ISOLATION AND CHARACTERISATION OF PARASITIC EGGS AND CYSTS FROM MOBILE PHONES AND HANDS OF USERS IN SAMARU MARKET ZARIA, NIGERIA

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER DEGREE IN EDUCATIONAL BIOLOGY.

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JUNE, 2015.

DECLARATION

I hereby declare that the work in this thesis titled **'ISOLATION AND CHARACTERISATION OF PARASITIC EGGS AND CYSTS FROM MOBILE PHONES AND HANDS OF USERS IN SAMARU MARKET ZARIA, NIGERIA.'** was performed by me in the Department of Biological Sciences under the supervision ofProf I. S Ndams and Dr. E. Kogi. The information derived from the literature has been duly acknowledged in the text and list of references provided. No part of this work has been presented for another degree at any institution. I take exclusive responsibility for its strength and weaknesses.

Kindness Amarachi UCHEAGWU ____________________ ____________________

Signature Date

CERTIFICATION

This thesis titled **'ISOLATION AND CHARACTERISATION OF PARASITIC EGGS AND CYSTS FROM MOBILE PHONES AND HANDS OF USERS IN SAMARU MARKET ZARIA, NIGERIA'** by **Kindness Amarachi UCHEAGWU** meets the regulations governing the award of the degree of Master of Science (M.Sc.) of the Ahmadu Bello University, Zaria and is approved for its' contribution to knowledge and literary presentation.

Prof. I. S. Ndams, Chairman, Supervisory Committee Department of Biological Sciences, Ahmadu Bello University, Zaria.	__________________ Signature	__________________ Date
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DEDICATION

This work is dedicated to Jehovah God as a reminder of the vow I owe him.

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ABSTRACT

A study on the Isolation and characterisationof parasite eggs and cysts found on mobile phones and hands of users in Samaru market Zaria, Kaduna State was carried out from May 2013 to January 2014. A total of 470 samples from hands and phones was collected from Samaru market and shops around using sterile cotton swabs and examined for parasites by sedimentation method. The parasite encountered were in the following order *Cryptosporidium parvum*oocyst(10.20% on hands; 9.80% on phone), Hookworm eggs (8.50% on hands; 6.0% on phone), *Entamoebahistolytica*cyst (7% on hands; 3.20% on phone), *Strongyloidesstecoralis*egg(3.60% on hands ;1.30% on phone)*Coccidia*oocyst(2.80% on hands; 2.10% on phone), *Ascarislumbricoides* ova(2.60% on hands;),*Enterobiusvemicularis*ova (1.70% on hands; 0.20% on phone),*Giardia lamblia*cyst(1.10% on hands; 0.60% on phone),*Taenia species* ova (0.90% on hand; 1.70% on phone),*Strongyloidesstecoralis* larvae(0.90% on hands) *Balantidium species*cyst (0.90% on hands), Mite eggs (0.90% on hands), *Entamoeba coli* cyst (0.60% on hand; 0.20% on phone),*Toxocara*ova (0.60% on hands),*Trichurisova* (0.40% on hand; 0.60% on phone), *Fasciola species* egg(0.40% on hands),*Physaloptera species*(0.40% on hands), *Cyclosporacayetanensis*cyst(0.20% on hands; 0.20% on phone), *Isospora*oocyst (0.20% on hand). There was association between educational level (OR = 1.509; OR = 1.242; OR = 1.185), Lack of hand washing (OR= 1.04), Sharing of phones (OR = 1.15) and Handling of phones when in the market(OR=1.324)and the transmission of parasite infection. The study established unwashed hands and contaminated phones as potential source of transmitting parasites infections and thus recommends that hand washing with water and soap should be practiced regularly.

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LIST OF ABBREVIATIONS

1. WHO - World Health Organization
2. UNICEF - United Nation International Children Education Fund.
3. FEPA - Federal Environmental Protection Agency.
4. OECD - Organization for Economic Cooperation and Development

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DEFINITIONS

Fomite:	is an inanimate object that serves to transmit an infectious agent from person to person.
Helminthes:	Worm-like organisms living in and feeding on living hosts, receiving nourishment and protection while disrupting their host’s nutrient absorption, causing weakness and disease
Mobile Phone:	also known as cell phone is a device that can make and receive calls through a radio link whilst moving around a geographical area.
Prevalence;	is the measure of amount of disease in a population. It could be used to identify high-risk populations. It is a snap shot of disease at a single point in time.
Protozoa:	Single-celled eukaryotes (whose cells have nuclei) that commonly show characteristics usually associated with animals, most notably mobility and heterotrophy.
Sample:	A piece of population used to represent that population from which it is taken.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of Study

A parasite is an organism that has a deleterious symbiotic relationship with another organism or host species (Tanko, 1999). It can also be defined as an organism that lives in or on a second organism, called a host, usually causing harm and is generally smaller than the host; it is also of different species (Yusuf and Hussein, 1990). Parasites are also dependent on the host for some or all of their nourishment and sometimes cause the eventual death of the host (Kramer, 2006).

Intestinal parasites occur worldwide in all ages and socioeconomic groups, but are most prevalent in school age children who are frequently in the habit of playing in contaminated environment. In 1993, world development reported that intestinal helminthes ranked first and is the main cause of disease burden in children aged 5 – 4 years (Ademola, 2012). Multiple infections with several parasites such as hookworms, roundworms and amoebae are also common in children, and their harmful effects are often aggravated by co- existing malnutrition or micronutrient deficiencies (Akogun, 1989). The most common intestinal roundworms that infect children are *Ascaris lumbricoides* (Ascariasis), *Trichuris trichiura* (trichuriasis - whipworm infection), *Enterobius vermicularis* (Enterobiasis, oxyuriasis, pinworm infection), the hookworms - *Ancyclostoma duodenale* and *Necator americanus* (Hookworm infection) and *Strongyloides stercoralis* (strongyloidiasis) (Krupp and Milton, 1973). The symptoms of intestinal parasitic infection in humans include; abdominal pain, distention, weight loss, reduced appetite, gastro intestinal effects such as nausea, vomiting, anorexia and diarrhea, improper digestion of food leading to mal-absorption from the small intestine and growth retardation (Shryock and Swarout, 1980). Most intestinal parasites can be transmitted directly by hands to other persons or to food from contaminated clothing or the perianal area (Hoeprich, 1975).

Parasitic infections are more common in rural or developing areas of Africa, Asia, and Latin America than in developed countries. Travelers are at risk of acquiring parasitic infection while on transit. A person who visits such areas can unknowingly aquire parasitic infections and bring it back home. Until recently, USA, parasitic infections are not widespread but these infections are on the rise because people bring parasites with them when they migrate to the U.S and soldiers often return to the U.S bringing parasites with them from overseas (Kucik *et al.*, 2006). In developed areas, parasitic infections may also affect immigrants and people with weak immune system (such as those who have AIDS or who take drugs that suppress the immune system).

In some situations, parasitic infections may also occur in places with poor sanitation and unhygienic practices. Parasites increase their fitness by exploiting host for resources necessary for the parasites survival i.e. food, water, heat, habitat, soil and dispersal. Parasites reduce host fitness in many ways, ranging from general or specialization pathology such as impairment of secondary sex characteristic, to the modification of host behaviour (Rutala, 2006).Such occurrence of parasites as discussed above is not new, in Nigeria. The Nigerian environment has been described as poor (Abdullahi and Abdullazeez, 2000) due to the lack of personal, community and environmental hygiene (Akogun, 1989; Yusuf and Hussein, 1990). This poor state of hygiene is accounted for by the presence of immature stages of parasite eggs and cysts on water closet handles (Nock and Geneve, 2002), on toilet door handles (Sanni, 1997), on beaks and legs of domestic chicken (Abuja, 1997) in the air and soil (Lawande, 1983), and on the sole of shoes (Nock and Tanko, 2000) indicating the widespread presence of parasite cysts and eggs in the Nigerian environment. The danger is evidently obvious; that hands could easily pick the cysts and eggs from these contaminated sources and pass them directly to the mouth or contaminated food (Nock and Tanko, 2000).

The above discussions demonstrate the potential danger that the indiscriminate disposal of fecal materials and lack of hygiene in Nigeria portends. Once they are introduced into the soil, their eggs and cysts can be transported on contact with any subject, a situation that accounts for the high prevalence and incidence of parasitic infection in both humans and animals. Examples of ways, through which parasites can come in contact with people include, contaminated hands (Ademola, 2012), fingers (Dyek, 2001) key holders, beaks of chickens(Abuja, 1997) mobile phones (Akinyemi *et al*., 2009), computer keyboards (Ndams and Jimoh, 2006, Ajenifuja and Ajibode, 2012) currencies (Elom *et al*., 2012; Uneke and Ogbu, 2007), soil (Hotez *et al*., 2004) and other surfaces such as mobile phones, currencies and other surfaces. Such receptacles used by parasites to spread are known as fomites. Studies have shown that contamination from the skin, anal region, wounds, nasal secretions and aerosols generated by sneezing and coughing are potential sources of transfer of microorganisms to currency notes during handling and by extension mobile phones (Mackintosh and Hoffman, 1984). It has also been confirmed that items held with the hands can be contaminated by drugs and other substances. Contamination of currencies by drugs has been detected in the United States and United Kingdom (Ritter, 1997; Thompson, 2002).

The global system for mobile telecommunication (GSM) established in 1982 in Europe provided improved communication network. Until the late 1980s, most mobile phones were large in size and permanently installed in vehicles as car phones (Jagadeesan *et al*., 2013). With the advancement in technology, leading to the miniaturization of circuitry, the majority of mobile phones are handheld. These devices serve and support many services such as short message service (SMS) for text messaging, email, pocket switching for access to the Internet, and multimedia service (MMS) for sending and receiving photos and video (Al-Abdallah, 2010). In 25 years, mobile phones have gone from being rare and expensive piece of equipment used primarily by the business elite, to a pervasive low cost personal item.

In many countries, the number of mobile phones outnumbers landline telephones, with most adults and children now owning them. Presently, Africa has the largest growth rate of cellular subscribers in the world with African markets expanding nearly twice as fast as Asian markets (Jagadeesan *et al.,* 2013). The availability of prepaid or pay as you go services, where the subscriber does not have to commit to a long term contract, has helped fuel this growth on a monumental scale, not only in Africa but on other continents as well. With high level of mobile phone penetration, a mobile culture has evolved, where the phone becomes a key social tool, and people rely on their mobile phone address book to keep in touch with their family and friends (Goldblatt *et al.*, 2007). Mobile phones serve as clocks, organizers, reminders, calculators etc., depending on the mobile phone accessories. With all the achievements and benefits of the mobile phone especially public handsets, it is easy to overlook the health hazard; it might pose to its many users (Jagadeesan *et al*., 2013). Many users may not have regard for personal hygiene coupled with the location of call centre and the likely number of users per day (Idowu and Rowland, 2006).

