PREVALENCE OF INFANTILE PLASMODIASIS AND GEOHELMINTHIASIS IN FOUR HOSPITALS IN KADUNA METROPOLIS, KADUNA STATE, NIGERIA

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BY

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DECEMBER, 2016.

DECLARATION

I declare that the work in this thesis entitled, "**Prevalence of infantile Plasmodiasis and Geohelminthiasis in four Hospitals in Kaduna Metropolis, Kaduna State Nigeria**" has been carried out by me in the Department of Biology under the supervision of Prof. I. H. Nock and Prof. I. S. Ndams. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other Institution.

Rakiya GARBA _____ _____

Signature Date

CERTIFICATION

This thesis entitled, **"Prevalence of Infantile Plasmodiasis and Geohelminthiasis in four Hospitals in Kaduna Metropolis,Kaduna State Nigeria"** byRakiya GARBA, meets the regulations governing the award of the degree of Master of Science of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my late father AlhajiGarbaSambo, my husband AlhajiNuhuGarba and my lovely boys KhalifaAbubakar S. Nuhu and Abdullahi A. Nuhu and daughter Aisha HumairaNuhu for their support and encouragement throughout the period of the study.

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ABSTRACT

Stool and blood samples were collected from 552 infants in four hospitals in Kaduna metropolis, between October 2013 and March 2014, to determine the status and public health significance of plasmodiasis and geohelminthiasis. Blood samples from four hundred infants (400) were collected and processed using the thin film Giemsa stain technique. Stool samples (152) were processed by the formol – ether concentration technique. A structured questionnaire was administered to obtain gender, age and associated risk factors. Overall, 269 (67.25%) of the 400 infants examined were positive for *Plasmodium falciparum* infection. The prevalence was significantly ($p<0.05$) higher in female (34.25%) than in male (33.0%) infants. The age group 21 – 24 months had the highest prevalence (17.75%) while the age group 1-4 months had the least (3.0%); the prevalence among age groups was not significantly different ($P>0.05$). Risk factors in*P.falciparum*infection was associated with old age, bushes, pools of water or sewage around homes andnon-utilization of mosquito netwere associated. Of the 152 stool samples examined, the prevalence of geohelminth infection was 32.95%. *Ascaris lumbricoides* was highest (25.66%) while *Hookworm (3*.95%) and *Trichuristrichiura (3.25%*) were the least. Infection was significantly ($P<0.05$) higher in females (20.39%) than in males (12.50%). Infants between the ages of 21 – 24 months had the highest prevalence(7.99%) while the least was among age group 1 – 4 months (0.67%); the prevalence of geohelminthinfection not significant ($p>0.05$) and increases with age. Conditions most frequently associated with infection included the well water, pit latrine toilet facilities, poor personal hygiene, and the level of maternal education. The studies showed a relatively high prevalence of *Plasmoduimfalciparum* and geohelminth infections among infantsandsuggest the need for public education on the effective use of drugs and insecticide treated mosquito bed nets in the control of the diseases.

TABLE OF CONTENTS

DECLARATION iii

CERTIFICATION iv

DEDICATION v

ACKNOWLEDGEMENTS vi

ABSTRACT vii

LIST OF FIGURES xii

LIST OF TABLES xiii

LIST OF APPENDICES xiv

CHAPTER ONE..... 1

INTRODUCTION..... 1

1.1 Statement of the Research Problem..... 5

1.2 Justification 5

1.3 Aim..... 6

1.4 Objectives 6

1.5 Hypotheses..... 6

CHAPTER TWO 7

2.0 LITERATURE REVIEW..... 7

2.1Epidemiology of Malaria..... 7

2.1.1 Malaria (Plasmodiasis) in Infants:..... 10

2.1.2 Transmission of Malaria:..... 11

2.2Pathology..... 14

2.3Diagnosis..... 16

2.4 Treatment and Case Management 17

2.5 Prevention and Control 20

2.6 Distribution of Geohelminths Worldwide 23

2.6.1 Infant Geohelminthiasis: 24

2.7 Geohelminth Parasites 29

2.8 Epidemiology and Disease Burden 30

2.9 Prevention and Control of Geo-Transmitted Helminths 31

CHAPTER THREE 35

3.0 MATERIALS AND METHODS 35

3.1 Study Area 35

3.2 Study Population 37

3.3 Study Design 37

3.4 Sample size 37

3.7.1 Administration of Questionnaires 38

3.8.1 Examination of Samples 39

3.8.2 Identification of Parasites 40

3.10 Data Analyses 40

CHAPTER FOUR 41

RESULTS 41

4.0 Overall Prevalence of Plasmodiasis in Infants 41

4.1 Prevalence of Plasmodiasis in Infants in Relation to Gender 41

4.2 Prevalence of Plasmodiasis in Infants in Relation to Age 41

4.3 Prevalence of Plasmodiasis in Infants in Relation to Hospitals 41

4.4 Prevalence of Plasmodiasis in Infants in Relation to Mother's Occupation 45

4.5 Prevalence of Plasmodiasis in Infants in Relation to their Mother's Educational Status 45

4.6 Prevalence of Plasmodiasis in Infants in Relation to Sources of Domestic Water Supply 45

4.7 Prevalence of Plasmodiasis in Infants in Relation to Some Risk Factors 49

4.8 Overall Prevalence of Geohelminths.....49

4.9 Prevalence of Geohelminthiasis in Infants in Relation to Gender 49

4.10 Prevalence of Geohelminthiasis in Infants in Relation to Age 49

4.11 Prevalence of Geohelminthiasis in Infants in Relation to Hospital 54

4.13 Prevalence of Geohelminthiasis in Infants in Relation to Mothers' Occupation 54

4.14: Prevalence of Geohelminthiasis in Infants in Relation to Mother's Educational Status.....54

4.14: Prevalence of Geohelminthiasis in Infants in relation to Domestic Source of Water Supply 58

4.15 Prevalence of Geohelminthiasis in Infants in Relation to Risk Factors.....58

4.16 Prevalence of Geoherminthiasis in Infants in Relation to Feeding Pattern.....58

CHAPTER FIVE.....62

5.0 DISCUSSION 62

CHAPTER SIX.....68

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS 68

6.1 Summary 68

6.2 Conclusion……68

6.2 Recommendations……69

REFERENCE……..70

APPENDICES…..79

LIST OF FIGURES

Figure **page**

1. Life cycle of *plasmodium falciparum*…….14

2: Map of Nigeria, Kaduna State and Kaduna Metropolis indicating the Hospitals Sampled……..38

LIST OF TABLES

Table **Page**

Table 2.1: Prevalence and distribution of major human geohelminths 28

Table 4.1: Prevalence of plasmodiasis in infants in relation to gender 42

Table 4.2: Prevalence of plasmodiasis in infants in relation to their age four Hospitals in Kaduna Metropolis 43

Table 4.3: Prevalence of plasmodiasis in infants in relation to four hospitals in Kaduna Metropolis 44

Table 4.4: Prevalence of plasmodiasis infection in infants in relation to mothers' occupation 46

Table 4.5: Prevalence of plasmodiasis in infants in relation to mothers' educational status 47

Table 4.6: Prevalence of plasmodiasis in infants in relation to domestic sources of water 48

Table 4.7: Prevalence of plasmodiasis in infants in relation to some risk factors 50

Table 4.8: Overall prevalence of geohelminthes in the four hospitals sampled (N= 152) 51

Table 4.9: Prevalence of geohelminthiasis in infants in relation to gender 52

Table 4.10: Prevalence of geohelminthiasis in infants in relation to age 53

Table 4.11: Prevalence of geohelminthiasis infection in infants in relation to hospital 55

Table 4.12: Prevalence of geohelminthiasis in infants in relation to mothers' occupation 56

Table 4.13: Prevalence of geohelminthiasis in infants in relation to mothers' educational status 57

Table 4.14: Prevalence of geohelminthiasis in infants in relation to domestic sources of water 59

Table 4. 15: Prevalence of geohelminthiasis in infants in relation some to risk factors 60

Table 4.16: Prevalence of geohelminthiasis in infants in relation to items of feeding 61

LIST OF APPENDICES

Appendix Page

1: Questionnaire……80

2: Informed consent form……...82

3: Ethical clearance form……83

4: Soil Transmitted helminth Eggs……..84

5: Ring – form trophozoites of *P. falciparum* in a thin blood smear……84

CHAPTER ONE

INTRODUCTION

Billions of people throughout the world are afflicted with one parasitic infection or the other especially in the tropical areas of the world. Prominent among these infections arePlasmodiasis(malaria), trypanosomiasis, onchocerciasis,intestinal worm infections and schistomiases (Wuropa*et al*., 1989. Malaria affects1- 3.3billion people or half of the world's population, in 106 countries and territories. WHO estimated in 2010 that 216 million cases of malaria occurred, 91% in the African region, 655,000 malaria deaths and 86% were children under 5 years of age. Malaria is the third leading cause of death for children under five years worldwide after pneumonia and diarrheal disease (WHO, 2005).

Malaria remains a leading cause of morbidity and mortality worldwide especially in pregnant women and children, and particularly in tropical Africa, where thirty countries account forat least 90% of the malaria deaths (WHO, 2005). Nigeria, Democratic Republic of Congo (DCR), Ethiopia, Uganda accounts for nearly 50% of the global malaria deaths (WHO, 2005),

Malaria *is* the secondleading cause of death from infectious diseases in Africa after HIV/AIDS. Almost 1 out of 5 deaths of children under 5 in Africa is due to malaria (WHO, 2011).Malaria is a major public health problem in Nigeria where it accounts for more cases and deaths than any other country in the world and also remains a risk for 97% of Nigeria's population; the remaining 3% of the population live in malaria free highlands. There are estimated 100 million malaria cases with over 300,000 deaths per year in Nigeria, this compares with 215,000 deaths per year in

Nigeria from HIV/AIDS. Malaria contributes to an estimated 11% of maternal mortality (WHO, 2005).

The disease is caused by protozoan parasites of the genus *Plasmodium.* The five species that are active in human infections are *P. falciparum, P. vivax, P. malariae*, *P.ovale* and *P. knowlesi*. The most serious forms of the disease are caused by *P. falciparum* and *P. vivax* (Trampuz*et al.*, 2003). In recent years, some human cases of malaria among monkeys occur in certain forested areas of south-east Asia (WHO, 2012).

The pathogens are transmitted by female *Anopheles* mosquito under environmental temperature of between 18 and 29^{0C} with suitable humidity (Ukoli, 1999).About 20 different *Anopheles* species are locally important around the world. All of the important vector species bite at night. *Anopheles* mosquito breed in water and each species has its own breeding preference (WHO, 2012). Transmission is more intense in places where the mosquito life span is longer (so that the parasite has time to complete its development inside the mosquito) and where the mosquito prefers to bite humans rather than other animals. For example, the long lifespan and strong human – biting habit of the African vector species is the main reason why more than 90% of the world's malaria deaths are in Africa (WHO, 2012). Infants are thought to be protected against malaria during the first 6months of life, largely due to the transfer of maternal antibodies and the presence of fetal heamoglobin. These young infants have received little attention in terms of malaria research and treatment guidelines and this age group has systematically been excluded from clinical trials. The true prevalence of malaria in young infants is not well characterized, yet defining the prevalence is critical, especially in the light of the ongoing epidemiologic shifts in populations at risk for malaria (Cotter *et al.*, 2013). Data on the prevalence and clinical outcomes

of malaria in young infants are limited and contradictory; some studies show minimal while others report that the risk for malaria increases in the first months of life; according to the intensity of transmission (Kleinlouwenberg*et al*., 2005). A few reports indicate that the prevalence of the disease is higher than previously thought and that, after birth the period of protection against malaria is shorter than the widely quoted 6months (Nwenka*et al.*, 2004). A better understanding of the risk for malaria in early infancy is needed to develop antimalarial drugs and inform policy decision for this age group (Larru*et al.*, 2009).

Most of the 1-3million people who die each year from malaria are children, mainly in Africa, which is hyper-endemic for the disease. In older children, malaria has a similar course as in adults. However, in children below the age of 5 years, particularly infants, the disease tends to be a typical and more severe (Kakkilaya, 2011).

In malaria –endemic countries, malaria transmission does not occur in all parts of the country. Even within tropical and subtropical regions transmission will not occur in high altitude, during cooler seasons in some areas, in deserts (excluding the oases), in some Island in the Pacific Ocean which have no local *Anopheles* species capable of transmitting malaria andin some countries where transmission has been interrupted through successful eradication.

Generally, in warmer region closer to the equator transmission will be more intense, malaria is transmitted year around and *Plasmoduim falciparum* predominates.

In addition to malaria, parasitic infections caused by soiltransmitted helminths have increasingly gain recognition as an important public health concern, particularly in developing countries. According to WHO, the level of helminth infections can be viewed as an index of a community's progress towards a desirable level of sanitation (WHO, 1981), poor hygiene in children, with the prevalence of such infection being an excellent indicator of socio-economic status (Schultz,

1992). Many helminth parasites remain major contributors to morbidity and some mortality in developing countries (WHO, 1987).

