaluation of intestinal parasitosis detected among Algerians (1984-1988)] *Bulletin of Society Pathology Experiment* 83 (4): 510-6.

Barreto M, Genser B, Strina A, Teixeira M.G, Assis A.M.O, Rego R.F, (2007). Effect of city-wide sanitation programme on the reduction in the rate of childhood diarrhea in northeast Brazil: assessment by two cohort studies. Lancet; 370-1622-8.

Beaver PC, (1975). Biology of soil-transmitted helminthes: the massive infection. Health Laboratory Science; 12:25-116.

Beer RJ (1976). The relationship between Trichuris trichuria (Linnaeus (1758) of man and Trichuris suis (Schrank 1788) of the pig. Research in Veterinary Science; 20:47-54.

Bethony J., (1999). Familial resemblance in humoral immune response to defined and crude Schistosoma mansoni antigens in an endemic area in Brazil. *Journal on Infectious Diseases* 180:1665-1673.

Bethony J, Chan J.Z, Lin SX, Xiao SH, Zhan B, Li SW, Xue HC, Xing FY, Humphries D, Wang Y, Cheng G, Foster V, Hawdon JM, Hotez PJ (2002). Emerging patterns of *hookworm* infection: influence of aging on the intensity of *Necator* infection in Hainan Province, People's Republic of China. *Clinical. Infectious Disease* 35: 1366-1344.

Bethony J, Brooker S, Albonico M, Geiger SM, Loukas A, Diemert D, Hotez PJ (2006). Soil-transmitted helminth infections: *ascariasis, trichuriasis, and hookworm. Lancet.* 367:1521-1532.

Bockarie, M.J., Davies, J.B. (1990). The transmission of *onchocerciasis* at a forest village in Sierra Leone. II. Man-fly contact, human activity and exposure to transmission, *Annals on Tropical Medical Parasitology*. 84: 599-605.

Bouhoum K and Schwartzbrod J, (1997). Epidemiological study of intestinal helminthiasis in a MMarrakech raw sewage spreading zone. Zentralblatt for Hygiene and Umweltmedizin 200: 553.

Bowman, D.D (1999). "Georgis Parasitology for Veterinarians". Saunders, London Medical.

Brooker S, Beasley NM, Ndinaromtan M, Madjiouroum E.M, Baboguel M, Djenguinabe E, *et al.,* (2002). Use of remote sensing and a geographical information system in a national helminth control programme in Chad. Bulletin of World Health Organisation; 80: 783-9.

Brooker S, Clements A, Bundy D.A.P, (2006). Global epidemiology, ecology and control of soil-transmitted helminth infections. *Advanced Parasitology*; 62: 223-65.

Brooker S, Micheal E. (2000). The potential of Geographical Information Systems and Remote Sensing in the Epidemiology and Control of Human Helminth Infections. *Advances in Parasitology* 47: 245-87.

Brooker S, Pratap S, Waikagul J, Suvanee S, Kojima S, Takeuchi T, *et al.,* (2003). Mapping soil-transmitted helminth infections in Southeast Asia and implications for parasite control. *Southeast Asian Journal of Tropical Medical Public Health;* 34:24-36.

Brooker S., Bethony J., Hotez P.J (2004a). Human Hookworm Infection in the 21st Century. *Advances in Parasitology;* 58:197-288.

Brooker S., Whawell S., Kabatereine N.B., Fenwick A., Anderson R.M (2004b). Evaluating the Epidemiological Impact of National Control Programmes for Helminths. *Trends in Parasitology;* 11:537-45.

Brooker, S.(2007). Spatial epidemiology of human Schistosomiasis in Africa: risk models, transmission dynamics and control. *Transactional Royal Society of Tropical Medicine and Hygiene* 101:1-8.

Brooker, S., Peshu, N., Warm, P.A., Mosobo, M., Guyatt, H.L., Marsh, K., and Sow, R.W (1999). The epidemiology of *hookworm* infection and its contributions to anaemia among pre-school children on the Kenyan Coast. *Transactions of the Royal Society of Tropical Medicine and Hygiene,* 91:240-246.

Brown, H.W. (1928). A qualitative study of the influence of oxygen and temperature on the embryonic development of the pig ascarid (*Ascaris suum,* Goetz). *Journal of Parasitology,* 14(3): 141-160.

Bull, (2001). Understanding the effects of printed health education materials: Which features lead to which outcomes? *Journal of Health Communication*; 6:265–79.

Bundy D. A., Chan M. S., Savioli L (1995). Hookworm Infection in Pregnancy. *Transactions of the Royal Society of Tropical Medicine and Hygiene.* 89:521–22.

Bundy D.A., Wong M.S, Lewis L.L, Horton J (1990). Control of geohelminths by delivery of targeted chemotherapy through schools. *Transactional Royal Society of Tropical Medicine & Hygiene;* 81:115-20.

Bundy D.A.P (1995). Epidemiology and transmission of intestinal helminthes, in: farthing, M.J.G, Keusch, G.T & Wakelin, D (Eds.0, Enteric infection 2, *Intestinal Helminths*, *Chapman & Hall Medical*; 5-24.

Bundy D.A.P, Medley G.F (1992). Immuno-epidemiology of human geohelminthiasis: ecological and immunological determinants of worm burden. *Parasitology;* 104:105-119.

Bundy, (2004). Intestinal nematode infections. In: Murray CJL, Lopez AD, Mathers CD, eds. Global epidemiology of infectious disease: Global burden of disease volume IV. Geneva: World Health Organization. 243–300 http://whqlibdoc.who.int/ publications/2004/9241592303.pdf (accessed Feb 20, 2006).

Campillo M, Rojo-vazquez F (1999). Parasitologia Veterinaria, 1st Edition McGraw. Rev.ibero-latinoam Parasitol (2010); 69(1): 46-51.

Centre for Disease Control and Prevention (2010). Parasite – Soil Transmitted Helminths (STHs). Retrieved from www.cdc.gov/parasites/sth/- 2nd November 2011.

Chan M.S (1997). The global burden of intestinal nematode infections: fifty years on. *Parasitology Today*; 13:438-43.

Chan M.S, Medley G.F, Jamison D, Bundy D.A (1994a). The evaluation of potential global morbidity attributable to intestinal nematode infection. *Parasitology journal:* 109: 373-87.

Cheesbrough M, (1998). District Laboratory practice in Tropical Countries. Cambridge University Press. Part 1; pp: 209-211.

Cheesbrough M, (2000). District Laboratory practice in Tropical Countries. Cambridge Universal Press. Part 2.

