PREVALENCE OF INFANTILE AND MATERNAL GEOHELMINTHIASES IN PARTS OF KADUNA STATE, NIGERIA

BY

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PREVALENCE OF INFANTILE AND MATERNAL GEOHELMINTHIASES IN PARTS OF KADUNA STATE, NIGERIA

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DECLARATION

I declare that the work in this thesis entitled "Prevalence of Infantile and Maternal Geohelminthiases in Parts of Kaduna State, Nigeria" has been carried out by me in the Department of Biological Sciences Ahmadu Bello University, Zaria. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other Institution.

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Name	Signature	Date

CERTIFICATION

This thesis entitled "PREVALENCE OF INFANTILE AND MATERNAL GEOHELMINTHIASES IN PARTS OF KADUNA STATE, NIGERIA" by Zacharista Ifeamaechi NWOYE meets the regulations governing the award of the degree of Ph.D Zoology of the Ahamadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to my parents late Mr. Nwoye Nnadi and Mrs. Chiawonamoke Nwoye; my aunt, Miss Caroline Onwu and my sister, Mrs Bibiana Okeke.

ABSTRACT

This study evaluated the prevalence of infantile (0–12 months) and maternal geohelminth infections in parts of Kaduna State in order to provide data to enrich the pool of information required to paint a picture of infantile and maternal geohelminth infections and plan for the effective control of this disease. Stool samples were collected from five hundred and nine (509) mothers and their infants (513) from six general hospitals in the State and examined for geohelminth eggs by the sedimentation technique (Formol - ether concentration technique) and microscopy. Questionnaire was used to collect demographic data and risk factors. The data obtained from the questionnaire were analyzed using Odds Ratio. Percentage was used to determine the prevalence of geohelminth infections, Chi Square (χ^2) was used to determine association between geohelminth infections and gender of infants as well as the age of the mothers and their infants. Student's t– test was used to test the difference between the prevalence of geohelminth infections in mothers and their infants. ANOVA was used to test the differences in prevalence of geohelminth infections between the hospitals. The result from the stool samples examination revealed that 12.18% of the mothers and 1.56% of the infants were infected respectively. Eggs of *Ascaris lumbricoides*, hookworm and *Trichuris trichiura* were observed in mothers' stool samples while hookworm and *Ascaris* eggs were found in infants. Hookworm was the most prevalent species in mothers (8.45%) while *Ascaris lumbricoides* was the most prevalent (0.98%) in the infants. The difference in prevalence between the mothers and the infants was significant ($P<0.05$). In terms of sex of the infants, the prevalence was 1.10% in males and 2.08% in females, but was insignificant ($p>0.05$). The prevalence in the mothers was 18.97% in age group of 35–44 years, 15.51% in age group 15-24 years and 8.33% in age group of 25-34 years. In infants, 2.95% prevalence was observed in the age group 5-12

months while 0.36% in the age group 0–4 months. The difference in prevalence among the age groups in both mothers and the infants was significant (P< 0.05). For multiple or mixed infections, 2.16% of the mothers had dual infections of *Ascaris lumbricoides* and hookworm, and 0.20% had hookworm and *Trichuris trichiura*. Intensity of geohelminth infections in mothers was 4.72%, 7.07% and 0.20% light infections of *Ascaris lumbricoides*, hookworm and *Trichuris trichiura* respectively. They had 1.18% and 1.38% moderate infections of *Ascaris lumbricoides* and hookworm respectively. The infants had 0.98% and 0.59% light infections of *Ascaris lumbricoides* and hookworm respectively. Factors that had significant association with geohelminth infections in mothers include non-formal education (prevalence, 22.22%; Odds Ratio, 2.883), dumping of refuse around the house (prevalence, 16.67%; Odds Ratio, 1.979), use of well as source of drinking water (prevalence, 14.78%, Odds Ratio, 1.816), lack of awareness about geohelminthiasis (prevalence, 14.75%, Odds Ratio, 2.921) and having up to 5-8 or 9-12 children in a family respectively (prevalence, 23.30%, 75%, Odds Ratio, 2.942 and 22.678 respectively). In infants, walking barefoot and failure to refrigerate infants' food had significant association with infantile geohelminth infections (prevalence, 1.77%, 5.38%, Odds Ratio, 1.7126 and 5.133 respectively). In conclusion, this study revealed high prevalence of geohelminth infections in mothers and low prevalence in infants.

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CHAPTER ONE

1.1 INTRODUCTION

Geohelminths or soil-transmitted parasitic nematodes are helminths whose larval stages require a period of 2- 6 weeks of development or incubation in the soil before they become infective (Collier *et al*., 1998; Chessbrough, 2005). *Ascaris lumbricoides, Srongyloides stercoralis, Trichuris trichiura* and hookworm *(Ancylostoma duodenale* and *Necator americanus)* are the common geohelminth species that infect humans (Cooper, 2004).They are transmitted through contact with faecally contaminated soil. For instance *Necator* infection is acquired exclusively by the percutaneous route while *Ancylostoma* infection can be contracted either percutaneously, orally, transmammarily or transplacentally (Collier *et al*., 1998; Lucas and Gilles, 2003). *Strongyloides stercoralis* infections are contracted through percutaneous route as well as auto-infection/faeco-oral transmission (Collier *et al*., 1998; Lucas and Gilles, 2003). *Ascaris lumbricoides* and *Trichuris trichiura* infections are acquired exclusively by oral route (Roberts and Janovy, 1996).

About 3.5 billion people worldwide are infected with these parasites, occurring most frequently in developing countries of the tropics, where risk factors such as poverty, low level of education and awareness, poor health services, inadequate sanitation, lack of access to sanitation facilities and clean or safe drinking water, geophagia, failure to wear footwear and indiscriminate disposal of human and animal faeces occur (Nmorsi *et al.*, 2009; Kunwar *et al.*, 2006; Awasthi *et al*., 2008; Chukwuma *et al.*, 2009). Globally, 807–1221 million, 576–740 million, 604–795 million and 30–100 million people are infected with *Ascaris lumbricoides*, hookworms, *Trichuris trichiura* and *Strongyloides stercoralis* respectively (WHO, 2006).

In Nigeria, about 15 million people are infected with *Ascaris lumbricoides* while several thousands are infected with *Strongyloides stercoralis*, *Trichuris trichiura*, hookworm and other helminths (Anosike *et al*., 2006). High morbidity and mortality caused by geohelminth infections is of serious public health importance; WHO (1990) stated that worm infections are associated with a substantial number of deaths as a result of very high prevalence of infecton each year. This is supported by an earlier report by WHO (2006) which stated that globally about 12000–135000 deaths occur annually as a result of geohelminth infections.

About 1.3 billion people are globally infected with hookworm and about 65,000 deaths are recorded annually (Fekadu *et al.*, 2008). The severe anaemia caused by hookworm infection in pregnant women is an important contributor to maternal mortality. Its adverse effects on women's health make them tired, breathless and less able to work and care for their children (Brooker *et al.*, 2008).

Generally, the effects of geohelminth infections on the hosts are many and include symptoms such as abdominal pain, diarrhoea, nausea, vomiting, iron deficiency anaemia, vitamin A deficiency, cough, pneumonitis, anorexia, enteritis, haemorrhage, hypoproteinaemia, fatique and shortness of breath. Additional symptoms that have been observed in infants include poor brain development, retarded growth, weight loss, impaired lactation and malnutrition (Adeyeba and Tijani, 2002; Awi–Waadu, 2005). Chijioke *et al.* (2012) noted that high global prevalence of ascariasis results in 20,000 deaths per year due to intestinal obstruction, especially in children while hookworm infections increase maternal mortality, impaired lactation, low birth weight and prematurity. According to Chukwuma *et al*. (2009), geohelminth infection is the second leading cause of mortality in

infants in Africa which is promoted by poor hygiene habits that permit soil contamination by faeces containing helminth eggs. Geohelminths are the major enteric pathogens of childrenn (infants) in many regions of the world. First infection occurs in infancy and may persist into adulthood through repeated infection exposures to a faecally contaminated environment (Cooper, 2004). Lucas and Gilles (2003) noted as well that infants may be parasitized soon after birth by eggs on the mother's fingers and this is detrimental to their growth and development. Millions of people suffer from geohelminth infections but the children (infants) and women bear a heavier pathological burden (Kunwar *et al.*, 2006).

Despite the fact that severe consequences have been observed in infants, little attention has been paid to them. In view of this, Goodman *et al.* (2007) were of the opinion that the lack of focus on pre-school age children, especially infants is based on the assumption that low prevalence and intensity of infection do not result in significant morbidity. Goodman *et al.* (2007) also stated that incomplete immune system development and a high metabolic demand make the infants a group that may be especially susceptible to growth defects induced by geohelminth infections.

The few studies that have been carried out in infants show high prevalence rates of geohelminthiases. For instance, Awasthi *et al.* (2008) reported 50.3% prevalence in Uttar Pradesh and Jharkhand in India. Jardim-Botelho *et al*. (2008) reported 20.9% prevalence in Brazil while Wright *et al.* (2009) observed 70.7% prevalence in Pemba Island Zanzibar in United Republic of Tanzania. In addition, Vikram *et al,* (2008) reported 35% in Karachi, Pakistan while Belyhun *et al.* (2010) observed 4.9% prevalence in Butajira, Ethiopia. High prevalence of geohelminthiasis has also been recorded in women in many parts of the

world. A prevalence of 61.5% in the Himalayan region of Nepal (Kunwar *et al.,* 2006), 25.7% in Ghana (Yatich *et al.,* 2010) and 43.5% in Butajira, Ethiopia Belyhun *et al*., 2010). The effect of helminth infections in women is most profound in women with hookworm infection and particularly in women at child bearing age.Over 44 million pregnancies are currently complicated by maternal hookworm infections, placing both mothers and children (new born) at higher risk of death during pregnancy and delivery. Such infected women are very vulnerable to the effects of geohelminth infections because they spend most of their lives either in child bearing or as lactating mothers (Kunwar *et al.,* 2006).

In Nigeria, few studies carried out on infantile geohelminth infections showed high prevalences. For instance, Tamranat *et al*. (2008) reported 8.6% prevalence in infants in Ogun State. Nmorsi *et al.* (2009) reported 92.6% prevalence in Ekpoma, Edo State while Kirwan *et a*l. (2009) reported 13.0% in Osun State. These high prevalence rates of infantile geohelminthiasis are detrimental to the growth and development of the infants. In women, the situation is similar. Chukwuma *et al.* (2009) reported a 91.6% geohelminth infection in female in Ebenebe, Anambra State. Similarly, 92.7% of the females examined for geohelminth infection in Port–Harcourt were infected (Awi–Waadu, 2005). Furthermore, Chijioke *et al*. (2012) reported a 19.5% geohelminth infection in mothers in Enugu. Anosike *et al.* (2006) observed a 37.3% geohelminth infection in Naraguta, northern part of Jos North L.G.A., Plateau State, out of which 39.3% were females while 34.5% were males. This indicates that women especially mothers are more vulnerable to geohelminth infections than their male counterpart.

From all these observations on high prevalences of geohelminth infections in mothers and their infants, there is need to pay serious attention to infantile and maternal

geohelminthiases. Based on this aforementioned, this research was borne to evaluate the prevalence status in parts of Kaduna State.

1.2 Statement of the Research Problem

In Nigeria, geohelminthiasis in mothers and infants is poorly reported because of low tempo of research. This is moreso in the northern part of Nigeria, and particularly Kaduna State. The tempo of research and reporting on infantile and maternal geohelminthiases and the associated risk factors are low and insufficient to assess the level of associated morbidity in Kaduna State.

1.3 Justification

This study will provide useful data on the prevalence of infantile and maternal geohelminth infections and the associated risk factors in the study area and also enrich the pool of information required to fully understand the status of the disease towards establishing the desirability or otherwise of an intervention programme for infants and mothers.

1.4 Aims and Objectives

To evaluate the prevalence status of infantile and maternal geohelminthiases and the associated risk factors in parts of Kaduna State.

Objectives

(i) To determine the prevalence of geohelminth infections in infants and their mothers.

(ii) To determine the prevalence of geohelminth infections in infants and their mothers in relation to location.

(iii) To determine the association between infantile and maternal geohelminth infections and age, and gender.

(iv) To determine the intensity of geohelminth infections in infants and their mothers

(v) To determine the association between infantile and maternal geohelminth infections and risk factors.

1.5 Hypotheses

(i) The prevalence rates of geohelminth infections in infants and their mothers have no significant problem in Kaduna State

(ii) The prevalence of infantile and maternal geohelminth infections are not significantly associated with location

iii) Infantile and maternal geohelminth infections are not significantly associated with age and gender.

(iv) The intensity of geohelminth infections in infants and their mothers is not of public health significance.

(v) Infantile and maternal geohelminth infections are not significantly associated with risk factors.

CHAPTER TWO

LITERATURE REVIEW

2.1 Geohelminths

Geohelminths are soil–transmitted parasitic nematodes in which the larval stages require a period of development or incubation in soil before they become infective (Collier *et al*., 1998; WHO, 2006). *Ascaris lumbricoides, Srongyloides stercoralis, Trichuris trichiura* and hookworm *(Ancylostoma duodenale* and *Necator americanus)* are the common geohelminth species that infect humans (Cooper, 2004). According to Irene *et al*. (2009), the illness caused by geohelminths is recognized as a major cause of disability in resource – poor regions of the tropics, where about 2 billion people are infected.The effects of geohelminth infections on the hosts are many and include symptoms such as abdominal pain, diarrhoea, nausea, vomiting, iron deficiency anaemia, vitamin A deficiency, cough, pneumonitis, anorexia, enteritis, haemorrhage, hypoproteinaemia, finger clubbing, fatique and shortness of breath. Additional symptoms that have been observed in infants include poor brain development, retarded growth, weight loss, impaired lactation, malnutrition and death due to intestinal obstruction (Adeyeba and Tijani, 2002; Lucas and Gilles, 2003; Awi–Waadu, 2005).

2.2 Global Distribution of Human Geohelminths

Geohelminths are cosmopolitan in distribution and about 1billion people are infected globally (WHO, 2006). The global estimate for *Ascaris* infection is put at between 807 and 1221 million, *Trichuris*, 604 and 795 million, hookworm , 576 and 740 million and *Strongyloides*, 30 and 100 million (WHO, 2006). Hookworm infection has been recognized as the major contributor to gastrointestinal blood loss, iron and energy deficiencies, protein

and zinc deficiencies thereby causing malnutrition and anaemia. These effects are more profound in women at child bearing age (Kunwar *et al*., 2006). In addition, when *Ancylostoma duodenale* infection occurs through the oral route, the early migrations of third-stage larvae cause a syndrome known as wakana disease which is characterized by nausea, vomiting, pharyngeal irritation, cough, dysponea and hoarseness (Hotez, 2004).

Lucas and Gilles (2003) also stated that hookworm is endemic in the tropics and subtropics and occurs in various parts of tropical Africa, South eastern USA, Meditarranean countries, Asia, the Caribbean, West Africa and Central and South America while *Ascaris* is world–wide in distribution but highest prevalence is in the humid climates of Asia, Africa and tropical America. *Trichuris* are found world–wide but are prevalent in warm humid parts of the tropics while the global distribution of *Strongyloides* varies widely and commonly found in South East Asia, Africa, Europe in Yugoslavia, Romamia but the area with the highest endemicity is north east Brazil. According to them, heavy infection of *Trichuris trichiura* may cause bloody diahrrhoea, anaemia and prolapse of rectum.

Fekadu *et al*. (2008) reported 32.1% prevalence of hookworm, 17.4% of *Ascaris* and 8.1% of *Trichuris* in Asendabo town, Jimma zone, South West Ethiopia. .Adhikari *et al.* (2006) observed 55% prevalence of *Trichuris*, 26% of *Ascaris*, 12% of hookworm, and 2% of *Strongyloides* in Kathmandu valley of Nepal.

Meike *et al.* (2006) reported 11%, 9% and 9% prevalence for *Ascaris*, *Trichuris* and hookworm in San Jouny Martinez; 3%, 8% and 10% in Fomento, all in Cuban. Ikram *et al.* (2009) reported 45.5%, 3.5%, and 3.5% prevalence of *Ascaris*, *Trichuris* and hookworm in rural Peshawar. Oberhelman *et al.* (1998) observed 7.5%, 0.10%, 3.8% and 0.2% prevalence of *Ascaris*, hookworm, *Trichuris* and *Strongyloides* respectively in rural

Nicaragua. Hung *et* al. (2005) reported 23%, 1.9% and 0.5% prevalence of hookworm, *Trichuris* and *Ascaris* in South Vietnam. Huat *et al*. (2012) observed 35.7% prevalence of geohelminths; consisting of 30.4% and 5.3% of *Trichuris* and *Ascaris* in Malaysia. Emma *et al.* (1998) reported 14.5% and 0.8% prevalence of *Ascaris* and *Trichuris* respectively in Chapas, Mexico. Yamamoto et *al*. (2000) reported 40.3% and 71% prevalence of *Ascaris* and *Trichuris* in Siniloan Republic of the Philippines.

Liabsuetrakul (2009) reported 10.3%, 5.7% and 6.3% prevalence of ascariasis, trichuriasis and hookworm infection respectively in women of southern Thailand. Awasthi and Pande (1997) observed 11.9% prevalence of *Ascari*s in Lucknow in India. Mwambete and Kalison (2006) observed 46.54%, 37.48% and 15.9% prevalence of *Ascaris,* hookworm and *Trichuris* in Mwananyamda hospital and 40.50%, 41.83% and 17.68% prevalence of *Ascaris,* hookworm and *Trichuris* respectively in Amana hospital, all in Dares Salaam, Tanzania. Curtale *et al*. (1998) reported 2.4%, 0.6% and 0.4% prevalence of *Ascaris*, *Trichuris* and hookworm respectively in Upper Egypt. Kanwar *et al*. (2006) observed 53.0%, 20.3% and 2.7% prevalence of hookworm *Ascaris* and *Trichuris* in Nepal. Belyhun *et al.* (2010) reported 43.5% of geohelminth infections in Butajira, Ethiopia. Vikram *et al.* (2008) observed 16.5% prevalence of *Ascaris* in urban slum of Karachi, Pakistan. Yatich *et a*l. (2010) reported 12.3%, 7.9%, 5.6% and 3.9% prevalence of *Ascaris*, hookworm, *Trichuris* and *Strongyloides* respectively in Kumasi, Ghana. Wright *et al.* (2009) reported 42.0%, 16.8% and 1.5% prevalence of *Ascaris*, hookworm and *Trichuris* respectively in Pemba Island, Zanziibar Jardim-Botelho *et al.* (2008) observed 69.8%, 50.8%, 8.1% and 1.1% prevalence of hookworm, Ascaris, *Strongyloides* and *Trichuris* in rural area of Brazil. Awasthi *et al*. (2008) observed 50.3% prevalence of geohelminth infections in Uttar

Pradesh and Jharkhand, India. Goodman *et al*. (2007) reported 43.8%, 17.7% and 3.6% prevalence of geohelminth infections in Wesha, Vitongoji and Pujini villages of Zanzibar. Standley *et al*. (2009) observed 93%, 24% and 12.9% prevalence of *Ascaris,* hookworm and *Trichuris* respectively in Uganda. Jardim-Botelho *et al.* (2009) observed 52.3%, 39.5% and 29.0% prevalence of *Ascaris,* hookworm and *Trichuris* in Gem, Nyanza province of western Kenya.

2.3 Prevalence of Human Geohelminths in Nigeria

Studies have shown the occurrence of human geohelminths in Nigeria.

According to Anosike *et al.* (2006) about 15 million Nigerians were suffering from ascariasis while several thousands were suffering from strongyloidiasis, trichiuriasis and hookworm infection. They reported 12.7%, 7.4%, 6.7 and 1.0% prevalence of hookworm, *Strongyloides, Ascaris* and *Trichuris* respectively in Naraguta northern part of Jos North local government area of Plateau State. Studies have shown that *Ascaris lumbicoides,* hookworm, *Trichuris trichiura* and *Strongyloides stercoralis* are prevalent in Kaduna State. Nock *et al*. (2003) reported 20.7%, 20.5%, 9.3% and 1.5% prevalence of *Ascaris*, hookworm; *Trichuris* and *Strogyloides* in Samaru, Zaria, Kaduna State. Nmorsi *et al.* (2009) also reported 85.7%, 65.7% and 2.9% prevalence of *Ascaris,* hookworm and *Trichuris* in Ekpoma, Edo State. Awi-waadu (2005) observed 36.2%, 17.6%, s12.8% and 9.0% prevalence of *Ascaris,* hookworm, *Trichuris* and *Strongyloides* in Bori Military Cantonment Port-Harcourt, Rivers State. Chukwuma *et al.* (2009) observed 54.1%, 45.5%, 5.9% and 1.8% prevalence of *Ascaris,* hookworm, *Strongyloides* and *Trichuris* respectively in Ebenebe town, Anambra State. Studies have shown that geohelminth infections are common in Enugu State. Ozumba and Ozumba (2002) reported 14.3%, 7.4%, 2.2% and

0.9% prevalence of hookworm, *Ascaris*, *Trichuris* and *Strongyloides* respectively in University of Nigeria Teaching Hospital Enugu, Enugu State while Chijioke *et al.* (2012) observed 19.5% prevalence of *Ascaris* in Enugu metropolis of Enugu State.

