EFFECTS OF INTESTINAL PARASITIC INFECTIONS ON NUTRITIONAL STATUS OF PRIMARY SCHOOL CHILDREN IN IMO STATE, NIGERIA

BY

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A DISSERTATION SUBMITTED IN THE DEPARTMENT OF PARASITOLOGY AND ENTOMOLOGY, FACULTY OF BIOSCIENCES,NNAMDI AZIKIWE UNIVERSITY, AWKA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D) PUBLIC HEALTH PARASITOLOGY, OF THE NNAMDI AZIKIWE UNIVERSITY, AWKA

OCTOBER, 2018

CERTIFICATION PAGE

I hereby declare that this work "**Effects of Intestinal Parasitic Infections on Nutritional Status of Primary School Children in Imo State, Nigeria**" is the product of my own research efforts, undertaken under the supervision of **Prof. Obioma C. Nwaorgu (FAS)** and has not been presented elsewhere for the award of any degree or certificate. All sources have been duly distinguished and appropriately acknowledged.

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APPROVAL PAGE

The dissertation titled “Effects of Intestinal Parasitic Infections on Nutritional Status of Primary School Children in Imo State, Nigeria” has been examined and approved as meeting the requirement for the award of Doctor of Philosophy (PhD) degree in Public Health Parasitology, in the Department of Parasitology and Entomology, Faculty of Bioscience, NnamdI Azikiwe University, Awka.

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DEDICATION

I dedicate the successful completion of this programme to God Almighty who, protected, strengthened, provided me with good health and saw me through.

ACKNOWLEDGMENTS

I sincerely thank God Almighty for all His mercies and goodness towards me in the course of this programme. To God I give you all the glory.

My immense and unquantifiable gratitude goes to my supervisor, Prof. Obioma C. Nwaorgu whose care, constructive criticisms, and painstaking supervision made this work a success. I am most grateful to her.

I acknowledge specially the tireless efforts of the Head of Department of Parasitology and Entomology, Dr. Edith N. Nwankwo for her good efforts towards the successful completion of this programme. I must not fail to appreciate the Departmental Post-Graduate Co-ordinator, Dr. Miriam.O. Iwueze, for all her assistance and timely support throughout the programme.

I also appreciate the collective efforts and dedication of Prof. Ikechukwu O. Onyali, Prof. Christine I. Eneanya, Prof. Angus E. Onyido, Prof. James I. Mbanugo, Prof. Chinyelu A. Ekwunife, Mr. Chukwudi M. Egbuche and Miss Chikaodili Ukonze towards the completion of this programme, may God bless you all.

My gratitude goes to the Head of Ethical Committee of Imo State Specialist Hospital, Owerri, Dr. B.U. Uduji for his support and approval of the research by his committee ensuring that the research was conducted in the study area.

I am thankful to Dr. Callistus M. Nwokeji, a Medical Practitioner and a Public Health Parasitologist, who has been mentoring me since my undergraduate days, may God reward you abundantly.

I appreciate in a special way Mr. and Mrs Henry Oparah for their immeasurable support.

I appreciate the support and encouragement I received from the present and former Directors of Academic Planning and Development Unit, Office of the Vice Chancellor, Federal University of Technology, Owerri, Prof. Ifeanyi Iwueze and Prof. Collins N Ubbaonu. I also extend my gratitude on the moral support of my Deputy Director, Dr. Emilia Nwaokenkwo and my colleagues, Mrs. Chinyere C. Nwogu, Dr. Obinna C. Ofozoba, Mr. Frank U. Duru, Mrs Francisca Nkachukwu, Mr. John Uzoechi, Mrs Uchechi Onyemelaonu, Mr. Innocent Okeh and Mr. Raphael A. Onyeji. Thank you all!

My profound gratitude goes to my brothers Mr. Bruno Esomonu, Mr. Magnus Esomonu and Mr. Emeka Akpunku for their support. I am thankful to my mother Lolo Maria Esomonu who gave me ceaseless encouragement during the course of this work. I thank my lovely sisters, Miss Chikodi Esomonu, Mrs. Chinenye I. Nwachukwu, Mrs Nkechi F. Esomonu, Dr. Chinagorom P. Ibeachu and Miss Chisom J. Esomonu for their prayers. I will also use this medium to thank my brother-in-laws and sister-in-law, Rev. Fr. Tobias Ihejirika, Mr. Ugochukwu Ihejirika, Rev. Fr. Prof. Walter Ihejirika and Miss Chidinma Ihejirika for their words of encouragements.

In a very special way, I acknowledge my lovely husband Dr. Chinedu. E. Ihejirika for his immense commitment, contributions, and care towards the completion of this programme and to my children, Michaella, Mildred and Tricia, mummy is grateful. God bless you all.

ABSTRACT

Intestinal parasitic infections represent a large and serious medical and public health problem in developing countries. Children are the most affected due to their vulnerability to infection. A cross-sectional study was conducted from April to October in 2015, to determine the effect of intestinal parasitic infections (IPIs) on nutritional status of school age children in Owerri and Orlu senatorial zones, in Imo State, Nigeria. Faecal and blood samples were collected from 1200 randomly selected schoolchildren within the ages of 6-13 years and transported to the laboratory for analysis. Faecal samples were examined using Kato Katz method and formol-ether concentration techniques, while blood samples were examined using cyamethahaemoglobin method. Anthropometric indices were used as indicators of nutritional status, children whose Height-for-Age, Weight-for-Age and Weight-for-Height were <-2 standard deviation (SD) were classified as moderately stunted, underweight, and wasted, while children whose Height-for-Age, Weight-for-Age and Weight-for-Height were <-3SD were classified as severe stunting, wasting, and underweight respectively. Children whose haemoglobin level were <8.0g/dl were classified as being anaemic. Total prevalence rate of 19.3% was recorded in the study areas with *Ascaris lumbricoides* (3.8%), *Trichuris trichiura* (1.3%), hookworm (1.8%), *Strongyloides stercoralis* (0.2%), *Taenia* sp (0.5%), *Entaomeba histolytica* (7.7%), *Entamoeba coli* (3.7%) and *Giardia lambia* (4.2%). There was no significant difference between prevalence of intestinal parasitic infections in rural areas of Orlu and Owerri (P>0.05) Zones and urban areas of Orlu and Owerri (P>0.05) Zones. Prevalence of co-infection was 3.8%. Majority (73.4%) of the children had light intensity. Anthropometric study results showed that 79(31.3%) of the children studied were malnourished, and 50(16.6%) of them were infected. Stunting (under-height) was the most prevalent (26.0%) type of malnutrition recorded in the study areas, followed by under-weight (4.0%) and wasting 1.4%. Seventy two percent (72%) of the children infected with intestinal parasitic infections had normal anthropometric parameters. Malnutrition was significantly (P< 0.05) higher in children infected with *Ascaris lumbricoides* and hookworm than others. There was no variation between prevalence of the three types of malnutrition in infected and non-infected children (P >0.05). There was no significant difference between stunting and under-weight (P > 0.05) among infected children with respect to sex. There was no significant relationship between prevalence of intestinal parasitic infections and prevalence of stunting and underweight in infected children with respect to age (P>0.05). In uninfected children, age was associated (P < 0.05) with wasting, but was not associated with stunting and under-weight (P > 0.05). Relationship between malnutritional indicators (stunting and under-weight) and locations was not significant (P> 0.05) in infected children. Malnutrition was insignificantly higher (P > 0.05) in children whose parents are artisans, followed by children whose parents are self-employed. The prevalence of anaemia was 17.4% and this did not vary significantly (P>0.05) among infected and non-infected children. Children that had co-infection recorded higher prevalence (2.2%) of severe anaemia. In infected children, anemia varied significantly with respect to location (P < 0.05). The highest prevalence of severe anaemia (4.8%) was recorded in children infected with hookworm. There was an association (P < 0.05) between anaemia and intensity of helminth infection. Children that had heavy intensity of intestinal parasitic infection were malnourished, while 41.7% of children that recorded light infection were malnourished. Malnutrition was not significantly (P > 0.05) higher in children with heavy and moderate intensity of helminth intestinal infection. The prevalence of intestinal parasitic infections and anaemia were moderately low among school age children in the study areas. Low intensity parasitemia with intestinal parasites had no significant effect on the malnutrition and haemoglobin profile of the children in the study areas. Improved sanitation and more deworming efforts should be sustained to ensure further decline in prevalence of intestinal parasitic infections.

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CHAPTER ONE

INTRODUCTION

Intestinal parasitic infections are amongst the most widespread of all chronic human infections worldwide (Wafa, 2010). Intestinal parasitic infections represent a large and serious medical and public health problem in developing countries, these infections constitute a global health burden causing morbidity in 450 million people, majority being children (WHO, 1998; Odu *et al.,* 2013). In Sub-Sahara Africa, intestinal helminths are the most common diseases with very high negative public health and socio-economic impact (Lozano *et al.,* 2012). In Nigeria, high morbidity rate in children have been correlated with intestinal parasitic infection (Oninla *et al*., 2007; Unachukwu and Nwakanma, 2014). Amoebiasis, giardiasis, ascariasis, hookworm infection, and trichuriasis are among the most common intestinal parasitic infections worldwide (de Silva *et al*., 2003; Opara *et al.,* 2012).

According to Pullman and Broker (2008), although in the latent phase, most parasites can be tolerated asymptomatically, active infections, especially by multiple parasites, can cause health problems and developmental deficits in school children. Reinfection is one of the main concerns in endemic areas with precarious socioeconomic conditions. In these poor settings, a large proportion of persons can be reinfected in a relatively short period of time (Pullan and Brooker, 2008).

The distribution and prevalence of various species of intestinal parasites vary from region to region. This is because of several environmental, social, cultural and geographical factors. They spread mostly in areas with poor sanitation and are most common in tropical developing countries of African, Asian, and South American continents (CDC, 2011). According to Amare *et al*. (2007), Barbara *et al*. (2011), Cinthia e*t al*. (2010) and Solomon *et al*. (2012), intestinal parasitic infections are closely associated with poor economic status, poor personal and environmental sanitation, overcrowding conditions, limited access to potable water, cultural beliefs, tropical climate and low latitude. The poor people of under-developed nations experience a cycle where under-nutrition and repeated infections lead to excess morbidity that can continue from generation to generation (Amare *et al.*, 2007).

People of all ages are affected by this cycle of prevalent intestinal parasitic infections, although, school aged children are more affected (Mehraj *et al.*, 2008). It had been long recognized as an important health problem especially among Nigerian children (Tamramat and Olowu, 2008). School children carry the heaviest burden of the associated morbidity (Odu *et al.,* 2013), due to their dirty habits of playing or handling of infested soils, eating with soiled hands, unhygienic toilet practices, drinking and eating of contaminated water and food (Barbara *et al*., 2011; Sayasone *et al.,* 2011; Ademiluyi and Odugbesan, 2013).

Intestinal parasites are transmitted to man when faecal matters get into the mouth. This can happen through contaminated food or water, oral sex play or non-sexual intimate contact, such as changing of baby's diaper (WHO, 2008; CDC, 2011). They may also penetrate the body through the skin (in the case of hookworm infection and intestinal schistosomiasis) or if contaminated soil is ingested accidentally (Hassan *et al*., 2014). Other parasites that live in animals, such as pigs and cows can infect man through eating undercooked meat or drinking unpasteurized milk. Swimming in contaminated water also may result in infestation by certain parasites, such as *Schistosoma mansoni*, which is responsible for intestinal schistosomiasis. Parasitic intestinal infestations often occur in outbreaks, when several people have symptoms at the same time. This is especially likely if many people are exposed to the same supply of contaminated food or water (CDC, 2011).

The public health importance of gastro-intestinal tract parasites is due to their high morbidity in school children and women during their child-bearing years, which might result to increased metabolic rate, anorexia, chronic anemia, and diarrhea. Intestinal parasites can cause different signs and symptoms in patients. A list of symptoms include: abdominal pain, chills, chronic fatigue, colitis, abdominal distension, digestive disturbance, fever, enlargement of various organs, headaches, weight loss due to malnutrition, weakness, immunodeficiency, nausea/vomiting insomnia, skin ulcers, rectal prolapse, mental problems, lung congestion, memory loss, night sweats and sometimes mentally related disorders (Ayeh-Kumi *et al*., 2009).

Diarrhea, including that of intestinal parasitic origin, remains one of the most common illnesses in children, and one of the major causes of infant and childhood morbidity in developing countries (Mbuh *et al*., 2010). WHO (1987) reported that mean haemoglobin level is affected by high parasitic load, hence the need to check haematological parameters.

Absar *et al.* (2010) reported that the public-health and socio-economic consequence of intestine helminthes are of considerable global concern especial in the children's health and development where it cause malnutrition, which compromise their learning capabilities in their formative years.

Children are the most affected due their vulnerability to nutritional deficiencies (Opara *et al*., 2012). The poor people in developing countries experience a cycle where under nutrition and repeated infections lead to excess morbidity that can continue from generation to generation (Cooper 2007).

Apart from morbidity related problems associated with intestinal worms have great effects on nutritional status and cognitive performance especially among pre-school and school aged children (Opara *et al.,* 2012; Nwaneri and Omuemu, 2013). Tamramat and Olowu (2008) in a study on prevalence and nutritional effects of helminth infections in pre-school rural children in Nigeria reported that about three-quarter of children infected with intestinal parasites were under-nourished. Moreover, they cause iron deficiency anaemia, loss of appetite and other physical and mental problems (Amare *et al*., 2007).

Intestinal parasitic infections cause decreased intake in the body's nutrient requirement by their interface with absorptive surfaces, physical obstruction of intestinal lumen, production of proteolytic substances and consumption of nutrients intended for the body (Stephenson *et al*., 2000; Nwaneri and Omuemu, 2013).

Akinbo *et al.* (2011) reported that gender and season had no correlation with the prevalence of intestinal parasites. Agents of intestinal parasitic infections are found in polluted environment such as refuse heap, gutters and sewage units and around humans dwelling in crowded and unhealthy situations (CDC, 2011). Inadequate potable water is a major predisposing factor in intestinal disease transmission in Imo State (Esomonu *et al.,* 2012). This is also associated with inadequate waste management systems, which have exposed urban and rural areas dwellers of Owerri to high level of unhygienic and unsanitary conditions (Ikpeama *et al.,* 2016).

Case definition of infection due to intestinal parasite is through recovery of protozoan trophozoites and cysts, helminthes eggs and larvae in faecal samples (WHO, 1994). In a very large population, clinical symptoms can be used to define a case for further confirmatory test.

Control measures against intestinal parasites include chemotherapy, personal hygiene and environmental sanitation. Chemotherapy is an effective short-term measure while hygiene and environmental sanitation are effective long-term control measures (WHO, 1990). Control in school age children delivered through school system is the main intervention strategy in a community (WHO, 1987).

1.1 **Justification of the Study**

The impact of intestinal parasitic infections in developing countries particularly among school aged children, despite efforts by government and individuals to reduce it to the barest minimum, cannot be over emphasized. Intestinal protozoan and helminth infections have been associated with malnutrition, dehydration, and anemia (Eleni et *al.,* 2014). Helminth disease is one of the neglected tropical diseases in which WHO is interested in, and would want to see eliminated. Although several researches have been conducted on the effects of intestinal parasitic infections on nutritional status of primary school children in many parts of Nigeria, there is paucity of published data on the effects of intestinal parasitic infections on nutrition in Imo State in recent times. The findings from the study would provide baseline epidemiological data on the burden of intestinal parasitic infections and malnutrition of the vulnerable group in Orlu and Owerri Zones. The knowledge of prevalence of intestinal parasitic infections would be an excellent indicator of the quality of life in the study areas. The study could also provide an epidemiological mapping of Owerri and Orlu Zones and schools of those infected children. The findings of the study would also encourage appropriate authorities to embark on health intervention programmes on malnutrition and intestinal parasitic infections in Imo State, Nigeria.

1.2 **Aim of the Study**

The aim of this research work was therefore to determine the effects of intestinal parasitic on nutritional status of primary school children in Owerri and Orlu Senatorial zones of Imo State.

1.3 **Specific objectives**

The specific objectives of this study were to determine

1. the prevalence and intensity of intestinal parasitic infections among children (aged 6-13years) from primary schools in Imo State.
2. the relationship between intestinal parasitic infections and anthropometric indices among these children;
3. the prevalence of anaemia with respect to number of co-infections, location and type of parasite isolated from infected children in the study areas.
4. the relationship between intensity of intestinal parasitic infections, malnutrition, and anaemia.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Intestinal Parasite

Intestinal parasites are those types of entero-parasites, which infect the lumen and lining tissue of the lumen of the small and large intestine (Loukopoulos *et al.,* 2007). They are larger than bacteria and viruses but some of them are so small that one cannot see them without a microscope. World Health Organization (WHO) (WHO, 2004) revealed that intestinal parasitic infections are endemic worldwide and have been described as constituting the greatest single worldwide cause of illness and diseases. The two main types of intestinal parasites are the helminths and the protozoa. There are thousands of types of gastrointestinal parasites that live in the human body and not only do they thrive on the food eaten by humans (Huang and White, 2006), but they also do destroy vital organs in a bid to accelerate their multiplication thereby causing injury and even death (Nwoke, 2009). The detrimental effects of parasites have been established to be species specific (Que, 2007).

In their adult stages, helminths cannot multiply in the human body. These parasites are commonly transmitted through ingestion of contaminated food and/or water because of poor sanitation and hygiene (Neghab *et al*., 2006). Sometimes, transmission occurs through close contact between infected and non-infected individuals as in infected food handlers and consumers, respectively (Neghab *et al*., 2006). Infection with pathogenic intestinal parasites results in considerable gastrointestinal morbidity, malnutrition and mortality worldwide, particularly, among young children in developing countries (Feng and Xiao, 2011).

Intestinal parasitic infections are among the most common infections worldwide (Kang *et al.,* 1998). Intestinal parasitic infection varies considerably from place to place in relation to the disease (WHO, 2008). Intestinal parasitic infections are widely distributed virtually throughout the world, with higher intensity in developing countries (Haque, 2007; Hotez *et al.,* 2008*;* WHO, 2008)*.* According to the World Health Organization (2002) estimate; globally there are 800-1000 million cases of ascariasis, 700-900 million of hook worm infection, 500 millions of trichuriasis, 200 million of giardiasis and 500 million of *Entamoeba histolytica* (Roma and Worku, 1997). Multiple infections by these parasites, e.g hookworm, roundworm and amoeba also occur (Simon-Oke *et al.,* 2014).

2.1.1 Protozoans

Protozoa are single celled (unicellular) eukaryotic organisms. They are broadly divided into: intestinal, e.g. *Entamoeba histolytica*, *Giardia lamblia* and *Cryptosporidium parvum*; urogenital protozoa e.g. *Trichomonas vaginalis*, and blood and tissue protozoa e.g. *Toxoplasma gondii* and *Plasmodium falciparum*. Pathogenic protozoa are referred to as parasites and cause a wide array of clinical diseases (CDC, 2009). Protozoa can multiply inside the human body, which contributes to their survival and enables serious infections to develop. Sometimes two or more can cause infection at the same time, a concept known as polyparasitism (; Sayyan *et al.,* 2005; CDC, 2009). In developing World, it is “usual” to harbor several protozoa at any given time due to sanitation inadequacies (CDC, 2009). The prevalence of *Giardia intestinalis* and *E. histolytica* has been estimated at 2–3% in the developed world and 20–30% in developing countries (Escobedo and Cimerman, 2007). *Cryptosporidium* spp*.* is another major causal agent of diarrhoea, primarily affecting immunocompromised individuals such as those infected with HIV (Jex *et al.,* 2011).

Giardia lamblia, a pear-shaped flagellated protozoan is a causative agent of girdiasis. It has been found to be one of the most prevalent intestinal parasitizing protozoan worldwide, currently infecting 200 million and is the cause of 2.8 billion infections annually (Moraes-Neto *et al*., 2010). *G. lamblia* has a worldwide distribution and is considered one of the main nonviral causes of diarrhea in industrialized countries. Higher prevalence is found in tropical and subtropical areas, in urban than in rural where *Giardia lamblia* affects up to 30% of the population (Minvielle *et al.,* 2004). In industrialized countries, the prevalence of intestinal parasites such as *Giardia* ranges from 2% to 5%, whereas in developing countries it ranges from 20% to 40% (Ali *et al*., 1999). Clinical presentations of giardiasis vary greatly. However, clinical presentation of giardiasis ranges from asymptomatic to acute and to chronic gastrointestinal infections (Garba and Mbofung, 2010). Infection due to *G. lamblia* is characterized by diarrhea, maldigestion, abdominal cramps, bloating, malabsorption and weight loss (Dawson, 2005). *Giardia* is common among children and travelers and morbidity is usually limited to early childhood (Hollm-Delgado *et al*., 2008). Because giardiasis is spread by fecal-oral contamination, the prevalence is higher in populations with poor sanitation, close contact, and oral-anal sexual practices (CDC, 2009). The disease is commonly water-borne because *Giardia lamblia* is resistant to the chlorine levels in normal tap water and survives well in cold environment (CDC, 2009).

Cyst excretion occurs intermittently in both formed and loose stools, while trophozoites are mainly found in watery stool. Stool studies for ova and parasites continue to be a mainstay of diagnosis. Examination of a single stool specimen has a sensitivity of 50 to 70 percent; the sensitivity increases to 85 to 90 percent with three serial specimens (Katz and Taylor, 2001). Increased prevalence in human as well as in some of the surrounding animals offers an emerging concern about the role played by some animals in human giardiasis (Olson, 2004). Each individual eliminates up to 900 million cysts per day.

Entamoeba histolytica, the causative agent of intestinal amoebiasis affects more than 50 million people worldwide (Ramana and Kranti, 2012). Humans are the most significant reservoir of infection even though morphologically identical amoebae have been isolated from certain domestic and wild animals (Petri and Singh, 1999). Inside the intestine, *Entamoeba histolytica* lives as a trophozoite that means vegetative stage of protozoa showing motility and the ability to grow, feed, and reproduce. It produces resistant cysts by which it is transmitted (Fernandez, *et al*., 2002). Some of the clinical symptoms of acute intestinal amoebiasis include diarrhea, bloody stool that may contain necrotic mucous, abdominal pain, tenderness and fever (Petri and Singh, 1999). Symptoms of amoebic liver abscess usually involve fever, right upper abdominal tenderness/ pain, weight loss and colitis (Petri and Singh, 1999).

Thus, it is ranked second only to malaria as the cause of mortality infection (Ramana and Kranti, 2012). *Entamoeba histolytica* has been recovered worldwide and is more prevalent in the tropics and sub-tropics than in colder climates. However, in poor sanitary conditions in temperate and colder climates, infection rates have been found to equal that seen in the tropics (Kouontchou *et al.,* 2002). It is the second leading cause of the death from parasitic diseases worldwide. *E. histolytica* is capable of invading the intestinal mucosa and may spread to other extra intestinal organs; mainly the liver, the kidneys, lungs, and brain. Thus, *E. histolytica* is unique among the intestinal amoeba because it is able to invade tissue and clinical presentation may range from an asymptomatic infection to a disseminated fatal disease. Both *E. histolytica* and *Entamoeba dispar* share similar morphological characteristics, and this make the diagnosis of *E. histolytica* difficult (Ramana and Kranti, 2012).

Cryptosporidium pavum is a protozoan parasite that causes cryptosporidiosis. It affects the intestines and is typically an acute short-term infection. It is spread through the fecal-oral route, often through contaminated water (CDC, 2009); the main symptom is self-limiting diarrhea in people with intact immune systems. In immuno compromised individuals, such as AIDS patients, the symptoms are particularly severe and often fatal (Chen *et al*., 2007). Treatment in symptomatic patient is with fluid rehydration, electrolyte correction and management of any pain.

2.1.2 Intestinal Helminths

Helminths include the nematodes (roundworms), trematodes (flukes) and the cestodes (tapeworms). Representatives of each of these groups are important human parasites. The adult worms inhabit the intestine; discharge the eggs or larvae they produce in faeces (WHO, 2004).

Helminth infection is among the most prevalent intestinal parasitic infections of humans from developing parts of the world where there is low coverage of hygiene and sanitation, such as in Latin America, China and East Asia, and Sub-Saharan Africa (CDC, 2011). Helminths alone had high global prevalence: estimated 1.5 million cases of ascariasis, 1.2 million cases of hookworm infection, 1.05 million cases of trichiuriasis, and 200– 300 million cases of schistosomiasis had been reported (Ezeamama *et al*., 2005). It was estimated that greater than one-fourth of the world's people are infected with hookworm, *A. lumbricoides* and *T. trichiura*, higher prevalence are recorded among school-age children in developing countries (CDC, 2011). Intestinal helminths hardly ever cause death. As an alternative, the saddle of disease is related to less mortality than to the chronic and subtle effects on health and nutritional status of the host (Stoltzfus *et al*., 2004).

2.1.2.1 Intestinal Nematodes

Nematodes are characterized by their elongated, cylindrical, and unsegmented bodies. The sexes are separate, the males typically being smaller than females. The most important nematode parasites predominantly distributed in developing countries include *Ascaris lumbricoides,* hookworm*, Trichuris trichiura* and *Enterobius vermicularis*; with varying prevalences (WHO, 2002). They are also the second most predominant cause of outpatient morbidity (Nwoke, 2009). Transmission of roundworm is mainly through faecal-oral route. Roundworm infection is transmitted by ingestion of infective eggs from human faeces that contaminate the drinking water, foods, hands and living environment.

Faecal-contaminated soil may be carried long distances on feet or footwear and by animals into houses. Children playing in a compound pick up infective eggs from the ground or play things. Transmission of infection by contaminated dust is also possible (UNICEF, 2002).

In addition, these nematodes have a relatively short lifespan, and re-infection occurs only after a life-cycle stage outside the human host (Gupta *et al.,* 2009). However, *S. stercoralis* is a unique nematode that has an auto-infective cycle and frequently causes chronic infection. In immunosuppressed hosts, *S. stercoralis* may become invasive, causing serious morbidity and mortality.

Ascaris lumbricoides is the most common and largest intestinal parasitic nematodes (is robust). Ascariasis is infection with the parasitic roundworm *Ascaris lumbricoides*. Ascariasis is caused by consuming food or drink contaminated with roundworm eggs. It is found in association with poor personal hygiene, poor sanitation, and in places where human feces are used as fertilizer (Maguire, 2009). Mature males and females usually live in the small intestine where they lay eggs that are present in feces. In the jejunum, they feed on semi-digested food present in the host (Neva and Brown, 1994). They secrete antitrypsin and thus, and are capable of adequately competing with the host system for ingested protein. They are resistant to normal peristaltic movement of the gut by assuming an S-shaped configuration, pressing their cuticle against the columnar epithelium of the host. They can live 10-24 months (Maguire, 2009). The mature female lays approximately 200,000 eggs per day, which they pass out in the feces in unembryonated form. The resilient nature of their eggs made them capable of surviving a wide range of hot and cold temperature, chemical disinfectant and other extreme condition (Neva and Brown, 1994). The eggs of Ascaris embedded in the soil can remain infective for years (Gilgen and Mascie-Taylor, 2000).

Hookworms are nematodes belonging to the family Ancylostomatidae. The two major genera that infect humans are Ancylostoma and Necator. They are characterized by the presence of oral cutting organs in the adult stages (Hotez *et al.,* 2008). Human hookworm infection is caused by either *Necator americanus* or *Ancylostoma duodenale.* These two species of hookworm share a common life cycle. Eggs hatch into rhabditiform larvae, feed on bacteria in soil, and molt into the infective filariform larvae (Nwoke, 2009). Enabled by moist climates and poor hygiene, filariform larvae enter their hosts through pores, hair follicles, and even intact skin. Maturing larvae travel through the circulation system until they reach alveolar capillaries. Breaking into lung parenchyma, the larvae climb the bronchial tree and are swallowed with secretions. Six weeks after the initial infection, mature worms have attached to the wall of the small intestine to feed, and egg production begins.

Strongyloidiasis is human disease that is caused by *Strongyloides stercoralis* a (roundworm). Strongyloidiasis was first described in France in 1876. Its clinical symptoms include; principally skin symptoms, abdominal pain, diarrhea and weight loss. In some people, particularly those who require corticosteroids or other immunosuppressive medication, strongyloides can cause a hyperinfection syndrome that can lead to death if untreated. The hyperinfection syndrome causes symptoms in many organ systems, including the central nervous system (Montes *et al*., 2010). The larvae thrive in warm, moist/wet soil. People who engage in work that involves contact with soil and walking barefooted as well are low are at risk of being infected with *Strongyloides stercoralis* system (Montes *et al*., 2010). Ivermectinis (drug) is widely used in the treatment of strongyloidiasis.

Trichuriasis, which is infection with the parasite *Trichuris trichiura,* or whipworm, is a very common intestinal helminthic infection worldwide. The whipworm derives its name from its characteristic whiplike shape; the adult (male, 30-45 mm; female, 35-50 mm) buries its thin, threadlike anterior half into the intestinal mucosa and feeds on tissue secretions, not blood. This relative tissue invasion causes occasional peripheral eosinophilia. The cecum and colon are the most commonly infected sites, although in heavily infected individuals, infection can be present in more distal segments of the gastrointestinal tract, such as the descending colon and rectum (Nwoke, 2009). About one quarter of the world's population is thought to carry the parasite (CDC, 2011). Trichuriasis has a worldwide distribution, particularly among countries with warm, humid climates. Trichuriasis was a highly prevalent soil-transmitted helminthiasis until the 1970s (Ok *et al*., 2009). Most infected individuals have no distinct symptoms, if lightly infected.

Trichuris is also notable for its small size compared with *Ascaris lumbricoides*. Only individuals with heavy parasite burden become symptomatic. Vitamin A deficiency has been seen in patients with trichuriasis.

2.1.2.2 Intestinal Cestodes or Tapeworms

Cestodes (tapeworms) are segmented worms that cause disease in humans and other animals. Approximately 45 species of *Taenia* have been identified; however, the two most commonly responsible for human infection are the pork tapeworm *Taenia solium* and the beef tapeworm *Taenia saginata* (WHO, 2002). These species requires one intermediate host where the embryo develops into an infective larval stage. Cattle and pigs are intermediate hosts for *T. saginata* and *T. solium* respectively (Singh and Prabhaker, 2002).

Another tapeworm is *Hymenolepis nana* (dwarf tapeworm) is a common human parasite and the smallest tapeworm known to infect humans. Transmission is by ingesting eggs in food or drink or from contaminated hands (Gerald *et al*., 2009). The eggs are infective by the time they are passed in faeces and internal autoinfection occurs. Hydatid disease, also called hydatidosis or echinococcosis, is a cyst-forming disease resulting from an infection with the metacestode or larval form of parasitic dog tapeworms from the genus *Echinococcus* (Gerald *et al*., 2009).

2.1.2.3 Intestinal Trematodes

Intestinal trematodes, just like other intestinal parasites, commonly infect human intestine. Their morphological development involves three stages, the egg (ova) which is the excretory stage, larvae (miracidium, metacercariae, cercariae) which is the infective stage and adult worms. The major intestinal trematodes include Fasciolidae (e.g., *Fascioloposis buski*), Echinostomatidae (*Echinostoma* spp.) and Heterophyidae (*Heterophyes heterophyes* and *Metagonimus yokogawai*), which are responsible for the bulk of intestinal trematodiasis in humans (Keiser and Utzinger, 2004). In addition, *Schistosoma mansoni* and *Schistosoma japonicum* can cause severe intestinal complications. They are, however, blood rather than intestinal flukes and live in blood vessels, but their eggs penetrate into the intestine causing intestinal damage, portal hypertension, and progressive enlargement of the liver and spleen. Schistosomiasis is a trematode disease caused by different species of

Schistosoma (Ross *et al*., 2002). *Schistosoma mansoni* is a dioecious trematode with distinctive sexual dimorphism regarding both sexes, with females slightly longer and more slender than males (Nwoke, 2009). Male posses a ventral sex canal (gynecophoric canal) in which the females reposes. Adult schistosomes live in pairs in the portal venous blood vessesl or in vesicle venules of the caval system, where females lay non-operculate, partially embryonated eggs (Nwoke, 2009). The worms live on the average of a few years, but in exceptional cases, they may persist for as long as 30 years or more. The females produce prodigious numbers of eggs, which are forced through the walls of either the intestine are discharged in the excreta (Nwoke, 2009).

2.2 **Prevalence of Intestinal Parasitic Infection**

The distribution and prevalence of various species of intestinal parasites differ from region to region because of several environmental, social, and geographical factors, as well as human behavior. Because many parasitic lifecycles require warm weather for host-to-host transmission, intestinal parasitic infections are found more prevalent in temperate and tropical regions. The impacts of these infections are more significant in low- and middle-income countries where they contribute to greater economic impact, morbidity, and mortality.

2.2.2 **Prevalence in Africa**

Intestinal parasitic infections are highly prevalent diseases in tropical countries especially among school-aged children (Lozano *et al*., 2012). Tulu *et al.* (2014) investigated the prevalence of intestinal parasitic infections in Yadot primary school of Delo-Mena district, Bale zone, South Eastern Ethiopia and reported overall prevalence of 26.2%. In Sudan also, prevalence of infections with *S. mansoni*, among 6,122 children from 27 schools in the White Nile Province were 10.1% (Ahmed *et al*., 1996). In Kenya, prevalence of 23.7% was reported among food handlers (Biwott *et al*., 2014). In Dadeldhura district of Nepal, Tiwari *et al*. (2013) recorded prevalence of 31.13%. A population-representative survey in children aged 0-10 years from Afghanistan reported an overall infection prevalence of 41% (Steinmann *et al.*, 2010). In Eastern Cape Province, South Africa, Nxasana *et al.* (2013) reported prevalence of 64.8% among primary school children.