Chigozie J. Uneke, Kelvin O, Eze, Patrick G. Oyibo, Nelson C. Azu, Emmanuel Ali (2007). Soil-transmitted Helminth infection in school children in South-Eastern Nigeria: The Public Health Implication. *The Internet Journal of Third World Medicine.* Volume 4 (1):20-25.

Christian P., Khatry S. K., West K. P (2004). Antenatal Anthelmintic Treatment, Birthweight, and Infant Survival in Rural Nepal. *Lancet.*; 364:981–83.

Cooper P.J, Chico M.E, Rodrigues L.C, Ordonez M, Strachan D, Griffin G.E, (2003). Reduced risk of atopy among school-age children infected with geohelminth parasites in a rural area of the tropics. *Journal of Allergy Clinical Immunology;* 111;995-1000.

Cooper PJ (2006). The Potential impact of early exposures on geohelminth infections on the development of atopy. *Clinical Review Allergy Immunology;* 26:5-14.

Cooper, E. (1991). Intestinal Parasitoses and the modern description of disease of poverty. *Transactional Royal Society of Tropical Medicine & Hygiene* 85; 168-70.

Cooper, E.S and Bundy, D.A.P (1988). *Trichuris* is not trivial. Parasitology today 4:301-306.

Cox, F.E.G, (2002). History of human parasitology. *Clinical Microbiology Review* **15:**595-612.

Crompton D.W (1999). How much helminthiasis is their in the world? *Journal of Parasitology*; 85: 397-403.

Crompton D.W.T (1989). Prevalence of ascariasis In: Ascariasis and its prevention and control, D.W.T Crompton, M.C Nesheim and Z.S. Pawloski (eds.). University Press Pp, 135-144.

Crompton D.W.T, Saviola L (1993). Intestinal Parasitic Infection and Urbanization. *Bulletin of the World Health Organization;* 71:1-7.

Dayan A.D (2003). Albendazole, mebendazole and praziquantel. Review of non-clinical toxicity and pharmacolinetics. *Acta Tropicals.* 86: 141-59.

De Silva NR, Hotez PJ, Montressor A, Engels D, Savioli L (2003). Soil-transmitted helminth infections: updating the global picture. *Trends in Parasitology* 2003; 19:547-51.

Drake L. J., Jukes M. C. H., Sternberg R. J., Bundy D. A. P (2000). Geohelminth Infections (Ascariasis, Trichuriasis, and Hookworm): Cognitive and Developmental Impacts. *Seminars in Pediatric Infectious Diseases;* 11:245–251.

Druihe P., Tall A., Sokhna C. (2005). Worms can worsen malaria: towards a new means to roll back malaria. ? *Trends in Parasitology*. 21:359-362.

Duniya, D. (2000). Prevalence of geohelminth eggs in the stool of selected primary school pupils and soil of the school environment in Zaria. M.Sc. Thesis, Department of Biological Sciences, Ahmadu Bello University, Zaria, Pp 51.

Emmanuel, K. (2007). Bwari Area Council; Making a head-way under seasoned leadership. Retrieved from www.ngex.com/news/public/article.php?ArticleID=704-. 16th December 2011.

Etim, S.E. and Akpan, P.A. (1999) Studies on Geophagy as risk factor for geohelminthiasis in Calabar, Cross River state, Nigeria. *Nigerian Journal of Parasitology,* 20: 91-98.

Etim, S.E., Akpan, P.A., Abeshi, S.E., and Offiom, O.E. (2002). Intestinal helminth infections in children: Implications for helminth control using school based mass chemotherapy. *Nigerian Journal of Parasitology,* 23: 53–60.

Fairbairn, D.(1957). The biochemistry of *Ascaris*. *Experimental Parasitology*, 6:491-554.

Fairbairn, D.(1961). The In Vitro hatching of *A. Lumbricoides* eggs. *Canadian Journal of Zoology*, 39:153-162.

Ferreira C.S Ferreira M.U, Noguera M.R (1994). The prevalence of infection by intestinal parasites in an urban slum in Sao Paulo, Brazil, *Journal of Tropical Medicine Hygiene;* 97, 121-127.

Finchan, J.E., Markus, M.B., Adams, V.J (2003). Could control of soil-transmitted helminthic infection influence the HIV/AIDS pandemic? *Acta Tropicals;* 86:315-33.

Fleming, F.M., *Brookers S,* Geiger S.M, Caldas IR, Correa-Oliveira R, Hotez PJ and Bethony JM (2006). Synergistic associations between hookworm and other helminth species in a rural community in Brazil. *Tropical Medical International Health*. 11:56-64.

Forrester, J.E., Scott, M.E., Bundy, D.A., Golden, M.H. (1988). Clustering of *Ascaris Lumbricoides* and *Trichuris trichuria* infections within households. *Transactional Royal Society of Tropical Medical Hygiene* 82:282-288.

Galvani AP (2005). Synergistic association between *hookworm* and other species in a rural community in Brazil. *Tropical Medical International Health.* 11:56-64.

Garcia, H.H., Evans, C.A., Nash, I.E. (2002). "Clinical Microbiological Reviews" 15(4): 747-56.

Gills, H. (1996). Soil-transmitted helminthes (geohelminths). In Manson's tropical diseases. G. Cook, editor. W.B. Saunders. London, United Kingdom. 1369-1412.

Guarnera, E.A., G. Santillan, A. Botinelli and A. Franco (2000). "Canine Echinococcosis; an alternative for surveillance epidemiology. Veterinary Parasitology 88: 131-134.

Guyatt H. L. (2002). Do Intestinal Nematodes Affect Productivity in Adulthood? *Parasitology Today*; 16:153–58.

Harold, E.A., David, P.A., Sir James,A. Jeffcott, L.B. Frankling, Alice, M.W. eds (2000) *Merck Veterinary Manual*, eight edition. Pp 318-cf.

Hoagland K.E, Schad G.A (1978). *Necator Americanus* and *Ancylostoma duodenale:* Life history parameters and epidemiological implications of two sympatric hookworms of humans. *Experimental Parasitol;* 44, 36-49.

Holland C.V; Shea E.O; Asaolu S.O; Turley O; Crompton D.W.T (1996). A Cost-Effectiveness Analysis of Anthelminthic Intervention for Community Control of Soil-transmitted Helminth Infection: Levamisole and *Ascaris Lumbricoides*. *The Journal of Parasitology*, Vol. 82, No. 4. Pp. 527-530.

Holland CV, Taren DL, Crompton DWT (1988). Intestinal helminthiases in relation to the socio-economic environments of Panamanian children. Social science medicine, 26: 209-13.

