SURVEY OF COMMERCIAL MOTOR VEHICLE STEERING WHEELS FOR PARASITE EGGS AND CYSTS IN ZARIA, KADUNA STATE, NIGERIA

BY

Saratu Hambali UMAR, DVM (UNI MAID) 2008

MSC/VET.MED/09579/2010-2011

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES,

AHMADU BELLO UNIVERSITY, ZARIA.

IN PARTIAL FULFILLMENT OF THE REQIREMENTS FOR THE AWARD OF

THE DEGREE OF MASTER OF SCIENCE IN VETERINARY PUBLIC

HEALTH AND PREVENTIVE MEDICINE

DEPARTMENT OF VETERINARY PUBLIC HEALTH AND PREVENTIVE

MEDICINE,

AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA

NOVEMBER, 2015

DECLARATION

I declare that the work in this Dissertation entitled "Survey of commercial motor vehicle steering wheels for parasite eggs and cysts in Zaria, Kaduna state, Nigeria**"** was performed by me in the Department of Veterinary Public Health and Preventive Medicine, Ahmadu Bello University Zaria, under the supervision of Professor E.C. Okolocha and Professor I. Ajogi. The information derived from the literature has been duely acknowledged in the text and a list of references provided. No part of this project dissertation was previously presented for another degree or diploma at this or any other institution.

UMAR HAMBALI SARATU	_____	_____
Name	Signature	Date

CERTIFICATION

This Dissertation entitled "SURVEY OF COMMERICAL MOTOR VEHICLE STEERING WHEELS FOR PARASITE EGGS AND CYSTS IN ZARIA, KADUNA STATE, NIGERIA" by SARATU HAMBALI UMAR meets the regulations governing the award of the degree of Master of Science of the Ahmadu Bello University, Zaria and has been approved for its contribution to knowledge and literary presentation.

Professor E. C. Okolocha Chairman, Supervisory Committee	_____ Signature	_____ Date
Professor I. Ajogi Member, Supervisory Committee	_____ Signature	_____ Date
Professor E. C. Okolocha HOD Vet. Public Health and Prev. Medicine	_____ Signature	_____ Date
Professor Kabiru Bala Dean, School of Post Graduate Studies	_____ Signature	_____ Date

DEDICATION

This work is dedicated to my parents late Alhaji Hambali Umar and Hajjiya Maryam Ibrahim for their love, care and support. May Almighty Allah reward them with the highest level in paradise (Aljannatul firdaus) amin.

ACKNOWLEDGEMENTS

All praise is due to Allah the provider, nourisher and sustainer for showering His mercies on His slaves and for seeing me through this work. My profound gratitude goes to my husband Muhammad SaghirAbdulazeez for his patience, understanding, encouragement and support throughout this work. May the Almighty Allah reward you abundantly.

My special gratitude goes to my supervisors Professor E. C. Okolocha for his guidance and intellectual support throughout the research and late Professor I. Ajogi who also contributed a lot to this work but did not live to see the end of it, may Allah reward you amin. I thank all the chairmen and drivers in my study area for their cooperation and for making this work a success. My heartfelt gratitude also goes to my sister and best friend Hajjiya Halimatus Saadiya for her love, care and support in all my endevours. You are truly a sister and I wish you the best in this world and the next.

My sincere appreciation goes to Prof. Ismaila Umar and his family for their love and care throughout my stay with them. To my dearest brothers and sisters, Muhammad Bashir Hambali, Salma Ibrahim, Dr Adama Hambali, Rahama Hambali, Maimuna Hambali, Abdul Qadr Hambali and Hauwa Hambali, I say a big thank you for being there when it mattered the most. May the blessings and mercies of Allah be with you, amin. I am indebted to my father, mother, brothers and sisters in-laws for their love and care. May Allah subahanahu wata ala reward your kindness amin.

I am also indebted to my lecturers at the Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria and the Laboratory staff of Veterinary Helmihology, Ahmadu Bello University, Zaria. Finally I would like to thank, Dr Sherifat Muhammad, Dr Usman Baba, Dr Maruf Lawal, Bintu Shettima, Dr Bilkisu Kaltungo, Dr Fatima Ibrahim Makintami, Dr Nabila Dalhatu, Dr Francis Eneche and Aishatu Jibril for their various support and contribution during this work.

ABSTRACT

Motor vehicle steerings can be contaminated with parasites that can pose health hazards to the users of such vehicles. The aim of the work was to determine the presence of parasite eggs and cysts on commercial motor vehicle steerings in Zaria, Kaduna State. Steerings of commercial motor vehicles were swabbed from five motor parks in Zaria Local Government Area. A total of 403 samples were collected between August, 2013 and February, 2014 and examined using zinc sulphate floatation medium of 1.19 specific gravity. Four hundred and three questionnaires were also used to study the risk factors for the prevalence of parasite eggs and cyst on the steerings. The overall prevalence of parasite eggs and cysts was 29 (7.2%). Cysts of *Entamoeba histolytica* were the most abundant 9 (31%), followed by Coccidian oocyst 7 (24.1%), cysts of *Giardia* 4 (13.8%), *Strongyloides* 3 (10.3%), hookworm eggs 3 (10.3%), Eggs of *Hymenolepis nana* 2 (6.9%) and cysts of *Balantidium coli* 1 (3.4%). Nineteen (4.5%) of the steerings of the drivers that owned animals were positive for parasite eggs and cysts while 10 (2.5%) of the steerings of the drivers that did not own animals were positive for parasite eggs and cysts. There were more parasite eggs and cysts 20 (5.0%) on motor vehicle steerings handled by more than one driver than those handled by only one driver 9 (2.2%). Fifteen (3.7%) of the steerings of the motor vehicles used occasionally to transport animals were positive for the parasite eggs and cysts followed by the steerings 14 (3.5%) of the motor vehicles that were not used to transport animals. None (0%) of the steerings of the motor vehicles that always transport animals was positive for parasite eggs and cysts. Twelve (3%) of the steerings that children had access to, were positive for the parasite eggs and cysts while 17 (4.2%) of the steerings that children did not have access to, were also positive for the parasite eggs and cysts. Twenty nine (7.2%) of the steerings of the drivers that washed their hands after visiting the

toilet were positive for the parasite eggs and cysts while none (0%) of the steerings of the drivers that did not wash their hands after visiting the toilet were also positive for the parasite eggs and cysts. Twenty three (5.7) of the steerings that were cleaned by the drivers were positive for parasite eggs and cysts while 6 (1.5%) of the steerings that were not cleaned by the drivers were positive for parasite eggs and cysts. There was no significant association between presence of the parasite eggs and cysts and animal ownership, children having access to steerings, transport of animals, cleaning of steerings and washing of hands after visiting the toilet ($p>0.05$). However there was a significant association (OR= 0.5, 95% CI= 0.24-1.89, P= 0.001) between presence of the parasite eggs and cysts and the number of drivers per motor vehicles. This study shows that motor vehicle steerings are contaminated with parasite eggs and cysts of public health importance. There is need for public enlightenment to commercial drivers on the risk of their motor vehicle steerings serving as formites for the transmission of parasitic diseases.

TABLE OF CONTENTS

Title i

Declaration ii

Certification iii

Dedication iv

Acknowledgemens v

Abstract vi

Table of contents viii

List of tables xi

List of plates xii

List of appendix xiii

CHAPTER ONE: INTRODUCTION 1

1.1 Background of the Study 1

1.2 Statement of Research Problem 2

1.3 Justification of the Study 3

1.4 Aim and Objectives of the Study 3

1.4.1 Aim of the study 3

1.4.2 Objectives of the study 3

1.5 Research Questions 4

CHAPTER TWO: LITERATURE REVIEW 5

2.1 History of Parasites 5

2.1.1 Discovery of the helminth worms . . . .

2.1.2 Discovery of the parasitic protozoa 6

2.2 Classification of Human Parasites 6

2.3 Parasites of Medical Importance 6

2.3.1 Fasciola species 7

2.3.2 Clonorchis sinensis 9

2.3.3. Paragonimus westermanni 11

2.3.4. Ascaris lumbricoides 13

2.3.5 Hookworm species 15

2.3.6 Trichuris trichura 19

2.3.7 Strongyloides stercoralis 21

2.3.8 Taenia species. 24

2.3.9 Hymenolepis nana 26

2.3.10 Hymenolepis diminuta 27

2.3.11 Diphyllobothrium latum 29

2.3.12 Entamoeba Histolytica 30

2.3.13 Other amebae inhabiting the alimentary canal 33

2.3.14 Giardia lamblia *35*

2.3.15 Trichomonas vaginalis *41*

2.3.16 Dientamoeba fragilis *38*

2.3.17 Other flagellates inhabiting the alimentary canal 40

2.3.18 Balantidium coli *40*

2.3.19 Coccidia species 41

2.4 Economic Importance of Intestinal Parasites 43

2.5 Control of Intestinal Parasites 45

2.5.1 Control of intestinal parasite in man 47

CHAPTER THREE: MATERIALS AND METHODS 51

3.1 Study Area 51

3.2 Study Design 51

3.3 Sample Size 51

3.4 Sampling Method 52

3.4.1 Sampling procedures 52

3.4.2 Questionnaire administration 53

3.5 Laboratory Analysis 53

3.5.1 Preparation of zinc sulphate solution 54

3.5.2 Identification of parasite eggs and cysts 54

3.6 Statistical Analysis 55

3.7 Study Instruments and Materials 56

CHAPTER FOUR: RESULTS 57

4.1 Prevalence of Parasite Eggs and Cysts on Vehicle Steerings . . 57

CHAPTER FIVE: DISCUSSION 70

5.0 Discussion 70

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS . . 76

6.1 Conclusion 76

6.2 Recommendation 76

References 77

Appendix 1 90

LIST OF TABLES

Table	Title	Page
4.1	Frequency of occurrence table showing the percentage positivity of parasite eggs and cysts recovered from swabs of commercial motor vehicle steerings in Zaria.	60
4.2	Frequency of occurrence table showing the individual prevalence of parasite eggs and cysts recovered from swabs of commercial motor vehicle steerings in Zaria.	61
4.3	Risk factors associated with the spread of parasite eggs and cysts on commercial motor vehicle steerings in Zaria.	62

LIST OF PLATES

Plates	Title	Pages
I.	Photomicrograph of Strongyloides egg recovered from swabs of a commercial motor vehicle steering in Zaria.	63
II	Photomicrograph of Hookworm egg recovered from swabs of a commercial motor vehicle steering in Zaria.	64
III.	Photomicrograph of the egg of *Hymenolepis nana* recovered from swabs of a commercial motor vehicle steering in Zaria.	65
IV.	Photomicrograph of a cyst of *Entamoeba histolytica* (iodine stained) recovered from swabs of a commercial motor vehicle steering in Zaria.	66
V.	Photomicrograph of a cyst of *Giardia* sp recovered from swabs of a commercial motor vehicle steering in Zaria.	67
VI.	Photomicrograph of Coccidia oocyst recovered from swabs of a commercial motorvehicle steering in Zaria.	68
VII.	Photomicrograph of a cyst of *Balantidium coli* recovered from swabs of a commercial motor vehicle steering in Zaria.	69

LIST OF APPENDIX

Appendix	Title	Page
1.	Questionnaire on parasite eggs and cyst on vehicle steerings and risk factors	91

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

A parasite is an organism that is entirely dependent on another organism, referred to as the host, through all or part of its life cycle and metabolic requirements. Parasites can be broadly classified into two groups: endoparasites and ectoparasites. Endoparasites are sub-classified into helminth (multicellular organisms) and protozoan parasites (unicellular organisms). Helminthic parasites are either flat in shape (trematodes), segmented ribbon-like (cestodes) or cylindrical (nematodes).Protozoan parasites are Sarcodina (amoebae), Mastigophora (flagellates), Sporozoa, or Ciliates.

Zoonotic infectious agents are among the most prevalent on earth and are thought to be responsible for over 60 percent of all human infections and 75 percent of emerging human infectious diseases (Cunningham, 2005). Human infestation caused by parasitic helminths is of particular importance given the recent acknowledgement that a number of species are important human pathogens (Mas-coma *et al.,* 2005; Garcia *et al.,* 2007). Helminthoses constitute the most common parasitic infestations of man and animals throughout the world which represent an important aspect of public health problems with great economic impact in tropical and subtropical countries (Suwannee *et al.,* 2004).

Intestinal parasite infections are the most common infections in a community, with over 400 million people infected all over the world (WHO, 1987; Adeyeba and Akinlabi, 2002). The most common parasites are *Ascaris lumbricoides*, Hookworms (*Necator americanus* and *Ancylostoma deodenale*), *Entamoeba histolytica* and *Entamoeba coli*. Others include *Trichiuris trichiura*, *Strongyloides stercoralis*and *Giardia lamblia* (Agi,

1997; Nikolic *et al*., 1998; Mbanugo and Onyebuchi, 2002). These infections have been reported to be widespread in Africa including Nigeria, Ivory Coast, Angola, New Guinea, Zimbabwe and Kenya (Muniz, 2008). It is estimated that about 12.5 million Nigerian children suffer from ascariasis (Arinola and Fawole, 1995), while up to 21 million suffer from hookworm infections (Hopkins, 1992). Other helminthic diseases endemic in Nigeria in particular and West Africa as a whole include trichuriasis, taeniasis, enterobiasis and fascioliasis (Annan *et al.,* 1986*;*Gbakima *et al*., 1994).Several workers attribute the high prevalence of these infections to poverty, poor personal hygiene, poor environmental hygiene such as lack of safe water supply and contamination of the environment by both human and animal waste, poor health services, and lack of adequate and proper awareness of the transmission mechanisms and life-cycle patterns of these parasites (Okpala, 1961; Jacobs, 1967; Kudo 1971; Crompton and Nesheim 1982; Mott *et al*., 1990; Ukoli, 1992; Crompton 1993; WHO, 1997; Adeyeba and Akinlabi, 2002; Mbanugo and Abazie, 2002).

1.2 Statement of the Research Problem

Zoonotic parasitic infestation constitute one of the major causes of public health problems in the world particularly in the tropics and subtropics (Jamaiah and Rohela, 2005; Ekpenyoung, 2008; King, 2010). Health-wise, they are associated with loss of weight, poor growth rate, mental retardation, anaemia, cardiac failure and sometimes death (Soulsby, 1978; Ukoli, 1992; Islek *et al*., 1993; WHO, 1994; Arinola and Fawole, 1995; Savioli *et al*., 1999). Helminths are able to modulate and suppress the host immune response in order to promote their own survival. This ability to alter immune response could be of potential detriment to the host if it interferes with the development of protective immune responses against other infections (Hembly, 2009). Motor vehicle steering may be contaminated by

drivers who are either sick or infected or having animals that are infected since communicable disease can be spread through formites (Pope *et al*., 2002; Michael *et al*., 2003). Companion animals play a significant role in the transmission of zoonotic disease worldwide and majority of the population in this part of the country are farmers (Schantz, 1991).

1.3 Justification of the Study

Motor vehicle steerings are handled by different commercial drivers or different people. The steerings are likely to be contaminated with parasites eggs or oocyst especially if handled with unclean hands. The steerings are hardly cleaned even if the car is washed thus there may be contamination and cross contamination between the drivers and their steerings with parasite eggs and cyst, this can pose a great health hazard especially if hands used on the steering are not washed before eating. There is paucity of information on the presence of parasites on commercial motor vehicle steerings in Zaria. This study will therefore provide information on parasite contamination on commercial motor vehicle steerings in Zaria.

1.4 Aim and Objectives

1.4.1 Aim

The aim of this study is to determine the presence of parasite eggs and cysts on commercial motor vehicle steerings in Zaria Kaduna State, Nigeria.

1.4.2 Objectives

The specific objectives are to determine**:**

i. the prevalence of parasite eggs and cysts on commercial motor vehicle steerings in Zaria,

ii. the association between parasite eggs and cysts on commercial motor vehicle steerings and risk factors such as animal ownership, number of drivers, children having access to steerings, transport of animals, cleaning of the steerings and hygiene practices such as washing of hands after visiting the toilet.

1.5 Research Questions

i. Are parasites eggs and cyst present on commercial motor vehicle steering in Zaria?

ii. Are risk factors such as animal ownership, number of drivers, children having access to steerings, transport of animals, cleaning of the steerings and practices such as washing of hands after visiting the toilet associated with the presence of parasite eggs and cysts on commercial motor vehicle steerings in Zaria?

CHAPTER TWO

LITERATURE REVIEW

2.1 History of Parasites

During our relatively short history on earth, man have acquired an amazing number of parasites, about 300 species of helminth worms and over 70 species of protozoa (Ashford and Crew, 1998), some derived from our primate ancestors and some from the animals that have been domesticated or from the animals we come in contact with during our relatively short history on earth. Many of these parasites are rare and accidental parasites, but man still harbor about 90 relatively common species, of which a small proportion cause some of the most important diseases in the world (Cox, 2002).

2.1.1 Discovery of the helminth worms

Helminths have plagued man prior to earliest recorded human history. The eggs of intestinal helminths were found in the mummified faeces of humans dating back thousands of years (Cox, 2002; Hotez *et al*., 2006; Hotez *et al*., 2008), and many of the characteristic clinical features of helminth infections are available in the ancient writings of Hippocrates, Egyptian medical papyri, and the Bible (Cox, 2002; Hotez *et al*.,2006; Hotez *et al*., 2008). Diseases caused by these helminths markedly altered the course of modern twentieth century world history (Kernan, 1959; Farley, 1991; Cox, 2002; Hotez *et al*., 2008), especially in China during the Cold War, when the schistosome was known as "the blood-fluke that saved Formosa" (Farley, 1991) 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 (Kernan, 1959; Farley, 1991; Cox, 2002).

2.1.2 Discovery of the parasitic protozoa

Protozoans are relatively small in size and because of their small size, it was not possible to recognize any protozoa until the invention of the microscope and its use by Antonie van Leeuwenhoek toward the end of the 17th century. The study of parasitic protozoa only really began two centuries later, following the discovery of bacteria and the promulgation of the germ theory by Pasteur and his colleagues at the end of the 19th century (Cox, 2002).

2.2 Classification of Human Parasites

The classification of parasites is controversial as there is no universally accepted system. Parasites form part of the animal kingdom which comprises about 800,000 identified species categorized into 33 phyla. The most acceptable taxonomic classification of human parasites includes endoparasites and ectoparasites. Endoparasites are sub-classified into helminthic parasites (multicellular organisms) and protozoan parasites (unicellular organisms). Helminthic parasites are either flat worms (trematodes), segmented ribbon like worms (cestodes) or cylindrical worms (nematodes) (Moro and Schantz, 2009). There are four classes of protozoans which include sarcodina (amoebae), mastigophora (flagellates), sporozoa, and ciliates (Baron, 1996; Moro and Schantz, 2009).

2.3 Parasites of Medical Importance

The medically important intestinal helminths are nematodes (roundworms), cestodes (tapeworms) and trematodes (flukes); and important genera include: *Fasciola*, Fasciolopsis,

C*hlonorchis sinensis*, and *Paragonimus westermani*,*Ascaris*, Hookworm, *Trichuris*, *Taenia* and *Enterobius*. Medically important intestinal protozoans include *Entamoeba*, *Giardia*, *Trichomonas*, *Cryptosporidium*, *Isospora*, *Pneumocystis* and *Balantidium* (Acari *et al*., 2000)**.**

2.3.1 Fasciola species

2.3.1.1 Morphology

(a) Eggs: Eggs are all thin shelled, ellipsoid, quinone coloured (bile stained) with an operculum that is often inconspicuous. *Fasciola hepatica* eggs measure 130 - 150μm by 63 - 90μm. Although eggs of *Echinostoma* species can usually be differentiated by size due to these flukes being much smaller in size than *F. buski* and *F. hepatica* (CDC, 2013).