Agbolade *et al.* (2004) observed 62.8% and 16.6% prevalence of *Ascaris* and hookworm respectively in some villages of Ijebu North, Ogun State. Adeyeba and Tijani (2002) observed 4.70%, 4.40% and 4.80% prevalence of *Ascaris*, hookworm and *Trichuris* in Peri–urban area of Ibadan, Oyo State. Kirwan *et al.* (2009) reported 12.5% and 1.4% prevalence of *Ascaris* and *Trichuris* in three villages out side Ile Ife, Osun State. Ezeagwuna *et al*. (2010) observed 25.38%, 15.38% and 5.77% prevalence of hookworm, *Ascaris* and *Trichuris* respectively in Ozubulu, Anambra State. Uneke *et al.* (2007) reported 10.8%, 4.3%, 1.2% and 0.6% prevalences of *Ascaris*, hookworm, *Trichuris* and *Strongyloides* in Onitcha, Anambra State, Nigeria. Damen *et al*. (2010) observed 33.5%, 28.5%, 18.4% and 13.3% prevalence of hookworm, *Ascaris*, *Strongyloides* and *Trichuris* respectively in Doi, Plateua State. Osasuwa *et al*. ((2011) observed 75.6%, 16.19%and 7.3% prevalence of *Ascaris* hookworm and *Trichuris* respectively in Isiohor , Evbuonore and Ekosodin villages of Ovia local government area of Edo State. Adefemi and Musa (2006) reported 14.5%, 2.0% and 3.3% prevalence of Ascaris, *Trichuris* and hookworm respectively in rural Ganmo and urban communities of Ilorin metropolis of Kwara State, Nigeria. Tamramat and Olowu (2008) observed 74.14%, 17.24%, 6.03% and 0.36% prevalence of *Ascaris*, hookworm, *Trichuris* and *Strongyloides* respectively in Ode Remo town, Ogun State .Ojurongbe *et al.* (2010) noted 12.7%, and 8% prevalence of *Ascaris* and hookworm in Federal Polytechnic, Ede, Osun State.

Ozaki (2009) reported 3.33% prevalence of hookworm in Zaria, Kaduna State. Auta (2006) observed 30.7%, 6.4%, 4.9% and 4.2% prevalence of *Ascaris*, hookworm, *Trichuris* and *Strongyloides* respectively in Gwagwada, Chikun local government area of Kaduna State. Salihu (2008) observed 5.83% and 18.3% prevalence of *Ascaris* and hookworm in Kaduna south local government area of Kaduna State. Ahmed (2004) reported 15.3%, 1.1% and 0.3% prevalence of hookworm, *Ascaris* and *Trichuris* in six secondary schools in Katsina State.

2.4 Prevalence of Geohelminth Infections in Infants

According to Cooper *et al*. (2011), geohelminth infections are highly prevalent infectious diseases of childhood in many regions of the tropics, and are associated with significant morbidity especially among pre-school and school-age children. Geohelminth infections had severe effects on infants. Such effects include poor brain development, stunted growth and sometimes death due to intestinal obstruction (WHO, 2006). Awasthi *et al.* (2008) reported 50.3% prevalence in Uttar Pradesh and Jharkhand in India. Jardim – Botelho *et al.* (2008) observed 20.9% in Brazil while Wright et al. (2009) observed 70.7% prevalence in Pemba Island Zanzibar, Tanzania. Belyhun *et al*. (2010) reported 4.9% in Butajira, Ethiopia while 35% was observed in Karachi (Vikram *et al.*, 2008). Goodman *et al*. (2007) observed 26.5% from three villages in Pemba Island Zanzibar, Tanzania. In Nigeria, Tamramat *et al.* (2008) reported 8.6% in Ogun State. Kirwan *et al*. (2009) observed 13.0% in Osun State while Nmorsi et al. (2009) reported 92.6% in Ekpoma Edo State.

2.5 Prevalence of Maternal Geohelminth Infection in Nigeria and Other Parts of the World (Mothers at Child-bearing Age; 15-45 years)

According to Kunwar *et al.* (2006) women and children have very low iron content in their blood which made them to be more vulnerable to iron deficieny anaemia caused by hookworm infection. They reported 61.5% prevalence in Himalayan region of Nepal. Yatich *et al*. ((2010) observed 25.7% in Ghana while 43.5% was reported in Butajira, Ethiopia (Belyhun *et al.*, 2010).

In Nigeria, Chijioke *et al.* (2012) observed 19.5% prevalence of *Ascaris* in Enugu metropolis of Enugu State. The report above indicates high prevalence of geohelminth infections in mothers and this affects their health seriously.

2.6 The Life Cycle of Geohelminths

Although geohelminths generally need soil for the eggs or the larvae to incubate and develop into infective stages, each geohelminth has a specific life cycle. The life cycle of *Ascaris lumbricoides* as described by Oyerinde (1999) and Cheesbrough (2005) is as follows; the female lays about 200,000 eggs per day in the intestine. The eggs are passed out with faeces of the infected man. The eggs are resistant to adverse environmental conditions. They embryonate outside their host. The eggs develop into rhabditiform larvae (L_1) in 10 days or longer depending on the temperature. The first stage larvae moult into second stage larvae (L_2) which serve as the infective stage. It takes about 30-40 days for the eggs to become infective after being laid.

Man becomes infected by ingesting the infective eggs through contaminated food or water. The eggs hatch in the small intestine of man. The hatched (L_2) larvae burrow into the gut

wall and may pass through the peritoneal cavity to the liver but they usually reach the liver via the portal circulation. They remain in the liver for few days then get carried to the heart from where they move to the lungs. They remain in the lungs and moult twice into third and fourth stage larvae (L_3 & L_4). Most of the fourth stage larvae break out of the lungs' capillaries into the alveoli but later break out of the alveoli and migrate up to the trachea, the pharynx and pass via the oesophagus back to the small intestine where they moult once into fifth stage larvae. They feed on intestinal content and develop into adult worms in the small intestine.

The life cycle of hookworm as described by Collier *et al*. (1998) and Oyerinde (1999) is as follows:

The gravid female lays about 10,000–30,000 eggs per day in the intestine. The eggs are laid at the stage of segmentation and passed out in host's faeces at 2, 4 or 8 cell stage. Under favorable environmental conditions, the eggs develop rapidly within 1-2 days in the soil and hatch into first stage larvae (L_1) with rhabditiform oesophagus. The larvae feed on bacteria and faecal matter in the soil. They grow and moult after 2-3 days into second stage larvae (L_2) with rhabditiform oesophagus still. The second stage larvae moult after 7 days into third stage larvae (L_3) with filariform oesophagus which serve as the infective stage of the worm. The larvae still retain the second stage larval skin hence referred to as sheathed larvae. The larvae leave the faeces and climb vegetation or move to the surface layer of the soil although they still need moisture since they are not resistant to drying.

Man is infected when he walks barefoot on infected soil or when the skin comes in contact with infective larvae which penetrate through the pores in the skin, hair follicles or broken

skin leaving the second stage larval skin behind. Studies also have shown that although *Necator* is acquired almost exclusively by the percutaneous route, *Ancylostoma duodenale* infection may be contracted either percutaneously, orally or transmammarily. When the L_3 larvae penetrate the skin, they enter the venules or lymphatics and be carried in the blood to the heart, the lungs where they moult into fourth stage larvae (L_4). They later migrate out of the lungs' capillaries into the alveoli and from there they move up to the trachea, the pharynx, and finally swallowed via the oesophagus. On reaching the small intestine, they moult once into fifth stage larvae, feed and develop into adult worms. The life cycle takes about five (5) weeks to be completed. The life cycles of *Ancylostoma duodenale* and *Necator americanus* are the same, only *that Necator americanus* lays less number of eggs.

The life cycle of *Trichuris trichiura* as described by Oyerinde (1999) and Cheesbrough (2005); the female lays about 2000–20, 000 single celled eggs per day in the intestine. The eggs are passed out with the faeces of the host to the soil where they embryonate after 3–6 weeks and become infective. Man is infected through the ingestion of food, water or drinks contaminated with the infective eggs of the parasite. The eggs hatch in the intestine of man. The small intestine is the location for growth and moulting .The infective larvae penetrate the villi and continue to develop in the small intestine but later migrate to the caecum and penetrate the mucosa where they mature to adult. The posterior end of each worm which bears the reproductive organs protrudes out into the lumen of the intestine (caecum) while the anterior end is embedded in gut mucosa. The development from the time of ingestion of the infective eggs to adult takes about three (3) months while the adult female begins to lay eggs three (3) months after maturity. Adult can live for about five (5) years in human body.

In life cycle of *Strogyloides stercolaris* as described by Oyerinde (1999) and Lucas and Gilles (2003), the parasitic female after copulation in lumen of the intestine of its host, burrows into the mucosa of the gut wall of the host and deposits its eggs The eggs are embryonated when laid and hatch into the first stage larvae in the gut wall. After hatching, the larvae pass into the intestinal lumen where they pass out with the host's faeces. The larvae can either develop into free–living stages or parasitic stages depending on the environmental conditions especially the availability of nutrients. For free–living forms, the rhabditiform larvae deposited along with faeces develop into free living generation. The adult male and female mate and the female deposits her eggs in the soil. The eggs hatch, releasing the first stage rhabditiform larvae (L_1) which eventually develop into adult free–living forms after four (4) moults. The free–living cycle may be repeated for many times under favorable environmental conditions.

For parasitic forms, under unfavorable environmental conditions, the L_1 rhabditiform larvae produced by the free–living females moult into second stage rhabditiform larvae (L_2) .The L_2 larvae moult into third stage larvae (L_3) which serve as the infective stage. The third stage larvae still retain the L_2 larval skin but difficult to see. Transmission is mainly by contact with soil contaminated with the infective larvae but auto–infection sometimes occurs. When the third stage larvae come in contact with the skin of a man, they penetrate the skin and enter the blood vessels and are carried to the heart, lungs where they break out of the lungs' capillaries into the alveoli. The young adults move to the trachea, the pharynx and get swallowed via the oesophagus to the small intestine where they moult once into fourth stage larvae (L_4), feed and mature into adult.

For auto infection, the L_1 larvae sometimes moult twice in the gut lumen forming third stage larvae which move down the gut and penetrate the mucosa of the lower part of the gut or the peri–anal skin. They enter the blood stream and get carried to the heart, lungs and finally return to the small intestine where they moult once into L_4 larvae and mature into adult.

2.7 Epidemiological Factors of Human Geohelminths

Geohelminths are cosmopolitan in distribution but some factors influence the distribution or spread of the helminths.

2.7.1 Poor environmental and personal hygiene

Indiscriminate defaecation creates an ideal environment for the growth and development of the geohelminths' eggs or larvae. Since the transmission of the helminths is through contact with contaminated soil, indiscriminate open air defaecation on the soil surface ensures that regular man–parasite contact is maintained (Oyerinde, 1999). Meike *et al.* (2006) were of the opinion that the continuous occurrence of intestinal parasites (Geohelminths) was as a result of poor environmental sanitation. In addition, Adhikari *et al.* (2006) stated that helminth infections remained highly endemic in the capital city of Nepal due to poor sanitary conditions. Furthermore, Fekadu *et al.* (2008) noted that the high burden of hookworm infection in school children in south west Ethiopia was due to prevailing poor environmental and personal hygiene. These authors recommended immediate treatment of these children and the improvement of their environmental and personal hygiene to curb the high burden of the infection among this study group. Hung *et al.* (2005) also observed that the high prevalence of parasitic intestinal helminth infections in children of Phan Tien in

southern Vietnam was due to low standards of sanitation and children walking bare foot. Nwambete and Kalison (2006) stated that the mothers of the infants infected with geohelminths in Dares Salaam, Tanzania agreed that they could be the source as a consequence of poor personal hygiene and lack of appropriate sanitary facilities. Awasthi *et al.* (2008) noted that open air defaecation placed children at an increased risk of intestinal geohelminth infections.

Belyhun *et al.* (2010) stated that the high rate of geohelminth infections in women of the rural areas of Ethiopia was as a result of lower sanitary measures as a result of not washing their hands with soap and water. They recommended that women should be encouraged to wash their hands with soap and water in order to reduce the rate of geohelminth infections. Unsanitary environment facilitates contamination of hands, food and water and most of the geohelminths are contracted through the ingestion of food, water or drink contaminated with infective eggs or larvae. In view of this Uneke *et al*. (2007) emphasized that a high level of contamination of objects by geohelminth eggs was the reflection of poor local level of environmental sanitation and personal hygiene.

Nock *et al*. (2003) noted that geohelminthiasis is promoted by poor hygiene habits like indiscriminate disposal of human and animal faeces which permits contact of geohelminth eggs with soil making soil an important vehicle for the development and transmission of the helminth eggs. In addition, Ezeagwuna *et al*. (2010) stated that the indiscriminate defaecation practiced by the pupils of Nza Central school due to lack of toilet facilities contributed to the high rate of geohelminth infections in that school. Furthermore, Damen *et al.* (2010) stated that the parasitic helminths are endemic in Nigeria due to poor

environmental sanitation, pollution and contamination of water and air with faecal matter containing infective stages of geohelminths.

Osazuwa *et al.* (2011) also believed that the higher prevalence of hookworm in age 1–5 years in rural communities of Edo State was an indication of poor hygiene. Olaniyi *et al.* (2007) noted that most of the authors of the papers reviewed, commented on the common unhygienic practices of the people such as defaecating indiscriminately or dumping of excrement at refuse depots, nearby bushes, underneath bridges, along bush tracks, motor highways, river banks and even open fields. According to them, the practice increases the rate of contamination of soil, food or water as well as transmission of geohelminths. They also observed that many houses lack lavatory facilities, public latrines are scarce, drainages are blocked by refuse leading to wide spread of geohelminths' ova or larvae especially during rainy season.

Adefemi and Musa (2006) said that intestinal geohelminth infestations persist and flourish where poverty, inadequate sanitation, improper health habits and overcrowding are entrenched. These factors they said are present in Nigeria hence they attributed the high prevalence of *Ascaris* in rural and urban communities of Kwara State to poor water supply and poor sanitation facilities which favour the development and transmission of the helminth. Awiwaadu (2005) also stated that pupils whose source of drinking water is river or stream and whose toilet system is either pit, bush or both were more susceptible to geohelminth infections as they are more exposed to contaminated soil or water environment due to their out door activities, as they play in the soil, swim or drink contaminated water. Ozumba and Ozumba (2002) attributed the high prevalence of intestinal geohelminths in

patients of UNTH Enugu, Enugu State to poor environmental sanitation, lack of public toilet, poor methods of waste disposal and poor socio economic status. Agbolade *et al.* (2004) observed from their study in Ijebu north of Ogun State, Nigeria that virtually all the villagers practice indiscriminate and open air defaecations while 31.2% indulge in finger–nail nibbling therefore attributing the high prevalence of *Ascaris* and hookworm among the villagers to high level of unhygienic practices. In addition, Adeyeba and Tijani (2002) said that the high prevalence of intestinal geohelminths was not unconnected with poor sanitation; lack of knowledge on health care hence concluded that the high prevalence of *Ascaris* is a reflection of environmental contamination and unsanitary life style in peri–urban area of Ibadan, Oyo State, Nigeria. Nmorsi *et al.* (2009) also stated that open air defaecation and poor sanitary disposal of human faeces are the principal factors in the aetiology of hookworm infections.

Chukwuma *et al*. (2009) observed that the primary school pupils infected with geohelminths in Ebenebe town of Anambra State, Nigeria go to school bare foot, lack toilets in their schools and defaecate indiscriminately around the bushes very close to their schools. They believed that the high prevalence of *Ascaris* in those pupils was due to unhygienic habit of not washing their hands before eating after playing in school, picking and eating food like biscuit or sweet that had fallen on the ground as they play as geophagia is a specific risk factor for the infection with the orally acquired soil transmitted nematode. Huat *et al*. (2012) also noted that open air defaecation and walking bare foot especially children enhance the transmission and spread of geohelminths especially hookworm.

2.7.2 Climatic factors

The climate of a place plays a vital role in the development and survival of geohelminths. The amount of rainfall, humidity, temperature, soil types, vegetation and light intensity in a particular place influence the epidemiology of geohelminths (Kunwar *et al*., 2006). Most of the geohelminths need high humidity, protected soil, sufficient rainfall and optimum temperature to survive or develop. *Trichuris trichiura* for instance needs suitable environmental conditions since the eggs that pass out with faeces will require about 3-6 weeks developing into infective stage as the eggs are not resistant to hard environmental conditions. *Trichuris* is endemic in areas with warm climate, heavy rainfall, high humidity and protected soil. It is rarely found in arid areas and high altitudes. The exposure of the eggs to direct sunlight kills the eggs through desiccation. (Roberts and Janovy, 1996; Cheesbrough, 2005).

The ideal climatic conditions for hookworm development are temperature of about 24–32^{o}C in a damp, sandy soil with plenty of decaying vegetable matter situated in the shaded area. The climatic conditions make it impossible for uniform distribution of hookworm worldwide. The prevalence of hookworm may be high in one geographical area while the adjacent geographical area may be free from infection. In temperate countries, the favourable conditions for the development and transmission of geohelminths, especially hookworm, occur during the warmer months while the climatic conditions for geohelminths prevails in the tropics and transmission occurs through out the year (Oyerinde, 1999). Brooker *et al.* (2008) also stated that since hookworm larval stages have limited motility, their rate of development and survival are dependent on the surrounding environmental humidity, temperature and ultra-violent light such that geographical differences in

transmission will be influenced by these factors and related factors like rainfall, soil type and altitude. Hookworm infection is restricted to warmer parts of the world and in habitats like mines in a more severe climate. Optimum temperature is necessary for the development of the larval stages of hookworm. The larvae develop to maturity in not less than 17^{o}C, with 23–30^{o}C being optimal. This indicates that favorable temperature enhances the development and transmission of hookworm infections while extreme temperature hinders or reduces the rate of transmission of hookworm infections.

Soil types, oxygen presence and shade or soil cover influence the epidemiology of hookworm. The larvae or juveniles of hookworm will not hatch in an undiluted faeces or water logged soil instead a loose humus soil with reasonable drainage and aeration favours the hatching and development of the larvae since their metabolism is aerobic .Both heavy clay and coarse sandy soil are not favourable as in the latter, they are sensitive to desiccation hence alternating drying and moistening are damaging to the juveniles. Furthermore, hookworm larvae develop best in near normal pH hence acidic or alkaline soil inhibits the development of the larvae. In addition, chemical influences the epidemiology of the helminths as urine mixed with faeces is fatal to the eggs while strong chemicals added to faeces as disinfectants of fertilizer are lethal to the free–living stages of the hookworm. Salt in water also inhibits hatching and fatal to the juveniles.

The larvae survive best in shady locations like coffee, banana or sugarcane plantations where the workers defaecate in shady cool secluded spots beneficial for their development and transmission since the repeated return to defaecation site exposes the workers to

continual re-infection The use of preferred defaecation sites makes hookworm to be endemic in arid areas (Roberts and Janovy, 1996; Lucas and Gilles, 2003).

Ascaris is more prevalent in moist climate especially where hygiene is low. The eggs are very resistant to adverse climatic conditions and most chemical agents which enable the eggs to remain viable for a long period of time but are killed by the temperature above 40^{o}C or by exposure to direct sunlight (Oyerinde, 1999) For *Strongyloides stercoralis,* infection is more in those living in mountain environments than in those living in low land areas due to inadequate sewage disposal facilities. It reproduces in warm moist conditions (Cheesbrough, 2005).

2.7.3 Lack of social amenities

Studies had shown that lack of social amenities like lack of health care facilities, portable water supply, public latrine and good house increase the rate of transmission and spread of the geohelminths Mwambete and Kalison (2006) noted that poor socio economic conditions of the majority of the Tanzanians favour the continuous transmission and spread of intestinal geohelminths. They also noted that many of the Tanzanians migrate to the urban areas in search of greener pasture which results in high population in urban areas leading to shortage of social facilities like portable water, inadequate latrine facilities, overcrowding. Inadequate social facilities contribute to poor hygienic conditions which favours the development and transmission of intestinal geohelminths especially among children under five. Furthermore, Chijioke *et al*. (2012) observed that the high prevalence of *Ascaris* in Enugu metropolis was due to absence of municipal services like good drainage network, pipe borne water supply and waste disposal facilities which made them to recommend for

government intervention by way of provision of clean environment, social amenities and provision of free medications for planned periodical deworming. Ozumba and ozumba (2002) still maintained that the high prevalence of *Ascaris* in Enugu urban was lack of social amenities such as portable water coupled with absence of public toilets.

Awasthi *et al*. (2008) noted that the high prevalence of geohelninth infections in developing countries was due to poor socio economic conditions like presence of inadequate housing, low levels of education and awareness, poor health services, inadequate sanitation, lack of access to sanitation facilities and clean drinking water. All these factors enhance directly or indirectly to the transmission and spread of geohelminth infections.

2.7.4 Socio-economic factors

Poverty contributes a lot in the transmission and spread of geohelminth infections. It was in view of this that Roberts and Janovy (1996) referred to geohelminthiasis as the disease of the poor and uneducated persons in underdeveloped areas of the world. They stated that promiscuous defaecation associated with poverty and ignorance keep the soil contamination high which increases the rate at which food and water are being contaminated with soil carrying eggs and larvae of geohelminths. Geohelminths infections are common among those that cannot afford foot wears as walking barefoot facilitates the skin contact with the larvae of some geohelminths.

In addition, Vikram *et al.* (2008) noted that the poor mostly lack access to education due to financial constraints. Lack of clean water and good housing among inhabitants of slums with poor hygienic environment and over crowded conditions also enhance geoheminth

infectoins. Emma *et al.* (1998) observed that all the household related indicators denoting greater poverty in highly deprived areas in the border region of Chiapas, Mexico were associated with the high prevalence of *Ascaris lumbricoides.* The indicators include; lack of electricity, lack of refrigerator, use of wood as cooking fuel, dirty floor, and water supply from communal source of river, overcrowding and living in a locality classified deprived areas. Olaniyi *et al.* (2007) stated that intestinal helminthic infections are still a disease of poverty as there is a strong correlation between parental socio economic status and intestinal parasitosis in children.

2.7.5 Characteristics of geoheminth species

The characteristics of geohelminths species count a lot in their epidemiology. The characteristics include; resistant to hard conditions, ability to produce large number of eggs (reproductive potential), longevity of eggs/larvae and phenotypic flexibility (Roberts and Janovy, 1996; Collier *et al.*, 1998). The longevity of the eggs, larvae and the adults of the geohelminths .plays a role in the transmission of the geohelminth infections to new host, continuity of the infections in a locality and introduction to new areas. The larvae of hookworms can survive for three weeks in condusive environmental conditions and a year in protected sites like mines while adults live for about 5-15 years in its host. Furthermore, the maximum survival of the infective stages of *Ascaris lumbricoides* and *Trichuris trichiura in* protected soil is about 15 and 6 years respectively. The adult *Ascaris lumbricoides* lives for about 1-2 years while *Trichuris trichiura* lives for about 1-3 years within their hosts. This long survival of the infective stages as well as the adults ensures continuous contamination of the soil which makes it impossible to prevent re-infection

when house yards have been liberally seeded with eggs even when proper sanitation habits are initiated later.

