PREVALENCE OF INTESTINAL PARASITIC INFECTION AND MALNUTRITION AMONG SELECTED PRIMARY SCHOOL CHILDREN IN SABON-GARI LOCAL GOVERNMENT AREA, KADUNA STATE, NIGERIA

BY

SOFIA HUSSEIN SULEIMAN

DEPARTMENT OF BIOCHEMISTRY

FACULTY OF LIFE SCIENCES

AHMADU BELLO UNIVERSITY ZARIA,

NIGERIA

APRIL, 2018

PREVALENCE OF INTESTINAL PARASITIC INFECTION AND MALNUTRITION AMONG SELECTED PRIMARY SCHOOL CHILDREN IN SABONGARI LOCAL GOVERNMENT AREA, KADUNA STATE, NIGERIA

By

Sofia Hussein SULEIMAN, B.Tech. (FUTMINNA, 2012)

P13SCBC8050

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

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTERS DEGREE IN NUTRITION

DEPARTMENT OF BIOCHEMISTRY,
FACULTY OF LIFE SCIENCES
AHMADU BELLO UNIVERSITY, ZARIA
NIGERIA

APRIL, 2018

DECLARATION

I SULEIMAN Sofia Hussein, hereby declare that the work in this thesis entitled "**Prevalence of Intestinal Parasitic Infection and Malnutrition among Selected Primary School Children in Sabongari LGA, Kaduna State, Nigeria**" has been carried out by me in the Department of Biochemistry. 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.

Sofia Hussein SULEIMAN	___________________	___________
P13SCBC8050	**Signature**	**Date**

CERTIFICATION

This thesis entitled "PREVALENCE OF INTESTINAL PARASITIC INFECTION AND MALNUTRITION AMONG SELECTED PRIMARY SCHOOL CHILDREN IN SABONGARI LOCAL GOVERNMENT AREA, KADUNA STATE, NIGERIA" by Sofia Hussein SULEIMAN meets the regulations governing the award of the degree of Master of Science (M.Sc.) Degree in Nutrition of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

Professor E. Onyike	__________________	______________
Chairman, Supervisory Committee	Signature	Date

Professor S.E. Atawodi, FAS

Member, Supervisory Committee	__________________	______________
	Signature	Date

Professor M.N. Shuaibu

Head of Department	__________________	_____________
	Signature	Date

Professor S. Z Abubakar

Dean Postgraduate School	____________________	______________
	Signature	Date

DEDICATION

This research work is dedicated to my beloved husband Engr. Dr. Hussein Suleiman Usman for his support and encouragement throughout my program. May Allah reward you immensely.

ACKNOWLEDGEMENT

In the name of Allah (SWT), the Most Gracious, the Most Merciful. Gratitude to Almighty Allah for giving me the opportunity to complete my M.Sc. in Nutrition in this noble institution.

I would like to first of all express my profound gratitude to my supervisors, Prof. E. Onyike and Prof. S.E. Atawodi for their tireless support, guidance and constructive suggestions which has made this thesis a reality. May Almighty Allah continue to bless you and your entire family.

My esteem appreciation goes to Prof. M.N. Shuaibu (Head of Department), Prof. Kola, Dr. S. M. Bala, Dr. Owolabi and other lecturers in the department for their constructive criticism, valuable contribution and creating time out of their schedule to go through my work.

My sincere gratitude goes to my parents Mr. and Mrs. Mohammed Umar for their prayer, support and advice. May Allah continue to grant you long life and prosperity. My indebtedness to my dear husband for his moral and financial support. Indeed, you have made me a better person and you have taught me that hard work pays. To my lovely children, Imran, Jamal and Nadia, thank you for your patience and endurance while I was in school. To my siblings Abdulganiyu, Issah, Khadijat, Sadiq, Abass and Halima, thank you for your kindness and moral support. To my in-laws, I sincerely appreciate your support.

My deep appreciation to my friends and colleagues, Mrs. Mark James, Mrs. Aduku, Jemila Lawal and my entire coursemates in ABU. Thank you all for your support and cooperation.

ABSTRACT

The prevalence of parasitic infections and malnutrition in school children from Sabon gari LGA was carried out. Data on demographic characteristics were collected using semi-structured, pretested questionnaires. Anthropometric measurements of weight and height were made using standardized weighing scales and stadiometer respectively according to WHO (2007) guide lines. Body Mass Index (BMI) for age was used as indicator to determine nutritional status. The stool specimens was collected and examined using cheesbrough concentration techniques. With regard to malnutrition, the prevalence (20.9%) was recorded in this study. Severe thinness was (1.0%), moderate thinness was (11.1%), overweight was (8.5%) and obese (0.3%). The degree of malnutrition was higher in girls (21.4%) than the boys (20.4%) but the difference was not statistically significant ($p > 0.05$). Private school had higher rate of malnutrition (23.0%) than public schools (20.0%) the difference was however, insignificant ($p > 0.05$). The result of stool examination showed that 45(17.0%) of the study subject were infected with parasites and the most frequent were *Ascaris, Schistosomiasis* and Hookworm among others. The magnitude of infection was higher in girls (18.5%) than the boys (14.7%). Public schools had higher infection rate (13.2%) than private schools (3.8%). There was significant association between the rate of infection and the children's habit of washing hands after using toilet, washing fruits before eating as well as the last time the children were dewormed. The rate of parasitic infection was not significantly associated with the nutritional status of the children ($p > 0.05$). Based on these results, it was concluded that intestinal parasitic infection is still present among school children in sabongari LGA, of Kaduna State.

TABLE OF CONTENT

CHAPTER THREE

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CDC	Center for Disease control
FAO	Food and Agriculture Organization
NIH	National Institutes of Health
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
STH	Soil Transmitted Helminth
WHO	World Health Organization

CHAPTER ONE

Introduction

1.1 Parasites and Parasitic Infections

Parasites are small animals or plants that lives on or inside another animal or plant and gets its food and nutrient from it (Oxford dictionary of English, 2017). Parasitic infections is a serious public health problem in the world, especially in developing countries and is a major cause of morbidity and mortality in childhood and among high-risk groups in most parts of the world. Intestinal parasitic infections are endemic and have been described as the greatest single worldwide cause of illness and diseases causing hundreds of thousands of avoidable deaths each year and are among the world's most common infectious disease (Mohammad *et al.*, 2012). Malnutrition and infection are widespread in almost all developing countries and is probably an additional health problem that impede learning among school-aged children (Opara *et al.*, 2012). In under developed countries, poor environmental .and personal hygiene, poor nutrition, overcrowding and climatic conditions favour the development and survival of these parasites (Opara *et al.*, 2012). Poverty and over dispersion of these parasites and diseases are the immediate causes of malnutrition and death in young children (Garba & Mbofung, 2010).

School children bear the heaviest burden of the associated morbidity due to their habits of handling or playing with infested soils, eating with soiled hands, unhygienic toilet practices, drinking and eating of contaminated water and foods (Opara *et al.*, 2012). The adverse effects of intestinal parasites among children are diverse, alarming and have detrimental effects on the survival, appetite, growth and physical fitness, school attendance, cognitive performance and may also cause malnutrition (Tadesse, 2005). A study conducted in Jamaica found a relationship between whipworm and psychomotor development among children aged three to six (Azad *et al.*, 2004).

Globally, it is estimated that among pre-school age children in developing countries, 183 million are underweight, 226 million are stunted and 67 million are wasted. Over one billion people mostly in the tropics and sub-tropics are infested with parasites mostly soil transmitted helminthes, malaria parasites and 200 million are infected with schistosomes (Garba & Mbofung, 2010).

In Nigeria, intestinal helminth infections have continued to prevail because of poor standards of living, poor environmental sanitation and ignorance of simple health promoting behaviours (Wosu & Onyeabor, 2014). Intestinal helminth infections are most common in school age children and they tend to occur in high intensity in this age group. These infections have been associated with an increased risk for nutritional anaemias, protein-energy malnutrition and growth deficits in children (Wosu &Onyeaabor, 2014). Amoebiasis, Giardiasis, Acariasis, Hookworm infection and Trichuriasis are among the most common intestinal parasitic infections worldwide. In children, chronic helminth infection may cause a number of negative health outcomes such as impaired physical and cognitive development (Sayasonea *et al.*, 2014).

1.2 Statement of Research Problem

Malnutrition is wide spread in developing countries and every year in the developing world, close to 12 million children die of inevitable causes and more than 6 million (55%) of these deaths could be directly or indirectly linked with malnutrition. It has been estimated that about 3.5 billion people globally and 450 million people are thought to be ill as a result of intestinal parasitic infections and the majority being children (Wosu & Onyeabor, 2014).

In Nigeria, Schistosomiasis, parasitic protozoans and soil transmitted helminth infection are important parasitic diseases and the highest transmission occur in the northern region (Unachukwu & Nwakanma, 2014). Abnormalities of intestinal mal-absorption can contribute to nutritional deficiency as nutrition play a major role in maintaining health. Several environmental and socio-economic factors such as poor sanitary condition, absence of portable water, poor housing can be implicated as contributing to this condition.

1.3 Justification

Nutrition plays a major role in maintaining health and malnutrition appears to generate vulnerability to a wide range of diseases and general ill-health. Roundworms and whipworm are estimated to infect one quarter of the world's population and school-aged children have the highest prevalence and levels of intensity among those infected. Roundworms (*Ascaris lumbricoides*) infects about one billion individuals of whom 400 million are school-aged children (Azad *et al*., 2004). Whipworms (*Trichuris trichiura*) infects about 750 million people including 300 million children of school age. Hookworm (ancylostomiasis) infection affects 750 million of whom 170 million are children (Azad *et al*., 2004). Schistosomes (Bilharzia*)* impair an additional 200 million including 90 million children (Azad *et al*., 2004).

These parasitic infections are associated with a particular symptoms. According to Azad *et al.* (2004). Roundworms usually leads to abdominal obstruction, impaired growth and development as well as malnutrition while, Whipworm is associated with iron deficiency anemia, chronic colitis and growth retardation.

There is scanty information on the prevalence of these parasites among school children in Sabon Gari Local Government Area. Thus, this study is undertaken to assess the prevalence of these intestinal parasites and malnutrition in school children in order to create awareness on the health risk of these parasite as well as develop and design a good programme that can improve the health status of school children in Sabon Gari.

1.4 Aim

The aim of this research is to assess the prevalence of intestinal parasitic infection on the nutritional status of some selected primary school children in sabon-gari LGA.

1.5 Objectives

The objectives of the research are to:

I. Determine the demographic characteristics, sanitation and hygiene practices of the primary school children

II. Determine the nutritional status of school children using anthropometric indices of height and weight and age

III. Assess the types, risk factors and prevalence of intestinal parasitic infection among primary school children in Sabon-Gari Local Government Area

IV Assess the dietary pattern of school children using food frequency questionnaire

V Determine the effect of Intestinal Parasitic Infection on the Nutritional Status of the School Children

CHAPTER TWO

LITERATURE REVIEW

2.1 Malnutrition

Malnutrition is a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein and other nutrient, causes measurable adverse effect on tissue/ body form (body shape, size and composition), function and clinical outcome (Willem *et al.*, 2010). Malnutrition has been adjudge as one of the commonest childhood ailments in Nigeria and several parts of sub-Saharan African and directly or indirectly accounts for most of the pediatric outpatient presentation as well as admission (Jombo *et al.*, 2011).

Malnutrition is estimated to contribute to more than one third of all child death, although it is rarely listed as the direct cause. FAO (2006) stated that approximately 826 million people in the world are undernourished, 792 million people are in the developing world and 34 million in the developed world. According to (Pelletier & Frongil, 2002), it is an underlying factor in many diseases in both children and adults and contributes greatly to the disability and adjusted life worldwide.

It is typically caused by a combination of inadequate food intake and infection which impairs the body's ability to absorb or assimilate food (Amuta *et al.*, 2008). It is more serious in children, combined with infection which has caused death of millions (WHO/UNICEF, 1981).

Under-nutrition does the greatest damage early in life, marked by underweight, wasting and stunting, while over-nutrition degrades the body gradually with heart disease, cancer, and other chronic diseases striking typically in middle and old age. The effects of under-nutrition such as stunting and blindness are often irreversible, while the effects of over-nutrition can be tamed through changes in diet and lifestyle (Gardner *et al.*, 2000). (Taha *et al*., 2013) stated that severe malnutrition has a high mortality rate among children in hospital in saharan Africa.

Malnutrition occur in different forms such as underweight, wasting and stunting. Wasting indicates current or acute malnutrition resulting from failure to gain weight or actual weight loss (Taha *et al*., 2013).Stunting is an indicator of past growth failure which is a sign of poor nutritional history while underweight is a combination of both acute and chronic malnutrition (Taha et al., 2013).

2.2 Parasitic Infection

Helminth infections refer to worms that live as parasites in the human body (Luong 2002). These infections occur when infective eggs or larva enters the body, mature ,lay eggs and feed off the person (Luong 2002).Worldwide, the magnitude of parasitic infection is enormous and about one billion people are infected with soil-transmitted helminths e.g. hookworm, roundworms and whip worms (Peter & Judith, 2008). Intestinal parasitic infections, especially helminths, are common health problems of pre-school children, school-age children and women of child bearing age including adolescent girls (Luong, 2002 and Reji et al., 2011). In addition, it is estimated that for children 5–14 years of age in low-income countries, intestinal worms account for 12% of the total disease burden (Reji *et al.*, 2011). Similarly, a high infection rate and worm burden were found among school age children aged 4-16 years and were attributed to poor sanitation and hygiene.

Studies in Africa have reported a high prevalence of intestinal parasitic infection amongst school children and the magnitude of the problem varies amongst countries as well as in areas within countries (Andy & Palmer, 2005). This can be due to socio-economic and environmental factors, climate, poverty, malnutrition, personal and community hygiene, population density, unavailability of drinking water, indiscriminate disposal of human and animal faeces and poor sanitary facility (Espinoza *et al.*, 2003; Mohammad *et al.*, 2012; Ojurongbe *et al.*, 2014).

A study from Kaduna state (Gwagwada) in Nigeria showed that out of 283 pupils examined for parasitic infections, 190 (67.1%) of them were infected with parasites with ascaris, schistosome and hookworm being the most prevalent(Timothy *et al*., 2013). Another study carried out in Akwa-ibom state in Nigeria also recorded a high rate of parasitic infection 67.4% with roundworms, hookworms and whipworm being the most common (Opara *et al*., 2013).