Hotez P.J., Brookers S., Bethony J.M., Bottazzi M.E., Loukas A., Xiao S.H (2004). Current Concepts: *Hookworm* Infection. *New England Journal of Medicine,* 351:799-807.

Hotez P.J, Brooker S, Bethony M.J, Bottazzi M.E, Loukas A, Xia O.S. (2004). Hookworm Infection. *New England Journal of Medicine; 351:* 799-807.

Hotez PJ, da Silva N, Brooker S, Bethony J (2003).Soil Transmitted Helminth Infections: *The Nature, Causes and Burden of the Condition* working paper No.3, Disease Control Priority Project. Bahesda, Manyland: Fogatory International Centre, National Institute.

Hotez, P.J (2002). China's *hookworms* [abstract]. *China quarts*. 172:1029-1041.

Hotez, P.J (2008). Forgotten people and forgotten diseases, the neglected tropical diseases and their impact on global health and development. *ASM* Press Washington D.C, pg; 215.

Hotez, P.J., Molyneux D.H., Fonwick A (2007). Control of neglected tropical diseases. *New England Journal of Medicine*. 357:1018-1027.

Hotez, P.J., Molyneux D.H., Fonwick A., Ottesen E., Ehrilch Sachs J.D., (2006). Inc orporating a rapid-impact package for neglected tropical diseases with programs for HIV/AIDS, tuberculosis, and malaria. *Plos Medical.* 3:102. http://www.who.int/wormcontrol/documents/en/001to011.pdf. 12th August 2011.

Humphries D.L, Stephenson L.S, Pearce E.J, The P.H, Dan H.T, Khanl L.T (1997). The use of human faeces for fertilizer is associated with increased intensity of hookworm infection in Vietnamese women. *Transaction of the Royal Society of Tropical Medicine and Hygiene;* 91:518-520.

Jaskoski B.J, (1951). Experimental Parasitology 1, 291

Jia, T.W., Zhou X.N., Wang X.H., Utzinger J., Steinmann P., (2007). Assessment of the age-specific disability weight of chronic schistosomiasis japonica. *Bulletin of World Health Organization.* 85**:**458-465.

John David T., and William A., Petri, Jr. (2006). *Markell and Vogue's Medical Parasitology, 9th Edition*. Saunders Elsevier Press. Retrieved from http://www.amazon.com/Markell-Voges-Medical-Parasitology-1-3, 29th August 2011.

Joseph F, Urban J, Nina R, Gloria I, Solano-Aguilara HD, Dawsona OI, (2007). Infection with parasitic nematodes cofounds vaccination efficacy. *Veterinary Parasitol;* 148:14-20.

Kabatereine NB, Tukahebwa EM, Kazibwe F, Namwangye H, Zaramba S, Brooker S, (2006). Progress towards country-wide control of schistosomiasis and soil-transmitted helminthiasis in Uganda. Transactional Royal Society of Tropical Medical Hygiene; 100:208-15.

Kiff, R.J. and Lewis-Jones, R. (1984). Factors that govern the survival of selected parasites in sewage sludges. Ch. 25 in Sewage Sludge Stabilisation and Disinfection, ed. Bruce, A.M., Chichester, Ellis Horwood, 453-461.

King C.H, Dickman K, Tisch D.J (2005). Reassessment of the cost of chronic helminthic infection: a meta-analysis of disability related outcomes in endemic schistosomiasis. *Lancet*; 365:1561-69.

King C.H., Dangerfield-Cha M, (2008). The unacknowledged impact of chronic schistosomiasis. Chronic Illness; 4(1): 65-79.

Kobayashi A. (1980). Studies on the mode of Ascaris infection in Japan. *Asian Parasite Control Organization;* Vol 3; 1178-2780.

Kobayashi J, Hasegawa H, Forli A.A, Nishimura N.F, Yamanaka A, Shimabukuro T, Sato Y (1995). Prevalence of intestinal parasitic infection in fire fans in Holambia, Sao Pulo Brazil. *Revised Instructional Medicine Tropical*, Sao paolo 37,13-18.

Lacey E (1990). Mode of action of benzimidazoles. *Parasitology Today.* 6:112-15.

Lansdowne R, Ledward A, Hall A, Issae W, Yona E, Matulu J, (2000). Schistosomiasis, helminth infection and health education in Tanzania: achieving behavior change in primary schools. *Health Education Research.;* 17:425-33.

Levine, N.O (1968) *Nematode parasites of domestic animals and man.* 2nd Edition Pp 317 - 372, Mineapolis, Burgess.

Lee, D.L. and Atkinson, H.J. (1976). Physiology of Nematodes. 2nd edition, MacMillan Press LTD., London; Pg 215.

Liebmann, H. (1964). Parasites in sewage and the possibilities of their extinction. In: Proceedings of the second International Conference, Advances in water pollution Research. Toyko, Vol. 2, J.K. Baars, Pergamon Press pp: 269-279.

Lilley J.H, Philips M.J, Tonguta K, (1992). A rewiews of epizootic ulcerative syndrome in Asia. Bangkok: Publication of Aquatic Animal Health Research Institute and Network of Aquaculture Centre in Asia-Pasific pg 73.

Lysek, H. and Bacovsky, J.(1979). Penetration of ovicidal fungi into altered eggs of Ascaris Lumbricoides. Folia Parasitologica, 26: 139-142.

Magnaval J.F., Galindo V., Glickman L.T., and Clanet M (1997). Human *Toxocara* infection of the central nervous system and neurological disorders: A case control study; *Parasitology*, 115 (5): 537 – 543.

Maikai, B.V., Umoh J.U., Ajanusi O.J., and Ajogi, I. (2008). Public health implications of soil contaminated with helminth eggs in the metropolis of Kaduna, Nigeria. *Journal of Helminthology* 82, 113-118.

Manson, P.R and Patterson, B.A (1994). "Epidemiology of *Hymenolepis nana* infections in Primary school children in Urban and rural Communities in Zimbague. *Journal of Parasitology* 80:245-250.

Mercado-Burgos, N., Hoehn, R.C and Holliman, R.B. (1975). Effect of halogens and ozone on *Schistosoma* ova. *Water Pollution Control Federation Journal*. 47:2411-2419.

Miguel EA, Kremer M.W (2003): identifying impacts on education and health in the presence of treatment externalities. *Econometrica;* 72:159-217.

Minivielle, M.C., Taus, M.R., Rafto, A., Ciarmels, M.L., and Basualdo, J.A (1993). "Seroprevalence of toxocarioasis in blood donors of Gualeguaychu, Argentina. *Transactiona of the Royal Society of Tropical Medicine and Hygiene* 94:373-375.