High fecundity of geohelminths also ensures that the soil is always seeded with the helminths eggs and larvae which favour the transmission and spread of the infections. The large number of eggs produced and laid ensures the maintenance of endemicity of the geohelminths. For instance, *Ascaris* produces about 240,000 eggs/day, hookworm, 10,000-25,000 eggs/day, *Trichuris,* 14,000–20,000 eggs/day. In a place where promiscuous or open air defaecation is practiced, the large number of eggs/larvae laid facilitates skin contact with the larvae, contamination of soil, food, water/drinks (Roberts and Janovy, 1996, Collier *et al.*, 1998). In addition, certain characteristic features of geohelminth eggs enable them to withstand hard environmental conditions and develop to infective stages. For example, *Ascaris* eggs are resistant to low temperature, desiccation and chemicals. The eggs can embryonate in 2% formalin, potassium dichromate, in 50% solution of hydrochloric, nitric, acetic and sulphuric acids as well as disinfectants due to the lipid layer of the egg shell which contains ascarosides or lipoprotein. The cortical or mucopolysaccharide layer of the *Ascaris* egg shell enables it to adhere to surfaces or objects like bank notes, door handles, clothes among others. This adhesive property facilitates the dissemination of the eggs hence increasing the rate of transmission and the spread of the helminth.

Unlike the *Ascaris* eggs, *Trichuris* and hookworm egg shells have no ascarosides or lipid layer therefore high temperature and chemicals destroy them preventing them from developing into infective stages. This reduces the rate of transmission and the spread of the

helminths (Oyerinde, 1999). In addition, the nature of the life cycle of the geohelminths contributes immensely to their epidemiology. The phenotypic flexibility of *Stongyloides stercoralis* in soil enables it to adapt its life cycle and development to suit the environmental conditions. The internal auto–infection involved in *Stongyloides* life cycle also allows the maintenance of the helminth within the host for years following the initial exposure. This type of life cycle favours the transmission of the helminth (Collier *et al.*, 1998)

2.7.6 Paratenic hosts

These are hosts where the larval stages of parasites survive temporary without undergoing any development before reaching their definitive host (Kanma and Binshak, 2015). Roberts and Janovy (1996) noted that the presence of paratenic hosts increases the chances of transmission of geohelminth infections. They observed that hookworm can survive in the muscles of the paratenic hosts like rabbits, lamb, cow, pigs, and that *Ancylostoma duodenale* can be transmitted through the ingestion of undercooked meat like beef, pork, lamb and rabbit.

2.7.7 Race

It was observed that white people are 10 times more susceptible to hookworm than the blacks. The prevalence and number of worms per individual also tend to be more among the whites than the blacks.The diferential effects of hookworm according to Roberts and Janovy (1996) was due to the lazy apathetic white trash which made their socio-economic level low when compared to the more industrious blacks.

2.7.8 Age of the host

Studies have shown that geohelminths prevalence was related to the age of the host In view of this, Roberts and Janovy (1996) noted that the prevalence of geohelminth infections was more in children than the adult while Oyerinde (1999) believed that all ages and both sexes appear to be equally susceptible to geohelminth infections and that high prevalence recorded for any group is due to exposure. He stated that geohelminth infections would be more prevalent in those whose occupation brings them in contact with contaminated soil; bricklayers, gardeners, farmers and miners. Awasthi *et al*. (2008) observed that *Ascaris* and *Trichuris* prevalence reach maximum at childhood and decreases at adulthood while the hookworm prevalence increases with age and reaches maximum in 20–30 years, and then decreases. The observation was in contrast with Kunwar *et al.* (2006) who noted that both the *Ascaris* and hookworm prevalence rates consistently increased with increasing age, with the highest infection occurring between the ages of 36 and 45.They attributed the high rate of infection to their responsibilities; increased mobility, more workload in the fields and livestock to fulfill their duty. They noted as well that *Trichuris* infection is highest in young women of ages 15–25 and decline afterwards.

Ozumba and Ozumba (2002) observed from their studies in Enugu that the prevalence of *Ascaris* was highest in 12–17 years which they attributed to their poor hygienic standard and greater mobility out doors which brings them into contact with conditions favouring the transmission of the helminth. The out doors activities according to them include; playing, working on farms where human faeces are used as night soil and eating out doors. Chukwuma *et al.* (2009) observed that *Ascaris* prevalence was significantly increased as the age of the pupils increased while hookworm and *Strongyloides* were more prevalent

among the younger age group. Kirwan *et al.* (2009) observed from their study on infants that *Ascaris* prevalence increased significantly in older infants with sharp increase at 12 months while the youngest infant infected was 5 months old. They attributed the increase in the older infants to weaning from breast milk to solid food and better mobility.

2.7.9 Host's immunity

Studies have shown that the ability of the helminths to establish themselves within the host depends on the level of the host's immunity. Collier *et al*. (1998) observed that the prevalence of *Strongyloides* infection was highest in individuals with underlying immune defects. WHO (2006) noted that geohelminths are refractory to host immunity, establishing chronic infections during host's life. According to them, geohelminths have complex life cycles within the human host, undergoing a succession of developmental stages which can carry stage–specific antigens and pass through a range of host tissues (skin, lungs and gut). They also believed that geohelminths survive within the host not just by warding of immune attack but instead by aggressively subverting the host immune response to create niches that optimize successful residence, feeding and reproduction. In a nutshell, if the helminths are able to subdue the immune response of the host, they will establish themselves and produce eggs/larvae which contaminate the soil, food and drinks hence facilitating the transmission and spread of the helminths.

2.7.10 Cultural practice

Some cultural practices favour the spread of geohelminth infections.

For instance, the use of water for cleaning after defaecation and the communal feeding from a common bowl in an open street yard, a usual practice in some rural areas, may

account for a high prevalence of geohelminth infections. Meals are often exposed to the wind, insects and domestic animals through which they may get contaminated with helminth eggs while participants are awaited (Olaniyi *et al.*, 2007).

2.8 Pathogenesis/Clinical Symptoms

Ascaris lumbricoides causes ill health which manifests in several symptoms. According to Roberts and Janovy (1996), when the juveniles of *Ascaris* break out of the lungs capillaries into the respiratory system, they cause a small haemorrhage at each site. Heavy infections cause small pools of blood to accumulate creating oedema with resultant clogging of air spaces. Accumulation of white blood cells and dead epithelium add to the congestion which is referred to as ascaris pneumonitis. Large areas of the lungs can become diseased and when bacterial infections become superimposed, death can result. Although occasionally *Ascaris* sucks from the intestinal wall, its main food is liquid contents of the intestinal lumen. In moderate and heavy infections, the resulting theft of nourishment can cause malnutrition and under development in small children. Abdominal pains and sensitization phenomena like rashes, eye pain, asthma, insomnia and restlessness often as allergic responses to metabolites produced by the worm A massive infection can cause blockage of the intestine and the pancreatic and bile ducts with grave results.

Multiple liver diseases have resulted from such invasion. The worms reaching the stomach are aggravated by the acidity and writhe, often causing nausea. The psychological trauma induced in one who vomits an 18 inch ascarid is difficult to quantify. The worms that reach the oesophagus while the host is sleeping may crawl into the trachea, causing suffocation or lung damage; they may also crawl into the Eustachian tubes and middle ear causing

extensive damage (Kanma and Binshak, 2005). According to Oyerinde (1999), the migrating larvae of *Ascaris lumbricoides* do not do much damage except in heavy infection; there may be some destruction of the tissues of the liver, hepatitis and haemorrhage. The most important lesions are produced in the lungs where passage of larvae via lung capillaries into the alveoli is accompanied by haemorrhage which may lead to oedema of the organ due to blood collecting in small pockets in the alveoli. Heavy infection may produce pneumonitis which is manifested in fever with temperature of up to 104^{o}C, shortness of breath, haemoptysis, headache, muscular pain. Occasionally some migrating larvae enter systemic circulation and may reach all the various organs of the body including the eyes, brain and kidney where they filter out and provoke host tissue reactions, often with mild to severe symptoms like meningitis, retinitis and epilepsy when the central nervous system is affected.

The presence of the adult worms in the intestine is associated with poor digestion, diarrhoea and inflammation of the bowel, epigastric pain, nausea and vomiting. The infection may be more in children, involving nervous symptoms, loss of weight, convulsion. The adult worms may block the bile and pancreatic ducts, Eustachian tubes and lungs which may lead to serious consequences. They sometimes block the larynx hence causing suffocation. Other complications attributed to *Ascaris* infection include peritonitis and acute appendicitis. Collier *et al*.(1998) stated that the larval migration of *Ascaris* via the liver and the lungs causes pulmonary ascariasis which is characterized with pneumonitis, dysponea, cough, substernal pain fever, asthma, decrease in food intake, eosinophilia. The presence of adult worms in the intestine results in abdominal pain, abdominal distention, nausea, vomiting, intermittent diarrhoea, anorexia, restlessness, anal itching, enterocolitis, jejunal

abnormalities and this leads to decrease in food intake, increased nutrient loss, mal-absorption of protein, fat, vitamin A, D-xylose and lactose.

The exposure to *Ascaris* allergen at any stage of the life cycle results in hypersensitivity reactions like asthma, conjunctivitis, facial oedema, urticaria, abdominal pain, heartburn, diarrhoea., decrease in food intake and increase in nutrient loss. Aggregation of the adult *Ascaris* in the intestine leads to intestinal obstruction, intussusceptions / volvulus. Invasion of the bile duct leads to obstructive jaundice, gallstone, cholangitis and liver abscess. Other symptoms of ascariasis are acute pancreatitis, acute appendicitis, intestinal perforation, peritonitis, upper respiratory tract obstruction.

Hookworm infections are also of public health importance considering the damage they do to the tissues and organs of their hosts through feeding and larval migration. Roberts and Janovy (1996) stated that the pathogenesis of the hookworms is in three (3) phases namely, the cutaneous or invasion phase, the migration or pulmonary phase and the intestinal phase. The cutaneous phase starts when the larvae penetrate the skin where they do little damage to the superficial layers but when they penetrate the dermis, they attack the blood vessels initiating tissue reaction that may isolate and kill the worms. The death of the worms will introduce pyogenic bacteria into the skin resulting into urticarial reaction causing ground itch. In the pulmonary phase, the larvae break out of the lung capillaries bed into the alveoli and progress up to the bronchi, to the throat and each site haemorrhages slightly with serious consequences in massive infections. The migration of the larvae in lungs may lead to dry cough and sore throat. Pneumonitis occurs in severe infections. Intestinal phase is

regarded as the most important period of pathogenesis of hookworm infections. The worms attach to the mucosa with their strong buccal capsules and their teeth feeding on blood.

The worms move from place to place but bleeding quickly ceases at a lesion that the worms left. The worms pass more blood through their digestive tracts. Blood loss per worm is about 0.03ml/day for *Necator americanus* and 0.26ml /day for *Ancylostoma duodenale.* Patient with heavy infections lose up to 200ml of blood per day but 40% of the iron will be reabsorbed before it leaves the intestine. A moderate infection will gradually produce an iron-deficiency anaemia since the body reserve of iron is used up. Slight intermittent abdominal pain, loss of normal appetite and desire to eat soil are common symptoms of moderate hookworm infections. In a very heavy infection, the patients suffer severe protein deficiency with dry skin and hair, oedema and potbelly in children with delayed puberty, mental dullness, heart failure and death. The drain of protein and iron is catastrophic to one who is subsisting on mineral diet. The chronic malnutrition in young people often causes stunted growth and below average intelligence, impairment in ability to produce IgG which results in lowered antibody response to hookworm and other infectious agents. Collier *et al*.(1998) also noted that iron deficiency anaemia, breathlessness, lassitude, headache, palpitation, apathy and depression are symptoms of hookworm infections.

Lucas and Gilles (2003) stated loss of appetite, iron deficiency anaemia and severe protein depletion as symptoms of hookworm infections The penetration of the skin by the larvae of hookworm induces ground itch or hookworm dermatitis which is characterized by intense itching and burning sensation followed by oedema, erythema and formation of lesions. The migration of the larvae produces urticarial rash while the break out of the larvae from the

lungs capillaries into the alveoli is accompanied by haemorrhage and blood accumulation in the air sacs. Adult worms in the intestine attach firmly to the mucosa by sucking in a plug of the intestinal villi into the mouth which leads to the digestion of some tissues of the villi and the breaking open of the blood capillaries through which they suck blood. The activities lead to enteritis with diarrhoea and anaemia. The anaemia results due to the iron deficiency resulting from blood loss.

In acute infection, the symptoms include abdominal discomfort, fever, anorexia, nausea, vomiting and diarrhoea. Heavy infection may be severe as to involve the vital organs like the heart, nervous system and kidneys causing malfunctioning as a result of impaired nutrition which is characterized by weakness, diarrhoea with blood and mucus alternating with constipation, marked anaemia, indigestion, physical dullness, loss of weight and marked eosinophilia (Oyerinde, 1999).

In *Trichuris trichiura* infection, the lacerations caused by the feeding activities of the worm may facilitate the establishment of secondary bacterial infection. Heavy infection in children leads to dysentery, rectal prolapsed and rectal bleeding (Collier *et al*., 1998). Oyerinde (1999) noted that light *Trichuris* infection is asymptomatic while the heavy infection results in loss of appetite, weakness, diarrhoea with blood, anaemia, eosinophilia, abdominal discomfort, rectal prolapsed, fever, blockage of appendiceal lumen, inflammation of gut epithelium and system intoxication which results from the absorption of the metabolic products of the worm into the host's system. Roberts and Janovy (1996) also stated that light trichuriasis is asymptomatic while the intense infection is associated with dysentery and rectal prolapsed. They indicated that the worms bury their anterior ends

inside the intestinal mucosa while feeding on the cell contents and blood hence the trauma in the intestinal epithelium and the underlying sub mucosa can cause a chronic haemorrhage that result in anaemia. Lucas and Gilles (2003) noted as well that heavy infection of over one thousand (1000) worms causes bloody diarrhoea, anaemia and prolapsed of the rectum.

In *Strongyloides* infection, the penetration of the skin by the larvae results in small haemorrhage, swelling with intense itching at the site of entry and if pathogenic bacteria are introduced along with the larvae, inflammation may result. During the migration of the larvae through the lungs, they damage the lung tissues which results in occasional pulmonary eosinophilic lung infiltrates or wheezing, a burning sensation in the chest, a non productive cough and bronchial pneumonia. In intestinal mucosa, the adult worms move randomly depositing eggs which results in an intense localized burning sensation or aching pain in the abdomen. The destruction of the intestinal tissues by the adult worms and the larvae results in sloughing of patches of mucosa, with fibrotic changes in chronic cases which sometimes results in death due to septicaemia following ulceration of the intestine. Chronic strongyloidiasis can result in relapsing colitis (Roberts and Janovy, 1996).The clinical and pathological aspects of stongyloidiasis are grouped into three categories namely, asymptomatic carriage, intestinal disease and hyper infection with or without dissemination. In chronic infection, the egg out put is usually low and constant proportionally few larvae undergo internal autoinfection. It is usually asymptomatic but where symptoms result, they involve gastrointestinal tract, intermittent abdominal pain and distension, bloating and diarrhoea alternating with constipation. Children may develop a mal-absorption syndrome leading to stunted growth and failure to thrive. Pruritus and

urticaria especially in peri-anal skin and buttocks are also common symptoms of chronic infection. A serpigenous pruritic eruption referred to as larva currens is usually found on the trunk or buttocks of the host due to the skin penetration by the auto infective filariform larvae in that area.

In contrast with the chronic infection, hyper-infection is associated with both increases in the number of the eggs produced as well as the proportion of the larvae that develop internally to filariform stage and invade the host. The increase in the number of the worms within the host results in dissemination of the larvae to various tissues. Hyper infection is associated with immunosuppressive therapy, gastrointestinal bleeding, paralytic ileus, perforation of intestine. The increase in the number of the worms migrating through the lungs often results in wheezing, dysponoea and occasionally pulmonary haemorrhage, patchy infiltrates, diffuse intestinal pneumonitis and bronchopneumonia. As the larvae gain access to arterial circulation, they may be carried to numerous tissues and organs like lymph nodes, endocardium, pancreas, kidneys. Involvement of the central nervous system can results in seizures and mental status changes. This is accompanied by pyogenic abscess or meningitis caused by bacteria which may be carried from the gut by migrating larvae.
Cutaneous manifestations of disseminated strongyloidiasis include petechiae and sometimes severe purpura (Collier *et al*., 1998). Oyerinde (1999) also stated that the penetration of the infective larvae into the skin is associated with petechial haemorrhage at the point of entry, pruritus, oedema and sometimes secondary bacterial infection may occur. According to him, the migration of the larvae through the lungs and the break out of the larvae from the lung capillaries into the alveoli result in haemorrhage, high eosinophilia with cough and general burning sensation of the thorax. The presence of the adults in the

intestine causes intermittent watery mucoid diarrhoea, inflammation of the intestinal mucosa with nervous symptoms such as depression, restlessness and insomnia. Dehydration of tissues and exhaustion were noticed in immunosuppressive patient; the infection may terminate fatally. Lucas and Gilles (2003) stated that creeping linear erythematous eruption (larva currens) and mal-absorption are symptoms of strongyloidiasis.

2.9 Economic Importance of Geohelminthiasis

The effects of geohelminthiasis on man's health especially the infants cannot be over emphasized. Studies have shown that geohelminthiasis has adverse effects on growth, development, nutrition, fitness and cognitive function of a child (WHO, 1990). Uneke *et al*. (2007) observed stunted growth of 1.6m (5.4%) and weight loss of 0.04kg (3.2%) among children infected with geohelminths in Onitsha, Anambra State, Nigeria. They also noted that ascariasis in children results in poor nutritional states. Furthermore, Adeyeba and Tijani (2002) reported a loss of about 2% of haemoglobin per gram of faeces in malnourished children infected with *Stongyloides stercolaris* in Ibadan, Oyo State, Nigeria. According to them, the children are clinically anaemic. They noticed as well that their weight reduced drastically. In addition, Jardim- Botelho *et al.* (2008) stated that stunting was associated with *Ascaris lumbricoides* infection among children and adolescents while low body mass was significantly associated with hookworm infections among adults and the elderly. Oberhelman *et al.* (1998) were of the opinion that the malnutrition caused by geohelminth infections may be one of the several important factors in the evolution of developmental disabilities through delayed central nervous system development in early childhood or decreased physical stamina. Awasthi and Pande (1997) observed that pre –

school children infected with geohelminths in Lucknow had lower haemoglobin than those without the infections and that those with the infections are anaemic.

Geohelminth infections cause weight loss, impaired lactation, malnutrition, retarded growth and poor brain development in children. The long term effects of hookworm infections include malnutrition, and delayed cognitive development especially in children, infants inclusive. The presence of 40 or more hookworm in the intestine can lead to the reduction of host's haemoglobin concentration below 1g/dl. Hookworm infection leads to anaemia which in turn influences the intrauterine growth rate, prematurity and the weight of a child at birth. Trichuriasis causes finger clubbing while ascariasis leads to lactose intolerance and malabsorption of vitamin A which in turn cause nutritional and growth failure.
(Drake and Bundy, 2001; WHO, 2006). Chijioke *et al*. (2012) stated that the high prevalence of ascariasis results in 20,000 deaths per year due to intestinal obstruction especially in children. Ikram *et al* (2009) observed that ascariasis was responsible for 50 60% of paediatric admissions in the surgical emergency department in Peshawar while hookworm infections cause impotence, reduce school attendance with subsequent effects on productivity and wage earning potential in adulthood.

Roberts and Janovy (1996) stated that trichuriasis leads to growth retardation, finger clubbing (an odd thickening of the ends of the digits), impair cognitive function and development in children while persons with hookworm infections suffer severe protein deficiency with dry skin, oedema and potbelly in children with delayed puberty, mental dullness, heart failure and death.

2.10 Diagnosis of the Geohelminths

Geohelminth infections are generally diagnosed through the microscopic examination of the fresh stool samples for the identification of either their eggs or the larvae using any of the following techniques; direct smear examination, concentration technique which consists of flotation and sedimentation methods .*Strongyloides stercoralis*. Can also be diagnosed through microscopic examination of the sputum for the identification of the larvae Adult *Ascaris* can be detected from the x rays of the intestine taken immediately after a barium meal. The adult can as well be recovered in faeces (Oyerinde, 1999; Lucas and Gilles, 2003, Cheesbrough, 2005).

2.11Treatment and Control of Geohelminthiasis

The morbidity and mortality caused by geohelminth infections are of great public health importance. The infections have claimed many lives especially mothers and infants that are more vulnerable than any other group. Brooker *et al.* (2008) noted that the severe anaemia caused by hookworm infection was an important contributor to maternal mortality while WHO (2006) stated that weight loss impaired lactation, malnutrition, retarded growth and poor brain development are the effects of geohelminth infections on infants. In view of these ugly effects, coupled with the fact that infants are the future of any nation, it becomes very necessary to control the scourge.

2.11.1 Chemotherapy/Treatment of geohelminthiasis

Treatment of infected persons is very important in curbing the transmission and spread of the geohelminth infections but effective treatment of geohelminth infections is dependent on the species and stages involved as well as the availability and efficacy of the

anthelminthic drugs. Some drugs may be infective in the treatment of some species or stages of geohelminths and fail to be effective in others. For instance, Roberts and Janovy (1996) stated that no efficient treatment of the migrating juveniles of hookworm has been discovered. This implies that for effective treatment of geohelminthiasis to be achieved, there should be careful selection of anthelminthic drugs. Lucas and Gilles (2003) stated that the efficacy of anthelminthic drugs varies according to the species in question. They suggested that in heavy geohelminth infections, selective treatment for appropriate species of the helminthic infection is preferable. In addition, they also advised that broad-spectrum anthelminthics, effective against more than one species of the helminths should be used in the treatment of multiple intestinal helminth infections.

