PREVALENCE OF TAENIA AND OTHER GEOHELMINTH EGGS IN SOILS OF RECREATIONAL PARKS OF ABUJA, NIGERIA

BY

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MAY, 2014

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(MSc/VET-MED/43048/12-13)

A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN VETERINARY PUBLIC HEALTH AND PREVENTIVE MEDICINE

DEPARTMENT OF VETERINARY PUBLIC HEALTH AND PREVENTIVE MEDICINE, AHMADU BELLO UNIVERSITY, ZARIA
NIGERIA

MAY, 2014

DECLARATION

I declare that this thesis titled **"Prevalence of *Taenia* and other Geohelminth Eggs in Soils of Recreational Parks of Abuja, Nigeria"**has been performed by me in the Department of Veterinary Public Health and Preventive Medicine under the supervision of Prof I. Ajogi, Prof O.J Ajanusi and DrJ.Kabir.The Information derived from the literature has been duly acknowledged in the text and in a list of references provided. No part of this thesis was previously presented for the award of another degree or diploma at any university.

Ishiyaku Musa, MOHAMMED

Name of Student	**Signature**	**Date**

CERTIFICATION

This thesis titled **"*PREVALENCE OF TAENIA AND OTHER GEOHELMINTH EGGS IN SOILS OF RECREATIONAL PARKS OF ABUJA, NIGERIA"*** by Ishiyaku Musa MOHAMMED,meets the regulations governing the award of the degree of Master of Science (MSc) in the Department of 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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Chairman, Supervisory Committee **Signature** **Date**

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ACKNOWLEDGEMENT

My profound gratitude goes to my major supervisor, Professor I. Ajogi for his patience, encouragement and guidance in perusing this work. My gratitude also goes to Professor O.J. Ajanusi for his profound assistance with information as well criticism and professional advice for the success of the work. Prof. A. K. B.Sackey for his professional Advice throughout the conduct of this work. Dr J. Kabir has been a consistent support and pillar ensuring the success of this work.

My gratitude also goes to the entire staff of the Department of Veterinary Public Health and Preventive Medicine, Veterinary Parasitology and Entomology, Ahmadu Bello University, Zaria and the entire staff of the Abuja Municipal Area Council for their support in guidance, advice and support throughout the period of this study.

Dr B. Maikai, Dr Y. Okubanjo, Dr M. Bisalla, Mal.Y.Magaji, Alh. Saleh for their contributions with current journals and laboratory analysis in respect of this study.

To my colleagues at the Department of Livestock and Pest Control Services of the Federal Ministry of Agriculture and Rural Development, Abuja, I say a big thank you for being there to support me during the period of this study. Special Thanks to the Director, Federal; Department of Livestock and Pest Control Services, Abuja, Dr G. Mshelbwala, Dr G. Mohammed for their understanding and excusing me from my schedule of work that enabled me to not only conduct this research study but also undertake the entire Msc. Programme.

To my wife Dr Fatima Mohammed for her continued support, encouragement and love that made the conduct of this research possible.

ABSTRACT

Soil contaminated with *Taenia* eggs can cause health related problems, mostly to people who come in contact with such soil either by playing with the soil or during recreational activity on the infested soil. This research work studied 184 soil samples from 16 selected recreational parks in Abuja to ascertain the prevalence population proportion of *Taenia*eggs and other Helminthes eggs using zinc sulphate flotation medium with a specific gravity of 1.25. Out of the 184 soil samples examined 49 samples were contaminated with *Taenia* eggs. A total of 12290 *Taenia* eggs were found in the 49 soil samples. However, it was observed that no *Taenia* egg was found from the samples collected from Cortland Garden. This implies that the total *Taenia* eggs count were gotten from 15 recreational parks. Millennium Park had the highest *Taenia* eggs count of 3640 (29.62%) followed by Jabi Lake Park with 2020 (16.44%) *Taenia* eggs, then Orbit Garden with 1800 (14.65%) *Taenia*eggs and Wuse Market Park with 1200 (9.93%) *Taenia* eggs. The other 11 recreational parks had *Taenia* eggs count of less than 900. The level of association between the prevalence rate of *Taenia* eggs in soil and soil pH was estimated using Pearson correlation analysis. At 0.05level of significance, the association was weak and therefore not significant. Also, the Cochran Q test was applied to determine if the population proportion of *Taenia* eggs is not significantly more prevalent than other geohelminth egg types in different soil textures and if the population proportion of all helminth egg types are the same for all parks locations. At 0.05 level of significance, it was observed that the population proportion of *Taenia e*ggs is significantly more prevalent than other geohelminth egg types and the population proportion of all helminth egg types were different for all sampled park locations. Based on this, it is recommended that public awareness on appropriate hygiene practices should be put in place while putting in

place sufficient sanitary facilities and enforcing land use regulationswill go a long way in reducing the risk of infection with *Taenia*.

TABLE OF CONTENTS

Title Page i

Declaration ii

Certification iii

Acknowledgement iv

Abstract v

Table of Contents vii

Appendix x

List of Figures xiii

List of Plates xii

CHAPTER 1: INTRODUCTION 1

1.1 Background of the Study 1

1.2 Statement of the Research Problem 3

1.3 Justification 4

1.4 Aim and Objectives 5

1.4.1 Aim 5

1.4.2 Objectives 5

1.5 Hypotheses for the Study 6

CHAPTER 2: LITERATURE REVIEW 7

2.1 Intestinal Helminths 7

2.2 Cestode Parasites of Economic and Public Health Importance 8

2.3 Common Examples of Intestinal Helminths (Geohelminths) of Zoonotic Importance 10

2.4 Taeniasis 23

2.5 Life cycle of *Taenia spp*. 23

2.6 Environmental Factors that Affect rate of Detection of Helminth Eggs.26

2.7 Prevention and Control of Helminth Infection.....27

CHAPTER 3: MATERIALS AND METHODS 30

3.1 The Study Area.....30

3.2 Sample Collection.....34

3.3 Mapping of selected Parks.....34

3.4 Sample Processing.....35

3.5 Questionnaire.....35

3.6 Data Analysis.....36

CHAPTER 4: RESULTS 44

4.1 Prevalence of Geohelmith egg type/*Coccidian*Oocyst in Samples of Abuja Recreational Parks.....44

4.2 *Taenia* egg Count of Soil Sample of 16 Recreational Parks.....44

4.2.1 Cochran Q Test on Helminth Egg Types for all the selected Parks.....45

4.3 Prevalence of other Geohelminth eggs and *Coccidia* oocysts in soil Sample of Abuja Recreational Parks.....45

4.3.1 *Toxocara eggs*.....45

4.3.2 *Ancylostoma* Eggs.....45

4.3.3 *Trichuris* Eggs.....46

4.3.4 *Ascaris* Eggs.....46

4.3.5 *Strongyle eggs*.....46

4.3.6 *Strongyloides* Eggs.....46

4.3.7 *Coccidian Oocyst*.....47

4.3.8 Mite Eggs.....47

4.4 Prevalence of Total Parasite Egg Count (EPG) for all Parks.....47

4.5 Questionnaire Analysis.....55

CHAPTER 5:DISCUSSION.....65

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS.....67

6.1 Conclusion.....67

6.2 Recommendations.....67

References……..68

LIST OF FIGURES

2.1: Life cycle of *Taenia* - - - - - - - 14

3.1: Map of Abuja and environs - - - - - - 31

3.2: Map of Abuja showing study areas - - - - - 33

4.1: Detection rate of *Taenia* eggs and eggs of other geoparacites in soils samples of Abuja parks - - - - - - - 52

4.2: Park prevalence rate of *Taenia* Eggs in soil samples of Abuja recreational parks - - - - - - - 53

4.3: Age Distribution of Respondents - - - - - 58

4:4: Level of education of respondents - - - - - 59

4.5: Sex Distribution of Respondents - - - - - 60

4.6: Distribution of frequently visited parks - - - - - 61

4.7: Respondents who eat at the Parks - - - - - 62

4.8: Respondents who come in contact with soil - - - - 63

4.9: Level of Awareness of *Taenia* - - - - - - 64

LIST OF TABLES

Table 3.1: List of Parks and their Geo-codes - - - - - 32

Table 4.1: Park prevalence rate of *Taenia* eggs - - - - 48

Table 4.2: Mean *Taenia* egg per Abuja recreational park - - - 49

Table 4.3: Prevalence of other *Geohelminths* in soil samples - - 50

Table 4.4: Egg per gram of soil samples of recreational parks in Abuja - 51

LIST OF PLATES

Plate I: *Taenia* Egg - - - - - - - - 16

Plate II: *Echinococcus* Egg - - - - - - - 17

Plate III: *Toxocara* Egg - - - - - - - 18

Plate IV: *Trichuris* Egg - - - - - - - 19

Plate V: *Dipyllidium* - - - - - - - - 20

Plate VI: *Ancylostoma* Egg - - - - - - - 21

Plate VII: Coccidia - - - - - - - - 22

Plate VIII: Mite - - - - - - - - - 37

Plate IX - - - - - - - - - - 38

Plate X - - - - - - - - - - 39

Plate XI - - - - - - - - - - 40

Plate XII - - - - - - - - - - 41

Plate XIII - - - - - - - - - - 42

Plate IVX - - - - - - - - - - 43

APPENDIX

Appendix I - - - - - - - - 76

Appendix II - - - - - - - - 77

Appendix III - - - - - - - - 78

Appendix IV - - - - - - - - 79

Appendix V - - - - - - - - 80

Appendix VI - - - - - - - - 81

Appendix VII - - - - - - - - 82

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The cestode parasites of major economic and public health importance are members of the family Taeniidae, genera *Taenia* and *Echinoccocus*. These parasites all have indirect life cycles involving a carnivorous or omnivorous definitive host, in which the adult stage develops in the small intestine and an intermediate host in which the larval (metacestode) form develops in the host tissues (Lightowlers, 1990). Taeniasis is an accidental human infection acquired by the ingestion of raw beef/pork containing an intermediate form (Cysticercus) of *Taeniasaginata*and *T.solium*-respectively.Humans are the final hosts, for *T. solium.* In *T.solium* however, humans can also be the intermediate hosts. In addition, the larval stage of other *Taenia* species (e.g., *T.multiceps*, *T.serialis, T.brauni, T.taeniaeformis*, *T.crassiceps*) can infect humans in various sites of localization including the brain, subcutaneous tissue, eye, or liver (CDC, 2008).

Auto infection is another route of infection for *T.solium*. Gravid proglottids are carried to the stomach by reverse peristalsis where the onchosphere become liberated and develops into the cysticercus.(WHO, 2009). This means that humans can become infected with eggs spread by other humans and develop cysticerci in their tissue. When humans ingest eggs, metacestodes develop within the muscle, under the skin, in the intestine, brain and spinal cord. The human to human transmission of disease results in most clinically serious forms of the disease. This is through direct contact with human faeces and develops cysticercus in their tissues resulting in cysticercosis (metacestode within tissue) which can lead to pain at site of the cysts, swellings,

fibrosis granulomas and calcification. When the cysticerci are located within nervous tissue, patients can experience paralysis and seizures that can be fatal (Merle and Nicole, 2000; Hector and Manish, 2008).

The great majority of *T. saginata* and *T.solium* carriers are unaware of their infection. However, carriers of *T.solium* carry a substantial risk of acquiring cysticercosis by faeco-oral autoinfection and members of their households are also at risk (WHO, 2009). The eggs from these cestodes are common environmental contaminants of human habitation, due largely to the environmental control and sanitation which constitutes a significant factor in the spread of the disease.

Humans, particularly children are at the highest risk of infection because of pica, geophagia, and playing on soils contaminated with human faeces (Uga and Kataoka, 1995). This is particularly true of *T.solium* infection where human infection can occur via the ingestion of eggs from contaminated soil. Dada (1980), obtained prevalence rates of 0.9%,0.6% and 0.6% respectively for *Taenia* infection for 3 ecological zones of Nigeria from a retrospective study of hospital records.

According to Nock and Tanko, (2000), shoes play a very important role in the epidemiology of intestinal parasite infection where *Taenia* eggs were found to be very high followed by coccidian oocyst. Shoes form an everyday part of man. Children are known to play with and even put shoes in their mouth. This further strengthens the risk of autoinfection and thus the great Public health concern.

1.2 Statement of the Research Problem

The presence of parasitic forms within urban squares and public recreation areas is of a significant health risk (Uga*et al.,* 1996; Minvielle*et al*., 2000). Among all helminth parasites involving the human central nervous system (CNS). *Taeniasolium*cysticercosis is by far the most common source of seizures and other neurological symptoms (Hector and Manish, 2008). Soil which is one of the principal sources of these parasites (Wong *et al*., 1994) can be contaminated with human faeces deposited in the environment

Contaminated shoes (Nock and Tanko, 2000) act as potential sources of infection for humans (Luty, 2001), especially children because of pica habit or playing in soil contaminated with *Taenia* eggs (Glickman and Schantz, 1981; Ruiz de Ybanez*et al*., 2001). Global warming has also created an environment that facilitates the rapid and widespread dissemination of water, soil and foodborne zoonotic pathogens (Gajadhar*et al.*, 2006). The lack of sanitary facilities such as toilets or the enforcement of environmental sanitation regulations may increase the risk of infection.Both forms of taeniasis usually have a minor impact on human health; taeniasis due to *T. solium*, however, is of significant public health importance as it plays a crucial role in the transmission of cysticercosis, a serious disease.

Cysticercosis is the infection with the larval tapeworm stage (cysticerci). Inside the body, cysticerci can develop in a number of tissues; those that are located in the central nervous system cause neurocysticercosis, the most severe form of the disease. (Sarti*et al.*,1992)

Neurocysticercosis is considered to be a common infection of the human nervous system and is the most frequent preventable cause of epilepsy in the developing

world. More than 80% of the world's 50 million people who are affected by epilepsy live in developing countries, many of which are endemic for *T. solium* infections in people and pigs (WHO, 2013).