2.2.3 **Prevalence in Nigeria**

In Nigeria, the prevalence of intestinal parasitic infection varies from one geographical zone to another. In Nigeria, high prevalence of intestinal parasitic infection is apt to occur in low socio economic condition, characterized by inadequate water supply, poor hygiene and poor sanitary disposal of faeces and ignorance of simple health promoting behaviors (Iduh *et al.,* 2015).

2.2.3.1 **Prevalence in Northern Nigeria**

Gimba and Dawam (2015) in work carried out in Gwagwalada, FCT-Abuja, Nigeria reported 42.9% prevalence of intestinal parasitic infections. In Jos, Chirdan *et al*. (2010) recorded 57.8% prevalence of intestinal parasitic infections. In Borno State, Biu *et al*. (2012) reported intestinal parasitic infections prevalence of 60.0% among school aged pupils in Mafa local government area. In Sokoto State, North- western Nigeria, Mohammed *et al*. (2015) reported 54.4% prevalence of intestinal parasitic infections. Another study by Iduh *et al. (*2015) documented prevalence of 74.5% among the Almajiris in the Sokoto metropolis, Nigeria. In Bauchi, Samaila *et al* (2016), in a study of prevalence of intestinal helmnth infections among two selected public primary schools in Bauchi Metropolis reported prevalence of 9.1 %.

2.2.3.2 Prevalence in South-Western Nigeria

Intestinal parasitic infections prevalence rate of 25.0% was reported by Akingbade *et al*. (2013) among children with diarrhea in Abeokuta, Ogun State, Nigeria. In Benin City, the total prevalence of intestinal parasitic infection was 3.9 % in a study conducted by Akinbo *et al*. (2011) among patients of a tertiary hospital. Also in Benin, intestinal parasitic infections prevalence of 20.7% was recorded orphanage home in by Nwaneri and Omuemu (2013). A study conducted by (Simon-Oke *et al.*, (2014) in AIfedore Local Government Area of Ondo State found 48.9% prevalence of intestinal parasitic infections. Okpala *et al.* (2014) reported intestinal parasitic infections prevalence of 13.8% in Edo in South Southern Nigeria. Awolaju and Morenikej (2009), reported prevalence of 48.40% in Osun State, Nigeria. Ojurongbe *et al.* (2014) documented intestinal parasitic infections prevalence of 46.3% in Osogbo, Osun State.

2.2.3.3 Prevalence in South-Southern Nigeria

A study on intestinal parasitic infections among primary school children in Rivers State, in 2011 revealed (27.66%) prevalence of different intestinal parasites, namely, *Ascaris lumbricoides* (51.78%), hookworm (25.0%), *Trichuris trichiura* (15.18%), *Strongyloides stercoralis* (7.14%), *Taenia* sp. (0.89%) and *Enterobius vermicularis* (0.01%), (Abah and Arene, 2015). In Akwa Ibom, Opara *et al*. (2012) recorded intestinal parasitic infections prevalence of 67.4% in school-aged children. In Akwaibom also, Usip *et al*. (2013), recorded prevalence of 59.1% among primary school pupils in Abak Local Government Area.

2.2.3.4 Prevalence in South Eastern Nigeria

A study on the prevalence of intestinal parasites conducted by (Uwaezuoke *et al.* (2006) among school children in Owerri Municipality of Imo State, Nigeria, revealed prevalence of (47.7%). Uwaezuoke *et al.* (2006) reported *Ascaris lumbricoides* as the most prevalent (18.5%), helminth, followed by *Trichuris truchiura* (10.7%), *Entamoeba histolytica* (7.3%), *Strongyloides stercoralis* (6.0%), and Hookworm

(5.3%). Another study on the prevalence of intestinal parasites among schoolchildren in Imo State conducted by Udensi *et al.* (2015*)* recorded (48.7%) prevalence. Oguoma *et al. (*2008) observed prevalence of 24. 8% in a study carried out in Owerri Metropolis, Eastern Nigeria. A cross-sectional survey was conducted by Kamalu *et al., (*2013), to determine the prevalence of intestinal parasites among students of post primary institutions in two contrasting communities (Owerri Municipal and Mbaitoli Council Area**)** in Imo State revealed prevalence rate of 43.0%. Opara *et al*. (2010) reported prevalence of 58% in Day–Care Centre in Owerri municipality, Imo State, Nigeria

In tropical rain forest communities in Umuahia North Local Government of Abia State, Wosu and Onyeabor (2014) reported intestinal helminths prevalence of (75.7%). In Enugu, prevalence of 38.85% was reported in a study carried out by Unachukwu and Nwakanma (2014).

In Anambra, Oluboyo *et al*. (2014) reported prevalence of 12.8% of intestinal parasitic infections. Intestinal parasitic infections prevalence of 72% has also been reported in school-aged children in Anambra State. In Anambra too, Anumba *et al.* (2016) obtained intestinal parasitic infections prevalence of 63.16% in orphanage homes. Ezenwaka *et al*. (2011) reported 18.5% prevalence of intestinal helminthes among children in Ogbaru, Anambra State with *A. lumbricoides* 9.5%, hookworm 7.5%, *Trichuris trichiura* 1.5%, *E. vermicularis* 1%, and Taenia species 1%. Also in Umuukwu, Aram, in Anambra State, Ezeagwuna *et al*. (2011) reported 47% prevalence of intestinal parasitic infections among schoolchildren. In Uli, Ihiala Local Government Area, Orji (2015), reported prevalence of 18% of intestinal parasitic infections. In addition, Ogbuagu *et al*. (2009) observed intestinal parasitic infections prevalence of 38.6% among patients in admission in Accident and Emergency Unit in Nnamdi Azikiwe Teaching Hospital Awka, Anambra State.

In Ebonyi State, Alo *et al.* (2013) recorded intestinal parasitic infections prevalence 57.2% from the fingers of school children in Ohaozara. Also in lead mining areas of Abia State, Nduka *et al.* (2006) recorded prevalence of 34.6%. In addition, Odo *et al*. (2016) documented intestinal parasitic infections prevalence of 52.5% in Uwani, Enugu State.

2.2.3 Gender Related Prevalence

Generally, sex is regarded as a determinant risk factor of disease condition, although it does not play appreciable role in intestinal parasitic infections. Many research works have been carried out on relationship between sex and prevalence of intestinal parasitic infections, some authorities observed significant relationship between sex and intestinal parasitic infection while some other researchers' findings were not in line. A study on prevalence of intestinal schistosomiasis by Nanvya *et al*. (2011) reported higher prevalence in males than in females, which could be due the fact that females were less likely to be infected because of social restriction to water contact activities like swimming, bathing, fishing and farming. Mohammed *et al.* (2015) also reported insignificant higher prevalence in male school aged children. Similarly, Ojurongbe *et al*. (2014) obtained higher prevalence for males than in their female counterparts. In a similar manner, Aly and Mostafa (2010) recorded higher infection rates in males and reasoned that this was a result of gender differences in recreational activities (Cauyan *et al.,* 2008, Udensi *et al*., 2015).

Ahmed *et al*. (1996) attributed it to the observation that boys are more outgoing and adventurous in nature and they tend to play away from their homes more than their female counterparts do. The study of Rudge *et al*. (2008) was also in line with the above. Rudge *et al*. (2008) was of the view that the higher prevalence in males than in females may be as a result of socio-cultural setup of the people of the study area;

these people are predominantly Muslims, Hausa and Fulani by tribe. Udensi *et al. (*2015) observed no significant differences in distribution of intestinal parasites by sex among primary school children in Jos, Plateau State, Markudi, Benue State and three geopolitical zones of Imo State respectively.

On the other hand, sex prevalence of intestinal enteric parasitosis studied by (Gimba and Dawam, 2015) in Gwagwalada, FCT-Abuja, Nigeria, showed a marginally higher prevalence in females (30.0%) compared with males (25.7%), but there was no statistically significant difference (p>0.05) between the enteric parasitosis and sex. This suggested that parasitic diarrheal diseases were independent of sex in Gwagwalada, FCT-Abuja, Nigeria. Another gender related prevalence conducted by Ono *et al*. (2001), showed no significant difference in the prevalence of diarrheal diseases in the two sexes caused by parasites. Tohon *et al*. (2008) in a study in Nigeria claimed that parasitic infections were not sex dependent. Nkengazong *et al*. (2009) investigated prevalence of intestinal parasitic infection with respect to sex and reported gender variation in Kotto Barombi and in Marumba South West Cameroon

2.2.4 Age and Prevalence Relationship

The age-specific susceptibility of infectious diseases play a crucial role in the epidemiology of these diseases. Pre-school and school-aged children and women of childbearing age, including adolescent girls, tend to have the higher proportion of worm infections. Although intestinal worms can infect all members of a population, school-aged children (5-13 years old) are at greater risk of heavy infections than others and are more vulnerable to the harmful effects of chronic infections(Awasthi *et al.,* 2003). These vulnerable groups would benefit most from preventive interventions (UNICEF, 2002).

Old age and impaired immune function can also predispose one to diarrheal disease. Every new born is susceptible to getting diarrhea (Ali *et al.,* 2008). Ali *et al.* (2008) reported that apart from six months of life when maternally acquired immunity and exclusive breastfeeding played a protective role, acute diarrhea morbidity decreases with child's age

Epidemiological studies have shown that intestinal parasitic infections occur in all age groups, but may be more prevalent in particular age group than other. Old age, young age and impaired immune function can also predispose one to intestinal worms. *E. histolytica* is one the causative agent. It agrees favourably with Awolaju and Morenikeji (2009) who reported no significant differences in prevalence of intestinal parasitic infection among primary and post-primary schools pupils in Ilesa West, Osun State, Nigeria. Also Abera *et al*. (2013) observed no significant difference between age and prevalence in primary school children and this indicates that age brackets studied are equally exposed to infection with soil-transmitted helminths.

2.3 Intensity of Intestinal Parasitic Infections

Infection intensity reflects the number of worms infecting the individual, and is a more reliable marker of treatment success. In addition, infection intensity is a better indicator of morbidity than prevalence in schistosomiasis (Davis, 2004). The intensity of infection is a major determinant of morbidity and approximately reflected in the number of characteristic cysts or egg passed out in faeces (Kongs *et al*., 2001). Quantifying the number of eggs in terms of classes of intensity allows the proportion of individuals suffering severe consequences to be quantified. Since the first objective of any control programme is the reduction of the proportion of highly infected individuals, this indicator is extremely important for the selection of the control measures, and in monitoring the results of the programme. The thresholds proposed for use by a WHO Expert Committee in 1987 for the classes of intensity for each helminth in stools has been in use until date. Kato-Katz techniqueis used to measure egg per gram (epg) is obtained by multiplying the number of eggs counted on the slide by a multiplication factor. This factor varies according to the size of the template used. WHO recommends the use of a template holding 41.7 mg of faeces in which case the multiplication factor to obtain egg per gram (epg). For hookworm infections the degree of severity varies not only according to the number of worms present but also to the age, species and nutritional intake of iron. Light intensity of infections is related to a loss of less than 2 mg of haemoglobin per gram of faeces. Heavy intensity infections correspond to a loss of more than 5 mg of haemoglobin per gram of faeces.

A study conducted by Awolaju and Morenikeji (2009) in South West Nigeria, showed no significant variation in the intensity of intestinal parasitic infections among primary and post primary school children. Stephenson *et al.* (2000b) observed that intensity of intestinal helminthes infection was higher among school age children.

2.4 Pathology of Intestinal Parasitic Infections

Infections with intestinal parasites commonly manifested as diarrhea and abdominal discomfort. More advanced infestations can present as nausea, vomiting, fever, dysentery, lack of appetite, haematuria, abdominal distension and weight loss (Reingold and Gordon, 2012). The alteration of normal gastro-intestinal flora by intestinal parasites is usually associated with diarrhea (Oninla *et al*., 2007).

Diarrheal disease is defined as passage of loose or watery stools at least three times a day (Ali *et al.,* 2008), but is considered by most when there is increased liquidity of stool with or without increased frequency of stool (Sundeep, 2004).

Diarrhea, including that of parasitic origin, remains one of the most common illnesses in children, and one of the major causes of infant and childhood mortality in developing countries (Mbuh *et al*., 2010). The most serious clinical manifestations of human protozoan infection include persistent diarrhoea usually associated with intestinal malabsorption, enteropathy, and dysentery because of acute or acute-on-chronic colonic inflammation producing colitis (CDC, 2011).

Diarrhea coupled with vomiting and weight loss can lead to malnutrition and wasting which are of significant concern, especially in cases that persist longer than two weeks (Reingold and Gordon, 2012).

Some parasites also cause low red blood cell count (anemia), and some travel from the lungs to the intestine or from the intestine to the lungs and other parts of the body. Infection with *Ascaris*, *Trichuris,* and hookworm may be associated with eosinophilia and hookworm with anemia, most pathology associated with these organisms is related to parasite load and migration. Many other conditions can result in these symptoms, so laboratory tests are necessary to determine their cause. In children, irritability and restlessness are commonly reported by parents (Dariel, 2007).

Abdominal discomfort and pain is one the major clinical symptoms of intestinal parasitic infections. Although majority of all infections due to *Amoeba histolytica* are asymptomatic, even asymptomatic infection is associated with a small but significant increased risk for developing invasive amoebiasis. Clinical symptoms of acute intestinal amoebiasis include bloody stool that may contain necrotic mucous, abdominal pain, tenderness and fever (Petri and Singh, 1999). Symptoms of amoebic liver abscess usually involve right upper abdominal tenderness/pain, weight loss and colitis (Petri and Singh, 1999).

Pulmonary symptoms can also occur during pulmonary migration of the filariform larvae. Dermatologic manifestations include urticarial rashes in the buttocks and waist areas. Blood eosinophilia is generally present (Graeff-Teixeira *et al*., 2009). Disseminated strongyloidiasis occurs when patients with chronic strongyloidiasis become immunosuppressed. It presents with abdominal pain, distension, shock, pulmonary and neurologic complications and septicemia, and is potentially fatal. The worms enter the bloodstream from the bowel wall, simultaneously allowing entry of bowel bacteria such as *Escherichia coli*. This may cause symptoms such as sepsis (bloodstream infection), and the bacteria may spread to other organs where they may cause localized infection such as meningitis (Graeff-Teixeira *et al*., 2009).

In individual that are immunocompetent, these infections are usually self-limiting and will resolve without specific intervention, although in some situations low-grade infection may persist without producing symptoms. In severe cases, the number of parasites may grow so large that the intestines become blocked. Some infections cause specific complications: amoebiasis can affect the liver, lungs and brain; parasites migrating through the lungs may cause difficulty in breathing; and hookworm infection can cause anemia and malnutrition, which can affect growth and development in children (CDC, 2011).

Intestinal parasitic infections affect children's growth, although stunting due to intestinal parasitic infections may not easily recognized as it occurs almost imperceptibly over time (UNICEF, 2002). Hookworm attaches to the intestine by biting into the lining, thus causing ulcers and lesions. Chronic infections with *S. mansoni* have been associated with hepatomegaly, splenomegaly, periportal fibrosis, hypertension, urinary bladder obstructions, cancer and tumor of the prostate glands (Mazigo *et al*., 2010a).

In some people, intestinal worms do not cause any symptoms, or the symptoms may come and go. If you have some of these symptoms, it does not necessarily mean that you are infected. These symptoms are also indicative to other diseases.

Common signs and complaints include coughing, cramping, abdominal pain, bloating, flatulence and diarrhea.

2. 5 **Mode of Transmission**

The intestinal parasites have four mode of transmission. The major routes of transmission are water, soil, and food, with faeces as a major transmissive vehicle. Intestinal parasitic diseases constitute a global health burden in numerous developing countries mainly due to fecal contamination of water and food (Odu *et al*., 2013).

2.5.**1 Faecal Oral Mode of Transmission**

This is the passage of infective material through contaminated faeces into the mouth of a new host. Intestinal nematodes are usually transmitted to humans through ingestion of infective eggs from focally contaminated food and water (e.g., *Ascaris lumbricoides*, *Trichuris trichiura*). The sticky nature of the eggs of *A. lumbricoides* makes it easier to adhere to raw fruits and vegetables. They also circulate in household dust and air, where they are inhaled or swallowed (O' Lorcain and Holland, 2000).

2.5.2 Penetration of Skin by an Infective Larve

An intestinal parasitic infection like intestinal schistosomiasis is spread by skin contact with water that contains the larval parasites. Man acquires infection through skin exposure to waters containing infective cercariae or by ingesting water that contains infective cercariae. Many authorities have reported that the frequency of water-contact activities correlated with infective rates, higher frequency of water contact was significantly associated with higher positivity of *Schistosoma mansoni* (Abou-Zeid *et al*., 2013; Hassan *et al*., 2014). Another intestinal parasite that is transmitted through body contact is hookworm, which dwells in focally contaminated soil. The infective larvae enter the body via the skin and travel through the blood stream to the small intestine by way of the lungs, trachea, oesophagus and stomach (De Silva *et al*., 2003).

2.5.3 Water and Foodborne

Inadequate sources of drinking water and contaminated food are major routes of transmission for intestinal parasites. According to CDC (2011)., unsafe water in developing countries accounts for 80% of their burden of disease (BOD). Water is a major source of parasitic disease transmission as there are currently one billion people without access to safe water causing two billion cases of diarrhea per year (CDC, 2011). Common infections spread this route are *Giardia, Cryptosporidium*, and *Acanthamoeba histolytica.* In addition, food-borne helminthiasis caused *Taenia solium* and *Taenia saginata*, which become infective after passing through an intermediate host (pig and cow). Colan *et al*. (2011) reported that the transmission of taeniasis was enhanced by comsuption of raw or under-cooked beef.

2.5.4. Zoonotic-linked Transmission.

Humans and animals share environmental locales; therefore, they can be accidental, intermediate, or final parasite hosts, which can be transmitted through contaminated food or water, or directly in intermediate stages through animal zoonoses (Slifko *et al.*, 2000). Domestic, wild, captive, and companion animals are possible infective agents due to poor hygiene or sanitation (Ramirez *et al.*, 2004). Approximately 20% of adult dogs and 90% of puppies have patent IPIs (Slifko *et al*., 2000). More than 60% of 1,700 diseases seen in humans originated in wild or domestic animals, contributing to millions of deaths and billions ill yearly (Ramirez *et al*., 2004; Karesh *et al*., 2012). Flies are a commonly overlooked zoonotic transmissive source as they ingest 1 to 3mg of parasite-infected feces over a few hours and can transmit ova and cysts internally or externally through bites or food (Slifko *et al*., 2000; Almeida and Santos, 2011). In Nigeria, a considerable amount of human and animal wastes is discharged into the soil daily leading to the contamination of the soil with soil transmitted helminths eggs and larvae (Adeyeba and Tijani, 2002).

2.6 Risk factors of Intestinal Parasitic Infections

Parasitic infections are governed by behavioral, biological, environmental, socioeconomic and health systems factors. Poverty, illiteracy, poor hygiene and sanitation, poor access to health care services, inadequate potable water have been linked with high prevalence of intestinal parasitic infections in developing countries (Ogbuagu *et al.,* 2009; Barbara *et al.,* 2011).

Intestinal parasitic infections such as schistosomiasis, amoebiasis and infections with the common soil-transmitted helminths (i.e. *Ascaris lumbricoides*, hookworm, and *Trichuris trichiura*) are usually associated with poor hygiene and sanitation (Utzinger *et al.,* 2010; Hotez and Ehrenberg, 2010). Helminth infection is among the most prevalent intestinal parasitic infections of humans from developing parts of the world where there is low coverage of hygiene and sanitation, such as in Latin America, China and East Asia, and Sub-Saharan Africa (Hotez *et al.,* 2008; WHO, 2008). Improving socioeconomic status, including enhanced access to quality health care, safe water, and adequate sanitation have the potential to significantly reduce the prevalence and intensity of parasitic infections, and hence reduce disease-related morbidity (de Silva *et al.,* 2003; Utzinger *et al.,* 2010). In addition, lack of awareness of simple health promotion practices is also a contributing factor (WHO, 1987).

Socio-economic factors have been identified to be responsible for the continued persistence of intestinal parasite infections in children. Some of these include poverty, poor housing facilities and number of household members (Nwoke, 2004). Wang *et al*. (2009) observed that socio-economic factors such as quality of housing, monthly income, employment, occupation had influence on the disease transmission and associated morbidity and mortality. Lack of proper and necessary awareness of the transmission mechanisms and life-cycle patterns of intestinal parasitic infections is a major contributory factor in the transmission of infections.

2.6.1Contaminated Food and Water

Many inhabitants of sub-Saharan countries have limited access to potable water for domestic use, leaving them with the option of using natural water bodies such as lakes, rivers, ponds, and other water sources contaminated with developmental stages of the schistosome parasite. Access to safe water in adequate quantity is one of the biggest challenges in the recent times (Esomonu *et al.,* 2012). Despite the national commitment to supply safe drinking water is difficult especially in the rural areas. Water scarcity in terms of quantity and quality has severe implications on the overall development and health of citizens.

Slifko *et al*. (2000) reported that in the United States, parasitic diseases cause approximately 2.5 million foodborne illnesses annually. It is also reported that 3.4 million people, mostly children, die annually from water-related diseases. This highlights the fact that even in a high-income country IPIs pose a significant health risk. It was noted that because of the lack of sanitation, water supplies were getting infected by sewage. This possibly contributed to a 50% parasite prevalence rate in the study (Moraes-Neto *et al*., 2010). Studies conducted in different countries have reported contamination of different water bodies by protozoan parasite cysts. In a study done in Brazil by, 4 of the 18 (22.2 %) water samples from open and protected wells including a sample from the city water supply systems were positive for oocyts of *Cryptosporidium* (Newman *et al*., 1993).

Several studies have clearly documented that the provision of safe water alone will reduce diarrhoeal and other enteric diseases, even in the absence of improved sanitation or other hygiene measures (Quick *et al.,* 2002). Waterborne protozoan parasite cysts that cause diarrhoeal diseases in both immunocompetent and immunocompromised individuals include *G. duodenalis* and *E. histolytica* whilst *C. parvum* and *C. cayetanensis* cause diarrhoea in mostly immunocompromised individuals (Marshall *et al.,* 1997).

2.6.2 Poor Sanitation and Hygiene

Poor sanitation and hygiene has been a major source of disease transmission that is more common in rural and peri-urban communities. A lack of awareness about hygiene, overcrowding, improper plumbing, animal contact, and inadequate disposal of refuse promote the spread of disease (Moraes-Neto *et al*., 2010). An investigation by Amuta *et al.* (2010) on risk factors of intestinal parasitic infections showed significant correlation between prevalence of intestinal parasitic infections and water sources. About 90% of intestinal parasitic infection related deaths are attributed to poor hygiene, inadequate sanitation, and unsafe water (Moraes Neto *et al*., 2010; Reingold and Gordon, 2012). About 50% of those severely affected with intestinal parasitic infections are children and 39 million people lose productive years according to disability adjusted life years (DALY) (Moraes-Neto *et al*., 2010). The infection is acquired through the feacal-oral route by consumption of food, water or drinks contaminated with cysts of the parasite. Aribodor *et al.* (2012), in a study observed that licking or sucking of faecally contaminated hands introduced infection to humans. High prevalence of *E. histolytica* infections is closely linked with poor personal hygiene, poor environmental hygiene, poor health service providers having inadequate supply of drugs, lack of adequate and proper awareness of the transmission mechanisms and life cycle patterns of these parasites (Mbanugo and Onyebuchi, 2002).

2.6.3 Socio-economic Factors

Socio-economic factors influencing the continuous transmission of the debilitating infectious diseases in sub-Saharan countries include poverty occupational activities, poor sanitation and hygiene, and non-availability of potable water for domestic use (Quick *et al.,* 2002).

Studies on human parasitic infections have demonstrated a common relationship between parasitic infections and lower socio-economic status of the region (WHO, 2006). Poverty is a serious public health problem in developing countries, a World Bank analysis confirmed that the majority of the sub-Saharan populations survive on between US$ 1.25–2 per day (Hotez and Kamath, 2009). Poverty compels an individual to use contaminated water sources for his domestic activities and this is likely to predispose to diseases. Wosu and Onyeabor (2014) in a study carried out among school children in a Tropical Rainforest Community of Southeastern Nigeria observed higher prevalence of worm infection among rural than in urban school children. Previous studies have shown that intestinal parasitic infections are endemic to the poorest communities in developing countries with weak health infrastructure, and are linked to poor hygiene, sanitation, and a lack of safe water supply (Moraes-Neto *et al*., 2010; Solomon *et al*., 2012).

In addition, lack of awareness about mode of transmission of parasitic infections increases the risk of intestinal parasites infection. Hence, better understanding of the above factors, as well as how social, cultural, behavioral and community awareness affect the epidemiology and control of intestinal parasites may help to design effective control strategies of these diseases (Kloos, 2005).

Occupational activities such as fishing and farming are also risk factors for transmission of the disease. Ikeh and Ismail (2015) in a study conducted in Northwestern observed higher prevalence of intestinal parasitic infections in children whose parents are farmers than other occupation studied. Sinnia *et al*. (2012) in another study reported higher prevalence in children of farmers. The reason for this is not farfetched, their children accompany their parent to farms and as such they play with the contaminated soil and negligent of their environment thus became more vulnerable to the common intestinal parasitic infections.

People at high risk of intestinal schistosomiasis infection are people involved in fishing activities, fishing, paddling of canoes and possibly handling of infected snail host in the case of collecting edible ones (WHO,1991). Houmsou *et al.* (2010) reported that the inhabitants in the endemic communities perceived risky behavior such as swimming, bathing, playing, fishing among others to cause schistosomiasis to become manifest. Contact with infected water is a vital factor in transmission of infection; women and children are exposed to infection during activities such as laundry, plate washing, bathing and water fetching for domestic use.

In addition, children of artisan may be more vulnerable as poverty contributes significantly to the high prevalence due to poor living condition, lack of safe water, sanitation and low level of education.

Illiteracy and low literacy level have also been highlighted as a major risk factor of intestinal parasitic infections. Women are essentially home managers and notable caregivers in their various families. Therefore, improved level of mother's education could enhance their chances of providing better healthcare in the home and particularly in influencing the health behavior of their children (Babar *et al.,* 2010). Higher level of education is usually associated with higher awareness of mode of transmission, causes and preventive measures of diseases (Desta-Haftu *et al.,* 2014). Secondly, literate mothers can influence health of their children by rejecting traditional beliefs and attitudes, leading to a greater willingness to accept developmental initiative and utilize modern healthcare.

Ogbain-Emovon *et al.* (2014) in a study observed that high literacy of majority of the mothers may have accounted for the relatively low prevalence of intestinal parasitic infections recorded in that study, as the prevalence decreased with increasing level of mother or caregivers education. Interestingly, several studies have demonstrated the impact of mother's level of education on prevalence of helminthiasis in children (Hual *et al*., 2012).

2.7. Intestinal Parasitic Infection and Nutrition

Globally, the term malnutrition is always been seen as lack of access to highly nutritious food. It is usually associated with poverty, mostly in developing countries where majority cannot afford good quality food. Children are more vulnerable to malnutrition than adult is. Malnutrition is a serious public health problem in children (UNICEF, 1998). WHO (2014) observed that one out of six children in developing countries show signs of being underweight and these points out a total number of 100 million children in the developing world. In most part of the world, cases of malnutrition are declining, except for African countries. In developing countries, malnutrition is one of the most important risk factors for high child mortality rates (WHO, 2014). Stunting, wasting and underweight are all consequences of malnutrition. Many researchers have established associations between malnutrition and intestinal parasitic infection (Opara *et al.,* 2012; Kidane *et al.,* 2014). The health consequences of intestinal parasitic infections included diarrhea, abdominal pain, vomiting, weight loss and manutrition (WHO, 2014).

Many research work reports indicated that intestinal parasitic infection have main impact on malnutrition, vitamin A deficiency, and iron deficiency which could reduce working capacity and productivity in adults and impaired growth, learning and school performance in children (Ezeamama *et al.,* 2006; Nwaneri and Omuemu, 2013). Most researchers reported that the most common effect of helminth infections on health is a subtle and insidious failure of children to achieve their genetic potential for growth (Stepheson *et al.,* 2000a; Ezeamama *et al.,* 2006; Nwaneri and Omuemu, 2013). Helminth infestation lead to nutritional deficiency and impaired physical developments, which will have negative consequences on cognitive function and learning ability (Norhayati *et al.,* 1998).

Malnutrition which is expressed as under-weight, stunting and wasting have the same cause in common, they are induced by a deficiency of certain nutrients such as protein energy malnutrition, micronutrients and chronic infections (Caulfield *et al.,* 2006). Low levels of nutrition among children cause serious long and short-term consequences in their physical and mental growth. Research studies have shown that environmental factors highly influence the malnutrition status of infants and children. The causes of malnutrition are multifactorial, a study conducted by Kikafunda *et al.* (1998) showed that negative socio-economic factors and environmental factors such as living in rural or urban areas, a lower socio-economic status, low parental education levels contribute to malnutrition in children. Babar *et al.* (2010) suggested that the main positive factors for malnutrition are inadequate food intake and poor health status that are influenced by poverty and lack of access to food, feeding practices, and family size (Babar *et al.,* 2010). Opara and Udoidung (2003) reported that the above factors, collectively or singly might have contributed to the malnutrition observed in their study. Kikafunda *et al.* (1998) suggests that a low educational level of the mother increases the probability for child malnutrition. Engebretsen *et al.* (2008) in a study observed that distal factors such as wealth, land ownership, parental age, and marital status, employment of both parents and education of both parents were associated with healthy growth of the child.

In large parts of Africa, the rate of malnutrition has not change (Kikafunda and Tumwine, 2006). Crompton and Savioli (1993) observed that most children in third-world countries fail to thrive because of the complex interactions due to a number of environmental factors in addition to inadequate diet. Children from homes with low or very low socio-economic status are a higher risk of malnutrition than those from households with middle to upper socio-economic status (Kikafunda *et al.,* 1998).

In ranking of the risk factors of malnutrition, infection is always the second before socioeconomic factors such as poverty and household size. Intestinal parasitic infections have been associated with malnutrition in children. Intestinal parasitic infections can adversely affect host nutrition in several ways. Specifically, they can depress appetite and food intake (Hadju *et al*., 1996), and once appetite is reduced, nutrient absorption can be impaired (Crompton and Nesheim, 2002). These parasites can also compete for micronutrients (Stoltzfus *et al.,* 1997) and blood loss resulting in the loss of iron or other essential nutrient Stoltzfus *et al.,* 1998). Some infections can have a negative effect on metabolic or nutrient excretion rates (Stephenson *et al*., 2000b). Adult helminths worm residing in good position in the small intestine interfere with their host nutrition and can induce damage to the intestinal mucosa that may reduce a person's ability to extract and absorb nutrient from food (Opara and Udoidung, 2003). Underweight is used to indicate a growth deficiency and lack of physical development (WHO, 2006).

Infection with non-invasive entero-pathogen may cause abdominal discomfort, diarrhea, dehydration, malabsorption and weight loss (Buret, 2008). Unlike most gastro-intestinal bacterial infections, intestinal parasitic infections tend to be chronic. In other words, they have long-term impact on host nutrition and growth (Stephenson *et al*., 2000b).

In the absence of any significant morphologic injury to the intestinal, other symptoms can be present (Buret, 2008). The mechanisms by which *Giardia lambia* and *Entemoba histolytica* cause diarrhea are multifactorial. These methods include parasite-induced chloride hyper-secretion, epithelial apoptosis and loss of barrier function leading to lymphocyte-mediated microvillous shortening, and reduction of absorptive surface area, which ultimately are responsible for maldigestion, malabsorption of nutrients, sodium, and water cleavage, down-regulation of anti-apoptotic Bcl-2, and increased expression of pro-apoptotic Bax (Panaro *et al.*, 2007). Studies in human patients with chronic giardiasis have now confirmed that infection with *Giardia duodenalis* is indeed associated with increased rates of enterocyte apoptosis (Troeger *et al.*, 2007). A high level of maternal education could lower childhood malnutrition through other pathways such as increased awareness of healthy behaviour, sanitation practices.

Eckmann and Gillin (2001) observed that the effect of intestinal parasitic infection on child nutrition, growth and development appear to depend on the burden, the species and host immune response. Although most researchers have stressed on heavy infection, some recent studies have unravel that light to moderate intensity can also impact negatively on child's growth and development (Wilson *et al*., 1999). In addition, and Stephenson *et al*. (2000a) and Ezeamama *et al*. (2005) reported that mild to moderate intensity helminth infection during childhood have been associated with undernutrition and reduced physical fitness. It has been reported that light hookworm infections of 20 – 50 adults' worms can result in significant iron losses (Stephenson *et al.,* 2000b). Even, mild to moderate intensity of helminth infection during childhood have been associated with under nutrition and reduced physical fitness (Tanner *et al.,* 2009). The most significant cause of nutritional stress resulting from helminth infection is hookworm associated iron-deficiency anaemia.