(b) Adult: the morphology of the adult flukes of *Fasciola, Fasciolopsis* and *Echinostoma*species are large leaf-shaped parasites about 2 –3 cm long. There are two suckers, an anterior oral sucker surrounding the mouth and a ventral sucker (acetabulum) on the ventral surface. The outer tegument is covered in tiny spines which face backwards (CDC, 2013).

2.3.1.2 Epidemiology

Fasciola hepatica infections have been reported in many countries including Europe and the USA. It is said to be more prominent in temperate zones while *Fasciola gigantica* is predominantly a tropical parasite and predominates in Africa where it is endemic (FAO, 2009; Chanie and Begashaw, 2012). It has also been recognized as an emerging human disease with approximately 2.4 million people infected and about 180 million people are at risk of infection (Chhabra and Singla, 2009). In Nigeria Ekong *et al*., 2012 reported a

prevalence of 12.7 in Jos and Onyeabor and wosu (2014) reported a prevalence of 22.53 in Abia.The eating of unwashed watercress is the source of infection (Mascoma *et al*., 1999a, 2005)

Fasciolopsis buski (giant intestinal fluke) are reported to be widespread in Asia and China, but they have been found to be endemic in Taiwan, Thailand, Bangladesh and India (Weng, 1989; Ditritch *et al*., 1992; Bhatti *et al* 2000*;* Graczy *et al*., 2001). Night soil is used as a fertiliser in these countries on plants such as water chestnut and caltrops (Mascoma *et al*., 1999a, 2005). The snails graze on these crops and thus transmission occurs when the definitive hosts eat them raw and unwashed, peeling the edible water plants with their teeth.

Infection with *Echinostoma* species are reported to be widespread in South East Asia and japan. It is thought to be contracted by injestion of fresh water snails (*Echinostoma ilocannum*) containing metacercaria (*Piola luzionica*) (Acari *et al*., 2000).

2.3.1.3 *Pathogenesis*

Light infections due to *Fasciola hepatica* may be asymptomatic. However, they may produce hepatic colic with coughing and vomiting; generalised abdominal rigidity, headache and sweating, irregular fever, diarrhoea and anaemia (Mascoma *et al*., 1999*b;* Acari *et al*., 2000).

Infections due to *Fasciolagigantica* occur mainly in cattle-raising areas and cause clinical symptoms similar to those of *Fasciolahepatica* although human infections are less common (Acari *et al*., 2000).

The adult flukes of *Fasciolopsisbuski* attach to the intestine, resulting in local inflammation and ulceration. Heavier infections may subsequently lead to abdominal pain, malabsorption and persistent diarrhoea, oedema and even intestinal obstruction. Marked eosinophilia may be seen (Acari *et al*., 2000; Arora and Arora, 2010).

The adult flukes of *Echinostoma* species attach to the intestine resulting in little damage to the intestinal mucosa. Light infections are generally asymptomatic and heavy infections may produce light ulceration, diarrhoea and abdominal pain (Acari *et al*., 2000).

2.3.1.4 Diagnosis

Laboratory diagnosis of fascioliasis can be made by detection of eggs in stool or in bile obtained by duodenal intubation (The eggs of *F. hepatica* and *F. buski*are indistinguishable), or by moderate to high eosinophilia or by immunodiagnostic test based on antibody detection (CDC,2013).

2.3.1.5 Treatment

Fasciola hepatica is not sensitive to praziquentel and therefore treatment remains a problem. Drugs commonly used for this infection are Buthianol, Triclabendazole and Dehydroemetine (Arora and Arora, 2010; CDC, 2013).

2.3.2 Clonorchis sinensis

2.3.2.1 Morphology

(a) Eggs: The eggs of *Clonorchis sinensis* contain fully developed miracidia and possess prominent opercular shoulders (flask shaped egg) and are operculate. They are bile-stained and measure 29μm by 16μm. In wet mounts they are transparent and their anatomy can be easily seen (Arora and Arora, 2010).

(b) Adult: The adult flukes measure 11 – 20μm by 3 – 4.5μm and are lanceolate in shape, translucent and brownish in colour. They are all hermaphroditic and possess two suckers (Acari *et al*., 2000).

2.3.2.2. Epidemiology

Clonorchis sinensis, also known as the Chinese liver fluke is a found in the Far East, mainly Japan, Korea, China, Taiwan and Vietnam (WHO, 1995) Infection with this parasites occur by eating raw or undercooked fish carrying the trematodes metacecariae and, therefore, communities living near bodies of water suitable for the transmission have a greater risk of infection than those living farther from water (Keiser and Utzinger, 2005, Sripa *et al*., 2010).

2.3.2.3 Pathogenesis

Many millions of people become infected every year but only a minority suffers from any illness. The pathology is related to the number of parasites present (Acari *et al*., 2000). Light infections of up to 50 eggs or more are usually asymptomatic. A heavy infection of 500 or more eggs may cause serious illness. Acute infections may be characterised by fever, diarrhoea, epigastric pain, enlargement and tenderness of liver and sometimes jaundice. The invasion by these worms in the gall bladder may cause cholecystitis, due to flukes becoming impacted in the common bile duct (Acari *et al*., 2000).

2.3.2.4 Diagnosis

Diagnosis is done either by demonstration of eggs by microscopical examination of faeces or aspirated bile by duodenal aspiration or by differential leucocyte count with eosinophilia (10-40%) or by demonstration of antibodies against *Clonorchis sinensis* by ELISA, complement fixation test and indirect haemagglutination test (Arora and Arora, 2010).

2.3.2.5 Treatment

A single dose of praziquentel 40 mg/kg body weight or 25 mg/kg orally for 3 doses spaced 8hrs apart is the recommended treatment (Arora and Arora, 2010).

2.3.3 Paragonimus westermanni

2.3.3.1 Morphology

(a) Eggs:The eggs are ovoid, brownish yellow, thick shelled and operculated. They measure 80 – 100μm by 45 - 65μm(Marty and Neafie, 2000).

(b) Adult: The adult worm is an ovoid, reddish brown fluke about 12 mm long. and may be confused with the ova of *Diphyllobothrium latum*(Marty and Neafie, 2000).

2.3.3.2 Epidemiology

Paragonimiasis occurs in several parts of the Far East, West Africa, and the Americas. It is estimated that 20 million people are infected worldwide and more than 290 million are at risk (Keiser *et al*., 2005; Zarrin-Khameh *et al*., 2008).Transmission occurs by eating raw or undercooked seafood or by ingesting raw meat from carnivorous animal hosts

that contain young flukes (such as wild boars). Transmission has also been reported via contaminated utensils, such as knives or chopping boards (Acari *et al*., 2000; Harrinasuta *et al*., 1993; Choo *et al*., 2003).

2.3.3.3Pathogenesis

Paragonimiasis may be categorized as acute paragonimiasis (i.e., the manifestations that follow relatively soon after infection), chronic pleuropulmonary paragonimiasis (i.e., the manifestations of established pulmonary disease), and ectopic paragonimiasis (i.e., the manifestations that result from the presence of the parasite in a location other than the lungs).

Acute Paragonimiasis (Early-Stage Disease). The acute or early stage of paragonimiasis consists of the manifestations of disease that follow the ingestion of the infective metacerariae and their migration to the pleural space.Patients are often asymptomatic early in the infection process or may have subclinical disease (Kagawa, 1997). The very early portion of this stage of infection occurs between 2 and 15 days following the ingestion event. Abdominal pain, fever, and diarrhea are possible early manifestations of infection and are more common in patients with heavy worm burdens (Zhong *et al*., 1981).

Chronic pleuropulmonary paragonimiasis (Late-Stage Disease). The chronic or the later stage of pleuropulmonary paragonimiasis occurs when the worms migrate to the pulmonary parenchyma. Adult worms are paired in a cyst, and fertilized eggs are produced. An exception to this occurs when the infection is caused by a triploid variant of *P.*

westermani, wherein a single worm occupies a cyst and pathenogenically produces viable eggs (Blair *et al*., 2008).

2.3.3.4. Diagnosis

Diagnosis is made by the demonstration of eggs in faeces or aspirated pleural effusion or sputum. Other diasnostic methods include serological test, skin test biopsy or x-ray of chest (Arora and Arora, 2010).

2.3.3.5. Treatment

The therapeutic agent of choice for pulmonary paragonimiasis is praziquantel (75 mg/kg/day given in three doses for 2 days for both children and adults) (Turner, 1998). Studies have demonstrated a 71 to 75% cure rate after 1 day, an 86 to 100% cure rate after 2 days, and a complete (100%) cure rate after 3 days with this dosage (Nawa, 2000).

2.3.4 Ascaris lumbricoides

2.3.4.1 Morphology

(a) Eggs: The eggs can be unfertilised, fertilised or decorticated and can show considerable variation in shape and size. They measure 85 - 95μm by 43 - 47μm (Acari *et al*., 2000).The fertilised eggs are oval in shape with a thick wall showing an irregular bumpy surface. They measure 45 - 75μm by 35 - 50μm. The outer covering has an albuminoid coat, stained golden brown by bile. The outer wall lies directly on top of a thick smooth shell, which is not easily distinguishable. Some have lost their albuminoid wall (Acari *et al*., 2000). The unfertilised eggs are longer and narrower than the fertile eggs, measuring 75 - 85μm by 35 - 50μm. The shell layers of the egg provide a very resistant

structure which can withstand many chemicals which make them ideal parasites of the intestine (Acari *et al*., 2000).

(b) Adult; the male measures 15cm with a diameter of 3 - 4mm and has a curled tail with protruding spicules. The female is 20 -35cm long with a diameter of 5mm with a straight pointed posterior end. The mouth has one dorsal and 2 ventral lips. Both are creamy white and the cuticle has fine circular striations (Acari *et al*., 2000).

2.3.4.2. Epidemiology

Ascariasis has a worldwide distribution and can result in severe infection causing approximately 60,000 deaths per year, mainly in children (O'Lacain and Holland, 2001). Up to 10% of the population of the developing world is infected with intestinal worms- a large percentage of which is caused by *Ascaris.* In Nigeria, different prevalences were reported in various states, these include; 60% in Osun (Ugbomoiko *et al*., 2009), 17.80% in Abia (Nduka *et al*., 2006), 5% in Borno (Biu *et al*., 2013), 38.2% in Edo (Obimiawe *et al*., 1991), 49.4% in Oyo (Arinola *et al*., 1995). 20.8% in Anambra (Enekwechi and Azubike, 1994) and Inabo and John (2012) reported a prevalence of 45.6 % in Kaduna state

2.3.4.3Pathogenesis

Small burdens of worms in the intestine may cause no symptoms. The patient may have symptoms of pneumonitis with cough and low grade fever during the migration of the larvae through the liver and lungs. This can be accompanied by wheezing, coughing and eosinophilia (Acari *et al*., 2000). In heavy worm burdens the adult worms actively migrate in the intestine resulting in intestinal blockage, vomiting and abdominal pain but infections may also be asymptomatic (Acari *et al*., 2000). The worms can penetrate through the wall

of the intestine, or into the appendix, travel up the common bile duct, which may become blocked or they may then enter the gal bladder or liver. A heavy worm burden in children may lead to severe nutritional impairment and growth retardation(Acari *et al*., 2000).

2.3.4.4 Diagnosis

Diagnosis is made by examination of stool for eggs by direct saline smear method or by demonstration of adult worms (Assafa *et al*., 2004).

2.3.4.5. Treatment

The drugs of choice include Mebendazole, Albendazole and Piperazine (Assafa *et al*., 2004).

2.3.5 Hookworm species

Hookworms infective to man comprise of 2 species, *Necator americanus* and *Ancylostoma duodenale* (CDC, 2013).

2.3.5.1 Morphology

(a) Eggs: The eggs are oval and transparent with a smooth thin shell and measure 56 - 75μm by 36 - 40μm. They are usually passed in the 4 - 8 cell stage in faeces and may be embryonated. The eggs of both species of hookworm are similar. (Acari *et al*., 2000)

(b) Adult: Both species have similar general morphology and measure approximately, females 10 – 13mm and males 8 – 11mm (Arora and Arora, 2010; CDC, 2013). The male species has a posterior copulate bursa which is absent from the female. The females though

possesses a vulva which is found at almost one third of the body length from the posterior end, and two ovaries. Most of the female body is occupied with eggs (CDC, 2013).

The mouth (or buccal cavity) of the two species show a conspicuous pair of chitinous plates on the dorsal surface. *Ancylostoma duodenale* buccal cavity bears 2 hook-like teeth on the top and 2 triangular cutting plates on the bottom while the mouth of *N. americanus* has 4 cutting plates, 2 on the ventral and 2 on the dorsal surfaces (Arora and Arora, 2010). The head is curved in both species but in *Necator* adults it is finer but more pronounced forming a definite "hook" at the anterior end. The buccal cavity is used to attach the worms securely to the mucosa of the small intestine with the teeth and cutting plates used to pierce the mucosa (Acari *et al*., 2000).

2.3.5.2 Epidemiology

Necator americanus is a new world hookworm, which was introduced from Africa to the western hemisphere. It can also be found in the Far East, Asia, Africa, South America and Oceania (CDC, 2013; Bahgat *etal*., 1999; Prociv and Croes, 1990, 1996).

Ancylostoma duodenale is an old world hookworm and the only species found in Europe and areas bordering the Mediterranean. It can also be found in the Middle East, North China, Africa, Asia and South America.

Larvae live for an average of 3 – 6 weeks in the tropics (*A. duodenale* can live at lower temperatures than *N. americanus* can, and so is found in more temperate climates) (Acari *et al*., 2000).Hookworms are estimated to infect 576–740 million persons globally (Crompton, 2000). In Nigeria however, different prevalences were reported in various states, these include; 60% in Oyo State (Asaolu *et al.,* 1992), 4.4% in Kwara State

(Awogun, 1984), 4.4% in Bauchi (Akogun, 1989). 14.80 in Abia (Nduka, *et al*., 2006), 50% in Borno (2013). Luka (1997) reported a prevalence of 25.9 in Kaduna State. Hook worms are usually transmitted through the coutaneous route. In an endemic area, contaminated soil may continually or seasonally bear large numbers of infective larvae which are found at the surface of damp soil (Nwosu, 1981; WHO, 1987). These infective larvae penetrate the skin of individuals, especially those who are in the habit of walking barefooted in villages and farms, and those who relax and pray under damp tree shades which form a conducive habitat for the development and penetration of hook worm larvae (Arinonal and Fawole, 1995).The eggs of these worms have been reported to be spread through formites (Awodi *et al*., 2001; Ekejindu *et al*., 2005; Matur *et al*., 2010).

2.3.5.3. Pathogenesis

Larval penetration of the skin may lead to pruritis, often termed 'ground itch' at the site of penetration (CDC, 2013). Respiratory symptoms may arise during the larval migration (CDC, 2013). The adult worm in the intestine may cause intestinal necrosis and blood loss as a result of the attachment of the adult to the intestinal mucosa (Acari *et al*., 2000) Patients with acute infections may experience nausea, vomiting, abdominal pain, diarrhoea and eosinophilia (CDC, 2013). Chronic infections may lead to iron deficiency and anaemia resulting in the excessive loss of iron. Heavy worm burden in children may have serious consequences including death (Acari *et al*., 2000; CDC, 2013).

2.3.5.3.1 Cutaneous larva migrans

When man comes in contact with hookworm larva of the dog (or cat), *A. braziliense* or *A. caninum*, penetration of the skin may take place (Malgor *et al*., 1996*;* CDC, 2013).

The larvae are unable to complete the migration to the small intestine and become trapped (Malgor *et al*., 1996). Trapped larvae may survive for weeks or even months, migrating through the subcutaneous tissues (Malgor *et al.,* 1996).

Trapped larvae have been known to produce severe reaction, forming tunnels through the tissues, causing intense itchy skin eruption, producing a red track under the skin which demonstrates accurately the wanderings of the larvae. Often intense pruritis and scratching may lead to secondary bacterial invasion, known as ‘creeping eruption’ or ‘cutaneous larval migrans’ (Malgor *et al*., 1996; Acari et al., 2000; CDC, 2013).

2.3.5.4. Diagnosis

Clinical history, hygiene status, and recent travel to endemic areas can give important clues for infection with hookworms. Definitive diagnosis rests on microscopic examination of eggs in the stool (CDC, 2013).

2.3.5.5. Treatment

Although Cutanous larva migrans is self limiting, antiparasitic and symptomatic treatments are often sought because of associated discomfort and potentials for bacterial infections with this disease. Albendazole or ivermectin are the drug of choice (Houchedez and Caumes, 2007). Elevated dosage of ivermectin might also kill larvae in muscle tissues. If anaemia is present it should also be treated along with the specific anti helminthic drugs (Arora and Arora, 2010).

2.3.6 Trichuris trichura

2.3.6.1 Morphology

(a) Eggs: the eggs are characteristically barrel-shaped, bile-stained with bipolar plugs. They measure 50 - 54μm by 20 - 23μm (Arora and Arora, 2010).

(b) Adult: the adult worms of *Trichuris trichura* are characterised by the enormously elongated capillary-like oesophagus (anterior end) with the anus situated in the extreme tip. The thin anterior portion of the worm is found embedded in the mucosa. There are no lips and the vulva is at the junction of the thread-like and thickened regions of the body. The posterior end is much thicker and lies free in the lumen of the large intestine. The female measures 35 - 50mm long and the male 30 - 45 mm long. (Acari *et al*., 2000).

2.3.6.2. Epidemiology

Trichuris trichura, have a cosmopolitan distribution though, it is more commonly seen in tropical climates and in areas where sanitation is poor (CDC, 2013). In 2002, the estimated number of persons infected gobally with whipworm was one billion (CDC, 2013) Different prevalences were reported in various states, in Nigeria. These include; 2.3% in Abia (Nduka *et al*., 2006), 2.2% in Enugu (Ozumba and Ozumba, 2002), 43.7% in Rivers (Udonsi *et al*., 1996), 27.3% in Edo (Obimiawe *et al*., 1991), Inabo *et al*., (2010) reported a prevalence of 22.8% in Kaduna Transmission occurs when the infective eggs are ingested, usually through consuming soil that has been contaminated with human feces via dirt covered food or hands (CDC, 2010, 2011).

2.3.6.3 Pathogenesis

Most infections due to this nematode are light to moderate with minimal or no symptoms. However, a heavy worm burden may result in mechanical damage to the intestinal mucosa due to the adult worm being threaded into the epithelium of the caecum (Acari *et al*., 2000). Abdominal cramps, tenesmus, dysentery and prolapsed rectum may occur in these cases. If a prolapsed rectum is observed, many worms may be seen adhering to the mucosa of the rectum. Symptomatic infections are usually only seen in children (Acari *et al*., 2000). The majority of infections are chronic and mild, with non-specific symptoms like diarrhoea, anaemia, growth retardation, and eosinophilia. (Acari *et al*., 2000).