According to Ojurongbe *et al.* (2014), five types species are responsible for wide spread of disease in humans and these include *Ascaris lumbricoides, Trichuris trichiura*, hookworm (*Ancylostoma duodenale* and *Necator americanus)* and *Strongyloides stercoralis*

Humans can host as many as 200 different types of parasites and 1 worm can produce an average of 20,000 eggs per day. The evidence demonstrating that parasite damage a child's health is unambiguous. These parasite may cause a reduction in food intake, malabsorption, endogenous nutrient loss, diarrhea, loss of weight, decreased child growth, iron deficiency, anemia and chronic blood loss (Peter and Judith, 2008; Unachukwu and Nwakanma, 2014).

Blood loss can be as high as 45 Ml/day, or equivalent of 9.9 mg of iron. Children free of parasites have better nutritional status, grow faster, learn more, and are freer of infections than are children with parasites (Peter & Judith, 2008).

2.3 Interaction between Malnutrition and Infection

Malnutrition and infection are wide spread in almost all developing countries and the endemic nature of both is probably also at the root of additional health problem that impede learning among school-aged children (Azad *et al.*, 2004). There is a strong relationship between malnutrition and infection and infant mortality, because poor nutrition leaves children underweight, weakened, and vulnerable to infections. Similarly, it is the primary cause of immunodeficiency worldwide, with infants, children, adolescents, and the elderly most affected (Peter & Judith, 2008).

Malnutrition can make a person more susceptible to infection, and infection also contributes to malnutrition, which causes a vicious cycle. An inadequate dietary intake leads to weight loss, lowered immunity, mucosal damage, invasion by pathogens, and impaired growth and development in children (Muller *et al.*, 2003). A sick person's nutrition is further aggravated by diarrhea, malabsorption, loss of appetite, diversion of nutrients for the immune response, and urinary nitrogen loss, all of which lead to nutrient losses and further damage to defense mechanisms which in turn causes reduced dietary intake (Peter & Judith, 2008)..

The causes of malnutrition and disease operate at different levels and the factors responsible are household food availability, personal health, health service and the psychosocial care environment. The existing primary health care infrastructure includes the types of services provided and the accessibility of health care (distance and affordability). Underlying the problem of malnutrition and disease is inadequate household food security, which the US Department of Agriculture defines as "access by all members at all times to enough food for an active, healthy life," not merely as adequate food for survival. Access to health services and environmental health conditions relate to essential drugs and immunizations, safe water, sanitation, and housing. Insufficient or delayed treatment also prolongs disease occurrence and severity (Peter & Judith, 2008).

Many of the basic causes of malnutrition also emerge at the national and international levels and relate to the availability and control of food. The political ideology of the ruling government and its commitment to preventing infectious disease and malnutrition affects the health of its entire population. Famine, for example, is a disaster caused not only by agricultural failures or natural disasters but too often by politics. Political factors are responsible for nearly all famines. Even with the droughts in Ethiopia and West Bengal, it was government policy, not agricultural failure that was responsible for the human crisis. Food supply, underlying health, and health care interact in important ways, and their combined effect is synergistic. The underlying causes may also change with the seasons. Rural households, for example, may experience an annual hunger season. Diarrheal diseases and malaria are more prevalent during rainy seasons, and respiratory tract infections are more prevalent during cold weather (Peter & Judith, 2008).

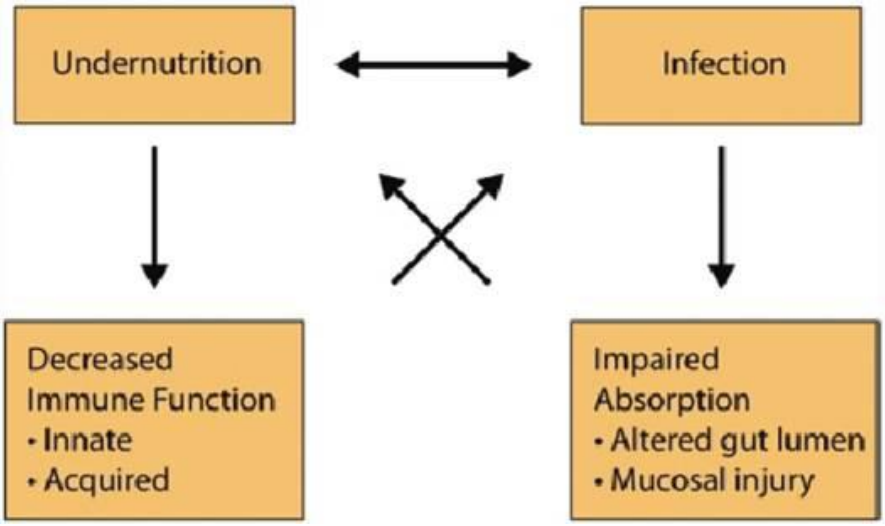

Figure. 2.1: Interactions between malnutrition and infection (source: Peter & Judith, 2008).

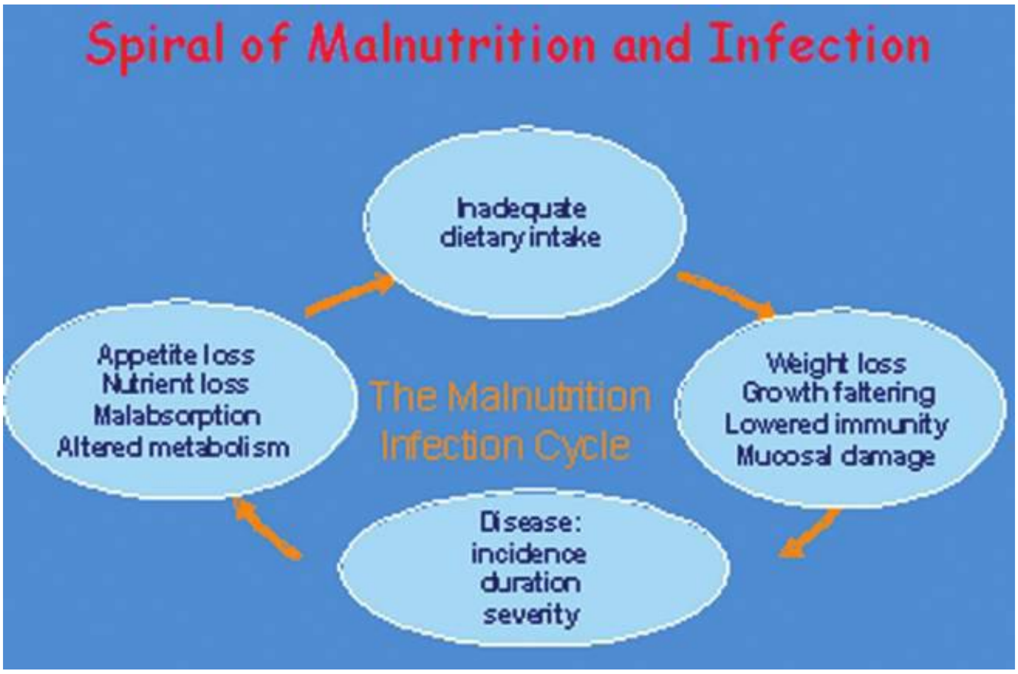

Figure 2.2: The "vicious cycle" of malnutrition and infection (**source: Peter & Judith, 2008**).

2.4 Nutrition and Parasite Interaction

The interaction between a host and nutrition can be considered from the effects of nutrition on the metabolic disturbances and pathophysiology induced by parasitism (Coop, 1999). Coop (1999) stated that the level of nutrition can influence the resilience and resistance of the host to parasitic infection. Resilience can be considered as the host's ability to maintain a reasonable level of productivity in the face of a parasitic challenge (Kyriazakis, 1999) and resistance is a measure of the host's ability to limit the establishment, growth rate, fecundity and/ or persistence of a parasite population.

According to coop (1999), the extent of metabolic impairment induced by a parasite is influenced by the level of larval challenge and the number of worms established and this is influenced by host factors such as age, nutritional and immune status. Generally, gastrointestinal nematode reduce nutrient availability to the host through reduction in voluntary food intake and/or reduction in the efficiency of the absorbed nutrient (coop & kyriazakis, 1999). These two mechanism to some extent depends on the location of the parasite on the gastrointestinal tract. Food intake usually returns toward normality as the host acquires resistance to infection. There are evidence from studies that the presence of worm in host is required to maintain anorexia (Coop, 1999). One of the key features of GI nematode infection is an increased loss of endogenous protein into the GI tract (Coop & Kyriazakis, 1999) partly as a result of leakage of plasma protein and partly due to mucoprotein production and sloughing of epithelial cell into the alimentary tract. Coop (1999) suggested that improved nutrition will lead to increase in host resilience, provided that the host continues to be offered access to a scarce food resources. According to Kyriazakis (1999), the duration of acquiring immunity during which the immune system recognizes the parasite and immunological changes could vary greatly from few days in protozoan infection to several weeks in helminth infections. Also, the nutrition of the host could have the potential to affect how rapidly immunity is acquired and the effect would be expected to be seen best in helminth infections in which the rate of acquisition of immunity is relatively lengthy (Coop, 1999).

2.5 Effects of Worm Infections on Child Growth, Development and Learning.

According to Awasthi *et al.,* (2003), most common effect of worm infection on health is a subtle and insidious constraint on normal physical development, resulting in children failing to achieve their genetic potential for growth and having the clinical consequences of iron deficiency anaemia and other nutritional deficiencies. Heavy hookworm burdens is recognized as an important cause of iron deficiency anaemia. Intense whipworm infection in children may result in *trichuris* dysentery syndrome, the classic signs of which include growth retardation and anaemia, and heavy burdens of both roundworm and whipworm are associated with protein energy malnutrition (Aswasthi *et al*., 2003).

Due to the high prevalence of infection in school children, it is a thing of concern that these infections can adversely affect cognition and educational achievement. The mechanism by which mental processes are affected is uncertain, but evidence suggest that the mechanism is indirect, perhaps meditated through iron deficiency anaemia and under nutrition (Awasthi *et al.,* 2003).

Whether helminth infections directly cause cognitive deficits is still a matter of debate. In an analysis, majority of 40 studies showed an association between *geohelminthic* infection and impaired cognitive or educational abilities, but few studies were well designed. Most studies show an effect in the most heavily infected children but with such mixed results it has been difficult to reach any strong conclusions as to whether *helminthiases* directly contribute to impair cognitive functioning. Recently, more comprehensive studies have used new measures of learning ability to detect the impact of infection (Aswasthi *et al*., 2003)

In Tanzania schoolchildren most heavily infected with worms achieved significantly lower scores in some tests of cognitive ability, but eradication treatment did not result in an immediate improvement in the children's ability to conduct these tests. However, when children were both treated and taught how to do cognitive tests they performed significantly better than children who were taught but not treated. These results suggest that children with chronic infection, and the constrained development that results from this, will need not only improved health but also a good education to catch up.

2.6 Assessment of Nutritional Status

Nutritional status is defined as the health of individual or population group as influenced by their intake and utilization of nutrients. According to Beaton *et al.* (1990), the concept of growth monitoring has been globally accepted as desirable and children in many countries especially developed ones have their nutritional status assessed regularly by various methods. One of the methods of assessing and monitoring growth in children is through anthropometry. When there is combined dietary assessment, the nutritional status of the children could be fairly determined. In developing countries like Nigeria, malnutrition is still a serious health problem and this is manifested in various forms as stunted growth, muscles wasting and diminished subcutaneous fat (Onimawo, 2001).

According to Dettwer (1991), children in developing countries experience poor health in early childhood as indicated by slow rate of growth and high mortality rates. Dietary deficiencies are potential causes of poor early childhood health problems although factors such as disease and lack of access to medical services are also important.

Children are usually assessed by comparing their weight and also by comparing their weight to their height indices. Previous studies have shown that between the age of 5 to 10 years, weight increases by 10 percent and height by 5cm annually (Lovell, 1972). The parameter of weight, height and subcutaneous fat deposition are dependent on the present and past nutrition of the individual. Therefore, in assessing growth of children, a combination of anthropometry and dietary studies have been known to give fairly accurate result (Cole *et al.*, 1997).

When nutritional assessment is properly made, it enables the identification of the nutrients whose supply is adequate or inadequate and makes appropriate decision possible in relation to the scope of the nutritional support that is necessary. Measurement of malnutrition is also of particular importance in cases of emergency where a population is high-risk and serves certain purposes of emergencies. Measurement of malnutrition also identifies the areas and the groups most affected or at risk, in terms of age, social and economic status amongst others

2.7 Hookworm (ancyclostomiasis)

Hookworm, Ascaris and whipworm are known as soil transmitted helminths (CDC, 2015). Human hookworm infection is a soil-transmitted helminthiasis caused by the nematode parasites *Necator americanus/* (*N. americanus*) and *Ancylostoma duodenale* (*A. duodenale*). Prevalence rate vary widely with altitude, climate, ecological and human factors. An estimated 576-740 million people in the world are infected with hook worm (USAID, 2015a). Adult hookworms live in the duodenum and jejunum, attached to the intestinal mucosa from where they suck blood. The chronic blood loss gradually depletes body iron stores, leading eventually to iron deficiency anaemia which may be widespread and often severe in an infested community (Pawlowski *et al.*, 1991). The largest numbers of cases of hookworm infection occur in impoverished rural areas of sub-Saharan Africa, Latin America, Southeast Asia, and China. In general, tropical coastal communities have the highest intensity of hookworm infection. *N. americanus* is the most common hookworm worldwide, while A. duodenale is more geographically restricted. There is no known animal reservoir for *N. americanus* or *A. duodenale*. Unlike other soil transmitted helminthiasis *i*nfections, such as ascariasis *(*roundworm) and trichuriasis *(*whipworm), in which the highest intensity infections occur primarily in school aged children, high intensity hookworm infections frequently occur in adult populations especially pregnant women and this infection can lead to adverse outcome for both the mother and her infant (USAID, 2015a).

2.8 Geographical distribution of hookworm

The geographical distribution of both species occur together, although N. americanus is the prevailing species throughout the tropics and subtropics. A. duodenale tends to prevail in cooler and drier climates e.g northern Africa and the eastern Mediterranean, part of northern China, north-west India and southern Europe. According to Pawlowski *et al.* (1991), hookworms are rarely found, or occur only as light infections, in arid zones where the dry seasons are prolonged, or in temperate climate.