2.8 Anaemia and Intestinal Parasitic Infections

WHO (1998) defined anemia as a condition in which the number of red blood cells (and consequently their oxygen-carrying capacity) is insufficient to meet the body's physiologic needs and may be due to reduced number of red blood cells, a low concentration of haemoglobin or a combination of both (UNIEF, 1998). It can denote decreased oxygen binding ability of each hemoglobin molecule due to deformity or lack in numerical development as in some types of haemoglobin deficiency (Rasmuussen *et al.,* 2001). To non-professionals, anemia is referred to as shortage of blood. Anaemia is the most common nutritional deficiency in the world. Haemoglobin (Hb) is the oxygen-carrying component of red blood-cells. It is measured in g/dl, which simply stands for grams per deciliter. Red blood cells(RBCs) are manufactured in the bone marrow and have a life expectancy of about 120 days (approximately 4months) (UNIEF, 1998).

The etiology of anaemia involves many factors, such as, socioeconomic, nutritional, biological, environmental, cultural characteristics, and the actions required encompass pertinent and relevant matters within the context of public health (Mora, 2002). Success in combating anemia depends on understanding its associated factors.

One of the consequences of chronic anemia is its association with behavioral disturbance in children as a result of impaired neurological development in infants, and reduced scholastic performance in children of school age. Another common syndrome of restless legs, which is more common in those with iron deficiency anemia, common symptoms include swelling of the legs or arms, vague bruises, chronic heartburn, vomiting, increased sweating, pallor and blood in stool. The most common cause of microcytic anemia is parasitic infections, while the most common cause of macrocyte anemia is due to deficiency of vitamin B12 or folate which is as a result of either inadequate intake or malabsorption from the gastro-intestinal tract as a result of intestinal parasitic infections (Rasmuussen *et al.,* 2001).

Intestinal parasites are organisms that live in the intestines and derive their nutrients from their host (Gerald *et al.*, 2009). It is a major contribution to maternal and child death in developing countries. Specific physiologic needs vary with a person's gender, age, residential elevation above sea level (altitude), smoking behaviour, and different stages of pregnancy (WHO, 1998). Intestinal parasitic infections, mostly the helminths have been found have strong correlation with an increased risk of nutritional anemia, protein-energy malnutrition and growth deficit in children (WHO, 2004).

Adedayo and Nasilro (2004) in their study reported that as estimated 44 million pregnant women had hookworm infections, which could cause chronic loss of blood from the intestines and predisposes the women to develop iron deficiency anemia. It has on record that the most significant cause of nutritional stress emanating from intestinal parasitic infection (helminth infection) is hookworm associated iron-deficiency anemia. Stoltzfus *et al*. (1997) found that light hookworm infections of 20-50 adult worms could result in significant iron losses.

Many researchers have reported that iron deficiency can undermine the growth and physical fitness in children. Poor nutrition adversely affects physical and mental growth of children. Malnutrition in early childhood is associated with significant functional impairment in adult life, reduced work capacity and decreasing economic productivity (Delpeuch *et al*., 2000). Kikafunda *et al*. (1998) have also observed a relationship between anemia and nutritional status in rural areas. Low intake of iron-rich foods and diminished nutrient absorption caused by changes to the gastrointestinal epithelium in malnourished individuals contribute towards development of anemia.

2.9 Prevention and control of Intestinal parasitic infections

Intestinal parasitic infections pose a significant global health challenge in terms of prevention, control, and direct patient care (Koplan *et al*., 2009). According recommendation from WHO (1987), prevention and control of intestinal parasitic infection constitutes several activities: the prevention and control must have short and long-term components, short-term measures are needed to take an early impact and comprehensive long-term measures to reduce transmission below the level needed to maintain the infection (WHO, 1987). The specific measures (provision of safe water, hand washing, food safety, sanitation, personal hygiene, proper disposal of excreta and health education), then non-specific measure like local epidemiological survey, rapid diagnosis and adequate treatment of patient, training, education and dissemination of information by national health workers are of paramount importance in the control and prevention of intestinal parasitic infections.

The World Health Organization (WHO, 1987) has recommended three main control strategies to prevent intestinal parasitic infections at school level, and these include: periodic deworming treatment, improved sanitation and safe water supply and health education. However, there is very limited evidence of the combined effect of these interventions on reinfection rates for helminths and protozoa among indigenous schoolchildren, particularly those in remote areas. Of these recommended strategies, the health educational component has been the primary focus, and various programs have been devised to promote healthy behaviours (Asaolu and Ofoezie, 2003).

Human behavior may be deliberate or unintentional and can promote health or contribute to ill health. Humana behaviour is of considerable importance in the transmission if intestinal parasitic infections and the success of control programmes may eventually depend on modification of human behaviour. For example, indiscriminate defecation, improper use of latrines, and the use of untreated human faeces for manure are deliberate acts that enhance transmission of infection. Human behaviours like direct defecation in river has been linked with the transmission of intestinal schistosomiasis, there is a need to educate people, both young and old on the implication of voiding their faecal waste into water bodies (Nwoke, 2009). Control programs may eventually depend on the modification of behavior patterns. Generally, infections can be practically controlled and prevented through improved environmental sanitation such as safe methods of faeces and waste disposal and provision of safe water supplies and health education on health promotion of personal and food hygiene (UNICEF, 2002).

Trainer (2003) observed that good personal hygiene, environmental sanitation safe and adequate water supply, washing of hands with soap, effective sewage disposal system and the avoidance of certain types of food associated with some diseases (e.g., raw vegetables and meat); reduce the transmission and risk of intestinal parasitic infections (Trainer, 2003). Improved sanitation and access to safe water supply are key factors in the control and elimination of intestinal parasitic infections (Rollinson *et al.,* 2013). Advancement in water supply and sanitation play a role in general economic development and growth of a country (Nwoke, 2009).

Anti-helminth drugs like Albendazole or Mebendazole are effective against several species of intestinal worms at the same time would only result in a short-term reduction of infection in a target population. Re-infection is quite frequent within a relatively short period. The long-term key preventive interventions such as: provision and use of safe and adequate water supply, improvement of environmental sanitation and practicing good sanitation and hygiene habits are the basic requirements to break the intestinal worm transmission routes and life cycles (UNICEF, 2002). While the implementation of a water supply and sanitation programme at the household and community level may take time, personal precaution against hookworm infection is to wear suitable footwear to protect the skin of feet, ankles and legs from coming into contact with infective larvae (UNICEF, 2002).

Alternative source of water should be provided in villages where water for drinking and domestic use is taken from irrigation canals. Campbell *et al.* (2014) opined that there is need to progress from emphasis on treatment of morbidity due to infection towards reduction in exposure to infection through the implementation of Water, Sanitation and Hygiene (WASH) intervention policy. Inhabitants of endemic areas need to be encouraged to reduce water contact as much as possible in a bid to reduce schistosomiasis transmission (Stothard *et al*., 2006). Such measures are usually slow to take effect, require considerable investment and need to be accompanied by social, economic and educational development. Due to constraints at the national and individual levels, controls of infection using the above methods have become unrealistic besides taking a long time. In recent years, the availability of single-dose broad-spectrum anthelminthics has helped in reducing the worm burden in endemic communities.

The prevention of contamination of water bodies by human waste will definitely break the disease transmission. An intensified effort at educating people on the risk of intestinal parasitic infections and transmission is necessary to assist in achieving positive behavioural changes regarding waste elimination and personal exposure to open water sources (Hotez and Kamath, 2009). The obvious strategies to prevent water contamination by human waste include; provision of latrine, education of persons working in field far away from latrines and other sanitary facilities on the need to bury excreta and introduction of more efficient sewage treatment and disposal system (Nwoke, 2009).

There are routine universal or selective deworming of population groups that are at risk of developing morbidity and chronic diseases using anthelminthic drugs. Studies have shown that periodic chemotherapy strategy has successfully lowered the intensity of *A. lumbricoides* and hookworm infections (Che, 2010). In the case of epidemics, the main type of prevention and control measures that should be applied is epidemic control, case management and community oriented programmes. In the case of waterborne outbreaks of protozoan infections like amoebiasis and giardiasis, the source of infection need to be determined followed by sanitary measures to stop further spread (WHO, 1987).

However, integrated approach with community participation has been the most effective control program of intestinal parasitic infections. The long-term objective is to reduce the prevalence, intensity of infection and severity of intestinal parasitic infections to levels at which they cease to be of public health significance.

Recently, in some countries, health promotion and awareness campaigns have used influential individuals or "peer leaders" to persuade others to adopt new practices (Kelly *et al*., 2006), but this strategy has yet to be applied to prevention and control of intestinal parasitic diseases. Peer leaders within a community can be identified through centrality measures similar to those used in social network analyses (Valente and Pumpuang, 2007)

In many countries, endemic intestinal parasitic infections are closely related to economic and social developmental processes and therefore their control may be a sensitive issue, both socially and politically. In others, the control of intestinal parasitic infections has proved a useful entry point for other primary health care activities, e.g., in childcare, health education, family planning and nutrition (Trainer *et al.,* 2003).

In areas where human excreta are used as organic fertilizer, people should be educated and motivated to use only the fully digested or properly composted human excreta and not to apply the raw or partially digested excreta to the field. Fully digested excreta are taken from a latrine pit where it has been sufficiently stored for one to two years. During this period, disease pathogens and worms' eggs have died out completely. It will not pollute the soil or the environment as well as the vegetables grown in the field (UNICEF, 2002).

Recently, in some countries, health promotion and awareness campaigns have used influential individuals or "peer leaders" to persuade others to adopt new practices (Kelly *et al*., 2006), but this strategy has yet to be applied to prevention and control of intestinal parasitic diseases. Peer leaders within a community can be identified through centrality measures similar to those used in social network analyses (Valente and Pumpuang, 2007).

2.10 Diagnosis

Many techniques have been employed in the diagnosis of intestinal parasites. Selection of a particular technique will depend on its availability and feasibility, affordability, its effectiveness (sensitivity) and level of professionalism involved. Some of these methods are direct smear microscopy, formol-ether concentration (FEC), McMaster, FLOTAC and Mini-FLOTAC DNA probes, PCR, and direct fluorescent antibody methods (Parija and Srinivasa, 1999). PCR, and direct fluorescent antibody methods offer high sensitivity, but are expensive for use in the developing world. Direct stool smear, formol-ether, and salt floatation techniques in the form of stool microscopy offers many advantages over other diagnostic methods for detecting intestinal parasites. If performed correctly, simple, and economical (Parija and Srinivasa, 1999). Moreover, diagnostic methods vary considerably in the quantification of egg counts, which is necessary to establish intensity of infection and to evaluate treatment effects (Albonico *et al*., 2012). The formalin-ether concentration technique (FECT) is a widely used sedimentation technique for the diagnosis of intestinal protozoa in preserved stool samples (Allen and Ridley, 1970). The recovery efficiency of the formol-ether concentration (FEC) for helminth eggs, protozoan oocysts and cysts is superior to the direct smear (Ritchie, 1984).

Due to the low density of the parasites in the faeces, direct microscopy is useful for the observation of motile protozoan trophozoites and the examination of cellular exudates, but is not recommended solely for the routine examination of suspected parasitic infections (Ritchie, 1984). It is essential to increase the probability of finding the parasites in fecal samples to allow for an accurate diagnosis. Therefore, a concentration method is employed. Direct wet mount examination should not be entirely excluded as the trophozoites are usually destroyed during the concentration procedure and therefore, microscopic examination of wet mounts should be performed). The concentration procedure requires the use of ether or ethyl acetate as a lipid removing agent and formalin as a fixative. Oocysts of the intestinal coccidians can be seen in a fecal smear by using a modified Ziehl-Neelsen method (Arcari *et al*., 2000).

In protozoan cysts, the number of nuclei and the presence of inclusions are the aid identification of protozoa. In trophozoites, the presence of red cells in amoebae is diagnostic of *Entamoeba histolytica* and flagella also aid identification of some protozoan trophozoites. In helminthes eggs, the shape of the egg, the thickness of the shell, the color of the ovum and the presence or absence of features such as an operculum, spine or hook lets are diagnostic pointers to the identity of the parasite (Arcari *et al*., 2000).

Permanent stained fecal smear might not be the best for for identification of trophozoites and cysts of the intestinal amoebae, flagellates and ciliates can be found and identified as trophozoite stages are most often found in watery or diarrheic fecal specimens and usually cysts are not seen in such specimens. On the other hand, cysts are the stage typically found in formed fecal specimens. A mixture of trophozoites and cysts may occur in softer and semi-formed feces. In direct smears of feces in saline, motile trophozoites may be found (WHO, 2004).

The problem of morphological similarity of two parasites like in the case of *E. histolytica* and the non-pathogenic *E. dispar* has been solved by antigen detection tests, which are now commercially available for the diagnosis of all three major intestinal protozoans. However, the diagnosis and treatment of intestinal helminthic infections have not been changed much and the traditional microscopic method can be used for their diagnosis (Haque, 2007)

Kato-Katz technique is a modification of direct smear procedure, and is especially useful for field surveys for infections because it also gives an estimation of the intensity of infection (WHO, 1994).The Kato-Katz technique WHO (1994) enables the diagnosis of soil-transmitted helminthiasis and intestinal schistosomiasis. Many researchers have satisfactorily applied this technique in studying the prevalence and intensity of intestinal parasitic infections (soil-transmitted helminthes). For the detection of the human soil-transmitted helminth (STH) species, *Ascaris lumbricoides*, *Trichuris trichiura* and the hookworms (*Necator americanus* and *Ancylostoma duodenale*), The World Health Organization (WHO) currently recommends the use of the Kato-Katz method, based on duplicate slides (WHO, 2004). Other commonly used methods include direct smear microscopy, formol-ether concentration (FEC), McMaster, FLOTAC and Mini-FLOTAC. All of these techniques rely on visual examination of a small sample of stool to determine the presence and number of STH eggs (WHO, 1994). Ngonjo *et al.* (2012) in an investigation on the prevalence and intensity of intestinal parasitic infection in Kenya u*sed* Kato Katz method for the helminthes, screening was based on double 47.1mg Kato-Katz smear.

Tulu *et al.* (2014) in a cross-sectional study, applied direct stool examination (using direct saline techniques) in determining the prevalence and its associated risk factors of intestinal parasitic infections among Yadot primary school children of South Eastern Ethiopia.

The number of parasitic forms of both protozoan and helminth parasites in fecal specimens is often too low to be observed microscopically in direct wet mounts or in stained smear preparation (WHO, 1994). In such cases, the use of concentration techniques increases the chances of detecting parasitic organisms, thus increasing the sensitivity of copromicroscopic techniques. The two most commonly used stool concentration techniques are sedimentation and flotation. Sedimentation techniques use solutions of lower specific gravity than the parasitic organisms, thus concentrating the latter in the sediment.

The most commonly used fixatives for stool preservation are either formalin or sodium acetate-acetic acid-formalin (SAF) (Ben Musa and Ibrahim, 2007). Ngonjo *et al.* (2012) used formol-ether concentration method for the screening of intestinal protozoa. Santos *et al.* (2005) found a higher sensitivity for the diagnosis of soil transmitted helminths and *Taenia* species except *Schistosoma mansoni* with formol-ether concentration (FECT) than the Kato-Katz method.

Flotac technique is a newly developed stool flotation method, which many researchers have employed in the diagnosis stool samples (Cringoli *et al.,* 2010). It was facilitated by the use of Flotac apparatus, which was developed in Naples, Italy. The method's principle was based on the centrifugation of stool samples in a flotation solution (FS) with a given specific gravity and the subsequent translation of the upper part of the fecal suspension containing the helminth eggs and intestinal protozoon cysts for microscopy. Flotac technique is able to diagnose not only helminths but also intestinal protozoon infections (Gualdieri *et al*., 2011). Studies carried out so far indicate that the Flotac technique detects human helminth infections with a higher sensitivity than the Kato-Katz technique (Knopp *et al.,* 2009). FLOTAC technique has high sensitivity, but a main limitation is the complexity of the method which involves centrifugation of the sample with a specific device, equipment that is often not available in laboratories in developing countries (Knopp *et al*., 2009). An innovation of the FLOTAC is mini-FLOTAC (improved quality of copromicroscopic diagnosis, a new simplified device) which was developed to overcome this bottleneck. One of the main advantages of this new method is that it can be more easily transferred out laboratories with limited facilities due to the lack of a centrifugation step. Another advantage of the mini-FLOTAC technique is that it permits work with fixed fecal sample, but can also be performed on fresh samples. This allows the possibility of examining the samples in different days and improves the quality control process; in addition, the combined use of the fill-FLOTAC device prevents any hazard of contamination of the operator. Nikolay *et al*. (2014) in an investigation on sensitivity of diagnostic tests for human soil-transmitted helminth infections, concluded that sensitivity was highest for the FLOTAC method, even when evaluated in low intensity settings, and this finding is consistent with previous evaluations (Glinz *et al*., 2010).

Oguoma and Ekwunife (2006) in their study which compared direct smear and formol-ether concentration techniques in diagnosing intestinal parasites, found that the sensitivity of formol-ether concentration was higher than direct smear. This is in agreement with the work carried out by Ikpeze *et al*. (2008) whose work shows 65.26% and 34.74% for formol-ether concentration and direct smear methods respectively. Yimer *et al.* (2015) evaluated the performance of diagnostic methods of intestinal parasitosis in school age children in Ethiopia using Kato Katz, formo-ether-concentration method and wet mount method, and concluded that the Kato Katz technique outperformed the Fecal Ether Concentration technique and the Wet mount method. Another comparative study on Kato Katz and the SAF methods conducted by Ghiwot *et al*. (2014) showed significant difference in estimating the prevalence of *S. mansoni* and *H. nana* infection among the participants. The Kato-Kastz method was superior in estimating the prevalence of *S. manosni* infection while the SAF method was better in determining prevalence of *H. nana* infection.

To get the best method of detection and identification, other diagnostic methods have been developed such as the Immunofluorescence (IF), (ELISA), culture and subsequent differentiation by isoenzyme analysis and the Polymerase Chain Reaction (PCR). These were introduced as alternative methods that are more sensitive and specific. These applications however, Real-time PCR reduces labor time, reagent costs and the risk of cross-contamination, and offers the possibility of detecting multiple targets in a single multiplex reaction. A multiplex real-time PCR has been described for the simultaneous detection of the most important diarrhea-causing parasites, *E. histolytica, G. lamblia, C. parvum／C. hominis* and *D. fragilis* and has demonstrated high sensitivity and specificity with species-specific DNA controls and a range of well-defined stool samples. However, the role of this assay as a diagnostic tool in a routine clinical laboratory requires further evaluation with respect to large scale screening and improved patient diagnosis (Ten Hove *et al.,* 2007).

2.11 Treatment of Intestinal Parasitic Infections

Intervention programmes designed to decrease the prevalence of intestinal helminths have focused on decreasing transmission through improved sanitation and handling of human waste and reducing human infections through drug treatment. The potential advantage of drug treatment is a rapid reduction in infection. The problem with this approach is that these effects may be temporary as the population is rapidly reinfected (WHO, 1996). Anthelmintics are drugs that are used to treat infections with parasitic worms. This includes flat worms (flukes and tapeworms and round worms) nematodes. It is extremely hard to eradicate helminthiases because of the close association between these diseases and poverty (WHO, 1996). As drugs to treat worms are safe and inexpensive, it is feasible to give periodic mass treatment without the prior diagnosis of individual infections.

Several drugs have been used in the treatment of intestinal parasitic infections, and notable among them are mebendazole, albendazole, pyrantel pamoate, metrifonate, piperazine, praziquantel and so on (WHO, 1996). Periodic de-worming with WHO recommended drug has been helped in no small measure in reducing the morbidity associated with worm infection. Preventive chemotherapy with antihelminthic drugs albendazole or mebendazole as recommended by WHO (1987) periodically has been a very good public health intervention method.

Nitazoxanide is a pyruvate ferredoxin oxidoreductase inhibitor, which acts against broad spectrum of protozoa and helminths that occur in the intestinal tract. It is currently used for the treatment of protozoan infections. The mechanism of action of this compound has not been found in nematodes because anaerobic electron transport enzymes are the potential target (Gilles and Hoffman, 2002).

Praziquantel is still the best drug for combating infections from *Schistisoma mansoni* afflicting humans, with a cure rate of 60–90% in various epidemiological settings (El-Ridi and Tallima, 2013). Praziquantel was discovered in the mid-1970s and it has continued to the mainstay of treatment and a critical part of community-based schistosomiasis control program since its discovery (Thomas and Gonnert, 1977). Praziquantel reliably cures 60-90% of patients and substantially decreases the worm (Adenowo *et al*., 2014). Praziquantel, a pyrazinoisoquinoline in randomized controlled trials has been shown to be a very safe oral drug for the treatment of schistosomiasis caused by the various schistosome species (Kanwai *et al*., 2011).

Broad-spectrum antibiotic drugs such as Thiabendazole by UNICEF (2002) was effective Enterobius, Strongyloides, Hookworm and Ascaris lumbricoide at the dose rate of 25mg/kg twice daily for 2 days. Pyrantel pamoate can also be used in a course of 50mg 1-3 times daily for 7 days. Bephenium hydroxynapthoate has been found to be safe and effective against *Ancylostoma* infections nematodes though it was very expensive.

Accoridng to Horton (2000), Albendazole had been shown to be effective against a wide range of helminth species in domestic animals and subsequently, during its development for human use, it was shown to be active against the major intestinal nematodes and three cestode species infecting humans. Its relative failure to be effective in most trematode infections such as *Fasciola hepatica* was ascribed to variation in kinetics of albendazole and the active metabolite albendazole sulphoxide in humans compared to ruminant species such as the sheep (the plasma half life in ruminants is some 5 to 10 fold longer than in humans).

Studies report on treatment results for the two hookworm species in 6272 subjects using a single dose of 400 mg albendazole showed an overall a mean cure rate of

77n7 % and an egg reduction rate of 87n8% were found. Separation of the two species (where the information was provided) showed that efficacy in *Ancylostoma duodenale* infections (cure rate 538\586; 91n8%) were better than for Necator americanus (cure rate 2606\3547; 75n0%). This deferential efficacy has been reported with other anthelminthic agents (Horton, 2000).

Benzimidole is another drug of choice for treatment of worm infection; Benzimidazoles were originally developed as plant fungicides and later as veterinary anthelminthics. It was first benzimidazole to be developed and licensed for human use was thiabendazole in 1962. Since then four other benzimidazoles (mebendazole, flubendazole, albendazole, triclabendazole) have been licensed for human use in various parts of the world. All are benzimidazole carbamates and show a broad spectrum of activity against helminth parasites (Horton, 2000).

The treatment of Giardia and intestinal amoebas is based on 5-nitro-imidazoles derivatives. Single-dose treatments can be used with tinidazole or secnidazole. Nitazoxanide is well tolerated antiparasitic agent with a broad spectrum because it is active on a lot of intestinal protozoa and helminthes (Dupouy-Cement, 2004).

Sorensen *et al.* (1996) in a study of efficacy of three anthelmintic drugs given in a single dose observed that albendazole was the drug of choice for mass deworming where hookworm disease is prominent.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was carried out in Imo State, Nigeria. Imo State is located in south-east geopolitical zone of Nigeria and lies within latitudes 4°45'N and 7°15'N, and longitudes 6°50'E and 7°25'E, with an area of about 5,100 km^2. Imo State is grouped into three geopolitical zones namely: Owerri, Okigwe and Orlu zones. The study was carried out in two zones with both urban and rural settlements, that is, Owerri and Orlu zones of Imo State. The map of Imo State showing Owerri, Orlu and Okigwe zones is shown in Figure 1. Figure 2 showed the study locations for Orlu zone while figure 3 showed the study locations in Owerri zone.

Owerri zone is made of nine (9) Local Government Areas (LGAs) namely; Aboh Mbaise, Ahiazu Mbaise, Ezinihitte Mbaise, Ikeduru, Mbaitoli, Ngor- Okpala, Obowo, Owerri Municipal, Owerri North and Owerri West. In Owerri zone, there are three Local Government Areas with urban settlements and they are, Owerri Municipal, Owerri North and Owerri West while the rest are rural areas. Among the three Local Government Areas with urban settlements, Owerri Municipal is the only one that is hundred percent urban while the other two have mixed type of settlements (urban and rural).

On the other hand, Orlu zone is made up of twelve (12) Local Government Areas namely; Ideato North, Ideato South, Isu, Njaba, Nkwere, Nwangele, Oguta,

Ohaji/Egbema, Orlu, Orsu, Oru East and Oru West. The urban LGAs in Orlu zone include Orlu and Oguta. This classification is in line with that of the Imo State Ministry of Lands, Survey and Urban Planning.

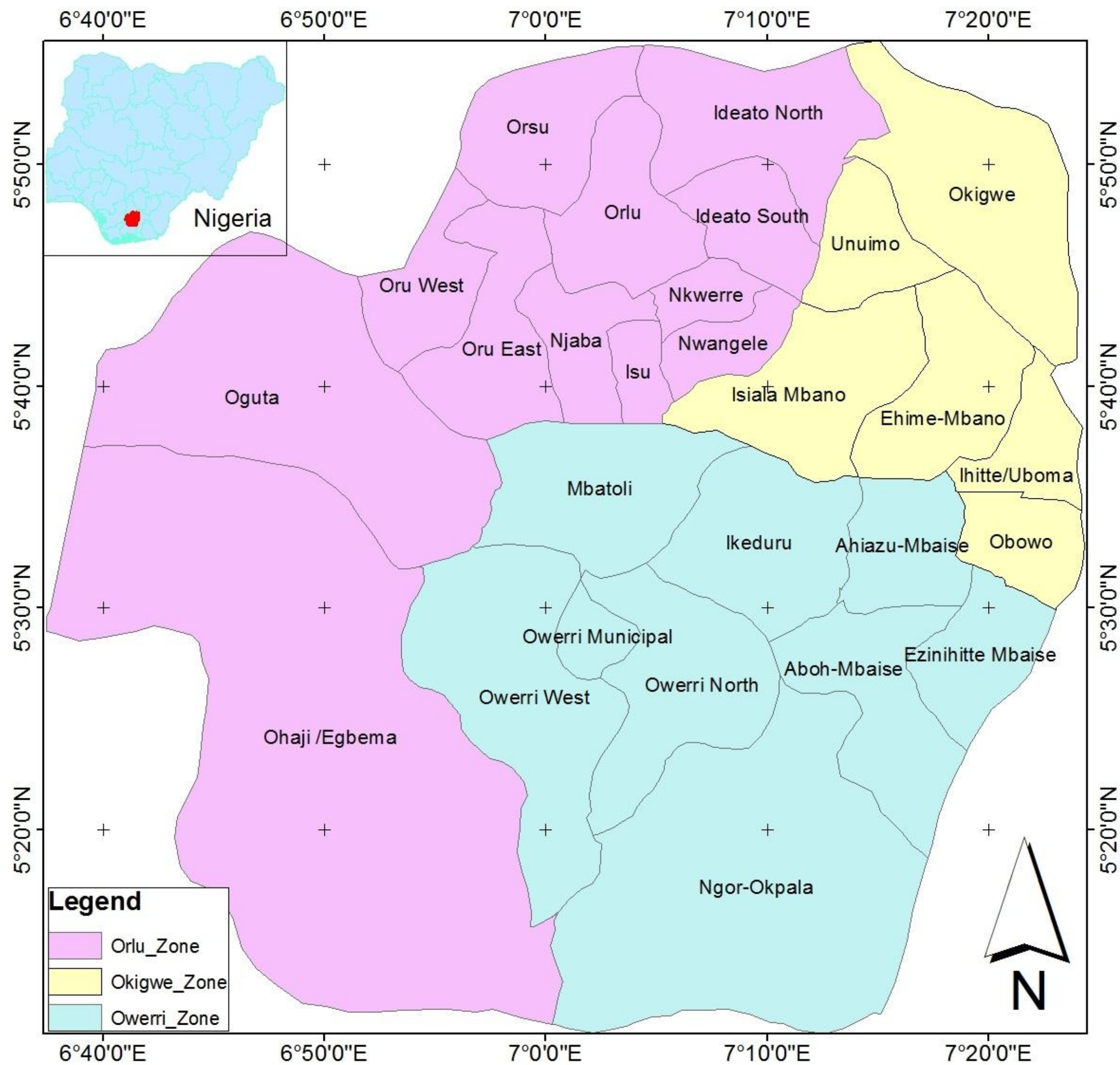

Fig. 1: Map of Imo State showing Orlu and Owerri zones

Source: Imo State Ministry of Urban and Rural Development

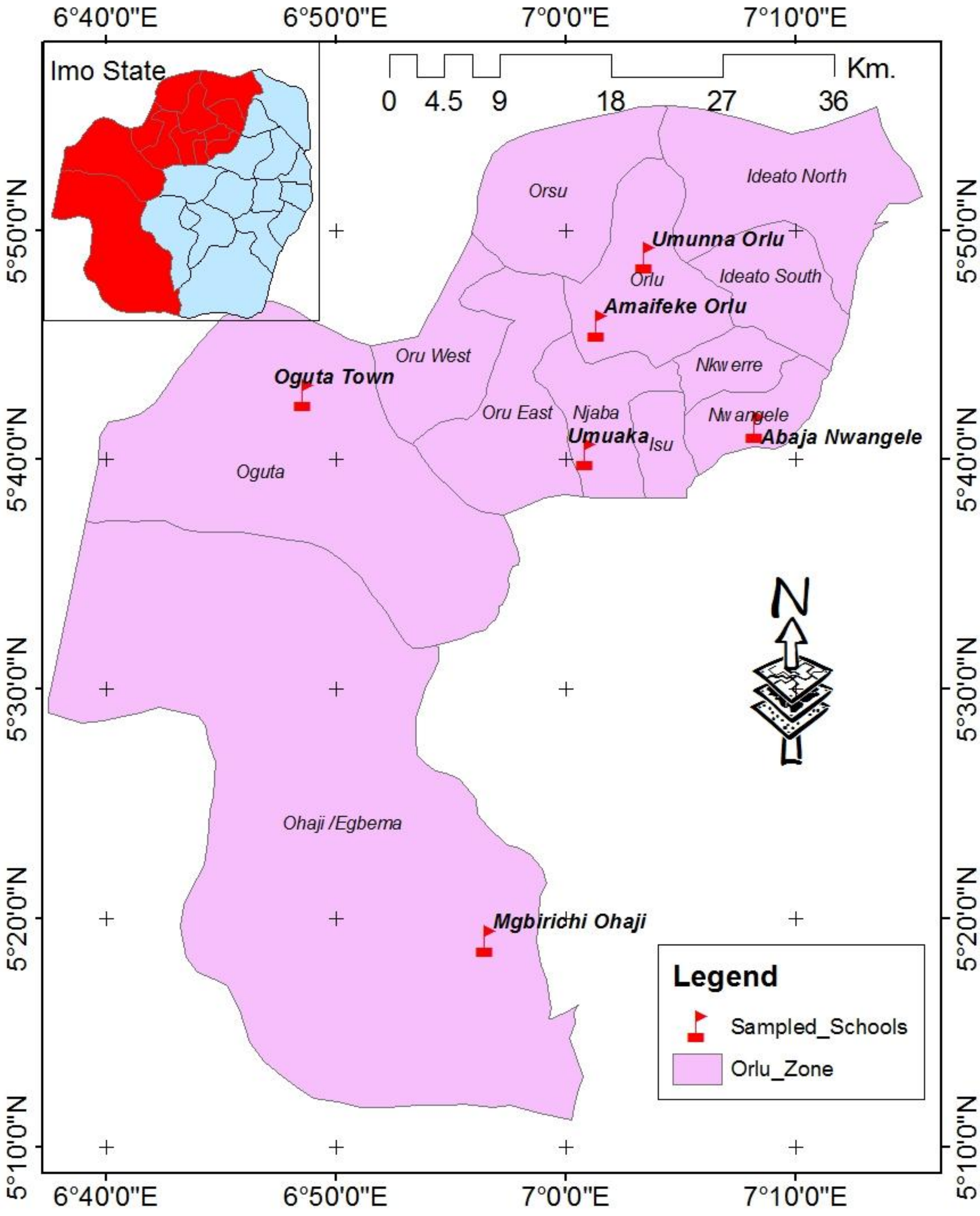

Fig. 2: Map of Orlu zone showing study locations

Source: Imo State Ministry of Urban and Rural Development,

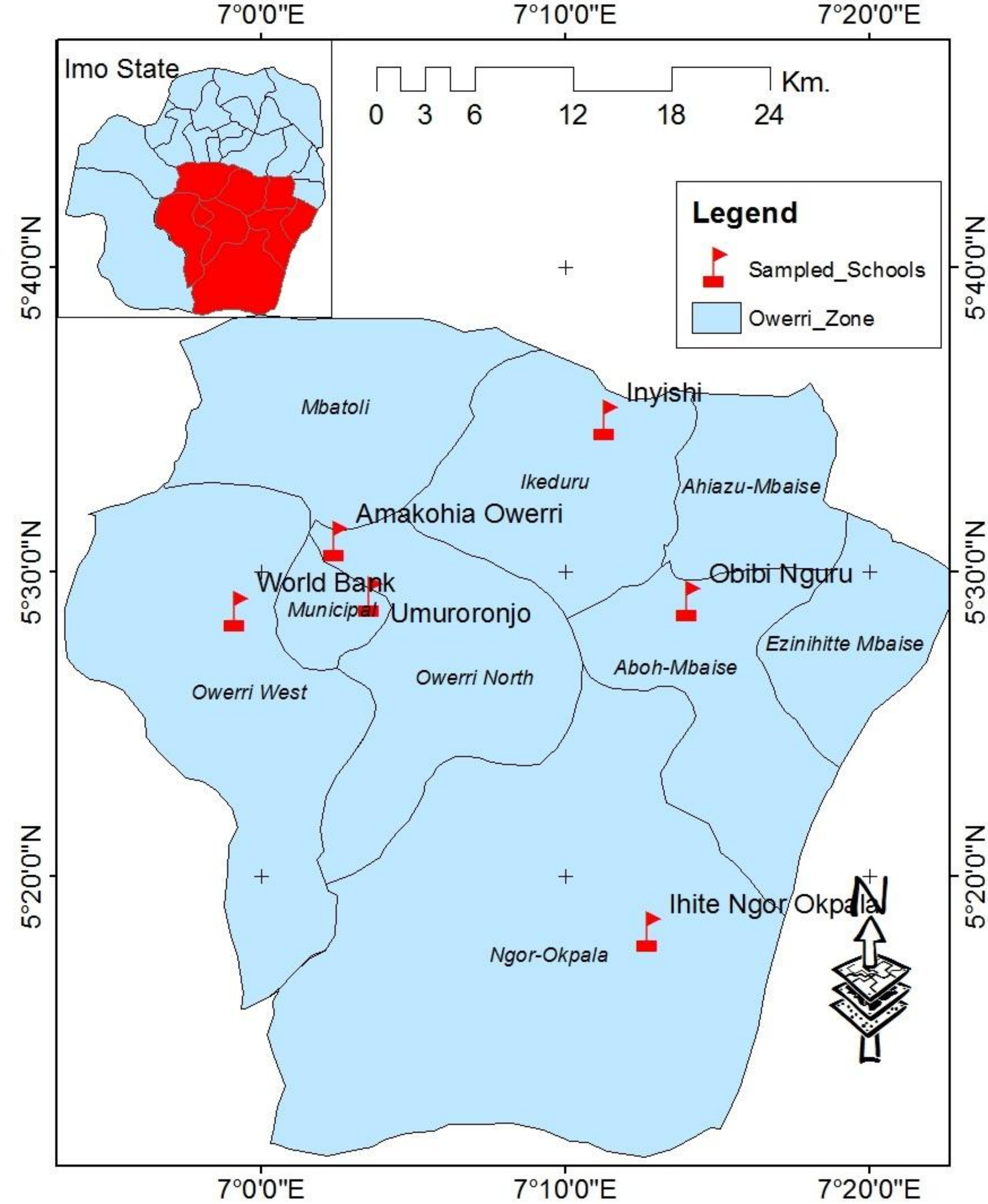

Fig. 3: Map of Owerri zone showing the study locations.