Cysticercosis mainly affects the health and livelihoods of subsistence farmers in developing countries of Africa, Asia and Latin America as it can lead to epilepsy and death in humans, reduces the market value of pigs and cattle and makes pork and beef unsafe to eat (WHO, 2013). The poor sanitary condition in developing countries such as Nigeria (Motarjemi*et al.,* 1993) accounts for the presence of parasitic immature stages in the soil (Mahdi and Ali, 1993), and air (Lawande, 1983).The soil is therefore contaminated with human faecal material that may contain eggs of *Taenia* with the contaminated soil acting as an indicator of the potential risk of exposure of humans to*Taenia.*

The epidemiological cycle occurs most commonly in environments with low socioeconomic or hygiene levels, deficient sanitary facilities or primitive pig rearing practices where the animals can gain access to human faeces (Cruz *et al*., 1989).

1.3 Justification

The WHO Global Burden of Disease Studies draws on a wide range of data sources to develop estimates of incidence, prevalence, severity, duration and mortality of diseases worldwide (Traub*et al.,* 2004). The study emphasizes the importance of surveillance program for zoonotic diseases such as taeniasis and or cysticercosis. People, especially those from socio-economically disadvantaged communities, are unaware that they are at risk of contracting diseases from contaminated soil and that living conditions such as unhygienic practices can exacerbate the risk of disease transmission from the environment.

In Nigeria people from all walks of life patronize similar facilities such as the recreational parks such as are found in Abuja and other cities. These can serve as means of contacting the *Taenia* eggs from shoes of those that have walked around the park (Nock and Tanko, 2000).

*Taeniasolium*cysticercosis remains a major public health problem in many developing countries of Latin America, Africa and Asia especially with the established increase in consumption of pork in Nigeria (Adebisi, 2008). Public awareness of sources of contamination and infestation by Taenia is poor. Inadequacy of sanitary facilities in Public parks persists and poor sanitary habits of the public constitute a problem.

Studying the extent of soil contamination in urban centers such as Abuja that has high human population density will aid in the determination of the presence of *Taenia*eggs in soil, Public health implication as well as device control measures against contamination of recreational parks. This can be by understanding the lifecycle of the parasite and developing appropriate interruptions in the cycle.

1.4 Aim and Objectives

1.4.1 Aim

To determine occurrence and proportion of *Taenia* eggs in relation to other geo-helminth eggs type in recreational parks in Abuja and the Public health implication.

1.4.2 Objectives

The objectives of this study were to:

1) Determine the extent of soil contamination with *Taenia* eggs in recreational parks in Abuja, Nigeria.

2) Determine the association between the prevalence of *Taenia* eggs and Soil type, Texture and pH respectively.
3) Determine the association between prevalence of *Taenia* eggs and the presence of stray animals in the parks.
4) Determine the extent of patronage of these parks by people through examination of records and oral interviews.

1.5 Hypotheses for the Study

The hypotheses of this study are:

1) The population proportions of all helminth egg types are the same for all park locations
2) The Population proportion of *Taenia*eggs is not significantly prevalent than other geo-helminth egg types in different soil; texture
3) There is no association between the prevalence of *Taenia* eggs in soil and the presence of stray animals

CHAPTER TWO

LITERATURE REVIEW

2.1 Intestinal Helminths

Helminths are worm-like organisms that live and feed off living vertebrate animal hosts (Maizel and Yazdanbaksh,2003). Parasites that live in the digestive tract are called gastrointestinal parasites.

The intestinal helminth parasites that parasitize the domestic & wild animals and humans are categorized into 3 groups: Cestodes are of the phylum Platyhelminthes and belong to the class of Cestoda,

Trematodes belong to the phylum Platyhelminthes and class Trematoda and Nematodes, which are members of the phylum platythelminthes and class Nematoda.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).

Eggs, larvae or even adult helminthes can infect the host through the mouth, anus, nose or skin. Human thus, become infected by coming in contact with soil, water or food that contain the egg or juveniles of these parasites (Soulsby, 1987; WHO, 1997). Intermediate hosts include cattle, pigs and rodents depending on the *Taenia s*pecies (Soulsby,1982).

Intestinal helminthes affect the health and well being of millions of people especially children, WHO (1997) stated that about four hundred millions of school age children are infected with different types of worms, and 130 countries endemic with the

infection worldwide (WHO 2006). Infection with helminths can cause abdominal pain, diarrhea, anemia, ulcers and various other health problems.

They also destroy tissue and organs in which they live. Long-standing and chronic infections can result to death (Soulby, 1987;WHO, 1997).

Clinical signs of helminth infection in animals are variable and occasionally some infected animals may be asymptomatic. However severe clinical cases in young dogs especially lead to diarrhea, anaemia and death (Ramirez-Barrios *et al*., 2004).

2.2 Cestode Parasites of Economic and Public Health Importance

The cestode parasites of major economic and Public Health importance are members of the family Taeniidae, genera *Taenia* and *Echinoccocus*. These parasites all have indirect life cycles involving a carnivorous or omnivorous definitive host, in which the adult tapeworm stage develops in the small intestine and an intermediate host in which the larval (metacestode) form develops in the tissues. (Lightowlers, 1990). Taeniasis is an accidental human infection acquired by the ingestion of raw beef/pork containing an intermediate form (cysticercus) of *Taeniasaginata*and *T.solium*. Hydatidosis is an infection caused by the intermediate stage of *Echinococcus* sp. For *T. saginata,* humans are the final host, which is also true for *T. solium.* In *T.solium* however, humans can also be the intermediate hosts. In addition, the larval stage of other *Taenia* species (e.g., *multiceps*, *serialis*, *brauni*, *taeniaeformis*, *crassiceps*) can infect humans in various sites of localization including the brain, subcutaneous tissue, eye, or liver (CDC,2008).

Autoinfection is another route of infection for *T.solium* (WHO, 2009). This means that humans can become infected with eggs spread by other humans and develop cysticerci in their tissue. When humans ingest eggs, cysticerci develop within the

muscle, under the skin, in the intestine, brain and spinal cord. Cruz *et al*.(1989) had earlier posited that autoinfection may occur following the regurgitation of gravid eggs from the intestine to the stomach as seen during vomiting but the frequency of this event is not clear.The human to human transmission of disease results in most clinically serious forms of the disease. Cysticercosis (metacestode within tissue) can lead to pain at site of the cysts, swellings, fibrosis granulomas and calcification.

When the cysticerci are located within nervous tissue, patients can experience paralysisand seizures that can be fatal (Merle and Nicole, 2000; Hector and Manish, 2008).The great majority of *T. saginata* and *T.solium* carriers (adult warm live in the intestines of host and eggs pass through the faeces) are unaware of their infection. However, carriers of *T.solium* carry a substantial risk of acquiring cysticercosis by faeco-oral autoinfection and members of their households are also at risk (WHO, 2009).

The eggs from these cestodes are common environmental contaminants of human habitation, due largely to the fact that environmental control and sanitation constitutes significant factors in the spread of the disease. (Fig. 2.1). Humans, particularly children are at the highest risk of infection because of pica, geophagia, and playing on soils contaminated with animal feces (Uga and Kataoka, 1995). This is particularly so of *T.solium* infection where human infection can occur via the ingestion of eggs from contaminated soil.

2.3 Common Examples of Intestinal Helminths (Geohelminths) of Zoonotic Importance

*Dipylidium. caninum, Toxocara*species*, Taenia, Trichiris and Ascaris* are among the most encountered geohelminths encountered by different researchers from different environments(Mizgajska, 2001; Ruiz de Ybanez*et al*, 2001*).*

i. Dipylidiumcaninum

This is the most common parasite of dogs and may also occur in cats and foxes The worm is also referred to as "cucumber tapeworm" because of the way the eggs cluster together resembling seeds of cucumber(Eguia-Aguilar *et al.,* 2004). . The adult cestodes reside in the small intestine of dogs and cats rarely causing serious disease. The clinical signs in dogs when present depend on the degree of infection, age, breed, condition and host. Clinical signs may include malaise, diarrhoea, colic, etc.The eggs of *D.*caninumare laid in capsules with each containing up to 30 eggs. The eggs of *D.caninum* measure about 45µm in diameter. A mature or gravid proglotid have a characteristic elongated oval shape, resembling cucumber seed (Soulsby, 1986), but mobility of the proglotid may make the cucumber structure to disappear (Eguia-Aguilar *et al.,* 2004).

ii. Hookworm

This is the most destructive helminth parasite of man. The worms occur in areas where sanitary and environmental conditions favour the development of eggs and larvae (Smyth, 1994). As at 1994, there are about an estimated 900 million cases of hookworm infection worldwide.

Cutaneous contact with the infective stages of canine hookworm leads to cutaneous larval migrans (CLM). Although clinical cases of cutaneous larval migrans (CLM)

appears to be uncommon, cases may still be endemic in socio-economically disadvantaged communities like may be found in developing countries like Nigeria.

Infection with *Ancylostoma*spp is mostly seen in people that walk bare-footed. Children mostly are affected. A study conducted in Kaduna, Nigeria, on the prevalence of helminth eggs in school play grounds in Kaduna showed that *Ancylostoma*spp accounted for 9% of the total helminthes detected (Maikai*et al.*, 2008).The eggs of hookworm are thin-walled and elongated with varying sizes (Harrold*et al*., 2000). Sizes of eggs vary with the species of the hookworm. *Ancylostomabraziliense* egg measures 75 x 45µm, *A. caninum egg* measures about 56-75 x 34-47µm and contains about eight cells when passed in faeces.

iii. *Trichuris species*

This is also known as "whip worm". Two species of particular interest are *Trichurisvulpis* 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 burdens can develop.Infection with *Trichuris* species is confined mainly to the tropics especially Asia and to a lesser degree of host specificity, even though canine whipworms have been recovered from humans on rare occasions.Eggs of *Trichuris* are lemon- shaped, having bipolar plugs with a thick shell. They are brownish in colour and contain un-segmented embryo when laid, and vary in sizes, with *Trichurisvulpis* measuring 70 -89µm with an average of 75µm (Smyth, 1994).

iv. *Toxocara* species

Toxocariasis is an accidental human infection acquired by swallowing eggs of *Toxacara,*a helminth found in dogs and cats (*Toxocaracanis* and *Toxocaracati*). Adult worm measures 9-18cm, are yellowish-white in color and occur in the intestine of the

definitive host. In adult dogs, the infection is usually asymptomatic. By contrast, massive infection with *T. canis* can be fatal in puppies (Svobodová, 1995). As paratenic hosts, a number of various vertebrates, including humans and some invertebrates can become infected. Humans are infected, like other paratenic hosts, by ingestion of embryonated*T. canis* eggs (Gillespie, 1988). The disease caused by migrating *T. canis* larvae results in two syndromes: visceral larval migrans and ocular larval migrans (Despommier, 2003).The eggs of *Toxocara* are subglobular, having a thick finely pitted shell and varying in sizes. *Toxocaracanis* egg measures 90 x75m and *T. cati* 65 x 75m (Soulsby, 1989; Smyth, 1994).

v. *Taenia*species

Members of the phylum Plattyhelminthes and class cestoda 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 and generally leaf-shaped, adult tapeworms are flattened, elongated and consist of segments called proglottids. Tapeworm varies in length of 2 – 3 mm to 10 mm and may have from three thousand to several thousand segments.

Cestodes are divided into a scolex, or head, which bears the organs of attachment, a neck that is the region of segment proliferation, and a chain of proglottids called the strobila, which elongates as new proglottids form in the neck region. The segments nearest to the neck are immature (sex organs not fully developed) and those more posterior are matured while the terminal segments are gravid, with the egg-filled uterus as the most prominent feature. A characteristic feature of the adult tapeworm is the absence of an alimentary canal; substances enter the tapeworm through tegument(Smyth, 1994).

The tapeworm however differs from flukes in the mechanism of egg deposition. Eggs in the tapeworm exit through the uterine pore in the centre of the ventral surface, rather than through the atrium as in flukes.

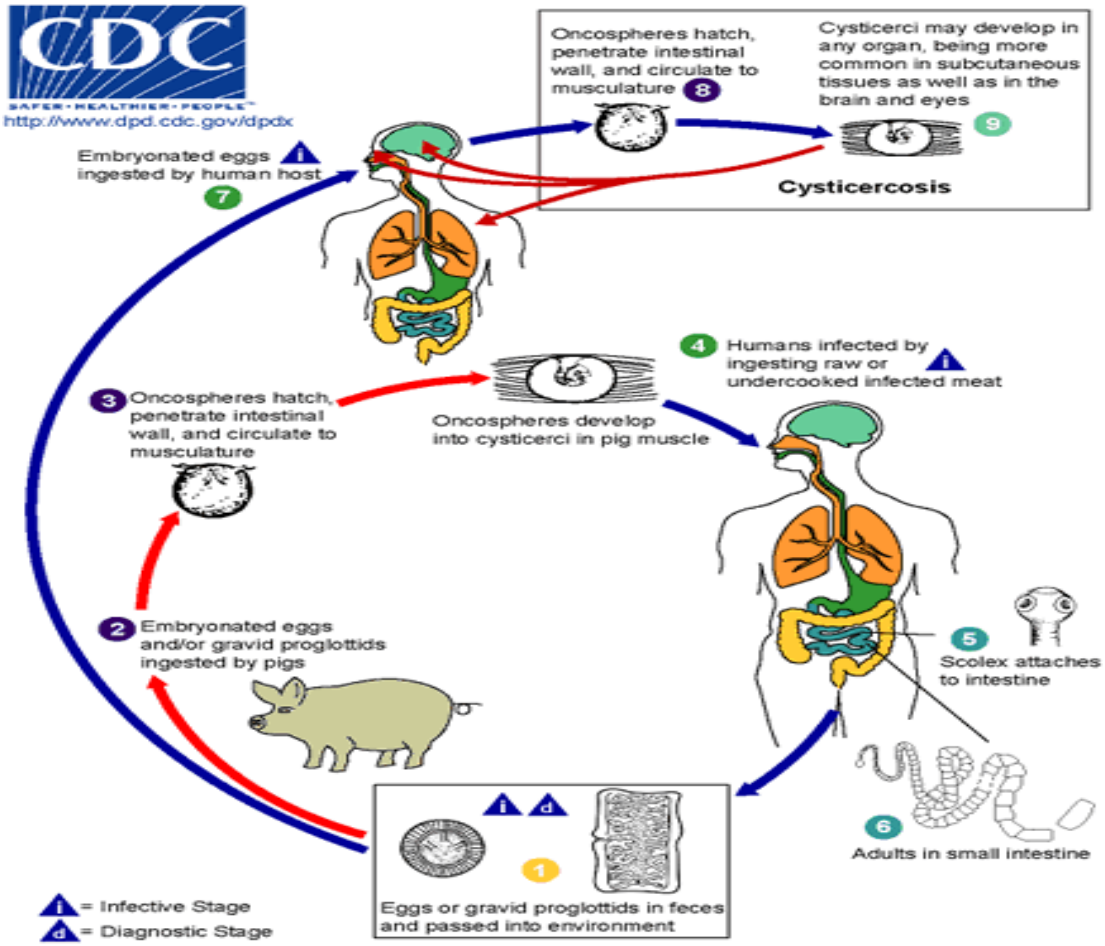


Fig 2.1: Life Cycle of *Taenia*Species

Larval forms, which are cystic or solid, inhabit the extra intestinal tissues. Tapeworm infection is the most common helminth infection in humans with both man and animals acting as definitive or intermediate hosts (soulby, 1986). About seven species of *Taenia*are found in the dometic dog, which may infect it singly or in multitudes. This includes: *Taeniahydatigena, T. pisiformis, T. multiceps, T. ovis and T. multicularis*. The most common adult tapeworms of man are *T. saginata* or *T. solium* (Soulby, 1987; Smyth, 1994) *T. saginata* is cosmopolitan most especially where hygiene may be poor and or raw or insufficiently cooked meat is consumed (Smyth, 1994). In Latin America, it is estimated that 75 million people live in endemic area and 400,000 people have symptomatic disease (Bern *et al*.,1999). Some studies suggest that the prevalence in Mexico is 3.1 and 3.9 with seroprevalence in areas like Guatemala, Bolivia and Peru as high as 20 % in human and 37% in pigs.