The soil transmitted helminths are a group of parasitic nematode worms causing infection through contact with their eggs or larvae that thrive in the moist soil of the world's tropical and sub-tropical countries; the eggs require an incubation period in soil to become infective

As adult worms, geo– transmitted helminths live for years in the human gastrointestinal tract. More than one billion people are infected with the host of one species (WHO, 2005).
Parasitic geo- helminthes are among the most common infections of humans worldwide. They occur throughout the developing countries and are most common in the poorest communities (Savioli*et al*., 1992).

Of particular worldwide importance are the round worms (*Ascarislumbricoides*), Whip worms (*Trichuristrichura)* and Hookworms (*Necatoramericanus,Ancylostomaduodenale*(WHO, 2004).

Factors that favors the prevalence of these geo- helminths most especially in the tropical and subtropical regions of the world includefavorable climatic conditions, human Activity, poor personal / environmental hygiene, lack of awareness on the route of infection, indiscriminate eating habits, lack of political will to implement control programmes and inadequate access to chemotherapy.
The mode of transmission of these parasitic helminths can be through the oral - faecal route, in which case the infective stage is ingested in food, water, vegetable and hands contaminated with human feaces. Also the infective larva can penetrate unbroken skin (Cheesbrough, 1992).

The parasites can live for several years in the human gastrointestinal tract. Human beings are regarded as the only major definitive host for these parasites, although in some case *Ascaris* infection can also be acquired from pigs (Crompton, 2001).

The contribution of the environment to the spread of these diseases, host factors such as behavioral and socioeconomic status of the public have received little or no attention though investigation are necessary in order to determine the association between attention of the human host plasmodiasis and geohelmenthiasis

Over the years, several investigations have been carried out in different communities in Nigeria on the prevalence of these two diseases which have been largely on adults. In northern Nigeria, especially in Kaduna metropolis, not much has been documented on the prevalence of plasmodiasis and geohelmenthiasis in infants (0-24 month). Therefore the current study, attention was focused on the prevalence of plasmodium and geohelminth infections in Kaduna metropolis in some selected hospitals towards providing the much needed information on the diseases in infants.

1.1 Statement of the Research Problem

The level of research and reporting on infantile plasmodiasis and geo- helminthiases in Kaduna in general and Kaduna metropolis in particular is low to the extent that the importance of these diseases on the health of infants is not fully known.

1.2 Justification

The low tempo of research and reporting on infantile geohelminthiasis is predicatedon poor understanding that geohelminth infections are not of public health importance in infants. Given that current information suggest otherwise, the present study on prevalence and risk factors

associated with plasmodiasis and geohelminthiasis in infants is intended to enrich the pool of informationneeded towards meaningful assessment of the status of the diseases and forthe designing of control measures in the area.

1.3 Aim

To evaluate the prevalence of plasmodiasis and geo- helminthiasis in infants attending selected hospitals in Kaduna metropolis.

1.4 Objectives

To determine;

i. Prevalence of infantile plasmodiasis and geohelminthiasis.

ii. Age and gender specific prevalence of infantile plasmodiasis and geohelminthiasis.

iii. Specific risk factors associated with *Plasmodium* and geohelminths in infants

1.5 Hypotheses

i. Infantile plasmodiasis and geohelminthiases are not prevalent in infants in the study area.

ii. The prevalence of infantile plasmodiasis and geohelminthiases are not significantly influenced by age and gender.

iii. Infantileplasmodiasis and geohelminthiases are not significantly associated with specific risk factors

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Epidemiology of Malaria

Malaria (*Plasmodiasis)* is the most prevalent disease in the world today. Each year it causes diseases in approximately 650 million people and kills between one and three million most of them young children in sub-Sahara Africa (Hay *et al.,* 2004). It is a public health problem in more than 90 countries inhabited by 2,400 million people 40% of the world population. Nigeria is known for high prevalence of malaria and it is a leading cause of morbidity in the country. Available records show that at least 50% of the populations of Nigeria suffer from at least one episode of malaria each year and this accounts for over 45% of all outpatient visits (Ojurongbe*et al.,* 2007). The disease accounts for 25% of infant mortality and 30% of childhood mortality in Nigeria thereby imposing great burden on the country in term of pains and trauma suffered by its victims as well as loss in outputs and costs of treatment (Ogungbanigbe*et al*., 2005). The disease is caused by protozoa parasites of the genus *Plasmodium*. The five species active in humans are *P. falciparum, P. malariae, P.vivax, P. ovale* and *P.knowlesi.* The most serious forms of the disease are caused by *Plasmodium falciparum* and *Plasmodium vivax* (Trampuz*et al*., 2003). The parasite is transmitted by female *Anopheles* mosquitoes under favorable environmental temperature of between 18 and 29^0C with suitable humidity of at least 60% (Ukoli, 1991). The development of malaria parasite inside the mosquito is more rapid as the temperature rises and ceases entirely below 60^0C increased rainfall and stagnant pools of water or surface water provide hospitable breeding grounds for the mosquitoes.

Malaria (*Plasmodiasis*) is endemic in Nigeria and the populations at highest risk include children, pregnant woman and non-immune host. Symptoms of the disease include cyclical bouts of fever, with muscle stiffness, shaking and sweating (Adefuoye*et al.*, 2007).

Consequences of severe malaria include coma and death if untreated young children are especially vulnerable (Idro*et al.*, 2007). Malaria is known to cause cognitive impairment, anemia during a period of brain development and also direct brain damage resulting from cerebral malaria to which children are more vulnerable (Boivin, 2002). Over the longer term, developmental impairment has been documented in children who have suffered episodes of severe malaria (Trampuz*et al.*, 2003).

In Nigeria, malaria is a major public health problem where it accounts for more cases of death than any other country in the world and is a risk for 97% of its population. The remaining 3% of the population live in malaria free highlands. *Plasmodiasis* is higher in the wet than dry season though this seasonal variation is more marked in the north than the south (Slake, 1986). Malaria is seriously felt in the poorest countries and those living under difficult and impoverished conditions (WHO, 1987).

In Africa, malaria is responsible for about 10% of hospital admission and 20-30% of outpatient consultations. Children are particularly at risk of the disease, malaria being the major childhood killer in rural tropical Africa, taking the life of one of 20 children before the age of 5 years. The disease causes anemia in children and pregnant women and increases vulnerability to other diseases.

Malaria is also a major cause of school absenteeism. In young adults in Africa, malaria is still one of the most common diseases and it tends to strike at the time when agricultural work is at its height (WHO, 1993).

Malaria is a major cause of disease and death in the countries of the African region. About 93% of the 550million people living in Africa are at risk of malaria. About 75% of the people in Africa live in areas of highly endemic stable transmission. Another 18% live in epidemic prone areas where malaria transmission is seasonal and unstable and where all age groups are vulnerable to infection and disease (WHO, 1995).

Currently, malaria affects more than 300 million people and kills an estimated 1.5 - 2.7 million people each year. At a meeting of 31 malaria experts in November, 1997 at World Health Organization Headquarters in Geneva it was agreed that global coordination of action against the disease is essential for the most effective use of resources (Africa Health, 1998).

Malaria (*Plasmodiasis*) is holoendermic in Nigeria with *Plasmodium falciparum* as the dominant strain. (Bruce-Chwatt 1952; Gilles, 1967; Moluneaix and Cramicara, 1980). It is the most common cause of outpatient visits to health facilities and is consistently reported as one of the five leading cause of death (Salako*et al.,* 1981). In 1994, Phillips adduce three major reasons for the continuous persistence of malaria infection in disregard to instituted control measures.

These factors include:

1. Spreading resistance of *Plasmodium falciparum* to chloroquine.
2. Impoverished economies, resulting in inadequate supplies of essential drugs, supplies and control tools

3. Development of epidemics in the wake of social unrest, climate changes, agricultural or land development, famine and refugee movement.

In parts of Africa where malaria is highly endemic, people are infected and re-infected so frequently that they develop a degree of acquired immunity. These subjects may become asymptomatic or mildly symptomatic carriers. The population develops and maintains a high degree of immune response while at the same time there is a nearly permanent present of very small numbers of malaria parasite in many subjects, mostly adults (WHO, 1990). Bruce - Chwatt (1988) described resistance which builds up in previously infected host in the presence of asymptomatic parasitemia as premonition. A real focus on malaria is long overdue. It is making an alarming come back in the region at the moment and the incredible rains we have been experiencing from some parts of the tropics has the potential of making the problem even worse. Combination therapy has caused significant drop in malaria cases globally.

2.1.1 Malaria (Plasmodiasis) in Infants: Newborns and infantsless than 12 months of age are one of the most vulnerable groups affected by malaria. During pregnancy, malaria infection in the mother cause low birth weight and result in infant death (WHO, 2010).In malaria endemic areas, infants once again become vulnerable to plasmodium malaria atapproximately 3 months of age when immunity acquired from the mother starts to wane. Infant are at increased risk of rapid disease progression, severe malaria and death. Severe anemia is particularly common in this age group (WHO, 2010).

More cases of malaria in the neonatal period are being reported, which may be due to congenital malaria derived via transplacental infection, malaria acquired postnatally from mosquito bites, or transfusional malaria following transfusion of packed red cells of whole blood exchange

transfusion (Quinn *et al.*, 1982, Picolli *et al*, 1983; McGregor, 1986; Thapa*etal*, 1987; Steketee, 1989).

2.1.2 Transmission of Malaria: Transmission also depends on climatic conditions that may affect the number and survival of mosquitoes, such as rainfall patterns, temperature and humidity. In many places, transmission is seasonal, with the peak during and just after the rainy season. Malaria epidemics can occur when climate and other climatic conditions suddenly favor transmission in areas where people have little or no immunity to malaria. It also occurs when people with low immunity move into areas with intense malaria transmission (for instance to find work, or as refugees).

Human immunity is another important factor, especially among adults in areas of moderate or intense transmission. Partial immunity is developed over years of exposure and while it never provide complete protection, it does reduce the risk that malaria infection will cause severe disease, for this reason malaria death in Africa occur in youngchildren whereas in areas with less transmission and low immunity, all age groups are at risk (WHO, 2012).

Approximately half of the world's population is at risk of malaria. Most malaria cases and death occur in sub – Saharan Africa. However Asia, Latin America and to a lesser extent in Middle East and parts of Europe and also affecting in 2011, 99 countries and territories had ongoing malaria transmission (WHO, 2012).

The natural ecology of malaria involves malaria parasites infecting successively two types of hosts: humans and female *Anopheles* mosquitoes. In humans, the parasites grow and multiply first in the liver cells and then in the red cells of the blood. In the blood, successive broods of parasites

grow inside the red cells and destroy them, releasing daughter parasites ("merozoites") that continue the cycle by invading other red cells (CDC, 2012)

The blood stage parasites are those that cause the symptoms of malaria. When certain forms of blood stage parasites ("gametocytes") are picked up by a female *Anopheles* mosquito during a blood meal, they start another, different cycle of growth and multiplication in the mosquito.

After 10-18 days, the parasites are found (as "sporozoites") in the mosquito's salivary glands. When the *Anopheles* mosquito takes a blood meal on another human, the sporozoites are injected with the mosquito's saliva and start another human infection when they parasitize the liver cells.Thus the mosquito carries the disease from one human to another (acting as a "vector"). Differently from the human host, the mosquito vector does not suffer from the presence of the parasites.

The malaria parasite life cycle involves two hosts (Figure I). During a blood meal, a malaria-infected female *Anopheles* mosquito inoculates sporozoites into the human host. Sporozoites infect liver cells and mature into schizonts , which rupture and release merozoites (Of note, in *P. vivax* and *P. ovale* a dormant stage [hypnozoites] can persist in the liver and cause relapses by invading the bloodstream weeks, or even years later.(CDC, 2012).