Source: Imo State Ministry of Urban and Rural Development

3.1.1 Infrastructure

There are still inadequate social amenities in Orlu and Owerri zones, just like other areas in Nigeria. In Owerri and Orlu zones, pipe borne water is hardly available, the most available source of water is borehole water and is not available in all homes. In rural areas of Owerri and Orlu zones, the major sources of water are borehole, river water, streams, spring water, and rain capture and pond water. The attendant long distances and rough roads associated with the access to streams and river, and selling of water with the attendant cost of provision of potable water by borehole owners might restrict access to adequate water supply to the inhabitants of the area. Even though the long distances are covered, lesser volumes of water are carried which reduces water availability and accessibility. Pond water, though available during the rainy season, are highly contaminated, and are not often used for drinking and other domestic purposes.

In the rural areas of Owerri and Orlu, the methods of faecal disposal include pit latrine and indiscriminate faecal disposal near and around bushes. Schools and homes in the urban parts of Owerri Zone have modern toilet facilities although water may not be available for proper hygienic up keep.

Data from Imo State Universal Primary Education Board showed that there were about five hundred and three (503) government-owned primary schools in Orlu zone with an estimated population of about one hundred and nine thousand, one hundred and fifty one (109,151) pupils. In Owerri zone, there were about four hundred and ninety three (493) government owned primary schools with an estimated population of about one hundred and six thousand, three hundred and forty one (106,341) pupils. Available health facilities include, one health centre in every community, one government owned hospital in every local government and some private hospitals in some communities.

3.1.2 Occupation

The dominant occupations of the people of Orlu and Owerri zones are civil service, farming, trading and artisanship. The major food crops grown in Orlu and Owerri zones areas are cassava, yam, maize, plantain, cocoyam, and fruits. Oil palm, raffia palm, rice, groundnut, melon, kola nuts, coconut are some of the cash crops produced in these areas. Some parts of Orlu zone (Oguta and Ohaji) have natural water and streams, which can be used for various industrial and developmental purposes to enhance their living standards. The people living close to the water are involved in fishing activities in addition to farming. The common domestic animals reared include goats, chicken and sheep for meat and also economic purposes. People in Orlu people also practice blacksmithing especially Umuozu indigenes. They also engage in either urban or rural based commercial activities.

3.1.3 Climate

In Orlu and Owerri zones, two seasons, wet (rainy) and dry are observed in the year. According to Imo State metrological records, the vegetation of Imo state is tropical rain forest. The rainy season begins in April and lasts until late October with annual rainfall varying from 1,500mm to 2,200mm (60 to 80 inches). The average annual temperature is above 20°C (68.0°F) which creates an annual relative humidity of 75%, with humidity reaching 90% in the rainy season. These areas experience dry season from December to March and harmattan commences from late December to late January. The hottest months in Imo state are between January and March. Double maxima, with the first maximum in June and the second in September also characterized the climate. There is thus a “little dry season” in-between known as “August Break” brought about by the seasonal north and southward movement of the ITCZ (Inter-Tropical Convergence Zone). Current mean maximum temperature is 32.1^oC while the current minimum temperature is 23.5^oC.

3.2 Experimental Design

A cross-sectional study was conducted from April to October in 2015, to determine the effect of intestinal parasitic infections (IPIs) on nutritional status of school age children in Owerri and Orlu senatorial zones, in Imo State, Nigeria. Twelve (12) primary schools in urban and rural areas of Owerri and Orlu (6 from each Zone) were selected using simple random sampling method. Faecal and blood samples were collected from 1200 randomly selected school children within the ages of 6-13 years and transported to the laboratory for analysis. Faecal samples were examined using Kato Katz method and formol-ether concentration techniques, while blood samples were examined using cyamethahaemoglobin method. Anthropometric indices were used as indicators of nutritional status, children whose Height-for-Age, Weight-for-Age and Weight-for-Height were <-2 standard deviation (SD) were classified as stunted, underweight, and wasted. Children whose haemoglobin level were <8.0g/dl were classified as being anaemic. Pupils with history suggestive of common childhood chronic illness such as sickle cell anemia, human immunodeficiency virus (HIV) were not included in the study.

3.3 Advocacy Visit

Advocacy visits were made to the Chairmen of the Local Governments Areas, the Local Governments' health officers and Executive Education Secretaries to solicit for their support. In the same manner, advocacy visits were made to traditional rulers in each of the selected communities, during which the purpose and the benefits of the research were discussed with their traditional rulers and the cabinet members. The Traditional Rulers gave consent and pledged their support. The head teachers of selected primary schools were visited with the ethical clearance for the study and approval from Department of Public Health, Imo State Ministry of Health. The need and benefits of the study were discussed with them. The objective of the study was explained to the teachers and parents/guardians of participants, and written informed consent was sought from parents or guardians of selected pupils before commencement.Data collection days were arranged with the teachers and parents/guardians were notified of the days through written notices and announcements in churches.

3.4 Ethical Clearance

The study was approved by the Department of Parasitology and Entomology, Nnamdi Azikiwe University Awka. Ethical clearance was obtained from Ethical Committee of Imo State Specialist Hospital Umuguma, Owerri Imo State before commencement of the study. Permission to conduct the research was also obtained from Department of Public Health, Imo State Ministry of Health. The copy of the Ethical Clearance is attached in the appendix (see Appendix I). Ethical considerations were applied by issuing of results of laboratory analysis to parents. Samples and data from participants were identified with codes and participants were assured of the confidentiality of data collected.

Table1: Number of Selected LGAs, Communities and Schools

Selected LGAs	Zone	No. of Comm.	Selected Community	Name of School	Designation
Aboh Mbaise	Owerri	33	Obibi Nguru	Obibi Primary School	Rural
Ikeduru	Owerri	29	Inyishi	Community Primary Inyishi Ikeduru	Rural
Ngor Okpala	Owerri	28	Ihitte	Community Primary School Ihitte Ngor	Rural
Njaba	Orlu	20	Umuaka	Hilltop Primary School Umuaka	Rural
Nwangele	Orlu	12	Abaja	Central School Njaba	Rural
Oguta	Orlu	24	Oguta	Uguta Town School	Urban
Ohaji/Egbema	Orlu	20	Mgberichi	Mgbirichi Central School Ohaji	Rural
Orlu	Orlu	35	Umunna &	Holy Trinity Primary School	Urban
			Amaifeke	Cental School Amaifeke	Urban
Owerri Municipal	Owerri	1	Umuroronjo	Development Primary School Ow.Municipal	Urban
Owerri North	Owerri	21	Amakohia	Orlu Road Primary School Amakaohia	Urban
Owerri West	Owerri	21	Worldbank	St. Mark’s Primary School Federal Housing	Urban

Source: Imo State Ministry of Urban and Rural Development

3.5 Selection of Local Governments Areas and Communities

Rural and urban areas in Orlu and Owerri zone were first identified. Owerri zone was divided into four strata using the map of Owerri zone. This was done to ensure proper representation of the area. The Local Government Areas in each of the subdivided area were given opportunity of being selected by adopting a simple random sampling technique (balloting). Through the random process, the following Local Government Areas were selected from Owerri zone; (Aboh Mbaise, Ikeduru, Ngor Okpala) as part of rural LGAs. Three Local Governments Areas in Owerri with urban settlements status (Owerri North, Owerri West and Owerri Municipal) were all included in the study.

In the same manner, Orlu zone was divided into three strata using the map of Orlu zone. This was also done to ensure proper representation of the area. The Local Government Areas in each of the subdivided area were given opportunity of being selected by adopting a simple random sampling technique (balloting). At, the end of the process, three LGAs (Ojaji/Egbema, Njaba, and Nwagele) were selected from Orlu rural LGAs. Random sampling method was not used in the selection of Oguta and Orlu LGAs as Orlu urban LGAs as they are the only two LGAs in Orlu zone with urban settlements, hence both were all taken.

Simple random sampling method was employed to select one community from each of the randomly selected Local Governments Areas. The selected comminties in Owerri and Orlu Zones are as shown in table 1.

3.6 Selection of Schools

A comprehensive list of all the schools within the randomly selected communities were obtained from Imo State Universal Primary Education Board, Owerri. Majority of the communities in Imo State have only two primary schools owned by government. One primary school was selected by balloting in each of the randomly selected communities. In a community where there is only one primary school, the school was taken. By applying this method in all the selected communities, twelve primary schools were selected for the study.

3.7 Selection of Study Population

a) For prevalence, Intensity and Anaemia

In each of the randomly selected schools, the head teacher provided the list of all the children within the ages of 5-13 years old in their schools. To ensure proper representation of all age groups, the pupils were listed according to their different age groups. Simple sampling method (random) was used to make selections from each age group, until one hundred pupils were selected from each school. In all, one thousand two hundred (1,200) primary school pupils (both sexes) were randomly selected from twelve primary schools in Owerri and Orlu Zones.

b) For anthropometric Study

For this study, 300 pupils were randomly selected from the already selected one thousand two hundred pupils (1200) used for prevalence and intensity study.

For all the studies, pupils with history suggestive of common childhood chronic illness such as sickle cell anemia, human immunodeficiency virus (HIV) were excluded from the study in accordance with the works of Saloojee and Cooper (2008).

3 .8 Sample Size Determination

The sample size was determined using Daniel (1999) statistical formula for determination of sample size using prevalence population. The formula was given as follows:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where n = sample size

Z = Z statistic for a level of confidence (1.96)

P = expected prevalence or proportion (assumed to be 50%, p = 0.5)

d = precision in proportion of one; at 5%, d =0.05)

Applying the formula above,

$$n = \frac{(1.96)2\ (0.5)\ (0.5)}{(0.05)2}$$

$$\frac{3.8416 \text{ x } 0.25}{0.0025}$$

$$= 384$$

The sample size determined by the above method was too small for a Ph.D research work. The sample size was increased to one thousand two hundred (1200) subjects.

3.9. Sample Collection

3.9.1. Stool Sample

Each pupil was provided with a clean, dry, caped, well-labeled specimen/container bottle for a fresh fecal sample collection. The pupils were adequately instructed on how to get a little portion of their stool (approximately 5g) into the bottles. Their class teachers helped to ensure compliance. At the time of collection, date of sampling, serial number of participant, age, sex and consistency of the stool (formed, soft, semi-soft and watery) were recorded for each subject on a recording format. Sample collection started in each of the selected Schools by 11.00am and ended at 1.00pm each day. Maximum of fifty (50) samples were collected per day. All stool samples were transported to Parasitology Laboratory, Federal Medical Centre, Owerri for analysis. About thirty (30) stool samples were analyzed per day, and the remaining samples were immediately preserved with 10% formalin.

3.9.2. Blood Sample

Blood sample (2ml) was collected from each child from the median cubital vein at the elbow using syringe and tunike. The blood samples were transferred into an EDTA sample bottle for analysis. The blood samples were transported to Federal Medical Centre (Owerri) laboratory within 60 minutes for analysis.

Objective 1: Determination of Prevalence and Intensity of Intestinal Parasitic Infections among Children from Primary Schools in Imo State.

3.9.3 Examination of Fecal Samples for Prevalence and Intensity of Helminths using Kato-Katz Cellophane Faecal Thick Smear Technique

Procedure

A small mount of faecal material was placed on a scrap paper and the small screen was pressed on top of the faecal material so that some of the faeces sieved through the screen and accumulated on top of the screen. The flat-sided spatula was scraped across the upper surface of the screen so that the sieved faeces accumulated on the spatula. A template with hole was placed on the centre of a microscope slide, and faeces from the spatula were added so that the hole was completely filled. Using the side of the spatula, the template was passed over to remove excess faeces from the edge of the hole (the spatula and screen may be discarded or, if carefully washed, may be reused again).

The template was carefully removed from the slide so that the cylinder of faeces was left completely on the slide. The faecal material was covered with the presoaked cellophane strip. The strip was made wet if faeces were dry and less so with soft faeces (when excess glycerol solution was present on upper surface of cellophane, the excess was wiped with toilet paper). The microscope's slide was inverted and firmly pressed the faecal sample against the hydrophilic cellophane strip on another microscope slide or on a smooth hard surface such as a piece of tile or a flat stone. With this pressure, the faecal material was spread evenly between the microscope slide and the cellophane strip. The slide was carefully removed by gently sliding it sideways to avoid separating the cellophane strip or lifting it off. The slide was placed on the bench with the cellophane upwards. Water evaporated while glycerol cleared the faeces. The slides were kept for one more hour at room temperature to clear the faeces material prior to examination under the microscope. The number of eggs of each parasite species was recorded and converted into the number of eggs per gram of stool (EPG) in order to determine the intensity of infection. Egg per gram of faeces (EPG) was determined by calculating the number of eggs per gram of faeces (epg), that is, egg mean count multiplied by multiplying factor (24). A multiplication factor was 24 because a template of 41.7mg was used. Infection intensity was categorized as light, moderate, and heavy infection created for common STH infections following the WHO standard procedure (Montresor *et al.*, 2002). The characteristics used to identify the species of eggs were as follow: size, shape, stage of development when passed in faeces, thickness of the eggshell and colour of the egg.

3.9.4 Determination of Prevalence of Protozoans Using Sedimentation Method (Formol-ether Concentration Technique)

Procedure

Approximately 1g of faeces was measured out and 10ml of 10% formalin was added and stirred until a cloudy suspension was formed. Gauze was fitted into a funnel and the funnel placed on top of the centrifuge tube. The faecal suspension was placed through the filter into the centrifuge tube until the 7ml mark was discarded with the lumpy residue. Then, 3ml of ether was added and mixed well for one minute before it was centrifuged for 3 minutes. After centrifugation, there were four layers in the tube. The first was that of ether, followed by the debris, formalin solution layer and the layer containing the eggs and cysts of parasites (the sediment). The fatty debris at the interface was then loosed with applicator stick and the supernatant was quickly poured off by inverting the tube. The small deposit at the bottom of the centrifuge was shaken before it was poured on to a slide and examined. Both the 10X and 40X objectives were used for detection/observation of eggs and larvae of helminth and cysts and trophozoites of protozoan parasites. The characteristics used to identify the parasite cysts or trophozoites of species of were as follow, the presence of nucleus, number of nuclei, shape, size, fibrils, motility, and number of flagella.

Objective 2: Determination of the Relationship between Intestinal Parasitic Infections and Anthropometric Indices among the Children

3.10 Anthropometric Measurement

3.10.1 Sampling and Registration of Subjects for Anthropometry

Three hundred (300) pupils were randomly selected from the one thousand and two hundred (1200) samples for anthropometry study. Anthropometric measurements of the pupils were carried out by a method described by WHO (1986). The subjects were weighed barefooted and in light clothing on a bathroom scale accuracy of 0.1kg. The scale was standardized before use with 11kg weight. Height was measured to the nearest 1cm, with a paper stadiometer attached to a vertical wall. Subjects stood barefooted with their scapula, buttocks and heels' resting against a wall, the neck was held in a natural non-stretched position, and the heels were touching each other. Nutritional status indicators were classified and standardized into Z-scores for height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) in EPI Info (version 3.2), relative to the WHO reference curves recommended for international use (WHO, 1986). Nutritional assessment of children were evaluated using the World Health Organization (WHO) 2007 recommended HC –for-age specific z-score cut-off value. Moderate under nutrition: <-2 standard deviation (SD) z-score value while severe under nutrition: <-3 standard deviation (SD).

The nutrition categories used for height-for-age were:

Over height (>97th percentile)

Normal height (51st -97th percentile)

Moderately under-height (3rd -51st percentile)

Severely under-height (<3rd percentile)

The nutrition categories used for weight-for-age were

Over weight (>97th percentile)

Normal weight (51st -97th percentile)

Moderately underweight (3rd -51st percentile)

Severely underweight (<3rd percentile)

The nutrition categories used for weight –for –height were:

Well Nourished (51st and above percentile)

Moderately Malnourished (3rd -51st percentile)

Severely Malnourished (<3rd percentile)

Classification used for Z-scores were:

<-3= severe

<-1 to <- 2 = moderate

<-1 = normal

>1 = above normal

Key

<60% of reference = severe acute malnutrition

60-75% of reference =moderate acute malnutrition

75-90% of reference = mild acute malnutrition

>90% = normal

3.11. Instrument for Data Collection

A well-articulated and structured questionnaire was used for data collection. The questionnaire was designed to seek information on demographic characteristics of the pupils.

3.11.1 Administration of the Questionnaire

The questionnaires and written informed consent were issued to mothers of study participants on the day of sample collection. The researcher administered the questionnaire to mothers and subjects in the schools visited. The researcher interacted with the study participants and their mothers on person-to-person interview and the questionnaire was completed on the spot and collected. The questionnaire had same numbering with the sample containers.

Objective 3: Determination of the Prevalence of Anemia with Respect to Number of CoInfections, Location and Type of Parasite Isolated from Infected Children In the Study Areas.

3.12 Determination of Haemoglobin Level

Estimation of haemoglobin concentration using the cyamethahaemoglobin method

Procedure

The method employed was as described by (Cheesbrough, 2002). Blood sample was collected with a syringe. Five (5mls) of Drabkin's solution was pipetted into the test tube. Twenty microliter (20µl) of the blood sample was also pipetted into the test tube. The solution inside the test tube was then covered and inverted several times, after which, it was left to stand at room temperature for 5-10 minutes at room temperature (37^{o}c) to ensure complete conversion. The solution was then poured into a cuvette and read with a spectrophotometer which was set to 100% transmittance at 540nm, using Drakin's solution as blank. The haemoglobin level was determined using Beer's law and standard curve. HiCN was used as standard

$$\text{Hb Concentration} = \frac{\text{Absorbance of test X Conc of standard X Dilution factor}}{\text{Absorbance of standard}}$$

Objective 4: Determination of the Relationship between Intensity of Intestinal Parasitic Infections, Malnutrition and Anemia.

3.13 Data Analysis

Statistical Package for Social Sciences (SPSS) version 15 Software Package was employed to analyze the data generated. Data generated (from prevalence and intensity of intestinal parasitic infections, and prevalence of anaemia) were sorted into categories and observations, and analyzed by using simple frequency tables and percentages. Chi-square at $P< 0.05$ level of significance was employed to test the following: the relationship between intestinal parasitic infections and anthropometric indices; the prevalence of anaemia with respect to number of co-infections, location and type of parasite isolated from infected children in the study areas and the relationship between intensity of intestinal parasitic infections, malnutrition, and anaemia.

CHAPTER FOUR

4.0 RESULTS

4.1 Prevalence and Intensity of Intestinal Parasitic Infections among Children from Primary Schools in Imo State.

4.1.1 Overall Prevalence of Intestinal Parasitic Infections in the Study areas

Table 2 shows the overall prevalence of intestinal parasitic infections in the study areas. Out of the 1200 children selected from the study areas (rural and urban areas in two senatorial zones (Owerri and Orlu) in Imo state), 232 subjects were positive for intestinal parasitic infections with a prevalence of 19.3%. In the four study locations, the highest prevalence of 23% (69) was observed in rural areas in Orlu (Orlu rural), followed by 21% (63) for rural areas of Owerrri zone (Owerri rural), and 18.3% (55) for Orlu urban. The least prevalence of 15% (45) was obtained in urban areas of Owerri zone (Owerri urban) (see Table 2). At $p>0.05$, there was variation in the prevalence of IPIs in rural areas of Owerri and Orlu. Similarly, there was no variation in the prevalence of IPIs in urban Owerri and Urban Orlu ($p>0.05$). The prevalence of IPIs was not significantly ($p>0.05$) higher in rural areas than urban areas.

Table 2: Overall Prevalence of Intestinal Parasitic Infections by study locations

Area/Locations	No Examined	No. Infected	Prevalence Rate
Orlu Zone			
Orlu Urban	300	55	18.3
Orlu Rural	300	69	23.0
Owerri Zone			
Owerri Urban	300	45	15.0
Owerri Rural	300	63	21.0
Total	**1,200**	**232**	**19.3%**

(Rural areas - X^2 =0.3497, df=1, P>0.05)

(Urban areas X^2 – 1.2, df = 1, P>0.05)

(Urban and Rural Area- X^2 = 3.6585, P>0.05

4.1.2 Species and Prevalence of Parasites Identified in Various Locations

Types and prevalence of parasites identified in various locations is shown in Table 3. Eight (8) intestinal parasites comprising of *Ascaris lumbricoides* (3.8%)*, Trichuris trichiura* (1.3%), hookworm (1.8%), *Stongyloides stercoralis* (0.2%)*, Taenia* sp (0.5%), *Entamoeba histolytica* (7.7%)*, Entamoeba coli* (3.7%)*,* and *Giardia lamblia* (4.2%) were indentified. The total prevalence of intestinal helminth infection was 7.5% while the prevalence of intestinal protozoan infection was 15.5%.

The prevalence of *Ascaris lumbricoides* was highest in Owerri rural (5.0%) followed by Owerri urban and Orlu urban (3.7% respectively). The least prevalence of *Ascaris lumbricoides* was obtained in Orlu rural (2.7%).

The prevalence of *Trichuris trichiura* was highest (2.0%) in Owerri rural followed by Owerri urban (1.3%). The least prevalence (1.0%) of *Trichuris trichiura* was observed in both Orlu urban and Orlu rural (see Table 3).

The highest prevalence (2.0%) of hookworm infection was obtained both in Owerri rural and Owerri urban, followed by Orlu urban (1.7%), while the least prevalence (1.3%) was in Orlu rural.

Taenia infection was only observed in Orlu urban and Orlu rural. The prevalence was higher in Orlu rural (1.3%) than in Orlu urban (0.7%).

S. stercoralis was only present in Orlu rural with a prevalence of 0.2%.

The highest prevalence of *E. histolytica* was observed in Orlu rural (10.7%), followed by Orlu urban (7.7%) while the least prevalence was recorded in Owerri urban (5.3%).

The highest prevalence of *G. lambia* was recorded in Owerri rural (5.3%), followed by Orlu rural (4.3%) while the least prevalence was observed in Orlu urban (3.3%).

The highest prevalence of *E. coli* was recorded in Owerri rural (5.0%), followed by Owerri urban and Orlu rural (3.3%) while the least prevalence was observed in Orlu urban (3.0%).

Table 3: Species and Prevalence of Parasites Identified in Various Locations

Location	No. Examined	*A. lumbriocoides*	*T. trichuria*	*Hookworm* spp	*Taenia* spp	*S. stercoralis*	*E. Histolytica*	*G. lamblia*	*E.coli*
Owerri urban	300	11(3.7)	4(1.3)	5(1.7)	0(0.0%)	(0.0%)	16(5.3%)	11(3.7)	10(3.3%)
Owerri rural	300	15(5.0)	6(2.0)	6(2.0)	0(0.0%)	0(0.0%)	21(7.0%)	16(5.3%)	15(5.0%)
Orlu urban	300	11(3.7)	3(1.0)	6(2.0)	2(0.7)	0(0.0%)	23(7.7%)	10(3.3%)	9(3.0%)
Orlu rural	300	8(2.7)	3(1.0)	4(1.3)	6(0.5)	2(0.7)	32(10.7%)	13(4.3%)	10(3.3%)
Total	1200	45(5.8)	16(1.3)	21(1.8)	6(0.5)	2(0.2)	92(7.7%)	50(4.2%)	44(3.7%)

4.1.3 Intensity of Intestinal Helminths with Respect to Location

As shown in Table 4, the intensity of intestinal helminths ranged from 166.7±55.0 epg for hookworm in Owerri rural to 9241.5±6553.5 epg for *Ascaris lumbricoides* in Owerri rural. The intensity of *Ascaris lumbricoides* was in highest in Owerri rural (9241.5±6553.5 epg) followed by Orlu urban (6196.4±4277.4 epg), while the least intensity (647.3+192.2 epg) was observed in Owerri urban. The intensity of *Trichuris trichiura* was highest in Orlu rural (1413.3± 23.1epg) and was lowest (500±225.5 epg) in Owerri rural. The intensity of hookworm infection ranged from 1293.3± 293.2 epg in Orlu urban to 166.7±55.0 epg in Owerri rural. The intensity of *A. lumbricoides* and *T. trichiura* did not vary at different locations ($P>0.05$) while the intensity of hookworm infection was significantly associated with location ($P<0.05$).

The intensity of *Taenia* spp was 880.0±720.0 epg and 240±46.2epg in Orlu urban and Orlu rural respectively. The intensity of *Strongyloides stercoralis* was 480.0±0.1epg in Orlu rural (Table 4).

Table 4: Intensity of Intestinal Parasitic Infections with Respect to Location (intensity in epg).

Location	***A. lumbriocoides***	***T. trichuria***	***Hookworm spp***	***Taenia spp***	***S. stercoralis***
0werri urban	647.3± 192.2	1080± 23.1	848± 217.0	--	--
Owerri rural	9241.5 ± 6553.5	500.0± 2255	166.7± 55.0	--	--
Orlu urban	6196.4± 4277.4	653.0± 73.5	1293.3±293.24	880.0± 720.0	--
Orlu rural	2930.0± 1137.2	1413.3± 213.3	940.0±384.2	240.0± 46.2	480± 0.1
Total	5274.3± 2423.9	845.0± 164.7	798.1±149.1	453.3± 132.6	48.01± 0.1

$P<0.05$

4.1. 4 Intensity of Intestinal helminthes Infections

Intensity of intestinal helminthes (light, moderate and heavy intensity) identified were as shown in Table 5. Generally, majority of the children had light infection (73.1%). The intensity of infection with *Ascaris lumbricoides* infection ranged from light to heavy. Out of forty five (45) schoolchildren that were infected with *Ascaris lumbricoides*, 36 (80%) had light intensity; eight (8) had moderate intensity while one (1) had heavy intensity.

Out of sixteen (16) children that were infected with *Trichuris trichiura*, six (6) of them had light intensity while ten (10) had moderate intensity. No heavy intensity was recorded for *Trichuris* infection.

Out of twenty one (21) schoolchildren that were infected with hookworm, majority of them (85.7%) had light intensity, while three (3) had moderate intensity.

There is no classification of intensity for *Taenia* spp and *Strongyloides sercoralis.*

Table 5: Intensity of Intestinal Helminthes Infections

Level of Infection Intensity (epg)	**No. Infected**	**Percentage**
A. lumbricoides		
Light (1-4999)	36	80.0
Moderate (5000-49,999)	8	17.8
Heavy (> = 50,000)	1	2.2
Total	45	100
Trichuris trichiura		
Light (1-999)	6	37.5
Moderate (1000-9,999)	10	62.5
Heavy (> = 10, 000)	0	0.0%
Total	16	100
Hookworm (infection)		
Light (1-999)	18	85.7
Moderate (2000 – 3999)	3	14.3
Heavy (> = 4000)		
Total	21	100
S. stercoralis	NA	
Taenia spp	NA	

4.1.5: Prevalence of Co-infection Infection among the Study Population

Table 6 shows that double infections were recorded. Out of the 232 children infected, 45(3.8%) had double infection while no triple was reported. The highest prevalence of mixed infection was an association between *Ascaris lumbricoides* and *E. coli* (31.1%), followed by *Trichuris trichiura* with *E. histolytica* (28.9%) while the least was association between *E. histolytica* with *E. coli*

Table 6: Prevalence of Co- infection Among the Study Population

No. Examined	No. Infected	No. Co-infection	Types of Parasites Co-infected				
			E. histolytical + *G. lamblia*	*T. trichiura* + *E. histolytica*	*A. lumbricoides* + *E. coli*	*E. histolytica* + *E. coli*	*G. lamblia* + *E. coli*
		No.	No. (%)	No. (%)	No. (%)	No. (%)	No.(%)
1200	232	45(15.6%)	9(20.0%)	13(28.9%)	14(31.1%)	2(4.5%)	7(15.6%)

4.2 Determination Relationship between Intestinal Parasitic Infections and Anthropometric Indices among the Children

4.2.1: Socio-demographic Characteristics of Children Used for Anthropometric Studies.

Socio-demographic characteristics of children used for anthropometric studies are as shown in Table 7. Among the three hundred children used for anthropometric studies, 136(45.3%) were males while 164(54.7%) were females. Majority (39.7%) of the children were between the ages of 8-10 years old the least 89(29.7%) were children aged 5-7 years. On their parent's occupation, majority 60 (20.0%) were pretty traders, 59(19.7%) were civil servants, 20(6.7%) were health workers, 11(3.6%) were clergy, 51(17.0%) were farmers, 50(16.6%) were self-employed while 49(16.3%) were artisans (Table 7).

Table7: Socio-demographic Characteristics of Children Used for Anthropometric Studies.

Variable	Category	Frequency
Sex	Male	136(45.3%)
	Female	164(54.7%)
Total		**300(100%)**
Age	5-7	89(29.7%)
	8-10	119(39.7%)
	11-13	92(30.6%)
Total		**300(100%)**
Parents' occupation		
	Civil servants	59(19.7%)
	Health worker	20(6.7%)
	Clergy	11(3.6%)
	Farmer	51(17.0%)
	Trader (petty)	60(20.0%)
	Self employed	50(16.6%)
	Artisan	49(16.3%)
Total		**300(100%)**

4.2.2 Prevalence of Malnutrition (stunting, under-weight and wasting) in Children Used for Anthropometric Study

Table 8 shows prevalence of malnutrition among 300 children used for anthropometric study. The prevalence of stunting was 31.3.0% (94). Twelve (12) children (4.0%) were under-weight while 4 (1.4%) had wasting (Table 8). The prevalence of stunting was significantly ($p<0.05$) higher than under-weight and wasting (12.0% and 4.0% respectively.

Table 8: Prevalence of Malnutrition (stunting, under-weight and wasting) in Children Used for Anthropometric Study

Type of Malnutrition	No Examined	No Malnourished
Height for Age	300	78(26.0%)
Weight for Age	300	12(4.0%)
Weight for Height	300	4(1.4%)
Total	300	94(31.3%)

4.2.3 Prevalence of Intestinal Parasitic Infections and Malnutrition among Infected Children Employed for Anthropometric Study

As shown in Table 9, the prevalence of intestinal parasitic infections among children employed for anthropometric study was 16.6%. The prevalence of malnutrition among infected children was 28.0% (14). Children infected with *Ascaris lumbricoides* had the highest prevalence of malnutrition (42.9%) followed by those infected with Hookworm and *E. coli* (21.4. %) while children infected with *T. trichiura* and *E. histolytica* had 0.0% prevalence of malnutrition (Table 9). At P-value of 0.005, there was significant relationship between the intestinal parasite a child is infected with and the prevalence of malnutrition.