Plate I: *Taenia* Egg (Source: CDC)



Plate II: *Echinococcus* egg (Source: CDC)



Plate III: *Toxocara* Egg(Source: CDC)



Plate IV: *Dipyllidium* Egg (Source: CDC)

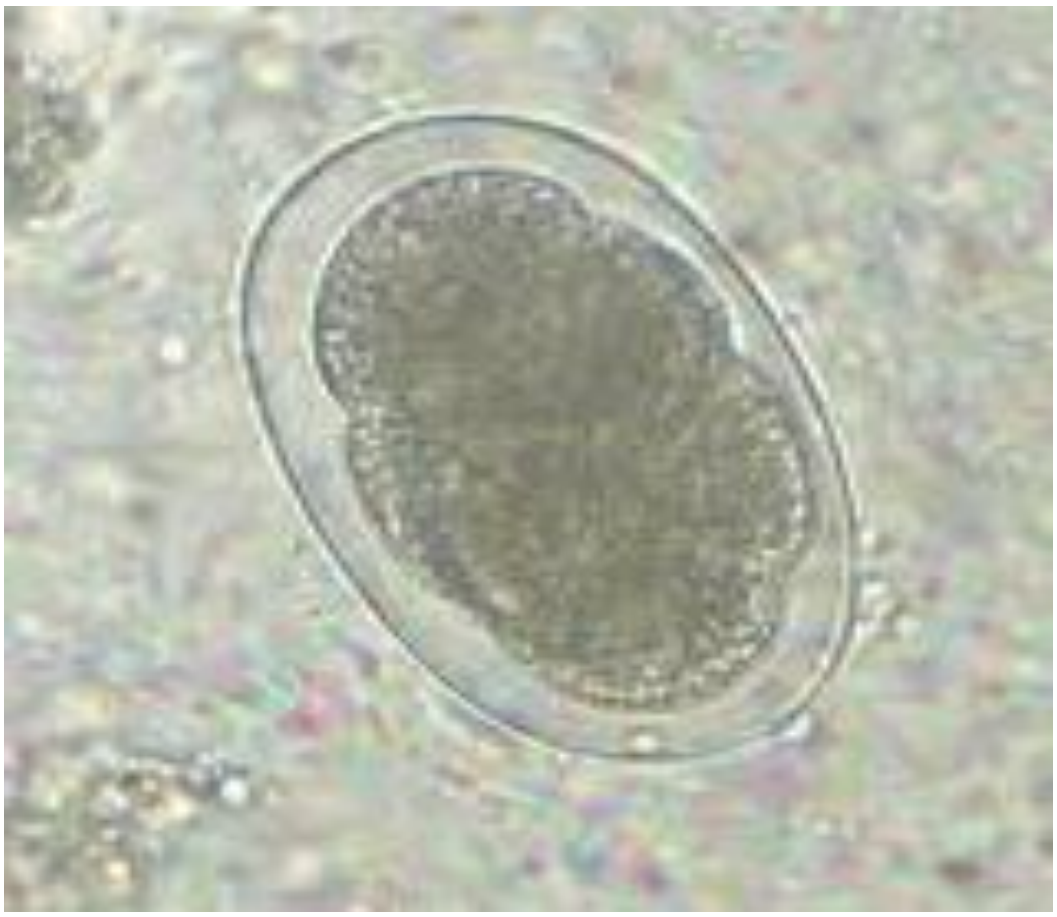


Plate V: *Ancylostoma* Egg (Source:CDC)

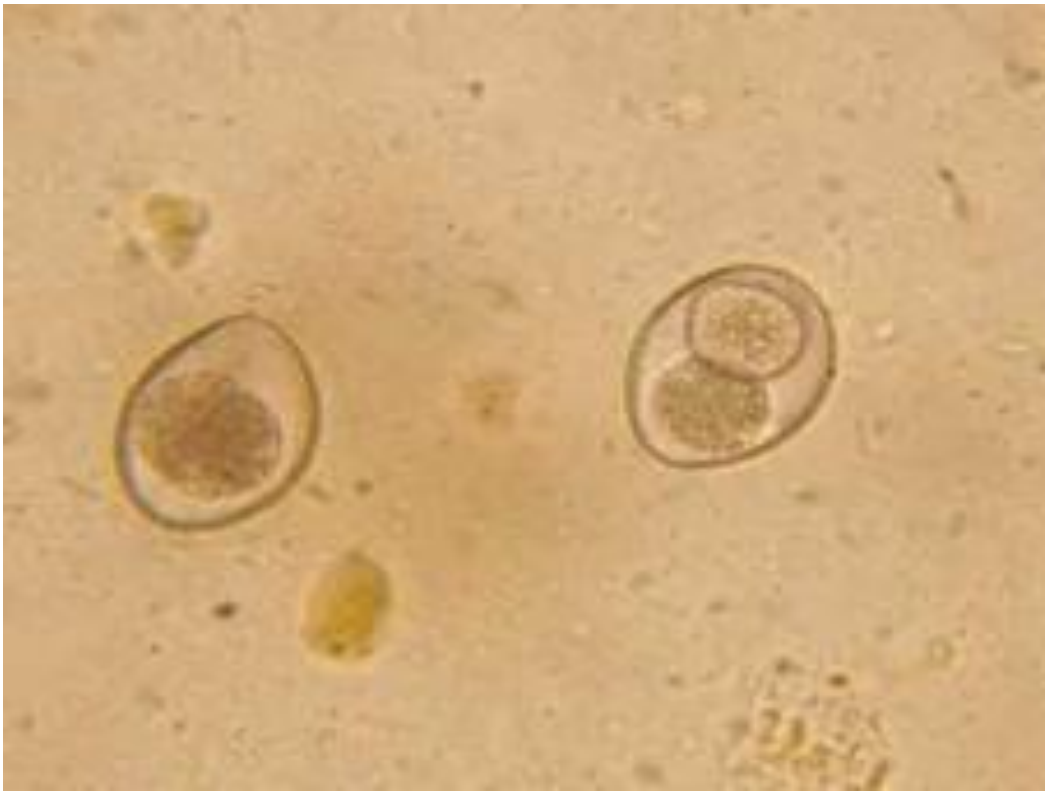


Plate VI: *Coccidia* Eggs (Source: CDC)

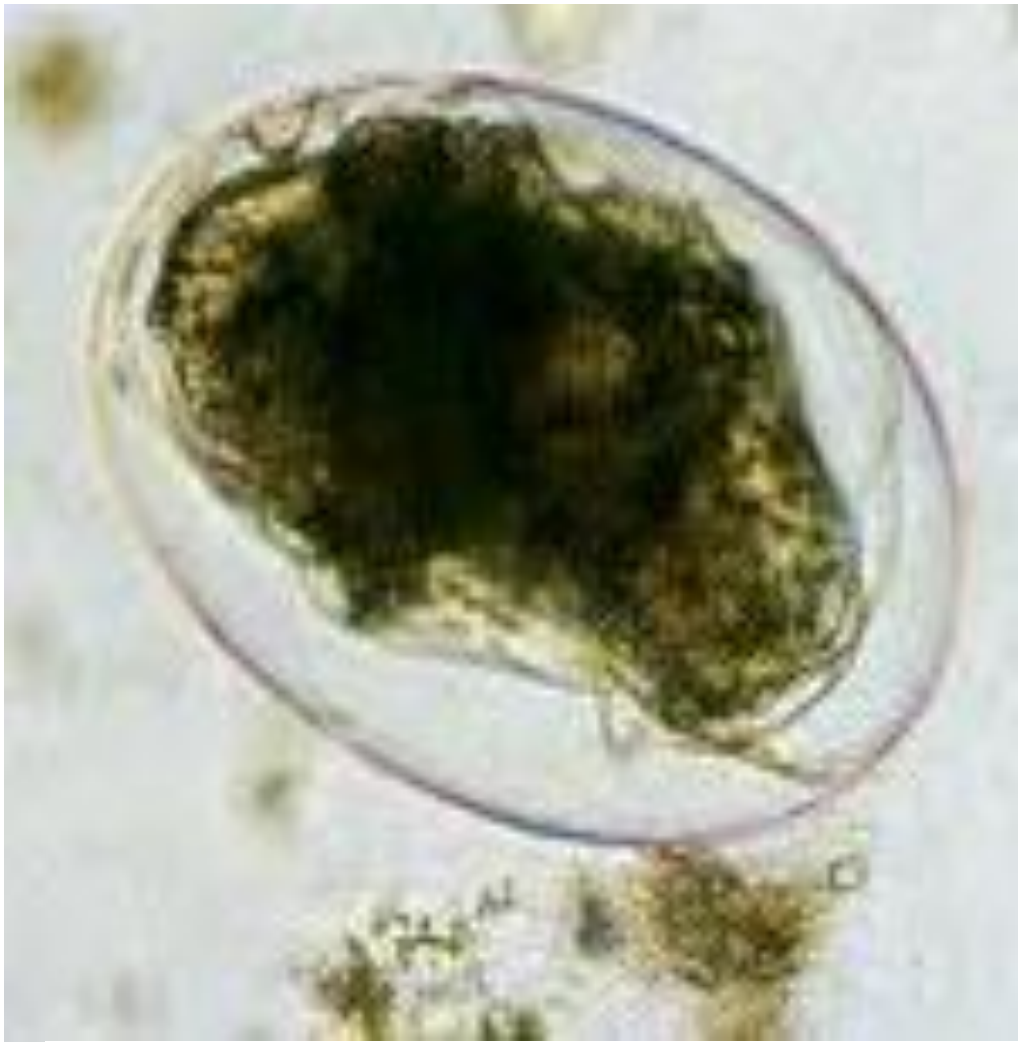


Plate VII: Mite Egg (Source: CDC)

2.4 Taeniasis

The adult tapeworms live in the intestines of the definitive hosts such as man. This infection is called taeniasis. Humans are the definitive hosts for *Taeniasolium*(the pork tapeworm) and *T. saginata*(the beef tapeworm). Humans are also the definitive hosts for *T. asiatica*, a newly recognized tapeworm found in Asia. It is currently uncertain whether *T. asiatica*is a subspecies of *T. saginata*(*T. saginataasiatica*) or a separate species. Animals are the definitive hosts for *T. crassiceps*, *T. ovis*, *T. taeniaeformis*, *T. hydatigena*, *T. multiceps*, *T. serialis*and *T. brauni*. *Taenia*larvae are found in the muscles, central nervous system (CNS), and other tissues of the intermediate hosts. Larvae are more likely to cause disease than the adult tapeworms. There are two forms of larval infection, cysticercosis and coenurosis. Soil-transmitted helminthiasis, commonly known as intestinal worm-infection, including Taeniasis primarily affects the world's deprived populations. An estimated 2.3 billion people in tropical and sub-tropical regions of the world are exposed to infection by hookworms, roundworms and whipworms. Infection causes a wide range of symptoms. These include intestinal manifestations such as diarrhea, abdominal pain, general malaise and weakness, mainly causing anaemia among women of child-bearing age and affecting the cognitive development and learning capacities of children. (WHO, 2013).

2.5 Life cycle of *Taenia spp.*

Tapeworms of the genus *Taenia*may be the most familiar of foodborne parasitic worms, with adults measuring 3-5 meters in length in the intestine of human hosts. Three species are of primary concern to humans and all have intermediate stages in important domestic animals, these are; *Taeniasaginata* in cattle and *Taeniasolium* and *Taeniaasiatica* in hogs. There have been reports that other mammals, including dogs

and bear, can serve as intermediate hosts for *T.solium*, reindeer can harbor *T. saginata*, and goat and monkeys can harbor *T. saginata*. Although *Taeniaspp*, are cosmopolitan, modern sanitary facilities and animal husbandry practices in developed countries have greatly decreased risk of infection (Doyle, 2003). However, in some regions of the world these parasites are a significant problem. *T.solium* in particular, may be present in as many as 20% of hogs (resulting in loss of productivity) and causes debilitating human disease that is difficult and expensive to treat (Fan, 1997).

The life cycle *of Taenia* involve two mammalian hosts. Adults in the human intestine may live for more than twenty years, producing several thousand eggs daily that pass out with the feces. If these are consumed by an intermediate host, they develop into larvae (cysticerci) which migrate to the muscles. Consumption of raw or inadequately cooked, infected beef or pork introduces the larvae into the human intestinal tract where they mature into adult worms. Infections may be asymptomatic or may generate non-specific complaints such as altered appetite, abdominal pain, diarrhea or constipation.