2.3.6.4. Diagnosis

Diagnosis of a *Trichuris trichura* infection is made by collecting a stool sample using a stool eggs and parasites exam and searching under a microscope for the presence of the characteristic football-shaped eggs (CDC, 2010; 2013). Light infections usually have low egg concentrations due to the eggs being shed intermittently, so fecal testing must be repeated. Because of this problem, the CDC recommends using a concentration technique in order to collect the eggs. In heavy infections, stool is often mucoid and contains Charcot-Leyden crystals. Also, in heavy infections, the worms can be detected using sigmoidoscopy, proctoscopy and colonoscopy (CDC, 2010).

2.3.6.5. Treatment

Trichuriasis is treated with antihelmintics such as oxantel, albendazole but more specifically, mebendazole, which is taken orally for three days (CDC, 2013).

2.3.7 Strongyloides stercoralis

2.3.7.1 Morphology

(a) Eggs; Eggs are rarely found in the stool as they hatch in the intestine. They are oval and thin shelled, resembling those of hookworm but are smaller measuring 50 - 58μm by 30 - 34μm (Arora and Arora, 2010).

(b) Larvae; The first stage rhabditiform larvae measure approximately 250μm long by 20μm wide (Arora and Arora, 2010). They have a bulbed oesophagus and a short buccal cavity (Acari *et al*., 2000). The third stage or filariform larva is approximately 500μm long and has a notched tail (Arora and Arora, 2010).

(c) Adults; Adults are slender and possess an extremely long oesophagus which in the female extends 1/3 to 1/2 of the body. The anal opening is ventral and the tail is pointed (Arora and Arora, 2010).

2.3.7.2. Epidemiology

Strongyloidiasis is currently recognized as a worldwide health problem. The disease is estimated to affect about 95 million people (Genta, 1989; Jorgensen *et al*., 1996). *Strongyloides stercoralis* are worms that are commonly found in warm areas, although it is known to survive in the sub-tropics (hot and humid conditions) (Acari *et al*., 2000).They are found mainly in Asia, Europe, Middle East and tropical Africa (Berks, 1987; Genta, 1989; Liu, 1993). Different prevalences were reported in Nigeria, these include; 37.14% in Kano (Adamu and Bassey, 2010), Luka (1997) reported prevalence of 1.1% in Kaduna State. Transmission occurs either by oral ingestion or by penetrating the skin through direct

contact with contaminated soil during agricultural, domestic and recreational activities (CDC, 2012).

2.3.7.3. Pathogenesis

Disease associated with infections due to *S. stercoralis* is varied, ranging from some patients being totally asymptomatic to the hyperinfection syndrome. There are 3 areas of involvement in *Strongyloides* infections; skin, lungs and intestine (Acari *et al*., 2000)

When the filariform larvae penetrates the skin they usually cause very little reactions, however with repeated infections the patient may produce a hypersensitive reaction that prevents the larvae from completing its life cycle. (Acari *et al*., 2000; CDC, 2012).The larvae may migrate to the lungs and thus stimulates an immune response which can result in a cough, wheezing and fever (CDC, 2012). Symptoms associated with intestinal strongyloidiasis may mimic a peptic ulcer due to ulceration of the intestinal mucosa. In heavy infections the intestinal mucosa may be severely damaged resulting in malabsorption. There may also be lower gastrointestinal bleeding. Eosinophilia may be high (CDC, 2012).

2.3.7.3.1. Hyperinfection syndrome

The autoinfective capability of larvae may be responsible for long term infections which persist for many years (Acari *et al*., 2000). The parasite and host reach an equilibrium state where neither host nor parasite suffers any adverse reactions (CDC, 2012). If this equilibrium is disturbed e.g. immunosuppression, the infection proliferates with immense numbers of larvae migrating to every tissue in the body, especially the lungs.

This condition is referred to as disseminated strongyloidiasis. This results in tissue damage, pneumonitis, brain damage or respiratory (CDC, 2012).

2.3.7.4. Diagnosis

There is no standard diagnosis of strongyloidiasis. The most frequent procedure however entails direct examination of stool specimens with enrichment and/or stool culture, but this often does not yield positive results even when the disease is present. Alternative tests (serology and polymerase chain reaction) are more efficient (CDC, 2012).

2.3.7.5. Treatment

Strongyloidiasis is a difficult infection to treat because, for many helminth infections, a treatment is considered sufficient if worm burden is below the level at which clinical disease develops (Liu and Weller, 1993; Grove, 1996). In *S. stercoralis*, however, only complete eradication of parasites removes the danger of potentially serious disease, that is, any truly effective anthelmintic must kill every autoinfective L_3 larvae, which are relatively resistant to chemical agents (Liu and Weller, 1993; Grove, 1996). Thiabendazol has been the drug of choice for the treatment of strongyloidiasis (Grove 1996; Zaha *et al*., 2000). However, recent studies have shown that ivermectin is the best drug for the treatment of uncomplicated *S. stercoralis* infection (Salazar *et al*., 1994). It is well tolerated and has a higher cure rate than thiabendazole. Other drugs, such as mebendazole and albendazole, have had variable therapeutic efficacy (Liu and Weller, 1993). Ivermectin has been found to be the most effective drug in treating disseminated strongyloidiasis (Daubenton *et al*., 1998) in patients with chronic intestinal disease, including children (Adenusi, 1997) and adults (Marti *et al*., 1996). Recently, ivermectin has also been

registered as the drug of choice in the World Health Organization's list of essential drugs for the treatment of *S. stercoralis* (Albonico *et al*., 1991).

2.3.8. Taenia species

2.3.8.1Morphology

(a) Eggs: Eggs of *Taenia* species are spherical, yellowish brown and measure 31 - 34μm in diameter. The shell is thick and radially striated. Within the shell, the onchosphere has 3 pairs of hooklets. However, the microscopical appearance of the eggs of *T. saginata* and *T. solium* are identical (Arora and Arora, 2010).

(c) Adults: The length of the adult *T. saginata* is 4 - 8 meters long and that of *T. solium* is 3 - 5metres long. The proglottids of *Taenia* species can be identified by the number of uterine branches; 7 - 13 for *T. solium* and 15 - 20 for *T. saginata*. If the scolex is recovered, the 4 suckers and rostellum of hooklets of *T. solium* will distinguish it from *T. saginata,* which has 4 suckers but no hooklets (Acari *et al*., 2000; Arora and Arora, 2010).

2.3.8.2. Epidemiology

T. saginata has a comsmopolitan distribution, but is more common in developing countries where hygiene is poor and the inhabitants have a tendency of eating raw or insufficiently cooked meat (Nithiuthai *et al*., 2004; Garcia *et al*., 2007). *T saginata* is the most common adult tapeworm found in man (Acari*et al*., 2000).*T solium* is mainly distributed in Africa, central and south America and Asia (Nithiuthai *et al*., 2004; Acari *et al*., 2000). In Nigeria however, different prevalences were reported in various states. These include 1.5% in Jos (Pius *et al*., 2012), 1.75% in Kaduna (Inabo and John, 2010), 5.6% in Borno (Biu *et al*., 2012)

2.3.8.3 Pathogenesis

The presence of the adult worm rarely causes symptoms apart from slight abdominal irritation with diarrhoea, constipation or indigestion (Acari *et al*., 2000; Robinson and john, 2009). The accidental ingestion of the embryonated ova of *T. solium* may result in cysticercosis in man (Acari *et al*., 2000). When the embryonated eggs are ingested, the embryos hatch out, migrate through the intestinal wall and are carried around the body in the circulation and deposited in various tissues (Acari *et al*., 2000). Muscle and subcutaneous tissues are usually infected, but cysticerci can infect most organs and tissues. Human cysticercosis is usually asymptomatic unless the infection is particularly heavy or cysticerci are formed in some vital area e.g. the brain, resulting in neurological sequelae (Acari *et al*., 2000).

2.3.8.4. Diagnosis

Diagnosis of intestinal taeniasis can be made by recovery of the characteristic ova in the stool. However, the ova of T. *solium* and T. *saginata* are identical and diagnosis is made by the recovery of the segments or scolex (Arora and Arora, 2010). The diagnosis of cysticercosis can be carried out using several methods which may include: biopsy of subcutaneous nodules, CT scan of the brain, X- ray of skull and soft tissues, differential leucocyte count and serological test such as indirect haemagglutination test (IHA), indirect flourescent antibody (IFA) and enzyme-linked immunosorbent assay (ELISA) can be used to demonstrate the specific antibodies in the serum (Arora and Arora, 2010).

2.3.8.5. Treatment

Four tablets Niclosamide chewed in a single dose or Mebendazole 100mg twice daily for three days can be used in the treatment of human tapeworm infection (Assafa *et al*., 2004) .

2.3.9 Hymenolepis nana

2.3.9.1 Morphology

(a) Eggs: The egg containing the oncosphere bears three pairs of hooklets and is surrounded by a membrane. This membrane has 2 polar thickenings or knobs from which arise 4-8 long, threadlike filaments extending into the space between the membrane and the colourless hyaline shell, unlike those of *H. diminuta* which do not possess any filaments (Acari et al., 2000 and Assafa et al., 2004)

(b) Adults; the adult tapeworm is normally 2.5 - 4cm long. The scolex is knob like in shape, has a rostellum with hooklets and 4 suckers. The segments are wider than they are long (Acari *et al*., 2000).

2.3.9.2 Epidemiology

Hymenolepis nana has a cosmopolitan distribution and is thought to be the most common tapeworm throughout the world.Infection occurs when the definitive host eat under-cooked, raw or lightly salted meat or by eating infected freshwater fishes (Raether and Hanel, 2003).

2.3.9.3 *Pathogenesis*

Infections due to *H. nana* may cause no symptoms even with heavy worm burdens. However, symptoms of restlessness, irritability, anorexia, abdominal pain and diarrhoea

have been reported. Heavy worm burdens may be caused by auto-infection which can be a problem in the immunocompromised (Acari *etal*., 2000).

2.3.9.4. Diagnosis

Demonstration of eggs in stool specimens using Concentration techniques and repeated examinations will increase the likelihood of detecting light infections. Other methods include gross observation of the parasite and Morphologic comparison with other intestinal parasites (Tanowitz *et al*., 1993; Raether and Hanel, 2003)

2.3.9.5. Treatment

The two drugs that have been described for the treatment of hymenolepisis are praziquantel and niclosamide. Praziquentel which is parasiticidal in a single dose for all the stages of the parasite is the drug of choice because it acts rapidly against *H. nana* (Tanowitz *et al*., 1993; Ortiz *et al*., 2002). Although structurally unrelated to other antihelminthics, it kills both adult worms and larvae. In vitro the drug produces vacuolization and disruption of the tegument in the neck of the worms,but not in more posterior portion of the strobila. Praziquantel is well absorbed while taken orally. Eighty percent of the drug is excreted as metabolites in urine within 24 hours (Tanowitz *et al*., 1993; Ortiz *et al*., 2002)

2.3.10 Hymenolepis diminuta

2.3.10.1 Morphology

(a) Eggs: The eggs are large, ovoid and yellowish with a moderately thick shell. They contain an onchosphere with 6 hooklets and a clear area between the oncosphere and the shell. They measure 70 - 85μm by 60 - 80μm (Acari *et al*., 2000).

(b) Adult: The adult worm is 20 – 60cm long. It has a knob like scolex with a rostellum but no hooklets and 4 suckers (in contrast to *H. nana*). The rostellum can be withdrawn into a rostellar sac. The tapeworm contains about 1000 proglottids, each of which is wider than long (Acari *et al*., 2000).

2.3.10.2. Epidemiology

Hymenolepis diminuta has a worldwide distribution and are infrequently found in humans, with only sporadic cases being reported (Tanowitz *et al*., 1993;)

2.3.10.3. Pathogenesis

The symptoms associated with *H. diminuta* infections are few if any (Acari *et al*., 2000).

2.3.10.4. Diagnosis

Demonstration of eggs in stool specimens using Concentration techniques and repeated examinations will increase the likelihood of detecting light infections.Other methods include gross observation of the parasite and Morphologic comparison with other intestinal parasites (Tanowitz *et al*., 1993).

2.3.10.5. Treatment

The 2 drugs that have been described for the treatment of hymenolepiasis are praziquantel and niclosemide (Tanowitz *et al*.,).

2.3.11 Diphyllobothrium latum

2.3.1I.1. Morphology

(a) Eggs:The egg is usually ovoid and has a small knob at the opercular end and is yellowish-brown in colour with a smooth shell, of moderate thickness. They measure 58 - 75μm by 40 - 50μm in size (Acari *et al*., 2000).

(b) Adult: Adult worms can reach up to a length of 10 metres or more and may contain up to 3,000 proglottids.The scolex is spatulate with no rostellum or hooklets. It has 2 shallow grooves or bothria, which are unlike the typical 4 suckers seen on the *Taenia* species. The proglottids measure 3mm long and 11mm wide and have a rosette shaped central uterus (Acari *et al*., 2000).

2.3.11.2. Epidemiology

The tapeworm, *D. latum* has a wide distribution, occurring especially in countries bordering the Baltic Sea (Finland, Sweden etc.): and also in Russia, Switzerland and North America. It is in these countries where the populations are known to eat uncooked or partly cooked (i.e. smoked) fish (Acari *et al*., 2000).

2.3.11.3 Pathogenesis

The infection caused by *D. latum* is due to the ingestion of raw, poorly cooked or pickled fresh water fish and the eggs of this parasite have been discovered in formite (Awodi *et al*., 2001) The symptoms associated with *D. latum* infection may be absent or minimal with eosinophilia. There may be occasional intestinal obstruction, diarrhoea, abdominal pain (Acari *et al*., 2000). The most serious symptom is the onset of pernicious

anaemia. This is due to a vitamin B_{12} deficiency, caused by excessive absorption of the vitamin by the adult worm and the absorption of cobalamins from the host intestine (occurring only in a small percentage of people) (Acari *et al*., 2000).

2.3.11.4 Diagnosis

Laboratory diagnosis of *D. latum* in humans can be made by identification of the characteristic operculated eggs or proglottids in the faeces (CDC, 2012). Occationally, portions of the worm upto several meters long may be vomited (CDC, 2012).

2.3.11.4 Treatment

Niclosamide and praziquantel are the drugs of choice for the treatment of diphyllobothriasis (CDC, 2012).

2.3.12 Entamoeba histolytica

2.3.12.1. Morphology

(b) Cyst: Cysts range in size from 10-20μm. The immature cyst has inclusions namely; glycogen mass and chromatoidal bars. As the cyst matures, the glycogen completely disappears and the chromotoidal bars may also be absent in the mature cyst (Assafa *et al*., 2004).

(a) Trophozoites: Viable trophozoites vary in size from about 10-60μm in diameter. Motility is rapid, progressive, and unidirectional, through pseudopods. The nucleus is characterized by evenly arranged chromatin on the nuclear membrane and the presence of a small, compact, centrally located karyosome. The cytoplasm is usually described as finely granular with few ingested bacteria or debris in vacuoles. In the case of dysentery, however,

RBCs may be visible in the cytoplasm, and this feature is diagnostic for *E.histolytica* (Assafa *et al*., 2004).

2.3.12.2. Epidemiology

Amoebiasis caused by the intestinal parasite *Entamoeba histolytica*, has an estimated worldwide prevalence of 500 million infected people and is responsible for 40,000 - 100,000 deaths each year. It is an important health problem, especially in developing countries (WHO, 1997; Sabastiaan *et al*., 2007). In Nigeria however, different prevalences were reported in various States. These include 3.2% (Elekwe and Ike, 1996) in Jos, 33.9% (Onyemelukwe and Ibe, 1994), in Enugu, 3.80% (Kogi *et al*., 1991) and 0.13% (Awodi *et al*., 2001) in Zaria, Kaduna state, 4.7% (Ekejindu *et al*., 2005) in Anambra, 3.70 (Nduka *et al*., 2006) in Abia and Matur (2010), got a prevalence of 12.5% in FCT, Abuja. The rate of infection by *E. histolytica* differs among countries, socio-economic and sanitary conditions and populations (Al-Harthi and Jamjom, 2007). It is highly endemic throughout poor and socio-economically deprived communities in the tropics and subtropics. Environmental, socio-economic, demographic and hygiene-related behaviour is known to influence the transmission and distribution of intestinal parasitic infections (Norhayati *et al*., 2003).

Patients infected with *E. hisolytica* pass non-infectious trophozotes and infectious cysts in their stools. Therefore, the main source of water and food contamination is the symptomatic carrier who passes cysts. Symptomatic amebiasis is usually sporadic. The epidemic form is as a result of direct person-to-person faecal-oral spread under conditions of poor personal hygiene (Assafa *et al*., 2004). Formites can also serve as a means of

transmission of cyst of this parasite (Awodi *et al*., 2001; Ekejindu *et al*., 2005; Matur *et al*., 2010).

2.3.12.3. Pathogenesis

Trophozoites divide and produce extensive local necrosis in the large intestine (Acari *et al*., 2001; Assafa *et al*., 2004). Invasion into the deeper mucosa with extension into the peritoneal cavity may occur. This can lead to secondary involvement of other organs, primarily the liver but also the lungs, brain, and heart (Assafa *et al*., 2004) Extraintestinal amebiasis is associated with trophozoites. Amoebas multiply rapidly in an anaerobic environment, because the trophozites are killed by ambient oxygen concentration (Acari *et al*., 2001; Assafa *et al*., 2004).

2.3.12.4. Diagnosis

Intestinal amoebiasis can be diagnosed by the examination of a fresh dysenteric faecal specimen or rectal scraping for trophozoite stage (Motile amoebae containing red cells are diagnostic of amoebic dysentery) (Acari *et al*., 2001; Assafa *et al*., 2004) or by examination of formed or semiformed faeces for cyst stage. (Cysts indicate infection with either a pathogenic *E. histolytica* or non-pathogenic *E.dispar*) (Assafa *et al*., 2004). Extraintestinal amoebiasis can be diagnosed by the use of scanning procedures for liver and other organs (Assafa *et al*., 2004). Specific serologic tests, together with microscopic examination of the abscess material, can confirm the diagnosis (Assafa *et al*., 2004; Arora and Arora, 2010).

2.3.12.5. Treatment

Acute, fulminating amebiasis is treated with metrondiazole followed by iodoquinol, and asymptomatic carriage can be eradicated with iodoquinol, diloxanide furoate, or paromomycin (Assafa *et al*., 2004). The cysticidal agents are commonly recommended for asymptomatic carriers who handle food for public use (Assafa *et al*., 2004). Metronidazole, chloroquine, and diloxanide furoate can be used for the treatment of extra intestinal amoebiasis (Assafa*et al*., 2004).

2.3.13 Other amoebae inhabiting the alimentary canal

Most of these amoebae are commensal organisms that can parasitize the human gastrointestinal tract. *E. hartmanni* resembles *E. histolytica* except in size, yet there is a slight overlap in the size range. The trophozoites do not ingest red blood cells, and their motility is generally less vigorous than that of *E. histolytica*. As in other amebae, infection is acquired by ingestion of food or water contaminated with cyst-bearing faece (Assafa *et al*., 2004).