Table 9: Prevalence of Intestinal Parasitic Infections and Malnutrition among Infected Children Employed for Anthropometric Study

No. Examined	No. Infected	Type of Parasite	Prevalence (%)	Type of Malnutrition		
				Stunting (%)	Under-weight(%)	Total No. of Malnutrition(%)
300	50(16.6%)	*A.lumbricoides*	12(24.0%)	4(33.3)	2(100.0%)	6(42.9%)
		T. trichiura	2(4.0%)	0(0.0%)	0(0.0%)	0(0.0%)
		Hookworm	3(6.0%)	3(25.0%)	0(0.0%)	3(21.4)
		E. histolytica	16(32.0%)	0(0.0%)	0(0.0%)	0(0.0%)
		G. lamblia	8(16.0%)	1(8.3%)	0(0.0%)	1(7.1%)
		E.coli	8(16.0%)	3(25.0%)	0(0.0%)	3(21.4%)
		Taenia spp	1(2.0%)	1(8.3%)	0(0.0%)	1(7.1%)
Total			50	12	2	14(28.0%)

Chi-square = 18.7708, $P<0.05$

4.2.4: Anthropometric Measurement of Infected and Non-infected Children Based on Height-for-Age Z-score

Table 10 shows height-for-age percentile distribution among infected and uninfected children. The prevalence of Height-for-Age among infected children was 24.0% (7+5/50) while the prevalence of Height-for-Age among the non-infected children was 26.4% (35+31/250). The prevalence of severely under-height was higher in non-infected (86.1%) than in infected children (13.9%). Similarly, the prevalence of moderately under-height was higher (83.20%) in non-infected than in infected children (16.7%). However, there was no significant (P >0.05) difference in the prevalence of moderately under-height and severely under-height in both infected and non-infected children (Table 10)

Table 10: Percentile Distribution of Infected and Non-infected Children Based on Height-for-Age Z-score

No. Examined	No. Infected (%)	No. Non-Infected (%)	Height-for-Age
11	1(2.0%)	10(36.0%)	Over-height
211	37(70.0%)	174(69.6%)	Normal height
42	7(14.0%)	35(14.0%)	Moderately under-height
36	5(10.0%)	31(12.4%)	Severely under-height
300	**50(16.7)**	**250(83.3)**	

P>0.05

4.2.4: Anthropometric Measurement of Infected and Non-infected Children Based on Weight-for-Age Z-score

Table 11 shows weight for age percentile distribution among infected and non-infected children. The total prevalence of under-weight among infected children was 4.0% (1+1/50) while in uninfected children, the total prevalence of under-weight was 4.0% (9+1/250) (Table 11). The prevalence of moderately underweight was higher in non-infected children (90.0) than in infected children (10.0%).However, the prevalence of severely under-weight was similar in both infected and non-infected children (50.0%). However, at P>0.05, there was no statistically significant relationship between the prevalence of severely under-weight in infected and non-infected children.

Table 11: Percentile Distribution of Infected and Non-infected Children Based on Weight-for-Age Z-score

No Examined	Infected (%)	Uninfected (%)	Weight-for-Age
17	3(17.6)	14(82.4)	Over-weight
271	45(16.6)	226(83.4)	Normal weight
10	1(10.0)	9(90.0%)	Moderately under-weight
2	1(50.0)	1(50.0)	Severely- under-weight
300	**50(16.7)**	**250(83.3)**	

P >0.05

4.2.6: Anthropometric Measurement of Infected and Non-Infected Children Based on Weight-For-Height

Table 12 shows weight for height percentile distribution among infected and non-infected. The total prevalence of wasting was 1.3% (4/300). The prevalence of under-weight among infected children was 0.0%, while in uninfected children; it was 1.6% (4). Prevalence of severe wasting children was not significantly higher in non-infected children than infected children (P >0.05). This means that there was no significant difference in rate of severe wasting in infected and non-infected children.

Table 12: Percentile Distribution of Infected and Non-Infected Children Based on Weight-For-Height

No Examined	Infected	Uninfected	Weight for height
296	50(16.9%)	246(83.1%)	Well nourished
4	0(0.0%)	4(100%)	Severe wasting
300	**50(16.7%)**	**250(83.3%)**	

P>0.05

4.2.7: Anthropometric Measure of Infected and Non-infected Children Based of Height-for-age Z score by Sex of Children

Table 13 shows height-for-age Z score distribution of infected and non-infected children by sex of children. Among the infected children, the prevalence of severe under-height was higher in male (8.3%) than in female (5.6%), but the difference was insignificant. In the opposite way, the prevalence of moderate under-weight among infected was higher in females (11.9%) than in males (4.8%).

However, among the non-infected children, higher prevalence of severe under-weight was recorded among the female (50.0%) than in male children (36.1%). The prevalence of moderate under-weight among non-infected children was higher in males (45.2%) than in females (38.1%). There was no significant variation in the prevalence of severe-under-weight with respect to sex for both infected and uninfected (P>0.05) (Table 13)

Table 13: Percentile Distribution of Infected and Non-infected Children Based of Height-for-Age Z-score with Respect to Sex

No. Examined	No. Males Infected	No. of Female Infected	No. of Males Uninfected (%)	No. of Females Uninfected (%)	Height for Age
11	0(0.0)	1(9.1)	4(36.4)	6(54.5)	Over-height
211	16(7.6)	21(10.0)	79(37.4)	95(45.0)	Normal height
42	2(4.8)	5(11.9)	19(45.2)	16(38.1)	Moderate under-height
36	3(8.3%)	2(5.6)	13(36.1)	135(50.0)	Severe under-height
300	**21(7.0)**	**29(9.7)**	**115(38.3)**	**135(45)**	

4.2.8: Percentile Distribution of Infected and Non-infected Children Based of Weight for Age Z- score by Sex

Table 14 shows weight-for-age Z-score distribution of infected and non-infected children with respect to sex. Among the infected children, prevalence of severe under-weight was (50%) in both infected and non-infected males, while in infected and non-infected females, the prevalence was (0.0%). There was no significant difference in the prevalence of severe under-weight in infected male and female and in non-infected male and female (P>0.05).

Table 14: Percentile Distribution of Infected and Non-infected Children Based of Weight for age Z- score with Respect to Sex

No Examined	No. Males Infected (%)	No. of Females Infected (%)	No. of Males Uninfected (%)	No. of Females Uninfected%	Weight- for- Age
17	1(5.9)	2(11.8)	4(23.5)	10(58.8)	Over-weight
271	18(6.6)	27(10.0)	107(39.5)	119(43.9)	Normal weight
10	1(10.0)	0(0.0)	3(30.0)	6(60.0)	Moderately under-weight
2	1(50.0)	0(0.0)	1(50.0)	0(0.0)	Severely- under-weight
300	**21(7.0)**	**29(9.7)**	**115(38.3)**	**135(45)**	

4.2.9: Anthropometric Measurement of Infected and Non-infected Children Based of Weight-for-height by Sex

Table 15 shows that almost all the children had normal weight-for-height, 296 out of 300 (98.7%). The prevalence of severe wasting among infected children was zero (0.0%) in both male and female. In non-infected children, the prevalence of severe wasting was higher in females (75%) than in males (25%), but this difference was not significant (P >0.05).

Table 15: Anthropometric Measurement of Infected and Non-infected Children Based of Weight- for–height with Respect to Sex

No Examined	No. Males Infected %	No. of Females Infected %	No. of Males Non Infected%	No. of Females non-infected %	Weight- for- Height
296	21(7.1)	29(9.8)	112(37.8)	134(45.3)	Well nourished
4	0(0.0)	0(0.0)	3(75.0)	1(25.0)	Severe wasting
300	**21(7)**	**29(9.7)**	**29(9.7)**	**135(45)**	

P>0.05

4.2.10: Anthropometric Measurement of Infected Children Based of Height for Age Z - Score with Respect to Age

As shown in Table 16, children within the age range of 11-13 years had the highest prevalence (16.7%) of severe under-height, followed by those within the ages of 5-7 years (11.8%). Similarly, the highest prevalence of moderate under-height was recorded in children within the age range of 11-13 years (33.3%), while the least prevalence (5.9%) was recorded in children within the ages of 5-7 years. However, there was no significant difference between the prevalence of under-height and intestinal parasitic infections in children (P >0.05).

Table 16: Percentile Distribution of Infected Children based of Height for Age Z - Score with Respect to Age (in years)

No. Examined	Age group 5 - 7 (%)	Age Group 8 - 10 (%)	Age Group 11-13(%)	Height for Age
1	0(0.0)	0(0.0)	1(2.0)	Over height
37	13 (76.5)	18(86.7)	6(50.0)	Normal height
7	1(5.9)	2(9.5)	4(33.3)	Moderately under-height
5	2 (11.8)	1(4.8)	2(16.7)	Severely- under-height
50	**17(100%)**	**21(100)**	**12(100)**	

4.2.11: Anthropometric Measurement of Infected Children Based of Weight-for - Age Z – score with Respect to Age

Table 17 shows weight-for-age percentile distribution of infected children with respect to age. Moderately under-weight was recorded in only one (5.9%) subject within the age group of 5-7years, while severe under-weight was also recorded in a child within the age range of 11-13 years. There was no significant difference between prevalence under weight and intestinal parasitic infections in infected children with respect to age at $P > 0.05$

Table 17: Percentile Distribution of Infected Children Based of Weight- for- Age Z – score with Respect to Age (in years)

No. Examined	Age group 5 -7 %	Age group 8 -10	Age group 11-13	Weight-for-Age
3	3(17.6%)	0.0%	0(0.0%)	Over-weight
45	13(76.5)	21 (100%)	11(91.7%	Normal weight
1	1(5.9%)	0(0.0%)	0(0.0%)	Moderately under-weight
1	0(0.0%)	0(0.0%)	1(8.3%)	Severely- under-weight
50	**17(100)**	**21(100%)**	**12(100%)**	

P >0.05

4.2.12: Anthropometric Measurement of Uninfected Children Based of Height-for – Age Z – score with Respect to Age

As shown in Table 18, among the uninfected children, the highest prevalence of moderate under-height (24.0%) was recorded in age group of 5-7years, followed by age group 8-10 years (11.7%). Children between the ages of 5-7years had the highest prevalence of severe under-height (18.1%) followed by children within the age range of 11-13 years (14.0%). There was no significant difference in the prevalence under -height among uninfected children with respect to age at (P>0.05).

Table 18: Percentile Distribution of Non-infected Children Based of Height- for – Age Z – score with Respect to Age (in years)

No. Examined	Age group 5 -7 %	Age group 8 -10	Age group (years) 11-13	Height-for-Age
10	6(8.3%)	4(3.1%)	0(0.0%)	Over-height
174	45(62.5%)	98 (76.6%)	31(62.0%)	Normal height
35	8(11.1%)	15(11.7%)	12(24.0%)	Moderately under-height
31	13(18.1%)	11(8.6%)	7(14.0%)	Severely- under-height
250	**72(100)**	**128(100%)**	**50(100%)**	

$P>0.05$

4.2.13: Anthropometric Measurement of Uninfected Children Based of Weight-for – Age Z – score with Respect to Age

Table 19 shows that the highest prevalence of moderate under-weight (4.2%) was recorded in age group of 5-7years, followed by age group 11-13 years (4.0%). Severe under-weight was only recorded among children within the age range of 5-7 years (1.4%). There was no significant variation between the prevalence of under-weight among uninfected children with respect to age at $P>0.05$.

Table 19: Anthropometric Measurement of Uninfected Children Based of Weight- for – Age Z – score with Respect to Age (in years)

No. Examined	Age group 5 -7 %	Age group 8 -10	Age group 11-13	Weight-for-Age
14	8(11.1%)	5(3.9%)	1(2.0%)	Over-weight
226	60(83.3)	119 (93.0%)	47(94.0%)	Normal weight
9	3(4.2%)	4(3.1%)	2(4.0%)	Moderately under-weight
1	1(1.4%)	0(0.0%)	0(0.0%)	Severely- under-weight
250	**72(100)**	**128(100%)**	**50(100%)**	

P>0.05

4.2.14: Anthropometric Measurement of Uninfected Children Based of Weight-for – Height Z – score with Respect to Age

Table 20 shows that severe wasting was only recorded in children within the age range of 5-7years (5.6%). The prevalence of severe wasting was 0.0% among children within the age group of 8-10 and 11-13 years. The prevalence of severe wasting varied significantly with respect to age group ($P<0.05$)

Table 20: Percentile Distribution of Uninfected Children Based of Weight- for – Height Z – score with Respect to Age (in years)

No. Examined	Age group 5 -7 %	Age group 8 -10	11-13	Weight-for-Height
246	68(94.4.%)	128(100%)	50(100.0%)	Well nourished
4	4(5.6%)	0 (0.0%)	0(0.0%)	Severe wasting
250	**72(100)**	**128(100%)**	**50(100%)**	

P <0.05

4.2.15 Anthropometric Measurement of Infected Children Based of Height for Age Z – Score with Respect to Location.

As shown in Table 21, the highest prevalence of moderate under-height in infected was observed in Owerri rural (31.3%) followed by Owerri urban (11.1%). Moderate under-height was not recorded among children in Orlu urban. The highest prevalence of severe-under-height was recorded among children in Owerri urban (22.2%) followed by Owerri rural (12.5%), while severe-under-weight was not recorded Orlu urban. There was no significant relationship between under-height and prevalence of intestinal parasitic infections in children with respect to location (P>0.05).

Table 21: Anthropometric Measurement of Infected Children Based of Height for Age Z – Score with Respect to Location

No. Examined	Owerri urban %	Owerri rural%	Orlu Urban %	(Orlu) rural %	Height-for-Age
1	0(0.0)	0(0.0)	0(0.0)	1(6.7)	Over-height
37	6(66.7)	9(56.3)	10(100.0)	12(80.0)	Normal height
7	1(11.1)	5(31.3)	0(0.0)	1(6.7)	Moderately under-height
5	2(22.2)	2(12.5)	0(0.0)	1(6.7)	Severely under-height
50	**9(100%)**	**16(100)**	**10(100)**	**15(100.0)**	

P >0.05

4.2.16: **Anthropometric Measurement of Infected Children Based of Weight-for-Age Z – Score with Respect to Location**

As shown in Table 22, moderate under-weight among children was only recorded in Owerri rural with prevalence of 6.7% while severe-under-weight was only observed in Orlu rural. There was no significant association between underweight and prevalence of intestinal parasitic infection among children with respect to location (P>0.05).

Table 22: Anthropometric Measurement of Infected Children Based of Weight-for-Age Z – Score with Respect to Location

Total Examined	**Owerri Urban (%)**	**Owerri rural (%)**	**Orlu Urban (%)**	**Orlu rural (%)**		**Weight for Age**
3	0(0.0)	0(0.0)	2(20.0)	1(6.7)		Over-weight
45	9(100.0)	15(93.8)	8(80.0)	13(86.7)		Normal weight
1	0(0.0)	1(6.3)	0(0.0)	0(0.0)		Moderately under-weight
1	0(0.0)	0(0.0)	0(0.0)	1(6.7)		Severely- under-weight
50	**9(100%)**	**16(100)**	**10(100)**	**15(100.0)**	**50(100)**	

P>0.05

4.2.17: **Anthropometric Measurement of Uninfected Children Based of Height or Age Z – Score with Respect to Location**

As shown in Table 23, the highest prevalence of moderate under-height among uninfected children was observed in Owerri rural (23.7%) followed by Owerri urban (15.2%). The highest prevalence of severe-under-height was recorded among children in Owerri urban (23.6%) followed by Orlu rural (11.7%). There was significant variation in the prevalence of stunting among uninfected children with respect to location ($P<0.05$).

Table 23: Anthropometric Measurement of Uninfected Children Based of Height- for-Age Z – Score with Respect to Location

No. Examined	Owerri urban %	Owerri rural%	Orlu Urban %	(Orlu) rural %	Height-for-Age
10	2(3.0)	1(1.7)	7(10.8)	0(0.0)	Over-height
174	49(74.2)	30(50.8)	48(73.8.)	47(78.3)	Normal height
35	10(15.2)	14(23.7)	5(7.7)	6(10.0)	Moderately under-height
31	5(7.6)	14(23.7)	5(7.7)	7(11.7)	Severely- under-height
250	**66(100%)**	**59(100)**	**65(100)**	**60(100.0)**	

$P<0.05$

4.2.18: **Anthropometric Measurement of Uninfected Children Based of Weight for Age Z – Score with Respect to Location**

As shown in Table 24, the highest prevalence of moderate under-weight among uninfected children was observed in Owerri urban (6.1%) followed by Owerri urban (5.2%). Severe-under-weight among uninfected children was only recorded in Orlu urban (1.5%). There was significant variation in the prevalence of under-weight among uninfected children with respect to location ($P<0.05$).

Table 24: Anthropometric Measurement of Uninfected Children Based of Weight for Age Z – Score with Respect to Location

No. Examined	Owerri urban %	Owerri rural%	Orlu Urban %	(Orlu) rural %	Weight-for-Age
14	2(0.0)	1(1.7)	10(15.4)	1(1.7)	Over weight
226	60(90.9)	55(93.2)	53(81.5)	58(96.7)	Normal weight
9	4(6.1)	3(5.1)	1(1.5)	1(1.7)	Moderately under-weight
1	0(0.0)	0(0.0)	1(1.5)	0(0.0)	Severely- under-weight
250	**66(100%)**	**59(100)**	**65(100)**	**60(100.0)**	

P<0.05

4.2.19: Relationship between Parents Occupation and Prevalence of Malnutrition among Infected and Non-infected Children Used for Anthropometric Study

Table 25 shows that total prevalence of malnutrition in children used for anthropometric study was 26.3%. The highest prevalence of malnutrition (34.0%) was recorded among children whose parents are self employed, followed by those that their parents were artisans (28.6%). The least prevalence of malnutrition (18.2%) was observed in children whose parents were clergy. There was no significant relationship between parents occupation and prevalence of malnutrition in children used for anthropometric studies in the present study ($P>0.05$).

Table 25: Test of Relationship between Parents Occupation Prevalence of Malnutrition in Infected and Non-infected Children Used for Anthropometric Study

Occupation	No Examined	Well nourished	Malnourished
Civil servant	59	47(79.7%)	12(20.3%)
Health worker	20	15(75.0%)	5(25.0%)
Clergy	11	9(81.8%)	2(18.2%)
Farmer	51	40(78.4%)	11(21.6%)
Trader (petty)	60	42(70.0%)	18(30.0%)
Self employed	60	33(66.0%)	17(34.0%)
Artisan	49	35(71.4%)	14(28.6%)
	300	221(73.7%)	79(26.3%)

P>0.05

4.3 The Prevalence of Anaemia with Respect to Number of Co-infections, Location and Type of Parasite Isolated from Infected Children in the Study Areas.

4.3.1 Prevalence of Anaemia (%) in Infected and Non Infected Children

As shown in Table 26, the total prevalence of anaemia in infected and non-infected children is 17.4%. The prevalence of anaemia was higher (21.1%) in infected children than in non-infected children (16.5). However, there was no statistically significant variation in the prevalence of anaemia between infected and non-infected children (P>0.05).

Table 26: Prevalence of Anaemia in Infected and Non-infected Children

IPI's Status	Number Examined	Anaemia	Not Anaemic
Infected	232	49(21.1%)	183(78.9%)
Non Infected	968	160(16.5%)	808(83.5%)
Total	**1200**	**209(17.4)**	**991(82.6%)**

X^2 = 2.7434, df – 1, P>0.05

4.3.2: Prevalence of Anaemia in Infected Children with Respect to Number of Parasite(s)

Table 27 shows that out of 232 infected children, 49 (21.1%) had anaemia, 29 (12.5%) mild, 19(8.2%) moderate and 1 (0.4%) severe. Severe anaemia was only reported in children with double infection (2.2%), similarly, prevalence of moderate anemia was higher in children that had double infection (9.1%) than those that had single infection (8.0%). There was significant relationship between anaemia and number of intestinal parasite in an infected child ($P<0.05$).

Table 27: Prevalence of Anaemia in Infected Children with Respect to Number of Parasites

Infection type	No. Examined	No-anaemia	Mild	Moderate	Severe Anaemia	
Single	188	145 (77.1%)	28(14.9%)	15(8.0%)	0(0.0%)	43
Double	44	38(86.4%)	1(2.3%)	4(9.1%)	1(2.2%)	6
Total	232	183(78.9%)	29(12.5%)	19(8.2%)	1(0.4%)	49(21.1%)

$P<0.05$

4.3.3: Prevalence of Anaemia in Infected Children with Respect to Location

As shown in Table 28, in Orlu rural the total prevalence of anaemia was 57.2% (28/49), 18 (26.1%) mild, 10(14.5%) moderate, 0.0% prevalence of severe anaemia, followed by Owerri urban with 12(24.%5), 8(8.9%) mild, 4(8.9%) moderate, and 0.0% prevalence of severe anaemia. Severe anemia (1.6%) was recorded only in Owerri rural. The highest prevalence of moderate anaemia was recorded in Orlu rural (14.5%), followed by Owerri urban (8.8%). The least prevalence of moderate anaemia was recorded in Orlu urban. At P <0.05, there was significant associated between anaemia and location of infected persons.

Table 28: Prevalence of Anaemia in Infected Children with Respect to Location

Location	Total Examined	Non-anemic	Mild	Moderate	Severe	Anemia
Owerri urban	45	33 (73.3%)	8(8.9%)	4(8.9%)	0(0.0%)	12
Owerii rural	63	57(90.5)	1(1.6%)	4(6.3%)	1(1.6%)	6
Orlu urban	55	52(94.5%)	2(3.6%)	1(1.8%)	0(0.0%)	3
Orlu rural	69	41(59.4%)	18(26.1%)	10(14.5%)	0(0.0%)	28
Total	232	183(78.9%)	29(12.5%)	19(8.2%)	1(0.40%)	49

$P<0.05$

4.3.4: Prevalence of Anaemia in Infected Children with Respect to the Type of Parasite

Table 29 shows that severe anaemia was recorded only in children infected with hookworm. The highest prevalence of anaemia was recorded in children infected with *E. histolytica* (38.8%), followed by those infected with *G. lamblia* (18.4%) and *E. coli* (12.3%). Children infected with *T. trichiura,* hookworm, *Taenia* spp, *G. lamblia* and *E. coli* had 0.0% prevalence of moderate anaemia. There was significant relation between the type of intestinal parasite and prevalence of anaemia ($P < 0.05$).

Table 29: Prevalence of Anaemia in Infected Children with Respect to the Type of Parasite

Parasite	Total Infected	Not-anaemic	Mild	Moderate	Severe	Anaemia
A . lumbriciodes	31	28(90.3%)	2(6.5%)	1(3.2%)	0(0.0%)	3
T. trichiura	6	5(83.3%)	1(16.7%)	0(0.0%)	0(0.0%)	1
hookworm	21	18(85.7%)	2(9.5%)	0(0.0%)	1 (4.8%)	3
E. histolytica	68	49(72.1%)	7(10.3%)	12(17.6%)	0(0.0%)	19
G. lamblia	33	24(72.7%)	9(27.3%)	0(0.0%)	0(0.0%)	9
E. coli	20	16(72.7%)	6(27.3%)	0(0.0%)	0(0.0%)	6
Taenia spp	6	4(66.7%)	0(0.0%)	2(33.3%)	0(0.0%)	2
S. stercoralis	2	2(100.0%)	0(0.0%)	0(0.0%)	0(0.0%)	0
E. histolytica + *G. lamblia*	9	6(66.7%)	2 (22.0%)	1(11.1%)	0(0.0%)	3
Trichuris + *E. histolytica*	13	12(92.3%)	0(0.0%)	1(7.7%)	0(0.0%)	1
Ascaris + *E. coli*	14	12(85.7%)	0(0.0%)	2(14.3%)	0(0.0%)	2
G. lamblia + *E. coli*	7	7(100.0%)	0(0.0%)	0(0.0%)	0(0.0%)	0
E. histolytica + *E. coli*	2	2(100.0%)	0(0.0%)	0(0.0%)	0(0.0%)	0
Total	232	183(78.9%)	29(12.5%)	19(8.2%)	1(0.4%)	49

$P < 0.05$

4.4 Determination of the Relationship between Intensity of Intestinal Parasitic Infections, Malnutrition and Anaemia.

4.4.1: Relationship between Intensity of Helminth Infection and Malnutrition in Children Used for Anthropometric Study

As shown in Table 30, the least prevalence (41.7%) of malnutrition was recorded among children with light intensity of intestinal helminth infection. Only a child recorded heavy intensity and the child had poor nutrition. However, at $P>0.05$, there was no association between prevalence of malnutrition and intestinal helminth infection.

Table 30: Relationship between Varying Intensity of Helminth Infection and Malnutrition in Children Used for Anthropometric Study

Class of Intensity	No. Infected	Malnourished	Not Malnourished
Light	12	5(41.7%)	7(58.3%)
Moderate	4	3(75.0%)	1(25.0%)
Heavy	1	1(100.0%)	0(0.0%)
Total	17	10	8

Taenia spp (unclassified) =1

P>0.05

4.4.2: Relationship between Varying Intensity of Helminth Infection and Anaemia

Table 31 shows that out of 82 children infected with intestinal helminths (*Ascaris lumbricoides*, *Trichuris trichiura* and Hookworm), the prevalence of anaemia was higher (33.3%) among children who had moderate intensity of helminth infections than those who had light intensity of helminth infections (3.3%). The child had heavy intensity of helminth infection was also anaemic. However, there was a significant relationship between the prevalence of anaemia and intensity of helminth infections ($P<0.05$).

Table 31: Relationship between Varying Intensity of Helminth Infection and Anaemia

Intensity		Anaemia	Not Anaemic
Light	60	2(3.3%)	58(96.7%)
Moderate	21	7(33.3%)	14(66.7%)
Heavy	1	1(100%)	0(0.0%)
Total	82	10	70

CHAPTER FIVE

5.0 DISCUSSION

Determination of the Prevalence and Intensity of Intestinal Parasitic Infections among Children from Primary Schools in Imo State

The results of this investigation showed low prevalence (19.3%) of intestinal parasitic infections among primary school children in Orlu and Owerri zones (see Table 1). This prevalence showed a decline in infection rate when compared with previous works by Oguoma *et al.,* (2008) and Udensi *et al*. (2015) in Imo State, where they reported prevalence of 24.8% and 47.7% respectively. Thomas *et al*. (2014) in Chikun, Kaduna South Local Government area of Kaduna state, Nigeria, have reported a similar prevalence (17.75%). Similarly, Orji (2015) reported intestinal parasitic infection prevalence of 18.0% among inhabitants of Uli community in Anambra State. A lower prevalence of 13.8% was been reported in Southern West of Nigeria by Okpala *et al.* (2014).

Epidemiological studies have revealed that the prevalence and distribution of intestinal parasitic infections are governed by behavior, socio-economic and environmental characteristic of the people (Abah and Arene, 2015; Suriptiastuti and Manan, 2011). The low prevalence obtained in this study could be as a result of the recent efforts by Imo State Government to reduce child mortality through improved sanitation, free mass drug administration in different Health Centres, improved personal hygiene through construction of classrooms with modern toilets and sinking of bore-hole water in majority of the schools in urban areas of Imo State.

Secondly, during the election campaign period, prior to the time of this study, there were also free de-worming programmes by some political parties as one of their campaign strategies. The fact that majority of the subjects had taken preventive treatment (deworming) before the time of this investigation could also explain the low prevalence. Many studies have demonstrated periodic deworming to be effective in reducing the burden of intestinal parasitic infections

(WHO, 2014; Stanley *et al.,* 2013). Furthermore, from responses from respondents, majority of the participants were aware of the causes, symptoms and ways of preventing intestinal parasitic infections. These include; provision of potable water, good personal hygiene, environmental sanitation, proper cooking of food and periodic deworming. Moreover, the subjects used in this study were apparently healthy children (without any clinical sign of intestinal parasitic infections).

Eight (8) intestinal parasites (*Ascaris lumbricoides, Trichuris trichiura, hookworm, Stongyloides stercoralis, Taenia sp, Entamoeba histolytica, Entamoeba coli,* and *Giardia lamblia*) were indentified (Table 3). Generally, (among the intestinal protozoan and helminths) *Entamoeba histolytica* was the most prevalent (7.7%) followed by *G. lamblia* (4.2%) and *Ascaris lumbricoides* (3.8%) Other researchers like Emmy-Igbe *et al*. (2011), Kidane *et al*. (2014) and Shah *et al*. (2006) made similar findings. Ogbuagu et al. (2009) reported *Entamoeba histolytica* as the most prevalent intestinal parasite, which agrees with the findings in this study, but is in disagreement with the investigations of Akinbo *et al*. (2011) who reported *Ascaris lumbricoides* as the most prevalent intestinal parasite. In some areas, the water pipes went through drainage pathways, in some instances; the pipes were broken, and left unattended to, which eventually might have contaminated the drinking water.

Among the three most prevalent helminths, *Ascaris lumbricoides* was the most prevalent (3.8%), followed by *Trichuris trichiura* (1.3%) and Hookworm (1.8%). According to Abah and Arene (2015), *A*. *lumbricoides*, hookworm and *Trichuris trichiura* were the major species of intestinal worm that infect children. This finding agrees with the findings of Sam-Wambo *et al.* (2012), Okpala *et al.* (2014), Alo *et al.* (2013), Ngonjo *et al.* (2012), Damen *et al.* (2010) and Uwaezuoke *et al.* (2006). The reasons for high prevalence of *Ascaris lumbricoides* are not farfetched as it has high biotic potential capacity of embryonated eggs to withstand extreme environmental factors (Nwoke, 2009). The eggs are covered with mucopolyssacharides that renders them adhesive to a wide variety of environmental surfaces, and this promotes longevity and enhances infectivity. Secondly, *Ascaris lumbricoides* being a soil-transmitted helminthes increases its transmission potential as school children (mostly in rural areas) are involved in some unhygienic behaviours like playing with sands. While playing with sands, their hands are contaminated with polluted soil which often contain infective eggs, thereby enhancing fecal –oral transmission (Nwoke, 2009).

Hookworm infection was the second most prevalent (1.8%) helminth (Table 3). This is in agreement with the report of (Abah and Arene, 2015). This could be as a result of children not wearing protective foot wears while playing outside or within the school premises.

The prevalence of *Trichuris trichiura* was 1.3%, the third most prevalent helminth. Lower prevalence have been reported by some researchers too (Abah and Arene, 2015). This could be due the fact that the female produces smaller number of eggs, and they are present in faeces in smaller number than *Ascaris lumbricoides* (De Silva *et al*., 2003).

The prevalence of taeniasis (0.5%) was low. Responses from respondents showed majority of mothers are very much aware that consumption of improperly cooked meat is a risk factor for the transmission of taeniasis. This observation is similar to those previously recorded by Abah and Arene (2015) in a study on prevalence of helminth infections in schoolchildren in Rivers State. Mbanugo and Onyebuchi (2002) also recorded similar report.

Strongyloides stercoralis had the least prevalence (0.2%) and this parasite was found only in Orlu rural. Obiajuru and Adaogu *et al*. (2013) have reported a higher prevalence (0.7%) in outpatients from Imo State Teaching Hospital Orlu, Imo State. Reduction in prevalence could be due to improved environmental and personal hygiene.

Epidemiological studies have shown that prevalence of intestinal parasitic infections vary from one locality to other. The prevalence of intestinal parasitic infections in the four locations was as follow: Orlu urban 18.3%, Orlu rural 23.0%, Owerri urban 15.0% and Owerri rural 21.0% (Table 2). When comparing prevalence of intestinal parasitic infections in rural areas in the two geopolitical zones of Imo State (Orlu and Owerri), the prevalence of intestinal parasitic infections was quite higher (23.0%) in Orlu rural than in Owerri rural (21.0%), but this difference was insignificant (P >0.05). Variation in prevalence was not expected to exist as these two locations had relatively similar environmental conditions. They share almost the same types of basic amenities, same socio-economic status of dwellers and same level of sanitation are known to prevail in rural areas The conditions listed above are known risk factors that predispose people to intestinal parasitic infections. Previous studies by Unachkwu and Nwakanma, (2014), Opara *et al. (*2012), Mbuh *et al.* (2010) and Oninla *et al.* (2007) established differences in prevalence in urban and rural communities but not rural to rural communities.

Similarly, when comparing prevalence of intestinal parasitic infection in the urban areas of Owerri and Orlu (Table 1), it was higher in Orlu urban (18.3%) than in Owerri urban (15.0%), but the difference was not statistically significant (P>0.05). According to Imo State Ministry of Urban and Rural Development, classification of urban areas in Imo State was based on functional definition of urban area in developing countries, so both urban areas (Orlu and Owerri) have almost the same basic amenities and socio-economic standards of dweller. This could explain the insignificant difference in prevalence of intestinal parasitic infections in the urban areas. The little variation (although insignificant) could be attributed to the fact that seat of administration is in Owerri urban, it receives more attention in the provision of facilities (bore-hole water, toilet facilities, foot wears) in schools, better access to health care and good waste disposal system.

The prevalence of intestinal parasitic infections was not significantly (P>0.05) higher in rural areas of Orlu and Owerri than in urban areas of Orlu and Owerri.

This findings is not in agreement with those of Mbuh *et al.* (2010), Opara *et al.* (2012) and Unachkwu and Nwakanma, (2014).

Multiple infections co-existed in the study subjects and the prevalence was 3.8%, which is moderately low. Similar prevalence of double infections have also been reported by Nematian *et al*. (2004), Opara *et al.* (2012), Tulu *et al. (*2014), and Simon-Oke *et al.* (2014). Some other researchers also reported multiple infections in their studies (Unachukwu and Nwakanma, 2014; Thomas *et al.,* 2014). These are evidences that that the occurrence of polyparasitism is a norm in developing countries. The commonest co-infection was that of *T. trichiura* and *E. coli.* No child had up to three parasites. The low prevalence rate of polyparasitism could be attributed also to improved sanitation and hygiene in schools through the provision of water and modern toilet facilities by the State Government. Although, the prevalence of multiple infections was low, previous findings suggested that this may have dangerous effect on the health of an infected child suffers double morbidity (Tchuem-Tchunte *et al.,* 2003), like severe abdominal pain and developmental deficits in schoolchildren (Nematian *et al.,* 2008; Oninla *et al.,* 2010).