After this initial replication in the liver (exo-erythrocyticschizogony), the parasites undergo asexual multiplication in the erythrocytes (erythrocyticschizogony). Merozoites infect red blood cells. The ring stage trophozoites mature into schizonts, which rupture releasing merozoites. Some parasites differentiate into sexual erythrocytic stages (gametocytes). Blood stage parasites are responsible for the clinical manifestations of the disease (CDC, 2012)

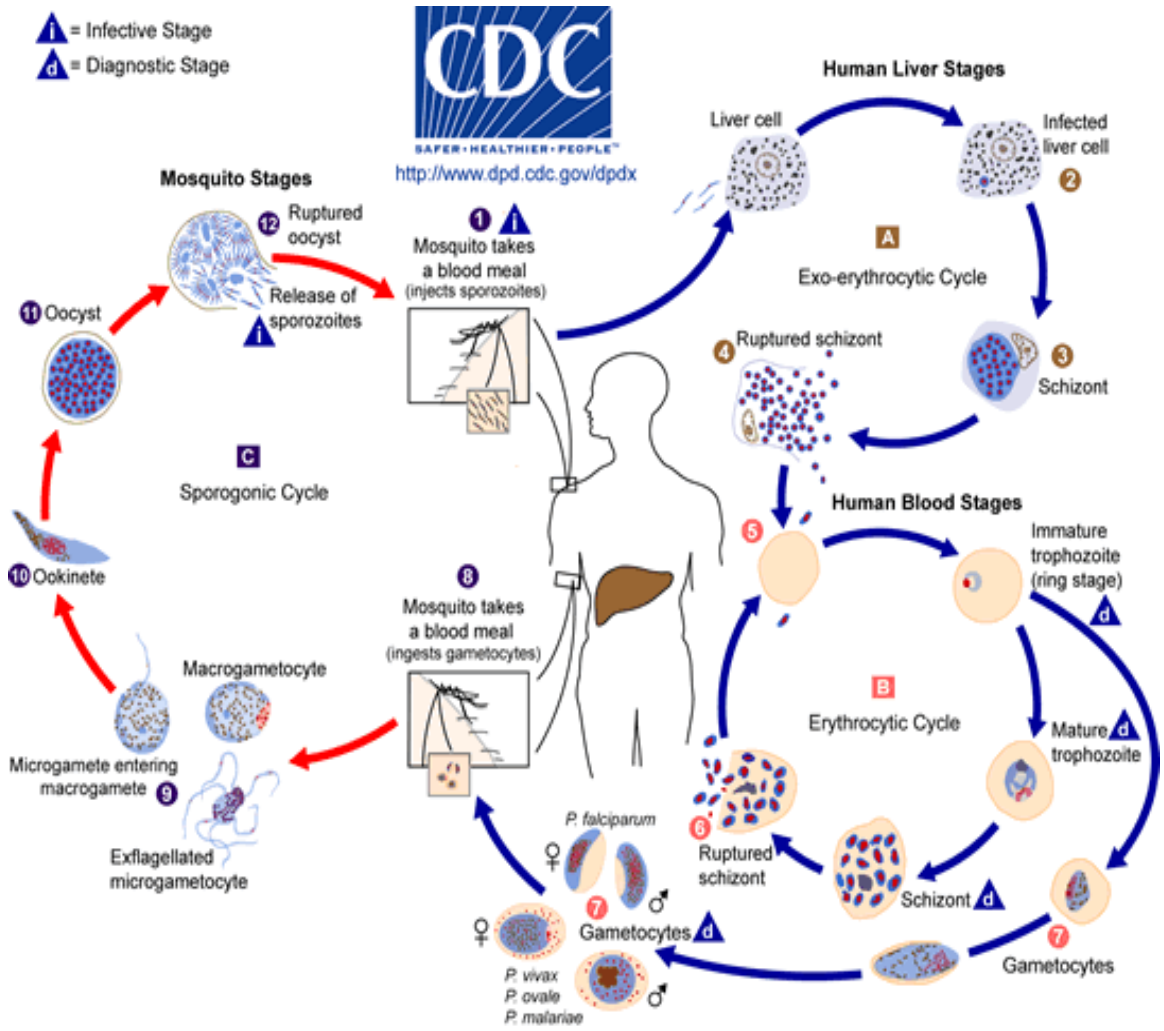


Figure I: Life cycle of the *Plasmoduim falciparum*

The gametocytes, male (microgametocytes) and female (macrogametocytes) are ingested by an *Anopheles* mosquito during a blood meal. The parasites' multiplication in the mosquito is known as the sporogonic cycle while in the mosquito's stomach, the microgametes penetrate the macrogametes generating zygotes. The zygotes in turn become motile and elongated (ookinetes) which invade the midgut wall of the mosquito where they develop into oocysts. The oocysts grow, rupture, and release sporozoites , which make their way to the mosquito's salivary glands and subsequent inoculation of the sporozoites into a new human host perpetuates the malaria life cycle (CDC, 2012).

2.2 Pathology

The characteristic feature of malaria is fever. It usually occurs in three stages as follows:

i. Cold stage, characterized by rigor and headache. The patient feels cold and shivers even though his or her temperature is rising.

ii. Fever stage, in which the temperature rises to its maximum and headache, is severe. Usually there are pains in the back and joints and often vomiting and diarrhea.

iii. Sweating stage, in which the patient perspires, the temperature falls and the headache and other pains are relieved until the next rigor. With *falciparum* malaria, attacks of fever may reoccur on alternate days or more commonly the fever tends to be continuous or irregular (Cheesbrough, 1987).

A *falciparum* infection is considered as severe when more than 5% of the red cells become parasitized (WHO, 1986). Severe *falciparum* malaria is more likely to occur in a non-immune person, person with lapsed immunity, pregnant woman (particularly prim gravid), an immunosuppressed person, or following splenectomy.

The following complications are associated with severe *falciparum* malaria:

i. Cerebral Malaria: This is the commonest cause of death; *falciparum* malaria is due to parasitized red cells and fibrin blocking capillaries and venules in the brain. Haemorrhaging from these small blood vessels may occur. In 1982, Warrell recommended a definition of cerebral malaria as the presence of unarousable coma, exclusion of other encephalopathies and confirmation of *Plasmodium falciparum* infection. Cerebral malaria usually occurs with heavy parasitaemia but it has been known to occur when the numbers of parasites are few, Children and non-immune, adults are more commonly affected (WHO, 1990).

ii. Anaemia: This can be severe and occur rapidly, particularly in young children, Anaemia in *falciparum* malaria is due mainly to the mechanical destruction of parasitized red cells. Parasitized cells also lose their deformability and are rapidly- phagocytosed and destroyed in the spleen. The production of red cells in the bone marrow is also reduced and there is a slow reticulocyte response. In a small number of patients, an immune destruction of red cells may occur (WHO, 1990).

iii. Blackwater fever: This is a rare but acute condition in which there is a rapid and massive intravascular haemolysis of both parasitized and non-parasitized red cells, resulting in haemoglobinaemia, hemoglobinuria, and fall in haemoglobin. It is accompanied by high fever, vomiting, and jaundice and is often fatal due to renal failure. Following a haemolytic attack the parasites are difficult to find in the blood. The urine appears dark-red to brown-black due to the presence of free haemoglobin in the form of rnethaernoglobin and oxyhaernoglobin. The urine contains protein, hyaline and granular casts, and epithelial debris (CDC, 2006).

iv. Diarrhea and vomiting: These features are common in acute and severe *falciparum* malaria, especially in children and non-immune adults.

v. Pulmonary Oedema: This complication is rare but often fatal. It frequently accompanies renal failure and occurs where there is heavy parasitaemia especially during pregnancy or following childbirth.

vi. Hypoglycemia: This finding is being increasingly reported in patients with severe malaria, especially children, pregnant women, and in those treated with quinine and quinidine (WHO, 1986).

2.3 Diagnosis

Testing is performed to help diagnose malaria to monitor for relapse and to determine drug susceptibility of the parasite causing the infection.

i. Microscope diagnosis: Malaria parasite can be identified by examining under the microscope a drop of the patient's blood, spread out as "blood smear" on a microscope slide. Prior to examination, the specimen is stained (most often with Giemsa stain) to give the parasite a distinctive appearance. This technique remains the gold standard for laboratory confirmation of malaria. However, it depends on the quality of the reagents, of the microscope and on the experience of the laboratorian(CDC, 2012).

ii. Antigen Detection: various test kits are available to detect antigen derived from malaria parasites. Such immunologic (monochromatographic) Test most often use a dip stick or cassette formal and provide result in 2 – 15 minutes. These "Rapid Diagnostic Tests" (RDTs) offer a useful alternative to microscopy in situations where reliable microscopic diagnosis is not available. Malaria RDTs are currently used in some clinical settings and programs. However, before malaria RDTs can be widely adopted several issues remain to be addressed, including improving their accuracy, lowering their cost, and ensuring their adequate performance under adverse field conditions(CDC, 2012)

iii. Molecular diagnosis: Parasite nucleic acid is detected using polymerase chain reaction (PCR). Although this technique may be slightly more sensitive than smear microscopy, it is of limited utility for the diagnosis of acute ill patients in the standard health care setting. PCR results are often not available quickly enough to be of value in establishing the diagnosis of malaria (CDC, 2012).

iv. Serology: Serology detects antibodies against malaria parasites, using either indirect immunofluorescence (IFA) or enzyme – linked immunosorbent assay (ELISA). Serology does not detect current infection but rather measures past exposures.

v. Drug resistance tests: Drug resistance tests must be performed in specialized laboratories to assess the susceptibility to anti-malaria compounds of parasites collected from a specific patient (CDC, 2012).

Two main laboratory methods are available:

i. In vitro tests: The parasites are grown in culture in the presence of increasing concentration of drugs; the drug concentration that inhibits parasite growth is used as endpoint.

ii. Molecular characterization: Molecular markers assessed by PCR or gene sequencing also allow the prediction to some degree, of resistance to some drugs (CDC, 2012).

2.4 Treatment and Case Management

As a response to the anti-malarial drug resistance situation, WHO now recommends that treatment policies for*P.falciparum* malaria in all countries experiencing resistance to mono-pyrimethamine and amodiaquine, should be in combination therapies, preferably those containing an artemisin derivative (ACT artemisine based combination therapy) (WHO, 2001c).

It is now considered that an effective anti-malarial treatment would have a greater impact on reducing mortality than merely improving second-line treatment or the management of severe malaria (WHO, 2001a, 2000b, 2003b; 2004a and 2004 d).

The concept of combination therapy is based on the synergistic or additive potential of two or more drugs, to improve therapeutic efficacy and also delay the development of resistance to the individual components.

Amodiaquine, artemisine derivatives arthemether/ lumefantrine, chloroquine and quinine are all safe to use in infants and children of all ages for the treatment of uncomplicated malaria. Clindamycin is apparently also safe in all ages but the data is limited. Sulfadoxine/pyrimethamine is contraindicated in infants under 2 months of age, mafloquine in infants under 3 months, primaquine in children under 4 years and tetracycline and doxycline in children under 8 years (WHO, 2001a).

Administration of anti-malarial drugs to infants and young children may be problematic and dosages should be based preferably on body surface area. However, given the absence of pharmacokinetic data in young children and infants the narrow therapeutic malarial drugs, most recommendations are based on the assumption that children need same mg/kg doses amounts as adults.

Combination therapy with anti-malarial drugs is the simultaneous use of two or more blood schizontocidal drugs with independent modes of action and different biochemical targets in the parasite (WHO, 2001c).

The advantages of artemisine that make them ideal combination partner (WHO, 2001a, and c) are:

i. Rapid reduction of parasite densities,
ii. Rapid resolution of clinical symptoms
iii. Effective action against multi-drug resistance *P. falciparum*
iv. No documented resistance as yet with the use of artemisine, and its derivatives;
v. Few clinical adverse reaction
vi. Reduction of gemetocytes carrier rates which may reduce transmission.

The following are the combination therapies currently recommended, (WHO, 2001c; 2003b; 2005 a and d);

i. Arthemether/lumefantrine
ii. Artesunate (3 days) plubamodiaquine (in areas where amodiaquine efficacy remains high);
iii. Artesunate (3 days) plus sulfadoxine/pyrimethamine (in areas where S/P efficacy remains high);
iv. Artesunate (3 days) plus mefloquine (reserved for areas of low transmission; and
v. Amodiaquine plus sulfadoxine/pyrimethamine (sp) (as an interim policy in areas where amodiaquine and s/p efficacy remains high. If countries for whatever reason are viable to move to ACTs).

Young African children infected with P. *falciparum* occur for about 75% of the more than 1 million deaths from malaria that occurs worldwide each year. In areas of intense perennial malaria transmission, clinical episodes occur from the age of approximately 3 months; with the highest burden of several diseases and death falling on children between the age of 6 months and 3 years who have not yet acquired adequate clinical immunity. Anaemia, low birth weight and the neurologist's sequelae of cerebral malaria are, in addition, complications of malaria that may compromise, the health and development of millions of children throughout the tropical world (Schellenberg*et al*., 2003).

The introduction of in vitro techniques for the assessment of drug sensitivity of *Plasmodium falciparum* has facilitated testing in individuals and communities; for correlation between in vivo and in vitro finding is very close in individual and communities with moderate, little or no immunity. However, this may not be the case in person with longstanding intensive contact with malaria, i.e. in semi-immune from that area hyper or holo-endemic for malaria (WHO, 1984).

The invitro test provides a means for the quantitative assessment of drug response related to individual (and grouped) parasite isolates. The results are therefore independent of the inference of immunity which largely determines the in vivo response and makes the interpretation of in vivo test result difficult.

Although the signs of suggesting the presence of drug resistance have so far come mostly from the vivo observation i.e. drugged, invitro are a careful additional method for monitoring the quantitative drug response. The in vitro system has the particular advantage of allowing the rapid testing of a large number of CNE and the simultaneous testing of a parasite population with several drugs (WHO, 1984).

2.5 Prevention and Control

In the 1986 report of the WHO Expert Committee on malaria, it was recommended that malaria control should be based on epidemiological approach and that it should be planned and coordinated within primary health care with the active participation of the community.

The WHO in 1993 set up an implementation of the Global malaria Control Strategy. The report went on to state that despite efforts this counting to eradicate or control it. Malaria disease in the tropic, it threatens about 40% of the world's population, undermining the health and welfare of families endangering the survival of children, debilitating the active population straining both countries and people scarce resources by excessive public health costs, low productivity and impaired growth.

The problem is becoming qualitatively more difficult to manage because of the continuous intensification and spread of resistance to anti-malarial drug among parasite, which poses a

serious threat of increased severity of disease and death. Quantitatively, the number of face of intense malaria transmission is increasing because of changing environmental condition or areas of intense economic development and the spread of malaria to areas previously free of the disease, as millions of people move to malarious areas to claim land, seek wealth or escape civil disturbances and war.