Mizgajska, H, (2001). Eggs of *Toxocara spp* in the environment and their public health implications. *Journal of Helminthology* 75: 147-151.

Mizgajska, H. (1997)."The role of some environmental factors in the contamination of soil with *Toxocara* specie and other geohelminth eggs. *Parasitology International* 46: 67-72.

Mohammed, F., (2010). The prevalence of Toxocara eggs in the soil of Abuja Recreational parks and gardens. M.Sc thesis submitted to ABU, Pages 1-50.

Montresor A, and Crompton D.W, (2003). Use of benzimidazoles in children younger than 24 months for the treatment of soil-transmitted helminthiasis. *Acta Tropicals*. 86: 223-32.

Montressor, A., Crompton, D.W.T., Bundy, D.A.P., Hall, A., and Salvioli, L. (1998). Guidelines for the evaluation of soil-transmitted helminthiasis and schistosomiasis at community level. http://whqlibdoc.who.int/hq/1998/who_CTD_SIP_98.1.pdf. Assessed December, 2012.

Moreas L.R, Cancio J.A, Cairncross S, (2004). Impact of drainage and sewage on intestinal nematode infections in poor urban areas in Salvador, Brazil. Transactional Royal Society of Tropical Medicine & Hygiene.; 98:197-204.

Morishita, (1972). Studies on epidemiological aspects of ascariasis in Japan and basic knowledge concerning its control. In: *Progress of medical Parasitology in Japan*, Meguro Parasitology Museum, Tokyo, Japan. *Progress of Medical Parasitology*. 4: 1-153.

Motarjemi, Y., Kaferstein, F., Moy, G and Quevedo, F (1993). Contaminated weaning food: a major risk factor for diarrhea and associated malnutrition. *Bulletin of World Health Organization* 68(6): 691-689.

Mungo (2008). What works? Unpublished report London.

Muniz, P.T., (2008). The major human helminthiasis and their prevalence in Africa. *African Journal of Clinical Investigations*, 118(4): 1311-1321.

Murray, C.J.L., and Lopez, A.D., editors (1996). The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020. *Harvard School of Public Health.* Cambridge, Massachusetts, USA. 990PP.

Nawalinski T.A and Schad G.A (1974). Arrested development in *Ancylostoma duodenule* : Course of a self-induced infection in man. *American Journal of Tropical Medicine Hygiene*; 23, 895-898.

Nock, I.H, Duninya D. and Galadima M (2003). Geo-helminth eggs in soil and stool of pupils of some primary schools in Samaru, Zaria, Nigeria. *Journal Parasitol;* 24: 115-22

Nolf, L.O. (1932). Experimental studies on certain factors influencing the development and viability of the ova of the human *Trichuris* as compared with those of the human *Ascaris*. *American Journal of Hygiene,* 16: 288-322.

Nwosu A.B.C, Anya A.O, (1980). Seasonality in human hookworm infection in an endemic area of Nigeria, and its relationship to rainfall. Tropenmedizin Und Parasitologie;31:201-208.

Oberg, C., Boilley, M.A., Duran, V., Matamala R. and Oxs, E. (1993). "Enteroparasitosis en poblacion riberena del lago villarrica, Chile. Boletin Chileno de Parasitologia. 48: 8-12.

Ogata, S, (1925). The destruction of Ascaris eggs. *Annals of Tropical Medicine and Parasitology,* 19: 301-304.

Ogo, N. I., Ajayi, J. A., Ajayi, O. O., and Madueke, A. (2004). Eggs and cysts of parasites contaminating Nigerian currency notes. *African Journal of Natural Sciences,* 7: 40-42.

Ogwurike B. A., Ajayi J. A., Ajayi O. O., Olaniyano O., Nangna'an J. Y., Ouwadare A. T., Ogo N. I. (2010). A Comparative Study of Helminthiasis among pupils of private and public schools in Jos North Local Government Area of Plateau State, Nigeria. *Nigeria Annals of Natural Sciences,* Volume 10 (1); (pp 28 - 47).

Olaniyi J.E, Muktar H.A, Pauline E.J (2007). Areview of intestinal helminthiasis in Nigeria and the need for school-based intervention. *Journal of Rural and Tropical Public Health* 6: 33, 33-39.

Ottesen, E.A. 2006. Lymphatic filariasis: treatment, control and elimination. *Advanced. Parasitology.* 61**:**395-441.

Otto G.F, (1929). A study of the moisture requirements of the eggs of the horse, the dog, human and pig ascarids. *American Journal of Hygiene;* 10:497-520.

Paniker C.J (2002). Textbook of Medical Parasitology. Published by Jaypee Brothers Medical Publishers (P) Ltd. 5th Edition. Pp 105-118.

Paul, A.J. Todd K.S., Diprieto J.A (1988). "Environmental contamination by eggs of *Toxocara* species in the city of Philadelphia. *Veterinary Parasitology* 26:339-342.

Peng W., Zhou X., Cui X., Crompton D.W., Whitehead R.R., Xiong J., Wu H., Peng J., Yang Y., Wu X., Xu K., Yan Y., (1996). *Ascaris*, people and pigs in a rural community of Jiangxi Province, China. *Parasitology;* 113: 545-557.

Phiri, K., Whitty C.J., Graham, S.M., and Ssembatya-Lule, G.(2000). Urban/rural differences in prevalence and risk factors for intestinal helminth infection in Southern Malawi. *Annals of Tropical Medicine Parasitology*, 94: 381-387.

Prakash V, Singhal K.C, Gupta R.R (1980). Anthelmintic activity of punica granatum and Artemisia Silver Siana. *India Journal of Pharmacol;* 12;62

Prociv. P and Croese J. (1996). Human enteric Infection with Ancylostoma Caninium: Hookworms reappraised in the light of a "New zoonosis". *Acta Tropica* 62(1): 23-44.

Rai SK, Kubo T, Nakanishi M, Sunmi K, Shibita H, Matsuoka A, Shrestha H.G, (1994). Status of soiltransmitted helminthic infection in Nepal. *Kansenshogaku Zassi*; *Journal of Associate Infectious Diseases* 68(5): 625-630.

Rai SK, Nakanishi M, and Upadhyay MP, (2000). Effect of intestinal helminth infection on retinol and carotene status among rural Nepalese. *Nutritional Resistance*; 20: 15-23.

Rai, D.R., Rai, S.K. Sharma, B.K., Ghimire, P and Bhatta, D.R. (2005). Factors associated with intestinal parasitic infection among children in a rural area of Kathmandu valley, Nepal, *Nepal Medical College Journal* 7:43-46.