Humans may also serve as the intermediate host for *T.solium* (but not for *T.saginata* or *T.asiatica*) when *T.solium* eggs are ingested via dirty hands or focally contaminated vegetables, larvae hatch in the small intestine and travel to various tissues and organs in the body where they encyst, causing cysticercosis. Some studies report that up to 40% of carriers of adult worms also have cysticercosis, indicating that fecal-oral transmission, either directly or via contaminated food or water, is common. Use of untreated urban sewage sludge on pasture may cause cysticercosis in cattle or hogs, while untreated human wastes containing *T.solium* eggs, if used as a garden fertilizer, could cause cysticercosis in humans, (Cabaret *et al.*, 2002).The most serious

consequences occur when the larvae reach the brain, causing neurocysticercosis that often triggers headaches, seizures, and other neurological symptoms. This is the most common parasitic disease of the central nervous system and is major concern in some areas of Latin America, Africa, Asia and Eastern Europe, (Fleury*et al.,* 2003; Nguekam*et al*., 2003; Noormahomed*et al.*, 2003 and Prasad *et al.,* 2003).

Even in the U.S., where infection with adult tapeworms is relatively rare, more than 1000 cases of neurocysticercosis occur each year. Most cases are diagnosed in immigrants from endemic areas, and approximately 10-12% of emergency room visits for seizures in southern California and New Mexico were due to this disease. Cases acquired in the U.S can sometimes be traced to contacts with immigrants, including cooks, infected with the pork tapeworm, who may cause foodborne outbreaks of neurocysticercosis (CDC, 1992).

The presence of parasite eggs in soil has been a subject of immense scientific interest and study for a while and in Nigeria, the state of personal and environmental hygiene is generally poor. People (adults and children) and animals (because of poor husbandry) do often defecate in the open. This has made the soil to be a very veritable focus of infection with a few vehicles. A study by Nock and Tanko (2000) conducted in Zaria concluded that the sole of shoes carry parasites ova and shoes are therefore a potential vehicle in the spread and subsequent transmission of intestinal parasitic infections to both man and animals.In West Africa, *T.solium*cysticercosis in pigs and man has been reported in Benin, Burkina Faso, Ghana, Ivory Coast, Senegal and Togo, and although official data are lacking, *T.solium* is anticipated to be present in most of the pig-raising regions of other West African countries as well.

In some regions of Nigeria, the prevalence of porcine cysticercosis and human taenosis is quite high (20.5% and 8.6% respectively). Surprisingly, however, no cases of human cysticercosis have been reported, although epilepsy is very common. Large epidemiological surveys have only been carried out in Togo and Benin, where the prevalence of human cysticercosis was 2.4% and 1.3%, respectively.It is concluded that the true prevalence of T. soliumcysticercosis in pigs and humans in Central and West Africa remains underestimated because of unreliable slaughterhouse data and the lack of awareness and diagnostic facilities in the public health sector.

2.6 Environmental Factors that Affect rate of Detection of Helminth Eggs

Some of the factors recognized to promote spread of helminth infection includes: contact with animals, poor hygienic practices (Mason and Patterson, 1994), improper waste disposal and faecal pollution(Wong *et al*., 1994),

Factors that may affect the detection of helminth eggs include: climate and vegetation, sampling and laboratory procedures. Others are selection of sampling sites, season of sample collection, depth of sample collection, number of samples collected, type of soil examined, preservation of samples and expertise in analysis of the samples.

i. Geographical distribution

Soil-transmitted helminthes infections are widely distributed in tropical and subtropical areas and, since they are linked to a lack of sanitation, occur wherever there is poverty (Brooker*et al.*, 2006).

ii. Environment

Deplorable environmental conditions accounts for the presence of different infective stages of parasites within the environment (Borji*et al.*,2011).

iii. Vegetation

Studies have shown that number of eggs discovered from moist and shady areas differ significantly from those collected from open sunny areas without vegetation (Ruiz de Ybanez*et al*., 2001).

iv. Faecal material

Faecal contamination by both human (Nock and Duniya, 2007) and animal (Uga, 1993) is likely the major factor in soil contamination by helminth eggs.

v. Socio-economic status

Previous studies have shown a significant presence of helminth infection in socially disadvantaged areas such as Asia, Africa, and South America (Traub*et al*., 2004).

vi. Types of soil examined

There is no direct relationship between soil texture and the prevalence of helmintheggs in soil even though physical properties of soil do influence survival of eggs in the soil (Mizgajska, 1997).

vii. Depth of soil sample collected

Studies have shown that irrespective of the depth used in taking soil samples, animal defecation is found to be evenly distributed in soil (Uga*et al*., 1996).

2.7 Prevention and Control of Helminth Infection

Helminth infection can be controlled by interrupting the transmission cycle. This can be achieved through public enlightenment, strict hygiene and administration of treatments for both human and animals. Fencing also helps in preventing stray animals' access to human domain.

i. Sanitation and Hygiene

Proper disposal of human and animal wastes to prevent contamination of foods and drinking water sources is an excellent and basic strategy for preventing many parasitic infections that are transmitted by the faecal-oral route. However, in many developing countries these wastes serve as fertilizer for crops. Composting of this material could kill parasite eggs. Other control measures include; Control of flies, cockroaches, and other insects may prevent dispersal of infective stages of parasites to foods, thorough washing of raw vegetables and fruits may remove cysts, oocyst, and eggs of parasites, but it is difficult to adequately clean some leafy vegetables and berries, frequent hand washing, use of clean utensils, and measures to prevent cross-contamination during food processing are also important.

ii. Animal husbandry and Meat inspection

Husbandry practices that limit exposure of pigs to contaminated feed and feces have been successful in developed countries in drastically reducing human infections with *Trichinella* and pork tapeworms. Inspection systems can detect parasites in pork, beef, and fish. These systems ensure that nearly all meat reaching consumers in the U.S is free of parasites.

iii. Rodent Control

Rodent control is also important to prevent pigs from consuming rodents carrying parasites. This could be by regular sanitation and fumigation of the environment with approved rodenticides.

iv. Use of drugs

Infected animals may be treated with drugs to kill parasites, and vaccines are being developed to prevent infections with certain parasites.

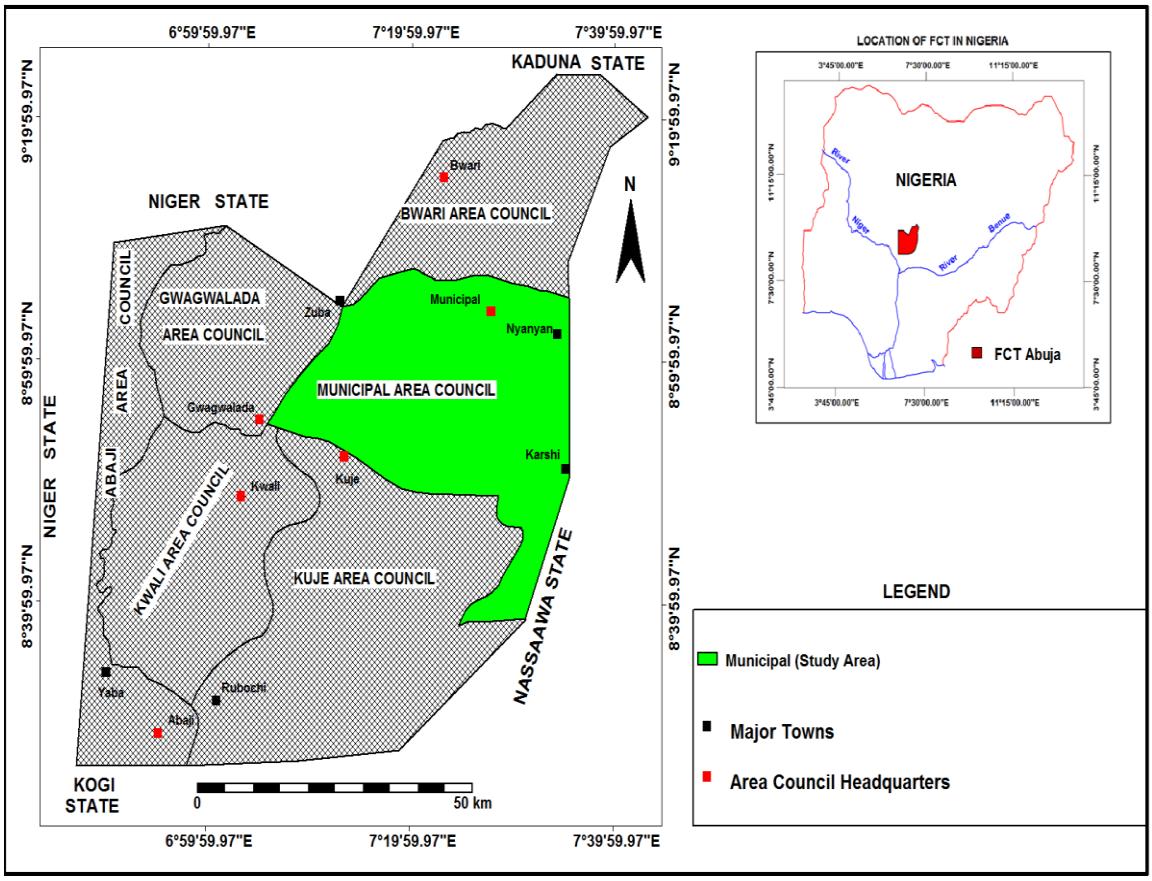
CHAPTER THREE

MATERIALS AND METHODS

3.1 The Study Area

The study was conducted in Abuja phase 1 which has five (5) districts. (Fig. 3.1) They are Abuja Central, Garki, Wuse, Maitama and Asokoro. Abuja is a city that covers an area of 713km2 and according to the 2006 census has an estimated population of 778,567 people **(**http://www.fct.gov.ng/). Over the years however, there has been an unprecedented movement of people into Abuja due to its pivotal role as the seat of Government of the Federal Republic of Nigeria.

Abuja is located on latitude 9^{o} 12' N and longitude 7^{o} 11' E (Table 3.1) and is characterized by three weather conditions annually. There is the rainy season which begins April and ends in October with a temperature range of 28^{0}C-30^{0}C at night. During the dry period temperature can be as high as 40^{0}C during the day and can drop to as low as 14^{0}C. The change in temperature is attributed to the high altitude and undulating terrain of the territory. Between the rainy and dry period there is a brief period of harmattan (December to March) with a common feature of dust haze. Annual rain fall of the territory ranges between 1100mm to 1600mm. The central area is located between the foot of Aso Rock and through the "Three Arms" Zone to the Southern base of the ring road that surrounds the city. The northern sector comprises Maitama and Wuse Districts, and the southern sector comprises Garki and Asokoro District**.**

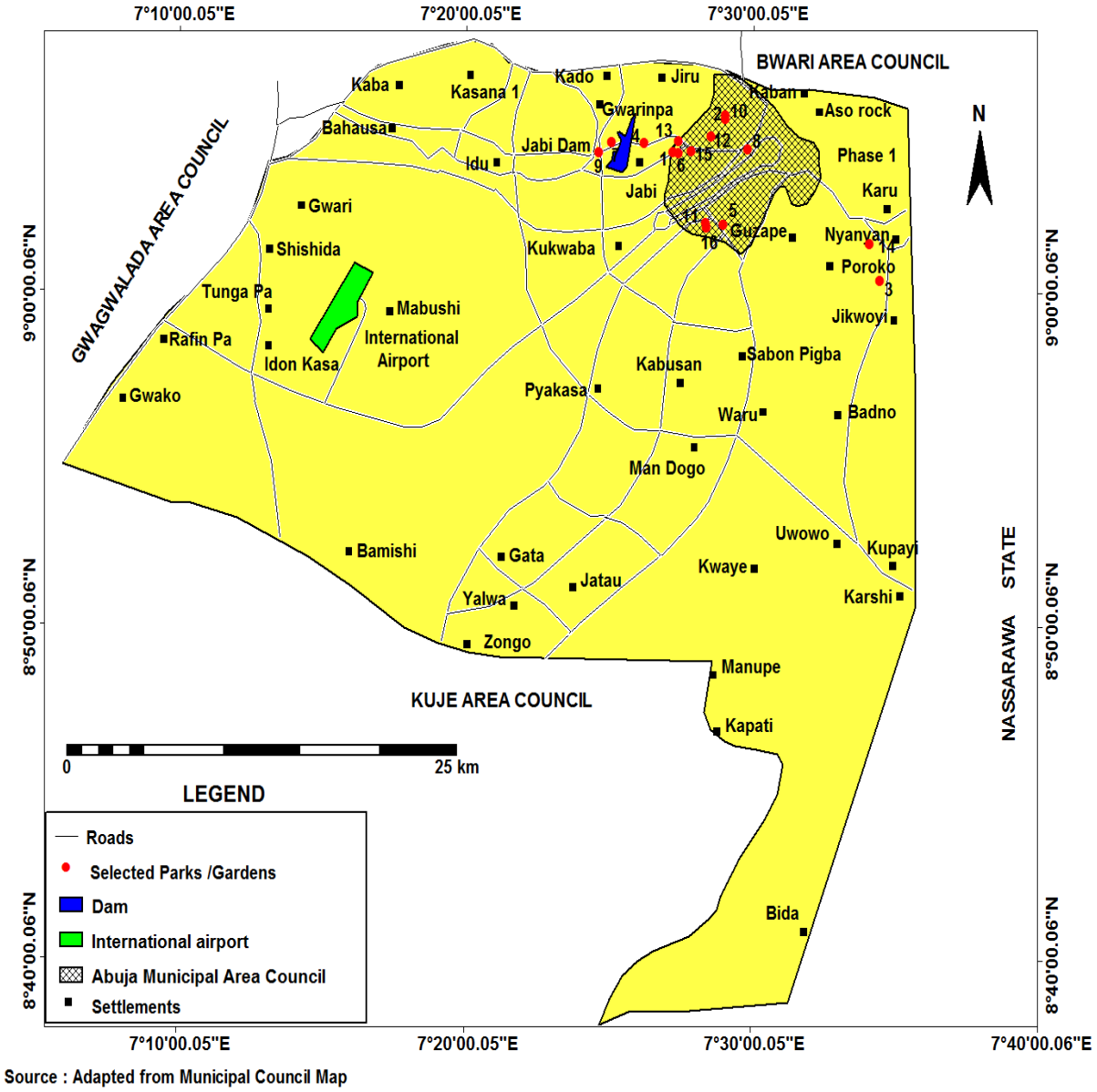


Source: Adapted and Modified from FCT Administrative Map, 2013

Fig. 3.1 Map of Abuja showing Abuja Municipal Area Council

Table: 3.1 List of Parks and their Geo-codes

S/N	ADDRESS	GPS_LAT	GPS_LONG	DISTRICT
1	BERGER PARK	9.06897783279419	7.453354597091675	FCC PHASE 1
2	CIRCLES GARDEN	9.085575342178345	7.48343288898468	FCC PHASE 1
3	CORTLAND GARDEN	9.00529146194458	7.573598027229309	FCC PHASE 1
4	EDEN GARDEN	9.073414206504822	7.43650496006012	FCC PHASE 2
5	EXECUTIVE GARDEN	9.032403230667114	7.482719421386719	FCC PHASE 1
6	GILMORE PARK	9.068489670753479	7.456369400024414	FCC PHASE 1
7	JABI LAKE PARK	9.073736071586609	7.417552471160889	FCC PHASE 2
8	MILLENNIUM PARK	9.070571064949036	7.496623992919922	FCC PHASE 1
9	NISA PARK	9.068629145622253	7.410498261451721	FCC PHASE 2
10	ORBIT GARDEN QUEENS FIELD FOUNTAIN	9.087340235710144	7.483636736869812	FCC PHASE 1
11	GARDENS	9.033926725387573	7.472226619720459	FCC PHASE 1
12	TENDER PARK	9.077019095420837	7.475375533103943	FCC PHASE 2
13	UNITY PARK MABUSHI	9.075876474380493	7.457200884819031	FCC PHASE 2
14	WUSE ROCK PARK	9.069637656211853	7.463595271110535	FCC PHASE 1
15	ZOOLOGICAL GARDEN	9.03124451637268	7.472435832023621	FCC PHASE