2.9 Life Cycle of Hookworm

Soil-transmitted helminths are transmitted by eggs. Mature female hookworms of the A. duodenale and N. americanus species produce between 5000 and 25,000 eggs each day (Pawloski, 1991). These eggs are passed in faeces under favorable conditions (moisture, warmth, shade), larvae hatch in 1 to 2 days (CDC, 2015). The released rhabditiform larvae grow in the faeces and/ or the soil. After 5 to 10 days, they become filariform larvae that are infective. These infective larvae can survive 3 to 4 weeks in favourable environmental conditions. On contact with the human host, the larvae penetrate the skin and are carried through the blood vessels to the heart and then to the lungs. They penetrate into the pulmonary alveoli, ascend the bronchial tree to the pulmonary to the pharynx and are swallowed. The larvae reach the small intestine where they reside and mature into adults.

The adult worms live in the lumen of the small intestine, where they attach to the intestinal wall with resultant blood loss by the host. Most adult worms are eliminated in 1 to 2 years, but the longevity may reach several years. Humans may also become infected when filariform larvae penetrate the skin. With most species, the larvae cannot mature (Pawlowski *et al.*, 1991).

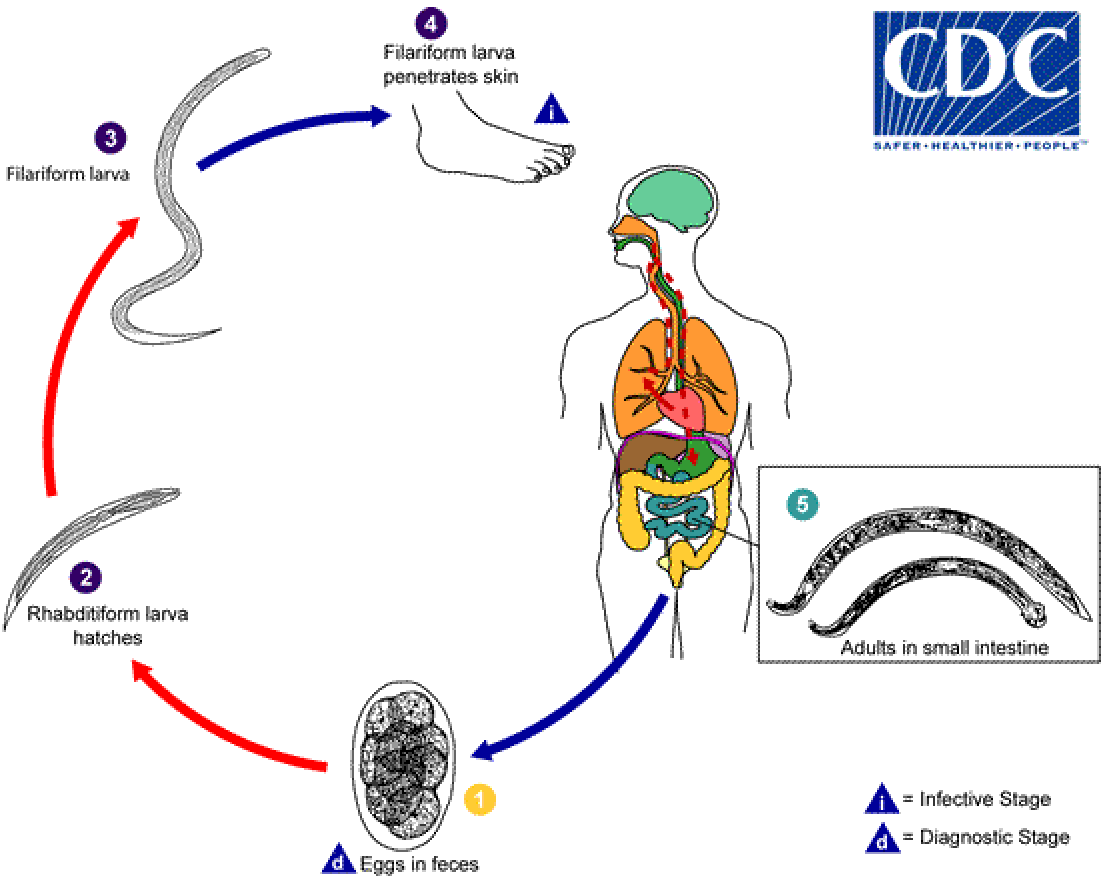

Figure 2.3: Lifecycle of Hookworm (**source: USAID, 2015a)**

2.10 Clinical Features and Pathology of Hookworms

Ancyclostomia duodenales and *Necator americanus* found attach to the mucosa of the small intestine in many people living in Tropical and Subtropical countries. In early stage of hookworm infection, symptoms, signs and pathological changes are transient and attributable to the penetration of the skin by larvae to the subsequent migration of larvae through the lungs and to the intestinal mucosal injury.

The symptoms and complications include:

2.10.1 Penetration of the Skin

When the invasive filariform larvae penetrate the skin, they may cause a stinging sensation, followed by irritation, erythema, oedema and a papulovascular eruption (ground itch). These symptoms rarely occur in people living in areas endemic for the hookworms specific to human, but may be noted in visitors from non-endemic areas (Pawlowski *et al.*, 1991).

2.10.2 Migration of Larvae

The migration of larvae through the body causes few pathological changes but small haemorrhages and leukocytic or eosinophilic infiltrations may occur where larvae pass through the alveolar walls of the lungs. Also, migration of larvae through the respiratory tract may cause coughing, due to irritation of the bronchial and tracheal mucous membranes (Pawlowski *et al.,* 1991).

2.10.3 Intestinal Infection

Hookworms in the duodenum and jejunum attach themselves to the intestine by engulfing a part of the intestinal mucosa in their buccal cavities. They then feed on blood from cut vessels and on mucosal tissue. At the point of attachment, some bleeding and inflammatory reaction usually occur, but these lesions heals fast when the hookworm move to other sites usually between every 4 to 6 hours. During this intestinal phase, the infected people may have duodenal-type pain, indigestion, loss of appetite or diarrhea. In areas where hookworm is prevalent, there is usually a high incidence of duodenal ulcer (Pawlowski *et al.*, 1991).

2.10.4 Chronic Blood Loss

Chronic blood loss from the duodenum and jejunum is the most severe consequences of hookworm infection. Blood loss may continue for many years if the infection is not adequately treated and can lead to depletion of body iron stores and eventually to iron deficiency anaemia. There is also loss of serum proteins, which may result in severe hypoalbumiaemia.

Several factors including the species of hookworm, the worm load, duration of infection, body iron stores, dietary iron intake and absorption and physiological iron requirement determines whether or not a person with hook worm infection develops anaemia.

2.11 Symptoms and Signs of Hookworm Anaemia

In chronic infection, the serious symptoms and signs are mainly those associated with anaemia.

When the anaemia is gradual in onset, symptoms may be slight even when hemoglobin levels are very low. Symptoms includes general weakness, shortness of breath, palpitation, dizziness, aching of the legs, loss of appetite, precordial or angina pain, blurred vision, ringing ears, difficulty in swallowing, tingling sensations in the hand, swelling ankles and men also complain of impotence (Pawlowski *et al.,* 1991).

In addition, pallor skin, conjunctivae, tongue and buccal mucosa, increased pulse pressure angular stomatitis which are common in iron deficiency anaemia. Children with hookworm anaemia may suffer from impaired growth, apathy, irritability, listlessness pica and poor academic performance (Pawlowski *et al.*, 1991).

2.12 Pattern of Transmission in Communities

Certain conditions in an appropriate climate will together ensure the maintenance and spread of hookworm infection in a community:

- Poor sanitation and indiscriminate defecation by villagers, inhabitants of urban area, or a labour force
- Use of inadequately composted human excreta as fertilizer
- Epidemic or focal outbreaks of hookworm infection may occur on plantations and among farm labourers, miners and tunnel worker exposed to high levels of infection under conditions that are favourable for transmission (Pawlowski *et al.*, 1991).

2.13 Roundworms (*ascariasis*)

Ascariasis is a soil transmitted helminthiasis (STH) infection caused by the roundworm *Ascaris lumbricoides*. Roundworms, or nematodes, are a group of invertebrates (animals having no backbone) with long, round bodies. They range in size from those that can be seen by the naked eye to those several hundredths of an inch long that can only be seen under a microscope (NIH, 2015). Infections are most found in warmer tropical climates and occur most often because of poor personal hygiene, poverty and ignorance; (Asaolu *et al.*, 2015; Raj&Co, 2015). Ascariasis affects an estimated 1 billion people worldwide and about half of the population is in tropical and subtropical areas, which causes an estimated 20,000 deaths each year (USAID, 2015b). According to Asaolu *et al.* (2015), it is the largest the largest nematode inhabiting the human alimentary tract and is usually found in the jejunum small intestine.

School-age children are particularly at risk for parasitic roundworm infections. The parasitic roundworms consume nutrients (nourishing materials) from the children, which can contribute to malnutrition, intestinal blockage and impaired growth (USAID, 2015b) Children suffering from malnutrition are infected more often than adults, with the most common age group 5 to 9 years old. Infection often occur in children by playing in contaminated soil, but eating uncooked food grown in contaminated soil or irrigated with inadequately treated wastewater is another avenue of infection (USAID, 2015; Raj 2015). Crowded living condition combined with a lack of access to health care, low levels of education, lack of clean water supply are other factors that can contribute to the infection (NIH, 2015).

2.14 Geographical Distribution of Round Worms

According to NIH (2015), infection by *ascariasis* is common in regions like Africa, Americas, E. Mediterranean, South-East Asia and Western pacific.

2.15 Lifecycle of Roundworms

Ascariasis lumbricoides is one of the most common and most prevalent parasites infecting humans in the world (Asaolu *et al.*, 2015). *A.lumbricoides* have a direct life cycle. The female release eggs which are passed with the host faeces. In addition, the eggs are brownish in colour, round to oval in shape and measures 45 to 75µm by 35 to 50 µm containing a developing embryo. Under a conducive climatic condition of temperature (25-30ºC), high humidity and sufficient amount of oxygen, fertilized eggs moult once and embryonate in 15 to 35 days to become infective.

The infective egg contains a second stage larva, coiled within the eggshell. Infection occurs when the infective eggs are ingested with contaminated food and water. The eggs hatch into larvae in the jejunum a few hours after being swallowed. Subsequently, the larvae penetrate the intestinal mucosa, move through the portal vessels and lymphatic system into the liver from where they are carried through the heart into the lungs. Subsequently, they penetrate the capillary walls and enter into the lung alveoli. After about 10 days in the lungs they move up the bronchi and trachea to the pharynx and are then swallowed down the oesophagus. This migratory phase lasts for about two weeks during which the larvae undergo two additional moults. On arrival at the small intestine, the fourth moult occurs and the larvae form immature adult worms. The worms mature and copulation takes place between adult male and female worms (Asaolu *et al.*, 2015). After approximately 2 to 3months, gravid females begins to multiply to produce ova which when excreted, complete the cycle.

Adult worms survive for one to two years in the human host during which time each female worm produces about 200,000 eggs per day. Diagnosis is by examining the host faeces for Ascaris eggs or adult worms. The fertilised egg of *A. lumbricoides* is the most resistant of all soil transmitted helminth eggs and can remain viable in the environment for many years.

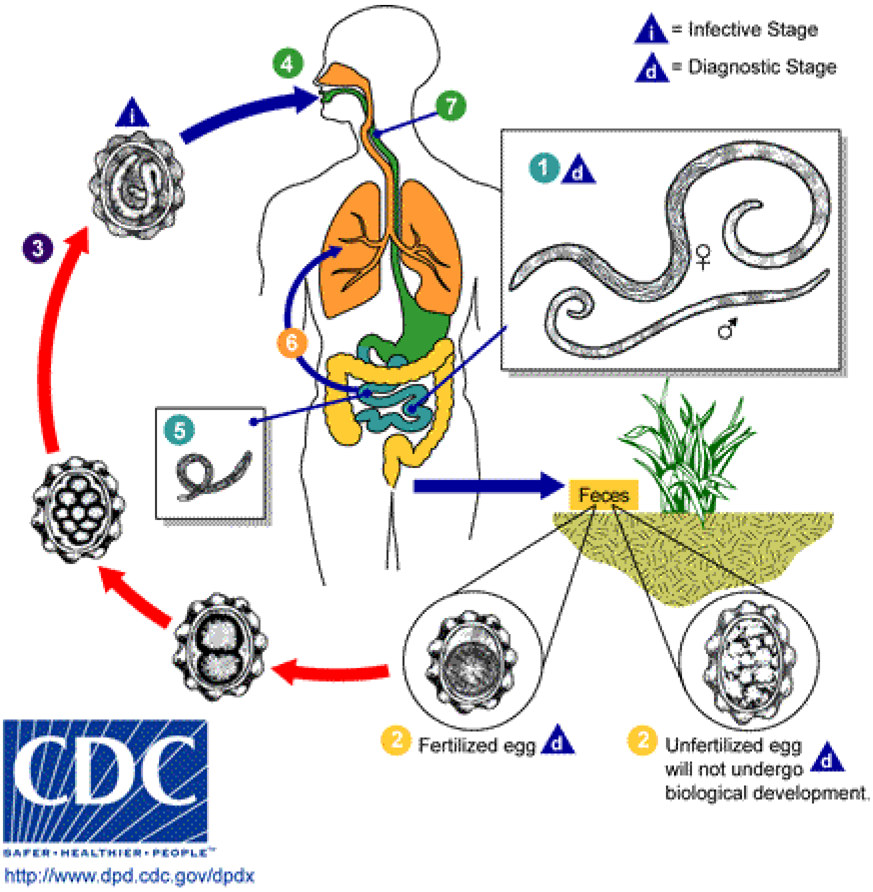

Figure 2.4: The life cycle of *Ascaris lumbricoides*.

2.16 Clinical Manifestation and Pathogenicity

Most infection with *A. lumbricoides* are asymptomatic. However, the clinical effects of heavier infections includes a wide range of manifestation with symptoms that are associated with the migration of juvenile or adult worms in infected organs (USAID, 2015b). Symptoms relates either to the larval migration stage or to the adult worm intestinal stage.

The symptoms and complications of infection include:

2.16.1 Pulmonary and Hypersensitivity Manifestation

Transient respiratory symptoms can occur in sensitized hosts during the stage of larval migration through the lungs. Symptoms associated with the pneumonitis known as Loffler's syndrome, tend to occur 1 to 2 weeks after ingestion of the eggs. The severity of symptoms tends to correlate with larval burden, but pulmonary symptoms are also less common in countries with continuous transmission of *A.lumbricoides*. Urticarial and other symptoms related to hypersensitivity usually occur toward the end of the period of migration through the lungs.