Ramirez-Barrios, R.A., Barboza-Mena, G., Jesus, M., Angulo-Cubillan, F., Elana, H., Fany, G. and Freddys, E. (2004). Prevalence of intestinal parasites in dogs under Verterinary care in Maracaibo, Venezuela. *Veterinary Parasitology.* 121: 11-20.

Raso G, Luginbul A, Adjoua C.A, Tian-Bi NT, Silute KD, Mathys B, Vounatsou P, Wang Y, Dumas ME, Holmes E, Singer BH, Tanner M, N'goran EK and Utzinger J

(2004). Multiple parasite infections and their relationship to self-reported morbidity in a community of rural Cote d'Ivoire. International Journal of Epidemiology; 33: 1092-102.

Reimers, R.S., Little, M.D., Akers T.G., Henriques, W.D., Bordeaux, R.C. and McDonnell, D. (1989). Persistence of pathogens in lagoon-stored sludge. EPA, 600/2-89/015. Retrieved from http://www.wpro.int/.healthtopics/Helminthosis/. 12th September2011.

Ruiz de Ybanez, M.R.., Ganjo, M.M., Goyena M. and Alonso, F (2000). Improved methods for recorvery eggs of *Toxocara canis* from soil. *Journal of helminthology* 74:349-353.

Ruiz de Y'banez M.R, Garijo M.M. Alonso, F.D (2001) Prevalence and viability of eggs of *Toxocara* spp. and *Toxocaris leonine* in public parks in eastern Spain. *Journal of helminthology 75*: 169-173.

Sam - Wobo, S.O., Mafiana, C.F., and Idowu A.B. (2004). The effects of surface soil exchangeable cations on the prevalence of *Ascaris lumbricoides* in Ogun state, Nigeria. *The Nigerian Society for Parasitology* 25:25-31.

Santos, (2005). Comparism of the thick smear and Kato-Katz techniques for diagnosis of intestinal helminth infections. Revised Society of Brasil Medicine Tropicals; 38: 196-98.

Savioli, I., Bundy, D.A., and Tomkins, A. (1992). Intestinal parasitic infections: a solvable health problem. *Transactions of The Royal Society of Tropical Medicine and Hygiene*, 86:351-354.

Schacher, J.F. (1957). A contribution to the life history and larval morphology of *Toxocara canis. Journal of Parasitology*, 43: 599-612.

Schantz, P.M. (1989). Toxocara larva migrans now. *American Journal of Tropical Medicine and Public Health*. 41: 21-34.

Schad G.A, and Warren K.S (1990). Hookworm disease, current status and new directions. Taylor and Francis, London, 71-102 Pp.

Schan G.A, Chodhury A.B, Dean C.G, Kochar V, NawaLirski T.A, Thomas J, Tonascia J.A (1973). Arrested development in human hookworm infections: an adaptation to seasonality unfavourable external environment. *Science* 180: 502-504.

Schantz, P.M. (1994). Of worms, dogs, and human hosts: continuing challenges for Veterinarians in prevention of human disease. *Journal of American Veterinary Medical Association. 204(7):1023-1028.*

Seamster, A.P. (1950). Development studies concerning the eggs *of Ascaris Lumbricoides* var. *Suum. American Midland Naturalist,* 43: 450-470.

Smyth, J.D.(1994). *"Animal Parasitology"* Cambridge University Press London. Pp 277-412.

Soulsby (1986). Echinococcus egg is typical taeniid egg. Hence there is difficulty differentiating them from Taenia eggs; 92:621-641.

Soulsby, E. J. L. (1982). Helminths, arthropods and protozoa of domesticated animals, 7th edition London, (ELBS and Bailiere, Tindall and Cassel Ltd). 809 pages.

Soulsby, E.J.I (1986) "Examination of faeces in : *Helminths, Arthropods and Protozoa of Domesticated Animals*, 7th Edition, William Clones Limited, Beccles and London. Pp 765-766.

Soulsby, E.J.I (1987) "Larva migrans in perspective. In : S.Geerts *et al.,* Editors, Helminth zoonoses, Martinus Nijhoff, Dordecht., Pp 137-145.

Sow S, de Vlas SJ, Plman K, Gryseels B (2004). Hygiene practices and contamination risks of surface waters by *schistosome* eggs: The case of an infested village in Northern Senegal. *Bulletin of Society Pathology Ecxperiment;* 7:12-4.

Stephenson L. S., Latham M. C., Ottesen E. A (2000). Malnutrition and Parasitic Helminth Infections. *Parasitology;* 121(Suppl.):123–128.

Stoll, N.R. (1999). This wormy world. *Journal of Parasitology.* 85:392-396.

Stoltzfus R. J., Chwaya H. M., Montresor A., Tielsch J. M., Jape J. K., Albonico M., Savioli L (2004). Low Dose Daily Iron Supplementation Improves Iron Status and Appetite but Not Anemia, Whereas Quarterly Anthelmintic Treatment Improves Growth, Appetite, and Anemia in Zanzibari Preschool Children. *Journal of Nutrition*; 134:348–56.

Stoltzfus R.J., Dreyfuss M.L., Chawaya H.M., Albonico .M (1997). Hookworm Control as a Strategy to Prevent Iron Deficiency Anemia. *Nutrition Reviews*; 55:223-32.

Tarmramat I.R., and Olowu, A.O. (2008). Study on Prevalence and Nutritional Effects of Helminthic infection in pre-school Rural Children in Nigeria. *Nigerian Medical Practitioner* Vol 54; No 1; pg 16-20.

Traub J.R., Robertson, I.D., Irwin, P.J., Menoke N. and Andrew Thompson R.C.A (2004) "Canine gastrointestinal parasitic zoonoses in India. *Trends in Parasitology* 21 (1) 42-48.

Udonsi J.K and M.I Amabibi (1992). The human environment, occupation and possible water borne transmission of the human hookworm *Necator americanus* in endemic coastal communities of the Niger Delta, *Nigeria Public Health,* 106: 63-71.

Udonsi J.K, (1988). Experimental and Field Studies on the viability of eggs and the infectivity of third stage larvae of the Creck waters of the Niger Delta Nigeria and their epidemiological significance. *Parasitol;* 96, 111-117.

Udonsi J.K, Atata G, (1987). *Necator americanuas:* Temperature, pH, Light and Larval development, longevity and dessication tolerance. *Experimental Parasiotol;* 63, 136-142.