Source : Adapted from Municipal Council Map

1= Berger Park 2= Circle Garden 3= Cortland Garden 4= Eden Garden 5= Executive Garden 6= Gilmore Park

7= Jabi Lake Park8 = Millennium Par 9 = NISA Park10 = Orbit Garden 11 = Queens Field Fountain Garden12 = Tender Vine Park

13= Unity Park14 = NUDB Park 15 = Wuse Market Park16 = Zoological Garden

Fig. 3.2 Map of Abuja showing Sampled Parks

While each district has its own clearly demarcated commercial and residential sectors, the Central District is the city's principal Business Zone, where practically all parastatals and multinational corporations have their offices located.

Out of the 20 parks located in these areas, 16 were randomly selected for sample collection.

3.2 Sample Collection

Samples were collected from the months of September to December 2008. Five long strides of the researcher were used to measure approximately $25m^2$ of an area. At every $2m^2$, a mark was made and a number placed. The marked areas were selected by balloting and replacement where ballot papers with the names of all the twenty parks were put together in a container and picked randomly, listed and replaced into the container. To collect a sample, the marked site was dug to a depth of about 3 cm using a hand trowel, after which about 100g of soil was collected. The collected samples were then stored in sealed labeled polythene bags and kept in the dark until examination as described byMaikai*et al.,* (2008). The samples were then transported by road to the laboratory in Zaria- a journey of about 4 hours.

3.3 Mapping of Selected Parks

In order to get the most accurate locations of the Parks within Abuja, Android phone was used to get the Geocodes of each park. The parks were then mapped using Arch-Info software to produce a map showing their locations on an administrative map of Abuja.

3.4 Sample Processing

Collected samples were taken for pH and texture analysis in the Soil Science Laboratory of the Institute for Agricultural Research (IAR) of Ahmadu Bello University, Zaria using the method described by Page *et al*., 1982.In the laboratory, egg recovery was carried out as described by Maikai*et al.*, 2008, which is a modified version of the sieving method devised by Ruiz de Ybanez*et al* (2000). Briefly, 50g of soil was weighed, mixed in a plastic container and washed with running tap water into 250ml beaker, using three sieves with mesh diameters 100µm, 400µm and 850µm,. The filtrate was allowed to settle for 15min and the liquid decanted. The sediment was collected in 30ml centrifuge tubes, shaken with 15ml Zinc Sulphate (specific gravity of 1.25) floatation solution and centrifuged at 1500xg for 5min. The supernatant was then poured into dropper bottles according to the sample and park. These were used tofill two chambers of McMaster slides. The slides were allowed to settle for 5min and then they were examined under a light microscope (x 10) for the presence of *Taenia*eggs. 2 drops of supernatant was also put on a slide to view the morphological characteristics of eggs as described by Soulsby (1987) were used to identify the eggs.

3.5 Questionnaire

To obtain vital and relevant information, a structured questionnaire was administered to parks' patrons as well as people residents nearby. The questionnaire sought to obtain essential information such as bio-data of Respondents including family demography, education/socio-Economic status, eating habits, frequency of visits to parks, availability of sanitary facilities at the parks, presence of animals at the parks and possible sources of *Taenia* eggs (appendix I).

3.6 Data Analysis

The statistical tools applied for this research work in analyzing the data collected are the correlation analysis and the Cochran Q test. The correlation analysis was used to measure the level of association between the prevalence rate of *Taenia* eggs in soil and soil pH while the Cochran Q test was applied to determine if the population proportion of *Taenia*eggs is not significantly prevalent than other geohelminth egg types in different soil textures and if the population proportion of all helminth egg types are the same for all parks locations. A significance level of 0.05 was adopted for both tests.

In this research work the statistical package for social sciences (SPSS) version 20 was used for the analysis.



Plate VIII: Goat at Jabi Park



Plate IX: People playing at Millennium Park Maitama



Plate X: Stream running through Nisa Park, Jabi



Plate XI: The only toilet in Nisa Park, Jabi



Plate XII: Broken down drainage atGilmor Park



Plate XIII: Weighing of Soil Samples for laboratory analysis



Plate XIV: Labeled Soil Samples ready for laboratory analysis

CHAPTER FOUR

RESULTS

4.1 Prevalence of Geohelmith egg type/coccidian Oocyst in Samples of Abuja Recreational Parks

Of the Sixteen (16) parks that were sampled for egg of Geohelminth, Millennium Park was found to have the highest positive sample of 12(50%). This is followed by Jabi park and orbit Gardens with 6(37.5%) each. Tender Vine and Circle gardens had 2(33.3%) positive samples each. Eden Park (16) had the least detection rate of Geohelminth (12.5%) while Cortland Park had no positive sample (Table 4.1). One Hundred and Eighty Four (184) samples were examined from the 16 parks. Of these, 183 (99.5%) had one helminth egg or the other. The commonest egg type encountered was that of *Taenia*spp which occurred in 49 (26.7%) samples, followed by *Toxocara* egg type which occurred in 27 (14.6%) of the samples. *Strongyloides* egg type had the lowest prevalence rate of 0.5%. Coccidiaoocysts occurred in 48 (26.1%) of the samples, while mite eggs were seen in 23 samples (12.5%).

4.2 *Taenia* egg count of soil sample of 16 recreational parks

A total *Taenia* egg count of 12,290 from the soil samples from 16 recreational parks in Abuja was found in the laboratory. Of this Millennium park had the highest egg count of 3,640 (29.62%) followed by Jabi lake park with 2,020 (16.44%). Orbit Garden had 1800(14.65%), followed by Wuse Market Park with 1,220 (9.93%), both Eden and Executive Gardens had 160(1.30%) each. The least egg count were found in Queensfield park and Area 1 Zoological Garden with 140(1.14%) each respectively.

4.2.1 Cochran Q Test on Helminth Egg Types for all the selected Parks

The total sample used for the determining the population proportion of Helminth egg types was 184. The Cochran Q test statistic value of 94.87 of 8 df with a probability value (P-value) of 0.0001 indicates that the prevalence population proportion of helminthes egg types are significantly different for all the parks' locations. Hence the first null hypothesis is rejected. The prevalence frequency distribution of helminth egg types is presented using a bar chart (Fig. 4.1)

0 indicates absence of helminth egg types. 1 indicates presence of helminth egg types.

4.3 Prevalence of other Geohelminth eggs and Coccidiaoocysts in soil Sample of Abuja Recreational Parks

4.3.1 *Toxocara eggs*

It was discovered that 2(40%) of the 5 soil samples from Cortland Park were positive for *Toxocara* eggs. Circles Park and Area 1 Zoological Garden with 6 samples each examined had 2(33.33%) rate of detection of *Toxocara*eggs respectively. In Millennium Park, 3(20.8%) of the 24 samples were positive .Of the 15 soil samples from Gilmore Park 3(20%) were positive for *Toxocara* eggs. These were followed by Eden Park 3(18.8%) positive samples of 16 samples for *Toxocara* eggs. Nisa, Jabi Lake, Berger parks and Orbit Garden had 2(12.5%) of 16 samples were positive for*Toxocara*eggs representing the least egg count for the helminth egg.(Table 4.3)

4.3.2 *Ancylostoma*Eggs

Examination of soil samples collected from the parks, Area 1 Zoological Garden had the highest positive samples for *Ancylostoma* eggs 2(33.3%) of 6 samples examined. This is followed by Executive Gardens with 1(25%) of 4 samples examined testing positive for the *Ancylostoma* eggs. NisaLake, Berger parks tested positive in 18.8% of

samples. The least positive tests(6.2%) were in samples collected from Jabi Lake, Eden and Wuse Market Parks respectively.(table 4.3)

4.3.3 *Trichuris* Eggs

Nisa Lake Park had the highest positive soil samples for *Trichuris* eggs with 6(37.5%) samples out of 16 samples testing positive. This is followed by Gilmore Park with 4(26.7%) samples out of 15 testing positive. Queensfield Park had 1(25%) out of the 4 samples testing positive. The least *Trichuris*egg count was found in Eden Park with 1(6.2%) out of 16 samples testing positive.

4.3.4 *Ascaris* Eggs

Samples examined revealed that Jabi Lake park had the highest positive samples for *Ascaris* eggs with 3(18.8%) of the 16 samples examined. This was followed by Millennium park, with 4(16.7%) of 24 samples examined, Gilmore park with 2(13.3%) of 15 samples examined, and Nisa Leisure Park with 2(12.5%) of the 16 soil samples examined. The least positive samples were from Berger Park with 1(6.2%) of the 16 soil samples examined.

4.3.5 *Strongyle eggs*

Millennium park had the highest number of soil samples with 4(16.7%) of 24 soil samples examined testing positive for *Strongylus*eggs. This was followed by Gilmore Park with 2(13.3%) of 15 samples, Nisa Leisure Park and Orbit Garden with 2(12.5%) of 16 samples each respectively. The least positive samples was from Wuse Market park with 1(6.2%) of 16 samples testing positive for *Strongylus* eggs.

4.3.6 *Strongyloides* Eggs

Gilmore Park recorded the only positive sample (n=1;6.2%) of 15 samples examined testing positive for *Strongyloides* egg.

4.3.7 Coccidia*Oocyst*

Of the 5 soil samples collected from Cortland Park, 3(60%) samples were positive for coccidian oocysts. Of the 4 samples from Executive Garden, 2(50%) were positive for Coccidiaoocysts while, of the 6 samples from Circle park, 3(50%) tested positive for coccidiaoocysts.

4.3.8 Mite Eggs

Area 1 Zoological Garden had the highest samples positive for mite eggs with 2(33.3%) of 6 soil samples positive for Mite eggs. This was followed by Gilmore Park with 4 of 15 soil samples (26.7%), Nisa Leisure park 4of 16 soil samples (25%), Millennium Park 5 of 24 soil samples (20.8%) and Jabi Lake Park 3 (18.8%) soil samples positive for mite eggs respectively. The least were Berger and Wuse market parks with 1(6.2%) of 16 soil samples positive for mite eggs respectively.

4.4 Prevalence of total parasite egg count (EPG) for all parks

Of the total parasites egg count (39,363) of all the 16 recreational parks sampled in Abuja, Millennium Park had the highest EPG of 10,155 (25.8%), followed by park Jabi Lake Park with 5265 (13.4%) EPG. Orbit Garden had 3700 (0.09%), Berger Park had 3180 (0.08%) and Nisa Leisure park with 3024 (0.08%) were 3rd, 4th and 5th respectively. Queensfield Park 300 (0.007%) had the least EPG.

Of the entire total parasite egg counted, *Taenia*12,290 (31.22%) had the highest egg count, followed by Coccidia 9,797 (24.89%), Toxocara 6390 (16.23%) was 3rd followed by Ascaris 3340 (8.49%), Trichuris 2640 (6.71%), Hookworm 2480 (6.30%), Strongyle 1107 (2.81%) and Strongyloides 200 (0.51%) [Table 4].

Correlation Analysis indicated that the soil pH had no effect on the prevalence of*Taenia*as well as other geohelminth egg types. The correlation analysis result

between *Taenia* and soil PH and it can be observed that the correlation value obtained is -0.266 with a P-value of 0.320. The P-value is greater than α=5% significance level which indicates that there is no significant association between *Taenia* and soil pH. This lack of association could be as a result of the small differences of the pH values for the soil samples ion the different parks studies. Hence, it can be concluded that there is no association between the prevalence of *Taenia* eggs in soil types and pH. Similar results were obtained for the correlation analysis for other geohelminth egg types and pH of the soil.