2.3.13.1 *Entamoeba coli* life cycle stages include; trophozoite, precyst, cyst, metacyst, and metacystic trophozoite. Typically the movements of trophozoites are sluggish, with broad short pseudopodia and little locomotion, but at a focus the living specimen cannot be distinguished from the active trophotozoite of *E. histolytica*. The cysts are remarkably variable in size. *E. coli* as a lumen parasite is non-pathogenic and produces no symptoms. The mature cyst (with more than four nuclei) is the distinctive stage to differentiate *E. coli* from the pathogenic *E. histolytica* (Assafa *et al*., 2004).

2.3.13.2 Entamoeba polecki is relatively cosmopolitan parasite of hog and monkey. It can cause human disease but is rarely isolated. The disease is manifested as mild, transient diarrhoea (Assafa *et al*., 2004).

2.3.13.3 Endolimax nana is a lumen dweller in the large intestine, primarily at the cecal level, where it feeds on bacteria. Motility is typically sluggish (slug-like) with blunt hyaline pseudopodia which projects shortly. Human infection results from ingestion of viable cysts in polluted water or contaminated food. Typical ovoid cysts of *E. nana* are confirmative. Rounded cysts and living trophozoites are often confused with *E.hartmanni* and *E.histolytica* (Assafa *et al*., 2004).

2.3.13.4 Iodamoeba buetschlii: -the natural habitat is the lumen of the large intestine, the principal site probably being the cecum. The trophozoite feeds on enteric bacteria; it is a natural parasite of man and lower primates. It is generally regarded as a non- pathogenic lumen parasite (Assafa *et al*., 2004).

2.3.13.5 Entamoeba gingivalis –only the trophozoite stage presents, and encystation probably does not occur. *E. gingivalis* is a commensal, living primarily on exudate from the margins of the gums, and thrives best on unhealthy gums (Assafa *et al*., 2004).

2.3.13.6 Blastocystis hominis is an inhabitant of the human intestinal tract previously regarded as non-pathogenic yeast. Its pathogenecity remains controversial. The organism is found in stool specimen from asymptomatic people as well as from people with persistent diarrhoea. *B. hominis* is capable of pseudopodia extension and retraction. The classic form that is usually seen in the human stool specimen varies tremendously in size, from 6-40μm. There are thin – walled cysts involved in autoinfection, and thick–walled cysts responsible

for external transmission via the faecal-oral route (Assafa *et al*., 2004). The presence of large numbers of these parasites (five or more per oil immersion microscopic field) in the absence of other intestinal pathogens indicates disease. The organism may be detected in wet mounts or trichome –stained smears of faecal specimens. However, the definitive role of *B. hominis* in disease remains to be demonstrated. These parasites have a worldwide distribution (Assafa *et al*., 2004).

2.3.14 Giardia lamblia

2.3.14.1. Morphology

(a) Cyst; the oval cyst is 8-12μm long and7-10μm wide, thick-walled with four nuclei and several internal fibers. Each cyst gives rise to two trophozoites during excystation in the intestinal tract (Assafa *et al*., 2004).

(b) Trophozoites the trophozoite is 9-12 μm long and 5-15μm wide anteriorly. It is bilaterally symmetrical, pear-shaped with two nuclei (large central karyosome), four pairs of flagella, two axonemes, and a suction disc with which it attaches to the intestinal wall (Assafa *et al*., 2004).

2.3.14.2. Epidemiology

Giardia lamblia is a cosmopolitan parasite with worldwide distribution and the most common protozoan isolated from gastrointestinal tract (Adam, 1991). The prevalence of infection varies from 2-7% in industrialized countries to 40% in tropical/subtropical regions with poor sanitation and hygienic conditions (Meyer, 1985; Flanagan, 1992; Scotti *et al*., 1996; Odoi *et al*., 2004). In Nigeria however, different prevalences were reported in various States. These include, 1.2% in Benin (Obiamiwe, 1977), 0.04% in Zaria, Kaduna State

(Awodi *et al*., 2001) and 0.85% in Anambra (Ekejindu *et al.,* 2005). Giardiasis typically occurs following the ingestion of water or foods contaminated with fecal material containing cysts, and the infective dose may be as low as 10 cysts (Grazioli *et al*., 2006). Formites can also serve as a means of transmission of cyst of this parasite (Ekejindu *et al*., 2005; Matur *et al*., 2010). The cyst stage is resistant to chlorine in concentrations used in most water treatment facilities (Assafa *et al*., 2004).

2.3.14.3 Pathogenesis

Infection with *G. lamblia* is initiated by ingestion of cysts. Gastric acid stimulates excystation, with the release of trophozoites in the duodenum and jejunum (Assafa *et al*., 2004). The trophozoites can attach to the intestinal villi by the ventral sucking discs without penetration of the mucosa lining, but they only feed on the mucous secretions. In symptomatic patients, however, mucosa-lining irritation may cause increased mucous secretion and dehydration. Metastatic spread of disease beyond the GIT is very rare (Assafa *et al*., 2004).

Symptomatic giardiasis ranges from mild diarrhea to severe malabsorption syndrome. Usually, the onset of the disease is sudden and consists of foul smelling, watery diarrhea, abdominal cramps, flatulence, and streatorrhoea. Blood and pus are rarely present in stool specimens, a feature consistent with the absence of tissue destruction (Assafa *et al*., 2004).

2.3.14.3.1. Immunity

The humoral immune response and the cellular immune mechanisms are involved in giardiasis. Giardia – specific IgA is particularly important in both defense against and clearance of parasite (Assafa *et al*., 2004).

2.3.14.4. Diagnosis

Obtaining a thorough travel and potential exposure history is important in establishing the diagnosis of giardiasis. Recent travel to the wilderness or a national park and travel to developing areas or other endemic areas of the world where fecal-oral hygiene is a problem are important parts of the history in any patient with persistent diarrhea. Demonstration of trophozoites or cysts in the stool on ova and parasite examination is the traditional standard for establishing the diagnosis (Meyer and Radulescu). Examination of preserved fecal specimens reveals cysts or trophozoites in most infections. Organisms are excreted in a highly variable pattern; multiple samples taken on different days are required for detection. (Dacinger and Lopez, 1975). A single stool sample misses 20 to 40 percent of the infections, whereas three stool samples miss less than 10 percent of infections (Hiatt *et al*., 1995).

2.3.14.5. Treatment

All patients with either cysts or trophozoites in the stool should be treated. Multiple classes of drugs are available for the treatment of giardiasis, each with different clinical properties and efficacies (Gardner and Hill, 2001; Wright *et al*., 2003; Ali and Nozaki, 2007) Nitazoxanide has received a Food and Drug Administration (FDA) indication for the treatment of giardiasis in children and has the advantage over metronidazole of a liquid formulation. Alternative drugs include: (i) furazolidone, which can cause hemolysis in

individuals with glucose-6-phosphate dehydrogenase deficiency; (ii) quinacrine, which is poorly tolerated because of nausea, vomiting and cramping side effects. (iii) Paromomycin for which clinical experience in the treatment of giardiasis is limited (Nash *et al*., 2001). All the drugs mentioned above are administered orally in their inactive probiotic forms (Gardner and Hill, 2001).

2.3.15 Trichomonas vaginalis

2.3.15.1. Morphology

Important features- it is a pear-shaped organism with a central nucleus and four anterior flagella; and undulating membrane extends about two-thirds of its length. It exists only as a trophozoite form, and measures 7-23μm long and 5-15μm wide (Assafa *et al*., 2004).

2.3.15.2. Epidemiology

This parasite has worldwide distribution, and sexual intercourse is the primary mode of transmission. Occasionally, infections can be transmitted by fomites (toilet articles, clothing), although this transmission is limited by liability of the trophozoites (Assafa *et al*., 2004). Rarely Infants may be infected by passage through the mother's infected birth canal. The prevalence of this flagellate in developing countries is reported to be 5% –20% in women and 2 –10% in men (Assafa *et al*., 2004).

2.3.15.3. Pathogenesis

The trophozoite is found in the urethra and vagina of women and the urethra and prostate gland of men. After introduction by sexual intercourse, proliferation begins which

results in inflammation and large numbers of trophozoites in the tissues and the secretions (Assafa *et al*., 2004). The onset of symptoms such as vaginal or vulval pruritus and discharge is often sudden and occurs during or after menstruation as a result of the increased vaginal acidity. The vaginal secretions are liquors, greenish or yellowish, sometimes frothy, and foul smelling (Assafa *et al*., 2004). Infection in the male may be latent, with no symptoms, or may be present as self limited, persistent, or recurring urethritis (Assafa *et al*., 2004).

2.3.15.3.1. Immunity

The infection may induce humoral, secretory, and cellular immune reactions, but they are of little diagnostic help and do not appear to produce clinically significant immunity (Assafa *et al*., 2004).

2.3.15.4. Diagnosis

In females, *Trichomonas vaginalis* may be found in urine sediment, wet preparations of vaginal secretions or vaginal scrapings while in males it may be found in urine, wet preparations of prostatic secretions or following massage of the prostate gland. Contamination of the specimen with faeces may confuse with *Trichomonas hominis* (Assafa *et al*., 2004).

2.3.15.5. Treatment

Metronidazole is the drug of choice. If resistant cases occur, re-treatment with higher doses is required (Assafa *et al*., 2004).

2.3.16 Dientamoeba fragilis

Dientamoeba fragilis was initially classified as an amoeba; however, the internal structures of the trophoziote are typical of a flagellate. No cyst stage has been described. The life cycle and mode of transmission of *D. fragilis* are not known (Assafa *et al*., 2004). It has worldwide distribution (Assafa *et al*., 2004). The transmission is postulated, via helminthe eggs such as those of *Ascaris* and *Enterobius* species (Assafa *et al*., 2004). Transmission by faecal- oral routes does occur (Assafa *et al*., 2004). Most infection with *D. fragilis* is asymptomatic, with colonization of the cecum and upper colon. However, some patients may develop symptomatic disease, consisting of abdominal discomfort, flatulence, intermittent diarrhea, anorexia, and weight loss (Assafa *et al*., 2004).

2.3.17 Other Flagellates Inhabiting the Alimentary Canal

2.3.17.1Trichomonas hominis –The trophozoites live in the caecal area of the large intestine and feed on bacteria. It is considered to be non-pathogenic, although it is often recovered from diarrheic stools. Since there is no known cyst stage, transmission probably occurs in the trophic form (Assafa *et al*., 2004).

2.3.17.2 Trichomanas tenax – was first recovered from the mouth, specifically in tartar from the teeth. There is no known cyst stage. The trophozoite has a pyriform shape and is smaller and more slender than that of *T. hominis* (Assafa *et al*., 2004).

2.3.17.3 Chilomastix mesnli – has both a trophozoite and cyst stage. It normally lives in the cecal region of the large intestine, where the organism feeds on bacteria and debris. It is considered to be non-pathogenic (Assafa *et al*., 2004).

2.3.18 Balantidium coli

2.3.18.1 Morphology

(a) Cyst: the trophozoite is quite large, oval, and covered with short cilia; it is 50 to 100 µm long by 40 to 70 µm wide. The cyst measure 50 to 70 µm in diameter (AL-Hindi, 2009)

(b) Trophozoites: Trophozoites of *B. coli* measure approximately 30-150µm in length x 25-120µm in width but have been known to attain lengths of up to 200µm. They are oval in shape and covered in short cilia. A funnel shaped cytosome can be seen near the anterior end. Multiplication is by binary fission in the trophozoite stage. In an unstained preparation, the organisms are easily recognized because of their size and rapid revolving rotation. In a stained preparation, the characteristic macro and micronuclei may be observed (Assafa *et al*., 2004).

2.3.18.2. Epidemiology

Human balantidiasis occurs worldwide; it is most prevalent in tropical and subtropical regions and developing countries. *B. coli* generally occur among pigs in warmer climates and monkeys in the tropics. Infection in humans is therefore also more common in those areas, especially in settings where hygiene is poor (Assafa *et al*., 2004). In Nigeria however, different prevalences were reported in various States. These include, 0.85% in Anambra (Ekejindu *et al*., 2005) and 0.04% by Awodi (2001) in Zaria, Kaduna state. Porcine fecal contamination of water or food consumed by humans is the principal means for acquisition of infection by humans. Person-to-person spread, including through food

handlers (Walzer *et al*., 1973; Hindsbo *et al*., 2000). Formites can also serve as a means of transmission of cyst of this parasite (Awodi *et al*., 2001; Ekejindu *et al*., 2005).

2.3.18.3. Pathogenesis

As with other protozoan parasites, asymptomatic carriage of *B. coli* can exist. Symptomatic disease is characterized by abdominal pain, tenderness, tenesmus, nausea, anorexia, and watery stools with blood and pus. Ulceration of the intestinal mucosa, as with amebiasis, can be seen; a secondary complication caused by bacterial invasion into the eroded intestinal mucosa can occur. Extra intestinal invasion of organs is extremely rare in balantidiasis. (Assafa *et al*., 2004).

2.3.18.4. Diagnosis

The standard Ova and parasite (Oand P) examination is recommended for recovery and identification of B. coli in stool specimens (CDC, 2013). Microscopic examination of direct saline wet mount may reveal motile trophozoites or cyst forms (CDC, 2013). The concentration technique is very usefull in demonstrating these organisms. In areas where pigs are the main domestic animal, the incidence of human infection can be quite high (Assafa *et al*., 2004).

2.3.19 Coccidia (Sporozoa)

2.3.19.1 Toxoplasma gondii

Toxoplasma gondii– causes toxoplasmosis. The definitive host is the domestic cat and other felines. Humans and other mammals are intermediate hosts. *T. gondii* is usually acquired by ingestion and transplacental transmission from an infected mother to the fetus can occur (Assafa *et al*., 2004). Transmission through venereal route can also occur (Crompton, 1976). After infection of the intestinal epithelium, the organisms spread to other organs, especially the brain, lungs, liver, and eyes. Most primary infections in immunocompetent adults are asymptomatic (Assafa *et al*., 2004). Congenital infection can result in abortion, stillbirth, or neonatal disease with encephalitis, chorioretinitis and hepatosplenomegaly. Fever, jaundice, and intracranial calcifications are also seen. (Assafa *et al*., 2004). For the diagnosis of acute and congenital infections, an immunofluorescence assay for detection of antibody is used (Arora and Arora, 2010). Microscopic examination of Giemsa–stained preparations shows crescent–shaped trophozoite. Cysts may be seen in the tissue. (Assafa *et al*., 2004). Treatment is with a combination of sulfadiazine and pyrimethamine (Assafa *et al*., 2004).

2.3.19.2 Cyclospora cayetanensis –is an intestinal protozoa that causes watery diarrhea in both immunocompetent and immunocompomised individuals (Assafa *et al*., 2004). It is classified as a member of the coccidian; the organism is acquired by fecal – oral transmission, especially via contaminated water supplies (Assafa *et al*., 2004). There is no evidence for an animal reservoir. The diarrhea can be prolonged and relapsing, especially in immunocompromized patients. Infection occurs worldwide. The diagnosis is made

microscopically by observing the spherical oocysts in a modified acid-fast stain of a stool sample (Assafa *et al*., 2004).

2.3.19.3Isospora belli – is an intestinal protozoan that causes diarrhea, especially in immunocompromized patients, e.g., those with AIDS (Assafa *et al*., 2004). Its life cycle parallels that of other members of the Coccidia (Assafa *et al*., 2004). The oocyst can also be spread through formites (Ekejindu *et al*., 2005) The organism is acquired by fecal-oral transmission of oocysts from either human or animal sources. The oocysts excyst in the upper small intestine and invade the mucosa, causing destruction of the brush border. The disease in immunocompromized patients presents as a chronic, profuse, watery diarrhea. The pathogenesis of the diarrhea is unknown (Assafa *et al*., 2004). The pathogenesis of the diarrhea is unknown (Assafa *et al*., 2004). Diagnosis is made by finding the typical oocysts in fecal specimens (Arora and Arora, 2010). The treatment of choice is trimethoprim-sulfamethoxazole (Assafa *et al*., 2004).

2.3.19.4 Cryptosporidium parvum – causes cryptosporidiosis, the main symptom of which is diarrhea. It is most severe in immunocompromized patients, e.g., those with AIDS. The organism is acquired by faecal-oral transmission of Oocysts from either human or animal sources. The oocysts excyst in the small intestine, where the trophozoite (and other forms) attach to the gut wall. Invasion does not occur. The jejunum is the site most heavily infested. The pathogenesis of the diarrhea is unknown; no toxin has been identified. (Assafa *et al*., 2004). Diagnosis is made by finding oocysts in fecal smears when using a modified Kinyoum acid–fast stain. Serological tests are not available. There is no effective drug therapy (Arora and Arora, 2010)

Cryptosporidium causes diarrhea worldwide, for large outbreaks of diarrhea caused by *Cryptosporidium* are attributed to inadequate purification of drinking water (Assafa *et al*., 2004). The disease in immunocompromized patients presents primarily as a watery, non-bloody diarrhea causing large fluid loss. Symptoms persist for long periods in immunocompromized patients, whereas self-limited in immunocompetent individuals. Although immunocompromized patients usually do not die of cryptosporidiosis, the fluid loss and malnutrition are severely debilitating (Assafa *et al*., 2004).

2.3.19.5 Microsporidia –are a group of protozoa characterized by obligate intracellular replication and spore formation (Assafa *et al*., 2004). *Enterocytozoon bienusi* and *Septata intestinalis* are two important microsporidial species that cause severe, persistent, watery diarrhea in AIDS patients (Assafa *et al*., 2004). The organisms are transmitted from faecal-oral route. It is uncertain whether an animal reservoir exists (Assafa *et al*., 2004).

2.4 Economic Importance of Intestinal Parasites

Parasitic infections affect millions of people and livestock worldwide causing health problems and economic hardship.Economic impacts of parasites of livestock may be divided into two groups - direct and indirect impacts. Direct impacts are those attributable purely to the presence of the parasite, e.g. reduced economic productivity of the livestock or economic loss due to mortality. Indirect impacts occur because some parasites, such as ticks, are also disease vectors, and the vector-borne diseases, if transmitted to a livestock host, often result in much greater economic loss than the presence of the parasite. Furthermore, by weakening the host the presence of a parasite may make the animal much

more susceptible to infection and adverse impact from other diseases, or to environmental stresses such as food deficits (McCauley et al., 1984).

Intestinal parasitic infection in man can result in acute illness, chronic disability and even death, especially among the rural communities and the poor urban dwellers, where they exert an impact on productivity, and consequently, the economy of the people (Ukoli,1992; Karrar and Rahim, 1995). Intestinal parasitic infections are known to contribute to economic losses in three major areas which include; Nutrition, growth and development, Work and productivity and Medical costs (WHO, 1987)

2.4.1. Nutrition, growth and development

Chronic helminthiasis is invariably associated with nutritional impairement expressed in the form of protein energy malnutrition, iron-deficiency anaemia and vitamin Adeficiency (Ukoli, 1992). Malnutrition makes its greatest toll on children who become stunted at a crucial period of their development, the advance consequencies of which may last till adulthood. Malnutrition resulting from parasitic infection has been shown to impair school performance (Ukoli, 1992).

Hookworm are classed as one of the most destructive of human parasitic helminthes as it has been recognized for a long time as a leading cause of Iron deficiency anaemia, and a lots of nutrients are wasted by ascariasis. This was well demonstrated in Kenya in the 1970's when the values of wasted nutrients was estimated at US $4.4 million per annum (Ukoli, 1992). Hookworms infective to man comprise of 2 species, *Necator americanus* and *Ancylostoma duodenale*. There is no intermediate host, with man being the only definitive host. It is estimated that there are some 900 million cases of infection worldwide (Crompton, 1989).