2.16.2 Intestinal Symptoms

Heavy infections with *Ascaris* may to result abdominal discomfort, anorexia, nausea and diarrhea. However, it has not been confirmed whether or not these nonspecific symptoms can truly be attributed to *ascariasis*. With relatively heavy infections, impaired absorption of dietary proteins, lactose and vitamin A has been noted, and steatorrhea may occur (Victoria State Government, 2015).

2.16.3 Intestinal Obstruction

A mass of worms can obstruct the bowel lumen in heavy *ascaris* infection, leading to acute intestinal obstruction. The obstruction occurs most commonly at the ileocecal valve. Symptoms include colicky abdominal pain, vomiting and constipation. Vomitus may contain worms. Approximately 85 percent of obstructions occur in children between the ages of one and five years. The overall incidence of obstruction is approximately 1 in 500 children. In endemic areas, it is estimated that between 5 to 35percent of all bowel obstruction are due to *ascariasis. Ascariasis* is said to be one of the most common cause of acute abdominal surgical emergencies in certain countries including South Africa and Myanmar (Victoria State Government, 2015)

2.16.4 Hepatobiliary and Pancreatic Symptoms

Symptoms related to the migration of adult worms into the biliary tree can cause abdominal pain, biliary colic, ascending cholangitis, obstructive jaundice, or bile duct perforation with peritonitis. Also, hepatic abscesses can result. The pancreatic duct may also be obstructed, leading to pancreatitis, and the appendix resulting in appendicitis. Occasionally, migrating adult worms emerge from the mouth, nose, lacrimal ducts, umbilicus or inguinal canal. High fever, diarrhea, spicy foods, anesthesia and other stresses have all been associated with an increase likelihood of worm migration.

Pathophysiologic mechanisms include: direct tissue damage, immunologic response of the host to infection with (larvae, eggs or adult worms), and obstruction of the lumen of the gastrointestinal tract by an aggregation of worms and nutritional sequel of infection (Victoria State Government, 2015).

2.17 Whipworms (Trichuris Trichiura)

Trichuris trichiura (T. trichiura), a whipworm, is the third most common nematode worldwide after Ascaris and hookworm (Tokmak et al., 2006; Akram 2009). It was *first* described in 1761 by Roederer. According to Akram (2009), the worm looks like a whip with a thick posterior end, and a long, thin anterior end. Adult whipworm is about 5 cm. long and reside in the gut where they intertwine their heads in the lining of the large intestine. It is a parasitic worm that infects 500 million humans in the tropical countries (Parasite in humans 2015; Akram 2009).In addition to prevalence, some parts of Asia rates are as high as 50 to 80% (Akram, 2009). It is a tropical disease of children 5 to 15 years. Whipworm infection is prevalent in countries with poor sanitation, and requires hot and humid environments to develop outside the host in the soil. Akram (2009) stated that "sanitation is the key in predicting whether or not a particular area is endemic, areas without sanitary systems to separate faeces and food will have more *T. trichiura* infection". Whipworm infection usually causes no clinical symptoms, although a severe infection can cause abdominal pain, mucous stools, diarrhea, constipation, painful urination, weight loss, and anemia (Tokmak et al., 2006; Akram 2009). Akram (2009) stated that heavy infection in children can cause nutritional deficiencies. Diagnosis is made by identifying *T. trichiura* eggs in stool specimen. However, the diagnosis of parasite infections by stool examination may be difficult in cases of infection only with a few male parasites

2.18 Geographical Distribution of Whipworms

Trichuriasis is a tropical disease and is prevalent in countries with poor sanitation. It can be seen in Africa, Asia, Europe, North and South America.

2.19 Life Cycle of Whipworms

Whipworm eggs are passed in the stool of an infected person. When the egg land on the soil, they develop into a two-cell stage, an advanced cleavage stage and then develop into embryos. The eggs become infective in 15 to 30 days. When the egg is swallowed due to eating of contaminated unwashed and uncooked vegetables, rice or beans, they hatch in the small intestine and move into its wall, where the larvae develop. When they reach adulthood, the thinner end burrows into the lumen, where it mates with nearby worms. The female begins to lay their eggs 60 to 70 days after infection and shed between 3,000 and 20,000 eggs per day.

Adults can live about 1 to 3 years and females can grow to 50 mm (2 inches) long (USAID, 2015c).

Small amounts of whipworms might not cause any symptoms. But if there are hundreds of worms, then they might cause bloody diarrhea and anemia due to severe vitamin and iron loss. The worms leave open wounds which cause inflammation of the intestinal wall. In some cases it may also develop rectal prolapse.

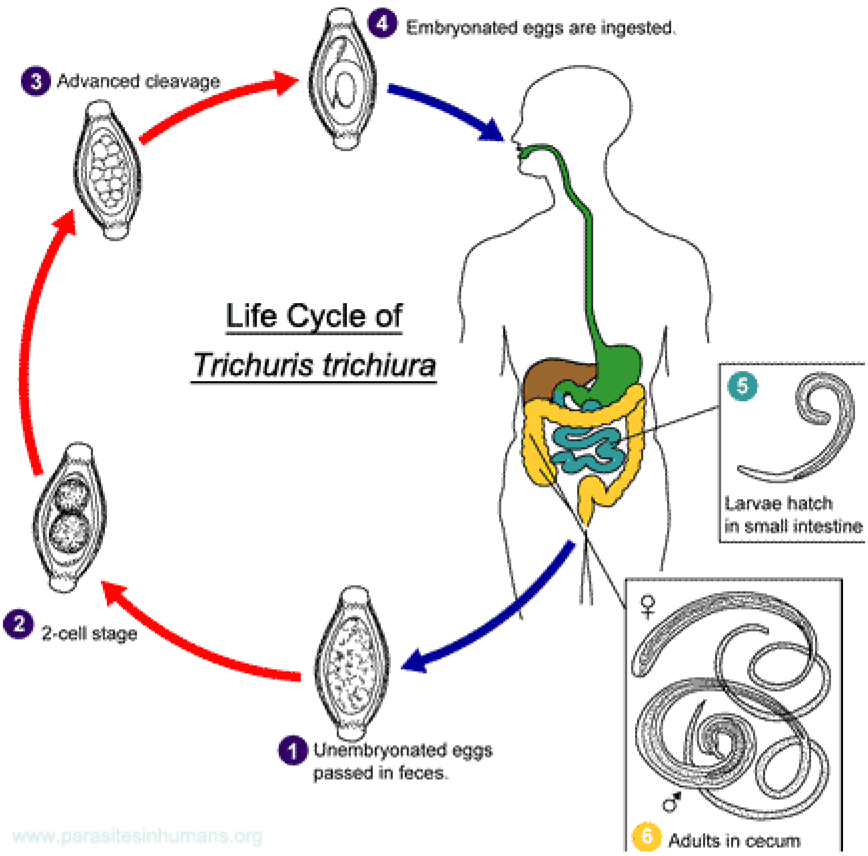

Figure 2.5: Life cycle of *Trichuris trichiura* (**Source: USAID, 2015c**).

2.20 Pathogenicity and Clinical Features

Infection is spread through the fecal-oral route. When eggs are ingested, it initiates infection. Eggs hatch in the duodenum, where the larvae invade and mature in the mucosa before migrating to the large intestine. Adult whip like worms embed their heads into the superficial mucosa of the colon and cecum. The life cycle is completed in about 3 months. Infection with *T.trichiura* is characterized by the invasion of the colonic mucosa by the adult Trichuris and the production of minor inflammatory changes at the sites of localization. The presence of adult worm in the mucous membrane irritate the nerves, causing diffuse colitis and diarrhea cramps. During heavy infections, dysentery and rectal tenesmus occur due to the attachment of the worm to the mucosa of the rectum. Clinical manifestation are determined mostly by the burden of the worm.

- Worms less than ten are asymptomatic.
- Heavier infections (massive infantile trichuriasis) are characterized by chronic profuse mucus and bloody diarrhea with abdominal pains and edematous prolapsed rectum.
- The infection may result in malnutrition, weight loss and anaemia and sometimes death.
- Finger clubbing (swelling of the nails and the area around the nails) is the best clinical predicator of the intensity of infection (Akram, 2009; USAID, 2015).

2.21 Schistosomiasis (Bilharzia)

Theodor Bilharz described a parasitic infection (bilharzia) in 1851 which was later termed

Schistosomiasis and is also known as snail fever. Schistosomiasis is an acute and chronic parasitic disease caused by blood flukes trematode worms (schistosomes) that reside in the abdominal veins of their vertebrate definitive hosts (WHO, 2015). It may affect the urinary tract or the intestines. There are different species of schistosomiasis which include; *Schistosoma haematobium*, *S.mansoni*, *S. intercalatum*, *S. japonicum*, and *S. makongi*. As at 2002, 200 million people in 74 countries had this disease; 120 million of them have symptoms, and 20 million have severe illness (Ross *et al.*, 2002).

According to WHO (2015), at least 261 million people required preventive treatment in 2013 and more than 40 million people were treated for schistosomiasis. It is estimated that at least 90% of those requiring treatment live in Africa. According to Ross *et al.* (2002), the 54 world health assembly set up a goal of treating annually at least 75 percent of school-age children that are infected with schistosomes and soil transmitted helminths. However, despite major advances in control and decrease in morbidity and mortality, the infection continues to spread to new geographic areas.

The disease transmission occurs when people suffering from schistosomiasis contaminate fresh water source with their excreta containing the parasite eggs which hatch in water. There are two major forms of schistosomiasis –intestinal and urogenital which is caused by five main species of blood fluke.

2.22 Geographical Distribution and Parasite Species of *Schistosomiasis*

Schistosomiasis is prevalent in tropical and subtropical areas, mostly in poor communities lacking access to safe drinking water and adequate sanitation. (Table 2.1)

Table 2.1: Parasite species and geographical distribution of *schistosomiasis*

	Species	**Geographical distribution**
Intestinal schistosomiasis	*Schistosoma mansoni*	Africa, the Middle East, the Caribbean, Brazil, Venezuela and Suriname
	Schistosoma japonicum	China, Indonesia, the Philippines
	Schistosoma mekongi	Several districts of Cambodia and the Lao People's Democratic Republic
	Schistosoma guineensis and related S. intercalatum	Rain forest area of central Africa
Urogenital schistosomiasis	*Schistosoma haematobium*	Africa, the Middle East, Corsica (France)

2.23 Life cycle of Schistosomiasis

Schistosomes have a typical trematode vertebrate-invertebrate lifecycle, with humans being the definitive host. The most common way of getting schistosomiasis in developing countries is by wading or swimming in lakes, ponds and other bodies of water that are infested with the snails (usually of the genera *Biomphalaria*, *Bulinus*, or *Oncomelania*) that are the natural reservoirs of the *Schistosoma* pathogen.

The eggs are released with faeces or urine. Under optimum condition, the eggs hatch and release miracidia which swim and penetrate specific snail intermediate host. The stage in the snail includes two generations of sporocyst and the production of cercariae. Upon release from the snail, the infective cercariae swim, penetrate the skin of the human host and shed their forked tail, becoming schistosomulae. The schistosomulae migrate through several tissues and stages to their residence in the vein.

Adult worms in human reside in the mesenteric venules in various locations which at times seem to be specific for each species. S.Japonicum is more frequently found in the superior mesenteric veins draining the small intestine and S. mansoni occurs more often in the superior mesenteric veins draining the large intestine. However both specie can occupy either location, and they are capable of moving between sites, so it is not possible to state unequivocally that one species only occur in one location. *S. japonicum* may produce up to 3,000 eggs per day. *S.haematobium* most often occur in the venous plexus of bladder, but it can also be found in the rectal venules. The female (size 7 to 20 mm; males slightly smaller) deposite eggs in the small venules of the portal and perivesical systems. The eggs are moved progressively toward the lumen of the intestine (*S. mansoni* and *S. japonicum*) and of the bladder and ureters (*S. haematobium*), and are eliminated with faeces or urine respectively.

Pathology of *S. mansoni* and *S. japonicum* schistosomiasis includes: katayama fever, hepatic perisinusoidal egg granulomas, symmer’s pipe stem periportal fibrosis, portal hypertension and occasional embolic egg granulomas in brain or spinal cord. Pathology of *S. haematobium* schistosomiasis includes: hematuria, scarring, calcification, squamous cell carcinoma and occasional embolic egg granulomas in brain or spinal cord. Human contact with water is thus necessary for infection by schistosomes. Various animals such as dogs, cats, rodent, pigs, horse and goats serve as reservoirs for *S. japonicum* and dogs for *mekongi.*

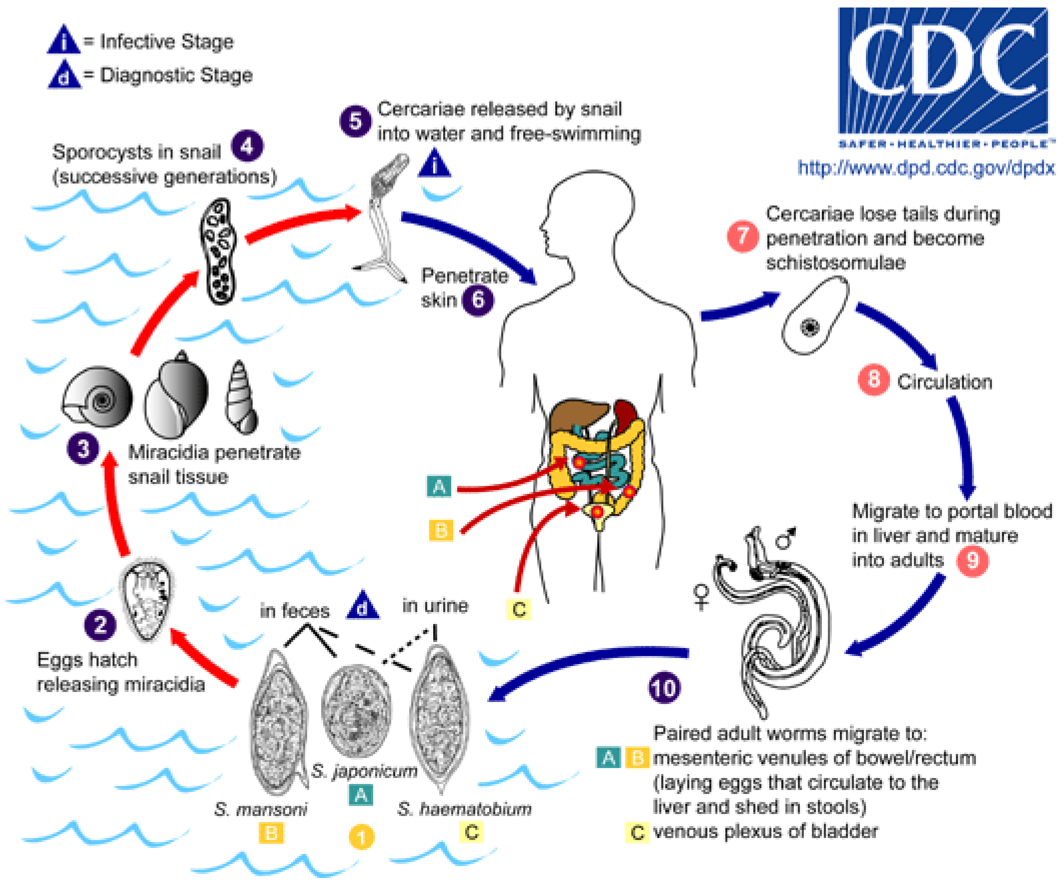

Figure 2.6: Lifecycle of schistomiasis

2.24 Clinical Features and Pathophysiology

Schistosomiasis infection can arise with immediate, acute and chronic manifestation.