Table 4.1:Park Prevalence Rate of *Taenia*Eggs in recreational Parks

Park	**No. of samples per park**	**No. Positive**	**% Positive**
Nisa leisure	16	3	18.8
Gilmore	15	3	20.0
Millennium	24	12	50.0
Jabi lake	16	6	37.5
UDBN	12	2	16.7
Berger	16	3	18.8
Orbit garden	16	6	37.5
NUDB	6	1	16.7
Tender vine	6	2	33.3
Eden	16	2	12.5
Cortland garden	5	0	0
Queen fields	4	1	25.0
Executive garden	4	1	25.0
Circles	6	2	33.3
Area 1 zoological	6	1	16.7
Wuse market	16	4	25.0
Total	**184**	**49**	**26.6**

Table 4.2 Mean *Taenia* egg per Abuja recreational Park

S/N	Park	No of Samples	*Taenia E*gg Count/Park	Total Egg Count/Park	% Egg Count/ Park	Mean Egg Count
1	Nisa Leisure	16	860	3024	28.44%	53.75
2	Gilmore	15	420	1934	21.72%	28.00
3	Millennium	24	3640	10155	35.84%	151.67
4	Jabi Lake	16	2020	5260	38.40%	126.25
5	UDBN	12	510	2150	23.72%	42.50
6	Berger	16	560	3180	17.61%	35.00
7	Orbit Garden	16	1800	3700	48.65%	112.50
8	NUDB	6	100	320	31.25%	16.67
9	Tender vine	6	180	500	36.00%	30.00
10	Eden	16	160	1440	11.11%	10.00
11	Cortland	5	0	0	0.00%	0.00
12	Queensfield	4	140	300	46.67%	35.00
13	Executive Garden	4	160	680	23.53%	40.00
14	Circles	6	380	1660	22.89%	63.33
15	Area 1	6	140	1540	9.09%	23.33
16	Zoological Wuse Market	16	1220	2720	44.85%	76.25
	Total		12290	38563		*P*-value = 0.115

Table 4.3: Prevalence of other Geohelminths in soil samples

Geo-parasites (%)

Park	No. of samples	*Toxocara*	*Strongylus*	*Strongyloides*	Hookworm	Coccidia	*Trichuris*	*Ascaris*	Mite egg
Nisa leisure	16	2 (12.5)	2 (12.5)	0 (0)	3 (18.8)	3 (18.8)	6 (37.5)	2 (12.5)	4 (25.0)
Gilmore	15	3 (20.0)	2 (13.3)	1 (6.7)	0 (0)	6 (40.0)	4 (26.7)	2 (13.3)	4 (26.7)
Millennium	24	5 (20.8)	4 (16.7)	0 (0)	2 (8.3)	8 (33.3)	3 (12.5)	4 (16.7)	5 (20.8)
Jabi lake	16	2 (12.5)	0 (0)	0 (0)	1 (6.2)	2 (12.5)	2 (12.5)	3 (18.8)	3 (18.8)
UDBN	12	2 (16.7)	1 (8.3)	0 (0)	1 (8.3)	2 (16.7)	2 (16.7)	0 (0)	0 (0)
Berger	16	2 (12.5)	0 (0)	0 (0)	3 (18.8)	4 (25.0)	2 (12.5)	1 (6.2)	1 (6.2)
Orbit garden	16	2 (12.5)	2 (12.5)	0 (0)	1 (6.2)	4 (25.0)	3 (18.8)	0 (0)	0 (0)
NUDB	6	0 (0)	0 (0)	0 (0)	0 (0)	1 (16.7)	0 (0)	0 (0)	0 (0)
Tender vine	6	1 (16.7)	0 (0)	0 (0)	0 (0)	1 (16.7)	0 (0)	0 (0)	1 (16.7)
Eden	16	3 (18.8)	0 (0)	0 (0)	1 (6.2)	2 (12.5)	1 (6.2)	0 (0)	2 (12.5)
Cortland	5	1 (20.0)	0 (0)	0 (0)	1 (20.0)	3 (60.0)	0 (0)	0 (0)	0 (0)
Queen fields	4	0 (0)	0 (0)	0 (0)	0 (0)	1 (25.0)	1 (25.0)	0 (0)	0 (0)
Executive garden	4	0 (0)	0 (0)	0 (0)	1 (25.0)	2 (50.0)	0 (0)	0 (0)	0 (0)
Circles	6	2 (33.3)	0 (0)	0 (0)	2 (33.3)	3 (50.0)	0 (0)	0 (0)	0 (0)
Area 1 zoological	6	2 (33.3)	0 (0)	0 (0)	1 (16.7)	2 (33.3)	0 (0)	0 (0)	2 (33.3)
Wuse market	16	0 (0)	1 (6.2)	0 (0)	1 (6.2)	4 (25.0)	0 (0)	0 (0)	1 (6.2)

Table 4.4: Egg per Gram (Epg) of Soil Samples 0f Recreational Parks in Abuja

Park	*Taenia*	*Toxocara*	*Strongylus*	*Strongyloides*	Hook worm	*Trichuris*	*Ascaris*	Total EPG
Nisa leisure	860	350	2	0	400	440	400	2452
Gilmore	420	360	2	200	0	400	340	1722
Millennium	3640	1960	83	0	240	840	1400	8163
Jabi lake	2020	760	0	0	140	240	1100	4260
UDBN	510	580	200	0	60	240	0	1550
Berger	560	240	0	0	600	100	100	1600
Orbit garden	1800	240	440	0	240	260	0	2980
NUDB	100	0	0	0	0	0	0	100
Tender vine	180	80	0	0	0	0	0	260
Eden	160	640	0	0	100	60	0	960
Cortland	0	120	0	0	80	0	0	200
Queen fields	140	0	0	0	0	60	0	200
Executive garden	160	0	0	0	60	0	0	220
Circles	380	440	0	0	220	0	0	1040
Area 1 zoological	140	620	0	0	140	0	0	900
Wuse market	1220	0	380	0	200	0	0	1800
Overall Total	12290	6390	1107	200	2480	2640	3340	28447
% parasite count of total egg count	31.22	16.23	2.81	0.51	6.30	6.71	8.49	

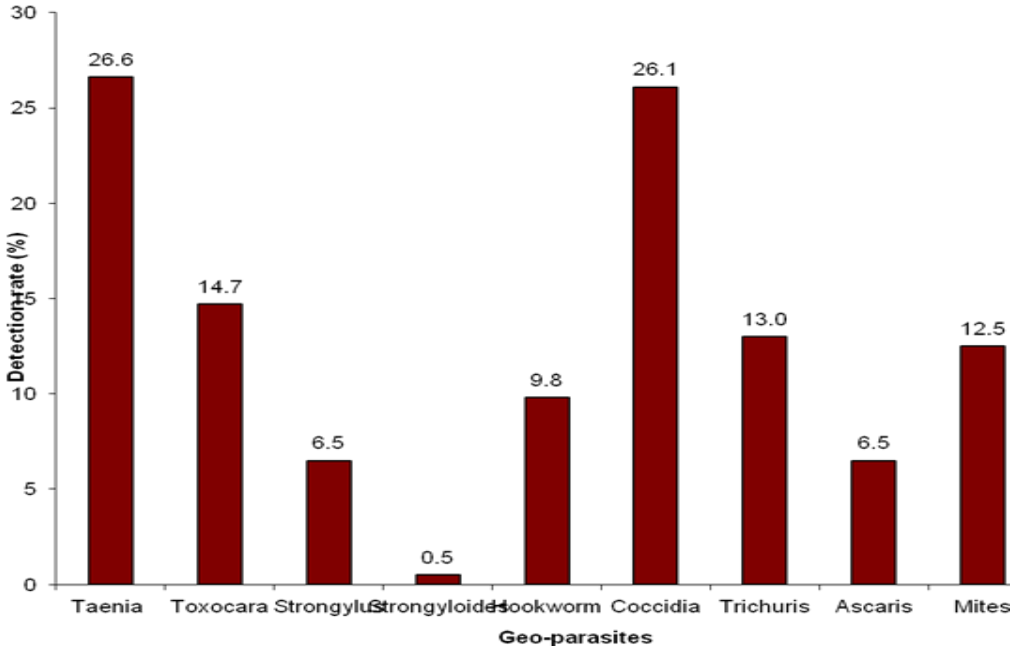


Fig. 4.1 Dectection rate of *Taenia* eggs and eggs of other geo-parasites in soil samples of Abuja recreational parks

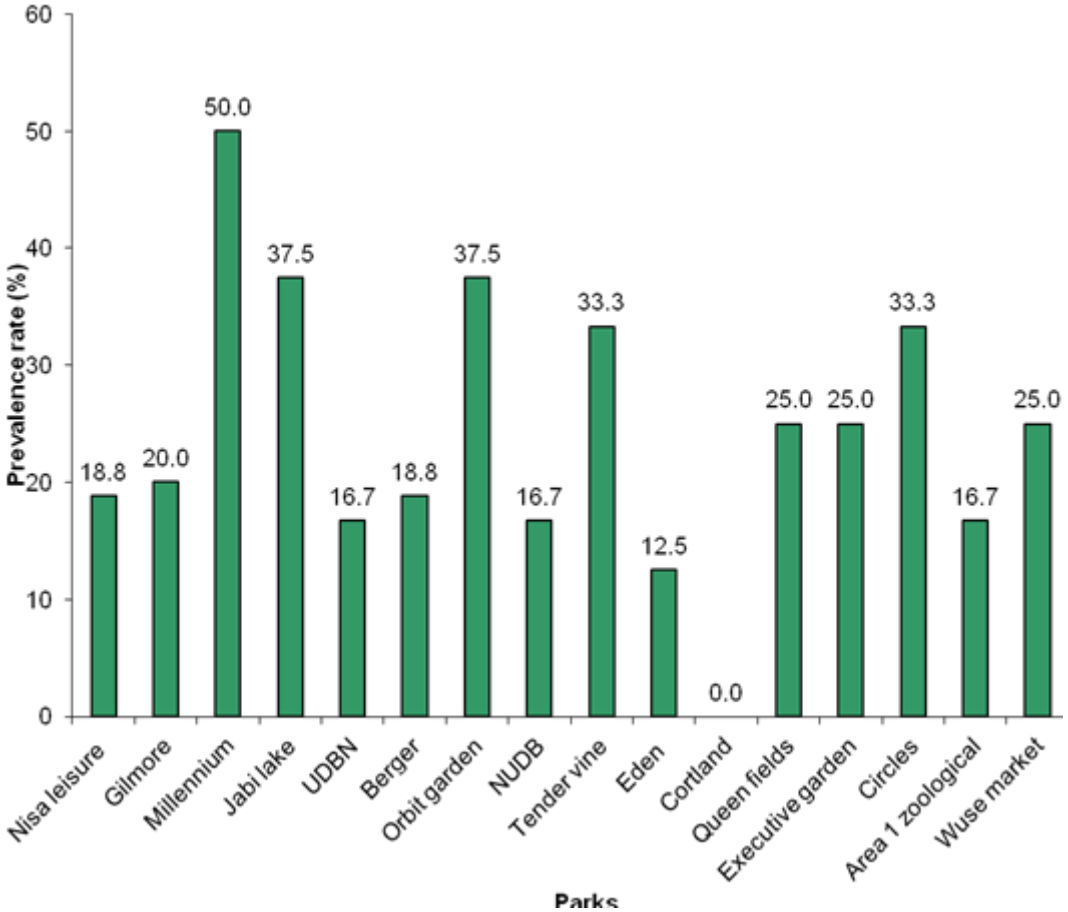


fig. 4.2 Park prevalence rate of *Taenia* eggs in soil samples of Abuja recreational parks

4.5 Questionnaire Analysis

A total of 200 questionnaires were distributed and returned out of which 37 (18.5%) were primary school certificate holders, 93(46%) of the respondents were secondary school certificate holders and 48 (24.0%) were tertiary certificate holders. 22 (11.0%) represent others.Out of the 16 parks surveyed, Millennium Park was the most patronized than the other parks. Analysis showed that 45.5% of the respondents often visited.One hundred and twenty five (62.0%) of the respondents live close to a park,74 (37.0%) live far from parks, and 5 (2.5%) live outside Abuja which suggests that these people only visit the parks occasionally. Out of the 200 respondents that visit parks, 41(20.5%) visit parks daily and 76(38.0%) said they visit parks occasionally.

One hundred and six (53.0%) of the 200 respondents said they visited parks alone, 51 (25.5%) said they went with other members of the family, Thirty four(17.0%) visited parks with children, 6 (3.0%) went with friends, 2(1.0%) went with a pet, no respondent (0.0%)took children and pets together to the parks. 1 (0.5%) did not respond. One hundred and fifty three (76.5%) out of 200 respondents said they ate in the parks, 45 (22.5%) don't eat at parks, 2(1.0%) did not respond. Out of the 200 respondents, 97 (48%) of respondents said they wash up plates and cutleries at the parks after eating. out which of this, 54(27%) said they use taps at the parks to clean up, 43 (21.5%)said they take water along with them for washing hands and 44 (22.0%) said they only clean up when they get back home. The remaining 59 (29.5%) said they never ate at the park.

In response to the question on the sufficiency of provision for cleaning up at the parks, 158 (79.0%) opined that Parks in Abuja have sufficient provision for cleaning

up, while 38 (19.0%) thought the provision was inadequate. 4 (2.0%) did not respond.Of the 200 respondents, 81 (40.5%) said they administer anthelmintics to their families, 96 (48.0%) said they never did, 20 (10.0%) said they had no families but they treat themselves and 3 (1.5%) did not respond. Therefore 102 respondents treat themselves and/or their families. 40 (20.0%) treat once a year, 34 (17.0%) treat twice, 11 (5.5%) treat thrice and 14 (7.0%) treat quarterly, the remaining 90(45%) respondents had no families.

Ninety (45.0%) of respondents said they had course to come in contact with soil at the parks, out of which 69 (34.5%) said they sat on the grasses, 12 (6.0%) said by playing in sand with children, 2 (1.0%) said they like playing with sand at the parks, 11 (5.5%) said when they clean or dust children up and 4 (2.0%) said when they help children put on shoes at the end of a visit to the parks. 102 (51%) of the respondents said they have never had course to come in contact with soil at parks.

One hundred and thirteen of the two hundred respondents(56.5%) said they had not sighted animals (stray or pets) at parks, 80 (40.0%) said they had while 7 (3.5%) did not respond. Twenty four (12.0%) of respondents say they had seen pigs at the parks and 2 (1.0%) said they had seen cattle at parks.Out of the 193 (97.5%) of the 200 responses on how they answer natures call at the parks, 167 (83.5%) said they go to the toilets at the parks, 27 (13.5%) go to bushes at the parks, 1 (0.5%) said they use other means, 5 (2.5%) did not respond. 198 (99.0%) of respondents said they have never sighted human feaces in any of the parks. 146 (73.0%) said there are sufficient toilets at parks, 41 (20.5%) said there are insufficient toilets at parks and 13 (6.5%) did not respond.