In October 1992, in Amsterdam, WHO brought together ministers of health from all countries to adopt a resolution to fight malaria together (WHO, 1993). A control strategy was agreed, aimed at preventing mortality and to reduce morbidity and social and economic loss due to the disease, through improving and strengthening of local and national capabilities. The aim of the Global malaria control strategy stipulates that since malaria varies throughout the control in all countries or situations. On the contrary, each country's circumstances will determine the most practicable way to identify local problem and priorities and to design and implement appropriate interventions. They key is competent local action.

The four basic technical elements of the global strategy are to:

i. Provide early diagnosis and promote treatment.
ii. Plan and implement selective and sustainable preventive measures, including vector control.
iii. Detect early, contain or prevent epidemics
iv. Strengthen local capacities in applied research to permit and promote the regular assessment of a country's malaria situation, in particular the ecological, social and economic determinants of the disease (WHO, 1993).

Throughout the African continent, early diagnosis and prompt treatment form the primary strategy for reducing malaria and morbidity organized vector control activities are carried out in a few of

the countries with endemic and stable malaria. However, if carefully chosen, preventive activities can have some impact. A major cause for concern in many countries of the African region is the scarcity of trained entomologists and epidemiologists in public health services. This lack will hinder the planning, implementation and evaluation of vector control in keeping with the requirements of the global malaria control strategy. Lack of resources is also a continuing constraint (WHO, 1995).

Measures used to prevent and control malaria includes:

1. **Indoor Residual Spraying (IRS):** Remain the most widely used malaria vector control method. Its application has been thoroughly standardized and there are clear specifications for suitable equipment and insecticides. Field guidelines on technical and operational issues are available in almost all languages of malaria endemic countries for example DDT insecticide.
2. **Personal Protection Measure:** are based on insecticide –impregnated materials such as bed nets and curtains mainly, but clearly we are facing implementation problems. It has been demonstrated that if they are properly applied they can provide a 30 to 60 percent reduction in malaria morbidity, and can be useful in terms of preventing drug resistance.
3. **Larval Control:** Given the nature of the vectors, which tend basically to breed everywhere in a small amount of water on the surface of the ground, this approach can be acceptable only under suitable mapping and characterization of breeding sites and will work mainly in urban and semi-urban areas. Larval control can be attained through environmental management, large space coverage, and community participation and can be done through chemical or biological control.

4. **Environmental Control:** Is used to prevent breeding, wasting and feeding of vectors, by source reduction and even through better housing, windows, doors, screening. Environmental change from road, den, or pipeline construction, deforestation, agriculture and irrigation can generate larval breeding sites. Environmental control can mostly be used in urban and semi-urban areas, and require community participation and inter-sectoral collaboration.

5. **Drugs:** Drugs have been critical in limiting morbidity and mortality, but treatment coverage of populations in most endemic countries is well below the level needed to interrupt transmission. Using drugs to;

a. Treat active infections, particularly in young children.

b. Prevent infections, especially in non-immune persons visiting or going to work in malarious areas or in persons with reduced immunity such as pregnant women.

6. **Biological Control:**Entomophagus bacteria (*Bacillus thuringiensis* and *Bacillus sphaericus*), fungi, microsporidians, predators and parasites are used against malaria vectors in the field condition. These controls are host specific and safer to the environment. The use of biocontrol agents for malaria control also poses certain operational constraints in view of the vastness of the anopheles breeding habitats and less acceptance for their use in domestic environments.

2.6 Distribution of Geohelminths Worldwide

The updated global distribution of geo- transmitted helminths revealed that the tropics and subtropics have wide spread infection of all three geohelminths. Estimates suggest that *A. lumbriocoides* infects 1.221 billion people, *T.trichuira* 795 million and hookworm 240million worldwide (de silva, *et al.*, 2003). The greatest numbers of geo- helminth infections occur in the

Americas, China, and East Asia and Sub-sahara Africa. *Strongyloidesstercoralis* is also a common geo-helminth in some of these regions, although detailed information on the prevalence of *strongyloidiasis* is lacking because of the difficulties in diagnosing human infection (de silva *et al*., 2003)

In most countries where soil transmitted helminths are endemic, school-age children experiences the highest prevalence and intensity of infection, particularly with *Ascarislumbricoides* and *Trichiristrichuira* (Hall*et al.*, 1997). Morbidity has been traditionally considered a result of heavy geo-helminth infections; children with light infections were thought to suffer no ill effects. There is increasing evidence however, that even low or a moderate intensity infection significantly retards childhood growth and development (Hall and Stephenson, 1994).

2.6.1 Infant Geohelminthiasis: Soil transmitted diseases ("helminth" means parasitic worm) are of major importance in developing countries. They are caused by infection with roundworm, hookworm, or whipworm and can include diarrhea, abdominal pain, and intestinal obstruction, aneamia and retarded growth and cognitive development. Children become infected by ingesting roundworm and whipworm eggs that have matured in soil contaminated by human faeces or by walking barefoot in contaminated soil where human hookworm eggs have hatched, producing larvae that penetrate the skin (CDC, 2014).

In recent years the deleterious impact of geo- transmitted helminth infections in preschool children has also been demonstrated; a review by Albonico and collagues (Albonico*et al.*, 2008) revealed that periodic deworming has been shown to improve growth, nutrient status (iron and Vitamin A) and motor language development in preschool children and justifies the inclusion of this age group in deworming programmes.

Children aged 24months and less make up between 5 and 10% of the 3.5billion people either infected with or at risk of infection from geo- transmitted helminthes (WHO, 2003). Evidence suggests that geo-transmitted helminthiases have a potential effect on growth and development of children under 24months of age (Abdel-Wahab*et al.*, 1974 Awasthi, *et al.*, 2000, Awasthi and Pande, 2001). Chronic STH infection resulting from *Ascaris, Trichuris* and hookworm can dramatically affect physical and mental development in children (WHO, 2002). Despite this, children of this age group continue to receive little or no attention largely because of lack of specific studies on such children giving rise to paucity of epidiomiological data. Hundreds of infantile disease associated with bloody stools, melana, anorexia and oedema were reported in China with 1960s. Many children showed clinical manifestation and eggs in their faeces on day 1-26 after birth and more cases occurred within 3 month of birth evidently these infection were mostly transmitted from the mother by transplacental and /or transmammary routes (Sen-Hai*etal.*, 2000). An epidemiological survey on geohelminth infection indicates that infantile geohelminthesis can occur at a high prevalence of 43.8% in Zanzibari (David *et al.*, 2007) and 50.35 (Awasthi *et al.*, 2008) in India until recently, Kirwan *et al.*, 2009) reported 13.01% infection rate on infantile geohelmitiasis in Ogun state, Nigeria.

Studies have also shown that the growth and physical fitness deficits caused by chronic STH infections are reversible following treatment with anthelmintic drugs (Stephenson *et al.*, 2000). Hookworms have long been recognized as an important cause of intestinal blood loss leading to iron deficiency and protein malnutrition, the iron deficiency anemia that accompanies moderate and heavy hookworm burdens is sometimes referred to as hookworm disease.

Geo-helminth infect more than one third of the African continent ‘s population at any time and the prevalence of *A. lumbricoides* and *T. trichiura* is greatest in equitorial ,central and west Africa, eastern Madagascar and South East Africa whereas hookworm is more widely distributed across the continent (Brooker*et al.,* 2006).

An examination of 2,394 stool sample from Indonesia showed the prevalences of *Ascarislumbricoides, Trichuristrichuira,* hookworms and *Strongyloidesstercoralis* as 73.7%, 62.6%, 24.5%, 1.6% respectively (Widjana*et al.,* 2000) .

A study of 286 randomly selected children in rural guinea showed that 53% of children were infected by at least one type of soil-transmitted nematode (Glickman*, et al.,* 1999) from Cameroon*, A. lumbricoides* was the most common geo-helminth encountered (54.9%) followed by *T. trichiura* (33.8%) and hookworm infection (20.3%)(Ndamukong *et al.,* 2000).In Nigeria, a 68.2% prevalence rate of intestinal helminthes from stool samples of children aged 0-17years was reported from Ibadan (Dada-Adegbola*et al.,* 2003).

Chukuwma*et al.,* 2009) in Nigeria reported that 53.6% soil and 87.7%stool samples were positive. The recovery rates from stool samples were; eggs of *A. lumbricoides* (54.1%) ,Hookworm (45.5%) and *T. trichiura* (18%). prevalence from soil samples showed (24.0%) of *Ascaris* eggs (25.9%) of hookworm eggs. Geo-helminth infection is the second leading cause of mortality in children 6 years of age in Africa (Ogbe*et al*., 2002).

The infection is promoted by poor hygienic habits such as indiscriminate disposal of human and animal faeces. This habit permits contact of faeces and its accompanying microbial load including geo-helminth eggs in the soil. Other risk factors include lack of safe water source, overcrowding,

poverty, geophagia, failure to wear foot wears, having pools of water/sewage around houses (Phiri *et al*., 2002).

In Nigeria a considerable amount of human and animal waste is discharged into the soil daily leading to the seeding of the soil with pathogenic organisms including geo-helminths eggs and larvae (Nock *et al.*, 2003). Infection may be direct or indirect through secondary sources as food, water, vegetables and fruits. Since most geohelminths infections are acquired through the faecal-oral route. Observations in Zaria Northern Nigeria showed that 70% of the soil samples in a school compound were contaminated with geohelmith eggs showing the level to which the soil can be contaminated with feaces (Nock *et al.*, 2004). Table 2.1 showed global prevalence and distribution of major human geohelminths.

Table 2.1: Prevalence and distribution of major human geohelminths

Disease	**Major etiologic agent**	**Global**	**Regions of highest prevalence**
Ascariasis	*Ascaris lumbirocoides* (roundworm)	1.221 billion	Developing regions of Asia, Africa and Latin America
Trichuriasis	*Trichuris trichiura*(whipworm)	795 million	Developing regions of Asia, Africa, and Latin America.
Hookworm	*NecatorAmericanus* and *Ancylostomaduodenale*	240 million	Developing regions of Asia, Africa and Latin America (especially areas of rural poverty)

Source :(Hotez*et al*., 2008)

2.7 Geohelminth Parasites

Adult Hookworms of the genera, *Necator* and *Ancylostoma*parasitise the upper part of the human small intestine. Whereas *Ascaris* (round worms) parasitise the entire small intestine and adult *Trichuris* (whipworms) live in the large intestine especially the caecum (Despomier*et al.*, 2005). The parasites can live for several years in the human gastrointestinal tract. Human beings are regarded as the only major definitive host for these parasites, although in some cases of*Ascaris* infections can also be acquired from pigs (Crompton, 2001). The geo- helminthes vary greatly in size and female worms are larger than male. After mating, each adult female produces thousands of eggs per day, which leave the body in the faeces (Despomier *et al*., 2005)

Infection with *T.trichuira* and *A. lumbricoides* is by ingesting the fully developed eggs. After ingestion of *Trichuris* eggs, the released larvae moult and travel to the colon where they burrow into the epithelia and develop into adult whipworms within about 12 weeks. (Despomier*et al.*, 2005).

Ascaris larvae penetrate the intestinal mucosa and after on obligatory extra intestinal migration. They enter the liver than the lungs, before passing over the epiglottis to re-enter the gastrointestinal tract and develop into egg laying adult worms about 9 -11 weeks after egg ingestion (Hotez*et al*., 2004).

Hookworm eggs hatch in the soil. The larvae molt twice to become infective third stage larvae, which are non-feeding but motile organisms that seek out higher ground to improve the chance of contact with human skin. After penetration, they enter subcutaneous venules and lymphatic vessels to access the host's afferent circulation.

Ultimately, the larvae become trapped in pulmonary capillaries, cut the lung, pass over the epiglottis and migrate into the gastro intestinal tract (Crompton, 2001).

About 5-9 weeks are needed for skin penetration until development of egg-laying adults. *A. dueodenale* larvae are orally infective and lactogenic transmission during breast feeding has seen postulated.

2.8 Epidemiology and Disease Burden

Geo-transmitted helminth infections are widely distributed throughout the tropics and subtropics. Climate is an important determinant of transmission of these infections, with adequate moisture and warm temperature essential for larval development in the soil (Brooker, 2006). Equally important determinant are poverty and inadequate water supplies and sanitation (de silva*et al*., 2003). In such conditions soil transmitted helminth species are commonly coendermic. Morbidity from this infection and the rate of transmission are directly related to the number of worms harbored in the host (Anderson and May, 1982), intensity of infection is the main epidemiological index used to describe geo-transmitted helminth infection.

Intensity of infection is measured by the Kato-Katz faecal thick-smear technique (Katz *et al*., 1972). For *A. lumbricoides* and *T. trichuira*, the most intense infections are in children aged 5-15years, with a decline in adulthood. Although heavy hookworm infections also occur in childhood, frequency and intensity common remain high in adulthood, even in elderly people (Bethony*et al.*, 2002). Soil transmitted helminth infections are often referred to as being "over dispersed" in endemic communities such that most worms are haboured by a few individuals in an endemic area (Anderson and May, 1982).