Uga S, (1993) "Prevalence of Toxocara eggs and number of feacal deposits from dogs and cats in sand pits of public parks in Japan. *Journal of Helminthology* 67: 78-82.

Uga S, and Kataoka, N, (1995). Measures to control Toxocara egg contamination in sand pits of public parks. *American Journal of Tropical Medicine and Hygiene* 52:21-24.

Uga S, Kataoka N. (1995b). Measures to control *Toxocara* egg contamination in sand pits of public parks. *American Journal of Tropical Medicine and Hygiene*; 52: 21-4.

Uga S, Wandee N, Virasakdi C (1997). Contamination of soil with parasite eggs and oocystes in southern Thailand. *Southeast Asian Journal of Tropical Medical Public Health*: 28 (suppl 3): 14-7.

Ukoli, F.M.A (1992). "Prevention and Control of Parasitic Diseases in Tropical Africa. University press P.L.C, Ibadan, Nigeria, Pp 13, 102-108, 113-114.

Unicef (1999). Sanitation and Hygiene; a Right for Every Child. New York.

WHO (2004). Helminthosis: WHO Model Formulary. Based on the 13th Model List of Essential Medicines 2003. Geneva:. World Health Organization; pp. 82–5.

WHO (1997). The World Health Report - conquering suffering enriching humanity. 12(6). Pubmed http://www.who.int/whr/1997/en/index.html

WHO (2002). *Helminth Control in School-Age Children: A Guide for Managers of Control Programs.*. World Health Organization. Retrieved from

WHO (2002). Prevention and Control of Schistosomiasis and Soil Transmitted Helminthiasis. *Report of a WHO Expert Committee*. Geneva: WHO Technical Report Series 912;

WHO (2004). " Integrated Guide to Sanitary Parasitology" Pg 159.

WHO (2005). Deworming for health and development. *Reports on the third global meeting of the partners for parasite control*. World Health Organization, Geneva.

WHO, (2004). Prevention and control of schistosomiasis and soil transmitted helminthiasis. Geneva: World Health Organization, *Report of a WHO expert.*

Williams, J.F., Colli, C.W., Leid, R.W., and Macarthur, R (1973). *Journal of Parasitology*. Pg; 59, 1141.

Wong, M.S., Simeon, D.T. Powel, C.A and Grantham Mc Gregor, S.M. (1994). "Geohelminth infections in school-aged children in Jamaica. *West Indian Medical Journal* 43: 121-125.

Woolhouse, M.E. (1989). Patterns in parasite epidemiology: the peak shift. Parasitology Today. 14:428-434.

Woolhouse, M.E., Taylor, P., Matanhire, D., Chandiwana, S.K. (1991). Acquired immunity and epidemiology of *Schistosoma haematobium. Nature.* 351: 757-759. Assessed November, 2010.

World Bank (1993)."World Development Report 1993: Investigating in Health". http://files.dcp2.org/pdf/WorldDevelopmentReport1993.pdf.Assessed january, 2011.

World Bank. (2003). *School Deworming at a Glance*. Public Health at a Glance Series. http://www.worldbank.org/hnp.

World Health Organisation, (2004). Helminthosis: Regional Office of the western pacific. htt://www.wpro.int/healthtopics/helminthosis/. Assessed March, 2012.

World Health Organization, (2008). Weekly epidemiological record. Progress record. Progress report on 2011 global target. 83(31): 261-284.

Yu S.H, Jian Z.X, Xu L.Q, (1995). Infertile hookworm disease in China. A review *Acta Tropica.* 59: 265-270.

Appendix I: Egg count of parasite eggs observed in soil samples of pre-primary and primary schools playgrounds in Bwari Area Council Abuja F.C.T

School	Taenia	Toxocara	Mite eggs	Coccidia	Fasciola	Strongyle	Hookworm	Schistosome	Trichuris	Strongyloides	Total EPG	Total EC
A	120	23	40	102	3	80	80	0	0	0	2.24	443
B	160	60	60	40	2	40	120	3	0	40	2.62	525
C	60	80	3	140	12	0	80	0	60	40	2.37	475
D	140	80	60	120	40	20	140	0	100	60	3.8	760
E	140	120	40	80	20	0	100	0	0	20	2.6	520
F	80	60	20	60	0	9	20	0	40	60	1.74	349
G	120	40	61	102	61	20	120	0	42	0	2.83	566
H	140	40	60	80	0	0	60	0	100	20	2.5	500
I	180	40	42	61	1	0	100	0	0	0	2.12	424
J	40	60	80	80	40	0	60	0	0	0	1.8	360
K	0	60	0	60	0	0	0	0	0	0	0.6	120
L	40	0	0	0	0	0	60	0	0	0	0.5	100
M	0	60	0	0	0	0	20	0	0	0	0.4	80
N	60	20	0	0	0	0	40	0	0	20	0.7	140
O	0	0	0	80	0	0	60	0	0	80	1.1	220
P	60	20	20	0	0	0	20	0	20	0	0.7	140
Q	0	20	60	0	0	0	40	0	60	0	0.9	180
R	80	20	40	60	0	0	60	0	40	0	1.5	260
S	40	20	60	0	0	0	0	0	0	60	0.9	180
T	20	40	60	0	0	0	80	0	0	0	1.1	160
Total count	1480	863	706	1065	179	169	1260	3	140	400	16.52	6607
% parasite count	22.4	13.1	10.7	16.1	2.7	2.6	19.1	0.1	7.4	6.1	100	

Mean ± SEM	69.2 ±8.95	50.2 ±6.81	47.1 ±5.28	82.0 ±7.7	11.8 ± 7.30	60 ± 20.0	43.3 ± 6.72	3	46.7 ± 6.67	44.4 ± 7.29

Appendix II: Detection rate of zoonotic geo-parasites in soil samples of pre-primary and primary schools' Playgrounds in Bwari Area Council Abuja F.C.T

Schools	No of Samples	No negative (-ve)	No Positive (+ve)	% +ve
A	32	16	16	6.4
B	28	14	14	5.6
C	30	12	18	7.2
D	30	8	22	8.8
E	30	6	24	9.6
F	30	12	18	7.2
G	32	16	16	6.4
H	30	10	20	8
I	32	10	22	8.8
J	30	4	26	10.4
K	10	5	5	2
L	10	6	4	1.6
M	8	6	2	0.8
N	8	2	6	2.4
O	10	4	6	2.4
P	10	6	4	1.6
Q	10	5	5	2
R	10	4	6	2.4
S	10	2	8	3.2
T	10	2	8	3.2
Total	400	150	250	62.5

Appendix 111: Association between the soil texture and the total number of parasite eggs collected from the various schools