112 (56.0%) of the respondents said they consume only beef, 44(22.00%) consume only chicken, 1 (0.5%) consume only pork and 43 (21.5%) consume all/some of the listed options. One hundred and ninety one (95.5%) respondents said they buy meat from the market When asked about how they prepared the meat, 31(15.5%) fried, 110 (55.0%) boiled, 14 (7.0%) smoked and 45(22.5%) use other means. 187(93.5%) said they eat only well cooked meat, 9(4.5%) of the respondents who eat pork, said they slaughter the pigs themselves. 12(6.0%) said they can eat fairly well cooked meat only, 1(0.5%) said they eat meat that is cooked 'rare', fairly or well cooked. None of our respondent admitted to taking meat that has visible blood.122 (61.0%) of the respondents said they are aware that there are diseases that can be passed unto humans through soils contaminated with faeces of infected animals, 78(37.0%) did not know. Of the 200 respondents, 74(37.0%) said they have heard of Taeniasis and or cysticercosis, 125(62.5%) had not, 1(0.5%) did not respond.

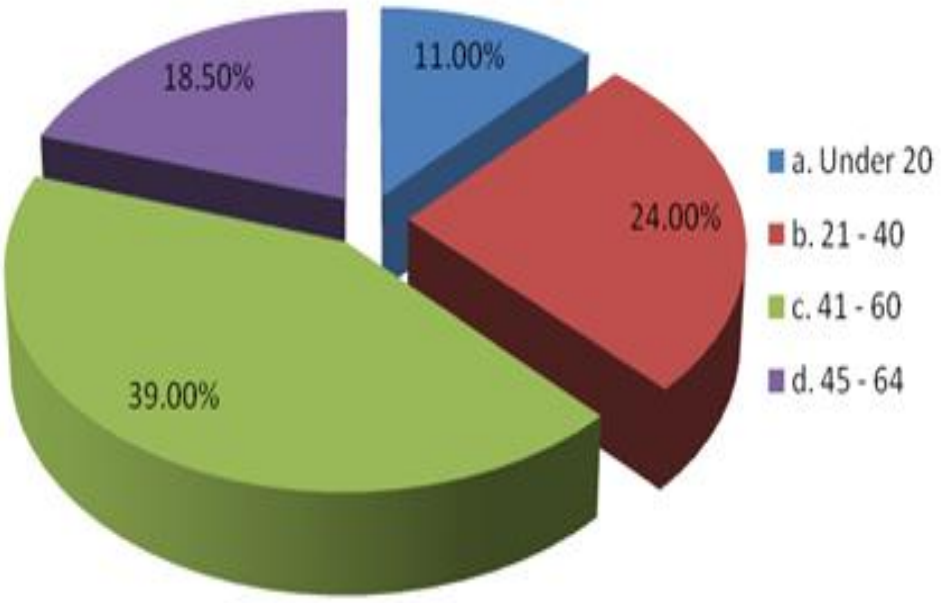


Fig 4.3: Age Distribution of the Respondents

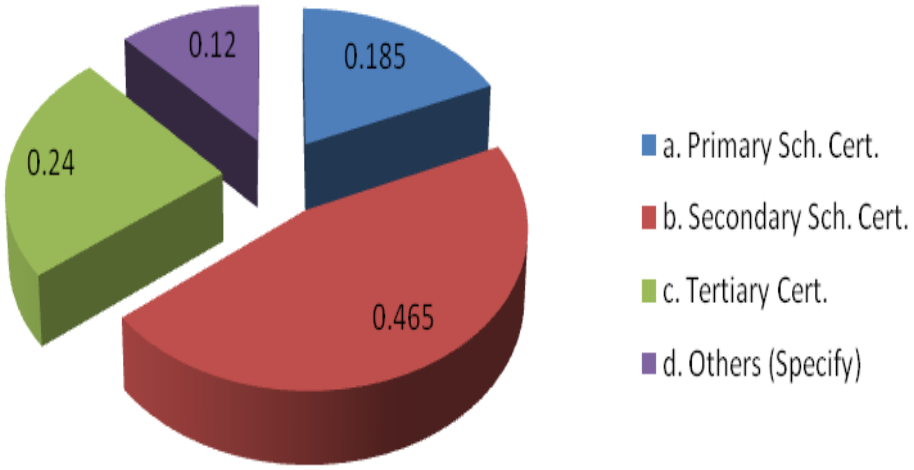


Fig. 4.4: Level of Education of Respondents

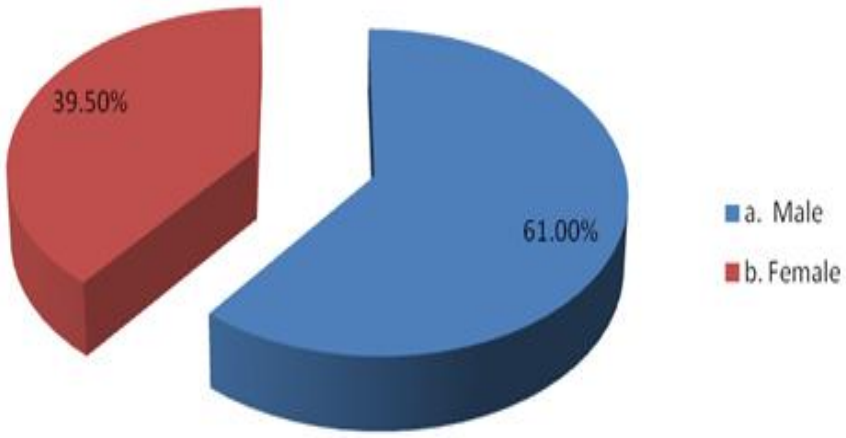


Fig. 4.5: Sex distribution of Respondents

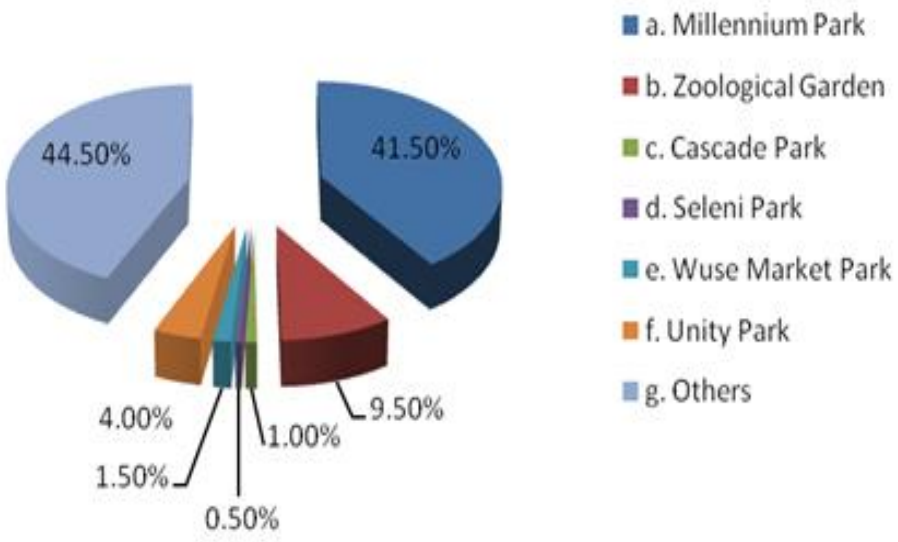


Fig. 4.6: Frequently visited Parks

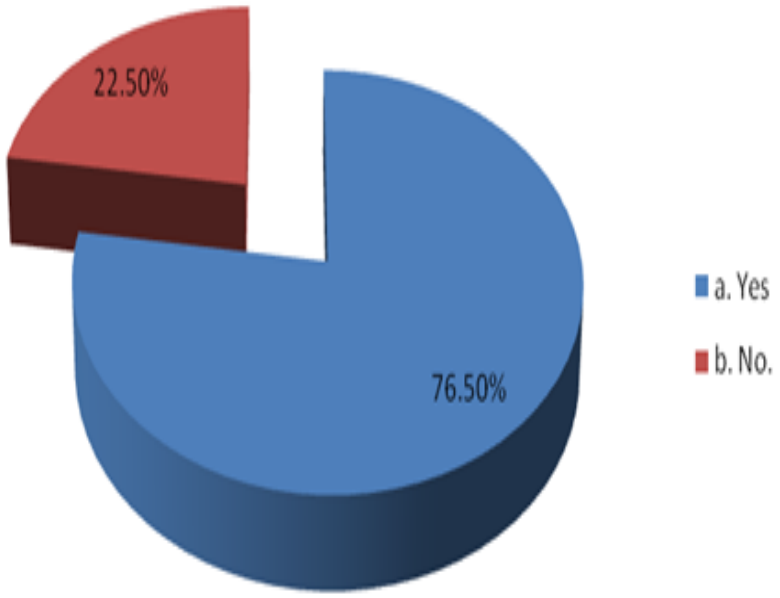


Fig 4.7: Respondents Who Eat At The Parks Versus Those That Do Not

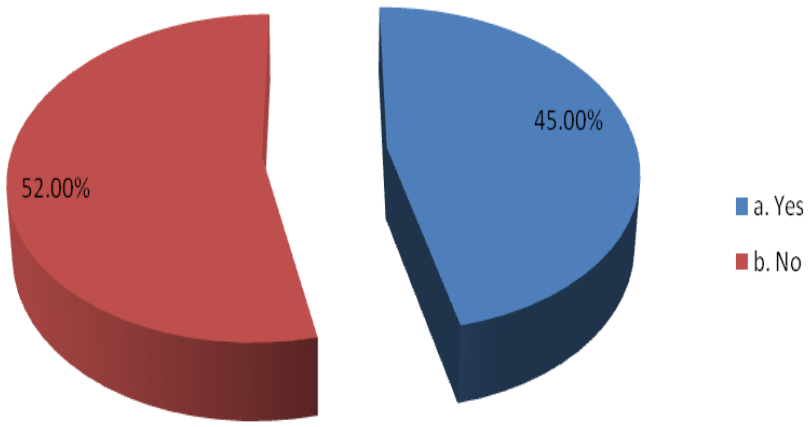


Fig 4.8 Contact with Soil at the Parks

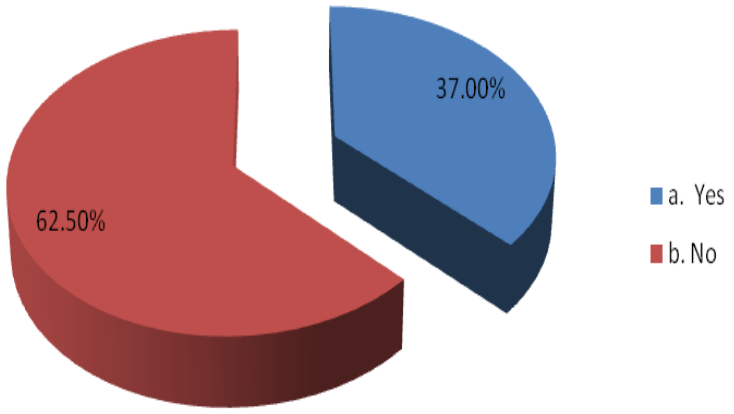


Fig 4.9: Awareness of Taenia or Cysticercosis

CHAPTER FIVE

DISCUSSION

In this study, it was observed that 99.5% of the soils sampled in the 16 parks in Abuja were contaminated with eggs of one Geohelminth or the other. There was a 72.2% contamination rate for *Taenia* eggs shown by this study which is considered high. This is followed by eggs of *Toxocara* and *Strongyloides* eggs. The period of soil sample collection was between September and December. This was during the rainy season towards the end of the season. Although, according to Smith *et al* (1984), rainfall may wash eggs away in an open park land, the poor drainage in most of the parks may have been responsible for the high rate of contamination. Further, the high number of humans that patronize these parks with the possibility of helminthes eggs' picked by soles of shoes as well as access to these parks by animals such as dogs through the broken down fence or unfenced parks, could result in the high level of contamination with eggs.*(* Paquate-Durand *et al,* 2007; Avoioglo and Balkaja,2011)**.** There were insufficient sanitary facilities in the parks which poses as a risk factor in the faecalcontamination of soils. This is in line with the findings of Schantz*et al.*, 1998 who identified low level of sanitary infrastructure e.g. toilets as a risk factor associated with cysticercosis in humans.

In this study, Eden Park had a lower prevalence of parasitic eggs (1.3% egg count). This could be attributed to the lower number of people that visited the park on account of size and preference. Further, due to its size, there is less likelihood of stray dogs having access to the park.Millennium Park had the highest level of contamination although on aggregate terms, the other sites may equally be contaminated. This can be attributed to the fact that Millennium Park is more than the

twice the size of each of the other Parks and had the highest patronage. Also, faecal contamination may be a significant factor as the park had only one functional toilet to serve thousands of residents that patronize it. Further, there is a stream that cuts through the length of the park where waste water from other locations within the FCT passes through. This may serve as a good distribution channel for the *Taenia*eggs as demonstrated by the findings of Dagny *et al.* (2010).

The lower prevalence of *Taenia* eggs in Eden Park may be due to the lower number of people who patronize the park and the absence of stray animals in the park which is fully fenced and patrolled. Also, the toilet facilities appeared adequate thus people are unlikely to resort to open defecation.Most recreational Parks sampled were not been used as approved with most converted to open air restaurants. Over time they have become converted to bars and restaurants where people go in the evenings to eat and drink as well as watch football matches on large screens. The implication of this is that there is a higher risk of contaminating these parks due to environmental sanitation insufficiency.

CHAPTER SIX

CONCLUSION, AND RECOMMENDATIONS

6.1 Conclusion

The present study conducted in 16 parks has shown a high level of soil contamination with *Taenia* eggs in Abuja parks and has confirmed that routine screening of soil samples can be used as an effective strategy in determining the extent of contamination of soils with helminthes eggs as previously shown. Further, screening can be done periodically to ascertain the status of the soils of these parks since a baseline has been established by this study.The knowledge of *Taenia* and Cysticercosis was low and this needs a sustained strategy of enlightenment of the populace. The land use of the Parks have been observed to be beyond what is approved to include conversion into bars and open-air restaurants with the attendant risk of contamination of the soil.