In West Africa, Nigeria inclusive and several areas of the world, mobile phone usage has increased dramatically, and in such environments where the percentage presence of parasitic microorganisms is likely high, (such as in hospitals, market places, abattoirs, and places-of-convenience), this could enhance pathogen transmission and intensify the difficulty of interrupting disease spread (Hota, 2004) more especially, with growing evidence that contaminated fomites or surfaces such as currency notes play a key role in the spread of parasitic infections (Awodi *et al*., 2000).

The constant handling of the mobile phones by users (in hospitals, by patients, visitors and health care workers, at homes, by mothers with young children, in banks, when handling money, in markets when buying and selling, in farms etc.) makes it an ideal item for transmission of microorganisms, as well as Hospital-Associated Infection (HAIs) (Fatma *et al*., 2009). This is especially so with those associated with the skin due to the moisture and optimum temperature of human body especially our palms and other parts of the body (Tagoe *et al*., 2011).

Previous studies on parasitic contamination of some electronic devices such as computer keyboards and accessories have been conducted in Ado- Ekiti in which the study indicated a high contamination of computer key boards and accessories with parasitic eggs (Ajenifuja and Ajibode, 2012). A similar study was conducted on public mobile phones along Benin-Sapele express way, Benin City (Ekrakene and Igeleke, 200; Brady and Kelly, 2000). Mobile phones have been reported to be a reservoir for micro organisms. Several researches have indicated the potential colonization of their surfaces by micro organisms and their ability to transmit diseases through their colonizing surfaces (fomites) of which the mobile phone is no exception (Oyero and Emikpe, 2007; Tagoe *et al*., 2011). It has been reported that a mobile phone can harbor more microorganisms than a person's lavatory seat, the sole of a shoe or the door handle. The combination of constant handling and the heat generated by phones creates a prime breeding ground for all sorts of micro organisms that are normally found on our skin (Brady *et al*., 2006; Ekrakene and Igeleke, 2007).

Mobile phones could be through different sources such as contaminated human skin, hand bag, phone pouch, pockets, environmental food particles, and dust, these sources are links through which micro organisms colonize the phone thus causing diseases that range from mild to chronic (Samba, 2005; Soto *et al*., 2006).

The above reports show that there is a great need for personal hygiene and sanitation. In recognition of the importance of hands in the dissemination of parasite cysts and eggs and other pathogenic microbes, the Global Hand Washing Day (GHWD) was first observed globally in 2006 (October, 15th) with the thrust to educate the world on the need to keep the hands always clean by washing with soap and water (Ademola, 2012). In Nigeria, Hand Washing Campaign was launched by the wife to the President of the Federal Republic of Nigeria in May 20th, 2008 (Ademola, 2012). Emphasizing the important role it can play to reach the Millennium Development Goals (MDG) in terms of health improvements, education and reduction of poverty and child mortality, as well as access to and effective use of water supply and sanitation services (Fewtrell *et al*., 2005).

The increased use of mobile phones at work even while handling money by cashiers, bank workers, in the market by the general public has created a growing concern on mobile phones as fomites (Tagoe *et al*., 2011). Hence, there is a need to ascertain if there is prevalence of parasitic cysts and eggs on mobile phones.

This study focuses on determining the presence of parasites, isolating and identifying the different parasitic cysts and eggs present on mobile phones and hands of users Samaru, Zaria Nigeria.

1.2 Statement of Research Problem

Zaria environment has been described as poor with little attention given to personal hygiene and environmental sanitation (Ndams and Jimoh, 2006). This has resulted to increased presence of pathogenic parasites and their associated diseases. Parasites that have been found to be contaminants of some electronic device such as computer keyboards (Ndams and Jimoh, 2006) and mobile phones are mainly of fecal origin (Awodi *et al.,* 2000, Tagoe *et al*., 2011). When hands are not washed properly, after passing out feces and are used to touch phone, the tendency is contamination with the trophozoite of a parasite, eggs, cysts or even the oocyst. This also raises the importance of proper hand washing as measures for preventing contamination and transmission of diseases associated with fecal oral route and autoinfection (Awodi *et al.*, 2000).

In Nigeria the widespread consumption of food without proper hand washing allows for transmission of diseases caused by bacteria, parasites and viruses (Ekrakene and Igeleke, 2007). Other attitudes such as exchanging or sharing of phones among users, giving mobile phones to children as toys and people using the phones as touch light held with their mouth could lead to the transfer of parasites and bacteria from such medium to the phones or vice versa. Mobile phones has been identified as one of the media by which bacterial pathogens could be transmitted but because of the uses and benefits derived from their usage their potential as health hazards is often overlooked (Brady *et al*., 2008) . The constant handling of the phone by different users makes it open for arrays of microorganisms, thereby allowing the spread of microbes from user to user (Ekrakene and Igeleke, 2007). Apart from the phone being contaminated during exchange among users, a person can personally contaminate food when eating from the phone or when buying or selling. For instance using the phone while in the toilet or bathroom and thereafter going to eat food without hand washing, could easily lead to contamination of the food (Ajenefuja and Ajibade, 2012).

According to WHO (World Health Organization), parasites are one of the leading cause of death after HIV/AIDS and tuberculosis. One out of 10 living persons suffers from one or more 7 major tropical diseases of which 5 are parasitic in nature (Adeboye and Adedayo, 2008). Recovery of some microbes on mobile phones by previous researches signifies a looming threat to public health (Abdullahi and Abdulazeez, 2000; Suleiman, 2005; Samba, 2005). Such parasites are responsible for intestinal disorders, nutritional deficiencies, weak immunity and anaemia (Barry, 2002). Microbiologists say that the combination of constant handling and the heat generated by the phones creates a prime breeding ground for all sorts of microbes (Goldblatt *et al*., 2007, Karabay *et al*., 2007).

There is a dearth of information regarding the degree to which mobile phones and the hands of their users are contaminated with parasites in particular. There is a need to carry out surface sampling of the hands of mobile phone users in order to identify the possible sources of contamination (Brady *et al*., 2008; Tagoe *et al.*, 2011). Studies on bacterial contamination abound (Tagoe *et al*., 2010, Jagadesan *et al*., 2013, Ekrakene and Igeleke, 2007; Ajenifuja and Ajibade, 2012) but there is scanty information regarding parasitic and helminthes contamination of mobile phones in Nigeria and elsewhere. The dearth of information necessitates this research, so that the information gap could be bridged.

Risk factor can be defined as any activity, occupation, way of life or habit which predisposes an individual to diseases resulting from parasite infestation (Idowu and Rowland, 2006; Suriptiatus and Widiastuti, 2011). People are exposed to parasites which is one of “Natures Hangman”. Therefore a clarion call is needed to increase awareness. With increase in population, urbanization and poor sanitation there is an increase of people and parasite co-existence. Therefore the study focuses on determining the role mobile phones play in association to these risk factors.

In Samaru, there is no baseline data on the prevalence of parasitic cysts and eggs on mobile phones and their users to justify or support the campaign on hand-washing or assess the success of the campaigns. It is against this background that this study is conducted.

1.3 Justification

Investigations into the diversity of parasitic organisms (cysts and eggs) found on hands and phones, and their distribution in public places such as markets, are highly desirable in the environmental parasitology and disease epidemiology. This will expose the health risk associated with having contact with mobile phones; create needed awareness on the importance of hand washing as a powerful public health intervention tool in the control of parasitic infections.

1.4 Aim of The Study

The aim of the study is to isolate and characterize parasite eggs and cysts from mobile phones and hands of users in Samaru market Zaria, Nigeria.

1.5 Objectives of the Study

1. To determine the prevalence of parasitic eggs and cysts on mobile phones and hand of users in Samaru market Zaria, Nigeria.
2. To determine the relationship between parasite prevalence on hands of petty traders and their mobile phones in relation to age and type of item sold by petty traders.
3. To determine the relationship between parasite prevalence on hands and mobile phones of petty traders and risk factors related to the use of phones.

1.6 Hypotheses

1. There are no parasitic eggs and cysts on hands and mobile phones of users in Samaru market Zaria, Nigeria.
2. The prevalence of parasite cysts and eggs on mobile phones and hands of petty traders is not influenced by age and type of item sold by petty traders.
3. The prevalence of parasite cysts and eggs on mobile phones and hands of petty traders is not influenced by risk factors related to the use of phones.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Parasites

The word 'Parasite' originates from two Greek words 'Para' which means 'beside' and 'Sitos' which means food. A parasite is an organism that is entirely dependent on another organism, referred to as its host, for all or part of its life cycle and metabolic requirements. In a strict sense the term parasite can simply be said to be referred to any infectious agent, but mostly, it is generally restricted to infection caused by protozoa and helminthes. (Suleiman, 2005).

2.2 Types of Parasites

There are two types of parasites:

1. The micro parasites: Are small and unicellular occurs within its host cells. Protozoa are micro parasites.
2. The macro parasites: Are basically large and does not have direct reproduction within its vertebrate host. This category includes the helminthes (Arora and Arora 2008).

2.3 Classification of Parasites

Parasites are basically classified into two, the Protozoan and the Helminthes.

2.3.1 The protozoa

Protozoa are small organisms that multiply within their vertebrate host. Among the protozoa that can infect and cause disease in man are those associated with excreta and found in the intestinal track (WHO, 1994, Sulaiman, 2005).

Protozoa which are eukaryotic and unicellular belong to the kingdom Protista and Helminthes which are eukaryotes and multicellular belong to the Kingdom animalia. It makes up approximately 70 percent of all invading organisms; protozoa are invisible to the naked eye. They are one-celled microscopic organisms. Certain protozoan, through their intensely rapid reproductive ability, can take over the intestinal tract of their host; and from there go on to other organs and tissues. Some feed on red blood cells. Some protozoa produce cysts - closed sacs in which they may be safely transported through food and water from one person to another. In the cyst state, protozoa are safe from destruction by human digestive juices. These one-celled parasites can actually destroy the tissues of their hosts. Common protozoa include: *Endolimax nana*, *Giardia lamblia*, *Entamoeba histolytica*, *Cryptosporidum parvum*, *Blastocystis hominis*, *Trichomonas vaginalis*, *Toxoplasma gondii*, *Cyclospora cayetanensis*, *Cryptosporidium muris*, *Pneumocystis carinii*, *Plasmodium malariae*, *Plasmodium ovale*, *Plasmodium vivax*, *Plasmodium falciparum*, *Leishmania donovani*, *Leishmania tropica*, and *Leishmania braziliensis* (WHO, 1994; Sulaiman, 2005).