2.24.1 Immediate Manifestation

According to WHO (2015), symptoms of schistosomes are usually caused by the body's reaction to the worm's egg. The cercarial (free-swimming larvae) from the parasite may cause maculopapular eruption at the site of penetration and skin reactions may develop within few hours after infection in migrants or tourists. A rash may appear up to one week later. The dermatitis is similar to, swimmer's itch but less severe.

2.24.2 Acute Schistosomiasis

Acute schistosomiasis (Katayama fever) is common in areas of high transmission rates. Symptoms are mediated by the immune complex and most cases begin with the deposition of an egg into the host tissue. The common symptoms include fever, headache, generalized myalgias, and bloody diarrhea. Respiratory symptoms have been reported in up to 70 percent of persons infected with *S. mansoni* but less frequently in those infected with *S. haematobium*. Aseptic meningitis is rare. There may be radiologic evidence of interstitial pneumonitis.

2.24.3 Chronic Schistosomiasis

Gastrointestinal and Liver Disease

Schistosomiasis results from the host's immune response to schistosome eggs and the granulomatous reaction evoked by the antigens they secrete. The intensity and duration of infection determine the amount of antigen released and the severity of chronic fibro-obstructive disease. The granulomas destroy the ova but result in fibrotic deposition in host tissues.

Most granulomas develop at the sites of maximal accumulation of eggs — the intestine and the liver (in the case of *S. mansoni* and *S. japonicum*) and the genitourinary tract (in the case of *S. haematobium*). However, periovular granulomas have been found in many types of tissue, including the skin, lung, brain, adrenal glands, and skeletal muscle. The inflammatory response may assist the migration of eggs into the lumen of the gut or urinary tract.

Eggs retained in the gut wall induce inflammation, hyperplasia, ulceration, micro abscess formation, and polyposis. Colicky hypo gastric pain or pain in the left iliac fossa is frequent. Diarrhea is common and may alternate with constipation. Diarrhea is particularly common in children, and its presence correlates strongly with schistosomiasis. Occult (or sometimes visible) blood in the feces is usual. Severe chronic intestinal disease may result in colonic or rectal stenosis. Inflammatory masses in the colon may even mimic cancer.

i. Infections in Travelers and Immigrants

Acute schistosomiasis is a problem for travelers, particularly those who visit Africa. Swimming in Lake Malawi, Lake Kariba, and the Zambezi River has been particularly problematic. Haematuria and diarrhea are common early symptoms. Although the average life span of a schistosome is five years, adult worms may live for decades. Immigrants from areas where schistosoma species are endemic can remain infected for 30 to 40 years. Urinary schistosomiasis can be misdiagnosed as bladder cancer or chronic prostatitis. Intestinal disease may be found in patients who are present with anemia and chronic gastrointestinal bleeding (Ross *et al.*, 2002).

ii. Genitourinary Disease

Urinary tract disease is a specific trait of infection with *S. haematobium*. Haematuria (blood in urine) is the first sign of established disease, appearing 10 to 12 weeks after infection. Chronic disease is caused by granulomatous inflammation that occurs in response to the deposition of eggs in tissue. Late manifestations also include proteinuria, fibrosis of the bladder, and obstruction of the ureter, renal colic, and renal failure. Secondary bacterial infection is frequent. Structural abnormalities of the urinary tract can occur in children.

The association between *S. haematobium* infection and squamous cell carcinoma of the bladder has been the subject of intense research and debate. In Egypt, Squamous-cell carcinoma of the bladder accounts for 18 to 28 percent of all cancers, with an incidence of 10.8 per 100,000 population. Male smokers appear to be at particular risk. The association appears to be consistent in many sub-Saharan nations as well. However, large autopsy series have failed to demonstrate a consistent association with a particular type of tumor, and squamous cell carcinoma of the bladder is prevalent in some countries that have a very low prevalence of *S. haematobium* infection or none at all.

S. haematobium infection causes genital disease in approximately one third of infected women. Vaginal bleeding, pain during intercourse and nodule in the vulva. Vulva schistosomiasis may also facilitate the transmission of human immunodeficiency virus (HIV) (Ross *et al.*, 2002).

In men, urogenital schistosomiasis can induce pathology of the seminal vesicles, prostate and other organs. This disease may also have other long-term irreversible consequences, including infertility.

iii. Neurologic and Other Manifestation

Symptoms do not develop in all persons with egg deposits in the central nervous system. The mechanism of egg deposition is unknown. The presence of egg deposits may reflect either aberrant migration of worms or the embolization of eggs from a remote location. Central nervous system schistosomiasis has been described in soldiers and aid workers serving in areas where schistosomiasis is endemic and in tourists who have had relatively limited exposure to such areas. Focal or generalized tonic–clonic epilepsy is a typical presentation for

S. japonicum infection with central nervous system involvement. Focal neurologic deficits may also occur. Among groups of Chinese adults hospitalized with schistosomiasis, up to 4.3 percent have central nervous system disease. The prevalence of epilepsy in communities where infections have occurred has been estimated at 1 to 4 percent, eight times as high as at base line. Transverse myelitis is the most common neurologic manifestation of S. mansoni or S. haematobium infection.

Schistosome infection during childhood causes substantial growth retardation and anemia, stunting and in some cases death. Successful chemotherapy leads to substantial but incomplete catchup growth and improvement in hemoglobin levels. Infected children may also have cognitive impairment and memory deficits. Schistosome infection appears to have adverse effects on both maternal health and the fetus. (Ross et al., 2002; WHO, 2015).

.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The study was conducted in primary schools in Sabongari Local Government Area, Kaduna state, with latitude 11.0700°N 07.4400°E and longitude 11.1167°N 07.7333°E. It is bordered to the south by Tudun Wada bridge, to the east by Zaria dam, to the west by Giwa Local Government Area and to the north by Kaduna-Kano express way. Sabon Gari Local Government Area (LGA) with an area of 70206 km2 and a projection of 286,871 people (Yero, 2015), is one of the twenty-three LGAs of Kaduna State (Olufunmilola, 2011). The inhabitants of the area are mainly Hausa, Fulani, Bajju, Yoruba, Igbo and other tribes (Abubakar *et al.*, 2015).

Sabon Gari local government area comprises of eleven wards; these are Angwan Gabas, Angwan Basawa, Angwan Auta Jushi, Angwan Jamaa, Angwan Dogarawa, Angwan Hanwa, Angwan Chikaji, Angwan Samaru, Angwan Bomo, Angwan Zabi and Muchia wards (Youngu *et al.*, 2012).

Figure 3.1: Map of Kaduna state (extracted from http://www.kadunastate.gov.ng).

.

3.2 Inclusion Criteria

All apparently healthy primary school children between the age of 7 to 15years attending primary school in Sabongari LGA Kaduna state and also not physical challenged.

3.2.1 Exclusion Criteria

Children attending primary schools in, Sabongari local government who are not within the range of 7 to 15 years, and are mentally and physically challenged.

3.3 Ethical Approval

Ethical approval was obtained from the Ministry of Health, Kaduna State, in accordance with the Helsinki declaration. Ethical approval was submitted to the principal of the selected primary school for permission to carry out the study.

3.4 Informed Consent

Prior to the enrollment of the children, permission was sought and obtained from the head-teacher of the respective schools and parents and/ or guardian of the children.

3.5 Sampling Techniques

The research covered 5 wards from Sabongari Local government. One private and one public school was chosen from each ward adding up to 10 schools. Stratified random sampling Technique was then carried out within the various primary schools.

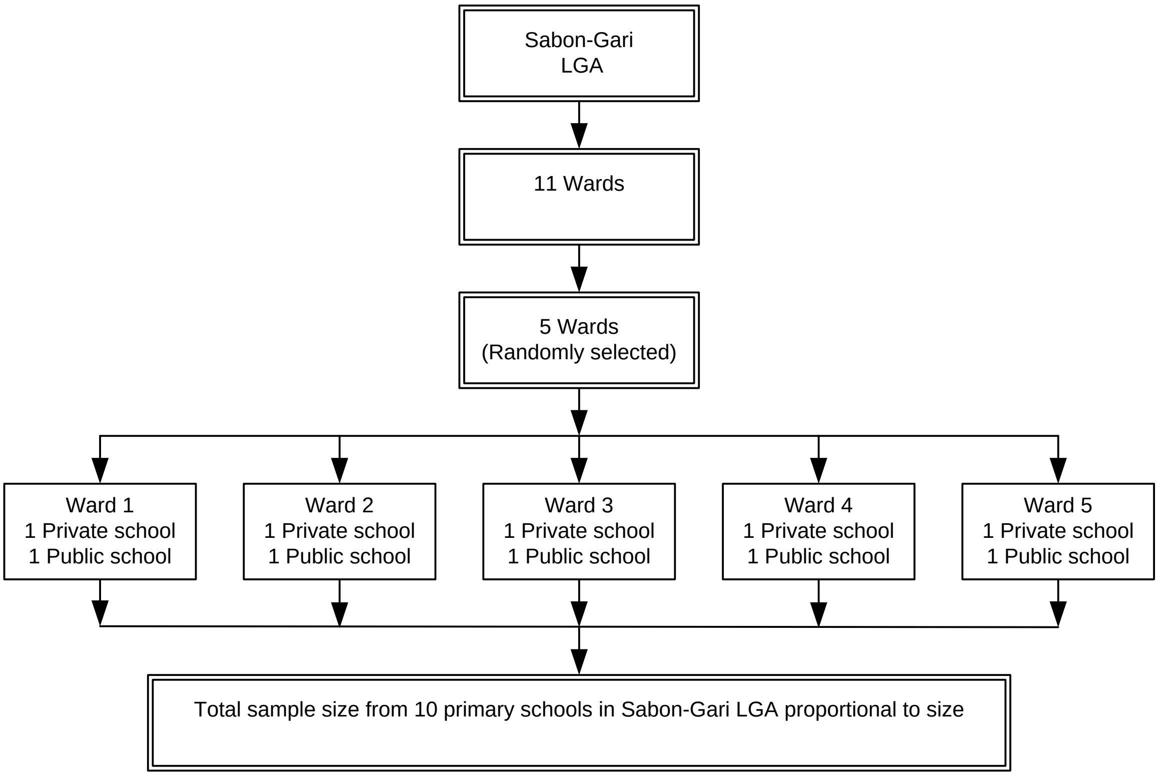

Figure 3.2: Sampling procedure for selection of the children.

3.6 Study Design

A descriptive, cross-sectional design was used for the study in order to determine the association between intestinal parasitic infection, socio- demographic factors and BMI in primary school children in Sabongari LGA. Questionnaire was used to gather information from the pupils. Information on demography, and hygiene practices as well as the type of pet they keep at home was gathered.

3.7 Sample Size

The sample size for this study was obtained using the formula:

$$n = \left(z^2 pq \Big/ d^2 \right)$$

(Tadasse, 2005).

Where:

n = the desired sample size

z = the standard normal deviation, usually set at $1.96 \approx 2.0$

p = the proportion in the target population having a particular trait or prevalence of the intestinal parasite (29%) (Odoba *et al*., 2011).

$q = 1.0 - p$

d = degree of accuracy desired, usually set at 0.05

n = (1.96^2 x 0.29 x 0.71/ 0.05^2)

Therefore, n=316

N= (5% x n) + 316

N= 5% x 316

So finally N is giving thus

N = 15.8+ 316

The total population size is 332

3.8 Collection of Faecal Sample

Each enrolled child was asked to bring a fresh faecal sample in clean, dry and labelled screw cap plastic containers. The pupils were adequately instructed on how to get a little portion of their stool into the bottles. The bottle was collected and the faecal sample was preserved with formalin and taken to the Ahmadu Bello University laboratory for analysis.

3.9 Anthropometric Measurements

Anthropometric measurements were taken for all the children. A height chart was used to measure heights of all the children. The children were measured without shoes on a flat floor. Heads were erect and hands were hung at their side in a natural manner. The measurement was taken to the nearest 0.1cm. The weights of all the children were taken using a digital weighing scale. The weight was taken and the measurement was taken to the nearest 0.1kg as described in the Food and Nutrition Technical Assistance Guide (Cogill, 2003).

3.10 Demographic Characteristics

Based on the objectives of the study, a semi-structured questionnaire was administered on the study group. It sought information of the children and their parents, which include, age, sex, educational level, occupation, income, hygiene practices and anthropometry measurement.

3.11 Calculation of Body Mass Index (BMI) for Age

The BMI for age was used to evaluate the nutritional status of the subject.

The BMI for age is the most appropriate variable for determining nutritional status for children above 5years and adolescence (Cole, 2007).

BMI = Weight (kg)/Height2 (m2)

3.12 Dietary intake records

The dietary intake was assessed using an un-quantified Food Frequency Questionnaire (appendix).

3.13 Laboratory Examination of Faecal Sample

For each of the stool specimen, a formol ether concentration techniques (Cheesbrough, 2000) was used as follows; one gram of the stool sample was emulsified in 4ml of 10% formol saline contained in a bottle. Additional 4ml of 10% formol ether was added and homogenized. The emulsified stool was sieved and collected in a centrifuged tube. 2mls of diethyl ether was added. The tube was stopped and mixed thoroughly for 1 minute. The stopper was loosened and the tube was centrifuged at 1000 revolutions for 1 minute. After centrifugation, the faecal debrils was loosened and was decanted along with the ether and formol saline leaving the sediment at the bottom. The sediment was mixed and placed on a clean grease free slide and covered with a coverslip and examined microscopically using x10 and x40 objectives.