2.4.2. Work and productivity

Iron deficiency anaemia is one of the consequencies of hookworm infection.Generally body weakness results from excessive diarrhea and dysentery caused by infections with protozoan parasites (Karrar and Rahim, 1995; Pungkak *et al*., 1996). This has been found to compromise physical fitness, thereby reducing the capacity to learn among school children as well as the capacity to carryout physical work .This ultimately depesses the productivity of workers in the industrial construction and Agricultural sectors which rely on labour-intensive methods. In Africa, this was demonstated in studies of road workers in Kenya and sugar cane cutters in Tanzania (Brooks *et al*., 1979; Vanden Bosseche, 1984).

2.4.3. Medical care

The cost of treating patients with intestinal parasitic infections is high. Though the estimate for Nigeria may be scarce, the cost of antihelminthics used for the treatment of some families in Kenya was estimated as US $ 0.19 million, while the Kenya Health Care spent about US $ 0.34 million for dealing with major intestial parasitic infections in 1976 (WHO,1987).

2.5 Control of Intestinal Parasites

In order to ensure an effective control of parasite in man, parasites that affect animals also need to be controlled as some parasites that affect animals also affects man.

2.5.1 Control of intestinal parasites in animals

In animals strategies for control of helminth parasites begin with a good understanding of the life-cycle of the helminth parasites (Tibbo, *et al*., 2011). Various

methods of controlling helminths that are currently in use and some of which will be more useful and relevant in future have been proposed by Gronvold *et al* (1993). divided into 2 major groups which include: Chemical control such as chemotherapy, use of poison, use of repellant and pheromones and Non-Chemical control such as biological control, worm vaccines, selection for host resistance, grazing management, nutritional management, interspecific competition and male sterile technique.

2.5.1.1 Chemical Control

Chemotherapy**:** Control of the larval stages will ensure breaking of the life cycle. The breaking of the parasite's developmental cycle can be achieved by the use of suitable anthelminthic drugs such as Levamisole Hydrochloride and various Benzimidazoles, many of which also act on the adult stages of the parasite (Sargison, 2011). Anthelmintics used to control helminths fall in 3 major categories:

Group-1. BZ is the Benzimidazoles or "white drenches".

Group-2. LM includes Levamisole and Morantel.

Group-3. ML are the macrocyclic lactones,

which include Doramectin, Ivermectin and Moxidectin, One of the greatest concerns of helminthologists in recent times is the issue of drug resistance which implies that certain drugs can no more be used in certain livestock. Chemical residues in food are a cause for concern for the future. Residues are a major point of concern in the use of anthelmintics. Certain Benzimidazoles and their prodrugs are known teratogens. The situation is even getting more disturbing with the advent of multiple drug resistance (Murphy *et al*., 2006; Sargison, 2011).

Other forms of Chemical Control include use of poisons, repellants and pheromones to control helminths have also been practiced in livestock with varying results and levels of efficacy (De and Sanyal, 2009; Knowles, 2011; Sargison, 2011).

2.5.1.2.Non-Chemical Control

Biologic control can be natural or applied. Certain organisms such as some Monacrosporium spp. have been tested for Fungi are known to attack and destroy helminths for example Arthobotrys spp. (A. oligospora) and biological control agents (De and Sanyal, 2009).

Grazing management, Apart from the use of drugs, there are husbandry practices and measures that are essential for control of helminth parasites. Farmers should avoid early morning grazing so that the animals do not take in the infective larvae of the parasite from the pasture. When the sun rises is the best time to take the animals for grazing. Rotational and zero grazing of the animals should also be carefully planned and carried out to maximize pasture consumption and encourage immunity of the animal as well as maximizing productivity (Bukhari & Sanyal, 2011).

2.5.1.4 .Worm vaccines

There are attempts to produce vaccines against worms in animals and humans. About 2 billion people are infected with helminths worldwide. Work in this area is still under research even though some level of success has been achieved (Harris, 2011). Host resistance selection breeds and species of animals are more resistant to helminths than others. Based on this a selection procedure should be used. There are other methods that can be used to control Helminthosis which includes nutritional management, interspecific

competition and male sterile technique. The best method varies from one farm to another and the expertise of the personnel involved.

2.5.2 Control of intestinal parasites in man

To control parasitic infections, a multi- dispilinary approach is needed. Environmental condition need to be improved upon, safe water supply and sanitation should be provided, social infrastucture should be created to permit the improvement of the care capacity of mothers and food handlers need to be educated on how to protect children from food- borne hazards (Baltazer *et al*., 1993).

Promotion of hygiene can be an intervention for control of diarrheal diseases with an infectious aetiology. Hygiene behaviour interventions can reduce the transmission of entero-pathogens by the faecal-oral route. Provision of clean water and good personal and domestic hygiene has produced a reduction in parasitic infection by 40% (Baltazer *et al*., 1993).

One of the best ways to reduce and control parasitic infections is to enhance the level of public health education. Every effort should be made to educate the community on the importance of improving the hygiene quality of foods and the environment. Karrar and Rahim (1995) observed that children with educated parents had less parasitic infections than those with non-aware parents. It is believed that enlightenment through public health education can help to persuade the people to change or at least modify some of their ways and beliefs for the better (Ukoli, 1992).

CHAPTER THREE

MATERIALS AND METHODS

3.1 The Study Area

Zaria is a major city in Kaduna State in Northern Nigeria located on the plateau of 2200 feet above sea level (Mortimore, 1970). It is positioned between latitude $11^{0}07^{1}51^{11}$N and longitude $7^{0}43^{1}43^{11}$E. According to the 2006 population census, the two LGA's that make up the Zaria urban area have a combined population of 698.348 (with Sabon gari having 291,358 and Zaria 406,990). Zaria climate is tropical continental characterized by cool, /humid wet season, a rainy season of approximately 210 days (May to October). The mean monthly temperature shows a maximum of 39.7^{0}C in June and13.8^{0}C in December (Agbogu *et al.,* 2006). Hausa-Fulani are the main ethnic groups and their major occupation is agriculture: Approximately 40-70% of the population's livelihood is from agriculture (Agbogu *et al.,* 2006).

3.2 Study Design

A cross sectional study design was carried out. Samples were collected from the major parks in Zaria. This Study was conducted from August 2013 to February 2014. The samples were obtained using convenient sampling method. A total of 403 vehicle steerings of commercial motor vehicles were swabbed.

3.3 Sample Size

Mahajan (1997), formula was used to calculate the sample size

$$N = \frac{Z^2Pq}{d^2}$$

Where q=1-p

N=sample size

p = prevelence (0.5% for unknown sample size)

d=desired absolute precision

z=confidence interval

For vehicle steering, the formula below was used for to calculate the sample size

$$N=\frac{1.96^2 \times 0.5 \times 0.5}{0.05^2}$$

N=384.The sample size sample size was increased to 403 to reduce sampling error.

3.4 Sampling Method

Proportionate sampling method was adopted in finding out the number of cars to be sampled in each park in Zaria, were the registered vehicles with the National Union of Road Transport Workers (N.U.R.T.W), and Nigerian Association of Road transport Owners (N. A. R. T. O) were used as our sampling frame. Convenient sampling method was used in sampling cars in each motor park.

The motor parks sampled were Agworo, Kongo, Federal college of Education (F. C. E), Tudun Wada and Zaria central park (Kofan Doka) with total registered vehicles of 145, 78, 36, 74, and 290 in which a proportion of 94, 50, 23, 48, and 188 cars were sampled from each respectively.

3.4.1 Sampling procedure

The major parks in Zaria Local Government Area were visited one after the other and the informed consent was sought from the chairpersons of the various parks, who introduced us to the drivers. Samples were collected for a period of six months (three times

a week) from August 2013 to February 2014. Commercial motor vehicle steerings were swabbed with cotton wool sourced from a pharmaceutical shop using hands covered with sterile hand gloves which were soaked in normal saline. The cotton wool was used in bits until the whole steering was swabbed. These were put into capped sterile bottles as described by Ekejindu (2005). It was then conveyed to the Helminthology laboratory of Department of Veterinary Parasitology and Entomology, Ahmadu Bello University, Zaria for analysis. Ten milliliter formal saline was poured in some samples and kept in the refrigerator at 4^{o}c before they were taken to the laboratory for analysis.

3.4.2 Questionnaire administration

Some of the questionnaires (10) were pretested in Zaria Central Park (Kofan Doka) and then evaluated. TheStructured questionnaires were administered (in form of interview) at all the motor parks (5 motor parks) sampled and was used to seek for information regarding animal ownership, number of drivers, children having access to steering, transport of animals, maintenance practices of vehicle steerings and hygiene practices such as washing of hands after visiting the toilet (appendix1)

3.5 Laboratory Analysis

Ten millilitres formal saline was poured into each of the sterile bottles and shaken vigorously to dislodge the content of the swab into the formal saline. The swab was removed after pressing it several times against the wall of the tubes using a pair of forceps (Ekejindu, 2005). Eggs were recovered using zinc floatation fluid containing 0.03% zinc sulphate and 0.1% sucrose as described by Arora and Arora (2010).

3.5.1 Preparation of zinc sulphate (ZnS04) solution*:*

To make approximately 500ml; 165g of zinc sulphate was weighed; also 50g of sucrose was weighed. Both were added together and dissolved in 500mls distilled water contained in a bottle and mixed well. The zinc sulphate was dissolved by standing the bottle in a container of hot water. The mixture was then mixed until the chemical was completely dissolved. Little amount (2gms) of thymol was added and the solution was allowed to cool at room temperature using hydrometer. The relative density of the solution was measured as 1.19 (Arora and Arora, 2010)

The content was then filtered using guaze into centrifuge tubes to reduce debris. It was then centrifuged at 1500 revolution per minute for 10 min. The tubes were then placed in a rack in a vertical position and zinc sulphate solution was slowly added with a dropper pipette to fill the tubes to the brim. A coverslip of 22 x 22 mm was placed on top of each tube so that its underside rests on the meniscus. The tubes were allowed to stand vertically in the rack with the coverslip suspended on top for 2 – 5 min. The coverslips were carefully lifted and mounted on a clean slide with the liquid side down. The slides were then examined using x10 magnification. A drop of iodine was added to some of the slides that were positive for cysts to clearly identify the cysts. A digital camera was used to take the pictures of the parasites eggs and cysts gotten in this study.

3.5.2 Identification of parasite eggs and cysts

Identification of the parasite eggs and cyst was made based on the characteristics and morphologies described by Cheesebrough (2000). Eggs that were seen as spherical or oval, hyaline, 35-40 in diameter with a smooth, thin and colourless outer shell and an inner

membrane (embryophore) with a space between two membranes filled with yolk granules and 4-8 polar filaments emanating from polar thickening at either end of the embryophore are considered positive for *Hymenolepis nana.*

Eggs that were seen as thin shelled, transparent and oval, containing larvae and measuring 50-58 μm x 30-34 μm were considered positive for *Strongyloides* sp.

Eggs that were seen as oval and transparent with a smooth thin shell and measuring 56 - 75μm by 36 - 40μm were considered positive for Hookwormsp.

Cyst of parasites that were seen as spherical measuring 10-15 μm in diameter, having a thick chitinous wall with four nuclei and 1-4 chromatoid bars, with a glycogen mass that stains brown with iodine were considered positive for *Entamoeba Histolytica*.

Cyst of parasites that are seen as spherical or oval measuring 40-60 μm surrounded by a thick transparent double layered wall contains one macronucleus, one micronucleus and vacoules was considered positive for *Balantidium coli.*

Cyst of parasites that are seen as oval in shape, measuring 11-14μm x 7-10μm in size, having two pair of nucei and several internal fibers were considered positive for *Giadia lamblia*

3.6 Statistical Analyses

Descriptive statistic was used. Statistical Package for Social Sciences (SPSS) Version 20.0 was used to calculate the Chi square test of association between the variables of the risk factors, $p < 0.05$ was considered significant while odds ratio (OR) was used to test the strength of the association between the variables. Prevalence was calculated using the formula:

Prevelence (%) =No of cars that were positive for the parasites X 100
Total number of cars sampled

3.7 Study Instruments and Materials

1. Structured questionnaire.
2. Sample bottles.
3. Cotton wool.
4. Plastic funnels.
5. Cover slip
6. Glass slides.
7. Latex hand gloves.
8. Zinc sulphate crystals
9. Sucrose.
10. Thymol.
11. Guaze.
12. Centrifuge tubes.
13. Laboratory record book.
14. Digital camera.
15. Computer

CHAPTER FOUR

RESULTS

4.1. Prevalence of Parasite eggs or cyst on Vehicle Steerings

Of the 403 steering swabs obtained, 29 (7.2%) were positive for parasite eggs/cysts. Eight types of helminth eggs and 21 types of protozoan cysts were encountered. Of the 29 positive cases, cyst of *Entamoeba histolytica* were the most abundant, consisting 9 (31%), followed by those of coccidia 7 (24.1%), *Giardia 4* (13.8%). *Strongyloides* and hookworm egg type each constitute 3 (10.3%) of the positive cases, followed by eggs of *Hymenolepis nana* 2 (6.9%) and the least of which was cysts of *Balantidium coli* 1 (3.4%) (Table 4.1).

The overall parasitic prevalence was 29 (7.2%) out of which individual prevalence was: *Balantidium coli* 1(0.25%), coccidia sp 7(1.74%), *Entamoeba histolytica* 9 (2.23%), *Giardia* sp 4 (0.99%), Hookworm sp 3 (0.74%), *Hymenolepis nana*, 2 (0.50%) and *Strongyloides* sp 3 (0.74%) (Table 4.2).

Out of the 403 respondents, 216 (53.6%) said they had animals while 185 (45.9%) said they do not have animals. The risk of parasite infestation on the steerings was evaluated in terms of animal ownership i.e whether having animals can be a risk in the spread of the parasite. Only 18 (4.5%) of the steerings of the respondents that had animals were positive for the parasites while 10 (2.5%) of the steerings of the respondents that do not have animals were also positive for the parasites. Despite the variations there was no statistically significant difference ($p>0.05$) (Table 4.3).

Of the 403 respondents, 243 (60.3%) said they allowed others to drive their vehicles while 159 (39.5) said they never allowed others to drive their cars. Having access to the steering was also considered as a risk factor. Of the cars that had only one driver, 20 (8.2%) were positive for parasitic eggs/cysts while 26 (8.7%) of those having more than

one driver were positive for parasitic eggs/cysts. There was a statistically significant difference ($p<0.05$) in the two groups (Table 4.3).

Of the 403 respondents, 189(46.9%) said they never transported animals, 10(2.5%) said they always transported animals, and 203(50.4%) said they occasionally transported animals. Transport of animals was another risk factor that was also considered. Fourteen (3.5%) of the steerings of the motor vehicles that were not used to transport animals were positive for the parasite, egg/cyst, 15 (3.7%) of the steerings of the steerings of those that occasionally transported animals were positive for parasite eggs/cysts while none (none) of the steerings of those that occasionally transported animals were positive for parasite eggs/cysts.. Despite the variations there was no statistical significance ($p>0.05$) in the rates (Table 4.3).

Out of the 403 respondents, 261 (64.8%) said children had access to their steerings while 142 (35.2%) said that children did not have access to their steerings. The risk of parasitic infestation on the steering was also evaluated in terms of children having access to the steering. Seventeen (4.2%) of the steerings of the respondents that did not allow children to have access to their steering were positive for parasites egg/cyst while 12 (3.0%) of the steerings of the respondents that allowed children to have access to their steerings were also positive for the parasites. Despite the variations there was no statistical significance ($p>0.05$) in the rates (Table 4.3).

Out of the 403 respondents, 342 (84.9%) said they washed their hands after toilet while 61 (15.1%) said they did not wash their hands after toilet. Washing of hands after toilet was another risk factor that was considered. Twenty nine (7.2%) of the steerings of those that wash their hands were positive for parasites while 0.0% of those that do not wash

their hands were positive for the parasite. Despite the variations there was no statistically significant difference ($p>0.05$) (table 4.3).

Of the 403 respondents, 308 (76.4%) said they cleaned their steerings while 95 (23.6%) said they do not clean their steerings. Twenty three (5.7%) of those that cleaned their steering were positive for egg/cyst while 6 (1.5%) that did not clean their steerings were also positive for the parasite. Despite the variation there was no statistically significant difference ($p<0.05$) in the rates of the two groups (table 4.3).

Table 4.1:**Frequency of occurrence table showing the percentage positivity of parasite eggs and cysts recovered from swabs of commercial motor vehicle steerings in Zaria**

Parasite cysts and eggs isolated	Frequency of occurrence	Percentage positivity
Balantidium coli	1	3.4
Coccidia sp	7	24.1
Entamoeba histolytica	9	31.0
Giardia sp	4	13.8
Strongyloides sp	3	10.3
Hookworm sp	3	10.3
Hymenolepis nana	2	6.9

Table 4.2: Frequency of occurrence table showing the individual prevalence of parasite eggs and cysts recovered from swabs of commercial motor vehicle steerings in Zaria

Parasite cysts and eggs isolated	Frequency of occurrence	Individual prevalence
Balantidium coli	1	0.25
Coccidia sp	7	1.74
Entamoeba histolytica	9	2.23
Giardia sp	4	0.99
Strongyloides sp	3	0.74
Hookworm sp	3	0.74
Hymenolepis nana	2	0.50

Table 4.3: Risk factors associated with the spread of parasite eggs and cysts on commercial motor vehicle steerings in Zaria

Risk factors	Variable	No positive (%)	Total	OR	95% CI	P value
Animal owner ship	Yes	18 (4.5)	216	0.95	(0.47-1.89)	0.33
	No	10 (2.5)	185			
Number of drivers	One	20 (8.2)	223	0.5	(0.24 – 1.89)	0.001*
	More than one	26 (8.7)	151			
Transport of animals	Always	0.0 (0)	10			0.83
	Occasionally	15 (3.7)	189	1.0	(0.8 – 2.5)	
	Never	14 (3.5)	203			
Children access to steering	Yes	12(3.0)	142	1.3	(0.6-2.8)	0.472
	No	17 (4.2)	261			
Hand washing after toilet	Yes	29 (7.2)	342	1.0	(1.0 -1.1)	5.6
	No	0 (0.0)	61			
Cleaning of steering	Yes	23 (5.7)	308	1.2	(0.4 – 3.0)	0.144
	No	6 (1.5)	95			

Key: OR is the odds ratio, CI is the confidence interval and * is the Significant P-value