Under the Protozoa we have the:

a. Amoebae: *Entamoeba histolytica, E. hartmanni, E. coli,*and *Endolimax nana.*

b. Flagellates: Intestinal, oral and genital flagellates: *Giardia lamblia, Trichomonas vaginalis, T. tenax, T. hominis.*

c. Blood and tissue flagellates: *Leishmania donovani, L. infantum, L. braziliensis complex, Trypanosoma brucei gambiense, T. cruzi.*

d. Sporozoa: *Plasmodium spp, Toxoplasma gondii, Isospora belli, Cryptosporidium parvum.*

e. Ciliates: *Balantidium coli*

f. Others such as *Microsporidium africanum*, *Encephalitozoon cuniculi* (WHO, 1994).

2.3.2 The helminths

Helminthes or parasitic worms are multicellular, bilaterally symmetrical, elongated, flat or round animals. They are usually, transmitted to humans during the consumption of raw mammal meat and through fecal oral route (Pozio, 2001).

Helminthes which occur as parasites in humans belong to two phyla:

- Phylum Plathyhelminthes
- Phylum Nematoda

Phylum Plathyhelminthes are also known as flat worms are dorsa ventrally flattened leaf like. Their alimentary canal is incomplete and body cavity is absent, are mostly hermaphrodites t. Human pathogenic helminthes of this phylum belong to two classes: The Cestoidea and the Trematoda (Arora and Arora 2008).

Phylum Nematoda are unsegmented dieocious worms with complete alimentary canal, no circulatory system with a simple excretory system, and have a body cavity with a high hydrostatic pressure (WHO, 1994).

2.4 Some Common Parasites (Protozoa)

2.4.1 *Amoebae*

A genus of protozoan parasites, belonging to the phylum Sarcomastigophora. There are three species infecting man namely, *Entamoeba coli*, (nonpathogenic), infects the intestinal track, *Entamoeba gingivitis* (non pathogenic) inhabits the mouth and *Entamoeba histolytica* (pathogenic), is the cause of amebiasis or *amoebi*c dysentery which is a worldwide infection affecting approximately 500 million people in the tropic. The protozoa alternate between a trophozoite and a cyst. Amoeba passes its life cycle only in one host. Man acquires infection by ingestion of mature quadrinucleate cysts in faecally contaminated food. Within the small intestine the cyst wall is lysed to form trophozoites. A large number of trophozoites are excreted along with blood and mucus in stool leading to amoebic dysentry Clinical ameobiasis is characterized by abdominal pain, fever, diarrhea, weight loss and dysentery (bloody mucus filled with stool) (Kathleen and Arthur, 2002).

2.4.2 *Giardia lamblia*

The parasites cause Giardiasis infection. The flagellate *Giardia intestinalis,* was first observed by Antonie Van Leeuwenhoek (Arora and Arora, 2000). It is the most common flagellate and is indicated by its trophozoite having a unique, symmetrical heart shape organelle positioned in a way that make it looks like a face. The cysts are small, compact and multinucleate and can survive for two months in the environment. Infection occurs with a dose of only 10 to 100 cysts. Mature cysts are the infective form of the parasite. Man acquires infection by ingestion of cysts in contaminated food and water. Symptoms include epigastric pain and chronic diarrhea of steatorrhea type (Arora and Arora, 2000).

2.4.3 *Cryptosporidium parvum*

Is a protozoan pathogen of the phylum *Apicomplexa.* It causes a diarrheal illness called *Cryptosporidiosis.* At first, *Cryptosporidium* was considered as an intestinal ailment mainly to calves, pigs, chickens and other poultry, but infection in man is caused by handling animals with infection or drinking contaminated water. The infection is initiated when cysts are ingested from focally contaminated food and water. The cysts give rise to sporozoites that penetrate the intestinal cells and live intracellular in them (Kathleen and Arthur, 2002). In other cases *Cryptosporidium,* causes gastrointestinal illness and is characterized by watery stool with mucus. People who are immune- compromised are threatened by this parasites because diarrhea one of its symptoms often become more severe with time and results in a prolonged life threatening, cholera like illness (Arora and Arora, 2000).

2.4.4 *Isospora belli*

It is an uncommon human intestinal parasite with a distinctive oocyst stage transmitted through faeces contamination that causes coccidiosis. Man acquires the infection by ingestion of food and water contaminated with sporulated oocysts from contaminated soil. The infection is usually asymptomatic or self limited. The most prominent symptoms are malaise, nausea and vomiting, diarrhea, fatty stool, abdominal coli and weight loss (Krupp and Milton, 1973; Kathleen and Arthur, 2002).

2.5 Some Common Parasites (Helminths)

2.5.1 *Ascaris lumbricoides*

Is a giant (up to 300mm long) intestinal roundworms that probably account for the greatest number of worm infections (estimated at one billion cases worldwide). The eggs hatch in the small intestine releasing motile larvae which penetrate the wall (Krupp and Milton, 1973). The females are 20- 30cm long and 5-6mm in diameter while the males are smaller with 15-17cm by 2-4mm with a pinkish white in colour (WHO, 1994). The worm reaches adulthood and reproduced, producing up to 200,000 fertilized eggs a day (Kathleen and Arthur, 2002). Man acquires the infection by ingestion of food, water and raw vegetables contaminated with embryonated eggs. In the small intestine the eggs hatch to liberate larvae. The larvae mature into adult female worms and gravid females begin to release eggs. Disease caused by *Ascaris lumbricoides* is known as Ascariasis. Other effects include malnutrition, retardation of growth, obstruction of the intestinal tract, allergic manifestations and respiratory obstruction by migrating larvae (Arora and Arora, 2000).

2.5.2 *Trichuris trichiura*

The common name for *Trichuris trichuira* is called (whipworm) which is referred to its likeness to a miniature buggy whips (Kathleen and Arthur, 2002). The worms are white in colour, with the females longer measuring 30-50um in length. Gravid females lay the eggs which are discharged in faeces. The eggs are barrel shaped with a mucus plug at each pole. Man acquires infection by ingesting embyonated eggs with contaminated food or water.It is a common parasite to man throughout the world (Krupp and Milton, 1973). This is transmitted like *Ascaris* but is restricted to the intestine throughout the development. Embryonic eggs deposited in the soil are not immediately infective until two to four weeks in a favourable soil (Hoeprich, 1975). Following sexual maturation and fertilization, the female eventually laid 300 to 500 eggs daily into the bowel (Kathleen and Arthur, 2002). The egg is smaller than that of *Ascaris lumbricoides*. Because female worms produce smaller numbers of eggs, they are often present in faeces in smaller numbers than Ascaris *lumbricoides* eggs (Suriptiatutis and Widiastuti, 2011).

2.5.3 *Strongyloides stercoralis*

Strongyloides stercoralis is the smallest nematode known to cause infection in man. Parasitic females measure 2-3um in width. The females are ovo-viviparous. In gravid females the eggs are conspicuous within its body. As soon as the eggs are laid the rhabditiform larvae starts hatching, as a result it is the larvae that are routinely detected not the eggs. The larva measures 180-380 µm in length by 14–20 µm in diameter. It has a short buccal capsule, a slender, pointed tail and a prominent genital primordium. The larva is easily recognized, either stained with iodine. *Strongyloides stercoralis* is an important nematode parasite of humans because of its ability to autoinfect and disseminate throughout the organ systems of immuno compromised or immuno suppressed individuals or others with malignancies, e.g. lymphoma (WHO, 1994).

2.5.4 Hookworm

Hook worm infection in human is caused by an infection with the helminthes nematode parasite namely *Necator americanus* (Western hemisphere) and *Ancyclostoma duodenale* (Eastern hemisphere). The hook refers to the adult oval cutting plates by which it is anchors to the intestinal villi and it curved anterior end. Unlike other intestinal worms infectious hookworm larva hatches outside the body and infect by penetrating the skin. The larvae measure 17um in diameter and 250um in length (Kathleen and Arthur, 2002). The adult worms attach themselves to the mucosa of the small intestine where they suck blood and mucosa substances (Roche and Benito, 1999), resulting to anemia (Franchot and Nicky, 2000). The male hookworm fertilizes the females which later lay eggs that are passed through faeces. Infections may also occur by oral and trans mammary route. According to Hotez, *et al.,* (2004), hookworm infection is among the most important tropical diseases in humans.

2.5.5 *Enterobius vermicularis*

The worm is also called pinworm (Krupp and Milton, 1973) with a small round white colored 12- 13mm long that usually infect the area around the anus and parts of the intestine. The worm is the most commonly seen intestinal parasite in a primary care practice (Frachot and Nicky, 2000). The embryonated pinworm egg has a hyaline shell and is asymmetric with one flattened side (Hoeprich, 1975). The worm result to itchiness around the anus and between the legs. Girls may have vaginal itching if the worms crawled forward (Frachot and Nicky, 2000).

2.5.6 *Taenia spp*

A number of species of adult tapeworm have recorded as human parasite. Although both *Taenia saginata and Taenia. solium are* cosmopolitan in distribution. Infections in man are limited to the area in which ingestion of raw or inadequately cooked beef or pork. Tapeworm often exceed 10 feet in length, The gravid segment of the worm detach themselves from the chain and escapes from the host intact or ruptures within the host releasing eggs in faeces (Krupp and Milton, 1973).

Parasites are known to transmit various diseases such as; Ascariasis (transmitted by roundworms or Ascaris), Amoebiasis transmitted by *Entamoeba histolytica* Strongiloidiasis (transmitted by hookworms), Giardiasis by *Giardia lamblia, and Balantidium coli which causes Balantidiasis* (Sulieman, 2005).

Diseases causing organisms typically include viruses, bacteria, fungi, protozoa, flatworms and roundworms. Diseases which are caused by bacteria, viruses and fungi are commonly referred to as infectious diseases such as cholera. Diseases cause by other organisms such as protozoans is commonly referred to as parasitic diseases (Taylor, 1997).