3.14 Statistical Analysis

Data obtained in this study were presented in tables, interpreted in percentage and analyzed with respect to age, sex, sanitation habits, types of toilet system, source of drinking water, possession of domestic pets etc. Comparisons were made between prevalence of intestinal parasites and sex and age groups of children using Chi-square test. Odd ratio was calculated and used to express the level of association between the prevalence of intestinal parasitic infection and the nutritional status of the children.

CHAPTER FOUR

RESULTS

4.1 Demographic Characteristics of Primary School Children in Sabon Gari LGA, Kaduna State

Demographic characteristics was collected from 305 children from primary school. A total of 202 pupils were from public schools while 103 were from private schools. The result shown in table 4.1 reveals that the age range of the children in both public and private school was between 7 yrs. and 15 yrs. In the public school, majority of the children (59.9%) were between the ages of 13- 15 years, (38.1%) were between 10-12 years, (2.0%) between the 7-9years while that of private school showed that majority (48.5%) were between 7-9 years, (27.2%) between 10-12 years, (24.3%) between 13-15 years. A total of 202 children were selected from public schools, 71 (35.6%) were boys and 131 (63.9%) were girls while in private schools, the total number was 103, 42 (40.8) were boys and 61 (59.2%) were girls. 192(95%) were Muslims and 10(5.0%) were Christians in public school while 50(48.5%) were Muslims and 53(51.5%) were Christians.

The educational qualification of the mothers whose children attend public school showed that 90(44.6%) had only primary education, 51(25.2%) had secondary education, 13(6.4%) had tertiary education and 48(23.8%) had no formal education.

Those in private school showed that 25(24.3%) of the mothers had primary education, 50(48.5%) had secondary education, 12(11.7%) had tertiary education and 16(15.5%) had no formal education.

Occupation wise, majority of the respondent 102(50.5%) whose children attend public school were traders, followed by 35(17.35%) were civil servant, 31(15.3%) were farmers

Table.4.1: Socio-demographic Characteristics of Primary School Children in Sabon Gari LGA

Characteristics	**Public Schools n= 202**		**Private Schools n=103**		**Total n=305**	
Age (Years)	**Frequency**	**%**	**frequency**	**%**	**frequency**	**%**
7-9	4	2.0	50	48.5	54	17.7
10-12	77	38.1	28	27.2	105	34.4
13-15	121	59.9	25	24.3	146	47.9
Sex						
Male	71	35.1	42	40.8	113	37.0
Female	131	64.9	61	59.2	192	63.0
Religion						
Islam	192	95.0	50	48.5	242	79.3
Christianity	10	5.0	53	51.5	63	20.7
Mothers level of Education						
Primary	90	44.6	25	24.3	115	37.7
Secondary	51	25.2	50	48.5	101	33.1
Tertiary	13	6.4	12	11.7	25	8.2
No formal Edu.	48	23.8	16	15.5	64	21.0
Mothers Occupation						
Farmer	31	15.3	14	13.6	45	14.7
Trader	102	50.5	53	51.5	155	50.8
Civil servant	35	17.3	14	13.6	49	16.1
Housewives	34	16.8	22	21.4	56	18.4

and 34(16.8%) were housewives. In mother's whose children attend private schools, majority of the respondent 53(51.5%) were also traders, followed by 22(21.4%) housewives, 14(13.6%) were farmers and 14(13.6%) civil servants**.**

4.1.1 Sanitation and Hygiene Practices

With regard to source of drinking water, Table 4.2, majority of pupils 111 (55.0%) from public school get their drinking water from the tap, followed by 88 (43.6%) from the well, and 3 (1.5%) from the stream. Tap was also the major source of drinking water 84 (81.6%) for those in private school, 15 (14.6%) from well and 4 (3.9%) from stream.

Regarding waste disposal system by those attending public school, pit toilet was mostly used 157 (77.2%), followed by 31 (15.3%) water closet and the least used was bush 14 (6.9%). Also pit toilet was the most used in private school 56 (54.4%) , followed by 46 (44.7%) that used water closet and bush 1 (1.0%) was also the least used.. Results from the type of floor used showed that 156 (77.2%) from the public schools use brick (cemented) floor, 36 (17.8%) use tiled floor and 10 (5.0%) use dirt (un-cemented). From the private schools, 62 (60.2%) use brick floor, 37(35.5%) use tiled floor, 4 (3.9%) use dirt (un-cemented floor). 114 (56.4%) respondent from public schools wash their hands regularly after using toilet, 8 (4.0%) do not wash their hands regularly and 80 (39.6%) do not wash their hand after using toilet while in private schools, 70 (68.0%) wash their hand after using toilet, 30 (29.1%) do not wash their hand regularly and 3 (2.9%) do not wash their hands at all.

Response from whether they wash their fruit and vegetables before eating showed that majority 121 (59.9%) of the respondent from public schools always wash their fruits before eating, 76 (37.6%) do not wash their fruit regularly while 5 (2.5%) respondent said they do not wash their fruits and vegetable at all. Also most of the respondent from private schools 70

(68.0%) wash their fruit and vegetables before eating, 31 (30.1%) do not wash their fruits regularly and 2 (1.9%) do not wash their fruits and vegetable at all.

Most of the respondent from the public schools 107 (52.5%) keep cats at home, 24 (19.3%) keep dogs, 71 (22.8%) do not keep any pet at home. Contrary to the public schools, most of

the respondent 51 (49.5%) from private schools do not keep any pet at home, 33(32.0%) keep cats at home, and 19 (18.4%) keep dogs at home. Most of the parents from public school 129 (63.9%) could not remember the last time they dewormed their children, 43 (21.3%) dewormed their children 1-3weeks ago, 27 (13.4%) dewormed 1-3months ago, 3 (1.5%) dewormed 4-6months ago. Response from parents whose children attend primary showed that majority 45 (43.7%) could not also remember the last time they dewormed their children, 35 (34.0%) dewormed 1-3months ago and 17 (16.5 %) dewormed 4-6months ago.

Table 4.2: Sanitation and hygiene practice of primary school children in Sabongari L.G.A

Characteristics	Public Schools N= 202 Frequency	%	Private Schools N=103 Frequency	%	Total N= 305 Frequency	%
Source of drinking water						
Well	88	43.6	15	14.6	103	33.8
Tap	111	55.0	84	81.6	195	63.9
Stream	3	1.5	4	3.9	7	2.3
Waste disposal system						
Pit toilet	157	77	56	54.4	213	69.8
Bush	14	6.9	1	1.0	15	5.0
Water closet	31	15.3	46	44.7	77	25.2
Type of floor						
Cemented floor (brick)	156	77.2	62	60.2	218	71.5
Tiles	36	17.8	37	35.5	73	23.9
Bare floor	10	5.0	4	3.9	14	4.6
Hand washing after toilet						
Yes	114	56.4	70	68.0	184	60.3
No	8	4.0	3	2.9	11	3.6
Not regularly	80	39.6	30	29.1	110	36.1
fruits and vegetable washing before eating						
Yes	121	59.9	70	68.0	191	62.6
No	5	2.5	2	1.9	7	2.3
Not regularly	76	37.6	31	30.1	107	35.1
Ownership of Pets						
Yes, Dog	24	19.3	19	18.4	43	14.1
Yes, Cat	107	52.5	33	32.0	140	45.9
No	71	22.8	51	49.5	122	40.0
Last time dewormed						
1-3 weeks ago	43	21.3	6	5.8	49	16.1
1-3 months ago	27	13.4	35	34.0	62	20.3
4-6 months ago	3	1.5	17	16.5	20	6.6
Can't remember	129	63.9	45	43.7	174	57.0

4.2 Nutritional Status Distribution of Children in Primary Schools, Sabon gari

The Body Mass Index (BMI) For Age of children in Sabon-gari Local Government was distributed into five (5) categories namely; Severe thinness, Thinness, Normal, Overweight and Obesity, according to the WHO reference standard for BMI for Age. The distribution of BMI for Age in children attending public and private primary schools showed that 241(79.0%) of the pupils were within the normal range and the girls attending public school had the highest frequency of (83.1%) and the lowest frequency recorded among boys in the private school (73.8%). Outside normal BMI for Age, overweight had the highest frequency (8.5%) which was reflected more in girls in the private school (13.1%), and less in boys in the private school (4.2%). Severe thinness and obese were low with frequencies less than (2.0%), moderate thinness was 11.1%. (Table 4.3).

4.2.1 Nutritional Status of Primary School Children within Age group

The nutritional status of the children as regards to their age showed that most of the children between the ages of 7-9, 10-12 and 13-15 years from both public and private schools were within normal range. However, severe thinness and thinness were high 8(10.4%) in children within 10-12 years from public schools than private schools 2(7.1%). The number of overweight children 9(11.7%) was also high in public school than private school 2(7.1%). However, they were more thin children in private school than public school across all age groups. (Appendix).

Table 4.3: Nutritional Status (BMI for Age) of School Children in Sabongari L.G.A., Kaduna State

Nutritional Status	Public Schools Total N= 202		Private Schools Total N=103		All Schools Total N=305	
	male n=71 %	female n=131 %	male n=42 %	female n=61 %	male n=113 %	female n=192 %
Severe Thinness	1 (1.4)	0 (0.0)	2 (4.8)	0 (0.0)	3 (2.7)	0 (0.0)
Thinness	8 (11.3)	18 (13.7)	4 (9.5)	4 (6.6)	12 (10.6)	22 (11.0)
Normal	59 (83.1)	102 (77.9)	31 (73.8)	49 (80.3)	90(79.6)	151 (78.6)
Overweight	3 (4.2)	11 (8.4)	4 (9.5)	8 (13.1)	7 (6.2)	19 (9.9)
Obese	0 (0.0)	0 (0.0)	1 (2.4)	0 (0.0)	1 (0.9)	0 (0.0)

BMI- Body Mass Index. Distribution was based on WHO Reference for BMI for Age

4.3 Dietary Patterns of Primary School Children in Sabongari LGA

A total of 280 children completed the Food Frequency Questionnaire. A total of 94(33.57%) attending private schools while 186 (66.43%) attending public primary schools. An un-quantified Food frequency Questionnaire (FFQ) was used to collect dietary information from the subjects. The frequency of eating different type of food was categorized into four groups (Never or less than once a month, 1 to 3 times a week, 4 to 6 times a week, 7 or more times a week). Table 4.4 shows the dietary pattern of 280 children in private and public primary school in Sabongari Local Government Area.

The various food types included food items from animal (dairy/dairy products, meat from all sources and eggs), food items from plant sources (legumes, cereals/tubers/pasta/bread, citrus fruits/tomatoes, and green leafy vegetables/carrots), high energy foods/drinks (cakes/doughnuts/buns/ puff, sugar sweetened drinks) and beverages (tea/ coffee).

4.3.1 Differences in Dietary Patterns between Private and Public Primary Schools

A Chi- square test was carried out between the Private and Public Schools to determine the difference in their pattern of consumption of the various foods. Results showed a significant difference in the frequency of intake of four food types. There was a significant difference (0.010) observed when the frequency of intake of dairy/dairy products of the public and private schools were compared. The public schools showed higher frequency of intake (15.1%) from “7 or more times” than the private primary school (11.7%). There was also a significant difference (0.000) in the frequency of intake of legumes where the public schools showed higher intake (36.6%) from “7 or more times” than the private schools that had a frequency of (14.9 %.).

Also, significant differences of (0.017) and (0.000) were observed in the frequency of intake of citrus drinks and sugar sweetened drinks with public schools having the higher frequencies (28.0, 15.6%) than private schools (12.8%, 5.3%) from 7 or more times (Table 4.4).

Table 4.4: Dietary Pattern of School Children in Sabongari L.G.A. of Kaduna State

	% of children consuming								
	1-3 times per week		**4-6 times per week**		**7or more times per week**		**Never/< once a month**		**P-value**
Food Groups	**Public (n=186)**	**Private (n=94)**	**Public (n=186)**	**Private (n=94)**	**Public (n=186)**	**Private (n=94)**	**Public (n=186)**	**Private (n=94)**	
Dairy/dairy products	45.2	56.4	15.1	22.3	15.1	11.7	24.1	9.6	**0.010***
Meat/fish and their products.	33.9	38.3	26.9	23.4	19.4	28.7	19.9	9.6	0.068
Eggs	36.6	45.7	24.2	25.5	19.4	7.4	19.9	21.3	0.066
Legumes	34.4	34.0	17.7	33.0	36.6	14.9	11.3	18.1	**0.000***
Cereals/tubers and pasta.	29.0	30.9	28.5	31.9	29.0	20.2	13.4	17.0	0.436
Citrus fruits, tomatoes.	30.1	40.4	28.5	26.6	28.0	12.8	13.4	20.2	**0.017***
Green leafy vegetables and carrots.	33.9	22.3	26.9	41.5	29.0	28.7	10.2	7.4	0.058
Cakes, doughnuts, buns.	29.0	37.2	28.0	23.4	19.9	11.7	23.1	27.7	0.189
Sugar, sweetened drinks.	28.5	54.3	24.7	26.6	15.6	5.3	31.2	13.8	**0.000***
Tea/coffee	31.2	29.8	26.9	34.0	28.0	20.2	14.0	16.0	0.427
Vitamin supplements.	23.1	36.2	22.6	19.1	21.5	18.1	32.8	26.6	0.148

4.4 Risk Factors of Intestinal Parasitic Infection

A summary of the responses of the pupils to the questionnaires and result of the statistical analysis showing the association between the risk factors and disease prevalence showed that odds ratio greater than 1 indicated an association between each of the factors and the prevalence of intestinal parasitic infection. (Table 4.5). Significant association were observed between intestinal parasitic infection and factors such as history of deworming (OR= 4.68, 95%CI=1.32-19.37), washing of hands after toilet (OR= 5.3, 95%CI=2.19-12.84) washing of fruits and vegetables before eating (OR= 3.57, 95% CI=1.58-8.04). There was no significant relationship between parasitic infection and some factors such as sources of water, keeping of pets at home and the types of toilets used at home (OR< 1) however, the prevalence of infection was more among those that used pit toilet (17.7%), got their water from well (22.2%) and those that kept cats at home (18.8%) and those who could not remember when their children were last dewormed (21.1%).

Table 4.5: Risk factors of Intestinal Parasitic Infection in Children from Sabon-gari LGA, Kaduna State.