Some drugs of choice for the treatment of geohelminth infections include levamisole hydrochloride (Ketrax) which is effective against *Ascaris* and hookworm (dosage; 2.5–5 mg / gm body weight, taken orally as a single dose) , mebendazole or vermox which is effective against *Ascaris, Trichuris* and hookworm (dosage;100mg twice daily for 3 days), pyrantel embonate (combantrin) is effective against *Ascaris* and hookworm (dosage; 20mg /gm body weight taken orally as a single dose), thiabendazole (mintezol) is effective against *Strongyloides stercoralis (*dosage; 25mg / kg body weight, twice daily orally for 3–5 days), albendazole is effective against hookworms (dosage; 400mg taken orally as a single dose) (Oyerinde, 1999, Kanma and Binshak, 2015). Kunwar *et al*. (2006) recognized the importance of treatment in the control of geohelminth infections hence they recommended that interventions by anthelminthic treatment targeted to all women of child bearing age, coupled with improvement in sanitation and appropriate health education will go a long way in reducing the rate of geohelminth infections. Fekadu (2008) also suggested

that immediate treatment of hookworm positive children and improved environmental and personal hygiene will curb the observed high burden of geohelminth infections among children.

2.11.2 Control of geohelminth infections

Apart from treatment of the infected persons, discouragement of indiscriminate defaecation and sanitary disposal of human faeces will contribute positively in the control of geohelminth infections. To buttress this, Chijioke *et al.* (2012) stated that proper intervention by the government by way of provision of clean environment, social amenities and free medications for planned periodical deworming programme will reduce the burden of ascariasis. Furthermore, the discouragement of the use of untreated human faeces for fertilizer and regular use of footwear will prevent skin contact with the larvae of hookworm and *Strongyloides* therefore reducing the rate of transmission (Oyerinde, 1999; Lucas and Gilles, 2003). Studies have shown that poor environmental sanitation, poor personal hygiene and lack of social amenities enhance the transmission and spread of geohelmith infections. In view of this, Belyhun *et al.* (2010) stated that deworming strategies, provision of safe drinking water and health education about soap use especially the rural residents will drastically reduce the rate of geohelminth infections especially in mother to child transmission. Ozumba and Ozumba (2002) also noted that improvement in water supply, environmental sanitation and the economy in general will help in reducing the prevalence of geohelminths.

Nock *et al.* (2003) also emphasized on the need of legislation and its accompanying enforcement towards having and sustaining a clean and intestinal parasite-free

environment. Still on clean environment, Tamramat *et al.* (2008) recommended that government should ensure that policies are in place to enforce the provision of at least ventilated improved pit latrines in homes and that health education in the clinics should advocate rigorous hand washing especially after defaecation, before meal preparation and deworming of children from 6 months. In addition, Adeyeba and Tijani (2002) were of the opinion that only a well organized health education programmed on personal hygiene and community health, adequate supply of portable and safe water, in addition to the provision of basic sanitation facilities like toilets shall bring a long lasting solution to the menacing problems of geohelminth infections. Chukwuma *et al*. (2009) stated that for effective control of geohelminth infections to be achieved, health programme for the control of the helminth should be established in a community and education regarding geophagia prevention should be an integral component of the programme.

2.12 Mode of Action of Anthelminthics

According to Markel *et al.* (1986) the mode of actions of most of the anthelminthics drugs of gastrointestinal helminths especially benzimidazole derivatives include the following;

(i) Irreversible inhibition of the glucose and other nutrients uptake on the part of the worm but has no such effect on man. The inhibition will immobilize the worm and paralyze the activities of the cells of the parasites which eventually lead to the death of the helminths. An example of the drug is mebendazole.

(ii) Albendazole kills helminth by decreasing ATP production in the worm, causing energy depletion, immobilization and finally death.

(iii) Pyrimidine derivatives like pyrantel pamoate depolarize the myoneural junction/ganglionic block of nicotinic neuromuscular transmission in the worms, paralyzing them in spastic condition and finally leading to the death of the helminths.

(iv) Some of the drugs interfere with the transport of glucose into the worm thereby distorting the respiratory activities of the helminths which leads to the death of the parasites.

(v) Niclosamide inhibits the oxidative phosphorylation in the mitochondria of the worm.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The study area is Kaduna State. Kaduna State lies on 9° 1′-11°31′ N and 6° 1′-8° 31′ E is in the North West geographical zone of Nigeria. It is bounded in the North by Katsina and Kano States, in the South by Nassarawa State and the Federal Capital Territory, in the East by Bauchi and Plateau States and in the West by Zamfara and Niger States (Fig.1). The vegetation is the Guinea Savannah type with a land mass/area of 46,053 km^2. It has two distinct seasons (rainy and dry seasons). The rainy season starts from April and extends to September while the dry season starts from October and ends in March. The harmattan period (within the dry season) is between November and February every year. The harmattan period is characterized by reduced temperature, dry wind and dusty cloud (Salihu, 2008). The State is made up of 23 Local Government Areas with a population of 6,113,503; most of the inhabitants are farmers but there are also petty traders, civil servants and casual workers (Galleria Media Limited, 2011; NPC, 2006).

Urban slums are common while the supply of pipe–borne water is inadequate hence many of the inhabitants resort to the use of water from the boreholes, streams/ rivers and wells (Nock *et al*., 2003). Some of the residents have no functional toilets thereby defaecating indiscriminately in their environment. Furthermore, poor waste disposal and drainage system characterizes most of the communities in Kaduna State (Nock *et al*., 2003).The indiscriminate defaecation leads to the contamination of the soil, food and water bodies with the faeces carrying the eggs and larvae of the helminths (Nock *et al*., 2003). Six government general hospitals were used as sampled locations (Fig.1). They include Barau

Dikko Specialist Hospital, Kaduna in Kaduna North Local Government Area, Gambo Sawaba General Hospital Kofar Gayan, Zaria in Zaria Local Government Area, General Hospital, Makarfi in Makarfi Local Government Area, General Hospital, Kachia in Kachia Local Government Area, Dr .Gwamna Awan General Hospital, Kakuri in Kadna South Local Government Area and Mohammed Dabo Lere Memorial Hospital, Saminaka in Lere Local Government Area. The selection of General Hospitals was to facilitate the collection of the samples since most of the mothers attend them because of free treatment given to the infants.

3.2 Sample Size Determination

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

$$N = \frac{Z^2(p)q}{L^2}$$

Where

N = Sample Size

Z = Standard Normal Distribution

p = Prevalence of the infection

q = Proportion of individuals not infected

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

$Z^2 = (1.96)^2$

p+q = 1

L = 0.05

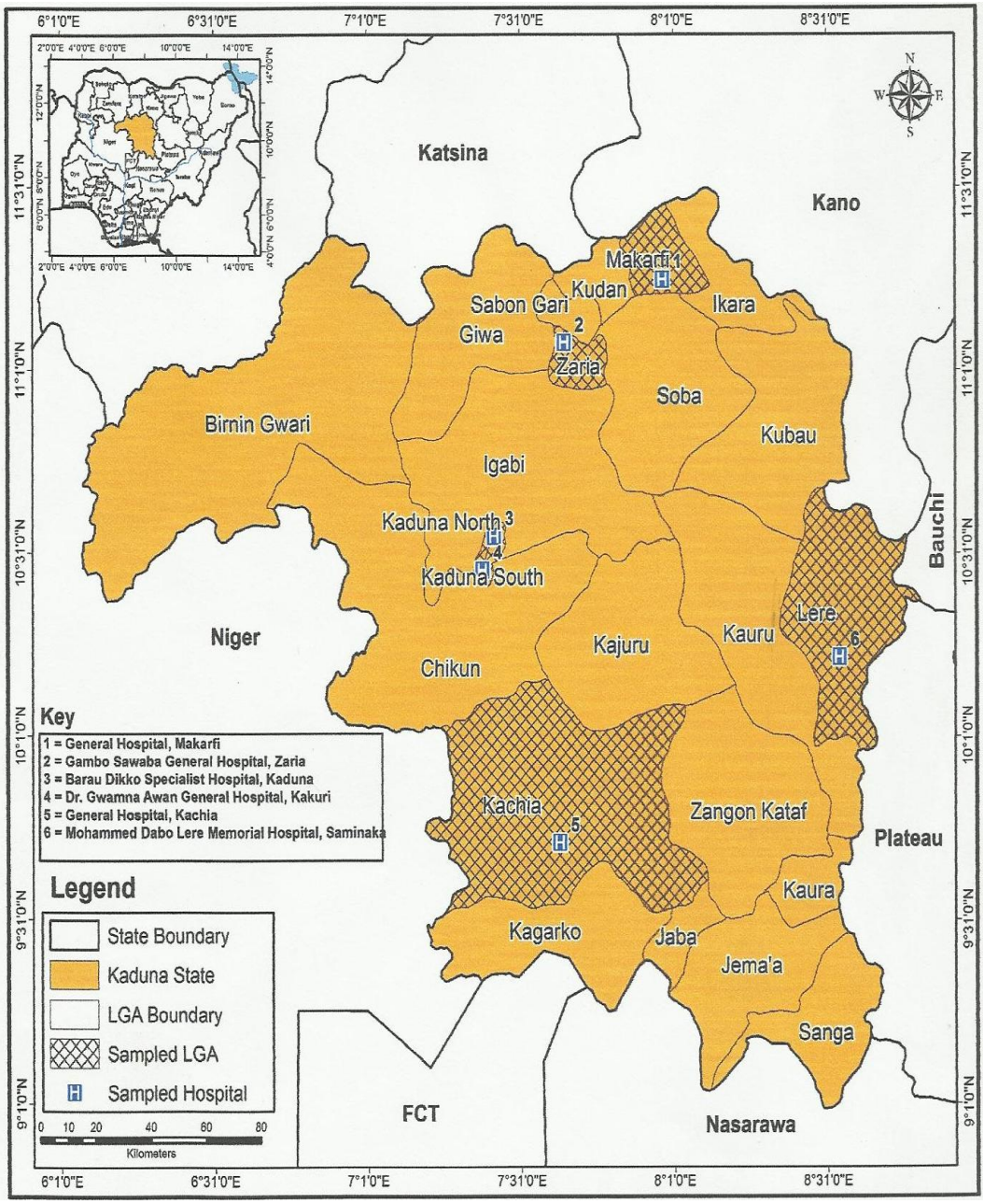


Figure 1: Map of Kaduna State showing Sampled LGAs and Hospitals

Source: Adapted and modified from the administrative map of Kaduna State

Substitution:

p = 90% = $\frac{90}{100}$ = 0 .90

q = 1– 0.90 = 0.10

N = $\frac{(1.96)^2(0.90)(0.10)}{(0.05)^2}$ = $\frac{3.8416 \times 0.90 \times 0.10}{0.0025}$ = $\frac{0.345744}{0.0025}$ = 138 × 6 = 828

3.3 Sample Population

Six government general hospitals were used as sampled location. They include Barau Dikko Specialist Hospital, Kaduna, Gambo Sawaba General Hospital Kofar Gayan, Zaria, General Hospital, Makarfi, General Hospital, Kachia, Dr .Gwamna Awan General Hospital, Kakuri and Mohammed Dabo Lere Memorial Hospital, Saminaka. From the sample size computation, 138 (infants, 69 and the mothers, 69) were selected from each of the six hospitals mentioned above; giving a total population of 828 (414 infants and 414 mothers) as estimated sample size. The sample size used was 1022 (509 mothers and
513 infants).

The age of the infants ranges from 0–12 months (Goodman *et al.*, 2007). The mothers consist of those .that are within the child-bearing age (15-45 years).

3.3.1 Exclusion and non–inclusion criteria

Stool samples were not collected from mothers/care givers who had no infants with them.

3.4 Permission and Ethical Clearance

Permission was sought (Appendix I) and obtained from the Kaduna State Ministry of Health and the consent of the mothers/care givers was also sought and obtained after they were adequately briefed on the nature and importance of the study.

3.5 Sample Collection

Each caregiver/ mother was given two sterile specimen bottles and informed on how to collect stool from their infants. The bottles for the collection of the stool sample of the infants were labeled 'I' while those of the Mothers were labeled 'M' and also accorded numbers serially .Questionnaires were used to collect demographic data such as name, age, and sex of the infants; and risk factors such as occupation and educational status of the mothers/caregivers, method of refuse disposal, source of water for the family and the type of toilet system used by the parents (Appendix:II). The questionnaires were administered to the mothers/caregivers during the collection of stool samples. Stool samples from the infants and their mothers/care givers were collected from the out patient section and the children's ward of the hospitals. The samples were preserved in 10% formalin for later laboratory examination (Sloss *et al.,* 1994).

3.6 Examination of Faecal Samples

The stool samples were examined in the laboratory of each of the hospitals where they were collected using the sedimentation technique (formol–ether concentration technique) as described by Cheesbrough (2005).

3.6.1 Formol–ether concentration technique (Cheesbrough, 2005).

One gram (1gm) of each faeces was emulsified in 4 ml of 10% formol water in a screw cap bottle. Three to four milliliters (3–4 ml) of 10% formol water was added to the mixture of the faeces.The bottle was capped and its content mixed by shaking the bottle thoroughly. The emulsified faeces was sieved into a beaker using a 0.50mm tea strainer. The suspension was transferred into the centrifuge tube and 4ml of diethyl ether was added. The tube was corked and the suspension mixed thoroughly by shaking it for 1 min. The stopper was loosened using a tissue wrapped around the top of the tube, to release the pressure that had built up in the tube. The suspension was centrifuged with eppendorf AG 22331 (Hamburg) centrifuge 5804 (Germany) at 750-1000g (approx. 3000rpm) for 1 min.The supernatant was decanted while the sediment remained in the tube. The tube was kept in an upright position to allow the fluid from sides of the tube to drain to the bottom.The bottom of the tube was tapped to re–suspend and mix the sediment. Two drops of the sediment were placed on a microscope slide and covered with a cover slip and examined under the ×10 objective lens of the Olympus CX 41 binocular microscope and the eggs found were counted.

3.7 Identification of Geohelminth Eggs

The identification keys by Sloss (1970) and Cheesbrough (2005) were used to identify the eggs of helminths. Some of the identification features for *Ascaris lumbricoides* egg (the photomicrograph of the egg) include thick mammillated outer layer, unsegmented ovum, fertilized egg is round in shape while unfertilized egg is longer and narrower, fertilized egg measures 50-70 by 40–50 µm. For hookworm, the egg is oval shaped, thin shelled, segmented ovum and measures about 60–75 by 36-40µm. The features of *Trichuris*

trichiura egg are presence of mucoid protruding plug at both ends, unsegmented ovum, lemon shaped, smooth shell and it measures about 50–54 by 22–23µm. The features of *Strongyloides stercoralis* larva include muscular oesophagus, short buccal cavity, the infective filariform larva is long when compared to rhabditiform larva, presence of paired alae on both sides. The egg from free–living adult female is oval shaped and measures about 50-70 µm.

3.8 Data Analysis

Prevalence was determined by dividing the number of individuals infected by the number of individuals examined; then multiplied by one hundred

$$\frac{\text{Number infected}}{\text{Number examined}} \times \frac{100}{1}$$ (Margolis *et al.*, 1982).

Chi Square (χ^2) was used to determine association of geohelminth infections with male and female infants, as well as the age of the mothers and the infants. Analysis of variance (ANOVA) was used to determine the differences in prevalence of geohelminth infections between locations.

Students't- test was used to test the difference in prevalence of geohelminth infections in infants and their mothers.

The intensity of the geohelminth infections in mothers and their infants was classified based on WHO method of classification (Appendix XI). The intensity of geohelminth infections was determined using first principle of Stoll's method (which is the number of parasites' eggs per gramme of faeces) (Garcia and Brucker, 1997). Mean intensity of the parasites was determined by dividing the total number of individuals of a particular parasite

species in a sample of a host species by the number of infected individuals of the host species in the sample (Mean number of individuals of a particular parasite species per infected host in a sample) (Mangolis *et al*., 1982).

Odd's Ratio was used to determine association between geohelminth infection and risk factors. A soft ware, 'ANALYSE IT', was used for the Odd's Ratio analysis. Correlation analysis was used to determine whether the prevalence of geohelminth infection in mothers is correlated with that of their infants.

CHAPTER FOUR

RESULTS

4.1: Overall Prevalence of Geohelminth Infections in Mothers and their Infants

Out of 509 mothers examined, 62 (12.18%) were infected with at least one species of geohelminths (Table 4.1). The eggs of three species of the helminths identified in mothers included *Ascaris lumbricoides* (5.89%; Plate I), hookworm (8.45%; Plate II) and *Trichuris trichiura* (0.20%; Plate III).

Out of 513 infants examined for geoheminth infections, 8(1.56%) were infected. Two species of geohelminths identified were *Ascaris lumbricoides* (0.98%) and hookworm (0.59%). *Trichuris trichiura* and *Strongyloides stercoralis* were not encountered in the infants.

Statistically, there was a significant difference ($P< 0.05$) between the prevalence of geohelminth infections in mothers and the prevalence of their infants (Appendix: III). The results also showed a correlation ($r = 0.98$) between the prevalence of geohelminth infections in mothers and that of their infants (Appendix IV); an indication that the prevalence of geoheminth infections in infants is linked to that of their mothers.

4.2: Prevalence of Geohelminth Infection in Mothers and their Infants with Respect to Location / Sampled Hospitals

The prevalence of geoheminth infections in mothers and their infants varied with locations / sampled hospitals.

Table 4.1: Overall prevalence of geohelminth infection in mothers and their infants

			Geohelminth		
	Number examined	**Number infected (%)**	***Ascaris***	**Hookworm**	***Trichuris***
Mothers	509	62(12.18)*	30(5.89)	43(8.45)	1(0.20)
Infants	513	8(1.56)	5(0.98)	3(0.59)	0(0.00)

*The total number of infected mothers is less than that of geohelminths because 12 mothers had mixed infection.



Plate I: *Ascaris lumbricoides* Egg (× 400) Note the thick outer layer and the spherical shape.

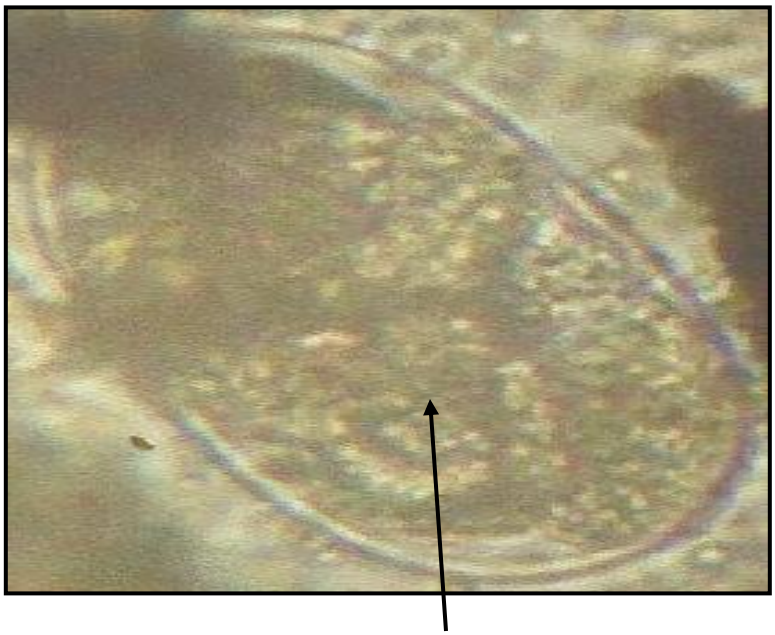


Plate II: Hookworm Egg (× 400). Note the segmented embryo, oval shape and thin outer layer

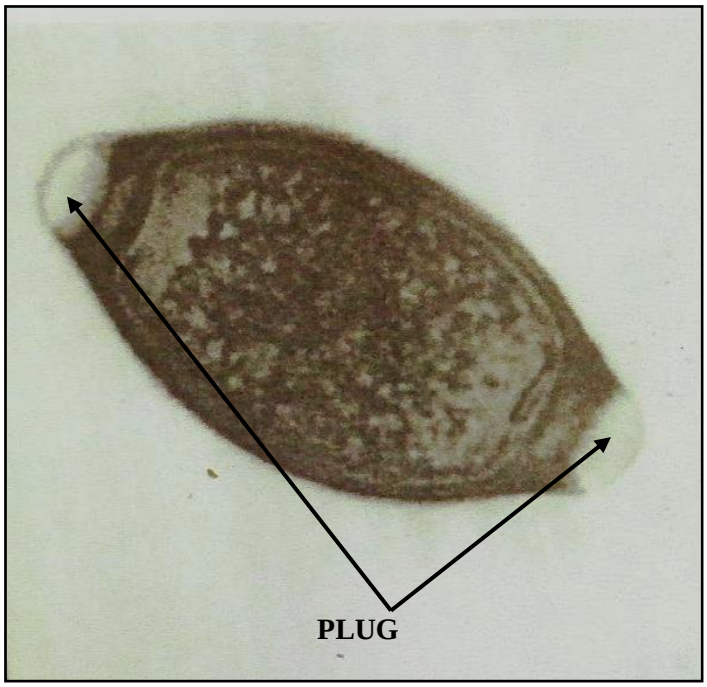


Plate III: *Trichuris trichiura* Egg (× 400) with a plug at each end

With respect to mothers, significant variations in prevalence (P<0.05; Appendix: VI) were observed amongst the hospitals with Mohammed Dabo Lere Memorial Hospital, Saminaka recording the highest prevalence (43.04%) followed by Gambo Sawaba General Hospital, Zaria (10.58%) while Barau Dikko Specialist Hospital, Kaduna had the least prevalence (2.22%) (Fig.2). In infants, geohelminth infections were found in only two hospitals namely Mohammed Dabo Lere Memorial Hospital Saminaka (7.59%) and Gambo Sawaba General Hospital, Zaria (1.91%) (Fig.2). The differences in prevalence in infants among the hospitals /locations were statistically significant (P < 0.05; Appendix: VII); the distribution of geohelminths in each hospital is shown in Appendix V.

4.3: Prevalence of Geohelminth Infections in Relation to Gender of Infants

The prevalence in relation to gender of the infants (Fig.3) showed that females were numerically more infected (2.08%) than their male counterparts (1.10%) but statistically, there was no significant association of geohelminth infection with gender (χ^2, P > 0.05) (Appendix:VIII).