Many parasitic diseases are zoonotic (that is diseases and infections in which the agent are naturally transmitted between man and other vertebrate animals (WHO, 1994). Most parasitic helminthes have at least two hosts, the definitive host where sexual reproduction occurs and the intermediate host which support immature or larval forms. There are several varieties of worms that enters the human body and live there as parasites some are visible to the naked eye while some can only be seen under the microscope. Some are only common in tropical countries whereas others are common all over the world (Hugh, 1975).Worms that parasitize human are amazingly diverse, ranging from barely visible roundworms (0.3mm) to huge tapeworms 25m long and varying from oblong- and crescent shaped to whip like or elongate flat ribbons (Kathleen and Arthur, 2002).

2.6 Distribution and Prevalence of Parasites

Parasitic infections are a global problem. Worldwide, more than a billion people are estimated to be infected with just one species of parasite *Ascaris lumbricoides,* mostly in developing countries (Harhay *et al*.,, 2001). Human association with enteric parasites extends into human history (Alum *et al.*, 2010; Stephenson *et al*., 2000). Some of these enteric parasitic agents, also called neglected intestinal parasites are responsible for causing not only chronic infection predisposing to malnutrition in children thereby lowering their resistance to infectious diseases, but also lead to malabsorption and further malnutrition by impairing intestinal absorption of nutrients critically required for child's growth and cognitive development (Jasti *et al*., 2007; Bradley and Jackson, 2004). This leads to the development of a vicious cycle of malnutrition - enteric pathogens - malnutrition synergy. For example, *A. lumbricoides*, a soil transmitted helminth (STH) sheds up to 200000 ova per day in the feces of infected person. With ineffective collection and treatment of human waste particularly in developing countries, *A. lumbricoides* ova widely contaminate the environment essentially maintaining a vicious cycle of malnutrition - enteric parasite – malnutrition synergy in human populations living under un-hygienic conditions as seen in most developing countries today (Cancrini, 2006).

Parasitic diseases have existed since ancient times but are still major public health problems today which are influenced by many factors including rapid travel, immigration and the increase in number of immune-compromised patients (Kathleen and Arthur, 2002). The distribution of diseases worldwide is striped by the difference between developed and developing countries (Gerald and Larry, 2006).

In Southern and Eastern United States, it is estimated that up to 10% of the total population in endemic areas is infected with whipworms (Hoeprich, 1975). Comparison in Latin America reported that parasitic infection is serious threat to child survival among the children under the age of five worldwide, it was also known to cause 19% of under five mortality in Honduras, 23% in Nicaragua, 20% in El Salvador and 43% in Guatemala (Erica, 2008). The prevalence of intestinal parasitic infection was assessed on the Island of Biokko Equatorial Guinea of which the average prevalence of most common protozoan and helminthes intestinal infection in rural and urban areas respectively was as follows; *Entamoeba histolytica* and *E. dispa* (14.9% and 32.7% respectively). *Giardia lamblia* (7.2% and 8.6*%),* *Ascaris lumbricoides* (45.8% and 31.4%) *and Trichuris trihiura* (25.7 and 36.4%) (Roche and Benito,1999). In Nigeria, high prevalence of intestinal parasites ranging between 14% and 42% especially in the communities without toilets has been reported (Nwosu, 1979). Nock and Geneve, (2002) reported on the prevalence of cysts and eggs on the handles of water closets in toilets of staffs and students in Zaria of which oocysts of coccidian was reported with the highest prevalence of 64%, cysts of *Entamoeba* 16% and eggs of, *Ascaris*

45% and hookworm 32% were observed. In addition (Dyek, 2001) reported a total of 7.9% prevalence of parasite cysts and eggs on the fingernails of primary school both (public and private) in Zaria of which *Schistosome mansoni* (1.3%), *Taenia* sp. (11.4%), *Ascaris* sp (19%), hookworm (18%), mite and adult louse of 13% (ectoparasite), mite eggs 38% were observed. Counting 24 bunches of assorted dirty notes of naira resulted in the recovery of oocysts of *Isospora* sp. and eggs of *Taenia* sp, hookworm and mites from the hands of five (20.8%) occasion (Awodi *et al.,* 2000).

2.7 Economic Importance

Parasites live externally or internally in the human body where it interferes with the normal working of the body (Taylor, 1997). The most common disease caused by parasites is diarrhoea. One of the principal factors contributing to child morbidity and child mortality in tropical countries is the high frequency of diarrheal episodes due to intestinal infections which contribute to childhood growth retardation (Guerrant, 1986). Hookworm, roundworm and whipworm are the three main nematode infections implicated in growth retardation of children in tropical countries (Stephenson *et al.,* 1989). Hookworm causes systemic secondary effect related to iron deficiency, anaemia and possibly malnutrition or malabsorption (Roche and Benito, 1999; Hotez *et al.,* 2004) Hookworm infection in children reduces school attendance with subsequent effect on the productivity and wage earning potential in adulthood. In children, chronic hookworm diseases retard physical growth which is most apparent at puberty (Hotez *et al.,* 2004). Approximately 80 years ago, an inverse correlation was observed between the hookworm burden and a child's intelligence quotient. More recent evidence suggests that hookworm infection although mild had profound adverse effect on memory, reasoning ability and reading comprehension in childhood. Most of these effects are probably attributed to the presence of iron deficiency anaemia in which infants and pre-school children are particularly vulnerable to the developmental and behavioural deficits caused by iron deficiency anaemia and few analysis indicate that hookworm infection remain an important contributor to the anaemia in this age group (Hotez, *et al*., 2004).

Ascaris. lumbricoides ova widely contaminate the environment essentially maintaining a vicious cycle of malnutrition - enteric parasite – malnutrition synergy in human populations living under un-hygienic conditions as seen in most developing countries today (Cancrini, 2006; Cox, 2002). Parasitic infections in humans are usually transmitted through fecal-oral route, using vehicles such as food, water environment, and hands contaminated with protozoa (oo)cysts and nematode ova, such as *Cryptosporidia*, *Giardia*, *Entamoeba histolytica*, *Enterobius* (pinworms), and *Ascaris* (roundworms) (Idowu and Rowland, 2006). Such infections lead to loss of appetite, impaired digestion, malabsorption, and malnutrition which culminates in poor growth, cognitive development and eventually predisposing the vulnerable population to additional infectious agents including parasites (Ijaz and Rucino, 2012). Ascariadiasis causes vitamin A deficiency and possible malnutrition as a secondary effect. Trichuriasis causes iron deficiency, anaemia and possibly malnutrition (Roche and Benito, 1999).

The diarrhea prevalence rate in Nigeria is 18.8% and is one of the worst in sub-Sahara Africa and above the average of 16%. Diarrhea accounts for over 16% of child deaths in Nigeria and an estimated 150,000 Deaths mainly amongst children under five occur annually which is as a result of poor sanitation and hygiene practices.

Diarrhea is also closely linked to mal-nutrition, a condition that is associated with more than half of all under-five deaths. Undernourished children, in turn, have compromised immune systems and at higher risk for developing pneumonia – which also contribute to high children mortality in the country. This chain reaction illustrates that good hygiene practices such as hand washing are critical for child survival and development (Matur *et al.*, 2009).

2.8 Factors Contributing to the Spread of Parasites

Basic factors responsible for the spread of parasitic infection are environmental insanitation, poor personal and hand hygiene practices, socio-economic factor, age range of host and occupation.

2.8.1 Environmental insanitation

The quality of the environment plays an important role in the spread of parasites. Insanitary environmental conditions, greatly facilitates the spread of parasites through faecal, oral and person to person routes (FEPA, 2004). Statistics have shown that about two third of the diseases affecting our population has been identified as due to poor water and sanitary conditions. The environment is a complete ware of physical, chemical and biotic factors that interact with each other and impact upon all living things and their surroundings (UNICEF, 2009)

The lack of portable water and poor environmental sanitation are the reasons why diseases associated with unhygienic disposal of human faeces and refuse are so common in developing countries most especially in Nigeria (OECD, 2005). Even in public areas such as schools sanitation is not a priority because people do not realized the need for a safe and clean environment. Thus, most school environment has been turned into dumping sites for wastes (Awoyemi, 2008).

Parasitic diseases associated with low standard of sanitation remain the leading cause of morbidity and mortality in many developing countries. Amoebiasis prevalence rates vary from as low as 2 percent to 60 percent or more in areas devoid of sanitation. The severity of diseases in tropical areas is due to widespread poverty, lack of good drinking water and poor sanitation as well as climatic influence (Amuta, *et al.*, 2004).

The major factors underlying the low level of access to adequate sanitation in Nigeria include, lack of relevant and effective policy on environmental sanitation, inadequate implementation of health, housing and other related policies, lack of community awareness and concerns on environmental issues as well as inadequate knowledge and access to low cost sanitation technologies, high level of poverty and low level of rural development (FEPA, 2000).

2.8.2 Poor personal and hand hygiene practices

Parasites are easily transmitted through fecal-oral route. This is more common today, with the advent of technology in creating mobile phones which can easily be handled, exchanged without washing hands after use. The internet and mobile phones are progressively becoming an effective means of communication in Nigeria, thus there is an upsurge of people visiting the internet cafes, for some reason to browse while almost everyone has a phone. During the use of the computer, the keyboard and mouse are used for input of commands with the fingers and palms of the hands, thus acting as points of contact between the internet and its users (Ajenifuja and Ajibade, 2012).

The significance of hand washing at critical moments leads to reduction in diarrhea which is the second leading cause of death amongst Nigerian Children (after malaria). Hand washing can reduce diarrhea episodes by about 30% and up to 47% reduction has been achieved in some cases (Ademola, 2012). Several studies have also indicated that hand washing with soap may also have as much as 40% reduction in Acute Respiratory Infections (ARI) amongst children (UNICEF, 2009). ARI and diarrhea are the two leading killers of children worldwide and this shows that hand washing with soap is by far the most cost effective intervention for the reduction of child mortality and morbidity (UNICEF, 2009). In Nigeria the state of personal and environmental hygiene is generally poor; the soil in the environment is usually infected with faecal matter which results in poor state of hygiene arising from improper disposal of faeces (Suleiman, 2005)

Intestinal parasitic infections is sometimes associated with the socio-economic status of a person and are often a reflection of family and community hygiene (Samba, 2005) For example amoebiasis infection can be spread when infected people do not dispose off their faeces, in a sanitary manner or do not wash their hands properly after going to the toilet. The lack of portable water supply and poor environmental sanitation are the reasons why diseases associated with unhygienic disposed of human faeces and refuse are so common in developing countries (OECD, 2005). Parasitic infections, food and water contamination, malnutrition, inadequate sanitation, poor hygiene and poor health services coupled with poor housing are some of the causes of poor health (Sulaiman, 2005). A favourable environment to the parasite, indiscriminate defecation habits and a population that does not wear shoe favour the hookworm infection cycle, in such areas, children are particularly susceptible. In temperate regions, ascariasis is generally associated with low standard of personal hygiene (Krupp and Milton, 1973). Many important parasitic diseases are associated with human excreta and urine. An estimated 85% of the populations in developing countries do not have adequate disposal system for human waste (Faechem *et al.,* 1983).