Light intensity predominated in various specific helminth infections. This could explain why there was no relationship between anthropometric measurements and prevalence of intestinal parasitic infection and the implication is that most of the children may have suffered acute infections. It had been reported that children who experience heavy infection intensity are at higher risk of suffering from higher degree of morbidity (Ramdath *et al.,* 1995).

The intensity of intestinal helminths infection varied ($P<0.05$) from one location to another. This agrees with the finding of Quihui-Cota *et al. (*2004), in Mexican schoolchildren. Variations in intensity could be attributed to life style, cultural differences, host factors such as, variability in susceptibility and immunological response to parasite invasion (Mcsharry *et al*., 1999).

Determination of Relationship between Intestinal Parasitic Infections and Anthropometric Indices among Children Studied

Many researchers have linked intestinal parasitic infections (mostly helminthes) with an increased risk of protein- energy malnutrition and growth deficits in children, low pregnancy weight gain and intrauterine growth retardation followed by low birth weight (Rodriguez-Morales *et al.,* 2006; Opara *et al.,* 2012). Intestinal parasitic infections may aid malnutrition by several mechanisms. These include impaired nutrient absorption resulting to infection and reduction of appetite (Stephenson *et al.,* 2000b).

Prevalence of malnutrition (31.3%) observed in the present study was far above the observation of WHO (2014) that reported that one out of six (16.6%) children in developing countries show signs of malnutrition. This study was in line with 24% prevalence reported by Amuta *et al.* (2008) and 30.0% prevalence reported by Opara *et al. (*2012).

Stunting (under-height) was the most prevalent (26.0 %) type of malnutrition recorded in the study areas, followed by under-weight (4.0%) and wasting 1.4%. This was supported by the findings of Opara *et al*. (2012), who observed under-height as the most prevalent manifestation of malnutrition in urban school-aged children in Nigeria, was not in line with the findings of Kidane *et al.* (2014), who reported under-weight as the highest manifestation of malnutrition.

Prevalence of intestinal parasitic infections was 16.7% among children used for anthropometric study, this low prevalence of intestinal parasitic infections could explain the reason for insignificant relationship between malnutrition and prevalence of intestinal parasitic infections. Malnutrition was significantly higher (p=0.005) higher (42.9%) in children infected with *Ascaris lumbricoides,* hookworm (21.4%) and *E. coli* (21.4%). *Ascaris lumbricoides* and hookworm infections have been significantly associated with malnutrition (Opara *et al.,* 2012; Unachukwu and Nwakanma, 2014), even though malnutrition was not associated with intestinal parasitic infection in the present study.

It has been reported that intestinal parasitic infections can interfere with growth and development of a child (Opara and Udoidung, 2003), though there was relatively low degree of malnutrition and insignificant association with intestinal parasitic infections, underweight and wasting found in few children (4.0% and 1.3% respectively) could be as a result of other factors like poverty and other infections.

The total prevalence of stunting was 26.0% and it was not associated with intestinal parasitic infections in the study area. Intestinal parasitic infections are not the only cause of malnutrition in children, the etiology of malnutrition are multifactorial, for example, stunting is mostly due long-term poor nutritional intake and is the best indicator of growth retardation in children over long period of time (Unachukwu and Nwakanma, 2014). Other categories of malnutrition (under-weight and wasting) had no association with intestinal parasitic infections in both infected and uninfected children (P>0.05).

Anthropometric values of children showed that most of the children infected with intestinal parasitic infections had normal anthropometric parameters. The impact of intestinal parasitic infections depends on the prevalence rate and intensity of infection (Stephenson *et al.,* 2000a). The prevalence (16.7%) obtained in the present study was below the prevalence suggested by Stephenson *et al.* (2000b). Low prevalence of intestinal parasitic infections could also explain why there was insignificant relationship between intestinal parasitic infections and prevalence of malnutrition.

Secondly, majority of the children (71.4%) had light infection, low intensities of intestinal parasitic are known to cause minimal or no clinical impact (Ilechukwu *et al.,* 2014*).* Stephenson *et al.* (2000b) was of the view that relationship between helminth infections and nutritional status of young children in a population should be over looked in communities where the prevalence is below 20%. This study suggested that reduction in growth (weight and height) was not associated with intestinal parasitic infection in the study areas, it could be due to other health problems and poverty.

The prevalence of severe-under-height (stunting) which means slow growth of the skeletal system was not significantly higher (12.4%) in uninfected children than in infected children (10.0%), also there was no variation in moderate-under-weight in infected and non-infected children(Table 10). The observation of under-weight in non-infected children is a clear indication that it was not associated with intestinal parasitic infection in the study area. It could be because of low socio-economic status of the respondents that may have resulted to protein energy malnutrition.

There was no significant difference between stunting, under-weight and wasting in both infected and uninfected children with respect to sex at P>0.05. This supports the fact that intestinal parasitic infections occur regardless of sex.

Similarly, there was no significant relationship (P>0.05) between prevalence of intestinal parasitic infections and prevalence of stunting and underweight in infected children with respect to age (Table 16-17). This means that all the infected children within age brackets used for the investigation in the study area had equal chances of becoming malnourished. This agrees with the report of Unachukwu and Nwakanma (2014). In uninfected children, age was associated (P<0.05) with stunting, but was not associated with under-weight and wasting (P>0.05).

Relationship between malnutritional indicators (stunting and under-weight) and locations was not significant (P>0.05) in infected children (Tables 21-22). This implied that in these two Zones in Imo State, malnutrition occurred irrespective of location. The higher prevalence of stunting (although insignificant) recorded in Oweri zone (rural and urban) could due to other factors like poor feeding. There is higher availability of agricultural produce in Orlu zone than in Owerri zone. A place like Ohaji/Egbema in Orlu is the food basket of Imo that supplies food to other communities in Imo State and beyond. Secondly, it could due to increasing rate of migration to Owerri urban as the seat of administration of the state, which might have resulted to over population, which can bring about reduction in food availability.

Surprisingly, it was not same for uninfected, in uninfected children, malnutritional indicators (stunting and under-weight) varied significantly ($P<0.05$) with respect to location. Although malnutrition did not vary with respect to location in infected children, factors such as differences in socio-demographic and cultural differences may have contributed to this variation.

Result of prevalence of malnutrition in children used for anthropometric (both infected and non-infected) with respect to parents' occupation revealed malnutrition was insignificantly higher ($P >0.05$) in children whose parents are artisans, followed by children whose parents are self-employed (Table 25). This is in line with the findings of Al AReza *et al.* (2014), but disagrees with the report of Vella *et al.* (1992) who found an association between malnutrition and parents occupation.

Prevalence of Anaemia with Respect to Number of Co-infections, Location and Type of Parasite Isolated from Infected Children in the Study Areas.

The total prevalence of anemia among infected and non-infected children was 17.4%. Anaemia was insignificantly higher ($P>0.05$) in infected children than non-infected children. This was in conformity with the study conducted by Orji (2015), in Uli, Ihiala Local government Area, Anambra State.

The total prevalence of anaemia in infected children was 21.1% (Table 27). This prevalence was lower when compared with 50% prevalence reported by Ehiaghe *et al.* (2013), in infected children in Okada, Edo State and also prevalence of 32.8% observed by Leal *et al.* (2011), in Pernambuco, Norestede Brazil.

The number of species of intestinal parasite (either single or co-infection) found in an infected child was significantly associated with prevalence of anaemia

(P<0.05) (Table 27). Higher prevalence of anaemia was reported in children that had multiple infections. This was in line with the findings of Ehiaghe *et.al.* (2013), who reported higher prevalence of anemia in children infected with multiple intestinal parasites. The higher prevalence observed in children who had double infection could be as a result of impact of double morbidity due to multiple parasite infections.

Anemia in infected children varied significantly with respect to location (P<0.05). The highest prevalence (14.5%) of moderate anaemia recorded in Orlu rural areas could be attributed to socioeconomic factors such poverty and household size.

The association between low hemoglobin and parasite positivity seems possible because intestinal parasites are lodged in the duodenum and jejunum, the site of iron absorption (Rarness, 1992). Hookworm infection could predispose an infected child to anaemia due to feeding activities of hookworm parasite (Kazora and Mahm, 1992).

Relationship Between Intensity of Intestinal Parasitic Infections, Malnutrition, and Anaemia

On the association between varying intensity of helminth infection and indicators of malnutrition, malnutrition was not significantly (P>0.05) higher in children that heavy and moderate intensity of helminth infection than those that recorded light intensity of helminth infection. This finding is contrary to the report of Stephenson *et al. (*2000b), who observed that the impact of intestinal parasitic infections depends on the intensity of infection.

With regard to relationship between intensity of intestinal helminth infection and prevalence of anemia, there was a significant association (P<0.05) between varying intensity of helminth infections and prevalence of anemia in the study area (Table 31). This finding corroborates with that of Ramdath *et al.* (1995) who reported higher prevalence of anemia in children who were heavily infected with intestinal parasite.

5.1 Summary of Findings

1. The overall prevalence of intestinal parasitic infections in Owerri and Orlu zones of Imo State was 19.3%.

2. Eight (8) intestinal parasites were indentified in all the study areas.

3. *Entamoeba histolytica* was the most prevalent intestinal parasites (7.7%) followed by *Ascaris lumbricoide* (3.8%). The least prevalent intestinal parasite was *Strongyloides stercoralis* (0.2%).

4. The prevalence of intestinal parasitic infections was not significant (P>0.05), with respect to location, in Orlu rural (23.1%) than in Owerri rural (21.0%), similarly, prevalence of intestinal parasitic infections was also not significantly (P>0.05) higher in Orlu urban (18.3%) than Owerri urban (15.0%). The prevalence of intestinal parasitic infections was not higher in rural areas than urban areas (P.0>05).

5. The prevalence of double infection was 45(3.8%), no child had triple infection.

6. Majority (73.4%) of the children had light intensity.

7. The prevalence of malnutrition was 31.3%,

8. Seven (7) intestinal parasites were recorded in children used for anthropometric study with a prevalence of 16.7%.

9. There was no variation between prevalence of stunting, under-weight, wasting in infected and non-infected children at P<0.05

10. There was no variation in prevalence all categories of malnutrition among infected children used for anthropometric with respect to sex, age and location.

11. In uninfected children, age was associated ($P<0.05$) with wasting, but was not associated with stunting and under-weight ($P<0.05$)

12. There was no statistically significant relationship between parents' occupation and prevalence of malnutrition ($P>0.05$).

13. The prevalence of anemia was significantly ($P<0.05$) higher in Orlu rural than other areas studied.

14. The total prevalence of anaemia in children was 17.4%, anaemia was not significantly ($P>0.05$) higher in infected (21.1%) than uninfected (16.5%). Prevalence of severe and moderate anaemia were higher (2.2% and 9.1% respectively) in children that had double infection than those that had single infection (0.0% and 8.0% respectively).

16. Severe anemia was only recorded in children infected with hookworm, and highest prevalence (40.0%) of moderate anaemia was found in children infected with *Taenia* spp.

17. Malnutrition was insignificantly ($p=0.319$) higher in children who had heavy and moderate intensity of helminth infection than those that recorded light intensity.

18. There was a significant association ($p= 0.005$) between intensity of helminth infections and prevalence of anaemia

5.2 Recommendations

Considering the public health significance (morbidity and mortality) of intestinal parasitic infections in Nigeria and other developing countries, public health scientist should continue to encourage the sustenance of mass drug administration, which already exists in the study area, by advising incoming government on the need for continuity.

The effective of deworming programmes may be affected by cultural and religious beliefs, whereby some families do not accept free deworming programme. This problem should be addressed intensively through public health enlightment programmes.

The government and Non-Governmental Organisation should ensure that potable water such as tap water is provided in both rural and urban areas as borehole water, which was the major source of water in the study areas, was not available to all homes.

There is need for mass health educational programmes in the form of training or campaign on the ways of preventing intestinal parasitic infections. Public enlightment programmes can be extended to the use of radio and television messages, and use of bill boards

Medical test for identification of intestinal worm should be accompanied with some haematological test such as pack cell volume and haemoglobin level because of its association with anaemia

5.3 Conclusion

This study showed that there was moderately low prevalence (19.3%) of intestinal parasitic infections in Orlu and Owerri zones. The lower prevalence (when compared with other studies in Imo State) recorded in the study areas, has really demonstrated the impact of improved hygiene, provision of potable water and free deworming programmes by the present government and Non Governmental Organizations on the prevalence of intestinal parasitic infections. Intestinal parasitic infections did not vary with respect to location (urban/urban and rural/rural) while there was variation in urban/ rural locations. Malnutrition was not associated with intestinal parasitic infections in this present study. The fact that majority of the children had light intensity could be responsible for this non-association as the impact of intestinal parasitic infections depends on the prevalence rate and intensity of infection. Malnutrition recorded in the study might be due other factors like poor nutrition, poverty and other diseases. This study showed that malnutrition occurs regardless of sex and age among school-aged children. Intestinal parasitic infections were not associated with anemia in the study areas. The number species (single or double) of intestinal parasite found in an infected child was associated with prevalence of anaemia. Anaemia in infected children varied significantly with respect to location. There was no association between intensity and malnutrition, while there was an association between varying intensity of helminth infections and prevalence of anemia in the study area. Intestinal parasitic infections are still threatening developing countries.

REFERENCES

Abah, A. E. and Arene, F.O.I. (2015). Status of Intestinal Parasitic Infections among Primary School Children in Rivers State, Nigeria, *Journal of Parasitology Research*, 2015 (9):1-7

Abou-Zeid, A.H., Abkar, T. A. and Mohamed, R.O. (2013). Schistosomiasis infection among primary school students in a war zone, Southern Kordofan State, Sudan: a cross-sectional study. *BMC Public Health*, 13:643

Absar, A., Joseph, R., Rubino, M., and Khalid, I. (2010). The global war against intestinal parasite. *International Journal of Infectious Disease,* 14 (9): 732 - 738.

Abera, B., Alem, G., Yimer, M. and Herrador, Z. (2013). Epidemiology of soil-transmitted helminths, *Schistosoma mansoni*, and haematocrit values among school children in Ethiopia. *Journal of Infection in Developing Countries*, 7:253–260.

Adedayo, O. and Nasilro, R. (2004). Intestinal parasitoses. *Journal of National Medical Association*, 96(1):93- 96

Ademiluyi, I. A. and Odugbesan, J.A. (2013). Sustainability and impact of community water supply and sanitation programmes in Nigeria, An overview: African. *Journal. Agrilcutural Research,* 3 (12):811-817.

Adenowo, A.F., Oyinloye, B.E., Ogunyinka, B.I., Kappo, A.P. (2014). Impact of human schistosomiasis in sub-Saharan Africa. *The Brazilian Journal of Infectious Diseases,* 19(2):196-205.

Adeyeba, O. A. and Tijani, B.D. (2002). Intestinal helminthiasis among malnourished school-age children in peri-urban area of Ibadan, Nigeria. *African Journal of Clinical and Experimental Microbiology*, 3:24-8.

Ahmed, E.S., Daffalla, A., Christensen, N.O. and Madsen, H. (1996). Patterns of infection and transmission of human *Schistosoma mansoni* and *Schistosoma haematobium* in White Nile Province, Sudan. *Annals of Tropical Medicine* and *Parasitology,* 90(2):173–180.

Akingbade, O.A., Akinjinmi, A. A., Ezechukwu, U.S., Okerentugba, P.O.and Okonko, I.O. (2013). Prevalence of Intestinal Parasites among Children with Diarrhea in Abeokuta, Ogun State, Nigeria. *Researcher,* 5(9): 66 - 73

Akinbo,F.O., Omoregie, R., Eromwon, R., Igbenimah, I.O., and Airueghiomon, U. (2011). Prevalence of intestinal parasites among patients of a tertiary hospital in Benin City, Nigeria. *North American Journal of Medical Sci*ences*.* 3(10): 462–464.

Albonico, M., Ame, S.M., Vercruysse, J. and Levecke, B. (2012). Comparison of the Kato-Katz thick smear and McMaster egg counting techniques for monitoring drug efficacy against soil-transmitted helminths in schoolchildren on Pemba Island, Tanzania. *Transactions of the Royal Society of Tropical. Medicine and. Hygiene*, 106 (3):199–201

Ali, S. K., Mahmood, N., and Mohammed R. S. (2008). Epidemiology of acute diarrheal diseases among children under 5 years in Tehran, Iran. *Iranian Journal of Clinical Infectious Diseases,* 3(4): 193-198.

Ali, I., Mekete, M. and Wodajo, N. (1999). Intestinal parasitism and related risk factors among students of Asendabo Elementary and Junior Secondary school, South Western Ethiopia. *Ethiopia Journal of Health Development,* 13(2):157-161.

Allen, A.V.H. and Ridley, D.S. (1970). Further observations on the formol-ether concentration technique for faecal parasites. *Journal of Clinical Pathology,* 23(6):545–546.

Almeida, O. L. S. and Santos, J. B. (2011). Advances in the treatment of cutaneous leishmaniasis in the new world in the last ten years: A systematic literature review. *Anais Brasileiros De Dermatologia*, 86(3): 497–506.

Alo, M., Ugah, U. and Elom, M. (2013). Prevalence of Intestinal Parasites from the Fingers of School Children in Ohaozara, Ebonyi State, Nigeria. American *Journal of Biological, Chemical and Pharmaceutical Sciences*, 1(5): 22 -27

Al Reza, S., Mafiz, A.I., Afzal, A. and Hasan, M.M. (2014). The association of predisposing and enabling factors on nutritional status in children. *International Journal of Research in Engineering and Technology,* 3(6):3-9

Aly, N.S.M. and Mostafa, M.M. (2010). Intestinal parasitic infection among children in the Kingdom of Saudi Arabia. *Australian Journal of Basic and Applied Sciences,* 4:4200-4.

Amare, M., Gebere-Selassie, S. and Kassa, T.(2007). Prevalence of intestinal parasites among urban dwellers in South West Ethiopia. *Ethoipian. Journal of Health. Development,* 21(1): 12-17.

Amuta, E.U., Houmsou, R. S. and Mker, S.D. (2010). Knowledge and risk factors of intestinal parasitic infections among women in Makurdi, Benue State. *Asian Pacific Journal of Tropical Medicine*, 3(12): 993-996.

Amuta, E., Olusi, T. and Houmsou, R. (2008). Relationship of intestinal parasitic infections and malnutrition among schoolchildren in Makurdi, Benue State, Nigeria. *The Internet Journal of Epidemiology*, 7 (1),

Anumba, J.U. Onyido, A.E. Eneanya, C.I. Umeaneto, P.U. Iwueze, M.O. Okafor, E.N. and Chukwuekezie, O.C.(2016). Gastro-intestinal parasites among children in some orphanages of Anambra State, Nigeria. *Nigerian Journal of Parasitology*, 379(2)

Arcari, M., Baxendine, A. and Bennett, C.E. (2000). *Diagnosing Medical Parasites Through Coprological Techniques.* University of Southampton (Industrial Liaison) United Kingdom.

Aribodor, D.N., Anidebe, A.O., Eneanya, A.O. and Emelummadu, O.F. (2012). *Entamoeba histolytica* Infection in Children Aged 0-12 Years in Rural Communities in Anambra State, Nigeria. *Nigeria Journal of Parasitology*, 33(2):129-132.

Asaolu, S.O. and Ofoezie, I.E. (2003). The role of health education and sanitation in the control of helminth infections. *Acta Tropica,* 86(2-3):283-94

Awasthi, S. Bundy, D. and Savioli, L.(2003). Helminthic infections*. British Medical Journal,* 323:431–3

Awolaju, B.A. and Morenikeji, O.A. (2009). Prevalence and intensity of intestinal parasites in five communities in south-west Nigeria. *African Journal of Biotechnology,* 8(18):4542-4546.

Ayeh-Kumi, F., Quarcoo, S., Kwakye-Nuako, G., Kretchy, P., Osafo-Kantanka, A. and Mortu, S. (2009). Prevalence of Intestinal Parasitic Infections among Food Vendors in Accra, Ghana*. Journal of Tropical Medicine and Parasitology,* 32(1):1-8.

Babar, N.F., Muzaffar, R., Khan, M. A. and Imdad, S. (2010). Impact of socioeconomic factors on nutritional status in primary school children. *Journal of Ayub Medical College Abbottabad,* 22(*4*):15-8

Barbara, M., Mohion, B., Gulzira, K., Zulfira, M., Vreni J., Malika, H., Matluba, K., Laurent, K., Jürg, U.R. and Kaspar, W. (2011). Prevalence and risk factors of helminths and intestinal protozoa infections among children from schools in western Tajikistan. *Parasites and Vectors,* 4(195): 1-28

Ben-Musa N. A. and Ibrahim R. (2007). Long term formalin-preserved stool specimens for detection of intestinal parasites from school-aged children in Tripoli, Libya. *Journal of Egyptian Society of Parasitology,* 37:1049–1054

Biu, A.A., Mafa, F. and John, W.M. (2012). Prevalence of Intestinal Parasites in School Aged Pupils in Local Government Area of Borno State, *Nigeria. Journal of Medical and Applied Biosciences*, 4: 54 - 55

Biwott, G., Wanjala, P and Ngeiywa, M. (2014). Prevalence of gastrointestinal parasitic infections among food handlers in Eldoret Municipality, Kenya: *Journal of Biology, Agriculture and Healthcare,* 4(27):160-165

Buret, A. G. (2008). Pathophysiology of enteric infections with *Giardia duodenalis*. *Parasite*, 15, 261-265

Campbell, S.J., Savage, G.B., Gray, D.J. (2014). Water, sanitation, hygiene (WASH): a critical component for sustainable soil-transmitted helminth and schistosomiasis control. *PLoS Neglected Tropical Diseases,* 8 p. 2651

Cauyan, G.A. and Andaman, D.E., Maricar, S.M. (2008). Prevalence of intestinal parasites among schoolchildren in a Coastal Rural Area of Maragondon, Cavite, Southern Luzon, Philippines. *Acta Manilana* 56:43-9.

Caulfield, L.E., Richard, S.A., Rivera, J.A., Musgrove, P., and Black, R.E. (2006). Stunting, wasting, and micronutrient deficiency disorders. Oxford University Press New York

Centre for Disease Control and Prevention. (CDC). (2009). Intestinal Protozoan Parasites.http://www.dpd.cdc.gov/dpdx (Accessed March, 2017).

Center for Disease Control and Prevention. (2011). Human Diseases and Conditions. http://www.cdc.gov. Page last reviewed: July 22, 2015

Che, GM. (2010). Mental function, attention span and academic performance of school children infected with *Ascaris lumbricoides* and *Trichuris trichiura* in rural Peninsular Malaysia: The impact of anthelminthic treatment. Unpublished DSc Thesis, Tulane University

Cheesbrough, M. (2002). District Laboratory Practice in Tropic Countries, Part 2. Cambridge University Press. Cambridge Low Price Reprinted Edition 2002.

Chen, Y., Y. Zhang, B. Yang, T. Qi and H. Lu. (2007). Short report: Seroprevalence of *Entamoeba histolytica* infection in HIV-infected patients in China. *American Journal of Tropical Medicine and Hygiene* 77(5): 825-828.

Chirdan, O., Akosu, J. and Adah, S. (2010). Intestinal parasites in children attending day care centers in Jos, Central Nigeria. Nigerian *Journal of Medicine* 19(2):219-222.

Cinthia, A.A., Giovanna, R., Eliezer, K.N.G., Andres, B.T., Isaac, I.B., Essane, S., Marcel, T. and Bright, O. (2010). Parasitic Worms: Knowledge, Attitudes and Practices in Western Cote d'Ivoire with Implications for Integrated Control. *PLoS Neglected Tropical Diseases,* 4 (12): 910-1371.

Colan, J.C., Sripab, B., Attwood, S. and Newton, P.N. (2011). A review of parasitic zoonoses in a changing Southeast Asia. *Veterinary Parasitology,* 182: 22– 40

Cooper, N.R. (2007). Complement evasion strategies of microorganisms. *Immunology Today*, 12:327–31.

Cringoli, G., Rinaldi, L., Maurelli, M.P. and Utzinger, J. (2010). FLOTAC: new multivalent techniques for qualitative and quantitative copromicroscopic diagnosis of parasites in animals and humans. *Nature Protocol, 5:503–515.*

Crompton, D.W.T and Savioli, L. (1993). Intestinal parasitic infections and urbanization. *Bulletin of World Health Organization*, 71: (1) 1-7

Crompton, D.W.T. and Nesheim, M.C. (2002). Nutritional impact of intestinal helminthiasis during the human life cycle. *Annual Review of Nutrition*, 22:35-59.

Damen, J.G., Lar, P., Mershak, P., Mbaawuga, M. E. and Nyary, W.B. (2010). A comparative study of the prevalence of intestinal helminthes in dewormed and non-deworned students in a rural area in North-Central Nigeria. *Laboratory . Medicine,* 41:585-589.

Daniel, W.W. (1999). Biostatistics: A Foundation for Analysis in the Health Sciences. 7th edition. New York: John Wiley &Sons

Dariel, J. (2007). Cleanse and Purify Thyself Book One. Medford, Oregon: Christobe Publishing.

Davis, A. (2004). Clinical trials in parasitic diseases. *Transactions of Royal Society of Tropical Medicine and Hygiene*. 98:139–141.

Dawson, D. (2005). Food born protozoan parasites. *International Journal Food Microbial,* 103:207-227.

Delpeuch, F., Traissac, P., Martin-Pre, Y., Massamba, J.P. and Maire, B. (2000). Economic crisis and malnutrition: Socioeconomic determinants of anthropometric status of preschool children and their mothers in an African urban area. *Public Health Nutrition,* 3:39–47.

De Silva, N.R., Brooker, S., Hotez, P. J., Montresor, A. and Engels, D. (2003). Soil-transmitted helminth infections: updating the global picture. *Trends in Parasitol*ogy, 19: 547–551.

Desta-Haftu, D., Deyessa, N. and Agedew, E. (2014). Prevalence and determinant factors of intestinal parasites among schoolchildren in Arba Minch town, Southern Ethiopia. *American Journal of Health Research*, 2(5): 247-254.

Dopouy-Cement, J. (2004). New drug for the treatment of human parasitic protozoa, *Parassitologia.* 246 (1-2):81-4.

Eckamann, L. and Gillin, F.D. (2001). Microbes and microbial toxins: Paradigms for microbial–mucosal interactions1. Pathophysiological aspects of enteric infections with the lumen-dwelling protozoan pathogen *Giardia lamblia*. *American Journal of Physiology and Gastrointestinal Liver Physiology*, 280:1-6.

Ehiaghe, A .F., Tatfeng, Y.M., Ehiaghe, J.I. and Osaretin, U. (2013). Hemoglobin concentration of intestinal parasites infested children in Okada, Edo state, Nigeria. *Open Journal of Epidemiology*, 3, 149-152

Eleni, K., Sissay, M., Ameha, K. and Mulugeta, D. (2014). Prevalence of intestinal parasitic infections and their association with anthropometric measurements of school children in selected primary schools, Wukro Town, Eastern Tigray, Ethiopia. *International Journal Current Microbiology and Applied Sciences*, 3(3): 11-29

El-Ridi, A.F. and Tallima, H.A. (2013). Novel therapeutic and prevention approaches for schistosomiasis: Review. *Journal of Advanced Research*, 4:467–478

Emmy-Igbe, I.O., Ekwesianya, E.O., Ukaga, C.N., Eneanyi, C.I. and Ajaero, C.M. (2011). Prevalence of Intestinal helminths in Students of Ihiala L.G.A of Anambra State. *Parasitology*, 3:247-249.

Engebretsen, I. M., Tylleskär, T., Wamani, H., Karamagi, C., & Tumwine, J. K. (2008). Determinants of infant growth in Eastern Uganda: A community-based cross-sectional study. *BMC Public Health*, 8(1), 418.

Escobedo, A.A. and Cimerman, S. (2007). Giardiasis: A pharmacotherapy review. *Expert Opin Pharmacother*, 8 (12): 1885– 1902

Esomonu, O.C., Abanobi, O.C. and Ihejirika, C.E. (2012). Enteric pathogens and diarrhea disease potentials of water sources in Ahiazu Mbaise, Eastern Nigeria. *Journal of Public Health and Epidemiology*, 4(2): pp. 39-43

Ezeagwuna, D.A., Ekejindu, I.M., Nnamah, N. K. and Onwuzurike, P.A. (2011). Nutritional Impact of Intestinal Helminthiasis Among School Children in Umuikwu, Anam, Anambra LGA, Anambra State, *Abstract 27:27, Parasitology and Public Health Society of Nigeria*

Ezeamama, A.E., Friedman, J.F., Olveda, R.M., Acosta, L.P., Kurtis, J.D., Mar, V. and McGarvey, S.T. (2005). Functional significance of low-intensity polyparasite helminth infections in anemia. *Journal of Infectious Diseases*, 192(1):2160-2170.

Ezeamama, A., Friedman, J.F., Acosta, L.P., Bellinger, D.C., Langdon, Manalo, D.I., Olveda, R. M., Kurtis, J. D. and Mcgarvey, S.T. (2006). Helminths infection and cognitive impairment among Filipino children. *American Journal of Tropical Medicine and Hygiene,* 72(5):540-548.

Ezenwaka, C.O., Nsofor, C. J. and Nzeakor, S.O. (2011). Prevalence of intestinal helminths among primary school children in Ogbaru local government area, Anambra state, Nigeria. *Nigerian Journal of Parasitology*, 92.

Feng, Y. and Xiao, L. (2011). Zoonotic potential and molecular epidemiology of *Giardia* species and giardiasis. *Clinical Microbiology Reviews*, 24:110-140.

Fernandez, M.C., Verghese, S., Bhuvaneswari, R., Elizabeth, S.J., Mathew, T., Anitha, A. and Chitra, A.K. (2002). A comparative study of the intestinal parasites among children living in and around Chennai. *Journal of Communicable Diseases,* 31(10): 35-39.

Garba, C.M.G. and Mbofung, C.M.F. (2010). Relationship between malnutrition and parasitic infection among schoolchildren in the Adamawa Region of Cameroon. *Pakistan Journal of Nutrition,* 9 (11): 1094-1099

Gerald D. S., John J.JJ. and Larry S.R. (2009). Foundations of Parasitology (8th ed). McGraw-Hil.

Ghiwot, Y., Degarege, A. and Erko, B. (2014). Prevalence of Intestinal Parasitic Infections among Children under Five Years of Age with Emphasis on *Schistosoma mansoni* in Wonji Shoa Sugar Estate, Ethiopia. *PLoS One*. 9(10): e109793.

Gilgen, D. and M ascie-Taylor, C.G.N. (2000). The effect of anthhelmintic treatment on helminth infection and anaemia. *Parasitology,* 122:105-110

Gilles, H .M. and Hoffman, P.S. (2002). Treatment of intestinal parasitic infections: A review of nitazoxanide. *Trends in Parasitology*, 18: 95–97

Gimba, U.N. and Dawam, N. N. (2015). Epidemiological status of intestinal parasitic infection rates in children attending Gwagwalada Township Clinic, FCT-Abuja, Nigeria. *American Journal of Research Communication*, 2015, 3(2): 97-110

Glinz, D., Silue, K.D., Knopp, S., Lohourignon, L.K., Yao, K.P., Steinmann, P., Rinaldi, L., Cringoli, G., N'Goran, E.K. and Utzinger, J. (2010). Comparing diagnostic accuracy of Kato-Katz, Koga agar plate, ether-concentration, and FLOTAC for *Schistosoma mansoni* and soil-transmitted helminths. *PLoS Neglected Tropical Diseases* 4:e754.

Graeff-Teixeira, C., da Silva., A. C. and Yoshimura, K. (2009). *"*Update on Eosinophilic Meningoencephalitis and Its Clinical Relevance*". Clinical Microbiology Reviews 22 (2): 322–48*

Gualdieri, L., Rinaldi, L., Petrullo, L., Morgoglione, M.E., Maurelli, M.P., Musella, V., Piemonte, M., Caravano, L., Coppola, M.G. and Cringoli, G.(2011). Intestinal parasites in immigrants in the city of Naples (Southern Italy). *Acta Tropica,* 117(3)*:*196–201.

Gupta, N., Khan, D.K. and Santra, S.C. (2009). Prevalence of intestinal helminth eggs on vegetables grown in wastewater-irrigated areas of Titagarh, West Bengal, India. *Food Control*, 20: 942-945

Hadju, V., Stephenson, L.S., Abadi, K., Mohammed, H.O., Bowman, D. D. and Parker, R.S. (1996). Improvement in appetite and growth in helminth-infected schoolboys three and seven weeks after a single dose of pyrantel pomoate. *Parasiltology,* 113:497-504

Haque, R. (2007). Human intestinal parasites. *Journal of Health, Population and Nutr*ition, 25(4):387-391.