4.4: Overall Prevalence of Geohelminth Infections in Mothers with Respect to Age.

The prevalence of geohelminth infections was significantly influenced by the age of mothers; infection was highest in the age group 35–44 years, 11 (18.97%) , followed by the age group 15–24 years , 29(15.51%) ,while the least infection 22(8.33%) was in the age group of 25–34 years (Fig.4) The difference in prevalence among the age groups in mothers was statistically significant (χ^2 , P<0.05); an indication of a significant association of geohelminth infection with the age of the mothers (Appendix: IX). Hookworm recorded the highest prevalence in all age groups

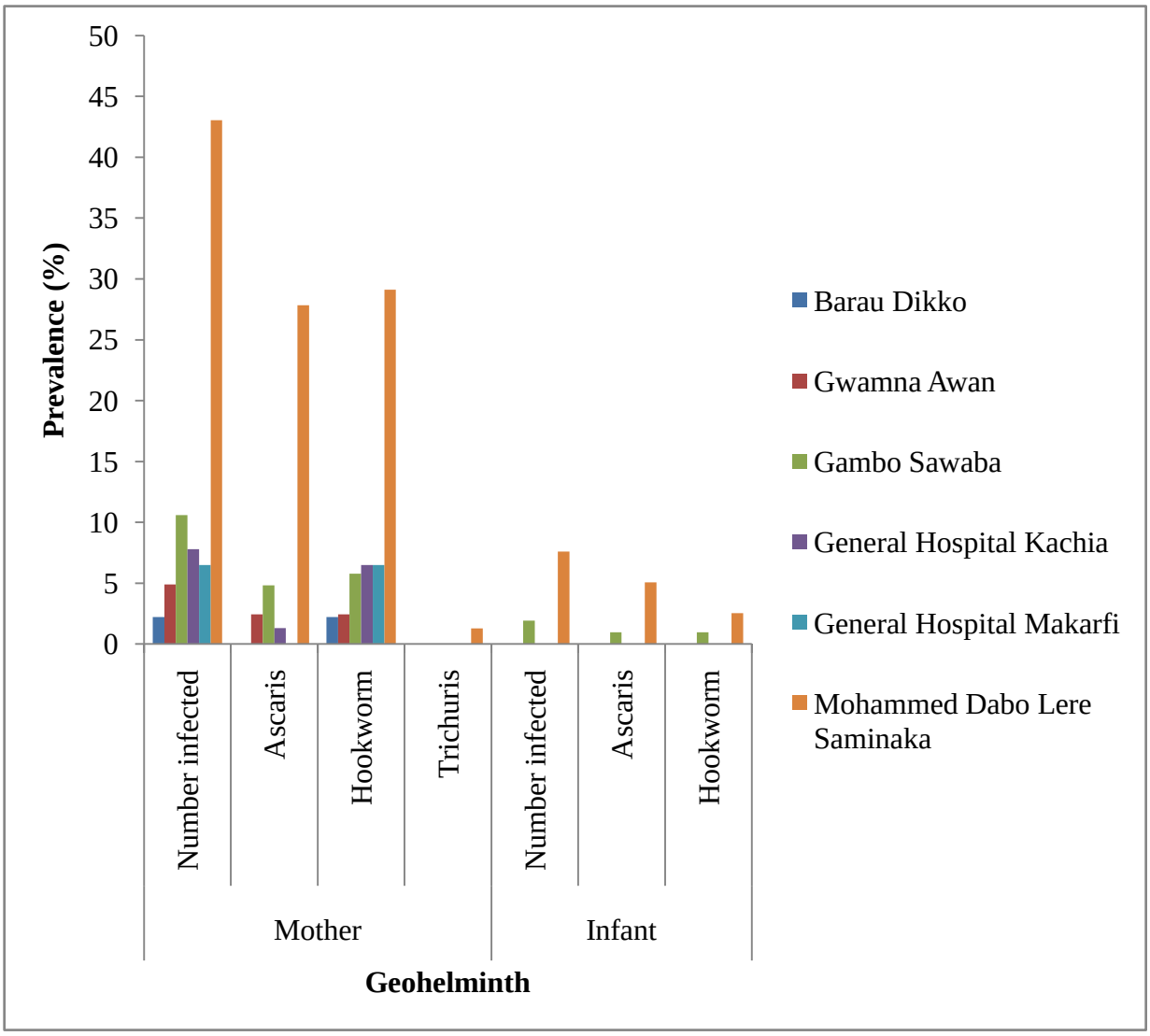


Fig. 2: Prevalence of geohelminth infections in mothers and their infants with respect to location/hospital

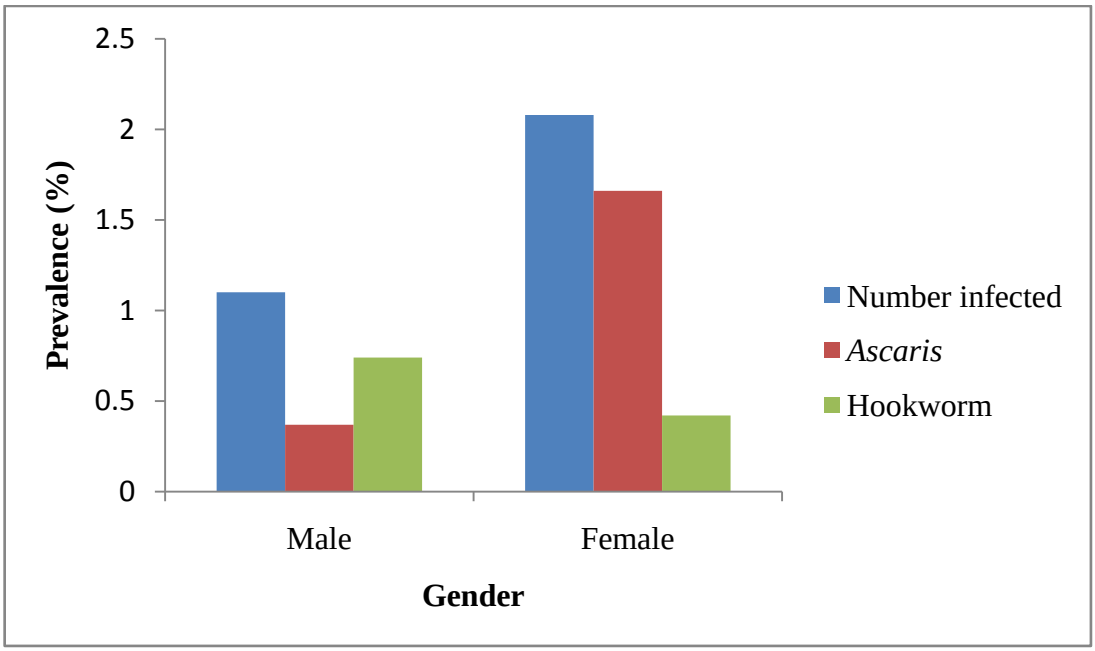


Fig.3: Prevalence of geohelminth infections in relation to gender of infants.

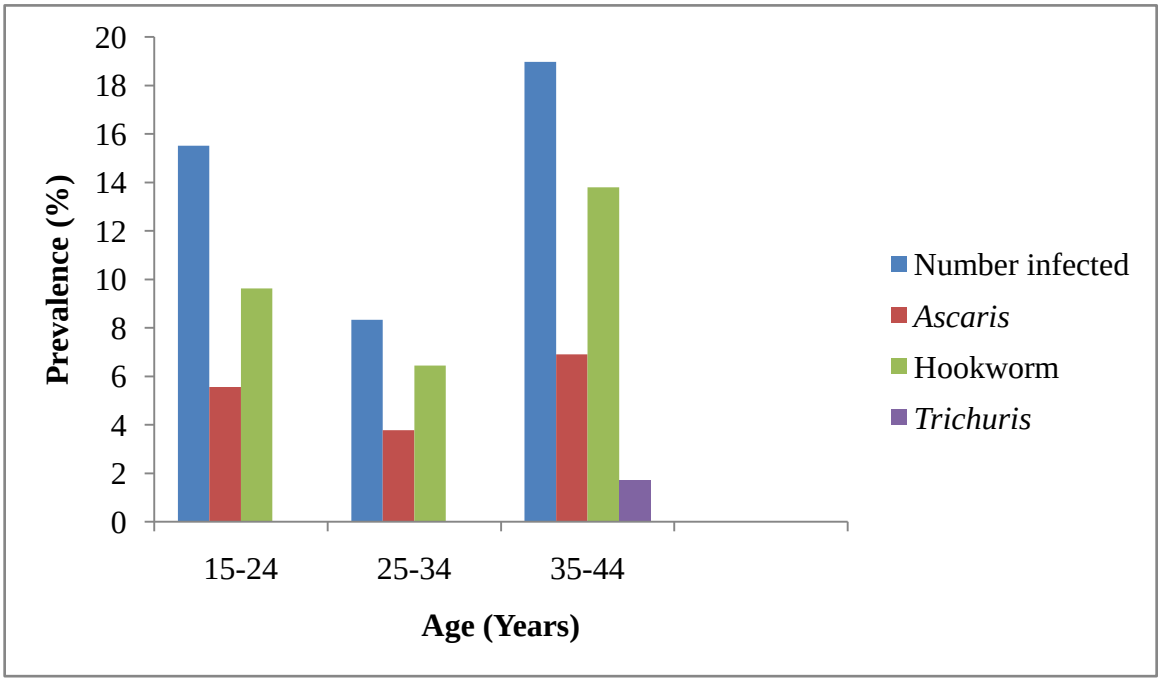


Fig 4: Overall prevalence of geohelminth infections in mothers with respect to age.

The age group 35–44 years had the highest prevalence (13.79%) followed by the age group 15–24 years (9.63% while the least (6.44%) was in the 25–34 years age group. This trend was absent for those age groups with *Ascaris lumbricoides* infection showing prevalences of 6.90%, 5.56% and 3.78% respectively. *Trichuris trichiura* was found only in age group 35–44 with a prevalence of 1.72% (Fig.4).

4.5: Overall Prevalence of Geohelminth Infections in Infants with Respect to Age

The age related geohelminth infections in infants show that infection was higher in the age group of 5–12 months 7(2.95%) than the age group of 0–4 months 1(0.36%) (Fig.5). The difference in prevalence between the age groups was statistically significant (χ^2, $P< 0.05$; Appendix: X). Geohelminth infection was associated with the age of the infants. The prevalence of geohelminth infections in infants increased as the age increased. *Ascaris lumbricoides* recorded higher prevalent in all age groups; the age group 5–12 months had the higher prevalence (1.69%) while the age group 0–4 months had (0.36%). This trend was absent with hookworm infection showing prevalence of 1.27% in age group 5-12 months. There was no hookworm in the age group 0–4 months.

4.6: Multiple Geohelminth Infections in Mothers and their Infants

About 2.36% of the mothers had multiple infections. *Ascaris lumbricoides* plus hookworm (*Ascaris lumbricoides* + hookworm) was 2.16% while hookworm plus *Trichuris trichiura* (hookworm + *Trichuris trichiura*) was 0.20 %. In infants, there was no mixed infection (Fig.6).

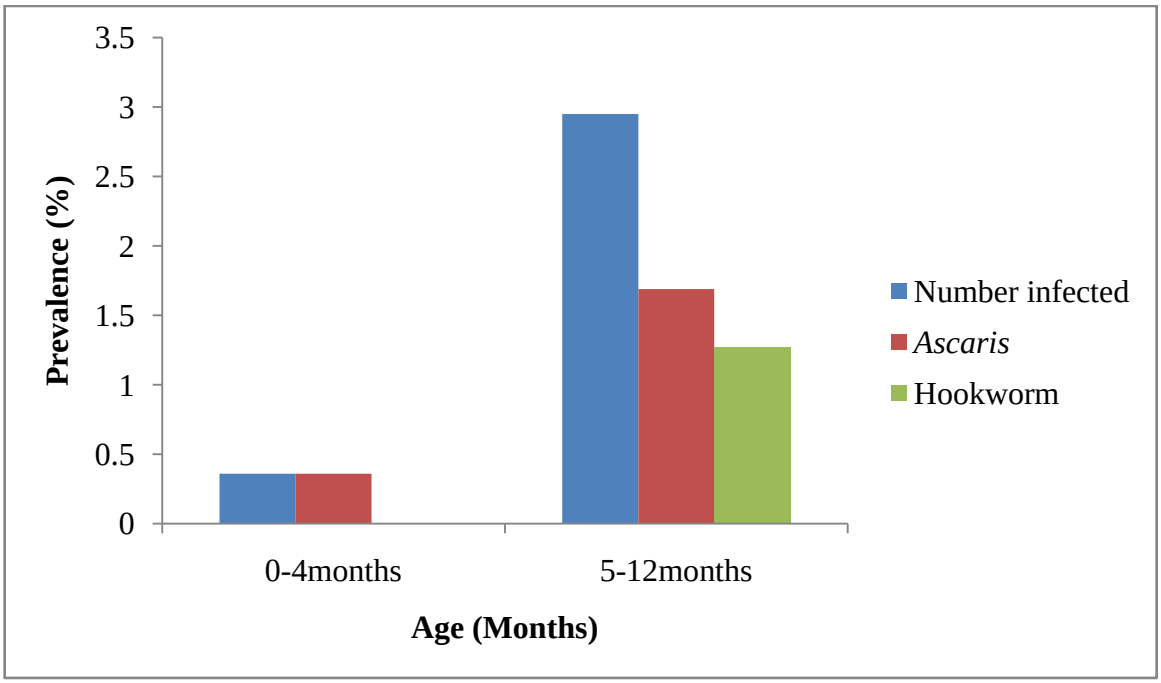


Fig 5: Overall prevalence of geohelminth infections in infants with respect to age

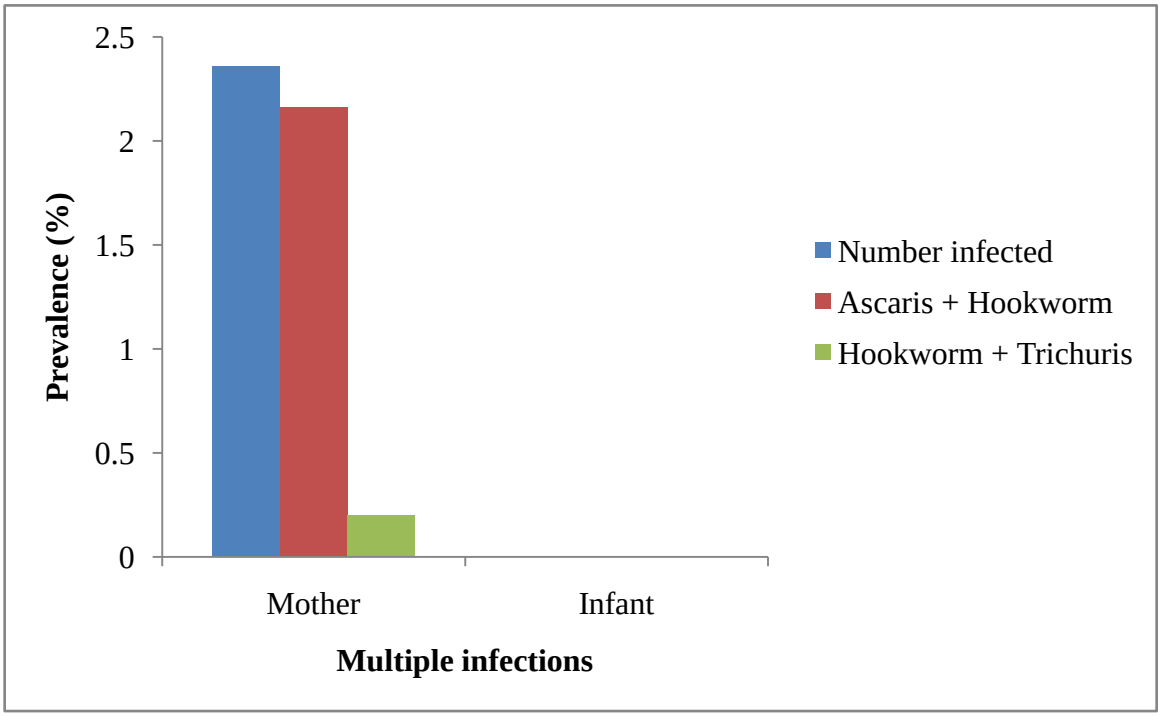


Fig.6: Multiple geohelminth infections in mothers and their infants

4.7: Intensity of Geohelminth Infections in Mothers and their Infants

The intensity of geohelminth infections in both mothers and infants is shown in Fig7 and 4.72% of the mothers had light infection (1–4999 epg) of *Ascaris lumbricoides*. It shows that 1.18% had moderate infection (5000–49999 epg) while none had heavy infection (≥ 50000 epg). For hookworm, 7.07% of the mothers had light infection (1-1999 epg), 1.38% had moderate infection (2000–3999 epg) and there was no heavy infection (≥ 4000 epg). The results also showed that 0.20% of the mothers had light infection of *Trichuris trichiura* (1–999 epg) (Fig.7). There was no moderate (1000-9999 epg) or heavy infection (≥ 10000). The mean intensity/average of *Ascaris* eggs per gram of faeces in mothers was 483; Hookworm was 349epg while *Trichuris trichiura* was 100epg. In infants, 0.98% had light infection of *Ascaris lumbricoides* while hookworm was 0.59%. There was no moderate or heavy infection of either *Ascaris lumbricoides* or hookworm in infants.The mean intensity/average number of geohelminth eggs per gram of faeces in infants was 140epg for *Ascaris lumbricoides* and 133epg for hookworm.

4.8: Prevalence of Geohelminth Infections in Mothers with Respect to Occupation

The prevalence of geohelminth infections in mothers in relation to occupation is presented in Table 4.2. Under occupation, mothers who were students had the highest prevalence of 13.51% followed by those engaged in business (13.17%), housewives (12.82%), farming (12.12%) and civil service (4.65 %). Infection was associated with occupations such as business, Housewife, student and farming (OR, 1.146, CI, 0.657 -1.999, P, 0.666; OR, 1.091, CI, 0.634–1.875, P, 0.781; OR, 1.593, CI, 0.672–3.777, P, 0.311; OR, 1.242, CI, 0.599–2.595, P, 0.556 respectively) (Appendix: XII).

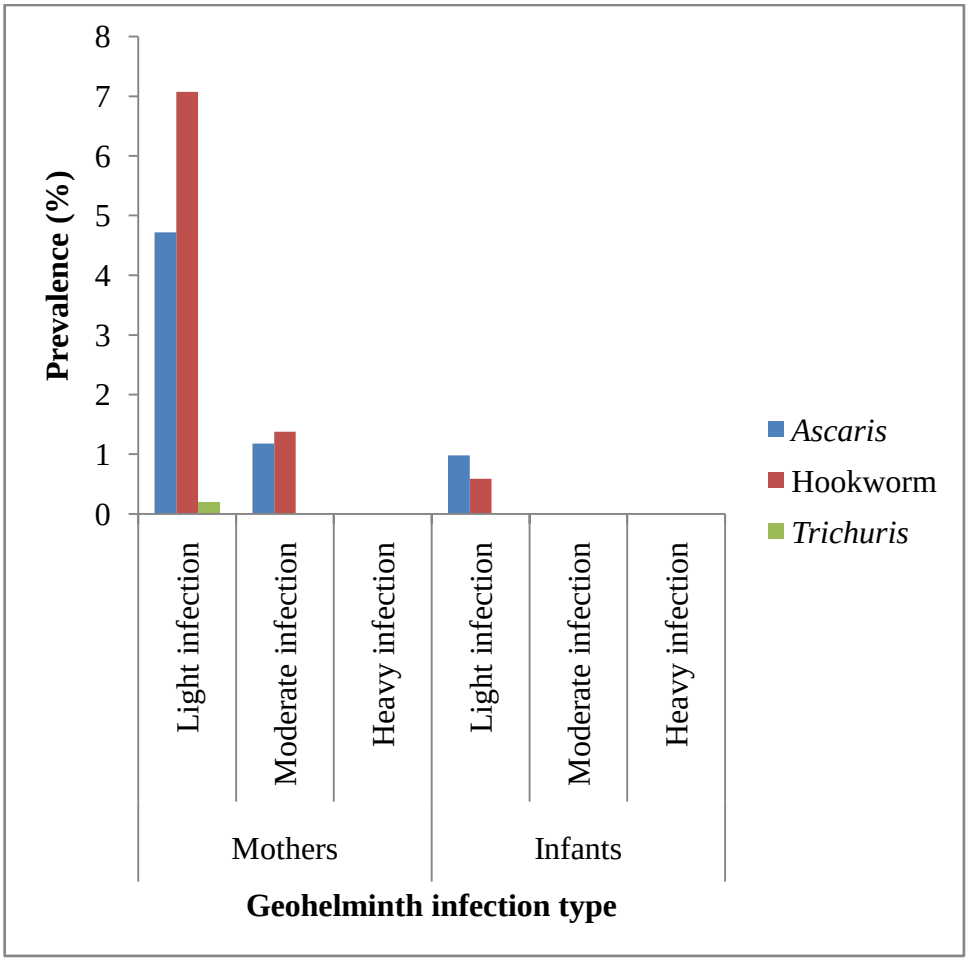


Fig. 7: Intensity of geohelminth infections in mothers and their infants.

(Using WHO classification; Appendix XI)

Table 4.2: Questionnaire analysis on geohelminth infections in mothers with respect to occupation

Occupation	Number examined	Number infected (%)
Business	167	22(13.17)
Housewife	196	25(12.82)
Civil servant	43	2(4.65)
Student	37	5(13.51)
Farming	66	8(12.12)

4.9: Geohelminth Infections in Mothers with Respect to Educational Status

With respect to the educational status, mothers who had no formal or western education had the highest prevalence of geohelminth infections (22.22%), followed by those that had only primary education (13.76%), while those that had obtained tertiary education had the least (5.16%) (Table 4.3). Primary and non-formal education was associated with maternal geohelminth infections but non-formal education was having a significant association (OR, 1.358, CI, 0.746–2.474, P, 0.332; OR, 2.883, CI, 1.643–5.060, P, 0.000 respectively) (Appendix XII).