2.8.3 Socio-economic factor

Gastrointestinal parasitic infection has been significantly reduced in developed countries by improving sanitation and other hygienic measures including hand washing and adopting proper hand hygiene practices (Bartram and Cairncross, 2010). However, people living in low socioeconomic areas of the society in developing countries suffer from infections of various types of parasites (Uneke and Ogbu, 2007). Diseases that are human induced or self-inflicted which are mostly brought by humans either as individual or collectively as a society is described as social diseases (Taylor, 1997). Several environmental and socio-economic factors have been identified to be responsible for the continual propensity of intestinal parasites in children (Samba, 2005). Most diseases caused by micro-organisms in tropical Africa are as a result of poverty and its accompanying features (Sulaiman, 2005) such as lack of sanitation, malnutrition, illiteracy, overcrowding alongside with ignorance which play an important role in the transmission of both the infectious and non-infectious diseases in tropical Africa. Human behaviour, cultural practices, customs and traditions, socio-economic conditions and the educational status of the population help to aggravate the spread of tropical diseases. The growing urbanization of most societies has created dense population centres which also help to aggravate the spread of tropical diseases (Sulaiman, 2005).

Much of the world's poverty is due to low level of economic development. Poverty is the economic condition in which people lack sufficient income to obtain certain minimal level of health services, food, housing, clothing and education generally recognized as a necessity to acquire an adequate standard of living. Parasitic infections cause human suffering and economic loss worldwide, but the burden is greatest in the underdeveloped countries. This is as a result of absence of basic infrastructures like good drinking water and poor sanitation. The parasites cause social problems and their effects are increased by the condition in disordered societies. Their presence hampers educational, political, economic development, imposing a tremendous burden on an already pre-carious health services in the poor areas of the world (Schimunis and Lopez, 1999).

The continuing cycle between parasites and human is often the result of parasites such as using the human excrement for fertilizer, exposing bare feet to soil or standing water eating undercooking or raw meat and fish and defecating in open soil (Kathleen and Arthur, 2002).

Helminthes have a far reaching impact on human health, economic and culture. It has been that there are probably more worms infection in human than there are human (due to multiple infections in one individual) although individual from all societies and regions play host to worms and sometimes in their lives, the highest case rate occurs among children in rural areas of the tropics and sub-tropics (Kathleen and Arthur, 2002).

2.8.4 Age of host

Age is the most important determinant. Mortality and morbidity rate often show a relationship to age (Herman, 1980). School children belong to the age group with the highest prevalence of parasitic infection in most communities or low economic grounds (Hoeprich, 1975). Widely reported in Nigeria (Gundrii and Akogun, 2006), the prevalence of diarrhoea in Nigeria show 18% and 10% of infants and under five respectively (Ademola, 2012), also *E. histolytica* and *E. disper* infection increase with age from 2-14 years old children, in which it is probably person to person (Roche and Benito, 1999). Young children have the lowest iron stores and are therefore most vulnerable to chronic blood loss as a result of hookworm infection while pinworm typically affects children between the ages of 5-15 years old (Franchot and Nicky, 2000).

2.8.5 Occupation

Several studies have indicated that people who handle dirty objects or those whose occupation are related to regular contact with public materials such as money are easily predisposed to parasite infections. A prevalence rate of 32% was recorded for cysts and ova of parasites on dirty naira notes (Matur *et al*., 2009). Dirty currencies are a potential source of contracting disease agents. It was observed that the presence of dirt on the notes was related with the presence of cysts and or eggs of parasites. Once a note had dirt on it, there was a high chance that it could harbour cysts and or eggs of parasites on it. Studies have revealed that parasite cysts and eggs are most prevalent on very dirty objects and mutilated materials (Matur *et al*., 2009).

2.9 Transmission of parasites

General Life and Transmission Cycle

The life cycle of parasite is very complex with the parasite changing into several distinct forms at different stages (Schmuins and Lopez, 1999) commonly involving more than one host (Kathleen and Arthur, 2002).

The life cycle of some helminthes include fertilized egg (embryo) and larva (adult) stages. In the majority of helminthes adult derive nutrients and reproduce sexually in the host body. In nematodes, the sexes can be either separate or hermaphroditic (meaning that male and female sex organs are in the same worm while cestodes are generally hermaphrodite. Most parasites complete life cycle by transmitting an infective form, usually an egg or larva to the body of another host, either of the same or different species. Generally, nematodes enter the host as eggs and complete their life cycle in the host while threadworms (pinworm), such as *Ascaris*, *Trichuris*, *Enterobius* and *Strongloides* enter the host through the skin as larvae. They migrate from the blood to the lungs and finally the intestine where they mature and reproduce excreted eggs hatch in the environment. For cestodes the larval worm ingested in raw beef and the pork in which the eggs are ingested and hatch in the body (Kathleen and Arthur, 2002).

Parasites are transmitted by several routes, and the same parasite may be transmitted by more than one route. There are five main routes of transmission: contact, droplet, airborne, common vehicle, and vector borne. (Canadian Committee on Antibiotic resistance, 2007).

Contact: It can be direct or indirect. Direct contact transmission involves a direct body surface-to-body surface contact and physical transfer of microorganisms between an infected or colonized person and a susceptible person, indirect contact transmission involves contact between a susceptible host and usually a contaminated inanimate object, such as equipment, instruments, and environmental surfaces. This is often the result of contaminated hands that are not washed which contaminate the object or environment (Canadian committee on Antibiotic resistance, 2007).

Contact or Aerosols: Transmission occurs when droplets containing microorganisms generated from the infected person are propelled a short distance through the air (usually less than one meter) and deposited on the host's eyes, nasal mucosa, or mouth (Canadian committee on Antibiotic resistance, 2007).

Airborne: Airborne transmission occurs by dissemination of either airborne droplet nuclei (small particle residue [five mm or smaller in size] of evaporated droplets containing microorganisms or dust particles containing the infectious agent (e.g. dust created by rotary powered foot care tools). Microorganisms carried in this manner remain suspended in the air for long periods of time and can be dispersed widely by air currents. These may become inhaled by a susceptible host within the same room or over a longer distance from the source client, depending on environmental factors (Canadian committee on Antibiotic resistance, 2007).

Common vehicle Transmission: Common vehicle transmission applies to microorganisms transmitted by contaminated items such as food, water and medications to multiple hosts and can cause explosive outbreaks. A major way to control such contamination is by using appropriate standards for handling food and water and preparing medications (Canadian committee on Antibiotic resistance, 2007).

Vector borne Transmission: Vector borne transmission occurs when vectors such as mosquitoes, flies, rats, and other vermin transmit microorganisms (Canadian committee on Antibiotic resistance, 2007).

Parasite lives in human and can be spread from person to person. The transmission powers is further facilitated by soil eating habit (geology) of children (Dada and Belino, 1979), handling of contaminated clothing and peri-anal area, indiscriminate defecation, the habit of walking barefoot, biting of finger nails and thumb sucking can easily release parasitic the eggs into the mouth leading to direct hand to mouth transmission (Franchot and Nicky, 2000).

2.10 Pathology

Pathological causes of intestinal nematodes depend on the intensity of the infection, the location of the parasite, the resistance of the host and the frequent co-existence of multiple parasitoses, (Hoeprich, 1975). Most worms do not remain in a single location and they migrate by various mechanisms through major systems inflicting injury (Kathleen and Arthur, 2002). Helminth pathology arises from worm feeding and migrating through tissues and accumulation of worms and worm products (Kathleen and Arthur, 2002). The migrating larvae of *Ascaris lumbricoides* produce minute hemorrhage of the intestinal wall on penetration and heavy infection in children results in volrulus, intestinal obstruction and appendicitis. The pathological effect of hookworm and other worms include enlargement and swelling of organs, hemorrhage, weight loss and anaemia caused by the parasites feeding in blood.

Adult tapeworm seldom cause pathologic changes in the intestine other than slight irritation of the mucosa and minor damage of the site of attachment of the scolex while *Diphyllobothrium latum* compete with the host for vitamin B12 producing a reversible hyper chromic and macrocytic anemia when attached to the jejunum (Hoeprich, 1975).

Life threatening manifestations of intestinal infection of *Entamoeba* are hemorrhage, perforation, appendicitis and tumour like growth called amebomas. Despite the popular misconception that intestinal worms cause weight loss by competing for food, weight loss is more likely caused by general malnutrition, malabsorption of food and vitamins due to intestinal damage, lack of appetite, vomiting and diarrhoea (Kathleen and Arthur, 2002).

2.11 Diagnosis

Diagnosis of helminthes infection require several steps of discovering of eggs, larvae or adult worms in stool, sputum, urine, blood or tissues biopsies (Kathleen and Arthur, 2002). Eggs are often detected on a direct smear using microscope to examine fresh stool (Hoeprich, 1975).

Concentration method involves sedimentation and flotation each with a number of techniques (Neva and Brown, 2004).

Sedimentation falls into simple and centrifuged chemical concentration. Simple sedimentation method is less effective than flotation for the concentration of protozoan cysts/ oocysts and many eggs (more satisfactory for *Schistosoma* and operculated eggs). It is also time consuming, although causes no distortion of the eggs, but if prolonged permits the hatching of *Schistosoma* eggs. The flotation techniques for the concentration of cyst and eggs are based on the differences in specific gravity of certain chemical solutions (1.12 to 1.21) and the helminth of eggs and larvae and protozoan cysts (1.05 to 1.15). Sugar, sodium chloride or zinc sulphate solutions are chiefly employed. The eggs and cysts float to the surface in the heavier solutions while faecal materials sink gradually to the bottom (Neva and Brown, 2004).

Centrifugal /chemical concentration is either with water or chemical is more efficient than simple sedimentation (Neva and Brown, 2004).

Stained dry smear method is used to examine *Cryptosporidium* oocysts. The oocyst of *Cryptosporidium* (trophozoite stage is not shed in faeces) is very small and appears like a yeast cell and cannot be identified by the conventional method of iodine stained preparation (Cheesebrough, 1992).

The formalin- ether method of concentration is also used for concentrating helminthes eggs (Hoeprich, 1975), the presence of formalin preserves eggs larvae and cyst so that the material can be examined hours or even days later (Neva and Brown, 2004).