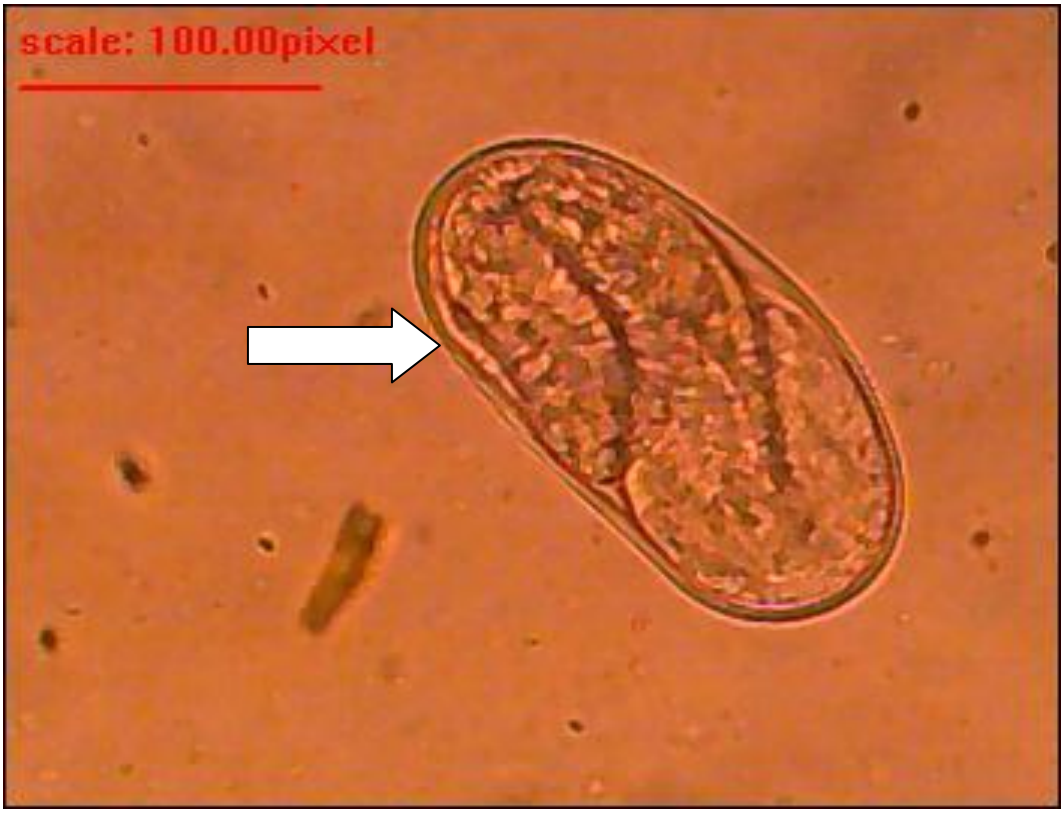


Plate I: Photomicrograph of Strongyloides egg recovered from swabs of a commercial motor vehicle steering in Zaria (Mag. x400)



Plate II: Photomicrograph of Hookworm egg recovered from swabs of a commercial motor vehicle steering in Zaria (Mag. x400)

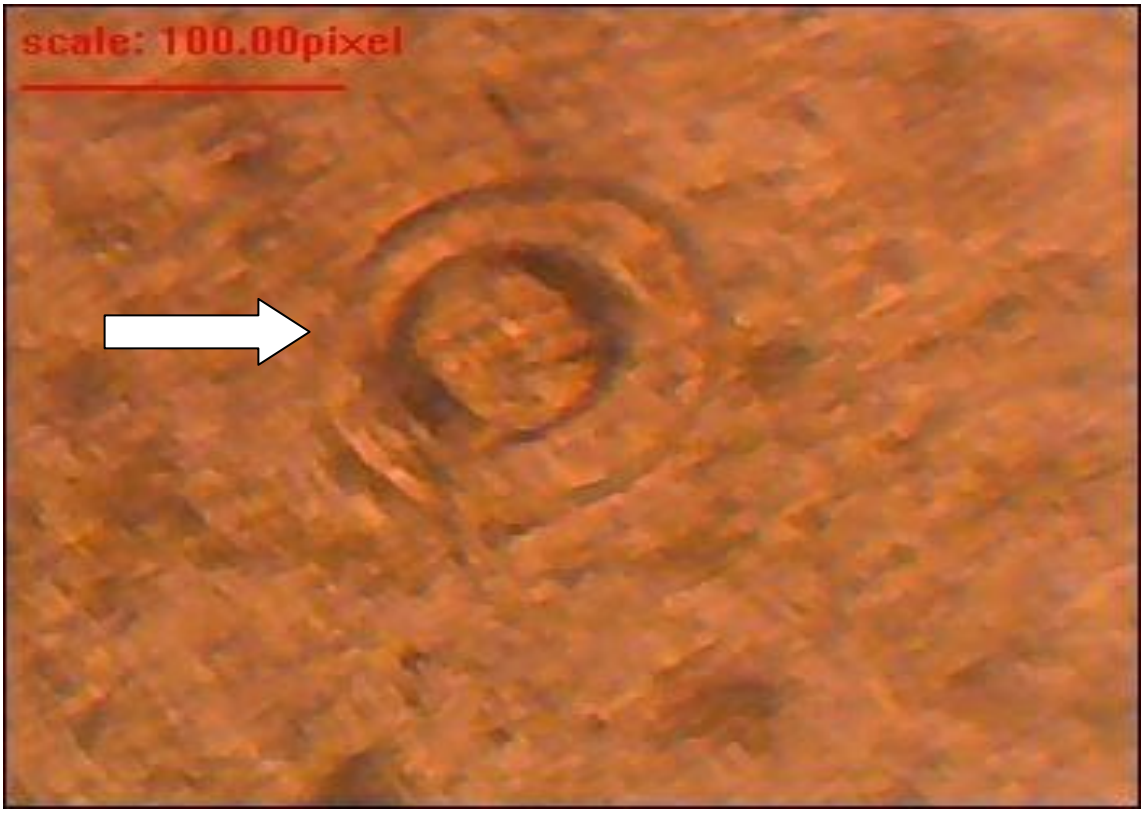


Plate III: Photomicrograph of the egg of *Hymenolepis nana* recovered from swabs of a commercial motor vehicle steering in Zaria (Mag. x400)

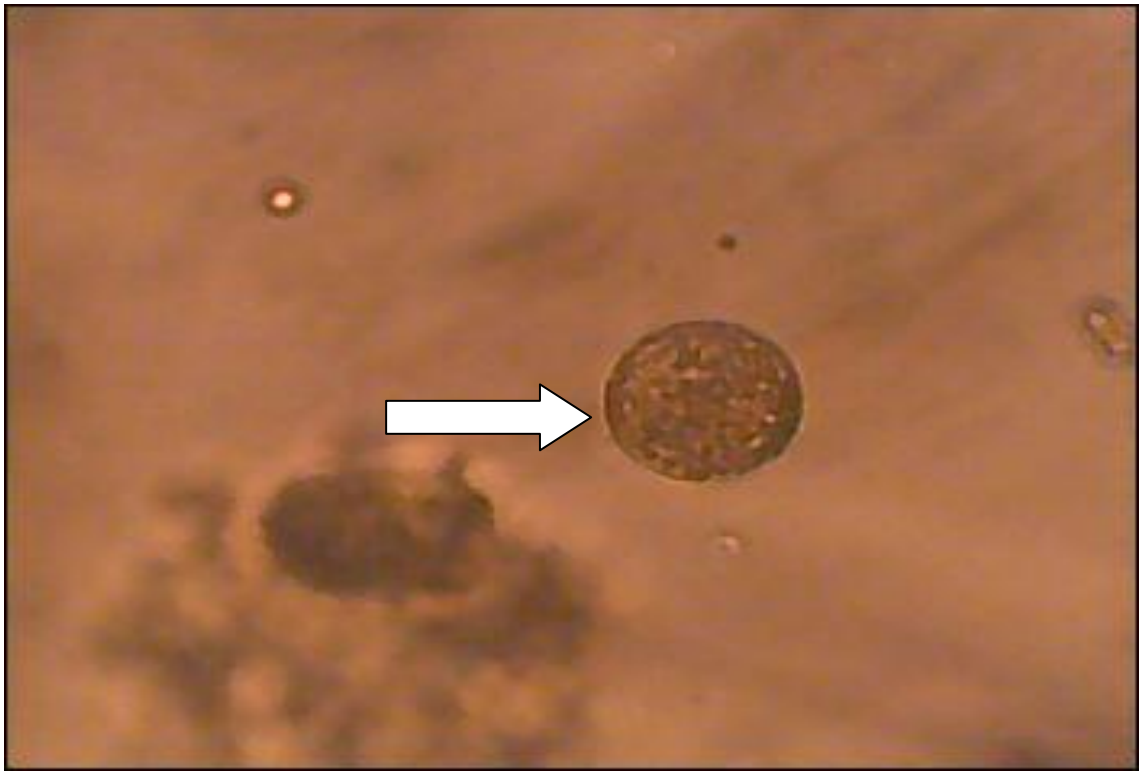


Plate IV: Photomicrograph of a cyst of *Entamoeba histolytica* (iodine stained) recovered from swabs of a commercial motor vehicle steering in Zaria (Mag. x400)

`



Plate V: Photomicrograph of a cyst of *Giardia* sp recovered from swabs of a commercial motor vehicle steering in Zaria (Mag. x400)

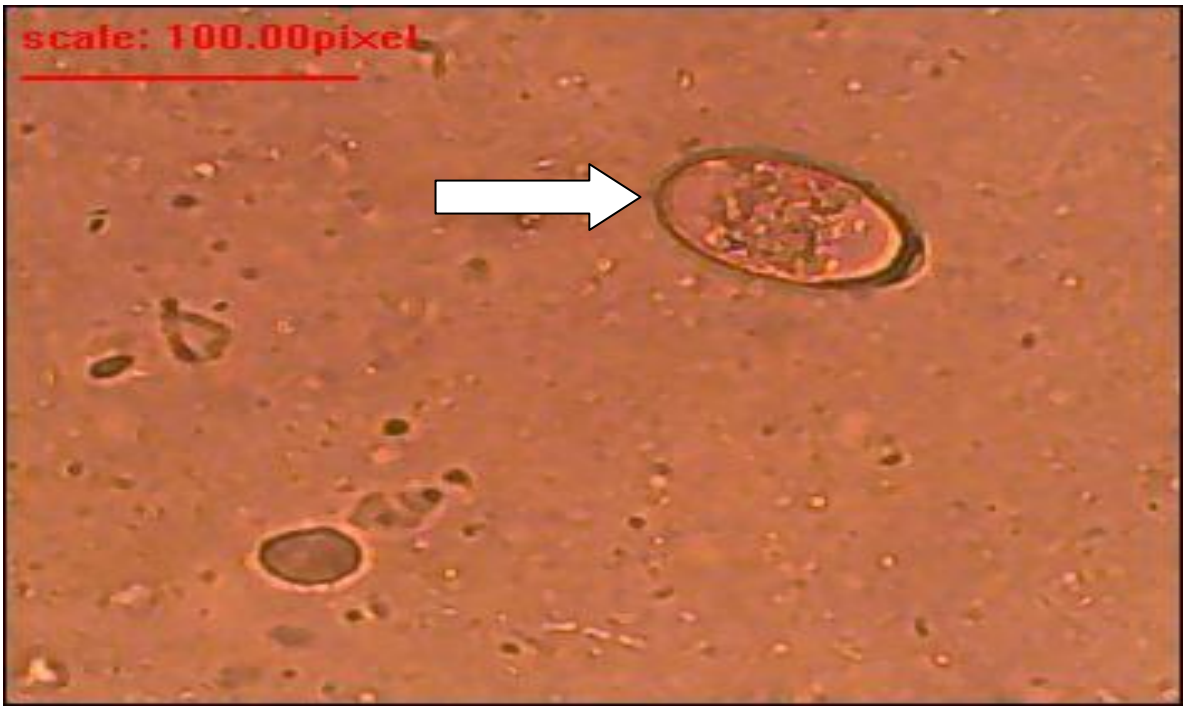


Plate VI: Photomicrograph of Coccidia oocyst recovered from swabs of a commercial motor vehicle steering in Zaria (Mag. x400)

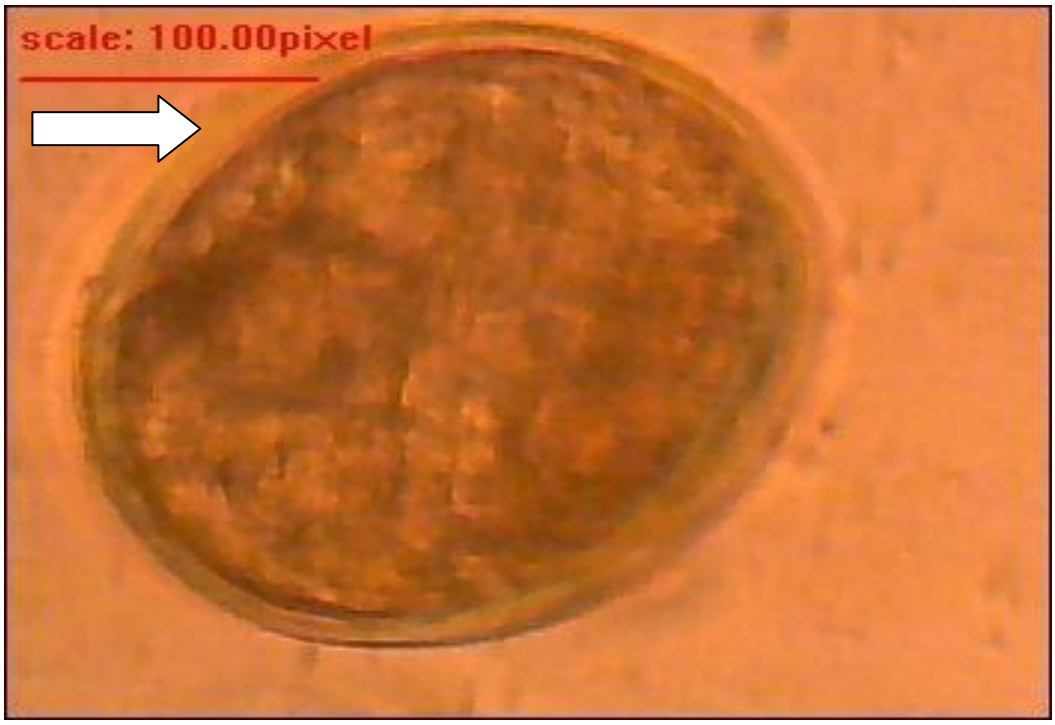


Plate VII: Photomicrograph of a cyst of *Balantidium coli* recovered from swabs of a commercial motor vehicle steering in Zaria (Mag. x400)

CHAPTER FIVE

DISCUSSION

The result ascribes a prevalence of 7.20% of parasite eggs or cysts on swabs of vehicle steerings. This could be due to some dirty habits of some drivers who may not always maintain some basic personal hygiene like washing of hands after the use of toilet or when they wash they do so with unclean or contaminated water. This is in agreement with the work of Jalaoso (1991), Ameh and Balogun (1997), Awodi *et al*., 2001, and Ekejindu *et al*., 2005, that formites can be a potential source of contacting bacterial, parasitic and fungal infection.

The observation of these parasite eggs and cysts on vehicle steerings was in line with those gotten on Naira notes. However more parasite eggs or cysts were recovered in Naira notes than the seven discovered in this study this might be because more people handle naira notes (Awodi, 2001) than vehicle steerings therefore the Naira notes are thus more likely to be contaminated with parasite eggs and cysts.

The prevalence of 0.25% gotten for *Balantintidium coli* in this study is similar to 0.04% obtained by Awodi (2001) and 0.85% obtained by Ekejindu (2005). This could be because the people that handle vehicle steerings also handle Naira notes and parasites eggs or cyst have been discovered to stick to the hands in the process of counting contaminated money (Awodi, 2001).

The prevalence of 1.74% gotten for *Coccidia* sp in this studies is similar to 0.13% of Awodi (2001) this could also be because the people that handle vehicle steering also handle Naira note and there is most likely the chances of the vehicle steering contamition by such notes (Awodi, 2001).

The prevalence of 0.25% gotten for *Entamoeba hystolytica cyst* in this studies is similar to 4.7% gotten by Ekejindu (2005) but different from that of Matur (2010) who got a higher prevalence of 12.5% This could be because he carried out his research during rainy season and these parasites are known to be more common during raining season.

The prevalence of 0.25% gotten for *Giadia* sp in this studies is similar to 0.04% of Awodi (2001) and 0.85% Ekejindu (2005) again this could be because the people that handle vehicle steering also handle different kinds of naira notes including the one contaminated with parasite eggs or cyst there fore it is most likely to get a similar prevalence (Awodi, 2001).

The prevalence of 0.74% gotten for *Hookworm* sp in this studies is similar to 0.85 gotten by Ekejindu (2005) but different from those of Matur (2010) who got a higher prevalence of 8.5%. This could also be because he carried out his research during rainy season and these parasites are known to be more common during this season.

Parasite eggs such as those of *Strongyloides* and *Hymenolepis* were not discovered from formites in a published data.

Entamoeba histolytica causes a disease known as amoebiasis and it is known to affect only man. It has been established to be associated with profuse bloody diarrhea (amoebic dysentery) colitis and rarely liver abscess (Stanley, 2005; Ali *et al*., 2008). Patients infected with *E. hisolytica* pass non-infectious trophozotes and infectious cysts in their stools. Therefore, the main source of water and food contamination is the symptomatic carrier who passes cysts. Symptomatic amebiasis is usually sporadic. The epidemic form is as a result of direct person-to-person faeco-oral spread under conditions of poor personal hygiene (Assafa *et al*., 2004).

Infection with coccidian parasites is generally known as coccidiosis.

The species of coccidia that are of zoonotic potential are *Toxoplasma gondii* and *Cryptosporidium parvum* (Dubey, 2004; Fayer, 2004). *Cryptosporidium* and *Toxoplasma* spare among the parasites that have great potentials in causing waterborne and foodborne diseases (David, 2005). *Toxoplasma gondii* causes toxoplasmosis, although it is a zoonotic parasite, it is different from *Cryptosporidium parvum* in that its primary host is feline. Infections with *Toxoplasma gondii* are usually asymptomatic but may be life-threatenig in immunocompromised individuals and in infected pregnant women.

There is also a risk of transplacental transmission (Desmonts and Cauvreur, 1974). *Cryptosporidium* species cause cryptosporidiosis, of which a vast majority of human cases are caused by *Cryptosporidium parvum.* Diarrhoea is the most common symptom of *Cryptosporidium parvum,* followed by abdominal pain and vomiting (David, 2005). The oocysts of *Toxoplasma gondii* and *Cryptosporidium parvum* are resistant to chlorine in concentrations used in most water treatment facilities (David, 2005), therefore they may be a threat to safe water supply and thus man can aquire the oocysts through contaminated drinking water or contaminated water used for other activities.

Giardia species are zoonotic parasites that cause a disese known as Giardiasis and have been reported to cause various problems to its host which include dyspepsia, malabsorption, and diarrhea (Kucik *et al*., 2004). Cysts of Giardia can remain infectious in cool damp environment and are known to be resistant to chlorine in concentrations used in most water treatment facilities (David, 2005) therefore it may be a threat to safe water

supply and thus man can aquire the cyst through contaminated drinking water or contaminated water used for other activities.

Infection with hookworms specie is known as Ancylostomiasis and is said to cause severe anaemia (Bundy, 1995) however Some hookworm species present a zoonotic potential such as *Ancylostoma caninum* and *Ancylostoma brazilense* which are the aetiologic agents of diseases known as eosinophilic enteritis (Landman and Prociv, 2003) and cutaneous larva migrans respectively

Strongyloides sp which is also of zoonotic importance is also associated with anaemia and cutaneous larval migrans (WHO, 2015). Although infection with these parasites is usually mild, it may be severe and life threatening in immunodeficiency (WHO, 2015).