A higher infection rate has been observed in children than adult and in males than in female (Magambo*et al., 19*98), which is due to their exposure to the source of infections, low hygienic standard and lack of education on the route of infections with prevalence and severity of infection being high in developing countries where health and sanitary facilities are unable to cope with the demands of increasing population with main burden been borne by young children with adverse effect on their physical and natural development which may be long lasting (WHO, 1995).

Indiscriminate eating habit due partly to poverty, poor personal and environmental hygiene also contributes to the prevalence of these helminthes since infections is achieved through a range of food stuff example fish and vegetable eaten raw (Crompton, 1999), through contaminated unwashed fingers. Cyst or ova being spread by flies and other animals and circulating bank notes and also contaminated air.

2.9 Prevention and Control of Geo-Transmitted Helminths

Prevention and control is aimed at reducing the intestinal helmninthiases. However, this will not be possible until poverty is reduced standard of living improved; sanitation and pipe borne water supplies are improved. The use of night soil and manure must be discouraged and enlightenment campaign also carried out on routes of infection. Suitable sewage treatment and disposal facilities should be provided.

Among the strategies of integrated control of neglected tropical diseases deworming programme represent one of the most efficient and cost effective means to improve child health and education, pregnancy outcome reducing anaemia, improve worker productivity, and prevent blindness and skin disease.

Single dose anthelminthic treatment, usually without prior diagnostic administered to high risk groups is the strategy of choice. This approach has been termed chemotherapy (Knoppy*et al.*, 2007).

Chemotherapy with single dose broad spectrum, safe and low cost antihelminthic drugs is the mainstay of programmes aimed at the control of morbidity due to intestinal nematodes (Savioli*et al.*, 1992).

STH infections can be controlled cost effectively using anthelmints (World Bank, 1993). Albendazole has been found to be most appropriate for mass chemotherapy however its efficacy against different geo-helminth has been variable (Ismail *et al.*, 1991, Albonico*et al*., 1994). Study done by Elmas*et al.*, 2004) in Kwazulu treatment with albendazole was very effective against hookworm and A. lumbricoides with cure rates (CR) of 78.8 and 96.4% and egg reduction rates (ERR) of 93.2 and 97.7% respectively however it was exceptionally ineffective against T. Trichiura (CR =12.7% ERR = 24.8%). Although both albendazole and mebendazole are deemed broach spectrum anthelmintic agents, important therapeutic differences affect their use in clinical practice. Both agents are effective against ascaris in a single dose. However in hookworm, a single dose of mebendazole has a low cure rate and albendazole is more effective. (Albonico *et al*., 2002). Conversely, a single dose of albendazole is not effective in many cases of trichuriasis (Adams *et al*., 2004) for both trichuriasis and hookworm infections, several doses of benzimidazole anthelmintic drugs are commonly needed. Another important difference between the two drugs is that mebendazole is poorly absorbed form gastrointestinal tract so its therapeutic activity is largely confined to adult worms. Albendazole is better absorbed especially when

ingested with fatty meals, and the drug is metabolished in the lives to a sulphoxides derivative, which has a high volume of distribution in the tissues (Dayan, 2003).

The regular treatment with benzimidazoleanthelmintics drugs in school age children reduces and maintains the worm burden below the threshold associated with disease (Savioli*et al*., 2002). The benefits of regular deworming in this age group include improvements in iron stores, (Stephenson *et al.*, 1989) growth and physical fitness, (Stephenson *et al*., 1993) cognitive performance and school attendance (Miguel, 2003). In younger children, studies have shown improved nutritional indicators such as reduced wasting, malnutrition and stunting and improved appetite (Aswasthi*et al*., 2000).

Treated children had better scores for motor and language milestones in their early development (Stoltzfus*et al*.,2004) although some investigators still find this relation controversial prevalent to their findings, administration of anthelmintic drugs to children infected with soil transmitted helminthes from 1 year of age is now deemed appropriate (Montressor, 2002).

If women in endemic areas are treated once or twice during pregnancy, there is substantial improvement in maternal anaemia (Torlesse*et al.*, 2001) and birth weight and infant mortality at 6 months (christain*et al.*, 2004).

In areas where hookworm infections are endemic, anthelmintic treatment is recommended during pregnancy except in the first trimester (Savioli*et al.*, 2002).

Combination therapy with drugs differing modes of action is an alternative strategy to improve efficacy and lower the risk of resistance (Albonico*et al.*, 2004). For example combinations of

levamisole with mebendazole and of pyrantel with oxantel are more effective than any single drug (Albonico*et al*., 2002).

Vaccination remains the method of choice to control soil transmitted helminthes infections, because it offers the possibility of a simple, single step for the interruption of infections, disease and transmission, several substantial obstacles impede vaccine development against soil transmitted helminthes (Maizels*et al.*, 1999).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

Kaduna lies between latitude 10^{o} 31' 23"N and longitude 7 ^{o} 26' 25"E with a land mass of 46,053km^2 and a population of 6,113,505 (Galleria Media Limited, 2004; NPC, 2006). The vegetation is of the guinea savannah type. There is poor sanitation/ waste disposal and drainage system in Kaduna metropolis.Kaduna metropolis (Fig 2) falls on latitude 10^{o} 25'N and 10^{o} 36'N and longitude 7^{o} 23'E - 7^{o}30'E with the elevation ranging from 600 to 650m above sea level. The approximate size of the area is 8000m (8km^2), comprising Kaduna North, Kaduna South and parts of Chikun and Igabi Local Government Areas all in Kaduna State of Nigeria. Kaduna experiences a tropical continental climate, which is characterised by two distinct seasons of dry and wet; the dry season is between October and April while the wet season starts around late April and lasts till October. Temperature in Kaduna is high throughout the year with a mean minimum and mean maximum temperature of 23^{oC} and 34^{oC} respectively. Kaduna State in general is poor in sanitation and water supply. The State is endemic for malaria and many parasitic infections.

This study was carried out in four hospitals within Kaduna metropolis namely: Yusuf Dantsoho and Biba Hospitals in Kaduna South Local Government Area as well andBarauDikko and Giwa Hospitals in the Kaduna North Local Government Area. The four hospitals provide basic primary health care services (inpatients and outpatient care). They also provide immunisation, dental, antenatal and postnatal care services, X-ray services and much more.

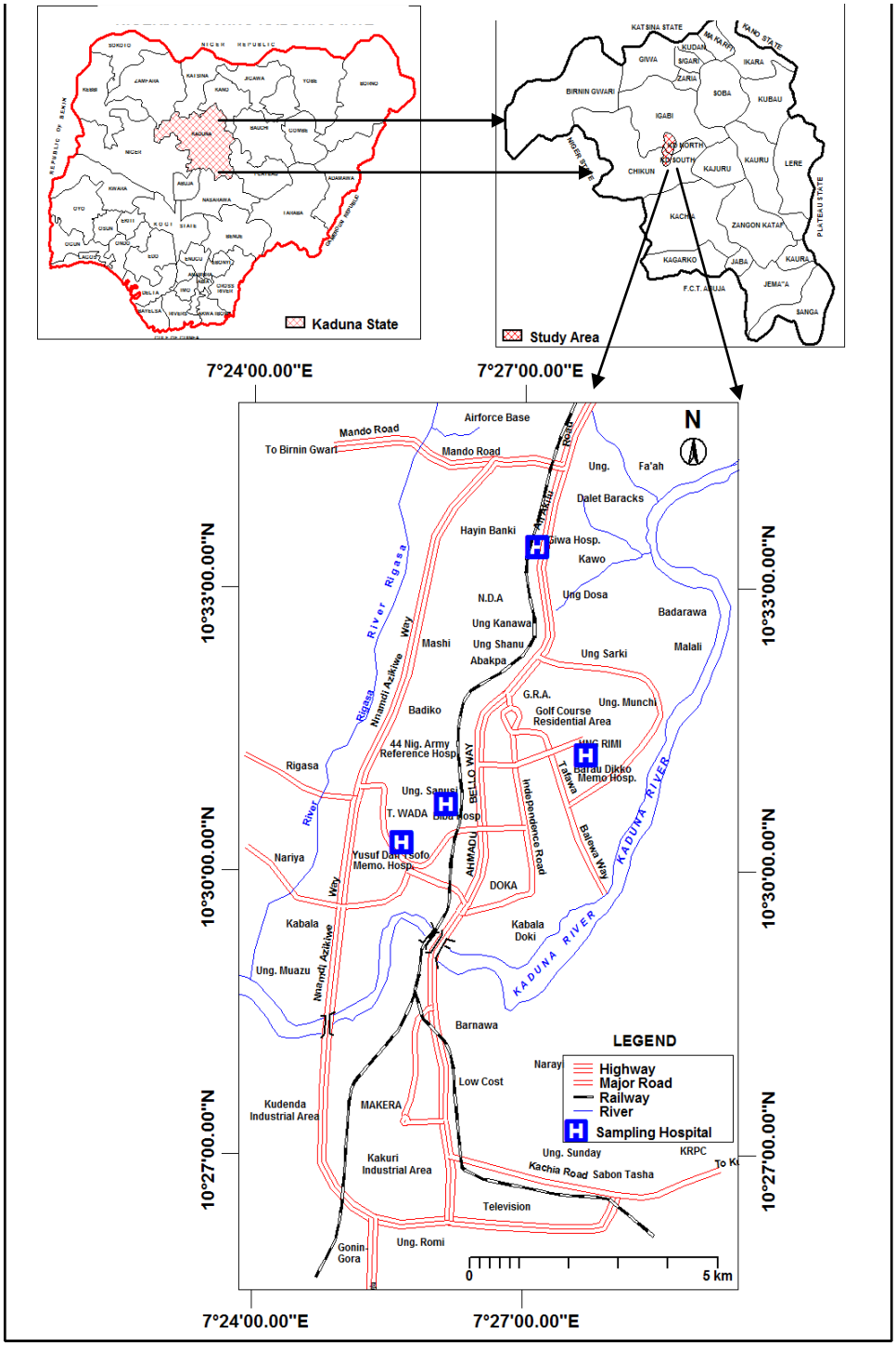


FIG 2: Map of Nigeria (Top Left), Kaduna state (Top right) and Kaduna Metropolis (Bottom) indicating the hospitals (H) sampled
Source: Adapted and modified from street guide map of Kaduna 2012

Yusuf Dantsoho and BarauDikko are publichospitals which provide free medical care services forchildren and their mothers. The environmental sanitation of the surroundings of the four hospitals was quite impressive and have no stagnant and surface water or bushes around.

3.2 Study Population

The study population consisted of five hundred and fifty two (552) male and female infants aged from 0-24 months, attending the four hospitals (BarauDikko, Yusuf Dantsoho, Giwa and Biba Hospitals in Kaduna metropolis) on referral on plasmodial and geohelminth infections.

Infant: An infant is aword derived from the Latin word 'infans' meaning unable to speak or 'speechless'. An infant is the very young offspring of a human or animal. When applied to humans, the term usually considered 'synonymous with a baby or bain. The approximate age for an infant is 0 – 3 years (CDC, 2012).

3.3 Study Design

A cross-sectional study design was used to evaluate and assess the prevalence and the risk factors associated that predispose infants with plasmodial and geohelminth infections with respect to age and gender.

3.4 Sample size

The sample size was determined using the formula of Samukaddu and Gerald (2006)

$$N=\frac{Z^2 (P) Q}{L}$$

Where N = Sample size

Z = Standard normal distribution

P = Prevalence of infection

Q = Probability

L = 5% error allowed in terms of 95% level of confidence.

$Z^2 = (1.96)^2$

P + Q = 1

L = 0.05

Substitution

P = 90% $\frac{90}{100} = 0.90$

Q =1_0.90 = 0.10

$N = \frac{(1.96)^2 * 0.90 * 0.10}{(0.05)2} = \frac{0.345744}{0.0025} = 138$ (per Hospital)

3.5 Ethical Clearance

Ethical clearance was obtained from the Kaduna State Ministry of Health and Medical Directors of the hospitals where blood and stool samples were collected.

3.6 Administration of Questionnaires

A structured questionnaire was administered on the mothers' of all infants recruited into the study (Appendix 1).

The questionnaire sought information on each child's gender, age and educational status of the mother. In addition it sought information on the sources of drinking water (tap, stream or well water), childfeeding practices(exclusive or non-exclusive breast feeding), type of toilet, and sanitation level of home environment, presence of pool of water, sewage and bushes around thehouse and hygiene practices of mothers /caregivers.

3.7 Sample Collection

Five hundred and fifty two (552) infants between the ages of 0-24months that were referred to the laboratory for malaria or intestinal worm screening were recruited for this study.

3.7.1 Stool samples collection

Stool specimens were collected in tight fitting sterile bottles in the morning from inpatients and outpatients and immediately taken to BarauDikko Hospital Laboratory for examination.

3.7.2 Blood samples collection

Safety procedures were adopted in the collection of blood samples by swabbing the area on the fingertip with 70% alcohol after which it was pricked with a sterile scalpel and blood taken into a capillary tube.

3.8 Examination of Samples

3.8.1 Blood: Thin blood films were prepared and labeled accordingly as recommended by the World Health Organization (WHO) and(Cheesebrough, 2000). Thin films were fixed with methanol and stained with 3% Giemsa stain at(pH 7.0) for 30min as recommended by WHO (WHO, 2000). The stained blood films were examined microscopically using thex100 (oil immersion) objective. The thin films were used to identify the parasite species and infective stage.