2.12 Control

Parasitic diseases can be managed /controlled by treatment, proper disposal of faeces good hygienic practices and sanitation (Kathleen and Arthur, 2002).

Control measures are aimed at minimizing human contact with the parasite or interrupting its life cycle through improved public health condition (Franchot and Nicky, 2000) with a view to control soil transmitted helminthiasis (ascariasis, triuchursis and hookworm infection) (Hotez *et al*., 2004). This can be achieved through regularr deworming of school age children along with adults, provision of safe water, sanitation and health education.

2.12.1 Treatment

Essential agents for the treatment of intestinal nematode infections listed by the WHO include pyrantel, levamisole and piperazine, in addition to mebendazole and albendazole. School- based de-worming offers a number of health related and other benefits to children including improvement in iron and heamoglobin status physical growth, cognition educational achievement (Ademola, 2012).

2.12.2 Safe water

The lack of safe water supply is the reasons why diseases associated with unhygienic disposal of human faeces and refuse are so common in developing countries (OECD 2005). With improvement in safe water supply, significant reduction in child mortality was noticed in many regions of the world (Ademola, 2012).

2.12.3 Health education

Most parasite diseases are associated with ignorance, poverty, the environment and the educational level of the community (Roche and Benito 1999). Health education defined the problem, the cause, the route, the solution and ultimately the prevention of diseases. It is therefore a suitable component to deworming (Nock, *et al.,* 2006).

2.12.4 Sanitation

Accordingly, improved environmental sanitation such as improved sewage and refuse disposal, proper drainage system, provision of water and food hygiene can significantly reduce the prevalence and incidence of some common parasites infections (Ajayi *et al*., 2006).

2.12.5 Proper disposal of faeces

The number of microorganisms in sewage is enormous. The kind of enteric parasites in faeces varies from place to place and from time to time (Hoeprich, 1975). Parasitic infection rates are significantly reduced through proper sewage disposal using sanitary latrines avoiding human faeces as fertilizer and disinfection of the water supply (Franchot and Nicky, 2000).

2.12.6 Practicing hand hygiene

Hand hygiene is the responsibility of all individuals. Hand hygiene refers to removing or killing microorganisms on the hands as well as maintaining good skin integrity. There are two methods of removing/killing microorganisms on hands: washing with soap and running water or using an alcohol- based hand rub. Generally, the focus is on microorganisms that have been picked up by contact with others, contaminated equipment, or the environment (transient or contaminating micro organisms). Effective hand hygiene kills or removes microorganisms on the skin and maintains hand health. Alcohol-based hand rub is the preferred method for decontaminating hands. Using alcohol-based hand rub is better than washing hands (even with an antibacterial soap) when hands are not visibly soiled. However, hand washing with soap and running water must be performed when hands are visibly soiled. If running water is not available, use moistened towel to remove the visible soil, followed by alcohol-based hand rub.

Effective Hand Washing Technique involves:

Remove hand and arm jewelery. Jewelery is very hard to clean, and hides parasites from the mechanical action of the washing.

Wet hands with warm (not hot) water. Hot water is hard on the skin, and will lead to dryness.

Apply liquid or foam soap.

Vigorously lather all surfaces of hands for a minimum of 15 seconds. Pay particular attention to finger tips, between fingers, backs of hands and base of the thumbs. These are the most commonly missed areas.

Using a rubbing motion, thoroughly rinse soap from hands. Residual soap can lead to dryness and cracking of skin.

Lastly, dry hands thoroughly, with a clean towel (Canadian committee on Antibiotic resistance, 2007; Ademola, 2012).

Most deaths caused by parasites are preventable by hand washing with soap which is combined with adequate sanitation (Awoyemi, 2008). Hands are the main vehicles of diarrheal and parasitic infections transferring them from person to person through direct contact or indirectly via surfaces and foods (Curtis *et al*., 2000). The connection between hand washing and diarrhoea is well established, previous research shows that children living in household exposed to hand washing promotion and soap had half the diarrhoea rate of children living in control neighborhood. Increasing the frequency of hand washing substantially decreases the occurrence of diarrheal in young children and the proximity of the materials necessary for washing hands, such as running water, soap or cleanser and a basin may lead to more frequent hand washing. Hand washing with soap and sanitation is one of the most feasible and sustainable options for improving public health in developing countries (Awoyemi, 2008). The need for hand washing and sanitation is immense. Diarrheal diseases kill 2-3 million children in developing countries every year. Here in Nigeria, over 150,000 deaths occur annually among children due to diarrheal (UNICEF, 2009). UNICEF country representative Dr. Linlim Roberts stated that hand washing is very essential in order to combat the high mortality rate caused by parasites. In Abuja, Nigeria launched the national hand washing campaign towards breaking the transmission cycle of communicable diseases in year 2008 (Ademola, 2012).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was conducted in Samaru market (11^0, 09' N, 7^0 39' E) located 80km from Kaduna, Nigeria. The area is a town opposite Ahmadu Bello University, Main campus along Zaria Sokoto road and Zaria Kaura/Namoda railway line. It is also one of the major settlements that make up the urban Zaria. The market operates on all days of the week and quite a number of people within the Local government area and environs patronize the market to make purchases.The major market day is Friday.

The inhabitants of Samaru are generally traders, farmers, tailors, weavers, cattle rearers, fishermen, civil servants and students. The sources of drinking water for household use are wells, taps, streams and bore-holes. Samaru is generally poor in environmental sanitation as evident by the poor sanitary habits of the people (adults and children) and poor animal husbandry as both men and animal often defecate in the open (Bellino and Dada, 1997), bringing about the contamination of soil with parasite eggs (Nock and Geneve, 2002; Nock *et al.,* 2003).

3.2 Study Site

The study site comprised of Samaru Market and shops located around the market. The site or sample point was chosen to reflect the level of hygiene of the area as evident by the presence of poor sanitation indices such as improper disposal of human and animal faeces, rubbish heaps, and poor animal husbandry (Fig 1).

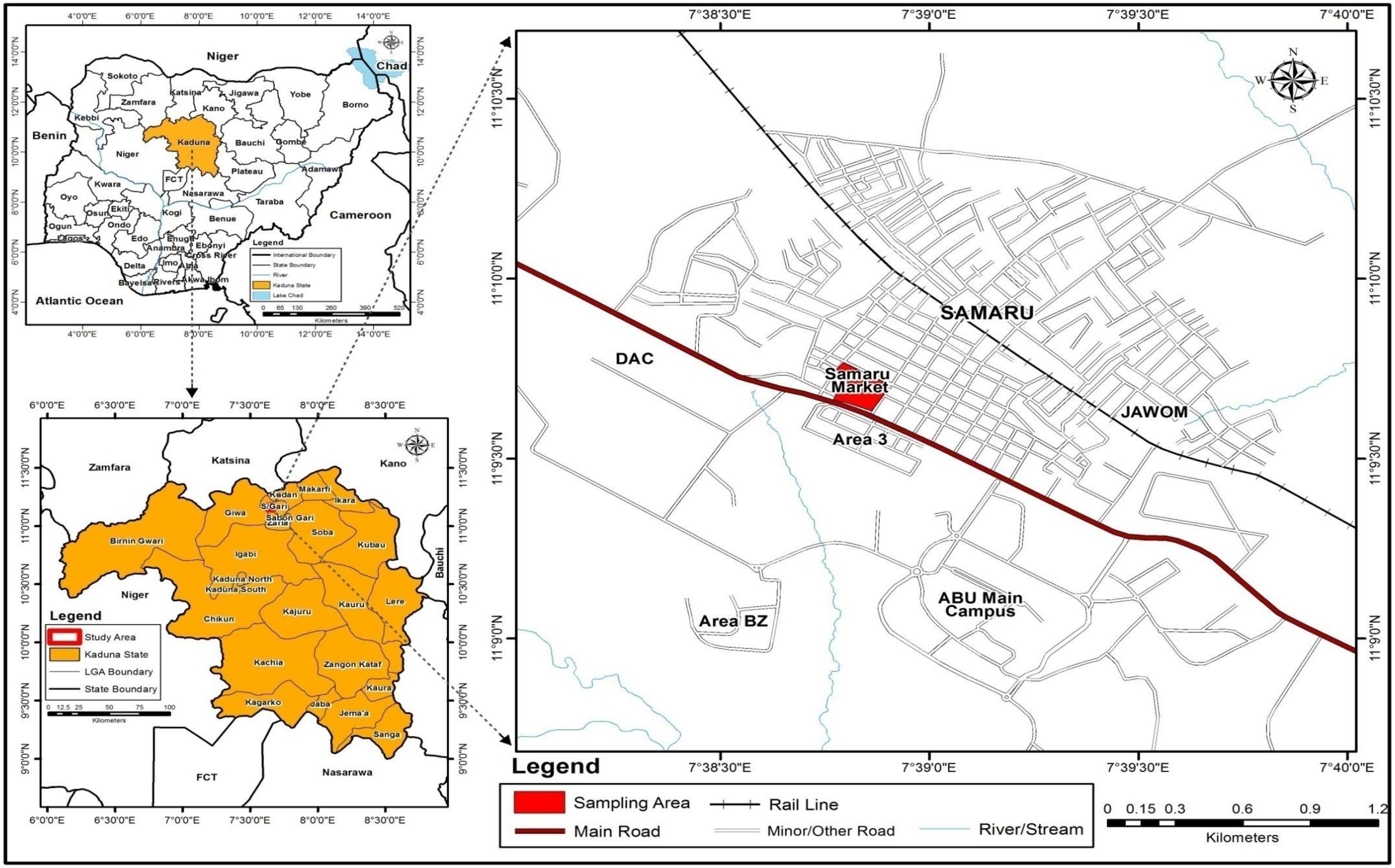

Figure 3.1: Map of Samaru showing Sampling Area (Samaru market)
Source: Modified from the Administrative Map of Sabon Gari L.G.A

3.3 Sampling Technique

Swab samples from the mobile phones of all participants from the market place were collected randomly during routine daily selling activity. A sterile swab was rolled over all exposed outer surfaces of the cell phones which have been in use for at least two months. Care was taken to ensure that the keypads and all buttons were swabbed, since these areas are most frequently in contact with the tips of fingers. Areas that were often neglected such as phone casing was also swabbed. Samples from both hands of the sellers were also taken.