4.10: Geohelminth Infections in Mothers with Respect to Source of Drinking Water, and Boiling of Water before Drinking

The prevalence in relation to source of drinking water shows that those who were using stream/rivers or ponds had the highest prevalence (18.42%), followed by those that used well (14.78%) while those that used other means had the least prevalence (5.88%) (Table 4.4).Well and stream/river were associated with geohelminth infections but well had a significant association (OR, 1.816, CI, 1.026–3.215, P, 0.041; OR, 1.708, CI, 0.718-.065, P, 0.205 respectively) (Appendix: XIII).

With regards to boiling and filtering of water before drinking, the mothers who boiled or filtered their water before drinking had less prevalence (11.11%) than those who did not boil their water before drinking (12.98%) (Table 4.4). Not boiling water before drinking was associated with geohelminth infections (Appendix XIII).

Table 4.3: Questionnaire analysis on geohelminth infections in mothers with respect to educational status

Educational Status	**Number examined**	**Number infected (%)**
Primary	109	15(13.76)
Secondary	204	20(9.80)
Tertiary	97	5(5.16)
Non-formal- education	99	22(22.22)

Table 4. 4: Questionnaire analysis on geohelminth infections in mothers with respect to source of drinking water, and boiling of drinking water

Water source, and boiling of drinking water	**Number examined**	**Number infected (%)**
Source of water		
Well	291	43(14.78
Pipe borne water	163	11(6.75)
Stream /river	38	7(18.42)
Others (Satchet / bottled water)	17	1(5.88)
Filtering/boiling of water		
Yes	189	21(11.11)
NO	316	41(12.98)

4.11: Geohelminth Infections in Mothers with Respect to Socio-economic Factors

The prevalence of geohelminth infections in mothers in relation to type of toilet showed that those that defaecate in open field/bushes had the highest prevalence (16.18%) followed by those using pit latrines (12.71%), while those using water closet had the least (9.16%) (Table 4.5). Pit latrine and open defaecation were associated with geohelminth infections (Appendix XIV). Furthermore, mothers who did not wear their shoes always when going out of their homes had the highest prevalence (13.33%) followed by those who wear shoes always (12.72%) while those who regularly walk barefoot had the least prevalence (7.94%) (Table 4.5). Regular and irregular wearing of shoes was associated with geohelminth infections (Appendix XIV).

The prevalence in relation to type of floor showed that mothers whose home floors were cemented had less prevalence (10.65%) than those living in homes with uncemented floors (16.94%) (Table 4.5). Uncemented floor was associated with geohelminth infections (Appendix XIV). The prevalence in relation to the number of children showed that mothers who had up to 9–12 children had the highest prevalence (75%) followed by those having up to 5–8 children (23.30%) while those having 1-4 children had the least (8.71%) (Table 4.5). Having up to 5-8 and 9-12 children was significantly associated with geoheminth infections (Appendix XIV).

4.12: Geohelminth Infections in Mothers with Respect to Types of Hygiene Practices

Geohelminth infections in relation to refuse disposal showed that mothers who disposed their refuse around their homes had the highest prevalence (16.67%) followed by those that bury their refuse (12.07%), while those that dump refuse into the river were not infected

Table 4. 5: Questionnaire analysis on geohelminth infections in mothers with respect to socio-economic factors

Socio-economic factor	Number examined	Number infected (%)
Type of toilet		
Pit latrine	299	38(12.71)
Water system	142	13(9.16)
Open field defaecation	68	11(16.18)
Wearing shoes while going out of the house		
Yes	401	51(12.72)
NO	63	5(7.94)
Sometimes	45	6(13.33)
Type of floor		
Cemented floor	385	41(10.65)
Not cemented	124	21(16.94)
Number of children in family		
1 – 4	402	35(8.71)
5 – 8	103	24(23.30)
9 – 12	4	3(75.00)

(0.00%) (Table 4.6). Dumping refuse around the home was significantly associated with maternal geohelmith infections (Appendix XV). Mothers who had sewage water around their homes had less prevalence (10.63%) than those who did not have sewage water (13.47%) (Table 4.6). Absence of sewage water was associated with geohelminth infections (Appendix XV).

It was observed that mothers who did not wash fruits before consumption had the highest prevalence (17.24%) followed by those that sometimes washed fruits before consumption (13.79%), while those who washed fruits before eating them had the least prevalence of geohelminth infection (11.78%) (Table 4.6). Irregular and non washing of fruits before consumption were associated with geohelminth infections (Appendix: XV).

Mothers who washed their hands with soap and water after visiting toilet, before and after eating had less prevalence (11.89%) than those who did not wash their hands, (15.79%) (Table 4.6). Non-washing of hands after visiting the toilet was associated with geohelminth infections (Appendix XV).

4.13: Geohelminth Infections in Mothers with Respect to Awareness campaign

The mothers who claimed to have heard about geohelminthiasis had less prevalence (5.59%) than mothers who had not heard about the disease (14.75%) (Table 4.7). Lack of awareness about geohelminthiasis was significantly associated with maternal geohelminth infections (Appendix XVI). In the same vein, mothers who live where health talks were usually organized had less prevalence (10.28%) than those who live where health talks were not organized (13.56%) (Table 4.7). Lack of health talks was associated with geohelminth infections (Appendix XVI).

Table 4. 6: Ouestionnaire analysi on geohelmith infection in mothers in relation to types of hygiene practices

Types of hygiene practices	Number examined	Number infected (%)
Refuse disposal method		
Burning	212	21(9.91)
Burying	58	7(12.07)
Dumping into river	35	0(0.00)
Dumping around home	204	34(16.67)
Sewage water presence in surrounding		
Yes	207	22(10.63)
NO	297	40(13.47)
Washing fruits before consumption		
Yes	382	45(11.78)
NO	29	5(17.24)
Sometimes	87	12(13.79)
Washing hands after visiting toilet		
Yes	471	56(11.89)
NO	38	6(15.79)

Table 4.7: Questionnaire analysis on geoheminth infections in mothers with respect to awareness campaign

ıess campaign	**ımber examined**	**ımber infected (%)**
ɛr you have heard about geohelminthiasis		
	143	8(5.59)
	366	54(14.75)
ɛr health talks were being organized in your area		
	214	22(10.28)
	295	40(13.56)

4.14: Prevalence of Geohelminth Infections in Infants with Respect to Mothers' Occupation and Educational Status

It was observed in this result that the infants whose mothers were students had the highest prevalence (2.70%), followed by those whose mothers were housewives (2.55%) while those whose mothers were business women had the least (1.20%) (Table 4. 8). Housewife and students were associated with infantile geohelminthiasis (Appendix XVII).

About the educational status of the infants'mothers, the results showed that the infants whose mothers obtained tertiary education had the highest prevalence (2.06%) followed by those whose mothers had no formal education (2.02%), Primary (1.84%) while those whose mothers had secondary education had the least (0.98%,) (Table 4.8). Primary, tertiary and no formal education were associated with infantile geohelminthiasis (Appendix XVII).

4.15: Geohelminth Infections in Infants with Respect to Source of Drinking Water, Presence of Sewage Water and Boiling of Water

Based on source of drinking water, the infants whose mothers' source of water was well had the highest prevalence of (2.06%), followed by those whose mothers were using pipe borne water (1.23%) while those whose mothers were using stream/river or other means of water sources were not infected (Table 4.9). The use of well was associated with infantile geohelminth infections (Appendix XVIII).

The infants who had sewage water around their houses had more prevalence ((1.45%) than those who did not have sewage water (1.35%) (Table 4.9). Presence of sewage water in surrounding was associated with infantile geohelminth infections (Appendix XVIII)

Table 4.8: Questionnaire analysis on geohelminth infection in infants (0–12 months) with respect to mothers' occupation and educational status

Mothers' occupation and educational status	Number examined	Number infected (%)
Mothers'occupation		
Business	167	2(1.20)
House wife	196	5(2.55)
Civil servant	43	0(0.00)
Student	37	1(2.70)
Farming	66	0(0.00)
Mothers' education		
Primary	109	2(1.84)
Secondary	204	2(0.98)
Tertiary	97	2(2.06)
Non- formal education	99	2(2.02)

The prevalence of geohelminth infections in infants with respect to boiling of water showed that the infants whose mothers did not boil or filter their water before drinking recorded more prevalence (2.22%) than those whose mothers did boil or filter their water before drinking (0.53%) (Table 4.9). Drinking of unboiled water was associated with infantile geohelminthiasis (Appendix XVIII).

4.16: Geohelminth Infections in Infants with Respect to Socio-economic Factors

In type of toilet used, the infants whose mothers were using water closet had the highest prevalence (2.11%) followed by those whose mothers had no toilets (1.47%) while those whose mothers were using pit latrines had the least (1.34%) (Table 4.10). The use of water closet was associated with geohelminth infections in infants (Appendix XIX). In addition, infants whose home floors were cemented had less prevalence (1.30%) than those whose floors were not cemented (2.42%) (Table 4.10). Non cemented floor was associated with geohelminth infections in infants (Appendix XIX). It was observed that infants whose mothers had up to 5-8 children had more infection (2.91%) than those whose mothers had 1-4 children (1.24%), while those whose mothers had up to 9-12 children had no infection (Table 4.10). Having up to 5–8 children was associated with geohelminth infections in infants (Appendix XIX). Furthermore, the results revealed that the infants who usually eat sand had more prevalence (2, 34%) than those who did not eat sand (0.84%) (Table 4.10). Eating sand was associated with geohelminth infections in infants (Appendix XIX). The results also showed that infants who walk barefoot had more infection (1.77%) than those who always wear their shoes (1.48%) (Table 4.10). Walking barefoot was significantly associated with geohelminth infections in infants (Appendix XIX).

Table 4. 9: Questionnaire analysis on geohelminth infections in infants (0–12 months) with respect to source of drinking water, presence of sewage water and boiling of water

Water source, sewage water and boiling of water	**Number examined**	**Number infected (%)**
Well	291	6(2.06)
Pipe borne water	163	2(1.23)
Stream/river/pond	38	0(0.00)
Others	17	0(0.00)
Presence of sewage water in surrounding		
Yes	207	3(1.45)
NO	297	4(1.35)
Filtering/boiling water		
Yes	189	1(0.53)
NO	316	7(2.22)

Table 4.10: Questionnaire analysis on geohelminth infections in infants with respect to socio-economic factors

Socio-economic factor	Number examined	Number infected (%)
Type of toilet used		
Pit latrine	299	4(1.34)
Water system	142	3(2.11)
Open field defaecation	68	1(1.47)
Whether floor is cemented		
Yes	385	5(1.30)
NO	124	3(2.42)
Number of children in a family		
1–4	402	5(1.24)
5–8	103	3(2.91)
9–12	4	0(0.00)
Whether infants walk barefoot		
Yes	226	4(1.77)
NO	270	4(1.48)
Whether infants eat sand		
Yes	256	6(2.54)
NO	239	2(0.84)

4.17: Geohelminth Infections in Infants with Respect to Mothers' Hygiene Practices

The prevalence in relation to washing of fruits before consumption showed that the infants whose mothers usually wash their fruits before consumption had less infection (1.31%) than those whose mothers sometimes wash their fruits before consumption (3.45%) (Table 4.11). Irregular washing of fruits before consumption was associated with geohelminth infections in infants (Appendix XX).

It was also observed that the infants whose mothers usually wash their hands after visiting toilet had less infection (1.49%) than those whose mothers were not washing their hands after visiting toilet (2.63%) (Table 4.11). None washing of hands after visiting toilet was associated with infantile geohelminthiasis (Appendix XX).

Surplisingly, the infants of the mothers who claimed to be washing their hands before feeding them recorded the highest prevalence (1.72%) followed by those whose mothers did not wash their hands before feeding them (1.54%), while those whose mothers claimed to be washing their hands sometimes had the least prevalence (1.04%) (Table 4.11). Washing hands before feeding infants was associated with geohelminth infections in infants (Appendix XX).

The results showed that the infants whose mothers did not wash the utensils used before and after feeding them had the highest prevalence (4.35%) followed by those who usually wash the utensils (1.79%) while the infants whose mothers sometimes wash the utensils had no infection (Table 4.11). Both washing and non-washing of the utensil were associated with geohelminth infections in infants (Appendix XX).

Table 4.11: Questionnaire analysis on geohelminth infections in infants in relation to mothers' hygiene practices

Types of hygiene practice	Number examined	Number infected (%)
Washing fruits with water before consumption		
Yes	382	5(1.31)
NO	29	0(0.00)
Sometimes	87	3(3.45)
Washing hands with soap and water after visiting toilet		
Yes	471	7(1.49)
NO	38	1(2.63)
Washing hands before feeding infants		
Yes	348	6(1.72)
NO	65	1(1.54)
Sometimes	96	1(1.04)
Washing utensils before and after feeding infants		
Yes	392	7(1.79)
NO	23	1(4.35)
Sometimes	46	0(0.00)

4.18: Geohelminth Infections with Respect to Utensils used in feeding Infants, remaining of infants' food and food storage

The prevalence in relation to the type of utensils used in feeding infants showed that the infants whose mothers were using small plate and spoon while feeding them recorded the highest prevalence (1.88%) followed by those whose mothers were using bare hands (1.77%) while the least were those whose mothers were using feeding bottle (1.47%) (Table 4.12). The use of bare hands, small plate and spoon were associated with infantile geohelminthiasis (Appendix XXI). In addition, the infants whose food did remain after feeding had more prevalence (2.11%) than those whose food did not remain (0.74%) (Table 4.12). Food remaining after feeding infants was associated with geoheminth infection in infants (Appendix XXI).

The prevalence in relation to storage of infants' food showed that the infants whose food was not stored inside refrigerator had more prevalence (5.38%) than those whose food was stored in refrigerator (1.85%) (Table 4.12). None storage of infant food inside refrigerator was significantly associated with infantile geohelminth infections (Appendix XXI).

4.19: Geohelminth Infections in Infants with Respect to Refuse Disposal Methods

The prevalence in relation to methods of refuse disposal indicated that infants whose mothers bury their refuse had the highest prevalence (3.45%) followed by those whose mothers usually dump their refuse around their homes (1.47%) followed by those whose mothers usually burn their refuse (1.42%) while those whose mothers dump their own refuse into the river had no infection (Table 4.13). Burying method of refuse disposal was associated with geohelminth infections in infants (Appendix XXII).

Table 4.12: Questionnaire analysis on geoheminth infections in infants in relation to type of utensils used, remaining of infants' food and food storage

Infants' food	Number examined	Number infected (%)
Utensils used in feeding infants		
Feeding bottle	204	3(1.47)
Bare hands	113	2(1.77)
Small plate and spoon	160	3(1.88)
Whether infant food remain after feeding		
Yes	332	7(2.11)
NO	135	1(0.74)
Where the remaining food is stored		
Inside refrigerator	54	1(1.85)
Not inside refrigerator	93	5(5.38)

Table 4.13: Questionnaire analysis on geohelminth infections in infants with respect to methods of refuse disposal

Refuse disposal methods	Number examined	Number infected (%)
Refuse disposal methods		
Burning	212	3(1.42)
Burying	58	2(3.45)
Dumping into the river	35	0(0.00)
Dumping around the home	204	3(1.47)

4.20: Geohelminth Infections in Infants with Respect to Awareness Campaign

The infants whose mothers were aware of geohelminthiasis had less prevalence (0.70%) than those whose mothers were not aware (1.91%) (Table 4.14). Lack of awareness about geoheminthiasis was associated with infantile geohelminthiasis (Appendix XXIII).

Finally, the results showed that the infants whose mothers were living in areas where health talks were organized had less prevalence (0.94%) than those whose mothers were living in areas where health talks were not organized (2.03%) (Table 4.14). Lack of health talks was associated with infantile geohelminthiasis (Appendix XXIII).

Table 4.14: Questionnaire analysis on geohelminth infections in infants with respect to awareness campaign

Awareness campaign	Number examined	Number infected (%)
Whether you have heard about geohelminthiasis		
Yes	143	1(0.70)
NO	366	7(1.91)
Whether health talks were being organized in your area		
Yes	214	2(0.94)
NO	295	6(2.03)

CHAPTER FIVE

5.0 DISCUSSION

The results of this investigation revealed an overall prevalence of 12.18% geohelminth infections in mothers. The prevalence is high and has serious health implication on mothers. However, the prevalence is low when compared to previous reports from Nigeria (Enugu) and other parts of the world (Butajira,Ethiopia and Nepal), ranging from 19.5%-92.7% (Awi-waadu, 2005; Kunwar *et al*., 2006; Belyhun *et al.*, 2010; Chijioke *et al*., 2012). In infants, the low prevalence obtained (1.56%) is an indication that infants in the study area are probably not that exposed to geohelminth infections. The prevalence is also low compared with reports from other parts of Nigeria (Ogun State, Osun State and Edo State) and some parts of the world (Zanzibari, Butajira Ethiopia and Brazil) with a range of 3.8%-92.6%. (Goodman *et al.*, 2007; Awasthi *et al.*, 2008; Jardim-Botelho *et al.*, 2008; Tamramat *et al*., 2008; Kirwan *et al.*, 2009; Nmorsi *et al*., 2009; Wright *et al*., 2009; Belyhun *et al.*, 2010). The low prevalence obtained in this study when compared to the previous records may be attributed to the deworming programme going on in Kaduna State as well as the health talk given by nurses to pregnant women and mothers at the antenatal and postnatal clinics.

In this study, the three main species of geohelminths namely *Ascaris lumbricoides*, hookworm and *Trichuris trichiura* were observed in mothers with hookworm having the highest prevalence (8.45%) followed by *Ascaris lumbricoides* (5.89%) then *Trichuris trichiura* (0.20%). This is not surprising because hookworm and to lesser degree *Ascaris lumbricoides* are highly prevalent geohelminths in Kaduna State (Salihu, 2008) and Nigeria in general (Nmorsi *et al.*, 2009). The higher hookworm prevalence over other geohelminths

was also reported in Himalayan women of Nepal where hookworm prevalence was highest (53.0%) followed by *Ascaris lumbricoides* (20.3%) and then *Trichuris trichiura* (2.7%). Infection in Ethiopian mothers also showed higher hookworm prevalence (36.1%) than *Ascaris lumbricoides* (8.8%). The higher maternal hookworm infection obtained in this study may be due to the involment of women in activities such as farming and association with wet areas, which readily expose them to the parasite. This is supported by Belyhun *et al.* (2010) who reported high maternal hookworm infection that they associated with the time women spent in muddy and wet gardens, which are suitable for the third stage infective larvae of hookworm. This study also revealed that most mothers used well water, pit latrines while some even defaecated in open fields and some walked barefoot. These factors/conditions facilitate skin contact with the infective larvae of hookworm. To buttress the role of moisture in hookworm transmission, Dumba *et al* (2007) stated that the wetness of the squat area rendered traditional pit latrines lucrative places of hookworm transmission. In addition, Kunwar *et al*. (2006) stated that hookworms secrete bioactive polypeptides that dampen the immune system of the host thus facilitating the establishment of the parasite in the host.

The relatively low prevalence of *Trichuris trichiura* in this study may be attributed to the fact that the eggs of *Trichuris* are more highly sensitive to desiccation and direct sunlight which is obtainable in the study area (Roberts and Janovy, 1996). The reason for the absence of *Strongyloides stercoralis* another soil-transmitted helminth in this study was not clear since 1.5% and 4.2% prevalence were previously reported from the same study area by Nock *et al.* (2003) and Auta (2006) respectively.

Ascaris lumbricoides and hookworm have been reported in infants in Ogun State by Tamranat *et al*. (2008) with the former being more prevalent (74.14%) than the latter (17.24%). In this study, the pattern of occurrence of geohelminths in infants was not similar with that reported by Behylun *et al.* (2010) in Ethiopia, where hookworm prevalence was greater/higher than *Ascaris lumbricoides* but similar to what was reported by Nmorsi *et al.* (2009) in Ekpoma, Edo State, Nigeria.

The significantly higher prevalence of geohelminth infections observed in mothers than their infants may be attributed to the occupational activities of the mothers which expose them more to sources of geohelminth infections than their infants (Lucas and Gilles, 2003). In addition, at infancy, children interact less with their surroundings hence their chances of being exposed to the sources of geohelminth infections are reduced. The correlation between the prevalence of geohelminth infection in mothers and their infants observed in this study suggests that mothers are most likely responsible for transmitting geohelminth infection to their infants. To support this suggestion, Lucas and Gilles (2003) stated that infants may be parasitized at birth from the eggs on their mothers' fingers.

The results of this investigation also showed that the prevalence of geohelminth infections observed in mothers and their infants differed from one sampled hospital/location to another.The higher prevalence in mothers and infants from Gambo Sawaba and Mohammed Dabo Lere Memorial Hospitals may be due to the rural location of the hospitals, where social amenities like safe drinking water, functional public and private toilets are usually inadequate or lacking, coupled with the absence of health outreach programmes (based on information given by the respondents). The inadequate provision of

social amenities in those rural areas compels the inhabitants to drink well and stream water, and to defaecate in nearby bushes. These conditions favour contact with infective stages and the transmission of geohelminth infections (Olaniyi *et al*., 2007). Indeed, it was observed in this study that most of the mothers attending Dabo Lere Memorial Hospital were active farmers, an activity that exposes them and their infants to geohelminth, particularly hookworm infection. On the other hand, Barau Dikko Specialist Hospital, Kaduna, which was associated with low infection, is located in an urban area with readily available social amenities.

With respect to the gender of infants, the prevalence of infection although more in the female infants, than in males, did not differ significantly statistically indicating that both were equally at risk and that the very slight difference observed was by chance. Same infection levels in males and females may be attributed to the fact that the infants are too young to carry out any activities that may expose them differently to sources of geohelminth infections. They are always generally carried by their mothers.

Age of the mothers significantly influenced the prevalence of geohelminth infections. The highest prevalence of 18.97% that was observed in age group 35-44 years may be attributed to greater exposure to sources of infection such as more workload in the fields coupled with poor hygiene. This explanation is in agreement with the explanation given by Kunwar *et al*. (2006). It is interesting to note that it is in this group that *Trichuris trichiura* infection was found. The higher prevalence observed in mothers within the age group 15-24 years when compared with those within the age group of 25-34 years may be due to the fact that they

are young and presumably more active showing high mobility which may expose them more to sources of geohelminth infections.