3.8.2 Stool: Stool samples were processed using the sedimentation technique (formol ether concentration technique) described by Cheesbrough (2005).One gramme(1g) of preserved stool samples was homogenized and emulsified with 5ml of 10% formol solution. The test tube was shaken vigorously to ensure complete dissolution .The emulsion solution was filtered into centrifuge tube using fine sieve. About 5ml of diethyl-ether was added to the filtrate. The filtrate was shaken for about 20 sec, centrifuged at 300 rpm for 2 min. An applicator stick was used to loosen the suspended faecal debris and the supernatant decanted. The sediment was then

transferred onto a glass slide and covered with cover slip. The slide was examined at x10 initially and x40 objective of light microscope for geohelminth eggs and larvae. Eggs/larvae ofgeohelminth parasites were identified using the keys of Cross and Yomagushi (1992).

3.9 Identification of Parasites

The *Plasmodium*were identified by observingthe trophozoites stage under the microscope. Early trophozoites have the characteristics signet ring shape. Also unique to *P. falciparum* is the presence of multiple trophozoites in red blood cell while the gametocytes stage of *P. falciparum* has a crescent or banana shape (CDC, 2012)

3.10 Data Analyses

The prevalence of infection was calculated and expressed as percentages. The data of the prevalence on sex and age was tested for significance using the chi square analysis with $p \leq 0.05$ as significant level. Odds ratio was calculated to determine association of the risk factors with diseases.

CHAPTER FOUR

RESULTS

4.0 Overall Prevalence of Plasmodiasis in Infants

Overall, 269 (67.25%) out of the 400 infants examined where positive for *Plasmodiumfalciparum*infection.

4.1 Prevalence of Plasmodiasis in Infants in Relation to Gender

Table 4.1 showed that of the 211 male infants examined, 132 (33.0%) were infected with *Plasmodium falciparum* parasite, while of the 189 females examined, 137(34.25%) were infected. The prevalence was significantly higher in female infants than in the male infants ($P<0.05$).

4.2 Prevalence of Plasmodiasis in Infants in Relation to Age

The highest prevalence was 17.75 %(71/103) in the age group 21-24 months followed by the 17 – 20 months 15.5 %(62/90) (Table 4.2). There was no infection in infants less than 1 month old. The difference between infection rate and age of infants was not statistically significant ($P>0.5$).

4.3 Prevalence of Plasmodiasis in Infants in Relation to Hospitals

The distribution of infant plasmodiasis with respect to hospital was shown in Table 4. 3.Barau Dikko Hospital hadthe highest prevalence 20.5% (82/100), followed by Yusuf Dantsoho Hospital 18.75% (75/100), Giwa Hospital 16.5 %(66/100) and Biba Hospital 11.5% (46/100). Prevalences were significantly different ($p<0.05$) between the hospitals where infants were attending hospital referral.

Table 4.1: Prevalence of plasmodiasis in infants in relationto gender

Gender	Number examined	Number positive	Prevalence (%)	Odd Ratio	Confidence Interval	P-value		Remark
Female	189	137	34.25	1.58	1.03-2.41	0.035	S	
Male	211	132	33.0					
Total	**400**	**269**	**67.25**					

S = significant

Table 4.2: Prevalence of plasmodiasis ininfants in relationto their age four Hospitals in Kaduna Metropolis

Age category (month)	Number examined	Number positive	Prevalence (%)	P-value	Remark
<1	0	0	0.0	0.87	NS
1-4	22	12	3.0		
5-8	41	27	6.75		
9 – 12	58	39	9.75		
13-16	86	58	14.5		
17-20	90	62	15.5		
21-24	103	71	17,75		
Total	**400**	**269**	**67.25**		

NS = Not significant

Table 4.3: Prevalenceof plasmodiasis in infantsin relation to fourhospitals in Kaduna Metropolis

Hospitals	Number Examined	Number Positive	Prevalence (%)	P-Value	Remark
BarauDikko	100	82	20.5	0.00*	S
Biba	100	46	11.5		
Giwa	100	66	16.5		
Yusuf Dantsoho	100	75	18.75		
Total	**400**	**269**	**67.3**		

S = Significant

4.4 Prevalence of Plasmodiasis in Infants in Relation to Mother's Occupation

Table 4.4 showed that 72, 160, and 320 of the infants examined ,belonged to mothers that were housewives, business women and civil servants respectively, of which 42 (10.5%), 140 (35.5%) ,87 (21.75%) were infected respectively. The difference in prevalence was significant ($P<0.05$).

4.5 Prevalence of Plasmodiasis in Infants in Relation to their Mother's Educational Status

Table 4.5 showed that 43, 270, 200 and 39 infants examined belonged respectively to mothers that had primary, secondary, tertiary and informal educational background, of which24 (6.0%), 82 (20.5%), 113 (28.25%) , 50 (12.5%) were infected respectively. The differences in prevalence were significant ($P<0.05$).

4.6 Prevalence of Plasmodiasis in Infants in Relation to Sources of DomesticWater Supply

Table 4.6 showed that the prevalence was highest 28.75 %(115) in infant whose mother's source of water was well, followed by tap water 18.5% (74), bore hole12.5% (50) and other sources of water, 7.5% (30). These association were significant ($P<0.05$).

Table 4.4: Prevalence of plasmodiasis infection in infants in relation to mothers' occupation

Occupation	Number Examined	Number Positive	Prevalence (%)	P-Value	Remark
Housewife	72	42	10.5	0.000*	S
Businesswoman	160	140	35.0		
Civil servant	168	87	21.75		
Total	**400**	**269**	**67.3**		

S = Significant

Table 4.5: Prevalence of plasmodiasisin infants in relation to mothers' educational status

Educational status	Number Examined	Number Positive	Prevalence (%)	P-Value	Level of Significance
Primary School	43	24	6.0	0.00*	S
Secondary school	100	82	20.5		
Tertiary Education	200	113	28.25		
Informal Education	57	50	12.5		
Total	**400**	**269**	**67.25**		

S = significant

Table 4.6: Prevalence of plasmodiasis in infants in relation to domestic sources of water

Water sources	**Number Examined**	**Number Positive**	**Prevalence (%)**	**P-Value**	**Level of significance**
Well	135	115	28.75	0.01*	S
Bore hole	75	50	12.5		
Tap	120	74	18.5		
Others	70	30	7.5		
Total	**400**	**269**	**67.3**		

S = Significant

4.7 Prevalence of Plasmodiasis in Infants in Relation to Some Risk Factors

Table 4.7 showed that infection was highest 190 (87.6%), OR=22.80 in infants whose homes were surrounded by bushes, followed by those with pool of water or sewage around their homes142 (78.9%), OR=7.21.Those that did not sleep under mosquito net 235 (77.8%), OR=22.28, those whose mothers were not exposed to health talk by organizations 187 (74.2%), OR=7.65 and then those that use pit toilet 186 (72.9%), OR=7.93. There was significant association ($P<0.05$) between prevalence and these risk factors.

4.8 Overall Prevalence of Geohelminths

Table 4.8 showed of the 152 stool samples examined, 50 (32.9%) had eggs of geohelminths; *Ascarislumbricoides* was the most prevalent infection 39 (25.66%), followed by *Hookworm* 6 (3.95%) while the least was *Trichuristrichura* 5(3.29%).

4.9 Prevalence of Geohelminthiasis in Infants in Relation to Gender

Table 4.9showed that out of the 152 samples collected from the female infants, 31 (20.39%) were positive as against 19 (12.5%) in males; the difference in genderprevalence was not significant ($P> 0.05$).

4.10 Prevalence of Geohelminthiasis in Infants in Relation to Age

In Table 4.10, the prevalence of geohelminthiasis in relation to age was found highest 7.89 %(12) in infants of 13-16 months and 21-24 months age group and lowest 0.67 %(1) in the 1-4 months age group. The difference in prevalence among the age groups was not statistically significant ($P>0.05$).

Table 4.7: Prevalenceof plasmodiasis in infants in relation to some risk factors

Risk factors	Responses	Number Examined	Number Positive	Prevalence (%)	Odds Ratio	Confidence interval (95%)	P-Value	Level Significance
Type of toilet facilities	Pit latrine	245	186	72.9	7.93	5.46-11.50	0.00*	**S**
	Water system	307	83	25.4				
Pool of water or sewage around homes	Yes	180	142	78.9	7.21	4.75-10.94	0.00*	S
	No	372	127	34.1				
Bushes around homes	Yes	217	190	87.6	22.80	14.17-36.69	0.00*	S
	No	335	79	23.6				
Sleep under mosquito nets	No	302	235	77.8	22.28	14.18-35.02	0.00*	S
	Yes	250	34	13.6				
Attend Health talk	No	252	187	74.2	7.65	5.23-11.18	0.00*	S
	Yes	300	82	27.3				

Table 4.8: Overall prevalence ofgeohelminthes in the fourhospitals sampled (N= 152)

Geohelminthes	No. infected	Prevalence (%)
Ascarislumbricoides	39	25.66
TrichurisTrichiura	5	3.29
Hookworm	6	3.95
TOTAL	**50**	**32.9**

S = Significant

Table 4.9: Prevalence of geohelminthiasisin infants in relation to gender

Gender	Number examined	Number positive	Prevalence (%)	Odds Ratio	Confidence Interval	P-value	Level of significance
Female	82	31	20.39	1.63	0.82-3.25	0.16	NS
Male	70	19	12.5				
Total	**152**	**50**	**32.9**				

NS = Not significant

Table 4.10: Prevalence of geohelminthiasis in infants in relation to age

Age category (months)	Number examined	Number positive	Prevalence (%)	P-value	Level of Significance
<1	0	0	0.0	0.18	NS
1-4	16	1	0.67		
5-8	23	6	3.95		
9 – 12	24	8	5.26		
13-16	26	11	7.24		
17-20	30	12	7.89		
21-24	33	12	7.99		
Total	**152**	**50**	**32.9**		

NS = Not significant

4.11 Prevalence of Geohelminthiasis in Infants in Relation to Hospital

In Table 4.11, the prevalence of infantile geohelminthiasis with respect to the hospitals where samples were collected shows that the highest prevalence was in Yusuf Dantsoho(12.50%) followed by BarauDikko (11.18%), Biba Hospital (5.26 %)and the lowest was from Giwa Hospital (3.95 %). The difference in prevalence among the hospitals was significant (P<0.05).

4.13 Prevalence of Geohelminthiasis in Infants in Relation to Mothers' Occupation

Table 4.13 showed that the highest prevalence ofgeohelminthiasis was in infants whose mothers were housewives 25 (16.45%), followed by business women 14 (9.21%) and civil servant 11 (7.24%). Infection in infants was significantly associated with the occupation of mothers (P<0.05).

4.14: Prevalence of Geohelminthiasis in Infants in Relation to Mother's Educational Status

The prevalence of geohelminthiasis in infants in relation to the educational status of mothers is presented in Table 4.14 Infection was highest in infants whose mothers had only primary education 18 (41.9%), OR=10.73 followed by those infants whose mothers had secondary education 16 (5.9%), OR=0.46, infants mothers with tertiary education 6 (3.0%), OR=0.22 while the least was in infants whose mother had no formal education 10 (25.6%), OR=4.08. In all cases there was significant relationship between geohelminth infection in infants and mother's educational status (P<0.05).

Table 4.11: Prevalence of geohelminthiasis infection in infants in relation to hospital

Hospitals	Number Examined	Number Positive	Prevalence (%)	P-Value	Level of significance
BarauDikko	38	17	11.18	0.00*	S
Biba	38	8	5.26		
Giwa	38	6	3.95		
Yusuf Dantsoho	38	19	12.50		
Total	**152**	**50**	**32.9**		

S = Significant

Table 4.12: Prevalence of geohelminthiasis in infants in relation to mothers' occupation

Occupation	Number Examined	Number Positive	Prevalence (%)	P-Value	Level of significance
Housewife	72	25	16.45	0.000*	S
Businesswoman	50	14	9.21		
Civil servant	30	11	7.24		
Total	**152**	**50**	**32.9**		

S = Significant

Table 4.13: Prevalence of geohelminthiasis in infants in relation to mothers' educational status

Educational status	Number Examined	Number Positive	Prevalence (%)	Odds Ratio	Confidence interval (95%)	P-Value	Level of Significance
Primary school	43	18	41.9	10.73	5.31-21.69	0.00*	S
Others	509	32	6.3				
Secondary school	270	16	5.9	0.46	0.25-0.85	0.01*	S
Others	282	34	12.1				
Tertiary Edu Cation	200	6	3.0	0.22	0.09-0.52	0.00*	S
Others	352	44	12.5				
Informal Education	39	10	25.6	4.08	1.86-8.97	0.00*	S
Others	513	40	7.8				

S = Significant

4.14: Prevalence of Geohelminthiasis in Infants in relation to DomesticSource of Water Supply

Table 4.14 showed the prevalence of geohelminthiasis in infants in relation to source of water. Infants associated with well water 24 (15.79%) were the most infected than those whose water source was Bore hole water 12 (7.89%). Also infants whose water source was tap water 5 (3.29%) were the least infected while infants who had from other sources of water 9 (5.92%) were infected. The source of water has a significant relationship with geohelminthic infection ($P<0.05$)

4.15 Prevalence of Geohelminthiasis in Infants in Relation to Risk Factors

Table 4.15 – showed that infection in infants is associated with not filtering or boiling water before drinking, well as source of water not covered, pit toilet system, pool of water around homes, not washing hands before eating, not washing utensils after feeding, not listen to health talk and engage in geophagy.