Hymenolepsis nana causes hymenolepiasis and this specie only affects humans. Infection of these parasites in human adults, is of nuisance than a health problem, but in small children presence of many of this parasite in the childs intestine can be dangerous as they can absorb all the nutrients from the food the child eats (Onubugu 1978) leading to malnutrition.

Balantidium coli which is also a zoonotic parasite is associated with a disease known as balantidiasis and is the only ciliate that can affect humans (Assafa *et al*., 2004). Infection with these parasites is mostly asymptomatic, but people with other serious illnesses can experience persistent diarrhea, abdominal pain, and sometimes a perforated colon (CDC, 2015).

Isolation of these parasite eggs, cyst or oocyst has health implication because most of those that were isolated were gastointestinal parasites which cause infection to man through the faeco-oral route. This may be an indication that the level of hygiene was poor.

It was found in this study that factors such as animal ownership, transport of animals, children having access to the steerings, washing of hands after toilet, and cleaning of steerings were not strongly related to the prevalence of parasite eggs cysts and or oocyst on vehicle steerings (p- value >0.05).Despite this, the possibility of humans getting infected through these means exist.

It was recorded that nineteen (4.7%) of the steerings of the drivers that own animals were positive for parasite eggs and cysts while 10 (2.5%) of the steerings of the drivers that do own animals were positive for parasite eggs and cysts. Fifteen (3.7%) of the steerings of the motor vehicles that occasionally transport animals were positive for the parasite eggs and cysts followed by 14 (3.5%) of the motor vehicle steerings that never transport animals, while none (0%) of the motor vehicles that always transport animals were positive for parasite eggs and cysts. Though it was not statistically significant, chances are that those parasite eggs and cyst could be gotten from such animals as some of the eggs and cysts that were isolated are those of zoonotic parasites.

Recovering parasite eggs and cysts from the steerings of the respondents that wash their hands after visiting the toilet and not from the steerings of the respondents that do not wash their hands after visiting the toilet could be that those respondents that do not wash their hands after visiting the toilet are not harbor the parasites and thus cannot transmit it to the steerings and those positive cases gotten from the steerings of the respondents that wash their hands after visiting the toilet could be from other sources such as sharing their cars with other drivers that are harboring the parasites and do not wash their hands after visiting the toilet.

The second possibility could be that they acquired it from other means such as contaminated food and water as some of these drivers especially those that travel frequently are in the habit of buying any type of food (including fruits and vegetables) or stop by any place to ease themselves and thus use any kind of water to clean up. They could acquire the parasites from contaminated food and water they buy as it has been reported that intestinal parasites are mostly transmitted through faeco-oral routes and thus contaminated food, soiled hands of food handlers and occasionally water are known to transmit these parasites (Benenson, 1990; Balthazar *et al.,* 1993; Morterjemi *et al*., 1993).

Another possibility could be through contact surfaces such as the naira notes they handle, as parasites eggs and cyst have been discovered to stick to the hands in the process of counting contaminated money (Awodi, 2001)

The access of many people to the same steering is strongly related to the presence of parasite eggs, cyst or oocyst on the steerings ($p < 0.05$) therefore when many people handle the same steering, there is the likelihood of increased contamination with parasite eggs or cyst especially if handled with unclean hands.

CHAPTER SIX

6.1 CONCLUSION

The parasite eggs and cysts gotten from this study are those of high socio-economic importance and of great health implication that may pose danger to man. Cysts of *Entamoeba histolytica* were the most abundant 9(31%) followed by those of coccidian 7 (24.1%), *Giardia 4* (13.8%). *Strongyloides* 3 (10.3%), hookworm eggs 3 (10.3%), followed by eggs of *Hymenolepis nana* 2 (6.9%) and the least of which was cysts of *Balantidium coli* 1 (3.4%). The risk factor that was found to be important in the transmission of these parasite eggs and cysts was the handling of the steerings by many drivers 26 (8.7%). This research study therefore points out that steerings of cars may serve as a vehicle for the transmission of parasites to humans.

6.2. RECOMMENDATIONS

Based on the findings of this study, it is recommended that:

1. People that handle vehicle steerings should be educated on the need to wash their hands properly after handling the steering or after the use of toilet before handling anything.
2. The public need to be enlightened on the risk of vehicle steering serving as formites for the transmission of parasites.
3. There is need for campaign for regular deworming and treatment of drivers to reduce the risk of transmission among car users.
4. Decontamination agents like hypochloride and hydrogen peroxide should be used in cleaning the steerings

REFERENCES

Adamu, A. U. and Bassey, S. E. (2010). Incidence of *strongyloides stercoralis* infectionn in Ungogo, Nassarawa, Dala and Fagge local government areas of Kano State, Nigeria. Bayero *Journal of Pure and Applied Sciences*, 3(2): 76 - 80

Adenusi, A. A. (1979).Cure by ivermectin of a chronic, persistent, intestinal strongyloidosis. *Acta Tropica;*66(3):163-7.

Acari, M., Baxendine, A. and Bennette, C. E. (2000). *Diagnosing Medical Parasites Through Coprological Techniques.* Diasis Ltd printing press Southernpton, U. S.A.Vol. 4, 5 and 6: 1-26, 1-27, 4-24

Adam, R. D. (1991). The biology of *Giardia* spp. *Microbiology Review,* 55: 706-732

Adeyeba, O. A. and Akinlabi, A. M. (2002).Intestinal Parasitic infections among school children in rural community, South Nigerian. *Nigerian Journal of Parasitology*, 23: 11 – 18.

Agbogu, V. N., Umoh, V. J., Okuofu, C. A., Smith, S. I. and Ameh, J. B. (2006). Study of the Bacteriological and Physiochemical indicators of pollutant of surface waters in Zaria, Nigeria. *African Journal of Biotechnology*. 5 (9): 732 – 737.

Agi, P. I. (1997). Comparative Infections in two rural communities in then Niger Delta, *Nigeria. West African Journal of Medicine,* 1 6 (4): 232 – 236.

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.

Albonico, M., Crompton, D.W. and Savioli, L.(1999). Control strategies for human intestinal nematode infections. *Advances in Parasitology*; 42: 277-341

Al-Harthi, S. and Jamjom, M. (2007). Diagnosis and Differentiation of Entamoeba infection in Makhah Al-Mukarramah using microscopy and stool Antigen Detection Kits. *World Journal of Medical Science*, 2**:**15-20.

Ali, I.K, Clark, C. G, and Petri, W. A. J. (2008). Molecular epidemiology of amebiasis. *Infection, Genetics and Evolution,* 8(5): 698-707.

Ali, V. and Nozaki, T. (2007). Current therapeutics, their problems, and sulfur-containing-amino-acid metabolism as a novel target against infections by "amitochondriate" protozoan parasites. *Clinical Microbiology Review*; 20:164-167.

Ameh, M. and Balogun, Y. O. (1997). The health implication of microbial load of abused naira notes. *The Spectrum*, 4:138-40.

Annan, A., Crompton, D. W. T., Walters, D. E. and Arnold, S. E. (1986). An investigation of prevalence of intestinal parasites in pre-school children in Ghana. *Parasitology*, 92:209-217.

Arinola, O. and Fawole, O. (1995). Age and sex graded helminth infections in a Nigerian village. *The East African Medical Journal*, 72(2): 110-112.

Arora, D. R. and Arora, B. B (2010). Text book of Medical parasitology (3rd edition) CBS publishers and distributors, New Delhi, 21-237

Asaolu, S. O., Holland, C. V., Jegede, J. O., Fraser, N. R., Stoddad, R.C. and Crompton, D. W. T. (1992). The prevalence and intensity of soil-transmitted helminthiasis in rural communitiesin southern Nigeria. *Annals of Tropical Medicine and Parasitology*, 86(6): 279-287.

Ashford, R. W. and Crew**,** W. (1998). *The parasites of Homo sapiens. Liverpool School of Tropical Medicine*, Liverpool, United Kingdom.*Science Direct journal*, 15(12): 510

Assafa, D.,Kibru, E.,Nagesh, S.,Gebreselassie, S., Deribe, F. and Jemal, A. (2004).*Medical Parasitology*, USAID, Ethopia. 663: 22-78

Awodi, N. O., Nock, I.H. and Aken'Ova, I. (2001). Prevalence and public health significance of parasite cysts and eggs on Nigerian currency. *NigerianJournal of Parasitology.* 22: 137-142.

Awogun, I. A. (1984). The prevalence of intestinal parasites in children living in Ilorin, Kwara State.*The Nigerian Medical Practitioner*, 76(6):176-178.

Bahgat, M.A., El Gindy, A.E., Mahmoud, L.A., Hegab, M. H. and Shahin, A.M., (1999). Evaluation of the role of *Ancylostoma caninum* in humans as a cause of acute and recurrent abdominal pain. *Journal of Egypt Society of Parasitology*. 29,873-882

Balthazer, J. C., Tiglao, T. V. and Tempongko, S. B. (1993). Hygiene behaviour and hospitalized severe childhood diarrhea, A case-control study, *Bulletin of the World Health Organisation* (WHO), 71 (3/4): 323 - 328.

Bello, C. S. S., Tanyigna, K. B. and Olotu, C. O. (1997). Intestinal Parasites in Jos: A four-year Review. *Nigerian Medical Practitioner*, 4(1/2): 11-13

Benenson, A. S. (1990). Control of communicable diseases in man. American Public Health Association, 1015 Eighteenth Street, N. W., Washington D. C, pp532

Berks, S. L., Verghese, A., Alvarez S., Hall K. and Smith B. (1987). Clinical and epidemiologic features of strongyloidiasis. A prospective study in rural Tennessee. *Archives of Internal Medicine,* 147:1257- 61.

Bhatti, H. S., Malla, N., Mahajan, R.C. and Sehgal, R. (2000) Fasciolopsiasis a re-emerging infection in Azamgarh (Utterpradesh). *Indian Journal of Pathology and Microbiology*, 43, 73-76.

Biu, A. A., kyari, F. and John, W. M. (2012). Prevalence of intestinal parasites in school aged pupils in mafa local government area of Borno state, Nigeria. *Journal of Medical and Aplied Biosciences*, 4: 84-88.

Biu, A. A., Kofur, I. and Mohammed A. (2013). Prevalence of human gastro-intestinal parasites in biu, Borno State, Nigeria. *Journal of Biological Sciences and Bioconservation*, 5(2):8-12.

Blair, D., Agatsuma, T. and Wang, W. (2008). *Paragonimiasis*, In K. D. Murrell and B. Fried (ed.), Food-borne parasitic zoonoses, vol. 11. Fish and plant-borne parasites. Springer, New York, pp117-150.

Brooks, R. M., Latham, M. C. and Cromptom, D. W. T. (1979). The relationship of nutrition and health to worker Productivity in Kenya. *The East African Medical Journal*, 56: 413-421

Bukhari, S. and Sanyal, P. K. (2011). Epidemiological Intelligence for Grazing Management in Small Ruminants in India – *A Review of Veterinary World*, 4(2): 92-96.

Bundy, D. A. (1995). *Epidemiology and Transmission of Intestinal Helminths*. in Farthing, M.J.G., Keusch, G.T. and Wakelin, D. (Eds) Enteric Infection 2, Intestinal Helminths. London, Chapman and Hall Medical. 5–24.

Center for Food Security and Public Health. 2005 Anon. "Trichuriasis".. http://www.cfsph.iastate.edu/Factsheets/pdfs/trichuriasis.pdf 3/11/12

Centers for Disease Control and Prevention. Anonymous. "Parasites – Trichuriasis (also known as Whipworm Infection)". Last updated November 2, 2010. http://www.cdc.gov/parasites/whipworm/epi.html 3/10/12.

Centers for Disease Control and Prevention. Anonymous. "Parasites - Balantidiasis (also known as Balantidium coli Infection)". Last updated January 10, 2013. http://www.cdc.gov/parasites/balantidium/ 15/03/2015..

Centers for Disease Control and Prevention. Anonymous. "Parasites – DPDx - Laboratory Identification of Parasitic Diseases of Public Health Concern. Last updated November 29, 2013. http://www.cdc.gov/dpdx/hookworm/index.html 14/01/15.

Centers for Disease Control and Prevention. Anonymous. "Parasites – DPDx - Laboratory Identification of Parasitic Diseases of Public Health Concern. Last updated November 29, 2013. http://www.cdc.gov/dpdx/balantidium/index.html14/01/15.

Centrs for Disease Control and Prevention. Anonymous. "Parasites - Fascioliasis (Fasciola Infection)". Last updated January 10, 2013. http://www.cdc.gov/parasites/fasciola/ 07/10/2015.

Chanie, M. and Bengashaw, S. (2012). Assessment of the economic impact and prevalence of ovine fasciolosis in Menz Lalo Midir District, Northeast Ethiopia. Ethiopia. *Veterinary World*., 5(5): 261-264.

Chhabra, M. B. and Singla, L. D. (2009). Food-borne parasitic zoonoses in India: Review of recent reports of human infections. *Journal of Veterinary Parasitolology*. 23(2):.103-110.

Cheesbrough, M. (2000). *District laboratories practice in tropical countries*. Cambridge university pologyress, 209-211.

Choo, J. D, Suh, B. S. and Lee, H. S. I. (2003). Chronic cerebral paragonimiasis combined with aneurysmal subarachnoid hemorrhage. *American Journal of Tropical Medicine and Hygiene*; 69: 466.

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

Crompton, D. W. T. (1976). Entry in to host and site selection. In:Kenedy, C. R. (ed). *Ecological Aspects of Parasitology*. Holland Publishing Company, Amsterdam, 41-73

Crompton, D. W. T. and Nesheim, M. C. (1982). Nutritional science and parasitology: a case for collaboration. *Bioscience*, 32:677–680.

Crompton, D. W. T. ed. (1993). Human nutrition and parasitic infection. *Parasitology*, 107:S1–S190.

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

Cunningham, A. A .(2005). A walk on the wild side-emerging wild life diseases. *British Medical Journal*, 331:1214-1215.

Danciger, M. and Lopez M. (1975). Numbers of Giardia in the feces of infected children. *American Journal of Tropical Medicine and Hygiene* ; 24:237-241.

Daubenton, J. D. and Buys, H. A. and Hartley, P. S. (1998). *Disseminated strongyloidiasis in a child with lymphoblastic lymphoma. Journal of Pediatric Hematology Oncology;20:260-3.*http://www.cdc.gov/parasites/whipworm/gen_info/faqs.html 3/10/12.

David Dawson, (2005). Food borne protozoan parasites. *International Journal of Food Microbiology*, 103: 207-227.

De, S. and Sanyal, P. K. (2009). Biological control of helminth parasites by predatory fungi. *VetScan*, 4(1):125–133.

Ditrich, O., Nasincova, V., Scholz, T. and Giboda, M. (1992). Larval stages of medically important flukes (Trematoda) from vietiane province, Laos: part 2. Cecariae. *Annales de Parasitologie Humane et Comparee.* 67, 75-81.

Dubey, J. P. (2004). Toxoplasmosis – a waterborne zoonosis. In Waterborne zoonotic parasites (Gajadhar, ed.). *Veterinary Parasitology*, 126 (special issue), 57-71.

Ekejindu, I. M., Ekechukwu, A. C., and Ezeagawun, D. (2005). Prevalence of parasitic oocyst and ova on currency. *Journal of Biomedical Investigations,* 3: 16- 20.

Ekong, P. S., Juryit R., Dika N. M., Nguku P. and Musenero, M. (2012). Prevalence and risk factors for zoonotic helminth infection among humans and animals - Jos, Nigeria, 2005-2009. *The Pan African Medical Journal*, 12: 1-10.

Ekpenyong, E. (2008). Prevalence of intestinal helminths infections among school children in Tropical Semi Urban Communities. *Animal Research International*, 5: 804-10.

Elekwa, D. E. and Ikwe, E. L. (1996). A survey of incidence of intestinal parasites amongst primary school children in relation to socio-economic factors in Jos, Nigeria. *Nigerian Medical Practitioner,* 33(4):60-62.

Enekwechi, L. C. and Azubike, C. N. (1994). Survey of the prevalence of intestinal parasites in children of primary school age. *West African Journal of Medicine,* 13:227-230.

FAO (Food and Agricultural Organisation) (2009). Livestock Sector Brief, Ethiopia. Livestock Information and sector analysis and policy branch, FAO, Rome, Italy. pp15-16.

Farley, J. (1991). *Bilharzia, a History of Imperial Tropical Medicine*. Cambridge University Press. Cambridge, United Kingdom, pp359.

Fayer, R. (2004). Cryptosporidium: a waterborne zoonotic parasite. In Waterborne zoonotic parasites (A.A. Gajadhar, ed.). *Veterinary Parasitology*, 126 (special issue). pp37-56.

Flanagan, P. A. (1992). Giardia-diagnosis, clinical course and epidemiology. A review of *Epidemiology and Infection*,109: 1-22.

Garcia, H. H., Moro, P. L. and Schantz, P. M. (2007). Zoonotic helminth infection of humans: echinococcus, cysticercosis and fasciolosis. *CurrentOpinions in Infectious Diseases*, 20: 489-494.

Gardner, T. B. and Hill, D. R. (2001). Treatment of giardiasis. *Clinical Microbiology Reviews*, 14:114-128.

Gbakima, A. A., Shepard, M. and White, P.T. (1994). Intestinal helminth infections in rural school children in Njala, Sierra Leon. *The East African Medical Journal*, 71(2): 792-796.

Genta R. M. (1989). *Global prevalence of strongyloidiasis:* critical review with epidemiologic insights into the prevention of disseminated disease. *Review of Infectious Diseases*; *11:755-67.*

Graczyk, T. K. Gilman, R. H. and Fried, B. (2001). Fasciolopsiasis: is it a controllable food-borne disease? *Parasitology Research* 87: 80-83.

Grazioli, B., Matera, G., Laratta, C., Schipani, G., Guarnieri, G., Spiniello, E., Imeneo, M., Amorosi, A., Focà, A. and Luzza, F. (2006). *Giardia lamblia* infection in patients with irritable bowel syndrome and dyspepsia: A prospective study. *World Journal of Gastroenterology*, 12(12): 1941-1944.

Gronvold, J., Wolstrup, J., Nansen, P., Henriksen, S. A., Larsen, M. and Bresciani, J. (1993). Biological control of nematode parasites in cattle with nematode-trapping fungi: a survey of Danish studies. *Veterinary Parasitology*, 48(1-4), 311- 325.

Grove, D. I. (1996). Human strongyloidiasis. *Advanced Parasitology*, 38: 251-309.

Hiatt R.A., Markell E.K. and Ng E.: (1995). How many stool examinations are necessary to detect pathogenic intestinal protozoa? *American Journal of Tropical Medicine and Hygiene*, 53:36-39.

Harrinasuta, T. Pungpak, S. and Keystone, J.S. (1993). Trematode infections. Opisthorchiasis, clonorchiasis, fascioliasis, and paragonimiasis. *Infectious Disease of North America*; 7(3): 699-716

Harris, N. L. (2011). Advances in helminth immunology: optimism for future vaccine design? *Trends in Parasitology*, 27(7): 288-293.

Hembly, H. (2009). Helminths and our immune system. *Science Direct Parasitology International*,58: 121 – 127.

Hindsbo, O., Nielsen, C.V., Andreassen, J., William, A. L., Bendixen, M. and Nielson, M. A. (2000) Age-dependent occurrence of the intestinal ciliate Balantidium coli in pigs at a Danish research farm. *Acta Veterinaria Scandinavicca*; pp41:79.