6.2 Recommendations

The work has shown that there is an urgent need to provide the necessary sanitary infrastructure in all the parks as well as stricter control of the approved use of these parks.This work has shown the extent of contamination of soils in recreational parks in Abuja, there is insufficient information on the role that stray animals play in the contamination of the soils of the park. There is the need for further study on this.In addition, there is the need to study the health implications of this contamination of Abuja parks by geo-helminths, analysis of hospital records in the areas where the parks are located.

i) There is the need to institute a sustained campaign on the dangers of contaminated soils by geohelminth and the need to imbibe good sanitary practices.

ii) Enforcement of strict land use regulations by the relevant authorities to ensure that parks remain what they are set up to be.

iii) All parks must have fully functional and maintained toilet facilities as well as clean potable water.

iv) Drainages within the parks should be constantly maintained and treated.

v) People should soak their feet in antiseptic solution and use antiseptic wipes for the soles of their shoes before entering the recreational parks.

vi) Children and adults should not play with the soils at the park.

vii) The park workers should make sure no one defaecates in the parks.

viii) The parks should be fenced all round and proper drainages constructed.

ix) Stray animals especially dogs should not be allowed into the recreational parks.

x) When people eat on the park they should not leave bones and food remains that will entice scavengers in the place.

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APPENDIX I

PREVALENCE OF HELMINTH EGG TYPES, MITE EGGS AND COCCIDIA OOCYSTS IN SOILS OF PARKS IN ABUJA

Park	**No. of samples per park**	**No. of +**	**% +**	**Egg count per park**	**% egg count per park**	*Taenia*	***Toxocara***	***Strongylus***	***Strongyloides***	**Hookworm**	**Coccidia**	***Trichuris***	***Ascaris***	**Mite egg**
Nisa leisure	16	3	18.8	860	7.00	860	2 (12.5)	2 (12.5)	0 (0)	3 (18.8)	3 (18.8)	6 (37.5)	2 (12.5)	4 (25.0)
Gilmore	15	3	20.0	420	3.42	420	3 (20.0)	2 (13.3)	1 (6.7)	0 (0)	6 (40.0)	4 (26.7)	2 (13.3)	4 (26.7)
Millennium	24	12	50.0	3640	29.62	3640	5 (20.8)	4 (16.7)	0 (0)	2 (8.3)	8 (33.3)	3 (12.5)	4 (16.7)	5 (20.8)
Jabi lake	16	6	37.5	2020	16.44	2020	2 (12.5)	0 (0)	0 (0)	1 (6.2)	2 (12.5)	2 (12.5)	3 (18.8)	3 (18.8)
UDBN	12	2	16.7	510	4.15	510	2 (16.7)	1 (8.3)	0 (0)	1 (8.3)	2 (16.7)	2 (16.7)	0 (0)	0 (0)
Berger	16	3	18.8	560	4.56	560	2 (12.5)	0 (0)	0 (0)	3 (18.8)	4 (25.0)	2 (12.5)	1 (6.2)	1 (6.2)
Orbit garden	16	6	37.5	1800	14.65	1800	2 (12.5)	2 (12.5)	0 (0)	1 (6.2)	4 (25.0)	3 (18.8)	0 (0)	0 (0)
NUDB	6	1	16.7	100	0.81	100	0 (0)	0 (0)	0 (0)	0 (0)	1 (16.7)	0 (0)	0 (0)	0 (0)
Tender vine	6	2	33.3	180	1.46	180	1 (16.7)	0 (0)	0 (0)	0 (0)	1 (16.7)	0 (0)	0 (0)	1 (16.7)
Eden	16	2	12.5	160	1.30	160	3 (18.8)	0 (0)	0 (0)	1 (6.2)	2 (12.5)	1 (6.2)	0 (0)	2 (12.5)
Cortland garden	5	0	0	0	0.00	0	1 (20.0)	0 (0)	0 (0)	1 (20.0)	3 (60.0)	0 (0)	0 (0)	0 (0)
Queen fields	4	1	25.0	140	1.14	140	0 (0)	0 (0)	0 (0)	0 (0)	1 (25.0)	1 (25.0)	0 (0)	0 (0)
Executive garden	4	1	25.0	160	1.30	160	0 (0)	0 (0)	0 (0)	1 (25.0)	2 (50.0)	0 (0)	0 (0)	0 (0)
Circles	6	2	33.3	380	3.09	380	2 (33.3)	0 (0)	0 (0)	2 (33.3)	3 (50.0)	0 (0)	0 (0)	0 (0)
Area 1 zoological	6	1	16.7	140	1.14	140	2 (33.3)	0 (0)	0 (0)	1 (16.7)	2 (33.3)	0 (0)	0 (0)	2 (33.3)
Wuse market	16	4	25.0	1220	9.93	1220	0 (0)	1 (6.2)	0 (0)	1 (6.2)	4 (25.0)	0 (0)	0 (0)	1 (6.2)
Total	184	49	26.6	12290	100.00	12290								

APPENDIX II

Pairwise Comparison Test for Taenia egg and other Helminth egg types

Sample 1	Sample 2	Test Statistic	Standard Error	P-value
Taenia	Coccidia	-0.011	0.035	1.000
Taenia	*Toxocara*	0.120	0.035	0.027
Taenia	*Trichuris*	-0.136	0.035	0.005
Taenia	Mite	-0.141	0.035	0.002
Taenia	Hookworm	-0.168	0.035	0.0001
Taenia	*Strongylus*	-0.201	0.035	0.0001
Taenia	*Ascaris*	-0.201	0.035	0.0001
Taenia	*Strongyloides*	-0.201	0.035	0.0001

APPENDIX III

SOIL ANALYSIS

S/N	Park	PH	Texture
1	NISA Park	7.06	3
2	Gilmor	6.95	2
3	Millennium	6.96	2
4	Jabi Lake	6.90	3
5	UDBN	7.00	2
6	Berger	6.93	2
7	Orbit Garden	6.94	2
8	NUDB	7.10	3
9	Tendervine Park	6.97	2
10	Eden Garden	6.98	2
11	Cortland Park	7.80	3
12	Queensfield Park	6.96	2
13	Executive Garden	7.00	2
14	Circles Park	6.98	2
15	Area 1 Zoological Garden	7.00	2
16	Wuse Market	7.13	1

Key: 1--- Clay, Loam; 2--- Sandy, Clay, Loam; 3--- Clay

Appendix IV
Correlation analysis for comparing soil P^H and the Prevalence of and other Geohelminths

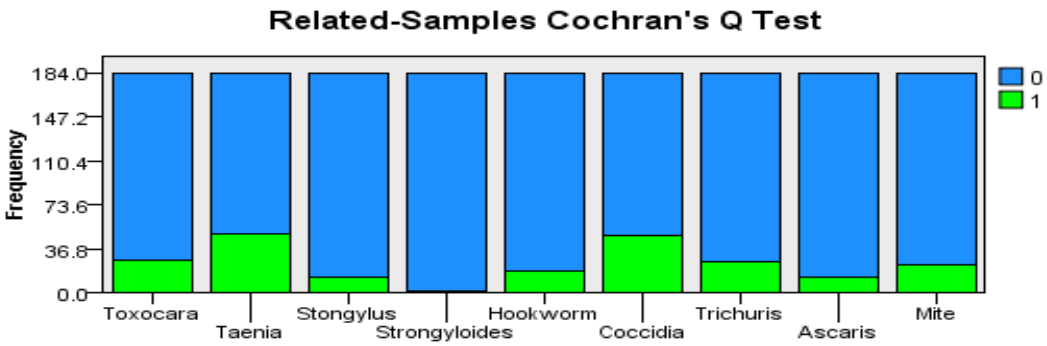
Correlations

		Taenia	Soil PH	Toxocara	Strongylus	Strongyloides	Hookworm	Trichuris	Ascaris
Taenia	Pearson Correlation	1	-.266	.759**	.386	.067	.319	.792**	.841**
	P-value		.320	.001	.140	.806	.229	.000	.000
	N	16	16	16	16	16	16	16	16
Soil PH	Pearson Correlation	-.266	1	-.242	-.057	.047	-.144	-.251	-.224
	P-value	.320		.367	.833	.863	.595	.349	.405
	N	16	16	16	16	16	16	16	16
Toxocara	Pearson Correlation	.759**	-.242	1	-.054	-.209	.183	.778**	.806**
	P-value	.001	.367		.843	.438	.497	.000	.000
	N	16	16	16	16	16	16	16	16
Strongylus	Pearson Correlation	.386	-.057	-.054	1	.466	.121	.101	-.123
	P-value	.140	.833	.843		.069	.654	.708	.650
	N	16	16	16	16	16	16	16	16
Strongyloides	Pearson Correlation	.067	.047	-.209	.466	1	-.054	-.043	-.079
	P-value	.806	.863	.438	.069		.842	.875	.771
	N	16	16	16	16	16	16	16	16
Hookworm	Pearson Correlation	.319	-.144	.183	.121	-.054	1	.252	.183
	P-value	.229	.595	.497	.654	.842		.347	.498
	N	16	16	16	16	16	16	16	16
Trichuris	Pearson Correlation	.792**	-.251	.778**	.101	-.043	.252	1	.803**
	P-value	.000	.349	.000	.708	.875	.347		.000
	N	16	16	16	16	16	16	16	16
Ascaris	Pearson Correlation	.841**	-.224	.806**	-.123	-.079	.183	.803**	1
	P-value	.000	.405	.000	.650	.771	.498	.000	
	N	16	16	16	16	16	16	16	16

**. Correlation is significant at the 0.01 level (2-tailed).

APPENDIX V

GRAPH OF COCHRAN'S Q TEST AND THE OUTPUT



Total N	184
Test Statistic	94.871
Degrees of Freedom	8
Asymptotic Sig. (2-sided test)	.000

APPENDIX VI

COORELATION ANALYSIS BETWEEN *TAENIA* AND SOIL PH

	Soil PH
Taenia	**– 0.266**
P-value	**0.320**
N	**16**

APPENDIX VII

QUESTIONNAIRE SURVEY OF PARK/GARDENS IN ABUJA MUNICIPAL AREA COUNCIL

SECTION A: BIODATA AND FAMILY DEMOGRAPHY

1. Sex: (a) Male
(b) Female

2. Age:
(a) Under 15
(b) 15-24
(c) 25-44
(d) 45-64
(e) Over 65

3. EDUCATIONAL BACKGROUND
(a) Primary School Certificate
(b) Secondary School Certificate
(c) Tertiary Certificate
(d) Others (Specify) ……

4.OCCUPATION :

Specify……

5. Where do you reside?

----------, which is:
(a) Close to a park area
(b) Far from a park area
(c) Outside Abuja

6. Marital Status:
(a) Single
(b) Married
(c) Divorced
(d) Widowed
(e) Separated

7. Household size:

(a) 1
(b) 2
(b) 3
(c) 4
(d) 5
(e) Over 5

SECTION B: FREQUENCY OF VISITS TO PARKS

8. How often do you visit parks?

(a) Daily
(b) Once a week
(c Once a month
(d) Occasionally
(e) Once a year
(f) Not at all

9. Which of the gardens in Abuja do you often visit?

(a) Nisa Leisure Park
(b) Gilmore Park
(c)Millennium Park
(d) Jabi Park
(e) UDBN Park
(f) Berger Park
(g) Orbit Garden Park
(h) NUDB Park
(i) Tender Vine Park
(j) Eden Park
(k) Cortland Park
(l) Queen fields Park
(m) Executive Garden Park
(n) Circles Park
(o) Area 1 Zoological Park
(p) Wuse Market Park

10. When you visit do you go:
    (a) Alone
    (b) With Children
    (c) With other members of the house hold
    (d) With your Pet (Dog)
    (e) With your Pet and Children

11. What normally takes you to the park?
    (a) To exercise
    (b) To Relax
    (c) On Picnic
    (d) To Celebrate Occasions
    (e) To work

12. Do you eat at the Park/
    a) Yes
    b) No

13.. How do you clean up at the park before and after eating?
    (a) I take water along
    (b) I use taps at the park
    (c) I clean up when I get back home

14. Do you treat your family against worms?
    (a) Yes
    (b) No

15. How often do you treat them against worms in a year?
    (a) Once a year
    (b) Twice a year
    (c)Thrice Year
    (d) Quarterly

16. Have you ever had course to come in contact with the soil at the park?
    (a) Yes
    (b) No

17. If yes, how did you come in contact with the soil?
    (a) I/we sit on the grass
    (b) I help children play with sand at the park
    (c) I like playing with sand at the park
    (d) I clean/dust children when they fall at the park
    (e) I help the children put their shoes on when we are to leave the park

18. Have you ever sighted Animals at the park?
    a) Yes
    b) No
    c) if yes, please specify…….

19. When you take children along, do you all get to eat at the park?
    (a) Yes
    (b) No

20. Do you think parks in Abuja have sufficient provision for cleaning up?
    (a) Yes
    (b) No

SECTION C: SANITARY FACILITIES AT THE PARK

21. Where do you or your children go to answer natures call
    a) Toilets
    b) Bush
    c) others

22. Does the park have Toilet facilities?
    (a) Yes
    (b) No

23. Do you think they are sufficient?
    (a) Yes
    (b) No

SECTION D: MEAT CONSUMPTION

24. What Meats do you consume at Home?
    a) Beef
    b) Chicken
    c) Pork
    d) All or some of the above (specify)……
26. How do you prepare it?
    a) Frying
    b) Boiling
    c) Smoking
    d) Other (specify)…….

27. Where do you get the meats from
    a) Buy from market
    b) Slaughter the pig myself
    c) Other (specify)

28. How well is the meat cooked?
    a) Very well
    b) Fairly well
    c) Rare*

* Not well cooked and blood can be seen on the meat

SECTION E: AWARENESS OF PARASITE/DISEASE

29. Have you ever heard of Taeniasis and or Cysticercosis?
    (a) Yes
    (b) No

30. Are you aware there are diseases that can be passed unto man through soil via roaming animals?
    (a) Yes
    (b) No

31. Do you know that children under the age of 6 are at greater risk of contacting such diseases because of their eating habits and mode of play?
    (a) Yes
    (b) No

SECTION F: (TO BE FILLED BY THE RESEARCHER BASED ON OBSERVATION)

32. Is the site fenced?
    (a) Yes
    (b) No

33. Any pigs seen at site?
    (a) Yes
    (b) No

34. Any cattle seen on site
    (a) Yes
    (b) No

35. Any humanfaecesseen per square meter?
    (a) Yes
    (b) No

36. Number of feaces seen per square meter ----------

37. Topography of site:
    (a) Gentle slope
    (b) Irregular slope
    (c Flat slope

38. Type of vegetation where sample is collected
    (a) Grassy
    (b) Bare

39. Soil Characteristic
    (a) Wet (Moist)
    (b) Dry (powdery)

40. Season of the year:
    (a) Rainy season
    (b) Dry season