3.4 Sample Size Determination

Since there is no available data on the prevalence of cysts and eggs on mobile phones and hands of their users in Samaru, Zaria, the 47.45% prevalence of parasite eggs and cysts on hands of primary school pupils in Zaria, Nigeria was used (Ademola, 2012) to calculate the sample size as described by Naing *et al*., (2006) as follows:-

$$n = \frac{z^2pq}{d^2}$$

Where n = Sample size

z = Standard normal deviation at 1.96 (which corresponds to 95% confidence interval)

p = Prevalence rate from previous studies on parasites on hands (Ademola, 2012)

q = 1-p; and

d =degree of accuracy/precision expected (allowable error) 5% = 0.05.

$$\text{Thus, } n = \frac{1.96^2 \times 0.4745(1-0.4745)}{0.05^2}$$

$$\frac{3.8416 \times 0.4745(0.5255)}{0.025}$$

$$\frac{1.8228392 \times 0.5255}{0.0025}$$

$$= \frac{0.95790}{0.0025}$$

$$=383.161$$

The calculated sample size is approximately 383 which is therefore the minimum sample collected for the study.

3.5 Permission from Market Authority

Prior to embarking on the study, permission was sought from the market authority, the sellers were educated on the significance of the study and their consent, sought.

3.6 Administration of Questionnaire

Structured questionnaire was administered to 470 petty traders recruited into the study. The questionnaire was designed to provide information on age, sex, educational background of seller, the habit of washing of hands before and after meals, washing of cleaning of phones, sharing of phones. Also data on the hand washing after using toilet, availability of water and soap for hand washing, presence of garbage piles, and presence of human and animal feaces in the environment and the petty trader awareness of hand washing campaign were obtained.

3.7 Collection of Samples

Four hundred and seventy (470 palms; 470 phones) swabbed samples were collected using sterile cotton wools soaked in normal saline, were collected from hands and phones of sellers. Samples from the mobile phones and hands of users of all participants from the marketplaces were collected randomly, using sterile swaps made of light cotton material, after which 10ml formalin was added as preservative in each swab placed in a sterile capped container. Swab samples from phones were placed in a separate container. Each container had a serial number that was assigned to the seller's questionnaire. The swab samples collected were taken to the Parasitological Unit of the Department of Biological Sciences, Ahmadu Bello University, Zaria for microscopy.

3.8 Examination of Samples

Each swab was repeatedly pressed mechanically against the internal wall of the bottle to dislodge any adhering cysts and eggs in the liquid preservative after which the samples collected were allowed to settle by gravity for 24 hours then the supernatant fluid was poured off leaving a sizable 10ml sediment, which was transferred into centrifuge tubes. The samples were centrifuged at 2,000rpm for 5 min. The supernatant fluid was poured off leaving the sediment (Neva and Brown, 2004). The sediment was mixed and a drop was transferred to a microscope slide using a Pasteur pipette. A drop of Lugol's iodine was added to aid viewing under a microscope. Cysts and eggs of parasites were examined under the microscope at X 400 magnification and were identified with the aid of Parasitology atlas (Jeffrey and Leech, 1975) and manual of Parasitology (Jeffrey and Leech, 1975; Cheesbrough, 1999).

To identify *Cryptosporidium* oocysts, smears were prepared from the sediment (care was taken not to make the smears too thick). The slides were flooded with 1% aqueous Carbon fushin, flamed from the bottom with a Bunsen flame for 1 minute and rinsed gently with distilled water. The slide was counter-stained with 1% methylene blue for 1 min, rinsed with tap water, drained and air-dried (Cheesbrough, 1999). The prepared slides were examined under oil immersion and using the x100 objective (Neva and Brown, 2004).

Cryptosporidium were identified as round shaped oocysts with large clear area (WHO, 1998). The oocysts in the direct smears measure from 4 to 6µm. They have a granular oocyst that is pinkish or reddish and a yellow hollow between the inner granule and the outer oocysts wall. Acid-fast staining procedures were effective because they stain the oocyst wall red.

3.9 Statistical Analysis

Prevalence of parasites was calculated and expressed as percentage with respect to Category of sellers, age, level of education, sex, hands and mobile phones and other risk factors. Chi-square ($\chi2$) was used to determine significant difference in prevalence of parasite with respect to the different categories of sellers. Odds ratio (OR) was calculated for association between risk factors and infection. Significance was determined at $P< 0.05$ at 95% confidence interval (C.I).

CHAPTER FOUR

4.0 RESULTS

4.1 Overall prevalence

Of the 470 hands and phones of petty traders examined, 168 hands and 116 phones were positive for parasites with a prevalence of 35.7% and 24.7% respectively. There was a significant association at $P<0.05$ between the prevalence of parasites recovered on hands and phones of petty traders in Samaru market (Table 4.1).

4.2 Identification and prevalence of the different Parasites Isolated

The cysts of some protozoans were identified such as *Coccidia* (Plate I), *Cryptosporidium parvum* (Plate II), *Entamoeba histolytica* (Plate III),. *Entamoeba coli*, *Giardia lamblia*, *Balantidium* species, oocysts of *Isospora belli* and *Cyclospora cayetanensis*. The Ova of some helminthes such as *Taenia* species (Plate IV), *Toxocara* (Plate V), *Ascaris lumbricoides* (Plate VI), *Trichuris trichiura*, *Physaloptera* species, *Enterobius vemicularis* (Plate VII) were also encountered,The larva of *Strongyloides* (Plate VIII), Hookworm eggs (Plate IX), the eggs of *Strongyloides stercoralis* (Plate X) and *Fasciola* species, as well as the egg of Mite which is an ecto parasite were recorded.

The most abundant parasite encountered in this study is *Cryptosporidium parvum* oocyst (Plate VI), a protozoan with 10.2% (48/470) prevalence on the hands and 9.8% (46/470) on phones. This was followed by Hookworm egg (Plate VII), a helminth with a prevalence of 8.5% (40/470) on hands (Table 4.2) and 6.0% (28/470) on phones (Table 4.2).

The least was *Isospora belli* oocyst and *Cyclospora cayetanensis* oocyst both are protozoans with a prevalence of 0.2% (1.0) on hands, while *Cyclospora cayetanensis*, *Entamoeba coli*, and *Enterobius vemicularis* ova (Plate X) had the least prevalence of 0.2% (1) each, on phones (Table 4.2).

4.3 Prevalence of Parasite in relation to categories of Petty Traders

Phone repairers had the highest prevalence of 54.3% and 45.7% on both hands and phones respectively while fruits and vegetable sellers (23.4%) had the lowest on hands and Yam sellers (12.0%) had the lowest prevalence among phones examined. No significant difference was observed in the prevalence of parasite at P>0.05 (Table 4.3).

4.4 Prevalence of Parasites obtained among Petty Traders of different educational levels

Prevalence of parasites obtained among different educational levels revealed that those with tertiary education had the highest prevalence of parasites 49.2% (29) and 39% (23) on both hands and their phones while those with Secondary education had the lowest on hands (33.30%) and those with primary education had the lowest on phones (17.70%). The difference obtained from parasites prevalent was not statistically significant at P>0.05 among the petty traders of different level of education (Table 4.4).

4.5 Prevalence of Parasites in relation to Gender of Petty Traders

The prevalence of parasites in relation to the gender of petty traders revealed that out of 49.6% (233) and 50.4%(237) of males and females were examined, the hands of 36.9% (86 males) and 34.6% (82 females) hands were positive for parasites while the phones of 27.0% (63 males) and 22.4% (53 females) were noted to be prevalent for parasites (Table 4.5). There was no significant difference in prevalence of parasite from both phones and hands amongst the different sexes of respondents P>0.05 (Table 4.5).

Table 4.1 Overall prevalence of Parasites on the hands and phones of Petty Traders

Source	No. Examined	No. Positive	$\chi 2$	Df	Odd ratio	C.I	P value
Hand	470	168 (35.7)	13.643	1	1.698	1.280-2.251	0.000
Mobile Phone	470	116 (24.7)					
Total	**940**	**248**					

Table 4.2 Identification and prevalence of the different Parasites isolated from hands and phones of Petty Traders

Parasite	Hand		Mobile Phone	
	No. Positive	%	No. Positive	%
Protozoa				
Cryptosporidium oocyst	48	10.20	46	9.80)
Coccidia oocyst	13	2.80	10	2.10
Isospora oocyst	1	0.20	0	0
Physaloptera ova	2	0.40	0	0
Entamoeba coli cyst	3	0.60	1	0.20
Entamoeba histolytica cyst	33	7.00	15	3.20
Balantidium cyst	4	0.90	0	0
Giardia lamblia cyst	5	1.10	3	0.60
Cyclospora cyst	1	0.20	1	0.20
Helminths				
*Strongyloides*eggs	17	3.60	6	1.30
Hookworm eggs	40	8.50	28	6.00
Larvae of *Strongyloides stercoralis*	4	0.90	0	0
Ascaris lumbricoides ova	12	2.60	5	1.10
Toxocara ova	3	0.60	0	0
Enterobius vermicularis ova	8	1.70	1	0.20
Fasciola spp egg	2	0.40	0	0
Trichiuris ova	2	0.40	3	0.60
Taenia ova	4	0.90	8	1.70
Ecto parasite				
Mite eggs	4	0.90	0	0

Table 4.3 Prevalence of Parasites in relation to the type of item sold by Petty Traders (n=470)

Petty traders	No. Examined	Hand		Mobile Phone	
		No. Positive	Prevalence (%)	No. Positive	Prevalence (%)
Food vendor	60	26	(43.30)	15	(25.00)
Fruit/Vegetable seller	107	25	(23.40)	22	(20.60)
Wears Sellers	34	18	(52.90)	12	(35.30)
Shoe Cobblers	36	15	(41.70)	10	(27.80)
Soup Condiments	98	32	(32.70)	20	(20.40)
Yam Seller	25	8	(32.00)	3	(12.00)
Butcher	47	15	(31.90)	11	(23.40)
Fish Seller	28	10	(35.70)	7	(25.00)
Phone/Watch Repairers	35	19	(54.30)	16	(45.70)
Total	**470**	**168**	**(35.70)**	**116**	**(24.70)**

χ^2= 2.34
Df= 8
P value= 0.9686 ns
ns= not significant

Table 4.4 Prevalence of Parasites in relation to different Educational levels of Petty Traders (n= 470)

Education	No. Examined	Hand		Mobile Phone	
		No. Positive	**Prevalence (%)**	**No. Positive**	**Prevalence (%)**
Primary	147	51	(34.70)	26	(17.70)
Secondary	264	88	(33.30)	67	(25.40)
Tertiary	59	29	(49.20)	23	(39.00)
Total	**470**	**168**	**(35.70)**	**116**	**(24.70)**

χ^2 = 2.19
Df= 1
P value = 0.1388ns
ns= not significant

Table 4.5 Prevalence of Parasites in relation to the gender of Petty Traders

Sex	No. Examined	Hand		Mobile Phone	
		No. Positive	Prevalence (%)	No. Positive	Prevalence (%)
Male	233	86	(36.90)	63	(27.00)
Female	237	82	(34.60)	53	(22.40)
Total	**470**	**168**	**(35.70)**	**116**	**(24.70)**

χ^2 = 0.27
P value= 0.6048 ns
ns= no significant difference observed

4.6 Prevalence of Parasites obtained from different age categories of Petty Traders

The prevalence of the parasites in relation to the age categories of petty traders was more in the hands of age group >45 years old, (43.8% (7)). Among phone users, the highest prevalence was in persons <25 years old (31.6% (42)). There was no significant difference in the prevalence of parasites obtained from hands and phones at $P>0.05$ (Table 4.6).