In infants, the prevalence with respect to age was statistically significant. Age was statistically associated with infantile geolminthiasis. The younger infants (0–4 months) that were feeding exclusively on breast milk/liquid had a lower prevalence than the older ones (5–12 months) that were feeding on both breast milk and solid foods. The reason for higher prevalence observed in older ones may be due to weaning from breast milk to intake of solid food, which carries a higher risk of ingestion of infective stages of geohelminths (Goodman *et al*., 2007). In addition, increased independent mobility of the older ones increases their chances of exposure to sources of geohelminth infections (Kirwan *et al*., 2009).

The few mixed helminth infections obtained in this study is an indication that the environmental and climatic conditions in the study area were conducive for the development and successful simultaneous transmission (Ojurongbe *et al.,* 2010). Although no mixed infections were recorded in infants, Goodman *et al.* (2007) and Belyhun *et al.* (2010) reported 55% and 0.4% prevalence respectively in this group. The absence of mixed infection in infants here may be related to the fact that the prevalence was very low in the mothers. The occurrence of light infections in most of the infected mothers and their infants may be related to the deworming programme going on in Kaduna State.

The prevalence of geohelminth infection in mothers in relation to occupation showed that doing business, being housewives and students and farming were associated with maternal

geohelminth infections, thereby labeling these groups as being at a higher risk of infection. The association observed in business mothers may be as a result of them giving more time to their businesses than to cleaning their environment. In addition, most of the business mothers patronize food vendors and sometimes eat in an open space where wind carrying faecally contaminated soil can easily contaminate their food. The housewives, who are supposed to be more committed to environmental sanitation, were heavily infected probably indicating a low level of personal hygiene (Anosike *et al*., 2006).

The association of geohelminth infections with student- mothers may be attributed to the fact that due to academic workload the students may not have time to cook food for themselves but buy food from food vendors with poor personal and food hygiene practices (Ojurongbe *et al*., 2010). The infants of the student- mothers having the highest prevalence of geohelminth infection may be attributed to the fact that most of the students leave their babies under the care of nannies while in school and most of the time, the nannies were not paying attention to what the babies are playing with or even eating.

It was not surprising that farming was associated with geohelminth infections since this activity increases the chances of contaminating the fingers and food of the farmers with the infective stages It was in view of this that Oyerinde (1999) described geohelminthiasis as disease of farmers and bricklayers.

The association of primary education and no formal education of mothers with geohelminth infections implies that mothers with little or no education were at a higher risk of acquiring infection. Mothers of this educational status are most probably ignorant of proper hygiene

habits and health-seeking behaviours and do not value simple health promotion practices as noted by Adefemi and Musa (2006), Dumba *et al*. (2007), Chijioke *et al*. (2012), and Huat *et al.* (2012). The highest prevalence observed in infants whose mothers obtained tertiary education may be due to the fact that most of them are civil servants and most often leave the care of their infants in the hands of house maids or nannies that may not pay attention to what the infants are eating or playing with.

In this study, drinking well water and water from stream and river were implicated in the acquisition of geohelminth infection by mothers and their infants. The high prevalence observed in those who drank well water and its significant association with geoheminth infection may be attributed to the fact that most of the wells were left open and prone to contamination with dirt or faecal matter carried by wind. The stream/river is also in the open and can be contaminated easily by either wind or rain water carrying faecal matter with the infective stages of the helminths. In addition, those using stream water may not always have enough water for carrying out their domestic chores such as washing or flushing of toilets, proper washing of vegetables, fruits, plates and other kitchen utensils since they will be economizing the little water they fetch from the streams. This situation facilitates the contamination of food and transmission of the goehelminths. In support of this view, Dumba *et al.* (2007) had stated that improvement in hygiene becomes possible when water is readily available for domestic use.

The lower prevalence of maternal and infantile geohelminth infections associated with drinking boiled and filtered water can mean that this treatment of water reduced the risk of

infection. Boiling would kill and filtering would physically remove the infective stages of the geohelminths.

The association of maternal geohelminth infection with the use of pit latrines and open fields in this study concurs previous reports from other parts of Nigeria (Adefemi and Musa, 2006; Uneke *et al*., 2007; Nmorsi *et al,* 2009; Ezeagwuna *et al.,* 2010). The high prevalence observed in those using pit latrines may be attributed to the poor sanitary condition of the toilets (Dumba *et al.,* 2007). Water closets are safer than pit latrines in places where there is enough water supply for flushing and washing of the toilet. It is therefore not surprising that those who had no toilet had the highest prevalence since open air defaecation would lead to soil pollution and continuous re-infection due to repeated return to the defaecation site (Roberts and Janovy, 1996).

It is surprising that mothers who walked around barefoot had a lower prevalence of infection than those who wore shoes. This unexpected observation may be attributed to incorrect information provided by the respondents. However, the observation was different in infants where those that walked around barefoot had the highest prevalence. Meike *et al.* (2006) observed the same in children in Cuba. The association of infantile geohelminth infection with walking barefoot in this study may be attributed to the fact that walking barefoot facilitates skin contact with the infective larvae of hookworm and *Strongyloides stercoralis.*

The prevalence of geohelminth infections was related to mothers whose house floors were uncemented. Such floors make floor sanitation difficult and at the same time provide a

suitable medium for the development of geohelminth eggs (Dumba *et al.*, 2007). The association of uncemented floor with infantile geohelminth infection in this study suggests that infants whose floors are not cemented have a greater chance of being infected with geohelminths. The reason may be attributed to the fact that uncemented floor encourages geophagy which favours geohelminth transmission in infants.

In this study, infection in mothers was associated with the number of children a mother had. It was observed that the higher the number, higher the infection. This may be due to inability of the mothers to cater for the large number of children coupled with the absence of good environmental sanitation (Uneke *et al.*, 2007; Huat *et al*., 2012). On the part of infants, the association may be attributed to the fact that mothers who have many children may not always give required attention to the infants which may expose them to geohelminth infection.

The significant association of geohelminth infection with dumping of refuse around homes observed in the present study may be attributed to the fact that rain water or wind can easily carry the contaminated refuse back into the homes thereby facilitating food contamination. This contrasts with the low prevalence observed in those who disposed of refuse by burning. On the other hand, the association of infantile geohelminth infection with burying method of refuse disposal in this study may be attributed to the contamination of the mothers' hands while burying the refuse which they may not wash before breast feeding the infants.

The higher prevalence observed in those who had no sewage/water around their houses may be attributed to wrong information provided by the respondents. Contrary to the observation in mothers, the association of infantile geohelminth infection with the presence of sewage water around their houses may be attributed to contamination of soil with the sewage water carrying the infective stages of geohelminths. The contaminated soil contaminates the fingers/toys of the infants when they play with the soil.

None and irregular washing of fruits before consumption were associated with maternal and infatile geohelminth infections. This is not suprising as fruits and vegetables are known to be associated with parasite eggs/cysts and oocysts (Roberts and Janovy, 1996). Thus consumption of unwashed fruits facilitates the transmission of the infective stages of geohelminths.

The association of non-washing of hands after visiting the toilet with maternal and infantile geohelminth infections is in agreement with previous reports which show that unwashed hands are a strong vehicle for the transmission of parasite immature stages (Huat *et al*., 2012). Thus unwashed hands promote the intake of food along with parasite eggs (Lucas and Gilles, 2003).

Infection in infants was associated with geophagy (eating sand). The association is not unexpected since geophagy is one of the factors that facilitate the transmission of geohelminth infections via the intake of contaminated soil. Infection in this group was also associated with infants being fed on their leftover food, which was most likely poorly stored and subsequently contaminated. Furthermore, storage of leftover food without

refrigeration was also significantly associated with geohelminth infection; this suggests that food stored inside the refrigerator is less prone to contamination.

The low prevalence of geohelminth infection in infants whose mothers used feeding bottles to feed them may probably indicate that the teat of the feeding bottles were kept covered when not in use, thereby reducing the chances of the food being contaminated, unlike plates and spoons.

The significant association of maternal and infantile geohelminth infections with the absence of awareness campaigns through health talks suggests that mothers who are ignorant of geohelminthiasis are more likely to be infected with geohelminths. In support of this, Ojurongbe *et al.* (2010) emphasized that the inadequate knowledge of the the mode of transmission of geohelminths made most of the victims not to be able to avoid exposure to the parasites.

CHAPTER SIX

6.0: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

The investigation was carried out to determine prevalence of infantile and maternal geohelminthiases in six hospitals in Kaduna State.The results show a prevalence of 12.18% ($^{62}/_{509}$) in mothers and a prevalence of 1.56% ($^{8}/_{513}$) in infants. Hookworm was the most prevalent (8.45%) while *Ascaris* and *Trichuris* had 5.89% and 0.20% respectively. Infection in infants was as low as 1.56% with *Ascaris* having more prevalence 5(0.98%) than hookworm 3(0.59%). There was significant difference between the prevalence of geohelminth infections in mothers and their infants. There was also a correlation between the prevalence of geohelminth infections in mothers and their infants.

Significant differences were recorded in the six general hospitals examined with Mohammed Dabo Lere Memorial Hospital, Saminaka having the highest prevalence in both the mothers (43.04%) and infants (7.59%) while Barau Dikko Specialist Hospital, Kaduna had the lowest infection in both mothers (2.22%) and infants (0.00%).

In terms of infants'gender, a non significant association was observed in male (1.10%) and in female (2.08%).

Significant association was recorded in age groups of the mothers; with age 35-44 years having the highest prevalence (18.97%) followed by the age 15-24 years (15.51%) while age 25-34 years had the least infection (8.33%). In infants, there was also a significant association observed among the age groups. The age group 5-12 months had more

prevalence (2.95%) than the age group 0-4 months (0.36%). The results also revealed that 2.36% of the mothers had multiple infections with *Ascaris lumbricoides* + Hookworm having 2.16% while hookworm + *Trichuris trichiura* had 0.20%. There was no mixed infection in infants.

The results in this study generally show low intensity in mothers and infants. Mothers had 4.72%, 7.07% and 0.20% light infections of *Ascaris lumbricoides*, hookworm and *Trichuris trichiura* respectively.The mothers also had 1.18% and1.38% moderate infections of *Ascaris* and hookworm respectively.There was no heavy infection. In infants, 0.98% and 0.59% had light infection of *Ascaris* and hookworm respectively. There was no moderate or heavy infection in infants.

Some factors were associated with geohelminth infections in mothers and infants. For instance, in occupation, business, house wife, students and farming were associated with maternal geoheminthiasis. In infants, housewife and students were associated with geohelminth infection. In terms of mothers' educational status, primary and non – formal education were associated with geoheminth infection in mothers while primary, tertiary and non–formal education were associated with infantile geohelminthiasis. The use of well/stream as source of drinking water, drinking of unboiled water, use of pit latrine/open air defaecation, dumping of refuse around the surrounding, uncemented floors, unhygienic practices, having many children and lack of health talks/awareness were associated with maternal geohelminthiasis while the use of well as source of drinking water, improper storage of infants food, geophagy, walking barefoot and unhygienic practices of the

mothers (like not washing hands before feeding a child and after visiting toilet) were associated with geohelminth infections in infants.

6.2 Conclusions

In this study, the prevalence of geohelminth infections in mothers (12.18%) is of health significance while that of the infants (1.56%) is not of health significance; therefore the null hypothesis which states that the prevalence rates of infantile and maternal geohelminth infections have no significant health problem in Kaduna State is rejected in mothers but upheld in infants.

Infantile and maternal geohelminth infections are significantly associated with locations therefore the null hypothesis that stated that the prevalence of infantile and maternal geohelminth infections are not significantly associated with location is rejected.

From the results of this study, gender has no significant influence on infantile geohelminth infection but age has a significant influence in both maternal and infantile geohelminth infections. For gender, the null hypothesis which stated that infantile and maternal geohelminth infections are not significantly associated with age and gender is upheld but rejected for age.

The intensity of geohelminth infections in mothers and their infants is not of health significance since the majority of the infected mothers (82.19%) and all the infected infants (100%) had light infection. The null hypothesis which stated that the intensity of geohelminth infections in infants and their mothers is not of public health significance is upheld.

In terms of risk factors, lack of formal education, the use of well as a source of water, having more than four (4) children, dumping of refuse around the surrounding, unhygienic practices of the mothers and lack of awareness are the major factors influencing maternal geohelminth infections while walking barefoot, improper storage of infants' food and unhygienic practices of the mothers are the major factors that influence infantile geohelminth infections. The null hypothesis which stated that infantile and maternal geohelminth infections are not significantly associated with risk factors is not upheld.

6.3 Recommendations

I. Mothers and their infants should be included in deworming programme as recommended by WHO (2006).

II. Public enlightenment/health talks should be regularly carried out via media, workshops, seminars, during antenatal and postnatal clinics to educate the public especially the mothers on the importance of environmental, personal and food hygiene.

III. Government should provide safe drinking water to the study area to reduce the rate of transmission of geohelminths in the area.

IV. The ongoing deworming programme in Kaduna State should be sustained and expanded to reach all.

V. Similar studies should be carried out in other states of the country to assess the status of this geohelminthiasis in mothers and their infants.

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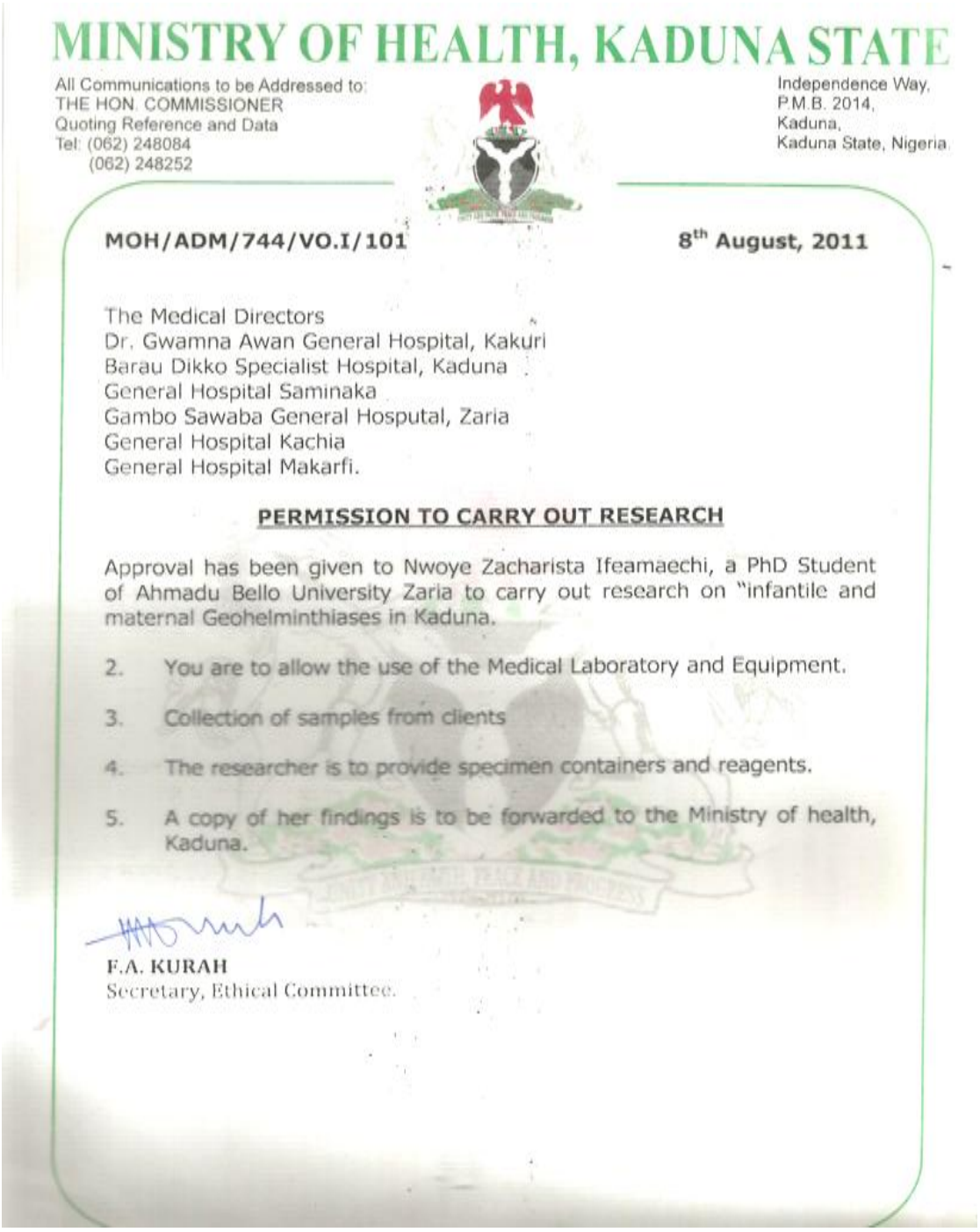
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Appendix I: Permission and ethical clearance



MINISTRY OF HEALTH, KADUNA STATE

All Communications to be Addressed to:
THE HON. COMMISSIONER
Quoting Reference and Data
Tel: (062) 248084
(062) 248252

Independence Way,
P.M.B. 2014,
Kaduna,
Kaduna State, Nigeria.

MOH/ADM/744/VO.I/101 **8th August, 2011**

The Medical Directors
Dr. Gwamna Awan General Hospital, Kakuri
Barau Dikko Specialist Hospital, Kaduna
General Hospital Saminaka
Gambo Sawaba General Hosputal, Zaria
General Hospital Kachia
General Hospital Makarfi.

PERMISSION TO CARRY OUT RESEARCH

Approval has been given to Nwoye Zacharista Ifeamaechi, a PhD Student of Ahmadu Bello University Zaria to carry out research on "infantile and maternal Geohelminthiases in Kaduna.

2. You are to allow the use of the Medical Laboratory and Equipment.
3. Collection of samples from clients
4. The researcher is to provide specimen containers and reagents.
5. A copy of her findings is to be forwarded to the Ministry of health, Kaduna.

F.A. KURAH
Secretary, Ethical Committee.

Appendix II: Questionnaire

Department of Biological Sciences
Ahmadu Bello University
Zaria
Kaduna State
8th March, 2012

Dear Respondents,

Iam a student of the above named institution. I am carrying out research on Infantile and Maternal Geohelminthiases in Kaduna State in partial fulfillment for the award of a Ph.D degree in Zoology.

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

(i). Name of the child_____

(ii). Age of the child _____

(iii) Sex of the child _____

(iv) Name of the mother/caregiver_____

(v) Age of the mother/caregiver _____

(vii) Occupation of the mother/caregiver _____

(vii) Educational status of the mother/caregiver (a) Primary school (b) Secondary school

(c) Tertiary institution (d) others / Non–formal education.

Please tick the appropriate option.

(1). Where do you get your drinking water? (a) Well (b) Pipe borne water

(c) Stream or River/pond (d) others

(2) Do you filter or boil your water before drinking? (a) Yes (b) No

(3) What type of toilet do you have? (a) Pit latrine (b) Water system (c) None.

(4) Do you have pool of water or sewage around your house? (a) Yes (b) No.

(5) How do you dispose your refuse? (a) Through burning (b) By burying

I By dumping into the river (d) By dumping it around the home.

(6) Do you always wear your foot wears when going out of your house? {a}Yes

(b) No {c} sometimes

(7) Is the floor of your house cemented? (a) Yes (b) No.

(8) How many children do you have?_____

(9). Do you wash your hands with soap before and after feeding your child?

(a) Yes (b) No (c) Sometimes.

(10) What do you use in feeding your child? (a) Feeding bottle (b) Bare hands

(c) Small plate and spoon.

(11) Do you wash the feeding bottle or the small plate and spoon before and after feeding your child? (a) Yes (b) No (c) Sometimes.

(12) Does the food of your child remain after feeding? (a) Yes (b) No.

(13) If yes, how do you store it? (a) Inside refrigerator (b) Not inside refrigerator

(14) Do you sometimes see your child putting sand into his mouth? (a) Yes (b) No

(15) Do you allow your child to walk out of the house barefooted? (a) Yes (b) No.

(16) Do you wash your fruits before eating them? (a) Yes (b) No (c) sometimes

(17) Do you wash your hands with soap after visiting the toilet? (a) Yes (b) No.

(18) Do you wash your hands with soap before and after eating? (a) Yes (b) No

(19) Have you heard about geoheminthiasis before? (a) Yes (b) No

(20) Do people organize health talk in your area? (a) Yes (b) No.

Thank you for your response

Nwoye Zacharista

Appendix III: Determination of significance level in prevalence of geohelminth infections between the mothers and their infants using Student's t–test

Mothers	**Infants**
0	0
2.44	0
4.81	0.95
1.3	0
0	0
27.85	5.06

t-Test: Two-Sample Assuming Equal Variances

	Mothers	**Infants**
Mean	6.066667	1.001667
Variance	117.1151	4.097217
Observations	6	6
Pooled Variance	60.60616	
Hypothesized Mean Difference	0	
Df	10	
t Stat	1.12689	
P(T<=t) one-tail	0.143052	
t Critical one-tail	1.812461	
P(T<=t) two-tail	0.286103	
t Critical two-tail	2.228139	

	Mothers	**Infants**
Hookworm	2.22	0
	2.44	0
	5.77	0.95
	6.49	0
	6.49	0
	29.11	2.53

t-Test: Two-Sample Assuming Equal Variances

	Mothers	Infants
Mean	8.753333	0.58
Variance	103.2164	1.057
Observations	6	6
Pooled Variance	52.13671	
Hypothesized Mean Difference	0	
Df	10	
t Stat	1.960596	
P(T<=t) one-tail	0.039179	
t Critical one-tail	1.812461	
P(T<=t) two-tail	0.078359	
t Critical two-tail	2.228139	

Appendix III: Cont'd

Trichuris	0	0
	0	0
	0	0
	0	0
	0	0
	1.27	0

t-Test: Two-Sample Assuming Equal Variances

	Mothers	**Infants**
Mean	0.211667	0
Variance	0.268817	0
Observations	6	6
Pooled Variance	0.134408	
Hypothesized Mean Difference	0	
Df	10	
t Stat	1	
P(T<=t) one-tail	0.170447	
t Critical one-tail	1.812461	
P(T<=t) two-tail	0.340893	
t Critical two-tail	2.228139	

Variation in the prevalence of geohelminth infections between mothers and their infants

	Mean prevalence		
Geohelminth	mothers	Infants	P. value
Ascaris lumbricoides	6.07 ± 4.42	1.00 ± 0.83	0.286103^{ns}
Hookworm	8.75 ± 4.15	0.58 ± 0.42	0.078359^{ns}
Trichuris trichiura	0.21 ± 0.21	0.00 ± 0.00	0.340893^{ns}

ns = not significant (P > 0.05)

Appendix III: Cont'd

mothers	Infants
2.22	0
4.88	0
10.58	1.91
7.79	0
6.49	0
43.04	7.59

P = 0. 040266 (P< 0.05)
a significant difference.