Factors	No. of pupils Infected No. %	No. of Pupils not infected No. %	odds ratio	95% C.I	P-value
Source of drinking water					
Well	20(22.2)	70(77.8)	0.87	0.34 - 2.09	0.84
Tap	25(14.7)	145(85.3)	0.01	0.02 - 0.11	0.99
Stream	0	6(100)	-	-	-
Waste disposal system					
Pit toilet	33(17.7)	153(82.3)	0.87	0.13 - 5.53	0.88
Bush	2(15.4)	11(84.6)	0.96	0.33 – 2.77	0.94
Water closet	10(14.9)	57(85.1)	-	-	-
Hand washing after usingToilet					
Yes	12(7.6)	145(92.2)	2.10	1.56 - 2.80	0.00
No	8(80.0)	2(20.2)	5.30	2.19 -12.84	0.00
Not regularly	25(25.3)	74(74.7)	-	-	-

Washing of fruits and vegetable before eating					
Yes	16(9.7)	149(90.3)	0.00	0.01-0.19	0.99
No	0(0.0)	6(100)	3.57	1.58 -8.04	0.02
Not regularly	29(30.5)	66(69.5)	-	-	-
Ownership of Pets at home					
Yes, Dog	6(15.4)	33(84.6)	0.93	0.26 -3.25	0.91
Yes, Cat	22(18.8)	95(81.2)	0.39	0.10 -1.40	0.15
No	17(15.5)	93(84.5)	-	-	-
Last time you dewormed					
1-3 weeks ago	9(16.4)	46(83.6)	0.00	0.00- 0.06	0.99
1-3 months ago	5(11.1)	40(88.9)	3.74	0.75-18.6	0.10
4-6 months ago	0(0.0)	19(100)	4.68	1.13-19.37	0.03
Can’t remember	31(21.1)	116(78.9)	-	-	-

4.5 Prevalence of Intestinal Parasite among Primary School Children in Sabongari LGA.

The purpose of the research was to determine the prevalence intestinal parasitic infection in primary school children in Sabon-gari LGA. The result presented are the data for 266 children (178 Public and 88 Private schools). There were 109 males and 157 females from both schools. About (17.0%) of the students had parasitic infection. A total of nine intestinal parasites were detected; Roundworm (6.8%) had the highest prevalence and others include Schistosomia mansoni (3.0%), Hookworm (3.0%), *Entamoeba histolytica* (1.1%), *Entamoeba coli* (1.1%), *Giardia lamblia* (0.8%), *Strongyloides* (0.4%), *Hymenolepis nana* (0.4%) and *Trichuris* (0.4%). This is shown in table 4.6.

The prevalence of parasitic infection from this study as shown in table 4.6 is (17.0%) and the rate of infection was higher in Public school (13.2%) than Private school (3.8%) but the difference was insignificant ($p>0.05$).

The age specific prevalence of parasitic infection in both schools is shown in Appendix A5. The highest infection rate was seen in children between 10-12yrs (20.0%), followed by 13-15yrs (17.1%) and 7-9yrs (10.6%) but was not significant at ($p>0.05$). Section A6 of Appendix shows the relationship between intestinal parasitic infection and sex. More infection was observed in the girls (18.5%) than the boys (14.7%) however, the difference was not significant ($p> 0.05$).

4.6 Prevalence of Malnutrition in School Children.

Table 4.12 shows the prevalence of malnutrition in children from some selected schools in Sabon gari LGA. The prevalence of malnutrition was (20.9%) and the rate of malnutrition was more in girls (21.4%) than the boys (20.4%).

In terms of school, Private schools recorded the higher rate of malnutrition (23.0%) than Public schools (20.0%) however, it was not significant (p>0.05). This is shown in table 4.7

4.7 Relationship of Intestinal Parasite and Malnutrition

Table 4.8 shows that the relationship between intestinal parasitic infection and malnutrition was statistically insignificant (p > 0.05) as majority of the children had normal weights and were not infected by intestinal parasites (78.7%) as well as the prevalence of infection being low from this study. Out of the stool sample collected from 29 thin children, only 8(17.7%) of them were positive with the intestinal parasites. Outside of the normal weight, only 1(2.2%) person was infected with intestinal parasites out of the 23 stool collected from the overweight children.

Table 4.6: Prevalence of Parasite among School Children from Public and Private Schools

Intestinal Parasites	Number and percentage of infection					
	Public Schools		Private Schools		All Schools	
	No	%	No	%	No	%
***Ascaris lumbricoides* (round worms)**	13	4.9	5	1.9	18	6.8
Schistosoma mansoni	6	2.2	2	0.8	8	3.0
Hookworms	5	1.9	3	1.1	8	3.0
***Trichuiris trichiura* (Whip worms)**	1	0.4	0	0.0	1	0.4
Strongyloides	1	0.4	0	0.0	1	0.4
Entamoeba histolytica	3	1.1	0	0.0	3	1.1
Entamoeba coli	3	1.1	0	0.0	3	1.1
***Hymenolepis nana* (tape worm)**	1	0.4	0	0.0	1	0.4
Gardia lamblia	2	0.8	0	0.0	2	0.8
Total	35	13.2	10	3.8	45	17.0

P=0.089, χ^2 =2.886

Table 4.7: Prevalence of Malnutrition among School Children from Private and Public Schools

	Percentage of children						
Nutritional Status Categories	Private Schools		Public Schools		All Schools		
	Male	Female	Male	Female	Male	Female	All
Severe thinness	2(4.8)	0(0.0)	1(1.4)	0(0.0)	3(2.7)	0(0.0)	3(1.0)
Thinness	4(9.5)	4 (6.6)	8(11.3)	18(13.7)	12(10.6)	22(11.5)	34(11.1)
Overweight	4(9.5)	8(13.1)	3(4.2)	11(8.4)	7(6.2)	19(9.9)	26(8.5)
Obese	1(2.4)	0(0.0)	0(0.0)	0(0.0)	1(0.9)	0(0.0)	1(0.3)
Total	11(26.2)	12(19.7)	12(16.9)	29(22.1)	23(20.4)	41(21.4)	64(20.9)

Prevalence=20.9%, Girls= 21.4%, Boys =20.4%

Private school= 23.0%, Public school= 20.0%, χ^2 = 6.82, P>0.05

Table 4.8: Association of Nutritional status and Intestinal parasitic infection

Nutritional status	Positive for parasite No %	Negative for parasite No %	Total stool collected No %
Severe thinness	0(0.0%)	3(1.1%)	3(1.1%)
Thinness	8(17.8%)	21(9.5%)	29(10.9%)
Normal	36(80.0%)	174(78.7%)	210(78.9%)
Overweight	1(2.2%)	22(10.0%)	23(8.6%)
Obese	0(0.0%)	1(0.0%)	1(0.4%)
Total Examined	45	221	266

χ^2 =5.756, P=0.218

CHAPTER FIVE

DISCUSSION

5.1 Discussion

Generally intestinal parasitic infection abounds in developing countries and school children carry the heaviest burden of the associated morbidity (Opara *et al*., 2012). The result from this study indicate that though the intensity of infection is low, intestinal parasitic infection (IPI) is still prevalent among school children in Nigeria.

The prevalence of (17.0%) recorded in this study is similar with that reported among children attending day care in Iran by Mohammed *et al*., (2014), Garba *et al*., (2010) in Adamawa region of Cameron and Gwagwada in Kaduna State, Nigeria by Alhassan et al., (2013) this may be due to variation in the geographical regions and environmental conditions and contrary to that reported by Unachukwu (2014) in Enugu and Ojorungbe (2011) in Ile-ife, Nigeria which reported higher prevalence.

Ascaris was the most prevalent infection in the children and is similar with studies recorded in Ile-ife by Ojurongbe *et al*., (2014) and Oluboyo (2014) in Anambra State, Nigeria and this may be because *Ascari*s infection occur by ingestion of embroyonated eggs from foods (Anosike *et al*., 2006). This supports the report from this study that showed a significant association between infection and habit of not washing fruits and vegetables before eating them. This shows that *Ascaris* is responsible for most intestinal parasitic infection in school children from Sabongari LGA and contrary to report by Odoba et al., (2012) in his studies conducted in Zaria on prevalence of helminths eggs on pupils and playground in which hookworm was the most prevalent. Findings from this study showed that the rate of hookworms and schistosomes infection were equal and second to ascaris infection. The rate of hookworm infection from this study is lower than report by Opara et al., (2012). *Schistosoma*

Mansoni infection was higher compared with report by Ojorungbe in Ife (2014) and lower than that recorded by Alhassan in gwagwada, Kaduna State. Alhassan *et al.,* (2014) reported that the maximum excretion of schistosome eggs occur after midday, but stools from this study were collected earlier than this period. This may have contributed to the low prevalence of schistosome infection recorded in this study. The prevalence of protozoan parasites recorded in this study was low and this is similar to report by Unachukwu & Nwakanma (2014).

The prevalence of infection was higher in public schools than the private schools but there was no significant difference of intestinal parasitic infection rate among schools. This is similar to report by Reji et al., (2011). This may be because most of the care givers (mothers) from private schools had more formal education than their counterpart and are thus more enlightened and informed about the need to practice good hygiene and how to prevent helminths infection.

Sex specific prevalence revealed more infection in girls than boys which corresponded with the reports by Anosike *et al.,* (2006) in central Nigeria and Reji *et al.,* (2011) and contrary to Tadasse (2005) in eastern Ethiopia. This may be because there were more females than males in this study and probably because, most girls do assist their parents in hawking their wares and are thus exposed to different communities where these infections may be endemic. However, no significant association was observed between the male and female.

Age related prevalence showed that the infection was prevalent across all age group with the highest infection rate seen in children between 10-12 years followed by 13-15years and then 7-9 years. This shows that the rate of infection is higher in older children. This is similar with report by Qdoba et al., (2012) and this may be that the younger children were given more supervision about their hygiene while the older ones may have been carried away by different activities thus neglecting the need for them to practice good personal hygiene.

The prevalence of malnutrition in this study (20.9%) is similar to (21.2%) reported by Reji *et al*., (2011) in Ethiopia. This may be due to the presence of Ascaris, hookworm and trichuris which were however, low in this study. Other factors may have contributed to the prevalence of malnutrition in this study which agrees with Opara et al., (2012) that the causes of malnutrition are multifactorial. Comparison of the rate of malnutrition between boys and girls indicated that the girls were more malnourished than the boys which is in agreement with studies by Garba (2010) in Cameroon and contrary to report by Taha et al., (2013). The likely reason is that adolescent girls lose blood monthly and so require more nourishing food than the boys. Another reason may be because in some households, the men and boys are given food first because they believe they eat heavier than the female. More so, the boys engage in menial jobs after school hours and are being paid which give them access to buy and eat foods outside their homes. The difference was however insignificant. Though the rate of infection was higher in public school children, there were more malnourished children in Private schools than the public schools, this may be due to uneven distribution of the selected children from both schools and the difference was however insignificant. A significant association was seen between infection and habit of not washing of fruits and vegetables. This is similar to report by Timothy, (2013) and he attributed this association to the unhygienic handling of these fruits and vegetables by food vendor as well as the use of excreta as manure Tadasse (2005), since children and their mothers go to farm to tend to their vegetables. The prevalence of intestinal helminth infection in relation to source of drinking water showed that infection was recorded from children that got their water from well as well as from tap but there was no significant association between infection and source of water. This is similar to report by (Timothy, 2013) and he suggested that the prevalence may be because contaminated soil particles are washed up into the open wells and the water drawn from the wells may be consumed without boiling or treatment. Result from this study also revealed an association between infection and the habit of not washing hands after using toilet. This is in agreement with report by Adanyi, *et al*, *(*2011) and contrary to report by Timothy, (2013).

When the difference in the dietary pattern between schools was compared, it showed that there were significant differences in some food products such as, legumes, citrus and sugar sweetened drinks with public schools having higher frequencies. There was also significant difference in dairy/dairy product with private schools having higher frequency.

The dietary pattern between genders was also compared and it showed there was significant difference in only one type of food product legumes and female had higher frequencies in legume consumption than the male. There was a significant association between their intake of vitamin supplement and their nutritional status.

There was no significant association between helminthic infection and the nutritional status of the children and this is similar to reports by Zulkifi (2000), Reji (2011) and Unachukwu (2014) and they stated that the social economic and physical environment in which an individual lives is a major determinant of the degree of association between intestinal parasites and nutritional status. Zulkifi *et al*., (2000) suggested that the lack of association between infection and nutritional status may be because of the single examination done on the stool which may miss light infection since egg excretion varies from day to day and the effect of this method used could diminish the statistical significance between these two factors which is true with this study.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study revealed that *Ascaris*, Hookworms and *Schistosomia mansoni* were the most prevalent intestinal parasitic infection in school children in Sabongari LGA. Sex had no significant association with infection. Helminth infection was more pronounced in the older children. This study revealed that infection with intestinal parasites is associated with habit of not washing hands after toilet as well as not washing of fruits and vegetables before eating. There was no significant association between source of water, types of toilets and the ownership of pets. The rate of infection was higher in the public school children than their private counterpart. Malnutrition was more prevalent in private school children than the public school children.

6.2 Recommendation

Though the magnitude of malnutrition and parasitic infection was low in this study, government should not relent on prevention and control measures by distributing free anti-worm medicines in schools. Regular nutritional assessment should be carried out on school children. Portable drinking water and good toilets should be provided especially in the public schools to prevent indiscriminate defecation around school premises. In addition, teachers should continue to educate their pupils on how to maintain good personal hygiene and healthy eating habits.

REFERENCES

Alhassan, A., Luka, S. A., Balarabe, M. L and Kogi, E. (2013). Prevalence and Selected Risk Factors of Intestinal Schistosomiasis among Primary School Children in Birnin-Gwari LGA, Kaduna State. *International Journal of Applied Biological Research*. 5(1):72-81.

Akram, H. (2009). *Trichuris trichiura*. *Mymensingh medical college, Bangladesh*, 1-14.

Amuta, E., Olusi, T & Homsou, R. (2008). Relationship of Intestinal Parasitic Infection and Malnutrition among School Children in Makurdi, Benue State Nigeria. *The Internet Journal of Epidemiology, 7*.

Andy, E and Palmer, A. (2005). Soil transmitted helminthiasis among school-aged children in Ethiope East Local Government Area, Delta State Nigeria. *African Journal of Biotechnology,* 4, 938-941.

Anosike, J.C., Adeiyongo, C.M., Abanobi, O.C., Amajuoyi, O.V., Dada, E.O., Oku, E.E., and Keke, I.R. (2006). Studies on the intestinal worm (helminthiasis) infestation in a central Nigerian rural community. *Journal of Applied Science and Environmental Management.* Vol 10 (2) 61-66.

Asaolu, O. S., Ofoezie, O. E., and Onyeji, O. C. (2015). *Ascaris lumbricoides* (Ascariasis). *Infectious Disease Antimicrobial Agents,* 1-8.