Hassan, A.H.A., Hong, S., Babiker, A.E.B., Hassan, R.A.M., Sulaiman, M.A.Z., Jeong, H., Kong, W., Lee, S., Cho, H., Nam, H., Oh, C.H. and Lee, Y. (2014). Prevalence, risk factors, and clinical manifestations of schistosomiasis among school children in the White Nile River basin, Sudan. *PubMed Central,* 7: 478

Hollm-Delgado, M. G., Gilman, R. H., Bern, C., Cabrera, L., Sterling, C. R., Black, R. E., and Checkley, W. (2008). Lack of an adverse effect of *Giardia intestinalis* infection on the health of Peruvian children. *American Journal of Epidemiology*, 168(6), 647-655.

Horton, J. (2000). Albendazole: A review of anthelmintic efficacy and safety in humans. *Parasitology*, 121(l):S113-32 ·

Hotez, P. J., Brindley, P. J. and Bethony, J.M. (2008). Helminth Infections: The Great Neglected Tropical Disease. *Journal of Clinical Investigation,* 118(4):1312.

Hotez, P. J. and Ehrenberg, J.P. (2010). Escalating the global fight against neglected tropical diseases through interventions in the Asia Pacific region. *Advanced Parasitology* 72: 31–53.

Hotez, P. J. and Kamath, A. (2009). Neglected tropical diseases in sub-Saharan Africa: Review of their prevalence, distribution, and disease burden. *PLoS Neglected Tropical Diseases,* 3:e412

Houmsou, R.S., Amuta, E. U. and Olusi, T.A. (2010). Prevalence of intestinal parasites among primary school children in Makurdi, Benue State, Nigeria. *The Internet Journal of Infectious Diseases*, 8(1).

Hual, L.B., Mitra, A.K., Jamil, N.I., Dam, C.P., Mohamed, J. H. and Wan-Muda, W.M. (2012). Prevalence and risk factors of intestinal helminth infection among rural Malay children. *Journal of Global Infectious. Diseases, 4*(1): 10-14.

Huang, D. B. and White, A.C. (2006). An updated review on Cryptosporidium and Giardia. *Gastroenterology Clinics of* North *America,* 35: 291-314

Iduh, M.U., Isaac, I. Z. and Mustapha, S. (2015). Prevalence of intestinal parasites among the “Almajiris” in Sokoto Mtropolis, Sokoto Nigeria, *International Journal of Novel Research in Life Sciences* 2(5): 11-17

Ikeh, E.I. and Aziah, I. (2015). Intestinal parasitic infection and assessment of risk factors in North-Western, Nigeria: A Community Based Study. *International Journal of Pharma Medicine and Biological Sciences,* 4(2): 141-145

Ikpeama, C.A., Obiajuru, I. O. C. and Ogoamaka, A.I. (2016). The impact of refuse disposal dump sites on the spread of intestinal helminthiasis in Owerri metropolis, Imo State, South Eastern Nigeria. *International Journal of Clinical Chemistry and Laboratory Medicine*, 2 (2): 13-18.

Ikpeze, O.O., Oguoma, V. M. and Igbodika, M.C. (2008). Evaluation of direct smear method and formol-ether concentration technique for the identification of intestinal parasites in Sub-Saharan Africa. *International Journal of Biosciences*, 3(3)

Ilechukwu, G.C., Ilechukwu, C.G.A., Ubesie, A.C., Onyire, N.B., Emechebe, G. and Eze, J.C. (2014). Relationship between Nutritional Status and Intensity of Common Intestinal Helminths among Children in Enugu, South-East Nigeria. *Annals Medical and Health Science Research*, 4(2): S119–S122.

Jex, A.R., Smith, H.V., Nolan, M.J., Campbell, B.E., Young, N.D., Cantacessi, C. and Gasser, R.B. (2011). Cryptic parasite revealed improved prospects for treatment and control of human cryptosporidiosis through advanced technologies. *Advances in Parasitology,* 77:141-173.

Kamalu, N.A., Uwakwe, F. E. and Opara, J.A. (2013). Prevalence of intestinal parasite among high school students in Nigeria, *Academic Journal of Interdisciplinary Studies,* 2(7): 7-16

Kang, G., Matthew, M. S., Rajaw, P.D., Daniel, D.J., Mathan, M.M., Mathan, V.I. and Muliyil, O. (1998). Prevalence of intestinal parasites in rural Southern India. *Tropical Medicine and International Health* 3(1): 70-75.

Kanwai, S., Ndams, I.S., Abdulkadir, J.S., Gyam, Z.G. and Bechemagbor, A. (2011). Cofactors influencing prevalence and intensity of *Schistosoma haematobium* infection in sedentary Fulani settlements of Dumbi, Igabi LGA, Kaduna State, Nigeria. *Science World Journal*, 6: 15–19.

Karesh, W. B., Dobson, A., Lloyd-Smith, J. O., Lubroth, J., Dixon, M. A., Bennett, M. and Heymann, D. L. (2012). Ecology of zoonoses: Natural and unnatural histories. *Lancet,* 380(9857): 1936–1945

Katz, D.E. and Taylor, D.N. (2001). Parasitic infections of the gastrointestinal tract. *Gastroenterology Clinics of North America* 30: 795-815.

Kazora, J.W. and Mahm, A.A.F. (1992) Intestinal nema-todes. In: Behrman, R.E., Kliegman, R.M., Nelson, W.E. and Vaughan, V.C., Eds., *Nelson's Testbook of Pediatrics*, 14th Edition, W.B. Saunders Co., Philadelphia, 896-899

Keiser, J. and Utzinger, J. (2004). Chemotherapy for major food-borne trematodes: A review. *Expert Opinion* on *Pharmacotherapy*, 5:1711-26

Kelly, J.A., Amirkhanian, Y.A., Kabakchieva, E., Vassileva, S, Vassilev, B., McAuliffe, T.L. (2006).Prevention of HIV and sexually transmitted diseases in high risk social networks of young Roma (Gypsy) men in Bulgaria: randomised controlled trial. *BMJ.* 333(7578):1098

Kidane, E., Menkir, S., Kebede, A. and Desta, M. (2014). Prevalence of intestinal parasitic infections and their associations with anthropometric measurements of school children in selected primary schools, Wukro Town, Eastern Tigray, Ethiopia. *International Journal of Current Microbiology and Applied Sciences,* 3(3): 11-29

Kikafunda, J.K. and Tumwine, J.K. (2006). Diet and socio-economic factors and their association with the nutritional status of pre-school children in a low-income suburb of Kampala City, Uganda. *East African Medical Journal*, *83*(10): 565-574.

Kikafunda, J. K., Walker, A. F., Collett, D., & Tumwine, J. K. (1998). Risk factors for early childhood malnutrition in Uganda. *Pediatrics*, *102*(4):e45-e45.

Kloos, H. (1995). Human behavior, health education and schistosomiasis control: A review. *Social Science* and *Medicine,* 40:1497-1511.

Knopp, S., Glinz, D., Rinaldi, L., Mohammed, K.A., N'Goran, E.K., Stothard, J.R., Marti, H, Cringoli, G., Rollinson, *D*, and Utzinger, J. (2009). FLOTAC: A promising technique for detecting helminth eggs in human faeces. Transactions of the Royal *Society* of *Tropical* Medicine and *Hygiene* 103: 1190–1194

Koplan, J. P., Bond, T. C., Merson, M. H., Reddy, K. S., Rodriguez, M. H., Sewankambo, N. K. and Wasserheit, J. N. (2009). Towards a common definition of global health. *Lancet*, *373* (9679):1993-1995.

Kongs, A., Marks, G., Verle, P. and Van Der Stuyft, P. (2001). The Unreliability of the Kato-Katz Technique Limits its Usefulness for Evaluating *S. mansoni* Infections. *Tropical Medicine and International Health* 6: 163-169

Kouontchou, S., Quakyi, I.A. and Befidi, R.M. (2002). Prevalence of Multiple Concomitant Intestinal Infections in Simbok, a Malaria Endemic Village in Cameroon. *Journal of the Cameroon Academy of Sciences,* 2: 202-296.

Leal, L.P., Filho, M.B., Cabral de Lira, P.I., Figueiroa, J. N and Osório, M.M. (2011). Prevalence of anemia and associated factors in children aged 6-59 months in Pernambuco, Northeastern Brazil. *Revista* de *Saúde Pública,* 45(3)

Lopez, A.S., Bendik, J.M., Alliance, J. Y., Roberts, *J.M.*, daSilva, A.J. and Moura, I.N.S (2003).Epidemiology of Cyclospora cayetanensis and other intestinal parasites in a community in Haiti," *Journal of Clinical Microbiology*, 41(5):2047–2054..

Loukopoulos, P., Komnenou, A., Papadopoulos, E. and Psychas, V. (2007). Lethal Ozolaimus megatyphlon infection in a green iguana (*Iguana iguana rhinolopa*). Journal of *Zoo and Wildlife Medicine,* 38: 131-134.

Lozano, R., Naghavi, M., Foreman., K., Lim, S., Shibuya, K., Aboyans, V., Abraham, J., Adair, T., Aggarwal, R., Ahn, S.Y., Alvarado, *M.,* Anderson, H.R., and Anderson,L.M. (2012). Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*, 380:2095–2128.

Maguire, J.H. (2009). Intestinal nematodes (roundworms). In: Mandell GL, J.E. Bennett, R. Dolan, eds. *Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases*. 7th ed. Orlando, FL. Saunders Elsevier 287.

Marshall, M.M., Naumovitz, D., Ortega, Y. and Sterling, C. (1997). Waterborne Protozoan Pathogens. *Clinical Microbiology Reviews,* 10:67-85.

Mazigo, H.D., Lwambo, N.J.S., Mkoji, G.M., Laurent, L.M., Kweka, E.J. and Waihenya, R. (2010a). Anaemia and organomegaly associated with parasitic infections among schoolchildren in Sengerema District, north--western Tanzania. *Tanzania Journal of Health Research,* 12 (4).

Mbanugo, J.I. and Onyebuchi, C.J. (2002). Prevalence of intestinal parasites in Ezinifite Community in Aguata L.G.A. of Anambra State, *Niger*ian Journal of *Parasitology*, 23:27-34.

Mbuh, V., Ntonifor, N. and Ojong, T. (2010). The incidence, intensity and host morbidity of human parasitic protozoan infections in gastrointestinal disorder outpatients in Buea Sub Division, Cameroon. *Journal of Infections in Developing Countries,* 4: 38-43.

McSharry, C., Xia, Y., Holland, C. V. and Kennedy, M. W. (1999). Natural immunity to *Ascaris lumbricoides associated* with Immunoglobulin E antibody to ABA-1 allergen and inflammation indicators in children. *Infection and Immunity,* 67, 48-489.

Minvielle, M.C**.,** Pezzani, B.C**.,** Cordoba, M.A**.,** De Luca, M.M**.,** Apezteguia, M.C**.** and Basualdo, J.A**.**(2004). Epidemiological survey of Giardia spp. and *Blastocystis hominis* in an Argentinian rural community. *Korean Journal of Parasitology,* 42(3):121-7.

Mohamed, K., Abdullah, M.R. and Omar, J. (2015). Intestinal parasitic infection and assessment of risk factors in North-Western, Nigeria: A community based study. *International Journal of Pharma Medicine and Biological Sciences,* 4(2)

Montes, M., Sawhney, C. and Barros, N. (2010). "*Strongyloides stercoralis*: There but not seen". *Current Opinion in Infectious Diseases*, 23(5): 500-504.

Montresor, A., Crompton, D., Gyorkos, T. and Savioli, L. (2002). Helminth Control in School-Age Children: A Guide for Managers of Control Programmes. Geneva:World Health Organization

Mora, J.O. (2002). Iron supplementation: Overcoming technical and practical barriers. *Journal of Nutrition,* 132(4):853S-5S

Moraes-Neto, A. H, Pereira, A. P., Alencar, M. F., Souza-Júnior, P. R., Dias, R. C., Fonseca, J. G. and Santos, C. P. (2010). Prevalence of intestinal parasites versus knowledge, attitudes, and practices of inhabitants of low-income communities of Camposdos Goytacazes, Rio de Janeiro State, Brazil. *Parasitology Research*, *107*(2), 295–307.

Nanvya, T.N., Dakul, D.A. and Mwansat, G.S. (2011). Schistosomiasis in Ndinjor District of Langtang North Local Government Area of Plateau State, Nigeria. *Nigerian Journal of Parasitology,* 32(2): 209-214.

Nduka, F.O., Nwaugo, V.O. and Nwachukwu , N.C. (2006). Human intestinal parasitic infection in Ishiagu- a lead mining area of Abia State. *Animal Research,* 3:505-7

Neghab, M., Moosavi, S., and Moemenbellah-Fard, M.D. (2006). Prevalence of intestinal parasites among Catering Staff of Students' Canteens at Shiraz, Southern Iran. *Pakistan Journal* of *Biological Sciences*, 9(14):2699-2703.

Nematian, J., Gholamrezanezhad, A. and Nematian, E. (2008). Giardiasis and other intestinal parasitic infections in relation to anthropometric indicators of malnutrition: A large, population based survey of school children in Tehran. *Tropical Medicine* and *Parasitology*, 102(3):209–14.

Neva, F.A. and Brown, H.W. (1994). Basic Clinical Parasitology, 6th ed. Norwalk, Connecticut Appleton and Lange.

Newman, R.D., Wuhib, T, Lima, A.A., Guerrant, R. L. and Sears, CL. (1993). Environmental sources of Cryptosporidium in an urban slum in Northeastern Brazil. *American Journal of Tropical Medicine and Hygiene,* 49(2):270-5.

Ngonjo, T.W., Kihara, J.H., Gicheru, M., Wanzala P. and Njenga, S.M. **(**2012). Prevalence and Intensity of Intestinal Parasites in School age Children in Thika District, Kenya. Mwandawiro C. S*, African Journal of Health Science,* 21:153-160

Nikolay, B., Brooker, S.J. and Pullan, R.L. (2014). Sensitivity of diagnostic tests for human soil-transmitted helminth infections: A meta-analysis in the absence of a true gold-standard. *International Journal for Parasitology,* 44 (11)

Nkengazong, L., Njiokou, F., Teukeng, F., Enyong, P. and Wanji, S. (2009). Reassessment of endemicity level of urinary schistosomiasis in the Kotto-Barombi focus (South West Cameroon) and impact of mass drug administration (MDA) on the parasitic indices. *Journal of Cell and Animal Biology*, 3 (9):159-164

Norhayati, M, Oothuman, P., and Fatmah, M.S. (1998). Some risk factors of *Ascaris* and *Trichuris* infection in Malaysian aborigine (Orang Asli) children. *Medical Journal* of *Malaysia*, 53:401–7

Nwaneri**,** D.U., and Omuemu, V.O. (2013). Intestinal helminthiasis and nutritional status of children living in orphanages in Benin City, Nigeria. *Nigerian Journal of Clinical Practice,* 16(2) 243 -247

Nwoke, B.E.B. (2009). *Worms and human diseases*. Aphabet Publshers, Owerri Imo State Nigeria, p.10-16

Nxasana, N., Baba, K., Bhat, V.G. and Vasaikar, S.D. (2013). Prevalence of intestinal parasites in primary school children of Mthatha, Eastern Cape Province, South Africa. *Annals of Medical and Health Science Research*, 3(4):511-6

Obiajuru, I. O. C. and Adogu, P, O. U. (2013). Prevalence of *Helicobacter pylori* and other intestinal parasites amongst duodenal and gastric ulcer patients at Imo state University Teaching Hospital, Orlu, south eastern Nigeria. *Journal of Medicine and Medical Sciences*, 4(9):362-369

Odo, G.E., Agwu, J.E., Ekeh, F.N., Ezea, C.O ., Aguoru ,G.C., Anya, C., Omeje, K.O. and Ubachukwu, P.O. (2016). Prevalence of intestinal parasites among school children in Uzo-Uwani Local Governemnt Area of Enugu State. *International Journal of Research Studies in Microbiology and Biotechnology (IJRSMB)* 2(2): 7-14

Odu, N.N., Elechi, V. I. and Okonko, I.O. (2013).Prevalence of Intestinal helminthes infection among primary school children in urban and semi-urban areas in Port Harcourt, Rivers State, Nigeria. *World Rural Observations,* 5(1):52-61

Ogbain-Emovon, E.A., Eigbedion, A.O., Ojide, C.K and Kalu, E.I. (2014). Prevalence and impact of socio-economic/environmental factors on soil transmitted helminth infection in children attending clinic in a tertiary hospital in Benin City, Nigeria. *International Journal of Basic, Applied and Innovative Research*, 3(2): 65 – 70

Ogbuagu, C.N., Eneanya, C.I., Chukwuma, C. and Ogbuagu, E.N. (2009). High prevalence of intestinal parasites in a Nigerian tertiary health Institution. *The Internet Journal of Parasitic Diseases.* 4(2): 177-79

Oguoma, V.M., Anyasodor, A. E. and Mbata, T.I. (2008). Prevalence of Intestinal protozoan parasites among children aged 5-12 years in Owerri among Owerri Metropolis, South- Eastern Nigeria, *The tropical Journal of Health Science,* 15(2): 43-48.

Oguoma, V. and Ekwunife, C. (2006). The need for a better method: comparison of direct smear and formol-ether concentration techniques in diagnosing intestinal parasites. *The Internet Journal of Tropical Medicine*. 3(2).

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

Ok, K.S., Kim, Y.S., Song, J.H., Lee, J.H., Ryu, S.H., Lee, J.H., Moon, J.S., Whang, D.H. and Lee, H.K. (2009). *Trichuris trichiura* infection diagnosed by colonoscopy: case reports and review of literature. *Korean Journal of Parasitology,* 47(3):275-80

Okpala, H.O., Josiah, S.J., Oranekwulu, M. U. and Ovie, E.G. (2014). Prevalence of Intestinal Parasites among Children in Day Care Centres in Esan West Local

Government Area, Edo State, Nigeria. *Asian Journal of Medical Sciences,* 6(4): 34-39,

O'Lorcain, P. and Holland, C.V. (2000). The public health importance of *Ascaris lumbricoides*. *Parasitology*, 12: 51-71.

Olson, M.E. (2004). Zoonotic protozoan parasites in cattle emerging issues. Proceeding of the WBC Congress, Quebec, Canada.

Oluboyo, O.O.B., Enweani, I.B. Ekejindu, A. O. and Olubayo, A.O. (2014). Prevalence of some intestinal parasitic infections in relation to body mass index of children resident orphanages in Anambra, State Nigeria., *European Scientific Journal*, 10(36)

Oninla, S.O., Owa, J.A., Onayade, A. A. and Taiwo, O. (2007). Intestinal helminthiasis among rural and urban schoolchildren in South-western Nigeria. *Annals of Tropical Medicine and Parasitology*, 101(8):705-713.

Ono, K., Rai, S.K., Chikahira, M., Fujimoto, T., Shibata, H., Wada, Y., Tsuji, H., Oda, Y., Rai, G., Shrestha, C.D., Masuda, K., Shrestha, H.G., Matsumura, T., Hotta, H., Kawamura, T. and Uga, S. (2001). Seasonal distribution of enteropathogens detected from diarrheal stools and water samples collected in Kathmandu, Nepal. *Southeast Asian Journal* of *Tropical Medicine*, 32: 520-6.

Opara, K.N., Nwoke, E.A., Onwuliri, C.O.E., Abanobi, O.C., Iwuala, C. and Amadi, A. N. (2010). Intestinal parasites among children in day-care centres in Owerri metropolis Nigeria. *Nigeria Journal of Parasitiology*,

Opara, K. N. and Udoidung, N. I.(2003). Parasitic contamination of leafy vegetable: A function of leaf area index. *Global Journal of Pure and Applied Science*, 9:25-29.

Opara, K.N., Udoidung, N.I., Opara, D.C., Okpok, E., Okon, O.E., Edosomwan,E.U., Anietie, J. and Udoh, A.N. (2012).The impact of intestinal parasitic infections on the nutritional status of rural and urban school-aged children in Nigeria**.** *International Journal of MCH and AIDS,* 1(1):73-82

Orji, N.M. (2015). Haematological profile of people infected with intestinal parasitiasis in Uli, Ihiala local government area, Anambra State, Nigeria. *Sky Journal of Medicine and Medical Sciences*, 3(4):042-046

Parija, S.E. and Srinivasa, H. (1999). Viewpoint: The neglect of stool Microscopy for intestinal parasites and possible solutions. *Tropical Medicine and International Health,* 4(7):522-4.

Panaro, M.A., Cianciulli, A., Mitolo, V., Mitolo C.I., Acquafredda A., Brandonisio O. and Cavallo, P. (2007). Caspase-dependent apoptosis of the HCT-8 epithelial cell line induced by the parasite *Giardia intestinalis*. *FEMS Immunology and Medical Microbiology*, 51:302-309.

Petri, W. A. and Singh, U. (1999). Diagnosis and management of amebiasis. *Journal of Clinical Infectious Diseases,* 29: 1117-1125.

Pullman, R., and Brooker, S. (2008). The health impact of polyparasitism in humans: are we under-estimating the burden of parasitic diseases?. *Parasitology* 135:783–794

Que, J.H. (2007). The prevalence of intestinal parasitic infection and food handling practices of` food handlers in Barangay solar, Olutanga Zamboanga Sibugay Province. PhD Thesis, Ateneo de Zamboanga University, Phillipines. pp. 11-18

Quick, R.E., Kimura, A., Theros, A., Tembo, M., Shamputa, I., Hutwagner, L. and Mintz E. (2002). Diarrhea prevention through household level water disinfection and safe storage in Zambia. *American Journal of Tropical Medicine and Hygiene,* 66:584-9.

Quihui-Cota L., Valencia, M.E., Crompton, D.W.T., Hagan, S.P., Diaz-Camacho, A and Traina, T. (2004). Prevalence and intensity of intestinal parasitic infections in relation to nutritional status in Mexican schoolchildren. *Tropical Medicine and Hygiene*, 98(11): 653-659

Ramana, K.V. and Kranti, P.G. (2012). Conventional microscopy versus molecular and immunological methods in the diagnosis of amoebiasis. Annals of *Medical* and *Health Science* Research 2(2):211-21

Ramdath, D.D., Simeon, D.T., Wong, M., Granthan, and McGregor, S.M. (1995). Iron status in varying Intensities of *Trichiuris trichiuria* infection. *Parasitology.* 110**:** 561-572**.**

Ramirez, N.E., Ward, L.A. and Sreevatsan, S. (2004). A review of the biology and epidemiology of cryptosporidiosis in humans and animals. *Microbes and infection,* 6: 773-785.

Rarness, L.A. (1992) Nutrition and nutritional disorders. In: Behrman, R.E., Kliegman, R.M., Nelson, W.E. and Vaughan, V.C., Eds., *Nelson's Testbook of Pediatrics*, 14th Edition, W.B. Saunders Co., Philadelphia, 105-146.

Rasmuussen, S.A., Fernhoff, P.M. and Scanlon, K.S. (2001) Vitamin B12 deficiency in children and adolescents. *Journal of Pediatrics*, 138, 10-17.

Reingold, A. L., and Gordon, A. (2012). Infectious Diseases. In M. H. Merson, R. E. Black, and A.J. Mills (Eds.), *Global Health: Diseases, Programs, Systems, and Policies* (3rd Ed., p. 177–241).

Ritchie, L.S. (1984). An ether sedimentation technique for routine stool examination. *Bulletin of the United States Army Medical Department*. 8(4):326.

Rodriguez-Morales, A.J., Barbella, R.A., Case, C., Arria, M., Ravelo, M., Perez, H., Urdaneta, O., Gervasio, G., Rubio, N., Maldonado, A., Aguilera, Y., Viloria, A., Blanco, J.J., Colina, M., Hernandez, E., Araujo, E., Cabaniel, G., Benitez, J., and Rifakis, P. (2006). Intestinal parasitic infections among pregnant women in Venezuela. Infectious Diseases in *Obstetrics* and *Gynecology,* 2006:23125

Rollinson, D., Knopp, S., Levitz, S., Stothard, J.R., Tchuem- Tchuenté, L.A., Garba, A., Mohammed, K.A., Schur, N., Person, B., Colley, D.G. and Utzinger, J. (2013). Time to set agenda for schistosomiasis elimination. *Acta Tropica,* 128:423–440

Roma, B. and Worku, S. (1997). Magnitude of *Schistosoma mansoni* and intestinal helminthic infections among school children in Wondo-Genet zuria, southern Ethiopia. *Ethiopian Journal* of *Health Development,* 11:125-129

Ross, A.G., Bartley, P.B., Sleigh, AC. (2002). Schistosomiasis. *New England Journal of Med*icine, 346:1212-20.

Rudge, J.W., Stothard, J.R., Basáñez, M.G., Mgeni, A.F., Khamis, I.S., Khamis, A.N. and Rollinson, D. (2008). Micro-epidemiology of urinary schistosomiasis in Zanzibar: Local risk factors associated with distribution of infections among schoolchildren and relevance for control. *Acta Tropica,* 105:45–54.

Samaila, A.B., Yarma, A.A. and Oshomoh, E.O. (2016). Prevalence of Intestinal Helmnth Infections among two selected public primary schools in Bauchi Metropolis. *Journal of Medical and Biological Science Research,* 2 (4): pp. 82-86

Saloojee, H. and Cooper, P. (2008). HIV and AIDS. *Paediatric nutrition in practice*. Switzerland: Reinhardt Druck, Basel Press p.162-7.

Sam - Wobo, S.O., Asiwaju, R., Idowu, O.A., Eromosele, C.O.and Adeleke, M.A. (2012). Communal evaluation of Intestinal Helminthes in some Guineaworm-

Controlled Communities in Ogun State, Nigeria. *Journal of Entomology and Nematology*, 4(2): 7-11.

Santos, F., Luciano, N., Cerqueira, E.J.L. and Soares, N.M. (2005). Comparison of the thick smear and Kato-Katz techniques for diagnosis of intestinal helminth infections. *Revista da Sociedade Brasileira de Med Trop*. 38(2):196–198.

Sayasone, S., Mak, T.K., Vanmany, M., Rasphone, O, and Vounatsou, P. (2011). Helminth and Intestinal Protozoa Infections, Multiparasitism and Risk Factors in Champasack Province, Lao People's Democratic Republic. *PLOS Neglected* Tropical Diseases 5(4): e1037.

Sayyan, A.A., Imanzadeh, F., Bagheri, Y., Karami, H., and Yaghoobi, M. (2005). Prevalence of Intestinal Parasitic infections in the Islamic Republic of Iran. The *Eastern Mediterranean Health Journal,* 11(3):1-7.

Shah, S.A., Zai, S. and Muhammad, A. (2006). Correlation of haemoglobin level with intestinal parasites in schoolchildren. *Journal of Postgraduate Medical Institute*, 20 (3)

Simon-Oke, I.A., Afolabi, O.J. and Afolabi, T.G. (2014). *European Journal of Biology and Medical Science Research,* 2(1):17-22

Singh, G. and Prabhakar, S. (2002). Taenia solium Cysticercosis: From Basic to Clinical Science. New York: CABI Publishing.

Sinniah, B., Sabaridah, I., Soe, M. M., Sabitha, P. and Awang, I. P. (2012). Determining the prevalence of intestinal parasites in three Orang Asli communities in Perak, Malaysia. *Tropical Biomedicine*, 29(2): 200-206.

Slifko, T. R., Smith, H. V, and Rose, J. B. (2000). Emerging parasite zoonoses associated with water and food. *International Journal for Parasitology*, *30*(12-13):1379–1393.

Solomon, A.W., Engels, D., Bailey, R.L., Blake, I.M., Brooker, S., Chen, J.X. and Peeling, W.R. (2012). A diagnostics platform for the integrated mapping, monitoring, and surveillance of neglected tropical diseases: rationale and target product profiles. *PLoS Neglected Tropical Diseases*, *6*(7):1746.

Sorensen, E., Ismail, M., Amarasinghe, D.K. and Hettiarachchi, I. (1996). The efficacy of three anthelmintic drugs given in a single dose. *Ceylon Medical Journal,* 41(2):42-5.

Stanley, C.N., Oreh, N. C. and Johnson-Ajinwo, R.O. (2013). Knowledge, attitudes and practices of intermittent deworming in Alakahia Community, Rivers State, Nigeria. *International Research Journal of Medical Sciences,* 1(7): 1-7

Steinmann, P., Usubalieva, J., Imanalieva, C., Minbaeva, G., Stefiuk, K., Jeandron A. and Utzinger, J. (2010). Rapid appraisal of human intestinal helminth infections among schoolchildren in Osh Oblast, Kyrgyzstan. *Acta Tropica*,116:178-184.

Stephenson, L.S., Lathan, M.C. and Ottesen, E.A. (2000a). Global malnutrition. *Parasitology,* 121: 5-22

Stephenson, L.S., Latham, M.C. and Ottesen, E. A. (2000b). Malnutrition and parasitic helminth infections. *Parasitology,* 121:523-538

Stoltzfus, R.J., Albonico, M., Chwaya, H.B., Tielsch, K.J. and Savioli, L. (1998). Effects of the Zanzibari school-based dewormimg program on iron status of children. *American Journal of Clinical Nutrition*, 68: 179-186.

Stoltzfus, R. J. Chway, H. M. Montresor, A, Tielsch, J. M., Jape, J. K., Albonico, M. and Savioli, L. (2004). Low dose daily iron supplementation improves iron status and appetite but not anemia, whereas quarterly anthelminthic treatment improves growth, appetite and anemia in zanzibari preschool children. *Journal of Nutrition,* 134(2) 348–356

Stoltzfus, R.J., Chwaya, H.B., Tielsch, K.J., Schulze, K.J., Albonico, M. and Savioli, L. (1997). Epidemiology of iron deficiency anaemia in Zanzibari school children: Importance of hookworms. *American Journal of Clinical Nutrition,* 65:153-159

Stothard, J.R., Mook, P., Mgeni, A.F., Khamis, I.S., Khamis, A.N. and Rollinson, D. (2006). Control of urinary schistosomiasis on Zanzibar (Unguja Island): a pilot evaluation of the educational impact of the Juma na Kichocho health booklet within primary schools. *Memorias Do Instituto Oswaldo Cruz,* 101: 119 –124.

Sundeep, S. (2004). Evaluation of diarrhea: The challenge continues. *Indian Journal of Medical Sciences*, 58 (2) 75-8

Suriptiastuti and Manan, W.S. (2011). Intestinal parasites from fingernails of sidewalk food vendors. *Universa Medicina*, 30(2): 120- 125

Tamramat, K. F. and Olowu, A.O. (2008). Study on prevalence and nutritional effect of infection in pre-school rural children in Nigeria. *The Nigerian Medical Practitioner*, 54: 16-20

Tanner, S., of helminth infections on childhood nutritional status in lowland Bolivia, Tsmane Leonard, W.R., McDade, T., Garca-Reyes, V., Godoy, T. and Huanca, T. (2009). Influence. Amazonia Panel study Working Paper 49.

Tchuente, L.A.T., Behneke, J.M., Gibert, F.S., Southgate, V.R. and Vecrysse, J. (2003). Polyparasitism with *Schistosoma* and soil transmitted helminth among schoolchildren in Loum, Cameroon. *Tropical Medicine and International Health*, 8(11): 975–986

Ten Hove, R., Schuurman, T., Kooistra, M., Möller, L., van Lieshout, L. and Verweij, J. J. (2007). Detection of diarrhoea-causing protozoa in general practice patients in The Netherlands by multiplex real-time PCR. *Clinical Microbiology and Infection,* 13(10):1001-7.

Thomas, H. and Gonnert, R. (1977). The efficacy of praziquantel against cestodes in animals. *Parasitenkd*, 52:117-127.

Thomas, H.Z., Jatau, E.D., Inabo, H.I., and Garba, D.D. (2014). Prevalence of intestinal helminths among primary school children in Chikun and Kaduna South Local Government areas of Kaduna state, Nigeria*. Journal of Medicine and Medical Research* 2(2):6-11

Tiwari, B.R., Chaudhary, R., Adhikari, N., Jayaswal, S.K., Poudel, T.P., Rijal, K.R. (2013). Prevalence of Intestinal Parasitic Infections among School Children of Dadeldhura District, Nepal. *Jordan Health Aid Society*, 3(1): 14-16

Trainer, E.S. (2003). Mass parasite control: A good beginning. *World Health Forum*, 6:248-253

Troeger, H., Epple, H.J., Schneider, T., Wahnschaffe, U., Ullrich, R., Burchard, G.D., Jelinek, T., Zeitz, M., From, M. and Schulzke, J.D. (2007). Effect of chronic *Giardia lamblia* infection on epithelial transport and barrier function in human duodenum. *Gut*, 56:328-335.

Tohon, Z.B., Mainassara, H.B., Garda, A., Mahamane,A.E., Bosqué-Olia. E., Ibrahim, M., Duchemin, J.B., Chanteau, S. and Boiser, P. (2008). Controlling Schistosomiasis: Significant decrease of Anaemia prevalence one year after a single dose of praziquantel in Nigerian schoolchildren. *Plos Neglected Tropical Diseases,* 2(5).

Tulu, B., Taye, S. and Amsalu, E. (2014). Prevalence and its associated risk factors of intestinal parasitic infections among Yadot primary school children of South Eastern Ethiopia: a cross-sectional study. *BioMedical Central,* **7**:848

Udensi, J.U., Mgbemena, I., C., Emeka-Nwabunnia, I., Ugochukwu, G.J. and Awurum, I.N. (2015). Prevalence of Intestinal Parasites among Primary School Children in Three Geopolitical Zones of Imo State, Nigeria. *Science Journal of Public Health,* 3(5): 25-28

Unachukwu, M. N. and 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.

UNICEF. (1998). Malnutrition: causes, consequences and solution. The state of the world's children.