Appendix IV: To determine whether geohelminth infection in mothers is linked with that of their infants using Correlation analysis

mothers	infants	
2.22	0	r = 0.985966
4.88	0	
10.58	1.91	
7.79	0	
6.49	0	
43.04	7.59	

The correlation (r) is positive therefore geohelminth infection in infants is linked

with that of their mothers.

Appendix V: Distribution of Geohelminths in mothers and their infants

Hospital		Number examined	Number infected (%)	Geohelminth		
				A. lumbricoides	Hookworm	*T. trichiura*
BDK,	M	90	2(2.22)	0(0.00)	2(2.22)	0(0.00)
	I	90	0(0.00)	0(0.00)	0(0.00)	0(0.00)
GAK	M	82	4(4.88)	2(2.44)	2(2.44)	0(0.00)
	I	84	0(0.00)	0(0.00)	0(0.00)	0(0.00)
GSZ	M	104	11(10.58)	5(4.81)	6(5.77)	0(0.00)
	I	105	2(1.91)	1(0.95)	1(0.95)	0(0.00)
GHK	M	77	6(7.79)	1(1.30)	5(6.49)	0(0.00)
	I	77	0(0.00)	0(0.00)	0(0.00)	0(0.00)
GHM	M	77	5(6.49)	0(0.00)	5(6.49)	0(0.00)
	I	78	0(0.00)	0(0.00)	0(0.00)	0(0.00)
MDLMHS	M	79	34(43.04)	22(27.85)	23(29.11)	1(1.27)
	I	79	6(7.59)	4(5.06)	2(2.53)	0(0.00)
Total	**M**	**509**	**62(12.18)***	**30(5.89)**	**43(8.45)**	**1(0.20)**
	I	**513**	**8(1.56)**	**5(0.98)**	**3(0.59)**	**0(0.00)**

*The total number of infected mothers is less than that of geohelminths because 12 mothers from Mohammed Dabo Lere hospital had mixed infection. M = mother, I = infants ,BDK = Barau Dikko Specialist Hospital, Kaduna, GAK = Gwamna Awan General Hospital, Kakuri, GSZ = Gambo Sawaba General Hospital, Zaria, GHK = General Hospital, Kachia, GHM = General Hospital, Makarfi and MDLMHS = Mohammed Dabo Lere Memorial Hospital, Saminaka.

. **Appendix VI:** Determination of significance level in the prevalence of geohelminth infections in mothers from all the sampled locations using ANOVA**.**

Anova: Two-Factor Without Replication=Mothers

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Barau Dikko	4	2.22	0.555	1.2321
Gwamna Awan	4	4.88	1.22	1.984533
Gambo Sawaba	4	10.21	2.5525	8.981825
General Hospital. Kachia	4	7.79	1.9475	9.546358
General Hospital Makarfi	4	6.49	1.6225	10.53003
Mohammed Dabo Lere	4	58.23	14.5575	258.9814
Ascaris	6	36.03	6.005	117.3239
Hookworm	6	52.52	8.753333	103.2164
Trichuris	6	1.27	0.211667	0.268817
Strongyloides	6	0	0	0

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*
Rows	570.4797	5	114.0959	3.207548	0.036271
Columns	340.2027	3	113.4009	3.188009	0.054349
Error	533.5661	15	35.57107		
Total	1444.248	23			

Appendix VII: Determination of significance level in the prevalence of geohelminth infections in infants from all the sampled locations using ANOVA**.**

Anova: Two-Factor Without Replication= Infant geohelminths

SUMMARY	Count	Sum	Average	Variance
Barau Dikko	4	0	0	0
Gwamna Awan	4	0	0	0
Gambo Sawaba	4	1.9	0.475	0.300833
General Hospital. Kachia	4	0	0	0
General Hospital Makarfi	4	0	0	0
Mohammed Dabo Lere	4	8.86	2.215	4.664167
Ascaris	6	6.01	1.001667	4.097217
Hookworm	6	3.48	0.58	1.057
Trichuris	6	1.27	0.211667	0.268817
Strogyloides	6	0	0	0

ANOVA

Source of Variation	SS	df	MS	F	P-value
Rows	15.70333	5	3.140667	4.128171	0.014737
Columns	3.483167	3	1.161056	1.526121	0.248559
Error	11.41183	15	0.760789		
Total	30.59833	23			

Test	**Compare Groups - 1-way ANOVA**
	Groups: Barau Dikko, Gwamna Awan, Gambo Sawaba, General Hospital Kachia, General Hospital Makarfi
Performed by	Madu
Date	27 October 20

n	24

Groups	n	Mean	SE	Pooled SE	SD
Barau Dikko	4	0.000	0.0000	0.5070	0.000
Gwamna Awan	4	0.000	0.0000	0.5070	0.000
Gambo Sawaba	4	0.475	0.2742	0.5070	0.548
General Hospital Kachia	4	0.000	0.0000	0.5070	0.000
General Hospital Makarfi	4	0.000	0.0000	0.5070	0.000
Mohammed Dabo Lere	4	1.898	1.2111	0.5070	2.422

Source of variation	Sum squares	DF	Mean square	F statistic	p
Groups	11.552	5	2.310	2.25	0.0939
Residual	18.505	18	1.028		
Total	30.057	23			

LSD

Contrast	Difference	95% CI	
au Dikko v Gwamna Awan	0.000	-1.506 to 1.506	
au Dikko v Gambo Sawaba	-0.475	-1.981 to 1.031	
v General Hospital Kachia	0.000	-1.506 to 1.506	
v General Hospital Makarfi	0.000	-1.506 to 1.506	
o v Mohammed Dabo Lere	-1.898	-3.404 to -0.391	(significant)
na Awan v Gambo Sawaba	-0.475	-1.981 to 1.031	
v General Hospital Kachia	0.000	-1.506 to 1.506	
v General Hospital Makarfi	0.000	-1.506 to 1.506	
n v Mohammed Dabo Lere	-1.898	-3.404 to -0.391	(significant)
v General Hospital Kachia	0.475	-1.031 to 1.981	
v General Hospital Makarfi	0.475	-1.031 to 1.981	
a v Mohammed Dabo Lere	-1.423	-2.929 to 0.084	
v General Hospital Makarfi	0.000	-1.506 to 1.506	
ia v Mohammed Dabo Lere	-1.898	-3.404 to -0.391	(significant)
rfi v Mohammed Dabo Lere	-1.898	-3.404 to -0.391	(significant)

Continuation of Appendix: VI and VII: Mean prevalence of geohelminth infections in mothers and their infants in parts of Kaduna State

Hospital	Mean Prevalence	
	Mothers	**Infants**
Barau Dikko Specialist Hospital, Kaduna	0.56 ± 0.56^{a}	0.00 ± 0.00^{a}
Gwamna Awan General Hospital, Kakuri	1.22 ± 0.79^{a}	0.00 ± 0.00^{a}
Gambo Sawaba General Hospital, Zaria	2.65 ± 1.54^{a}	0.48 ± 0.27^{ab}
General Hospital, Kachia	1.95 ± 1.55^{a}	0.00 ± 0.00^{a}
General Hospital, Makarfi	1.62 ± 1.62^{a}	0.00 ± 0.00^{a}
Mohammed Dabo Lere Memorial Hospital, Saminaka	14.56 ± 8.05^{b}	1.90 ± 1.21^{b}

Means with the same superscript are not significantly different ($P \geq 0.05$).

Appendix VIII: Determination of the association of geohelminth infections with male and female infants using Chi (χ^2) square.

The formula for $\chi^2 = \frac{(O-E)^2}{E}$

O = Observed; E = Expected

Male = 272, Number infected = 3

Female = 241, Number infected = 5

	Infected	Not infected	
Male	3a	269c	272
Female	5b	236d	241
	8	505	513

Expected value for a, b, c and d are

$a = \frac{(a+b)(a+c)}{GT} = \frac{(3+5)(3+269)}{513} = \frac{8\times272}{513} = \frac{2176}{513} = 4.24$

$b = \frac{(a+b)(b+d)}{GT} = \frac{(3+5)(5+236)}{513} = \frac{8\times241}{513} = \frac{1928}{513} = 3.76$

$c = \frac{(a+c)(c+d)}{GT} = \frac{(3+269)(269+236)}{513} = \frac{272\times505}{513} = \frac{137360}{513} = 267.76$

$d = \frac{(b+d)(c+d)}{GT} = \frac{(5+236)(269+236)}{513} = \frac{241\times505}{513} = \frac{121705}{513} = 237.24$

O	**E**	**O – E**	**$(O-E)^2$**	$\frac{(O-E)^2}{E}$
a = 3	4.24	-1.24	1.5376	0.3626
b = 5	3.76	1.24	1.5376	0.4089
c = 269	267.76	1.24	1.5376	0.0057
d = 236	237.24	-1.24	1.5376	0.0065
				0.7837

df = n – 1 =2 – 1 =1

Calculated value = 0.78, Tabulated value at 0.05 with 1 df = 3.84

The difference in prevalence between the male and female infants is not significant since the tabulated P. Value is greater than the calculated P. Value; therefore geohelminth infections are not gender sensitive (P> 0.05).

Appendix IX: Determination of significance level of association of geohelminth infections in mothers in relation to age using CHI Square (χ^2).

The CHI square formula = $\frac{(O-E)^2}{E}$

Age groups:

15-24years median = 20

25-34years median = 30

35-44years median = 39

Age:	*Ascaris*	Hookworm	*Trichuris*	*Strogyloides*	Total
20(29.49)	16(9.94)	18(14.25)	0(0.33)	0(0.00)	54
30(31.12)	10(10.49)	17(15.04)	0(0.35)	0(0.00)	57
39(28.39)	4(9.57)	8(13.72)	1(0.32)	0(0.00)	52
Total 89	30	43	1	0	163

Row 1 = $\frac{89\times54}{163}$ $\frac{30\times54}{163}$ $\frac{43\times54}{163}$ $\frac{1\times54}{163}$ $\frac{0\times54}{163}$

Row 2 = $\frac{89\times57}{163}$ $\frac{30\times57}{163}$ $\frac{43\times57}{163}$ $\frac{1\times57}{163}$ $\frac{0\times57}{163}$

Row 3 = $\frac{89\times52}{163}$ $\frac{30\times52}{163}$ $\frac{43\times52}{163}$ $\frac{1\times52}{163}$ $\frac{0\times52}{163}$

O	**E**	**(O-E)**	**$(O-E)^2$**	$\frac{(O-E)^2}{E}$
20	29.49	-9.49	90.06	3.0539
16	9.94	6.06	36.72	3.6941
18	14.25	3.75	14.06	0.9866
0	0.33	-0.33	0.11	0.3333
0	0.00	0.00	0.00	0.0000
30	31.12	-1.12	1.25	0.0401
10	10.49	-0.49	0.24	0.0228
17	15.04	1.96	3.83	0.2553
0	0.35	-0.35	0.12	0.3428
0	0.00	0.00	0.00	0.0000
39	28.39	10.61	112.57	3.9651
4	9.57	-5.57	31.03	3.2424
8	13.72	-5.72	32.71	2.3841
1	0.32	0.68	0.46	1.4375
0	0.00	0.00	0.00	0.0000
				19.7580

df = (r – 1) (c – 1) = (3 – 1) (5 – 1) = 2× 4 = 8; Cal. χ^2 = 19.7580, at 0.05, 8 df, tabulated value = 15.51

The difference in prevalence of geohelminth infections in mothers among the different age groups is significant since the calculated Chi square (χ^2) is greater than the tabulated value ($P < 0.05$).

Appendix X: Determination of significance level of association of geohelminth infections in infants in relation to age using CHI Square (χ^2)**.**

The formula for $\chi 2 = \dfrac{(O-E)^2}{E}$

O = Observed

E = Expected

0-4months = 276 Number infected = 1

5-12 months = 237 Number infected = 7

	Number infected	not infected	
0 -4 months	1a	275c	276
5 – 12 months	7b	230d	237
	8	505	513

Expected values for a, b, c, and d are; $a = \dfrac{(a+b)(a+c)}{GT} = \dfrac{(1+7)(1+275)}{513} = 4.3041$

$b = \dfrac{(a+b)(b+d)}{GT} = \dfrac{(1+7)(7+230)}{513} = \dfrac{8\times 237}{513} = 3.6959$

$c = \dfrac{(a+c)(c+d)}{GT} = \dfrac{(1+275)(275+230)}{513} = \dfrac{276\times 505}{513} = 271.6959$

$$d = \frac{(b+d)(c+d)}{GT} = \frac{(7+230)(275+230)}{513} = \frac{237 \times 505}{513} = 233.3041$$

O	E	(O- E)	$(O-E)^2$	$\frac{(O-E)^2}{E}$
a = 1	4.30	-3.30	10.89	2.5326
b = 7	3.70	3.30	10.89	2.9432
c = 275	271.70	3.30	10.89	0.0401
d = 230	233.30	-3.30	10.89	0.0467
				5.5626

Tabulated value = 3.841

df = n-1 = 2 – 1 = 1

There is significant association of geohelminth infection with the age of the infants since the calculated χ^2 value is greater than the tabulated value ($P < 0.05$)

Appendix XI: WHO Classification of intensity for geohelminth infections in stool examination

Helminth	Light infections	Moderate infections	Heavy infections
Ascaris lumbricoides	1–4999epg	5000–49999epg	≥ 50000epg
Hookworm	1–1999epg	2000–3999epg	≥ 4000epg
Trichuris trichiura	1–999epg	1000– 999epg	≥ 10000epg

Epg = eggs per gram of faeces (Source, Adefemi and Musa, 2006)

Appendix XII: Odd's Ratio analysis of responses from Questionnaire on geohelminth infection in mothers with respect to occupation and educational status

Occupation and educational status	**OR**	**C I**	**P value**
Business	1.146	0.657–1.999	0.666
Housewife	1.091	0.634–1.875	0.781
Civil servant	0.330	0.078–1.400	0.145
Student	1.593	0.672–3.777	0.311
Farming	1.242	0.599–2.575	0.556
Education Status			
Primary	1.358	0.746–2.474	0.332
Secondary	0.749	0.432–1.097	0.341
Tertiary	0.474	0.209-1.074	0.089
Non formal education.	2.883	1.643–5.060	0.000

Appendix XIII: Odd's Ratio analysis of responses from questionnaire on geohelminth infection in mothers with respect to water source and boiling of water

Water source	**OR**	**CI**	**P. value**
Water –source			
Well	1.816	1.026–3.215	0.041
Pipe borne water	0.421	0.213–0.832	0.113
River/stream	1.708	0.718–4.065	0.205
Others	0.442	0.058– 3.389	0.708
Boiling water before drinking			
Yes	0.838	0.479-1.468	0.578
No	1.193	0.681–2.088	0.578

Appendix XIV: Odd's Ratio analysis of responses from questionnaire on geohelminth infections in mothers with respect to socio-economic factors

Socio-economic factor	OR	C I	P value
Type of toilet used			
Pit latrine	1.128	0.655–1.945	0.683
WC	0.654	0.343–1.246	0.228
Open field defaecation	1.476	0.727–2.997	0.317
Wearing shoes while going out of the house			
Yes	1.285	0.645–2 .560	0.619
NO	0.588	0.226–1.529	0.409
Sometimes	1.121	0.454–2.767	0.811
Whether floor is cemented			
Yes	0.585	0.331-1.034	0.081
NO	1.711	0.967– 3.025	0.081
Number of children in a family			
1–4	0.283	0.162–0.493.	0.100
5–8	2.942	1.671–5.181	0.000
9–12	22.678	2.321–21.582	0.006

Appendix XV: Odd's Ratio analysis of responses from questionnaire on geohelminth infections in mothers in relation to types of hygiene practices

Types of hygiene practice	OR	CI	P. value
Refuse disposal methods			
Burning	0.687	0.393–1.200	0.217
Burying	0.988	0.427–2.286	1.000
Dumping around home	1.979	1.158-3.380	0.013
Sewage water presence in surrounding			
Yes	0.764	0.439-1.329	0.408
NO	1.309	0.752-2.276	0.408
Washing fruits before consumption			
Yes	0.778	0.426–1.419	0.424
NO	1.506	0.553–4.104	0.388
Sometimes	1.155	0.587–2.274	0.721
Washing hands after visiting toilet			
Yes	0.720	0.288–1.798	0.443
NO	1.390	0.556–3.471	0.443

Appendix XVI: Odd's Ratio analysis of responses from questionnaire on geohelminth infections in mothers with respect to awareness campaign

Awareness campaign	OR	C I	P value
Whether you heard about geohelminthiasis			
Yes	0.342	0.159-0.739	0.104
NO	2.921	1.353–6.305	0.004
Whether health talks are being organized in your area			
Yes	0.730	0.420–1.270	0.276
NO	1.369	0.788–2.380	0.276

OR = Odd's Ratio, CI = Confidence interval, P. Value = Probability value

Appendix XVII: Odd's Ratio analysis of responses from questionnaire on geohelminth infections in infants with respect to mothers' occupation and educational status

Mothers'occupation and educational status	OR	C I	P value
Occupation			
Business	0.679	0.136–3.400	1.000
Housewife	2.705	0.639–11.448	0.270
Student	1.845	0.221–15.412	0.456
Mothers' education			
Primary	1.227	0.244–6.168	0.682
Secondary	0.493	0.099–2.469	0.485
Tertiary	1.423	0.283–7.168	0.652
Non Formal education	1.388	0.276–6.984	0.656

OR = Odd'sratio, CI = Confidence interval, P. value = Probability value

Appendix XVIII: Odd's Ratio analysis of responses from questionnaire on geohelminth infections in infants with respect to water source, presence of sewage water and boiling of water

Water source, sewage water and boiling of water	**OR**	**CI**	**P. value**
Water sources			
Well	2.274	0.454–11.375	0.476
Pipe borne water	0.704	0.141–3.526	1.000
Presence of sewage water in surrounding			
Yes	1.077	0.239–4.864	1.000
NO	0.928	0.206–4.192	1.000
Boiling /filtering of water			
Yes	0.235	0.029–1.923	0.268
NO	4.259	0.520–34.887	0.268

Appendix XIX: Odd's Ratio analysis of responses from questionnaire on geohelminth infection in infants with respect to socio-economic factors

Socio-economic factor	OR	C I	P value
Type of toilet used			
Pit latrine	0.698	0.173-2.824	0.723
Water closet	1.563	0.369- 6.626	0.692
Open field defaecation	0.925	0.112–7.641	1.000
Type of floor			
Cemented floor	0.531	0.125–2.253	0.410
Not cemented	1.884	0.444–8.000	0.410
Number of children in family			
1– 4	0.437	0.103–1.857	0.374
5-8	2.406	0.565–10.237	0.207
Whether infants eat sand			
Yes	2.844	0.568–14.230	0.287
NO	0.352	0.070-1.759	0.287
Walking barefoot			
Yes	1.7126	0.724–3.6346	0.046
NO	0.0614	0.325–2.1462	0.7568

Appendix XX: Odd's Ratio analysis of responses from questionnaire on geohelminth infections in infants in relation to mothers'hygiene practices

Types hygiene practice	OR	C I	P value
Washing fruits before consumption			
Yes	0.500	0.118–2.123	0.396
Sometimes	2.900	0.680–12.369	0.149
Washing hands after toilet			
Yes	0.558	0.067–4.659	0.465
NO	1.792	0.215–14.953	0.465
Washing hands before breastfeeding infants			
Yes	1.395	0.278–6.987	1.000
NO	0.975	0.118–8.059	1.000
Sometimes	0.611	0.074–5.022	1.000
Washing utensils before and after feeding infants			
Yes	1.236	0.150-10.209	1.000
NO	2.799	0.330–23.755	0.338

OR = Odd'sratio, CI = Confidence interval, P. value = Probability value

Appendix XXI: Odd's Ratio analysis of responses from questionnaire on geohelminth infection in infants in relation to types of utensils used, remaining of infants' food and food storage

Infants' food	OR	C I	P value
Utensils used for feeding infants			
Feeding bottle	0.800	0.189–3.387	1.000
Bare hands	1.075	0.214–5.402	1.000
Plate and spoon	1.192	0.281–5.053	1.000
Whether infants' food remain after feeding			
Yes	2.886	0.352–23.685	0.448
NO	0.346	0.042–2.843	0.448
Where the remaining food is stored			
Refrigerator	0.825	0.099–6.841	1.000
Not inside refrigerator	5.133	1.202–21.912	0.027

OR = Odd's ratio, CI = Confidence interval, P. value = Probability value

Appendix XXII: Odd's Ratio analysis of responses from questionnaire on geohelminth infection in infants in relation to methods of refuse disposal

Refuse disposal methods	OR	C I	P value
Refuse disposal methods			
Burning	0.838	0.198–3.546	1.000
Burying	2.649	0.522–13.442	0.229
Dumping around home	0.800	0.189–3.387	1.000

Appendix XXIII: Odd's Ratio analysis of responses from questionnaire on geohelminth infection in infants with respect to awareness campaign

Awareness campaign	OR	CI	P.value
Whether you heard about geohelminthiasis			
Yes	0.361	0.044–2.962	0.452
No	2.769	0.338–22.707	0.452
Health talk being organized in your area			
Yes	0.454	0.091-2.273	0.477
NO	2.201	0.440–11.011	0.477