Schools (Public & Private)	No of samples +ve for helminth	Soil Texture
A	16	Loam, Sandy (Mixed)
B	14	Sandy, loam (Mixed)
C	18	Sandy, Clay (Mixed)
D	22	Loam, Sandy (Mixed)
E	24	Loam, Sandy (Mixed)
F	18	Loam, Sandy (Mixed)
G	16	Loam, Sandy (Mixed)
H	20	Loam, Sandy (Mixed)
1	22	Loam, Sandy (Mixed)
J	26	Sandy
K	5	Sandy
L	4	Sandy
M	2	Loam, Sandy (Mixed)
N	6	Sandy
O	6	Loam, Sandy (Mixed)
P	4	Sandy
Q	5	Loam, Sandy (Mixed)

R	6	Loam, Sandy (Mixed)
S	8	Sandy
T	8	Sandy
Total	250	Sandy, Loam, Clay

Appendix IV: Association between soil samples positive for helminth eggs from the various schools and pH value/type

School	Soil sample +ve for helminth egg	p.H value	p.H type
A	16	7.4	Slightly alkaline
B	14	7.3	Slightly alkaline
C	18	7.2	Slightly alkaline
D	22	8.6	Alkaline
E	24	7.1	Slightly alkaline
F	18	7.1	Slightly alkaline
G	16	7.6	Slightly alkaline
H	20	8.1	Alkaline
I	22	8.1	Alkaline
J	26	8.1	Alkaline
K	5	6.0	Acidic
L	4	8.0	Alkaline
M	2	6.2	Slightly acidic
N	6	7.8	Slightly alkaline
O	6	8.1	Alkaline

P	4	8.3	Alkaline
Q	5	8.2	Alkaline
R	6	8.1	Alkaline
S	8	6.1	Slightly acidic
T	8	7.7	Slightly alkaline
Total	250		

Appendix V: Correlation between the presence of helminth eggs, soil pH and mineral composition in soil samples of public school playgrounds

Helminth	pH	Nitrogen	Calcium	Organic Carbon	Sodium
Taeniids	r = 0.2599	r = -0.5743	r = 0.01057	r = -0.3801	r = 0.2231
	P = 0.4685	p = 0.0825	p = 0.9769	p = 0.2786	p = 0.5355
Toxocara	r = -0.2528	r = -0.06603	r = -0.5750	r = 0.1362	r = -0.6807
	P = 0.4811	p = 0.8562	p = 0.0821	p = 0.7076	p =0.0303
Mite	r = 0.3769	r = 0.08334	r = -0.2443	r = -0.02630	r = 0.08236
	P = 0.2831	p =0.8189	p = 0.4964	p = 0.9425	p = 0.8211
Coccidia	r = -0.3395	r = -0.3395	r = 0.01171	r = 0.1027	r = 0.02112
	P = 0.3372	p =0.9744	p = 0.5508	p = 0.776	p = 0.9535
Fasciola	r = 0.3868	r = 0.2075	r = -0.2976	r = 0.1203	r = -0.1431
	P = 0.2695	p = 0.5651	p = 0.4036	p = 0.7407	p = 0.6934
Strongyle	r = -0.09032	r = 0.6768	r = 0.439	r = 0.4032	r = 0.7311
	P = 0.8040	p = 0.0316*	p = 0.2042	p = 0.2480	p = 0.0163 *
Hookworm	r = -0.0888	r = 0.1024	r = 0.05572	r = 0.3576	r = -0.3508

	P = 0.8072	p = 0.7784	p = 0.8785	p = 0.3103	p = -0.3508
Schistosoma	r = -0.0413	r = 0.6667	r = 0.2116	r = 0.6740	r = 0.05772
	P = 0.7619	p = 0.0353*	p = 0.5572	p = 0.0326*	p = 0.8742
Trichuris	r = -0.0413	r = 0.06061	r = 0.005497	r = 0.0935	p = -0.2263
	P = 0.9098	p = 0.8679	p = 0.9880	p = 0.7972	p = 0.5296
Strongyloides	r = -0.7474	r = 0.3430	r = 0.2126	r = 0.5212	r = -0.2782
	P = 0.0130*	p = 0.3319	p =0.55554	p = 0.1224	p = 0.4365

Appendiex VI: Correlation between the presence of helminth eggs, soil pH and mineral composition in soils of private school playgrounds

Helminth	**p.h**	**Nitrogen**	**Calcium**	**Organic carbon**	**Sodium**
Taeniid	r = 0.2779	r = 0.2088	r = -0.3195	r = 0.1043	r = 0.5591
	P = 0.4370	p = 0.5627	p = 0.3682	p = 0.7744	p = 0.0929
Toxocara	r = -0.05357	r = -0.04583	r = 0.1531	r = 0.03774	r = 0.09963
	P = 0.8832	p = 0.8999	p = 0.6729	p =0.9176	p = 0.7842
Mite	r = -0.1090	r = 0.3425	r =-0.1794	r = 0.4092	r =-0.5081
	P = 0.470	p = 0.3327	p = 0.6200	p = 0.2403	p = 0.1338

Coccidia	r = 0.3696	r =-0.4313	r = 0.3840	r = -0.4082	r =-0.4431
	P = 0.2931	p = 0.2133	p = 0.2732	p = 0.2415	p = 0.1996
Hookworm	r = 0.1736	r =-0.02621	r = 0.2188	r =-0.2302	r = 0.2134
	P = 0.6316	p = 0.9427	p = 0.5437	p = 0.5223	p = 0.5540
Strogyloides	r =-0.1190	r =-0.3245	r = 0.5418	r =-0.5095	r =-0.3146
	P = 0.7434	p = 0.3602	p = 0.1057	p = 0.1325	p =0.3759

Appendix VII: Comparism of parameters of soil which contained geo-helminth eggs between public and private schools in Bwari Area Council, F.C.T

Parameters	Public School	Private School	P value
pH	7.46 ± 0.16[a]	7.99 ± 0.06[b]	0.010*
Sand	832.0 ± 23.75[a]	890.0 ± 10.33[b]	0.038*
Silt	52.0 ± 6.11[a]	48.0 ± 8.00[a]	0.696
Clay	106.0 ± 20.18[a]	62.0 ± 6.80[a]	0.063
Nitrogen	0.36 ± 0.06[a]	0.25 ± 0.04[a]	0.107
Calcium	3.38 ± 0.22 [a]	3.10 ± 0.22 [a]	0.385
Organic carbon	3.04 ± 0.42[b]	2.00 ± 0.17[a]	0.042*
Sodium	0.12 ± 0.21 [a]	0.10 ± 0.27 [a]	0.520

*Significant at P <0.05

Appendix VIII: Questionnaire

Dear Respondents,

Please, kindly answer the following questions, tick and provide written answers as requested by the questionnaire, it is for academic purposes only. Any information here will be treated with absolute confidentiality.