Hopkins, D. R. (1992). Homing in on helminths. *The American Journal of Topical Medicine and Hygiene*, 46(6): 626-634.

Hotez, P. J., Ottesen, E., Fenwick, A. and Moly- neux, D. (2006)The neglected tropical diseases: the ancient afflictions of stigma and poverty and the prospects for their control and elimination. *Advance in Experimental Medicine and Biology journal*, 582: 23–33.

Hotez, P. J. (2008). *Forgotten people and forgotten diseases, the neglected tropical diseases and their impact on global health and development*. American Society of Microbiology Press.

Houchedez, P. and Caumes, E. (2007). Hookworm-related cutaneous larva migras. *Journal of Travel Medicine,* 14: 326-333.

Inabo, H. I. And John H. D. (2010). Intestinal helminthes among children in orphanages in some parts of Kaduna state, Nigeria. *Continental Journal of Microbiology*, 4: 31 – 36.

Islek, I., Kucukoduk, S., Centninkaya, F. and Gurses, N. (1993). Effects of Ascaris infection on iron absorption in children. *Annals of Tropical Medicine and Parasitology*, 87(5): 477-481.

Jacobs, L. (1967). Toxoplasma and toxoplasmosis. *Advances in Parasitology*, 5: 1-37s

Jamaiah I, Rohela M. (2005). Prevalence of intestinal parasites among members of the Public in Kuala Lumpur, Malaysia. *Southeast Asian Journal of Tropical Medicine and Public Health*, 36: 68-71

John D. T., William A. and Petri, J. R. (2006). *Markeell and Vogue 's Medical Parasitology, 9th Edition. Saunders Elsevier press.* Retieved from htpp://www.amazone.com/Markell-voges-Medical-Parasitology-1-3, 29th August 2011.

Jolaoso, J. I. K. (1991). Dirty naira notes as vehicle for bacteria and mould infections and an agent of cross contamination. *Paper presented at the 19th annual conference of the Nigerian Society for Microbiologists, September 1991*.

Jorgensen, T., Montresor, A. and Savioli, L. (1996). *Effectively controlling strongyloidiasis (letter). Parasitology Today ;12,164.*

Kagawa, F. T. (1997). Pulmonary paragonimiasis. *Semininar in Respiriratoy Infection*, 12:149-158.

Karrar, Z. A. and Rahim F. A. (1995). Prevalence and risk facors of parasitic infections among under –five Sudanese children :A community based studies. *The East African Medical Journal*, 721(2): 103-109.

Keiser, J., Engels, D., Büscher, G. and Utzinger, J. (2005). Triclabendazole for the treatment of fascioliasis and paragonimiasis. *Expert Opinion on Investigational Drugs*, 14: 1513.

Keiser J, Utzinger, J. (2005). Emerging foodborne trematodiasis. *International Journal of Parasitology*. 11:1507-1514.

Keiser, J. and Utzinger, J. (2009). Foodborne trematodiasis. Clinical Microbiology Review. 22:466-483.

Kernan, F. A. J. (1959). The blood fluke that saved Formosa. *Harper's Magazine*. 45–47.

King, C. H. (2010). Parasites and poverty: The case of schistosomiasis. *Acta Tropica*, 113: 95-104.

Knowles, S. C. L. (2011). The effect of helminth co-infection on malaria in mice: A meta-analysis. *International Journal for Parasitology*. 41(10):1041-1051

Kogi, E., Umoh, J. U. and Vanjime, C. G. (1991). Intestinal parasites and gastro-enteritis among patients attending the university clinic, Samaru-Zaria, Nigeria. *The Nigerian Journal of Parasitology,* 12:77-80.

Kudo, R. R. (1971). *Protozoology*. Fifth edition. Charles C. Thomas Publishers, USA, 1170

Liu, L.X. and Weller, P. F.(1993). *Strongyloidiasis and other intestinal nematode infections. Infectious Diseases of North America,* 7: 655-82.

Luka, S. A. (1997). The Epidemiology of Schistosomiasis in Lere Local Government Area, Kaduna State Nigeria. MSc Thesis. Department of Veterinary Public Health and Preventive Medicine. Ahmadu Bello University, Zaria, 73.

Mahajan, B. K. (1997) *Methods of Biostatistics for Medical Students and Research Workers* 6^{th} *ed*. E.Jay per brothers ltd India. Pp 88-94.

Malgor, R., Oku, Y., Gallardo, R. and Yarzabal, I. (1996). High prevalence of *Ancylostoma* spp. Infection in dogs, associated with endemic focus of human cutaneous larval migrans, in Tacuarembo, Uraguay. *Parasite, 3*: 131-134.

Marti, H., Haji, H.J.and Savioli, L. (1996). A comparative trial of a single-dose ivermectin versus three days of albendazole for treatment of Strongyloides stercoralis and

other soil-transmitted helminth infections in children. *American Journal of Tropical Medicine and Hygiene*, 55:477-481.

Marty, A. M., and R. C. Neafie. (2000). Paragonimiasis, In W. M. Myers, R. C. Neafie, A. M. Marty, and D. J. Wear (ed.), Pathology of infectious diseases, vol. I. Helminthiases. Armed Forces Institute of Pathology, Washington, DC, pp49-67.

Mas-coma, s., Angles R., Esteban J. G., Bargues,, M.D., Buchon, P., Franken, M. and Strauss, W. (1999a) The Northern Bolivian Altiplano: A region highly endemic for human fascioliasis.*Tropical Medicine International Health*, 4: 454 -467.

Mas-coma, S., Bargues, M. D. and Estaban, J. G. (1999b). Human fasciolosis. In Fasciolosis (ed. J. P. Dalton) Oxford, UK: CABI, pp411-434.

Mas-coma, S., Bargues, M. D. and Valero, M. A. (2005) Fascioliasis and other plant – borne trematode. zoonoses. *International Journal of Parasitology*, 35: 1255-1278.

Matur, B. M., Malann, Y. D. and Edhomeriegu, Y. (2010). A survey of parasite cysts, eggs and bacteria on Nigerian currency in FCT. *Abuja ScienceJournal*, 3(1): 10-13.

Mbanugo, J. I. and Abazie, O. C. (2002). A Comparative study of intestinal parasitic infections of Pregnant and non pregnant women in Nkpor, Anambra State. *Nigerian Journal of Parasitology*, 23: 19 – 26.

Mbanugo, J. I. and Onyebuchi, C. J. (2002). prevalence of intestinal parasites in Ezinifite Community in Aguata LGA of Anambra State. *Nigerian Journal Parasitology* , 23: 27 – 34.

McCauley, R. H., Majid, A. A. and Tayer, A. (1984). Economic evaluation of the production impact of bovine schistosomiasis and vaccination in the Sudan. *Preventive Veterinary Medicine*, 2, 735-754.

Meyers, E. A. and Radulescu S. (1979). Giardia and giardiasis. *Advances in Parasitol.* 17:1-47.

Meyer, E. A. (1985). The epidemiology of Giardiasis. *Parasitology Today* 1: 101-105

Michael, B.V., Gangar, C. L. and Doyle, M. (2003). Use of alcoholic instant hand sanitizers as part of a food service hand hygiene program. *Food Service Technology* 3:71-80.

Mortimore, M. J. (1970). Zaria and Its Region: A Nigerian - Savanaa City & Its Environs. With map in back pocket.Nigerian Georaphy Association Zaria, 4:1-191.

Motarjemi, Y., kaferstein, E., Moy, G. and Quevedo, E. (1993). Contaminated weaning food: a major risk factor for diarrhea and associated malnutrition. *Bulletin of World Health Organisation*. 68(6): 691-698.

Mott, K. E., Desjeux, P., Moncayo, A., Ranque, P. and Raadt, P. (1990). Parasitic diseases and urban development. *Bulletin of World Health Organisation*, 68(6):691-698.

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

Murphy, T. M., Fahy, K. N., McAuliffe, A., Forbes, A. B., Clegg, T. A. and O'Brien, D. J. (2006). A study of helminth parasites in culled cows from Ireland. *Preventive Veterinary Medicine*, 76(1-2): 1-10.

Nawa, Y**.** (2000). Re-emergence of paragonimiasis. *Journal of Internal Medicine,* 39**:**353-354.

Nash, T. E. (2001). Treatment of patients with refractory giardiasis. *Clinical Infectious Diseases*, 33: 22–28

Nikolic, A., Djurkovic, O and Bobic, B. (1998). *Intestinal Parasitic Infections in Serbia*. Srpski Arhizua Celukumpo Lekarsivo, 126(1- 2): 1 – 5.

Nithiuthai, S., Anantaphruti, T.M., Waikagul, J. and Gajadhar, A. (2004) Waterborne zoonotic helminthiasis. *Journal of Veterinary Parasitology*, 180-181.

Nduka, F. O. Nwaugo, V. O. and Nwachukwu, N. C. (2006). Human intestinal parasite infections In Ishiagu. A lead mining area of Abia State, *Animal Research International,* 3(3): 505 – 507.

Norhayati, M., Fatmah, M. S., Yusof, S. and Edariah, A.B. (2003). Intestinal parasitic infections in man: a review. *Medical Journal of Malaysia*58:296-305.

Nwosu, A. B. C. (1981). The community ecology of soil transmitted helminth infections of soil transmitted helminth infections of humans in a hyperendemic area of southern Nigeria. *Annals of Tropical Medicine and Parasitology*, 75(2):197-203

Obiamiwe, B. A. (1977). The pattern of parasitic infection in human gut at the specialist hospital, Benin City, Nigeria. *Annals of Tropical Medicine and Parasitology*, 71(1): 35-43.

Obiamiwe, B . A. and Nmorsi, P. (1991) Human gastro-intestinal parasites in Bendel State, Nigeria. *Angewandte Parasitologie*, 32:177-183.

Odoi, A. Martin, S. W., Michel, P., Holt, J., Middleton, D. and Wilson J. (2004). Determinants of the geographical distribution of endemic giardiasis in Ontario, Canada: a spatial modelling approach. *Epidemiology and Infections*, 132: 967-976.

Okpala, I. (1961). A survey of the incidence of intestinal parasites among Government Workers in Lagos, Nigeria. *West African Medical Journal*, 10:148–157.

O'Lorcain, P. and Holland C.V. (2000). The public health importance of Ascaris lumbricoides. *Parasitology*, 121: 51-71.

Onubugu, U. V. (1978). Intestinal Parasites of School Children in Urban and Rural Areas of Eastern Nigeria. *Bakteriologie Hygiene Labotorie Origne* A. 242: 121-131.

Onyeabor, A. I. and Wosu, M. I. (2014). Prevalence of Bovine Fasciolosis Observed in Three Major Abattoirs in Abia State Nigeria *Journal of Veterinary and Advanced parasitology*, 4(11): 752-755.

Ortiz, J. J., Lopez, C. N., Gargala, G. and Favennec, L. (2002). Comparative clinical studies of nitazoxanide, albendazole and praziquantel in the treatment of ascariasis, trichuriasis and hymenolepiasis in children from Peru. *Transaction of the Royal Society of Tropical Medicine Hygiene,* 96:193-6.

Ozumba, C. C. and Ozumba, N. (2002). Patterns of helminth infection in the human gut in the University of Nigeria Teaching Hospital, Enugu, Nigeria. *Journal of Health Science*, 48:263-268.

Pius, S. E., Raymond J., Ndahi, M. D., Patrick, N. and Monica M. (2012). Prevalence and risk factors for zoonotic helminth infection among humans and animals - Jos, Nigeria, 2005-2009. *The Pan African Medical Journal*, pp12:6

Pope, T. W., Ender, P.T., Woelk, W.K. and T.M. Koroscil, (2002). Bacterial contamination of paper currency. *South Medicine Journal* 95: 1408-1410.

Prociv, P. Croese, J. (1990). Human eosinophilic enteritis caused by dog hookworm *Ancylostoma caninum*. *Lancet* 335 (8701): 1299-1302.

Prociv, P. and Croese, J. (1996). Human enteric infection with *Ancylostoma caninum*: hookworm reappraised in the light of a "new" zoonoses *Acta Tropica.* 62, 23-44.

Pungkak, S., Singhasvanon, V., Bunang, D., Radomyos, B., Nibadhasopin, P. and Harinasuta K. T. (1996) Albendazole as treatment of *Giardia lamblia* infection. *Annals of Tropical Medicine and Parasitology*, 90(5):563 – 565.

Raether, W. Hänel, H. (2003). Epidemiology, clinical manifestations and diagnosis of zoonotic cestode infections: an update. *Parasitology Research*, 91:412–38.

Robinson, M. N and John, P. D.(2009) Zonotic helminth infections with particular emphasis on fasciolosis and trematodiasis. *Philosophical transactions of the royal society, Series B,* 364;2763-2776.

Salazar, S. A,, Berk, S. H, Howe, D. and Berk, S. L. (1994). Ivermectin vs thiabendazole in the treatment of strongyloidiasis. *Infections in Medicine:*50-59.

Sargison, N. D. (2011) Pharmaceutical Control of Endoparasitic Helminth Infections in Sheep. *Veterinary Clinics of North America: Food Animal Practice*, 27(1), 139-156.

Savioli, L., Chitsulo, L. and Montresor, A. (1999). New opportunities for the control of fascioliasis. *Bulletin of World Health Organisation*. 77(4):Pp. 300.

Schantz, P. M. (1991). Of worms, dogs, and human hosts: Continuig challenges for Veterinarians in prevention of human diseases. *Journal of American Veterinary Medical Association.* 204(7): 1023-1028

Scotti, S., Pettoello, M., Polito, G., Carlomagno, F., Cop- pola, A. and di Martino, L. (1996). *Giardia duodenalis* infections in pedia- trics: our series. *Le Infections in Medicine* ; 4: 35-40. ,

Sebastiaan, J. V., Stark, D. J., Fotedar, R., Marriott, D., John, T. and Harkness, J. L. (2007). Amoebiasis: current status in Australia.*Medical Journal of Australia*,186: 412-416.

Soulsby, E. J. L. (1978). Helminths,arthropods and protozoa of domesticated animals,7th edition ELBS and Tindall, London, 809.

Sripa, B., Kaewkes, S., Intapan, P. M., Maleewong, W. and Bindley, P. J. (2010) Foodborne trematodiasis in Southeast Asia: epidemiology, Pathology, clinical manifestation and control. *Advanced Parasitology*. 72: 305-350.

Suwannee, N., Malinee, T. A., Jitra, W. and Alvin, G. (2004). Waterborne Zoonotic helminthiasis. *Veterinary parasitology* 126: 167-193.

Tanowitz, H. B., Weiss, L. M. and Wittner, M. (1993). Diagnosis and treatment of intestinal helminths. . Common intestinal cestodes. *Gastroenterologist*, 1:265–73.

Tibbo, M., Aragaw, K., Teferi, M. and Haile, A. (2011). Effect of strategic helminthosis control on mortality of communally grazed Menz lambs of smallholders in the cool central Ethiopian highlands. *Small Ruminant Research,* 90(1-3): 58-63.

Turner, J. A.(1998). *Trematodes, 4th ed., Vol. 2. W. B.* Saunders, Philadelphia, PA.

Ukoli, F. M. (1992). *Preventon and Control of Intestinal Parasitic Infection in Tropic Africa: The Main Issues.*University press, Inc. Ibadan, pp199.

Udonsi, J. K., Behnke, J. M. and Gilbert, F. S. (1996). Analysis of the prevalence of infection and associations between human gastrointestinal nematodes among

different age classes living in the urban and suburban communities of Port Harcourt, Nigeria. *Journal of Helminthology,* 70:75-84.

Vanden Bossche, H. (ed) (1984). Ecomnomic aspects of parasitic diseases:Proceeding of an industrial workshop. *Social Science Medicine,* 19(10): 1013- 1126

Walana, W., Tay, K. C. S., Tetteh, P. and Ziem, B. J. (2014). Prevalence of intestinal protozoan infestation among primary school children in Urban and peri-urban communities in Kumasi, Ghana. *Science Journal of Public Health,* 2(2): 55

Walzer, P. D., Judson, F. N., Murphy, K. B., Healy, G. R., English, D. K. and Schultz, M. G. (1973). Balantidiasis outbreak in Truk. *American Journal of Tropical Medicine and Hygiene,* 22(1):33.

Weiss, L. M. and Keohane, E. M. (1997). The uncommon gastrointestinal Protozoa: Microsporidia, Blastocystis, Isospora, Dientamoeba, and Balantidium. *Current Clinical Tropics in Infectious Diseases,* 17:147.

Weng, Y. L., Zhuang, Z. L., Jiang, H. P., Lin, G. R. and Lin, J. J. (1989). Studies on ecology of *Fasciopsis buski* and control strategies of fasciolopsiasis. *Zhongguo Ji Sheng Chong Xue Yu Ji Sheng Chong Bing ZaZhi,* 7: 108-111.

Whitfield, P. J. (1994). Parasitic helminths. I n: Cox FEG. (Ed) *Modem Parasttology,* 2nd edn Oxford;

WHO (1987). Prevention and Control of Intestinal Parasitic Infections. Report of WHO Expert Committee. *Technical Report Series*. 749 . World Health Organization, Geneva.

WHO (1997). WHO/PAHO/UNESCO report. A consultation with experts on amoebiasis. Mexico City, *Epidemiological Bulletin*, 18:13-14.

WHO: Control of Foodborne Trematode Infections, (1995). WHO *Technial Report Series,* volume 849.Geneva, World Health Organisation.

Wright, J. M., Dunn, L. A., Upcroft, P. and Upcroft, J. A. (2003). Efficacy of antigiardial drugs. *Expert Opinion on Drug Safety,* 2:529-541.

Zaha, O., Hirata, T,. Kinjo, F. and Saito, A. (2000). Strongyloidiasis—progress in diagnosis and treatment. *Internal Medicine Journal, 39:695-700.*

Zarrin-Khameh, N., Citron, D. R., Stager, C. E. and Laucirica, R. (2008). Pulmonary paragonimiasis diagnosed by fine-needle aspiration biopsy. *Journal of Clinical Microbiology*. 46:2137.

Zhong, H. L., L. Y. He, Z. B. Xu, and W. J. Cao. (1981). Recent progress in studies of Paragonimus and paragonimiasis control in China. *Chinese Medical Journal* 94:483-49

Zoakah, L. O. Idoko, L. O., Okwonkwo, M. O., Adeleke, A. O. and Kpamor, (1999). Intetinal Helminth infections and malnutrition in pre-school children in U? village in Plateau State, Nigeria. *Nigerian Medical Practitioner*, 37(5/6):67-

APPENDIX 1

QUESTIONAIRE ON VEHICLE STEERING AND RISK FACTORS

Please read and answer the following questions with a tick or fill the appropriate spaces as applicable to you.

Information provided shall remain confidential and will be used for academic purposes

Section: A

1. Serial NO
2. Location _____

Section B: Practices

3. Do you or any member of your household have animals?

   Yes ( ) No ( )

4. What kind of animals do you keep?_____

5. Do you allow animals into your car?

   No ( ) Yes always ( ) Yes occasionally ( )

6. Do you share your car with others?

   No ( ) Yes ( )

7. Do children have access to your car steering?

   Yes ( ) No ( )

8. Do you wash your hands after easing yourself?

   No ( ) Yes ( )

9. Do you clean your steering? No ( ) Yes ( )