4.16 Prevalence of Geoherminthiasis in Infants in Relation to Feeding Pattern

Table 4.16 – showed that the highest prevalence of geohelminth infection was in infants that were fed with bare hands 22 (14.47%), the lowest in those fed with feeding bottles 13 (8.55%) and those infants fed with plates and spoons was 15 (9.87%). There is significant difference in prevalence in relation to items of feeding ($P<0.05$).

Table 4.14: Prevalence of geohelminthiasis in infants in relation to domestic sources of water

Water sources	Number Examined	Number Positive	Prevalence (%)	P-Value	Level of Significance
Well	75	24	15.79	0.00*	S
Bore hole	40	12	7.89		
Tap	25	5	3.29		
Others	12	9	5.92		
Total	**152**	**50**	**32.9**		

S = Significant

Table 4. 15: Prevalence of geohelminthiasis in infants in relation some to risk factors

Risk factors	Responses	Number Examined	Number Positive	Prevalence (%)	Odds Ratio	Confidence interval (95%)	P-Value	Level of significance
Filter or boil water before drinking	No	476	34	7.1	0.29	0.15-0.55	0.00*	S
	Yes	76	16	21.1				
Well always covered	No	477	35	7.3	0.32	0.16-0.61	0.00*	S
	Yes	75	15	20.0				
Type of toilet facilities used	Pit latrine	255	34	13.3	2.99	1.61-5.55	0.00*	S
	Water system	327	16	4.9				
Pool of water or sewage around homes	Yes	180	35	19.4	5.75	3.05-10.84	0.00*	S
	No	372	15	4.0				
Wash hands before feeding	No	52	40	76.9	163.33	66.48-401.32	0.00*	S
	Yes	500	10	2.0				
Wash utensil after feeding	No	37	32	86.5	176.71	61.63-506.66	0.00*	S
G	Yes	515	18	3.5				
Refrigerate leftover food	Yes	400	35	8.8	0.88	0.46-1.65	0.68	NS
	No	152	15	9.9				
Listen to health talks	No	252	35	13.9	3.07	1.63-5.76	0.00*	S
	Yes	300	15	5.0				
Geophagy	Yes	65	35	53.8	36.71	18.08-74.56	0.00*	S
	No	487	15	3.1				

NS = Not significant
S = Significant

Table 4.16: Prevalence of geohelminthiasis in infants in relation to items of feeding

Items for feeding	Number Examined	Number Positive	Prevalence (%)	P-Value	Level of Significance
Feeding bottles	22	13	8.55	0.00*	S
Bare hands	70	22	14.47		
Small plates and spoons	60	15	9.87		
Total	**152**	**50**	**32.9**		

S = Significant

CHAPTER FIVE

5.0 DISCUSSION

In this study, a high prevalence (67.25%) of *Plasmodiasis* found in the infants (0-24 months) attending the four Hospitals in Kaduna metropolis showedthat*Plasmodiasis* is still a problem in infants.This is an indication of the degree to which infants are infected with the *Plasmoduim*parasites in the study area. Similarly, Sotimehin*et al*., (2008) and Mustapha and Aliyu (2004) reported children under 2years showed a relatively higher malaria prevalence than those in above 5 year age group in malaria endemic countries.

Female infants had higher prevalence of plasmodial infection as compared tothe males though the rates were not statistically significant. This indicated that both male and femaleinfants have similar exposure infection transmission.

The significantly higher prevalence of infection among the older infants as against the younger infants could be associated with more care and protection they had in comparison to older infants12-24months(Collier, 1998).This disparity could be as a result of sequestration of malarial parasites in the placenta, a consequence of infection with *Plasmodium falciparum* during pregnancy which is associated with infant anaemia (Van Eijk*et al*., 2002).

It was observed that infants between the ages of 1-4months with fever were found to be positive formalaria; similar observations have been reported in endemic and hyper endemic areas (Sotimehin, *et al*., 2008 and Kakkilaya, 2006). It was found that the infection increases with age from 0-10% in the first 4 months of life to 50-60% by the 12month and this persisted with over more infected cases during the second year.

The presence of malaria parasites in the blood of the new born may be as a result of congenital malaria as reported by Sotimehin*et al (2008*). Congenital malaria is defined as the presence of

malaria parasites in the erythrocytes of new born age <7days which was considered rare in endemic areas until recent studies started reporting high (Sotimehin*et al*., 2008).This explains why there was no infection recorded in infants <1month in this study. In this study, there was no case of congenital malaria reported

In this study, thehighest prevalence was observed in BarauDikkofollowed by Yusuf Dantsoho, while a low prevalence in Giwa and Biba Hospitals,the high prevalences in the former hospitals could be due to more cases recorded and recorded, though the variations in prevalence were significant.

Malaria is often unevenly distributed across urban environments with heterogenetics in maloriometric indices measured between and within many citizens Evidence is also accumulating that in urban areas, the poor may be most vulnerable to the impacts of malaria (klinkenberg *et al.,* 2006).

With regards to plasmodiasis in infantsin relation to mother's occupation, prevalence was significantly high among the business women as compared to civil servant and house wives. The high prevalence in business women infants could be due to frequency of absence from parental care leadingto greater exposure and transmission.

Significantly higher prevalence of *P. falciparum* was associated with low educational status of the infant mothers.

Based on the other factors that may influence the prevalence of plasmodium infection in this study, it was found that prevalence of infection was high among those infants whose parents' homes had pools of water and sewage around as compared with those that do not have pools of water and sewage around their homes.The sewage, pools of water and poor environmental

conditions provide conducive breeding ground for mosquitoes and therefore enhance transmission

Also prevalence of Plasmodium infection was higher among those infants whose parents' homes have bushes around as compared to those with no bushes around houses. Bushes around the homes serve as resting sites for the mosquitoes and enhance contact and transmission.

There was significantly high prevalence in infants from homes that used well as a source of water supply as compared to those using tap and borehole water. This could be due to the fact that well water can serve as breeding site for mosquitoes, therefore increasing mosquito –child contact and invariably transmission.

Also there was significantly higher prevalence of Plasmodial infection in infants whose mothers use the pit latrine as type of toilet which can also be a source of breeding site for mosquito as compared to those that use water system in which rate of prevalence is low.

Based on the educational health talks by Organizations there is decrease in the prevalence of *Plasmodiasis* as compared to those mothers who have no knowledge on how to protect their infants from mosquito bites because they lack the knowledge on home management and control of malaria.

Geo-transmitted helminths are a great public health problem in several tropical and subtropical developing countries such as Nigeria due to poor socio-economic status and personal hygiene (Girum, 2005).The overall prevalence of geohelminthiasis in the study area was 32.9%. This results showed that geohelminthiasis in infants is relatively high in Kaduna Metropolis.

With regards to gender, the female infants had higher prevalence ofgeohelminthic infection as compared to the male infants. There is no significant difference statistically.

.The prevalence of geohelminths infection increased with age. The age group 17-20 months had the highest infection. This is a reflection of the exposure pattern which is associated with the young toddlers who are usually active and want to explore their surrounding and as such play and eat the soil which may have been contaminated with eggs of the geohelminths. And the least prevalence was in the age group 1-4months which are virtually infected due to lack of parental care.

The overall prevalence of geohelminths in this study area (4 Hospitals in Kaduna) was 32.89%. This result showed that geohelminthiasis was relatively high in the Hospitals within Kaduna state.

These findings are however closely related to those studies conducted in other parts of Nigeria (Kirwan *et al.,* 2009), in Ile-Ife Osun State; Luka *et al*., 2000) in Lere L.G. of Kaduna State 56.80%),

Anosiki*et al,* (2006) in Jos Plateau State (37.30%), several other reports from other parts of tropical Africa have been very high (>70.0%) infection rates.

Moreover the prevalence (32.89%) of geohelminthiasis in the study might be due to usage of well water by mothers, low standard of hygiene and low nutritional status of the people of the area (Kogi *et al*, 1991).

Differences in prevalence of geohelminths could be related to several factors including educational status of the mother because they lack the knowledge on proper care of their infants.

Those mothers' of infants with primary school had the highest prevalence this could be due to lack of awareness on how to manage home and to control the geohelminths infection and the least prevalence was among infants whose mothers that had tertiary education indicating educational status of the mother has significant influence on the prevalence of geohelminths infections.

The prevalence of infection among the different occupational groups of the mothers of the infants in the study varied significantly being highest in house wives, business women and least among the civil servants. The high prevalence of geohelminth in infants whose mothers are house wives could be attributed to poor personal hygiene and the environment, as such infants are usually left to play around and eat whatever comes their way, especially soil and also without shoes.

The source of water is considered as an important risk factor for the prevalence of geohelminthiasis. The sources of water for drinking, bathing and household use can expose one to infection (Gindiri*et al*., 2000). Prevalence was highest among infants whose mother gave them well water and prevalence was least among infants who drank tap water.The use of wells as source of drinking water might expose the infant to helminth infections. This could be due to contaminants being introduced into the wells as containers used in drawing the water and or direct dump of dirt into the wells. Contamination of well water with disease-causing agents had been documented in parts of Nigeria. Inabo *et al.,* (2000) reported that contaminative helminth infection are positively associated with well water. These sources are not usually covered, hence they are predisposed to contamination by waste including human and animal faeces containing cysts, eggs and or larva spread by vector as flies (WHO, 2014; WHO, 2015). The chances of ingesting parasites cysts or eggs in water are greatly enhanced. This study also found that

usingpipe borne water inside a compound was a risk factor for helminth infection in infants. Other studies have shown that helminth infection among pipe borne water users in developed countries may arise from the poor quality of pipe borne water (Camaro*et al*., 2002).

There was significant association between geohelminths infection and the type of toilet used by infants' mothers. Those parents with pit latrine as source of toilet had high prevalence rate as compared to those parents with water system toilet. The high prevalence was due to poor hygienic condition of the pit latrine and usually the floor is not usually cemented and it is moist, the eggs/cysts of geohelminths can be found on such floors.

Also prevalence of infection was high for those with pools of water and sewage around their houses than to those without pools of water or sewage. The pools of water and sewage provided a suitable environment for the transmission of infection- this could contain eggs and cysts of parasites.

There was also high prevalence in infants whose mothers do not wash hands before feeding as compared to those that do wash the feeding items of the infants. The result of this study reveals that the hands of the mothers were contaminated with parasites' eggs/cysts, most especially using of unwashed hands after toilet, meal and before meal to eat.

The result from this study showed that infants are influenced by eating the soils because the soil can contain eggs/larvae of geohelminths. And whose mothers do not have adequate knowledge of taking care of their surrounding from any organizations are usually ignorant about the precautions to take as to prevent the occurrence of geohelminthic infection.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

The prevalence was significantly higher in the female and the age group 21-24 months had the highest prevalence in plasmodiasis infection.

- The prevalence was (significantly high in the female and the age group 13-16 months had the highest prevalence in geohelminthisasis infection. In plasmodiasis specific risk factors include old age, bushes, pools of water or sewage around homes and not sleeping under mosquito net while for geohelminthiasis specific factors include poor personal hygiene, pit latrine, level of maternal education

6.2 Conclusion

i. In this study on plasmodaisis and geohelminthiasis in infants attending selected hospitals in Kaduna Metropolis,the Overall prevalence of plasmodium infection (67.25%) and geohelmnith was (32.9%).

ii. Prevalence of plasmodiasisinfection was associated by genderand also infection increases with age of the infants.

iii. Also in the prevalence of geohelminthinfection, at least (3) species of geohelmniths infection the infants, these are *Ascarislumbricoides* (25.66%), *Trichuristrichiura (*3.29%), and Hookworm (3.95%).Infection was associated with gender and age of infants.

iv. Prevalence was associated with specific risk factors in both infections, lack of mosquito net, bushes, pools of water and sewage around homes, occupation of the mother, and type of toilet, sources of waterand educational status of the mothers. Generally, parasitic contamination was attributed to poor personal hygiene habits by the mother at home.

6.2 Recommendations

i. There is the need to intensify awareness and education and to make the ITNs (insecticide treated nets) available at affordable prices.

ii. Chemoprophylaxis is recommended in infants that has the potential to reduce Plasmodiasis(malaria) related morbidity and mortality.

iii. Seasonal malaria chemoprevention (SMC) previously referred to as IPT in children (PTC) involves in administration of full anti – malarial treatment courses during malaria season in children 3 – 59 months (treated with amodiaquine plus sulphadoxine – pyrimethamine) should be given monthly at intervals form the start of the transmission season up to a maximum of four doses.

iv. It is also essential to avoid stagnant pools bushes around homes and poor environmental conditions, which encourage the breeding of mosquitoes.

v. Improvement in sanitation practices and provision of clean water .where it is inadequate, in order to provide safe and clean water to the populace.

vi. The socio economic conditions of the people should be improved upon in order to enhance and control the case of geohelminthiasIs and to reduce morbidity and mortality caused by these parasites.

vii. The impact of each measure would be maximized through a health education program directed at the infants and their mothers in particular and to communities in general.