UNICEF. (2002). Prevention of intestinal worm infections through improved sanitation and hygiene. UNICEF East Asia and Pacific Regional Office Bangkok, Thailand. PP 1-28

Usip, E.L.P., Esiest, P. and David, N. C. (2013). The prevalence of human intestinal helminthes and the efficacy of anthelmentic lavamisole drug in Abak Local Government Area of AkwaIbom State, Nigeria. *Basic Researcher Journal of Medicine and Clinical Sciences,* 2(5): 52 -58

Utzinger, J., Botero-Kleiven, S., Castelli, F., Chiodini, P. L., Edwards, H., Kohler, N., Gulletta, M., Lebbad, M., Manser, M. and Matthys, K. (2010). Microscopic diagnosis of sodium acetate-acetic acid-formalin-fixed stool samples for helminthes intestinal protozoa: a comparison among European reference laboratories. *Clinical Microbiology* and *Infection,* 16:267–273.

Uwaezuoke, J.C., Udujih, O.S. and Onyeka, P.I.K. (2006). Prevalence of intestinal parasites among children in Owerri Municipality, Imo State, Nigeria. *International Journal of Natural and Applied Sciences*, 2(3): 201-204

Valente, T.W. and Pumpuang, P. (2007). Identifying opinion leaders to promote behavior change. *Health Education Behaviour,* 34(6):881-96

Vella, V., Tomkins, A., Borghesi, A., Migliori, G.B., Adriko. B.C. and Crevatin, E. (1992).Determinants of child nutrition in north-west Uganda. *Bulletin of World Health Organization,* 70:637-47.

Wafa, A.I. (2010). Intestinal parasite infection among Immunocompromised patient in Riyadh, Saudi Arabia. *Pakistan Journal* of *Biological Sciences,* 13: 390-394.

Wang, L.D., Guo, J.G., Wu, X.H., Chen, H.G., Wang, T.P., Zhu, S.P., Zhang, Z.H., Steinmann, P, and Yang, G.J. (2009). China's new strategy to block

Schistosoma japonicum transmission: Experiences and impact beyond schistosomiasis*. Tropical Medicine* & *International Health*, 14:1475–1483.

Wilson, W.M., Dufour, D.L., Baarac-Nieto, M., Reina, J.C. and Spur, G.B. (1999). Gastrointestinal parasitic infections, anthropometric, nutritional status, and physical work capacity in Colobian boys. *American Journal of Human Biology*, 11, 763-71

World Health Organization (WHO). (2014). Children: Reducing mortality. Retrieved from: http://www.who.int/mediacentre/ factsheets/fs178/en/

World Health Organization (WHO). (2008). Soil-transmitted helminths. WHO, Geneva.*Wkly. Epidemiological Record*, 83:237-252.

WHO. (1990). Health education in the control of parasitic diseases. W.C. 810

World Health Organization (WHO). (2007) Methods and Development: Geneva: WHO Child Growth Standards: Head Circumference- for –age, triceps skin fold-for-age and subscapular skin fold-for-age

World Health Organization (WHO). (2014). Fact sheet no 366. Available online at http;//www.who.int/wormcontrol. Accessed March, 2017

World Health Organization (WHO). (2004). Training Manual On Diagnosis Of Intestinal Parasites based on the WHO Bench Aids for the diagnosis of intestinal parasites pp 5

World Health Organization (WHO). (2002). The prevention and control of Schistosomiasis and soil transmitted Helminthiasis. Geneva

World Health Organization (WHO). (1998). *Control of tropical diseases*. Geneva: WHO; 1998.

World Health Organization (WHO). (1994). Bench Aids for the diagnosis of intestinal parasites. World Health Organization, Geneva.

World Health Organization (WHO). (1987). Prevention and Control of Intestinal Parasitic Infections. Report of a WHO Expert Committee. Technical Report Series 749 (1987). p. 12. World Health Organization, Geneva.

World Health Organization (WHO). (1986.). The Use and Interpretation of Anthropometry. Report of a WHO Expert Committee. Geneva, Switzerland. World Health Organization.

WHO. (1986) Multicenter Growth Reference Study Group. (2006). WHO Child Growth Standards based on length/height, weight and age. *Acta Paediatrica (Oslo, Norway: 1992).* 450 (76).

World Health Organization, UNICEF and UN. (1998). Iron Deficiency: Indicators for Assessment and Strategies for Prevention. WHO, Geneva, Switzerland

Wosu, M. I. and Onyeabor, I.A. (2014). The Prevalence of intestinal parasite Infections among School Children in a Tropical Rainforest Community of Southeastern Nigeria. *Journal of Animal Science Advance*, 4(8): 1004-1008

Yimer, M., Hailu, T., Mulu, W. and Abera, B. (2015). Evaluation performance of diagnostic methods of intestinal parasitosis in school age children in Ethiopia. *BMC Research Notes*, 8: 820.

APPENDIX II

Department of Parasitology and Entomology,
School of Biological Sciences
Nnamdi Azikiwe University, Awka,
Anambra State

Dear Sir/Madam,

INFORMED CONSENT

I am a Ph.D student of the above named Institution of higher learning on a research. I am carrying out a research on “Effects of Intestinal Parasitic Infections on Nutritional Status of Primary School Children in Orlu and Owerri Zones, Imo State, Nigeria.

Your child/ward has been selected through random process to provide blood and stool sample and information for the study. The test will be free and result will be issued to them at the end. Ethical clearance has been obtained from Ethical Committee of Imo State Specialist Hospital Umuguma, Owerri Imo State for the commencement of this study. Public Health Department, Ministry of Health are aware of this study have given their approval.

I humbly seek your consent and assistance in completing this research work. I plead with you to answer all necessary questions as accurately and honestly as possible. All information provided will be kept confidential.

Kindly give your consent by signing your name and signature in the space provided below.

Thank you for the anticipated co-operation

Name of parents………………………………….. Signature……………………….

………………………………
Esomonu Onyenonachi.c
Student Researcher

…………………………
Prof. O.C Nwaorgu
Supervisor

APPENDIX III- RAW

7Location			Orlu -Rural (OL)						
	NO INFECTED								
	HELMINTHS	Intensity	PROTOZOA	Intensity	Hb (g/dl)	AGE	SEX	WEIGHT (kg)	HEIGHT (m)
7	Hookworm	800			12.6	10	M	35	1.37
23			*E. histolytica*	720	13.3	8	F	24	1.19
65			*E. histolytica* *G.lamblia*	1920 1280	10.6	9	F	24	1.24
48			*E.histo*	1680	10.3	9	M	27	1.32
64	*A. Lumbricoides*	160			10.6	9	F	25	1.27
22			*E. histolytica*	880	13.3	9	F	26	1.24
56			*G.lamblia*	3280	13	8	M	23	1.21
49			*G.lamblia*	960	10.6	7	F	31	1.21
50	*T. trichiura*	1200			10	7	F	19	1.17
39			*E. histolytica*	640	9.3	13	F	19	1.09
9			*E. histolytica* *E.coli*	1040 1680	11.3	10	M	30	1.34
44			*E. histolytica*	1440	11	9	M	26	1.27

111	Hookworm	2000		1880	9	13	M	22	1.21
121			*E. histolytica*	1280	10.6	6	M	21	1.09
113			*E. histolytica*	840	8.3	5	M	19	1.01
126			*E.coli*	4800	10.6	6	M	20	1.09
76	A. *lumbricoides*	1960			10.6	12	M	35	1.42
105			*E. histolytica* *E.coli*	4080 6080	10.6	9	F	21	1.21
75			*E. histolytica*	720	10	11	M	32	1.39
74			*G.lambia*	4800	11.3	12	M	41	1.42
83			*E. histolytica*	1120	10.6	11	M	33	53.5
84			*E.coli*	1560	11	12	F	36	1.43
98			*E. histolytica*	2080	11	9	F	24	1.24
97			*G.lambia*	2800	10.3	11	M	34	1.42
30			*E. histolytica*	600	10.6	8	F	26	1.21
13			*E.coli*	1280	13	9	M	30	1.29
129	*Ascaris lumbricoides*	8000			10	7	F	30	1.32
34	*Taenia spp*	320			9	6	M	26	1.06
11	*S. stercoralis*	480			13	8	F	27	1.24
52	*Taenia spp*	160			11	9	F	26	1.27
134	Hookworm	800			12.6	10	M	35	1.37

257			*E. histolytica*	720	13.3	8	F	24	1.19
			E. histolytica	1920					
138			*G.lamblia*	1280	10.6	9	F	24	1.24
145			*E. histolytica*	1680	31	9	M	27	1.32
167	*Ascaris lumbricoides*	200			32	9	F	25	1.27
181			*E. histolytica*	800	13.3	9	F	26	1.24
193			*G.lamblia*	3280	13	8	M	23	1.21
167			*G.lamblia*	920	10.6	7	F	31	1.21
213	*T. trichuria*	1200			12.3	7	F	19	1.17
221			*E. histolytica*	14560	9.3	13	F	19	1.09
			E.histo	1040					
230			*E.coli*	1680	11.1	10	M	30	1.34
232			*E. histolytica*	1440	11	9	M	26	1.27
240	*Ascaris lumbricoides*	2000		1800	9	13	M	22	1.21
243			*E. histolytica*	1200	10.6	6	M	21	1.09
244			*E. histolytica*	840	9.3	6	M	20	1.09
247			*E.coli*	120	10.6	6	M	20	1.09
173	*Ascaris lumbricoides*	1960			10.6	12	M	35	1.42

256			*E. histolytica* *E.coli*	4000 6080	10.6	9	F	21	1.21
131			*E. histolytica*	720	10	11	M	32	1.39
139			*G.lamblia*	4800	11.3	12	M	41	1.42
210			E. histolytica	960	10.6	11	M	33	53.5
141			E.coli	1120	11	12	F	36	1.43
219			E. histolytica	2080	11	9	F	24	1.24
227			G.lambia	2840	10.3	11	M	34	1.42
214			E. histolytica	600	10.6	8	F	26	1.21
190			E.coli	1230	13	9	M	30	1.29
204	*Ascaris lumbricoides*	8000			10	7	F	30	1.32
196	Taenia spp	320			8.6	6	M	26	1.06
167	*S. stercoralis*	480			13	8	F	27	1.24
199	*Taenia spp*	160			11	9	F	26	1.27
279	Hookworm	160			10.6	9	F	25	1.25
280			E. histolytica	880	13.3	9	F	26	1.24
284			G.lambia	3480	13	8	M	23	1.21
289			G.lambia	920	10.6	7	F	31	1.19
291	*Ascaris lumbricoides*	1160			12.3	7	F	19	1.16

300			E. histolytica	600	9.3	13	F	19	1.09
			E. histolytica	1040					
294			G.lambia	1680	11	10	M	30	1.34
265			E. histolytica	1440	11	9	M	26	1.27
NO	*T. trichiura*	1840			9	13	M	22	1.21

Prevalence = 23.2%

APPENDIX IV

PICTURE OF INTESTINAL PARASITES IDENTIFIED

Plate 1: Egg of *Trichuris Trichiura*

Plate 2: Cyst of *E. histolytica*

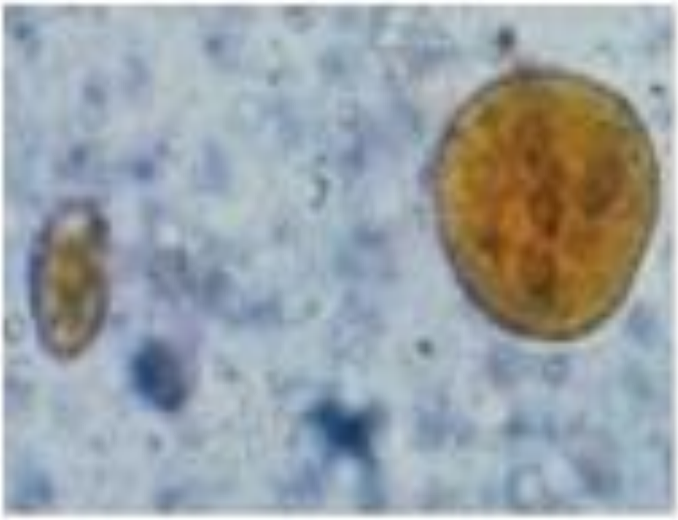

Plate 3: Cyst of *E. coli*

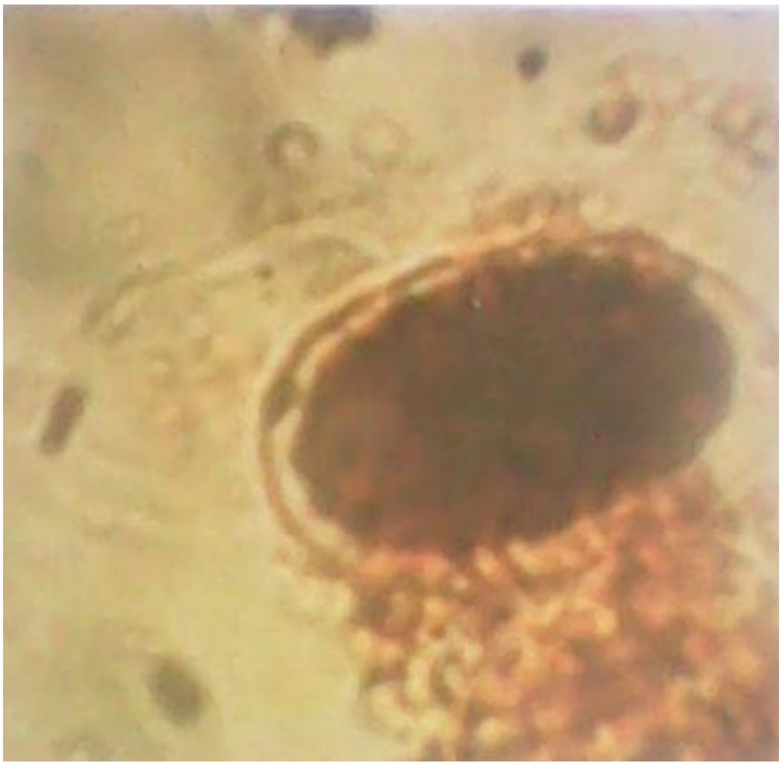

Plate 4: Egg of hookworm

Plate 5: Ovum of *Ascaris lumbricoides*

Plate 6: Larva of *Strongyloides stercoralis*

Plate7: Slides for Microscopy

APPENDIX V

STATISTICAL ANALYSIS

		Kind							
		Ascaris lumbricoides	Trichuris trichuira	Hookworm	E. histolytica	G. lambia	E. coli	Taenia spp	Total
Age group (years)	5 - 7	6	2	1	5	2	1	0	17
		35.3%	11.8%	5.9%	29.4%	11.8%	5.9%	.0%	34.0%
	8 - 10	3	0	1	8	2	6	1	21
		14.3%	.0%	4.8%	38.1%	9.5%	28.6%	4.8%	42.0%
	11 - 13	3	0	1	3	4	1	0	12
		25.0%	.0%	8.3%	25.0%	33.3%	8.3%	.0%	24.0%
Total		12	2	3	16	8	8	1	50
		24.0%	4.0%	6.0%	32.0%	16.0%	16.0%	2.0%	16.6%

	Value	df	p-value
Pearson Chi-Square	14.221	12	.287

Age group (years)

	Frequency	Percentage (%)
5 - 7	89	29.7
8 - 10	149	49.7
11 - 13	62	20.7
Total	300	100.0

Frequencies

Occupation * Intestinal parasitic infection Crosstabulation

		Intestinal parasitic infection	
		Present	Total
Occupation	Civil servant	8	8
		100.0%	100.0%
	Health worker	2	2
		100.0%	100.0%
	Farmer	7	7
		100.0%	100.0%
	Trader (petty)	9	9
		100.0%	100.0%
	Business man/self employed	13	13
		100.0%	100.0%
	Artisan	10	10
		100.0%	100.0%
	Others	1	1
		100.0%	100.0%
Total		50	50
		100.0%	100.0%

Occupation

		Frequency	Percent
	Civil servant	89	29.7
	Health worker	11	3.7
	Clergy	8	2.7
	Farmer	21	7.0
	Trader (petty)	60	20.0
	Business man/self employed	86	28.7
	Artisan	22	7.3
	Others	3	1.0
	Total	300	100.0

		Prevalence of malnutrition		
		Well nourished	Malnourished	Total
Occupation	Civil servant	6	2	8
		75.0%	25.0%	100.0%
	Health worker	2	0	2
		100.0%	.0%	100.0%
	Farmer	6	1	7
		85.7%	14.3%	100.0%
	Trader (petty)	6	3	9
		66.7%	33.3%	100.0%
	Business man/self employed	9	4	13
		69.2%	30.8%	100.0%
	Artisan	8	2	10
		80.0%	20.0%	100.0%
	No response	1	0	1
		100.0%	.0%	100.0%
Total		38	12	50
		76.0%	24.0%	100.0%

	Value	df	p-value
Pearson Chi-Square	2.158	6	.905

Frequencies

Height for age

		Frequency	Percent
Valid	Over height	11	3.7
	Normal height	211	70.3
	Moderately under-height	42	14.0
	Severely under-height	36	12.0
	Total	300	100.0

Crosstabs

*Height for age * Intestinal parasitic infection*

		Intestinal parasitic infection		Total
		Present	Absent	
Height for age	Over height	1 2.0%	10 4.0%	11 3.7%
	Normal height	37 74.0%	174 69.6%	211 70.3%
	Moderately under-height	7 14.0%	35 14.0%	42 14.0%
	Severely under-height	5 10.0%	31 12.4%	36 12.0%
Total		50 100.0%	250 100.0%	300 100.0%

Chi-Square Tests

	Value	df	p-value
Pearson Chi-Square	.769	3	.857

*Weight for age * Intestinal parasitic infection*

		Intestinal parasitic infection		Total
		Present	Absent	
Weight for age	Over weight	3 6.0%	14 5.6%	17 5.7%
	Normal weight	45 90.0%	226 90.4%	271 90.3%
	Moderately underweight	1 2.0%	9 3.6%	10 3.3%
	Severely underweight	1 2.0%	1 .4%	2 .7%
Total		50 100.0%	250 100.0%	300 100.0%

Chi-Square Tests

	Value	df	p-value
Pearson Chi-Square	1.933	3	.587

*Weight for height * Intestinal parasitic infection*

		Intestinal parasitic infection		Total
		Present	Absent	
Weight for height	Well nourished	50	246	296
		100.0%	98.4%	98.7%
	Severely malnourished	0	4	4
		.0%	1.6%	1.3%
Total		50	250	300
		100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	p-value
Pearson Chi-Square	.811	1	.368

Crosstab

Intestinal parasitic infection				Sex		Total
				Male	Female	
Present	Height for age	Over height	Count	0	1	1
			% within Sex	.0%	3.4%	2.0%
		Normal height	Count	16	21	37
			% within Sex	76.2%	72.4%	74.0%
		Moderately under-height	Count	2	5	7
			% within Sex	9.5%	17.2%	14.0%
		Severely under-height	Count	3	2	5
			% within Sex	14.3%	6.9%	10.0%
	Total		Count	21	29	50
			% within Sex	100.0%	100.0%	100.0%
Absent	Height for age	Over height	Count	4	6	10
			% within Sex	3.5%	4.4%	4.0%
		Normal height	Count	79	95	174
			% within Sex	68.7%	70.4%	69.6%
		Moderately under-height	Count	19	16	35
			% within Sex	16.5%	11.9%	14.0%
		Severely under-height	Count	13	18	31
			% within Sex	11.3%	13.3%	12.4%
	Total		Count	115	135	250
			% within Sex	100.0%	100.0%	100.0%

Chi-Square Tests

Intestinal parasitic infection		Value	df	Asymp. Sig. (2-sided)
Present	Pearson Chi-Square	1.931[a]	3	.587
	Likelihood Ratio	2.308	3	.511
	Linear-by-Linear Association	.288	1	.591
	N of Valid Cases	50		
Absent	Pearson Chi-Square	1.343[b]	3	.719
	Likelihood Ratio	1.342	3	.719
	Linear-by-Linear Association	.028	1	.868
	N of Valid Cases	250		

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is .42.

b. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 4.60.

*Weight for age * Sex*

Crosstab

Intestinal parasitic infection				Sex		Total
				Male	Female	
Present	Weight for age	Over weight	Count	1	2	3
			% within Sex	4.8%	6.9%	6.0%
		Normal weight	Count	18	27	45
			% within Sex	85.7%	93.1%	90.0%
		Moderately underweight	Count	1	0	1
			% within Sex	4.8%	.0%	2.0%
		Severely underweight	Count	1	0	1
			% within Sex	4.8%	.0%	2.0%
	Total		Count	21	29	50
			% within Sex	100.0%	100.0%	100.0%
Absent	Weight for age	Over weight	Count	4	10	14
			% within Sex	3.5%	7.4%	5.6%
		Normal weight	Count	107	119	226
			% within Sex	93.0%	88.1%	90.4%
		Moderately underweight	Count	3	6	9
			% within Sex	2.6%	4.4%	3.6%
		Severely underweight	Count	1	0	1
			% within Sex	.9%	.0%	.4%
	Total		Count	115	135	250
			% within Sex	100.0%	100.0%	100.0%

Chi-Square Tests

Intestinal parasitic infection		Value	df	Asymp. Sig. (2-sided)
Present	Pearson Chi-Square	2.928[a]	3	.403
	Likelihood Ratio	3.639	3	.303
	Linear-by-Linear Association	2.011	1	.156
	N of Valid Cases	50		
Absent	Pearson Chi-Square	3.632[b]	3	.304
	Likelihood Ratio	4.098	3	.251
	Linear-by-Linear Association	.842	1	.359
	N of Valid Cases	250		

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is .42.

b. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .46.

*Weight for height * Sex*

Crosstab

Intestinal parasitic infection				Sex		Total
				Male	Female	
Present	Weight for height	Well nourished	Count	21	29	50
			% within Sex	100.0%	100.0%	100.0%
	Total		Count	21	29	50
			% within Sex	100.0%	100.0%	100.0%
Absent	Weight for height	Well nourished	Count	112	134	246
			% within Sex	97.4%	99.3%	98.4%
		Severely malnourished	Count	3	1	4
			% within Sex	2.6%	.7%	1.6%
	Total		Count	115	135	250
			% within Sex	100.0%	100.0%	100.0%

Chi-Square Tests

Intestinal parasitic infection		Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Present	Pearson Chi-Square	.[b]				
	N of Valid Cases	50				
Absent	Pearson Chi-Square	1.376[c]	1	.241		
	Continuity Correction[a]	.446	1	.504		
	Likelihood Ratio	1.415	1	.234		
	Fisher's Exact Test				.337	.253
	Linear-by-Linear Association	1.371	1	.242		
	N of Valid Cases	250				

a. Computed only for a 2x2 table

b. No statistics are computed because Weight for height is a constant.

c. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.84.

```
CROSSTABS
  /TABLES=HA2 WA2 WH2  BY Agegroup
  /FORMAT= AVALUE TABLES
  /STATISTIC=CHISQ
  /CELLS= COUNT COLUMN
  /COUNT ROUND CELL .
```

Crosstabs

[DataSet1] I:\MRS IHEJIRIKA NEW\MRS IHEJIRIKA (B).sav

Height for age * Age group (years)

Crosstab

Intestinal parasitic infection				Age group (years)			Total
				5 - 7	8 - 10	11 - 13	
Present	Height for age	Over height	Count	1	0	0	1
			% within Age group (years)	5.9%	.0%	.0%	2.0%
		Normal height	Count	13	18	6	37
			% within Age group (years)	76.5%	85.7%	50.0%	74.0%
		Moderately under-height	Count	1	2	4	7
			% within Age group (years)	5.9%	9.5%	33.3%	14.0%
		Severely under-height	Count	2	1	2	5
			% within Age group (years)	11.8%	4.8%	16.7%	10.0%
	Total		Count	17	21	12	50
			% within Age group (years)	100.0%	100.0%	100.0%	100.0%
Absent	Height for age	Over height	Count	6	4	0	10
			% within Age group (years)	8.3%	3.1%	.0%	4.0%
		Normal height	Count	45	98	31	174
			% within Age group (years)	62.5%	76.6%	62.0%	69.6%
		Moderately under-height	Count	8	15	12	35
			% within Age group (years)	11.1%	11.7%	24.0%	14.0%
		Severely under-height	Count	13	11	7	31
			% within Age group (years)	18.1%	8.6%	14.0%	12.4%
	Total		Count	72	128	50	250
			% within Age group (years)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

Intestinal parasitic infection		Value	df	Asymp. Sig. (2-sided)
Present	Pearson Chi-Square	8.746[a]	6	.188
	Likelihood Ratio	8.472	6	.206
	Linear-by-Linear Association	2.357	1	.125
	N of Valid Cases	50		
Absent	Pearson Chi-Square	15.385[b]	6	.017
	Likelihood Ratio	15.971	6	.014
	Linear-by-Linear Association	.478	1	.489
	N of Valid Cases	250		

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .24.

b. 2 cells (16.7%) have expected count less than 5. The minimum expected count is 2.00.

*Weight for age * Age group (years)*

Crosstab

Intestinal parasitic infection				Age group (years) 5 - 7	8 - 10	11 - 13	Total
Present	Weight for age	Over weight	Count	3	0	0	3
			% within Age group (years)	17.6%	.0%	.0%	6.0%
		Normal weight	Count	13	21	11	45
			% within Age group (years)	76.5%	100.0%	91.7%	90.0%
		Moderately underweight	Count	1	0	0	1
			% within Age group (years)	5.9%	.0%	.0%	2.0%
		Severely underweight	Count	0	0	1	1
			% within Age group (years)	.0%	.0%	8.3%	2.0%
	Total		Count	17	21	12	50
			% within Age group (years)	100.0%	100.0%	100.0%	100.0%
Absent	Weight for age	Over weight	Count	8	5	1	14
			% within Age group (years)	11.1%	3.9%	2.0%	5.6%
		Normal weight	Count	60	119	47	226
			% within Age group (years)	83.3%	93.0%	94.0%	90.4%
		Moderately underweight	Count	3	4	2	9
			% within Age group (years)	4.2%	3.1%	4.0%	3.6%
		Severely underweight	Count	1	0	0	1
			% within Age group (years)	1.4%	.0%	.0%	.4%
	Total		Count	72	128	50	250
			% within Age group (years)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

Intestinal parasitic infection		Value	df	Asymp. Sig. (2-sided)
Present	Pearson Chi-Square	11.514[a]	6	.074
	Likelihood Ratio	12.078	6	.060
	Linear-by-Linear Association	3.439	1	.064
	N of Valid Cases	50		
Absent	Pearson Chi-Square	8.920[b]	6	.178
	Likelihood Ratio	8.530	6	.202
	Linear-by-Linear Association	1.074	1	.300
	N of Valid Cases	250		

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .24.

b. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .20.

*Weight for height * Age group (years)*

Crosstab

Intestinal parasitic infection				Age group (years)			Total
				5 - 7	8 - 10	11 - 13	
Present	Weight for height	Well nourished	Count	17	21	12	50
			% within Age group (years)	100.0%	100.0%	100.0%	100.0%
	Total		Count	17	21	12	50
			% within Age group (years)	100.0%	100.0%	100.0%	100.0%
Absent	Weight for height	Well nourished	Count	68	128	50	246
			% within Age group (years)	94.4%	100.0%	100.0%	98.4%
		Severely malnourished	Count	4	0	0	4
			% within Age group (years)	5.6%	.0%	.0%	1.6%
	Total		Count	72	128	50	250
			% within Age group (years)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

Intestinal parasitic infection		Value	df	Asymp. Sig. (2-sided)
Present	Pearson Chi-Square	.[a]		
	N of Valid Cases	50		
Absent	Pearson Chi-Square	10.050[b]	2	.007
	Likelihood Ratio	10.120	2	.006
	Linear-by-Linear Association	7.012	1	.008
	N of Valid Cases	250		

a. No statistics are computed because Weight for height is a constant.

b. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .80.

*Location * Height for age*

Crosstab

Intestinal parasitic infection				Height for age: Over height	Normal height	Moderately under-height	Severely under-height	Total
Present	Location	Owerri urban	Count	0	6	1	2	9
			% within Location	.0%	66.7%	11.1%	22.2%	100.0%
		Owerri rural	Count	0	9	5	2	16
			% within Location	.0%	56.3%	31.3%	12.5%	100.0%
		Orlu urban	Count	0	10	0	0	10
			% within Location	.0%	100.0%	.0%	.0%	100.0%
		Orlu rural	Count	1	12	1	1	15
			% within Location	6.7%	80.0%	6.7%	6.7%	100.0%
	Total		Count	1	37	7	5	50
			% within Location	2.0%	74.0%	14.0%	10.0%	100.0%
Absent	Location	Owerri urban	Count	2	49	10	5	66
			% within Location	3.0%	74.2%	15.2%	7.6%	100.0%
		Owerri rural	Count	1	30	14	14	59
			% within Location	1.7%	50.8%	23.7%	23.7%	100.0%
		Orlu urban	Count	7	48	5	5	65
			% within Location	10.8%	73.8%	7.7%	7.7%	100.0%
		Orlu rural	Count	0	47	6	7	60
			% within Location	.0%	78.3%	10.0%	11.7%	100.0%
	Total		Count	10	174	35	31	250
			% within Location	4.0%	69.6%	14.0%	12.4%	100.0%

Chi-Square Tests

Intestinal parasitic infection		Value	df	Asymp. Sig. (2-sided)
Present	Pearson Chi-Square	12.108[a]	9	.207
	Likelihood Ratio	13.471	9	.142
	Linear-by-Linear Association	4.272	1	.039
	N of Valid Cases	50		
Absent	Pearson Chi-Square	29.914[b]	9	.000
	Likelihood Ratio	29.271	9	.001
	Linear-by-Linear Association	.744	1	.389
	N of Valid Cases	250		

a. 12 cells (75.0%) have expected count less than 5. The minimum expected count is .18.

b. 4 cells (25.0%) have expected count less than 5. The minimum expected count is 2.36.

Location * Weight for age

Crosstab

Intestinal parasitic infection				Weight for age				Total
				Over weight	Normal weight	Moderately underweight	Severely underweight	
Present	Location	Owerri urban	Count	0	9	0	0	9
			% within Location	.0%	100.0%	.0%	.0%	100.0%
		Owerri rural	Count	0	15	1	0	16
			% within Location	.0%	93.8%	6.3%	.0%	100.0%
		Orlu urban	Count	2	8	0	0	10
			% within Location	20.0%	80.0%	.0%	.0%	100.0%
		Orlu rural	Count	1	13	0	1	15
			% within Location	6.7%	86.7%	.0%	6.7%	100.0%
	Total		Count	3	45	1	1	50
			% within Location	6.0%	90.0%	2.0%	2.0%	100.0%
Absent	Location	Owerri urban	Count	2	60	4	0	66
			% within Location	3.0%	90.9%	6.1%	.0%	100.0%
		Owerri rural	Count	1	55	3	0	59
			% within Location	1.7%	93.2%	5.1%	.0%	100.0%
		Orlu urban	Count	10	53	1	1	65
			% within Location	15.4%	81.5%	1.5%	1.5%	100.0%
		Orlu rural	Count	1	58	1	0	60
			% within Location	1.7%	96.7%	1.7%	.0%	100.0%
	Total		Count	14	226	9	1	250
			% within Location	5.6%	90.4%	3.6%	.4%	100.0%

Chi-Square Tests

Intestinal parasitic infection		Value	df	Asymp. Sig. (2-sided)
Present	Pearson Chi-Square	9.491[a]	9	.393
	Likelihood Ratio	9.969	9	.353
	Linear-by-Linear Association	.000	1	1.000
	N of Valid Cases	50		
Absent	Pearson Chi-Square	21.742[b]	9	.010
	Likelihood Ratio	19.526	9	.021
	Linear-by-Linear Association	1.684	1	.194
	N of Valid Cases	250		

a. 12 cells (75.0%) have expected count less than 5. The minimum expected count is .18.

b. 12 cells (75.0%) have expected count less than 5. The minimum expected count is .24.

*Location * Weight for height*

Crosstab

Intestinal parasitic infection				Weight for height		Total
				Well nourished	Severely malnourished	
Present	Location	Owerri urban	Count	9		9
			% within Location	100.0%		100.0%
		Owerri rural	Count	16		16
			% within Location	100.0%		100.0%
		Orlu urban	Count	10		10
			% within Location	100.0%		100.0%
		Orlu rural	Count	15		15
			% within Location	100.0%		100.0%
	Total		Count	50		50
			% within Location	100.0%		100.0%
Absent	Location	Owerri urban	Count	66	0	66
			% within Location	100.0%	.0%	100.0%
		Owerri rural	Count	59	0	59
			% within Location	100.0%	.0%	100.0%
		Orlu urban	Count	62	3	65
			% within Location	95.4%	4.6%	100.0%
		Orlu rural	Count	59	1	60
			% within Location	98.3%	1.7%	100.0%
	Total		Count	246	4	250
			% within Location	98.4%	1.6%	100.0%

Chi-Square Tests

Intestinal parasitic infection		Value	df	Asymp. Sig. (2-sided)
Present	Pearson Chi-Square	.[a]		
	N of Valid Cases	50		
Absent	Pearson Chi-Square	5.788[b]	3	.122
	Likelihood Ratio	6.531	3	.088
	Linear-by-Linear Association	1.929	1	.165
	N of Valid Cases	250		

a. No statistics are computed because Weight for height is a constant.

b. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .94.