Awasthi, S., Bundy, D. A. P and Savioli, L. (2003). Helminthic infections. *British journal of medicine,* 327, 431-433 doi 10.1136.

Azad, A. S., Nourjah, N and Shahbazi, F. (2004). Relationship of intestinal parasitic infections to malnutrition among schoolchildren near tehran, iran. *Southeast asian journal of tropical medicine and public health,* 35(1), 116-119.

Beaton, G., Kelly, A., Kevany, J., Martorell, P, and Manson, J. (1990). Appropriate uses of anthropometric indices in children.Areport based on an ACC/SCN Workshop. Nutrition policy discussion paper. *9*, 1-7.

CDC. (2015). Parasites-Hookworms. *CDC* 24/7*: Saving Lives, Protecting People.* Retrieved 2 August, 2015, from http://www.cdc.gov/parasites/hookworm/

Cole, A. H., Taiwo, O. O., Nwagbara, N. I and Cole, C. E. (1997). Energy intake, anthropometry and body composition of Nigerian adolescent girls: a case study of an institutionalized secondary school in Ibadan. *British Journal of Nutrition*, 77:496-509.

Coop, R.L and Kyriazakis, I. (1999). Nutrition and Parasitic Interaction. *Vertinary Parasitology Elsevier.* Vol 84(187-204).

Dettwer, K. A. (1991). Growth status of children in rural Mali: Implications for nutrition education programs. *American Journal of Human Biology,* 3:447-462.

Espinoza, E., Perez, H., Gill, M., Morales, G., Sandez, J., and Ramirez, M. (2003). Intestinal Parasite in Children in higly deprived areas in the border region of Chiapas, Mexico. *Salud Publica de mexico,* 45:379-387.

FAO. (2006). *The State of food security in the world: eradicating world hunger*. Viale delle Terme, Rome, Italy: FAO.1-8.

Garba, C.M.G and Mbofung, CMF. (2010). Relationship between Malnutrition and Parasitic Infection among School Children in the Adamawa Region of Cameroon Pakistan *Journal of Nutrition*, 9 (11): 1094-1099.

Gardner, G., Halweil, B., & Peterson, J. A. (2000). Underfed and Overfed: the global epidemic of malnutrition. *Washington, DC: World watch*.

Jombo, G. T. A., Damen, J. G., Amechi, I., Etukudo, N. S., & Dabit, O. (2011). Intestinal Parasitosis Among Undernourished Children of an Urban Settlement in West Africa: Pattern and Types. *Asian Journal of Pharmaceutical and Health Sciences, 1*(4).

Lovell, H. G. (1972). Height and Weight of West Indian children. *Journal of Royal Statistics and. Social science*, 135, 569-578.

Mohammed Hosein A.T., Mohammed Mehdi M and Mahdi Aghabagheri (2014). Prevalence of Intestinal Parasites in Children Attending Day-Care Centers in Yazd City Iran. *Journal of Community Health Research*, 3(2):96-102.

Mohammad, K. A. E.-A., Mohammad, A. A. E.-A., El-Nour, M. F. A., Saad, M. Y and Timsah, A. G. (2012). The prevalence and associated risk factors of intestinal parasitic infections

Muller, O., Garenne, M., Kouyale, B and Becher, H. (2003). The Association between Protein Energy Malnutrition, Malaria Morbidity and all cause Mortality in West African Children. *Tropical Medcine & International Health*, 8, 507-511.

NIH. (2015). Parasitic Roundworm Diseases. Retrieved 14 August, 2015, from http://www.niaid.nih.gov/topics/parasiticRoundworm/Pages/default.aspx

Ojurongbe, O., Oyesiji, K. F., Ojo, J. A., Odewale, G., Adefioye, O. A., Olowe, A. O.(2014). Soil transmitted helminth infections among primary school children in Ile-ife Southwest, Nigeria: A cross- sectional study. *International Research Journal of Medical Sciences, 2*(1): 6-10.

Oluboyo, B. O., Enweani, I. B., Ekejindu, I. M and Oluboyo A. O. (2014). Prevalence of some intestinal parasitic infection in relation to Body mass index in Anambra State, Nigeria. *European Scientific Journal* .Issn 1857-7881. 221-229.

Onimawo, I. A. (2001). Nutrition for Vulnerable Group. Ambik publishers, Benin City.

Oxford dictionary of English (2017). https://en.oxforddictionaries.com Retrived on January, 2017.

Pawlowski, Z. S., Schad, G., & Stott, G. (1991). Hookworm infection and anaemia: approaches to prevention and control. In W. H. Organisation (Ed.), (pp. 103). Geneva: WHO.

Pelletier, D. L., and Frongil, E. A. (2002). Changes in survival are strongly associated with changes in malnutrition in developing countries. *Food and Nutrition Technical Assistance.(FANTA) project. Academy of Educational Development, Washington DC*.

Peter, K., & Judith, K.-A. (2008). The interaction between Nutrition and Infection. *clinical Practices,* 1582-1588.

Raj&Co. (2015). Round Worms in Humans, Symptoms, Treatment, Life Cycle, Prevention. Retrieved22August,2015,fromhttp://rajn.co/roundwormsinhumanssymptomstreatmentlifecycleprevention, pg.1-7.

Reji, P., Belay, G., Erko, B., Legesse, M., & Belay, M. (2011). Intestinal parasitic infection and malnutrition amongst first-cycle primary school children in Adama, Ethiopia. *African Journal of Primary Health Care and Family Medicine*, 1-5. doi: 10.4102

Ross, G. P. A., Paul, B. B., Adrian, C. S., Richard, G. O., Yuesheng, L and Gail, M. W. (2002). Schistosomiasis. *New England Journal of Medcine (NEJM)*. doi: 10.1056/NEJMra012396. Pg. 1-6.

Tadasse, G. (2005). The prevalence of intestinal helminthic infections and associated risk factors among school children in Babile town,eastern Ethiopia. *Ethiopian Journal of Health Development*.19(2) 140-147.

Taha H. Musa., Elrasheed A. Ali., Hassan H. Musa and Arshad K.(2013). Anthropometric Paramerters of Malnutrition in Children 5-15Years old in Khartoum State, Sudan. *Journal of Public Health and Epidemiology*.Vol 5(8). Pp 313-318. Doi: 10.5897. Issn 2006-9723.

Timothy, A., Ezekiel, K.,Oricha and Kokori A. (2013). Studies on the intestinal helminths infestation among primary school children in Gwagwada, Kaduna, Northwestern Nigeria. *Journal of Biology, Agriculture and Health Care*. Vol 3(7). Issn 2224-3208.

Unachukwu, M., & Nwakanma, C. (2014). Prevalence of Intestinal Parasitic Infection and Malnutrition in Enugu Urban and Suburban Area. *International Journal of Medical Research and Review, 2*(6):565-572.

USAID. (2015a). HOOKWORM. *USAID's Neglected Tropical Disease Program: Target Disease, Soil-Transmitted Helminthiasis, Hookworm.* Retrieved 3 August, 2015, from http://www.neglecteddiseases.gov/target_diseases/soil_transmitted_helminthiasis/hookworm/index.html. Pg. 1-3.

USAID. (2015b). Roundworms: Ascariasis. *USAID's Neglected Tropical Disease Program: Target Disease, Soil-Transmitted Helminthiasis, Roundworm.* Retrieved 3 August, 2015,fromhttp://www.neglecteddiseases.gov/target_diseases/soil_transmitted_helminthiasis/roundworm/index.html. Pg. 1-4.

USAID. (2015c). Whipworm- Trichuris Trichiuras. *USAID's Neglected Tropical Disease Program: Target Disease, Soil-Transmitted Helminthiasis,.* Retrieved 4 August, 2015,fromhttp://www.neglecteddiseases.gov/target_diseases/soil_transmitted_helminthiasis/whipworm/index.html. Pg.1-3.

Victoria State Government. (2015). Ascariasis (round worm infection). *Infectious diseases-epidemiologyandsurveillance.*Retrieved9August,2015,fromhttp://ideas.health.vic.gov.au/bluebook/ascariasis.asp

WHO. (2015). Soil-transmitted helminth infection. *World Health Organisation.* Retrieved 5 August, 2015, from http://www.who.int/mediacentre/factsheets/fs366/en/

WHO/UNICEF. (1981). Infant and Young Child Feeding. *World Health Organisation*, 65.

Willem, F. N., Weenen, H., Rigboy, P., and Hetherington, M. M. (2010). Older Adults and Patient in need of Nutritional Support: Review of current treatment option and factors influencing nutritional intake. *Elsevier*.

Wosu, M. I and Onyeabor, A. I. (2014). Prevalence of Intestinal Parasitic Infection among School Children in a Tropical Rainforest Community of Southeastern Nigeria. *Journal of Animal Science Advance.* Doi 10.5455. Issn: 2251-7219.4(8) 1004-1008.

Zulkifli, A., Khairul, A., Atiya, AS and Yano, A. (2000). Prevalence of Malnutrition and Geohelminth infection among primary school children in rural kelantan. *SouthEast Journal of Tropical Medicine and Public Health*. Pg 339-345, vol 31(2)

APPENDIX

Table A1: Nutritional Status (BMI for Age) within Age Group in Primary School children in Sabongari LGA, Kaduna State

Schools	**Age-Group (Years)**	**Severe thinness**		**Thinness**		**Normal**		**Overweight**		**Obese**	
		Frequency	**%**	**frequency**	**%**	**frequency**	**%**	**frequency**	**%**	**frequency**	**%**
Public Primary Schools	7-9(4)	0	0.0	0	0.0	3	75.0	1	25.0	0	0.0
	10-12(77)	1	1.3	7	9.1	60	77.9	9	11.7	0	0.0
	13-15(121)	0	0.0	19	15.7	98	81.0	4	3.3	0	0.0
	Total (202)	1	0.5	26	12.9	161	79.7	14	6.9	0	0.0
Private Primary Schools	7-9(50)	0	0.0	2	4.0	39	78.0	9	18.0	0	0.0
	10-12(28)	0	0.0	2	7.1	23	82.1	2	7.1	1	3.6
	13-15(25)	2	8.0	4	16.0	18	72.0	1	4.0	0	0.0
	Total (103)	2	1.9	8	7.8	80	77.7	12	11.7	1	1.0
Total	7-9(54)	0	0.0	2	3.7	42	77.8	10	18.5	0	0.0
	10-12(105)	1	1.0	9	8.6	83	79.0	11	10.5	1	0.9
	13-15(156)	2	1.4	23	15.8	116	79.5	5	3.4	0	0.0
	Total (305)	3	1.0	34	11.1	241	79.0	26	8.5	1	0.3

BMI- Body Mass Index. Distribution was based on WHO Reference for BMI for Age

Table A2: Differences in Dietary Patterns between Male and Female in Private and Public Primary Schools (Food Item from Animal sources)

Food Item from Plant sources	**Gender**	**No**	**Frequency of intake** **1-3 times per week (%)**		**4 to 6 times per week (%)**		**7 or more times per week (%)**		**Never or < once a month (%)**		**p-value**
Diary/ daiy products	Male	101	57	56.4	12	11.9	14	13.9	18	17.8	0.176
	Female	179	80	44.7	37	20.7	25	14.0	37	20.7	
Meat from all sources	Male	101	41	40.6	26	25.7	21	20.8	13	12.9	0.449
	Female	179	58	32.4	36	25.7	42	23.5	33	18.4	
Eggs	Male	101	41	40.6	25	24.8	15	14.9	20	19.8	0.993
	Female	179	70	39.1	44	24.6	28	15.6	37	20.7	

Table A3: Differences in Dietary Patterns between Male and Female in Private and Public Primary Schools (Food Item from Plant sources)

Food Item from Plant sources	**Gender**	**No**	**Frequency of intake** **1-3 times per week (%)**		**4 to 6 times per week (%)**		**7 or more times per week (%)**		**Never or < once a month (%)**		**p-value**
Legumes	Male	101	30	29.7	48	27.7	24	23.8	19	18.8	0.053
	Female	179	56	36.9	36	20.1	58	32.4	19	10.6	
Cereals, tubers, pasta, etc	Male	101	32	31.7	32	31.7	24	23.8	13	12.9	0.776
	Female	179	51	28.5	51	28.5	49	27.4	28	15.6	
Citrus fruits, tomatoes, etc	Male	101	40	39.6	29	28.7	15	14.9	17	16.8	0.097
	Female	179	54	30.2	49	27.4	49	27.4	27	15.1	
Green leafy vegetables, carrots, etc	Male	101	34	33.7	34	33.7	26	25.7	7	6.9	0.497
	Female	179	50	27.9	55	30.7	55	30.7	19	10.6	

Table A4: Differences in Dietary Patterns between Male and Female in Private and Public Primary Schools (High energy foods/drinks and Vitamin Supplements)

Food Item from Plant sources	Gender	No	Frequency of intake: 1-3 times per week (%)		4 to 6 times per week (%)		7 or more times per week (%)		Never or < once a month (%)		p-value
Cakes, doughnuts, buns, etc	Male	101	29	28.7	29	28.7	14	13.9	29	28.7	0.418
	Female	179	60	33.5	45	25.1	34	19.0	40	22.3	
Sugar Sweetened Drinks	Male	101	42	41.6	22	21.8	13	12.9	24	23.8	0.601
	Female	179	62	34.6	49	27.4	21	11.7	47	26.3	
Tea/coffee	Male	101	33	32.7	31	30.7	20	19.8	17	16.8	0.433
	Female	179	53	29.6	51	28.5	51	28.5	24	13.4	
Vitamin Supplements	Male	101	34	33.7	17	16.8	17	16.8	33	32.7	0.179
	female	179	43	24.0	43	24.0	40	22.4	53	29.6	

Table A5: Prevalence of intestinal parasite according to Age

Age	**Number positive**	**Number negative**	Examined	χ^2	**p-value**
7-9yrs	5(10.6%)	42(89.29%)	47		
10-12yrs	18(20.0%)	72(80.0%)	90	**1.929**	**0.381**
13-15yrs	22(17.1%)	107(82.9%)	129		
Total	45(16.9%)	221(83.1%)	266		

P>0.05

Table A6: Relationship between Intestinal parasite infection and Sex

P>0.05

Gender	**No. Negative**	**No. Positive**	**Total Examined**	**$\chi2$**	**p-value**
Male	16(14.7%)	93(85.3%)	109		
Females	29(18.5%)	128(81.5%)	157	**0.658**	**0.417**
Total	45(16.5%)	221(83.4%)	266		