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APPENDICES

Appendix1: Questionnaire

DEPARTMENT OF BIOLOGICAL SCIENCES

SCHOOL OF POSTGRADUATE STUDIES

RESEARCH QUESTIONNAIRE

25TH JULY, 2013

Dear Respondents,

I am a student of the above named institution. I am carrying out a research on "prevalence of plasmodiasis and Geo-helminthiasis in infants(0-24 months) attending some Hospitals in Kaduna Metropolis in partial fulfilment for the award of a Masters Degree in Biology.

Please answer the questions below and any information given will be confidentially treated.

i. Name of child_____

ii. Age of child_____

iii. Sex of the child_____

iv. Name of the child Mother/caregiver_____

v. Occupation of the mother / caregiver_____

vi. Age of the mother / caregiver_____

vii. Educational status of the mother / caregiver_____

a. Primary school ( ) b. Secondary School ( )

c. Tertiary institution ( ) d. Others ( )

Please tick the appropriate option

1. Source of drinking water? a. Well ( ) b. Pipe borne water ( ) c. Stream water ( ) d. Pond ( ) e. Tap ( )
2. If you are using well as your source of water, is the well always covered?
   a. Yes ( ) b. No ( ) c. Sometimes ( )
3. Do you filter or boil your water before drinking?
   a. Yes ( ) b. No ( ) c. Sometimes ( )
4. What type of toilet do you use?
   a. Pit latrine ( ) b. Water system ( ) c. None ( )
5. Do you have a pool of water or sewage around your house?
   a. Yes ( ) b. No ( )
6. Do you have bushes around your house? a. Yes ( ) b. No ( )
7. Do you and infant sleep under mosquito net? a. Yes ( ) b. No ( )
8. Do you wash your hands before feeding your child? a. Yes ( ) b. No ( )
9. What do you use in feeding your child? a. Feeding bottle ( ) b. Bare hand ( ) c. Small plate and spoon ( )
10. Do you wash the feeding bottle or the small plate and spoon before and after feeding your child? a. Yes ( ) b. No ( ) c. Sometimes ( )
11. Does the food of your child remain after feeding? a. Yes ( ) b. No ( )
12. If yes, where do you store it? a. Inside refrigerator ( ) b. Inside the feeding bottle ( ) b. No particular place for storage ( )
13. Do you haveorganise health talks in your area? a. Yes ( ) b. No ( )
14. Does the child eat soil? a.Yes ( ) b. No ( )

Appendix 2: Informed Consent Form

DEPARTMENT OF BIOLOGICAL SCIENCES

SCHOOL OF POSTGRADUATE STUDIES

INFORMED CONSENT FORM (ICF) **JULY, 2013**

Serial No…… Hospital……. Age…… Phone No……

This Informed Consent Form is basically for children attending some selected Hospitals in kaduna state, Nigeria. We are inviting you to participate in this research work titled **"PREVALENCE OF PLASMODIASIS AND GEOHELMINTHIASIS IN INFANTS (0-24 MONTHS) ATTENDING SELECTED HOSPITALS IN KADUNA METROPOLIS, NIGERIA**"

I **Rakiya GARBA** a Postgraduate Student of the department of Biological Sciences Ahmadu Bello University, Zaria will be undertaking this research work.

Your participation will involve the collection of stool and 2mls of blood taken from the participant using needle that might cause a little pain. I will appreciate your participation in this study. The results obtained might be used to improve the understanding and management of the disease in the community. All information obtained will be treated confidential and used only for the purpose of this research. All investigations will be free. You can withdraw from the research exercise at any point in time. Participation is strictly voluntary and refusal to participate in the research will not in any way affect your right and benefit in this clinic/Hospital.

Kindly fill the space below if you have given your consent to participate.

CERTIFICATE OF CONSENT

I……. give my consent to participate in this study. I have been duly informed of the process and have given my free will and not under any pressure whatsoever.

……

Signature and right thumb print of subject Date.....

……

Signature and right thumb print of witness Date.....

……

Signature and right thumb print of investigator Date……

Appendix 3: Ethical clearance form

MINISTRY OF HEALTH, KADUNA STATE

MOH/ADM/744/VOL.1/212 — 25th January, 2013.

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ETHICAL APPROVAL

I have been directed to convey the Ministry's approval to Rakia Garba, M.Sc. Student of Biological Sciences Department, ABU – Zaria, Kaduna State.

Topic: **PREVALENCE OF MALARIASIS AND HELMINTHAIASIS IN CHILDREN (1-2 YEARS) ATTENDING BARAU DIKKO SPECIALIST HOSPITAL & YUSUF DANTSOHO MEM. HOSPITAL, KADUNA.**

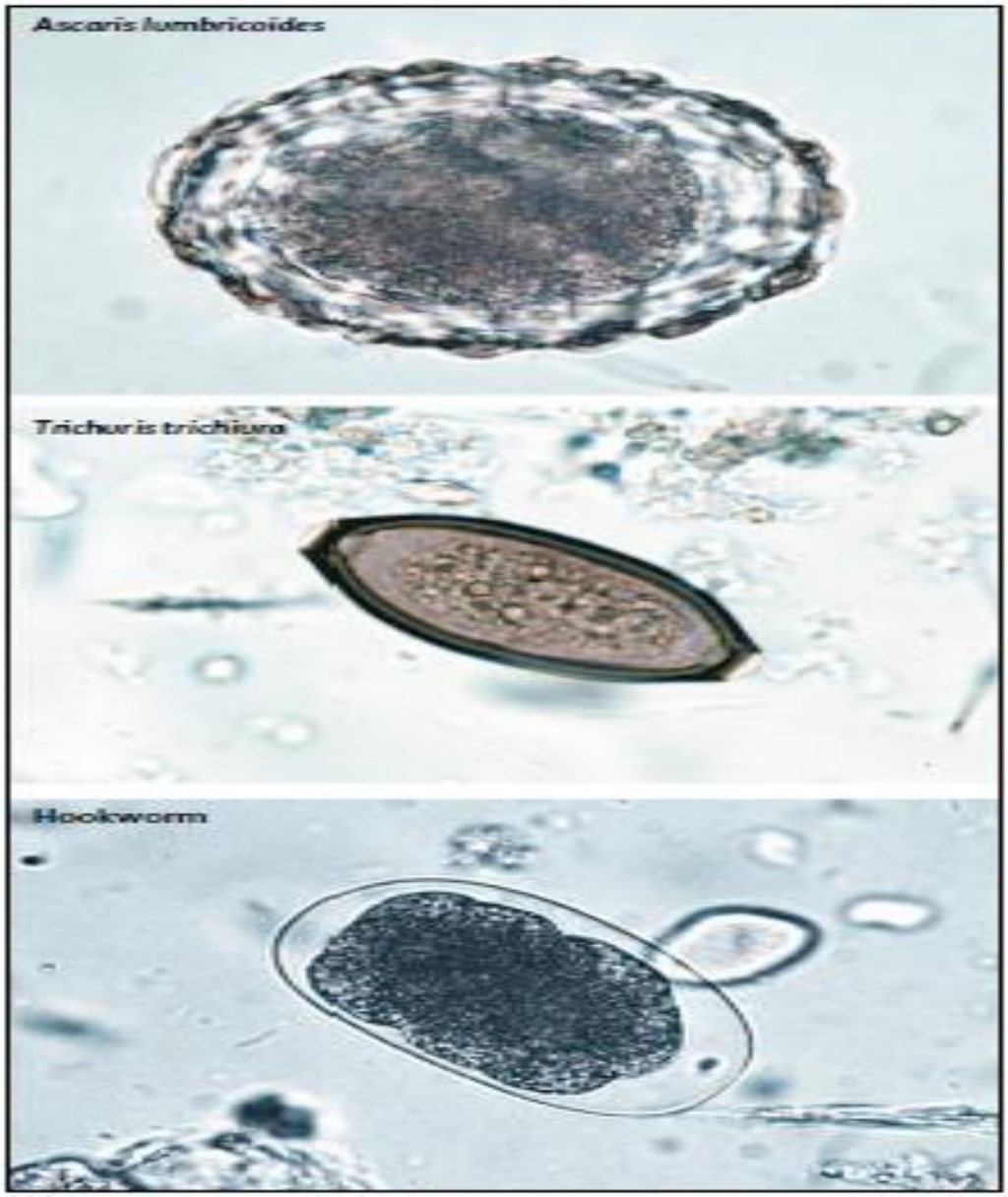
It is expected that necessary assistance be accorded to her in the process of her research, please.

However, it is mandatory for the researcher to submit a copy of her research finding(s) to the office of the Honorable Commissioner, Health as soon as it is concluded as you have the assurances of my highest regards.

Yours Faithfully,

JACOB KAYIT MUSA
SECRETARY, ETHICAL COMMITTEE

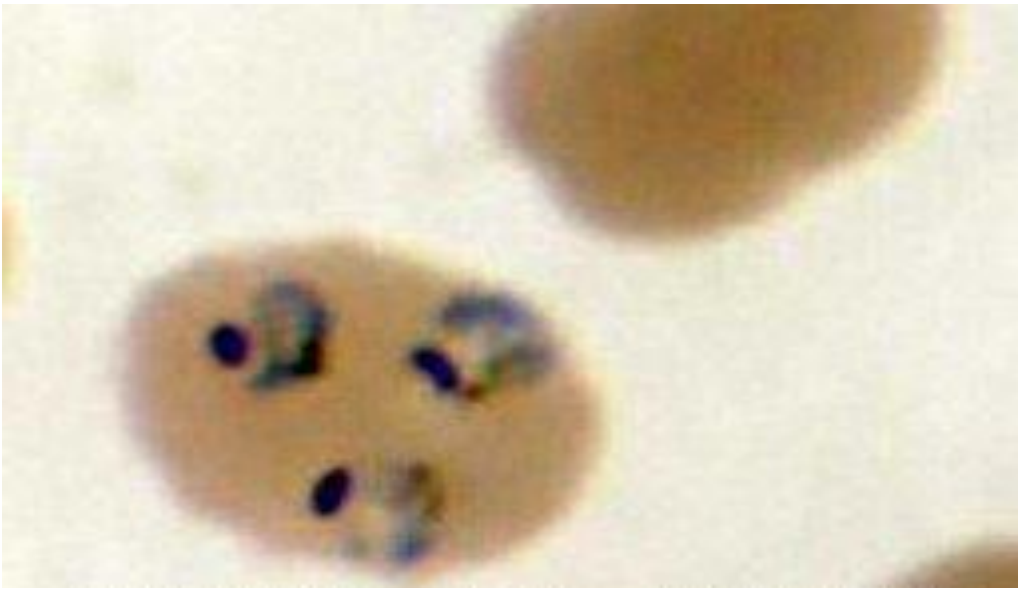
Appendix 4: Soil Transmitted Helminth Eggs



Mag. X 100

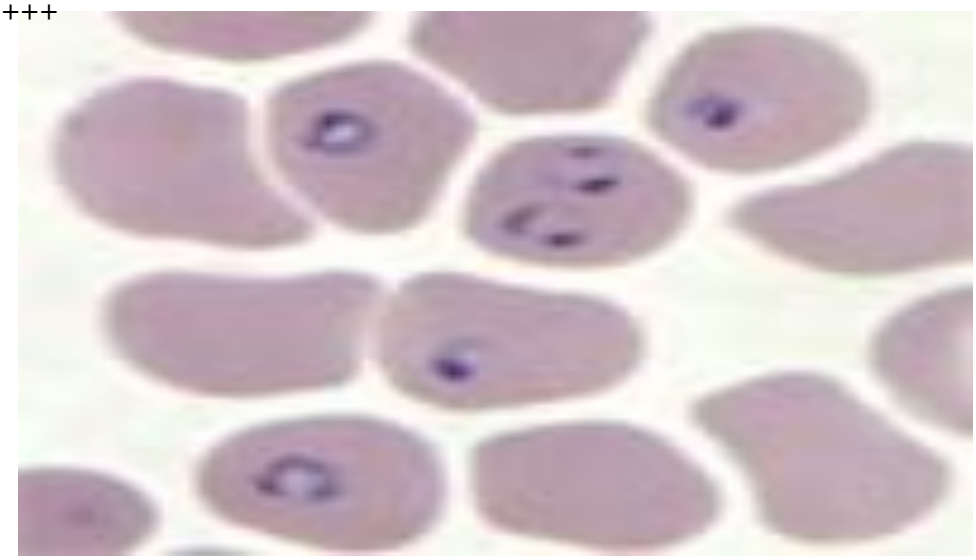
a. Ascarislumbricoides
b. Trichuristichiura
c. Hookworm

Appendix 5: Ring – form trophozoites of *P. falciparum* in a thin blood smear



Trophozoites - *Plasmodium falciparum*: Early trophozoites have the characteristic signet ring shape. Also, unique to *P. falciparum* is the presence of multiple trophozoites in one Cell

+++



Mag. X 100