Thanks for your co-operation and God bless.

SECTION A: (Information about the Pupil)

1. Sex Male [ ], Female [ ]
2. Age 0-5yrs [ ], 5-10yrs [ ], 10-15yrs [ ], 15yrs & Above [ ]

3. Residence Urban [ ], Rural [ ], Others [ ]

SECTION B: (Information about the Parents/Guardians)

1.Occupation: ____

2 Level of Educational Attainment: ____________________________________

3. Religion: Christian [ ], Muslim [ ], Atheist [ ],

Others (Indicate): ____

4.Annual income: (Indicate): ____

5. Marital Status: Married [ ], Single [ ], Divorced [ ], Widowed/er [ ],

Other (Indicate): ____

6. Do you own pet animal(s): No [ ], Yes [ ], If yes please indicate the animal(s)

____

7. Do you allow the animals to roam around your home? _____________

8. Do you know what soil- transmitted helminths are?

9. D your children play with these animals? Yes [ ], No [ ], No Opinion [ ]

10. Do your children play with soil? __________________________________

11. Do you treat your pets against helminth parasites? _________________

____

12. Do you think that playing with soils or pet animals can result in helminthosis? Yes [ ], No [ ], No comment [ ].

13. How often do you treat them in a year ________________________________

14. Have your child/ward suffered any helminthic disease for the past six months? Yes [ ], No [ ], No opinion ______________________________________

15. Where do you get effective treatment for the disease? Hospital [ ], Clinics [ ], Health [ ], Others [ ].

16. What are the risk factors of soil transmitted helminthes?____________________

____

17. Who treats your pet? ____

18. What role should the Veterinary Council of Nigeria, F.C.T and Federal Ministry of Health perform in the control of Helminthosis in Bwari Area Council?____

____

19. Give your recommendations on how Helminthosis can best be controlled/eradicated in Bwari Area Council_________________________________

Appendix IX: Sample Collection Form (Filled by the Researcher)

I. Name of School sampled _________________________________

II. Estimated Area of the play ground___________________________

III. Fenced [ ], Not Fenced [ ]

IV. Topography, Gentle sloped [ ], Irregular slope [ ], Flat plane [ ]

V. Types of vegetation Cover Bare ground [ ], Grass (covered) [ ]

VI. Presence of stray animals Yes [ ], No [ ]

VII. Detection of fecal sample Yes [ ], No [ ]

VIII. Number of faeces seen per playground ______________________

IX. Are there heaps of refuse within the site? ___________________

X. Are there wastes littered around? _____________________________

XI. Soil characteristics: Wet (moist) [ ], Dry (powdery) [ ]

XII. Level of Hygiene/cleanliness: High [ ], Moderate [ ], Low [ ]

Appendix X: Sample Collection Sites

Public Sch	Estimated Area	Private Schools	Estimated Area of playground
A. L.E.A Byazhin	160mx120m	K Esteem Mpape	50mx30m
B. L.E.A Bwari	150mx100m	L Infant Jesus Nur/Pri Sch Gbazango	50mx20m

C. L.E.A Dutse	150mx120m	M	Jubilee Nur/Pri School Dutse	50mx20m
D. L.E.A Igu	150mx120m	N	Loyal Destiny Nur/Pri Sch Kubwa	50mx30m
E. L.E.A Kubwa	140mx100m	O	Princess Nur/Pri School Byazhin	50mx30m
F. L.E.A Kawu	150mx100m	P	Peace-Care Nur/Pri Sch Byazhin	50mx20m
G. L.E.A Kuduru	160mx100m	Q	St. Bartholomew's Nur/Pri sch Kubwa	40mx20m
H. L.E.A Shere	150mx100m	R	Sunshine Nur/Pri Sch Dutse	40mx20m
I. L.E.A Usman	160mx100m	S	Success Nur/Pri Sch Bwari	50mx20m
J. L.E.A Ushafa	150mx120m	T	Messiah Nur/Pri Sch Kuduru	50mx30m

Appendix XI: Preparation of Flotation Media

Preparation of Zinc Sulphate (ZnSO4) Solution: To prepare approximately 500ml; 165g of Zinc sulphate was weighed; also 50g of sucrose was weighed. Both were added together and dissolved in 500ml distilled water contained in a bottle and mixed well. The bottle was stood in a container of hot water or water bath to dissolve the zinc sulphate. They were mixed until the chemical is completely dissolved and the solution allowed to cool at room temperature. Using hygrometer, the relative density of the solution was checked. When the density was not within 1.180-1.200, more chemical or water were added to bring the solution within the correct density range, (Cheesbrough, 2000).

Appendix XII: Meterological Data (2012)

Month	Temp Max (OC)	Temp Min (Oc)	Rain fall (mmHg)

January (2012)	34.77 ± 0.28	18.46 ± 0.42	0.00 ± 0
February (2012)	35.86 ± 0.14	22.68 ± 0.31	0.71 ± 0.71
March (2012)	37.68 ± 0.20	24.24 ± 0.26	0.61 ± 0.57
April (2012)	34.63 ± 0.29	24.61 ± 0.31	1.73 ± 0.57
May (2012)	31.59 ± 0.39	22.25 ± 0.24	7.43 ± 3.00
June (2012)	30.17 ± 0.29	22.25 ± 0.24	7.43 ± 3.00
July (2012)	28.44 ±0.24	21.50 ± 0.23	12.13 ± 2.99

Appendix XIII: Calculation

Quantity of soil used: 50g

Volume of ruled area of each McMaster well: 0.15ml

Total volume into which the eggs were washed: 15ml

Therefore,

$$50g \times \frac{0.15ml + 0.15ml}{15ml}$$

$$50g \times \frac{0.3ml}{15ml} = \frac{15}{15} = 1$$

This implies that,

Egg per gram = Sum of the counts from the two McMaster wells x 1

Bethony J, Williams JT, Kloos H, Blangero J, Alv es-Fraga L, uck G (2001). Exposure to *Schistosoma mansoni* infection in a rural area in Brazil. II: Household risk factors. Tropical Medical International Health; 6: 136-42.

Akogun O.B. (1989). Some social aspects of helminthiasis among the people of Gumau District, Bauchi State, Nigeria. *Journal of Tropical Medicine and Hygiene* 92:193-196.