4.6.1 Correlation between age, phone and hand

Correlation was strong between the different age groups ($C \geq 0.5$) between hands and phones at 0.998350168 ($C \geq 0.5$). A strong negative correlation was observed between age and phone and between age and hand (Table 4.7)

4.7 General result obtained in relation to Risk Factors

Habit of traders (Table 4.9), hand hygiene practices of traders and traders' awareness of environmental hygiene practices were considered to find out how they affect the prevalence of parasites on the hands and phones respectively. This is because these factors can predispose or reduce the contact of a seller to parasites.

4.7.1 Prevalence of parasites in relation to habit of the traders

There is a strong association between prevalence of parasites and the level of education of petty traders, Primary OR=1.509; Secondary OR=1.242; Tertiary OR=1.185, (Table 4.8).

The hands of those who do not share phones had more parasites (45.1% (23)) than those who share their phones with others (34.6% (145)), while the phones of those who shared phones showed a greater prevalence for parasites 25.1% (105) as against those who do not share (21.6% (11)). There was no significant prevalence ($P>0.05$) of parasite among those who either share their phones with others or those who do not. There was an association between sharing of phones and prevalence of parasites, OR=1.552 (Table 4.8).

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Those who kept their phones in their pockets had a high prevalence of habouring parasites on their hands 36.9% (69) compared to those who kept their phones on the table. The prevalence of parasites was higher on their phones 29.2% (54). There was no significant difference in the prevalence of parasites among the different places a phone is kept when not in use ($P>0.05$) except for phones kept in pockets where the difference was significant ($P< 0.05$). The result obtained by analyzing odds ratio indicates that there is association between phones kept in handbags OR=1.136 and table OR=1.281 to the prevalence of parasites (Table 4.8).

There is a strong association between the use of phones in market and the prevalence of parasite on the hands and the phones OR= 1.552 (Table 4.8).

Those traders, who wear hand gloves while selling items, had the greatest prevalence of parasites on both their hands (48.9% (22)) and their phones (28.9% (13)). The difference was not significant at $P>0.05$. There is association between wearing of hand gloves and the prevalence of parasites on their hands and phones OR=1.194, (Table 4.8).

4.7.2 Prevalence of parasite in relation to hand hygiene practices of the traders

Those who do not wash their hands before eating had a higher prevalence of parasites on their hands (36.4% (36)). Those who washed their hands before eating had a higher prevalence of parasites on their phones 30% (12). The difference was not significant at $P>0.05$. There is a strong association between the prevalence of parasites on hands and phones and the habit of not washing hands after using the toilet OR=1.045, (Table 4.9).

Those traders who do not wash hands with soap had a high prevalence of parasite on their phones 41.8% (66) than those who did not 32.70% (102).The prevalence of parasites on hands of traders who washed hands with soap was higher on their hands 45%(28.50) than those who did not 71% (22.80). No significant difference was observed in the prevalence of parasites based on the use of soap for hand washing. There is association between the use of soap and the prevalence of parasite on hands and phones OR=1.021, (Table 4.9).

Those who washed their hands after toilet had a higher prevalence on both their hands and phones 36.2% (149), 25% (103) respectively. There was no significant difference observed in the prevalence of parasites both on the hands and phones of respondents who either washed hands after toilet or do not at $P>0.05$ There was strong association between prevalence of parasites on hands and phones and hand washing after toilet OR=1.101, (Table 4.9).

Table 4.6 Prevalence of Parasites obtained from the different age categories of petty Traders

Age (Years)	No. Examined	Hand		Mobile Phone	
		No. Positive	Prevalence (%)	No. Positive	Prevalence (%)
<25	133	58	(43.60)	42	(31.60)
26 – 35	257	81	(31.50)	63	(24.50)
36 – 45	64	22	(34.40)	10	(15.60)
> 45	16	7	(43.80)	1	(6.30)
Total	**470**	**168**	**(35.70)**	**116**	**(24.70)**

$\chi 2$ = 4.44
Df = 3
P value = 0.2179
ns= not significant difference observed

Table 4.7 Correlation between Age, Phone and Hand

	Age	Phone	Hand
Age	1		
Phone	-0.791861436	1	
Hand	-0.812743881	0.998350168	1

Table 4.8 Prevalence of parasites on phones in relation to some habit of Traders

Risk Factors		No. Examined	No. Mobile Phones Positive	No. Hands Positive	χ2	Df	Odds ratio	C.I	P value
Educational Level									
	Primary	147	26(17.7)	51(34.7)	2.19	1	1.509	0.875-2.600	0.1388ns
	Secondary	264	67(25.4)	88(33.3)	0.80	1	1.242	0.751-2.061	0.3709ns
	Tertiary	59	23(39)	29(49.2)	0.30	1	1.185	0.649-2.169	0.5826ns
	Subtotal	**470**	**116(24.7)**	**168(35.7)**					
Sharing of Phone									
	Yes	419	105(25.1)	145(34.6)	1.15	1	1.552	0.715-3.202	0.2830ns
	No	51	11(21.6)	23(45.1)					
	Subtotal	**470**	**116(24.7)**	**168(35.7)**					
Place phone is kept when not in use									
	Handbag	86	18(20.9)	29(33.7)	0.15	1	1.136	0.600-2.148	0.6974ns
	Table	185	54(29.2)	68(36.8)	1.03	1	1.281	0.795-2.064	0.3093ns
	Pocket	12	41(21.9)	69(36.9)	18.23	1	0.309	0.179-0.534	0,0001**
	Hand	187	3(25)	2(16.7)	0.77	1	0.454	0.089-2.320	0.3793ns
	Subtotal	**470**	**116(24.7)**	**168(35.7)**					
Use phone when in market									
	Yes	440	108(24.5)	153(34.8)	0.38	1	1.324	0.553-3.162	0.5372ns
	No	30	8(26.70)	15(50)					
	Subtotal	**470**	**116(24.7)**	**168(35.7)**					
Wearing of Glove when selling									
	No	425	103(24.2)	146(34.4)	0.23	1	1.093	0.665-1.799	0.6342ns
	Yes	45	13(28.9)	22(48.9)					
	Subtotal	**470**	**116(24.70)**	**168(35.7)**					

Table 4.9 Risk factors associated with prevalence of parasites in relation to hand hygiene practices.

Hand Hygiene		No. Examined	No. Mobile Phones positive	No. Hands Positive	$\chi 2$	Df	Odds ratio	C.I	P. value
Hand Wash before food									
	Yes	371	92(24.80)	132(35.60)	0.02	1	1.045	0.586-1.864	0.8808ns
	No	99	24(24.20)	36(36.40)					
	Subtotal	**470**	**116(24.70)**	**168(35.70)**					
Use of Soap									
	No	312	71(22.80)	102(32.70)	0.01	1	1.021	0.629-1.350	0.9334ns
	Yes	158	45(28.50)	66(41.80)					
	Subtotal	**470**	**116(24.70)**	**168(35.70)**					
Hand Wash after toilet									
	Yes	412	103(25.00)	149(36.20)	0	1	1.01	0.483-2.113	0.9786ns
	No	58	13(22.40)	19(32.80)					
	Total	**470**	**116(24.70)**	**168(35.70)**					

4.7.3 Prevalence of parasites in relation to traders' awareness of environmental hygiene practices

The highest prevalence on hands 43.6% (41) was noticed among respondents who used water system while those who had no toilet had the highest prevalence on phones 25% (1). There was no significant difference in the presence of parasites in the hands and phones of users based on the type of toilet they used at P>0.05. There was strong association between prevalence of parasites on hands and phones and all types of toilet used OR=1.437 (Table 4.10).

The traders who had garbage piles around them (shop) had the highest prevalence of parasites on their phones 24.9% (89) while those who did not have garbage piles had more prevalence of parasites on their hands 45.1% (51). There was no significant difference in the parasite present on hands of respondents who had garbage piles around them or not at P>0.05. Significant association was observed among prevalence of parasites on hands and phones and the presence of garbage piles in market OR=1.016 (Table 4.10).

Those who had human/animal faeces around them had the highest prevalence of parasites on both their hands and phones 40.5% (66) 25.8% (42) respectively. There was no significant difference observed in the prevalence of parasites at P>0.05 (Table 4.10).

Those who do not clean their phones either with wet or dry materials had the highest prevalence of parasites on both hands and phones 39.3% (53), 27.4% (37) respectively, as against those who cleaned their phones either with dry or moist materials. There is association between not cleaning phones and the prevalence of parasite on hands and phones OR=1.016 (Table 4.10). There was no significant difference in the result obtained from both hands and phones among those who use different materials to clean their phones neither was any significant difference observed based on the frequency of cleaning their phone at P>0.05 (Table 4.10)

Those who disagreed that dirt affect Health had the highest prevalence on both their hands and phones 48.4% (15), 35.5 % (11) respectively. There was no significant difference observed in the prevalence of parasites in both hands and phones of those among those who either agreed or did not that dirt can affect health at P> 0.05.There is association between prevalence of parasites and respondents view on dirt affecting health or not OR=1.068 (Table 4.10).

Those who are aware of the Hand Washing Day in Nigeria had the highest prevalence of parasites on their hands 37.8% (102) while those who do not had the highest prevalence on phones 25.0% (50). There was no significant difference in the result obtained on both prevalence of parasites on hands and phones at P>0.05. There is association between awareness of the Hand Washing Day in Nigeria and prevalence of parasite on hands and phones of petty traders There is association between prevalence of parasites and respondents awareness of hand washing day OR=1.71(Table 4.10).

Table 4.10 Risk factors associated with prevalence of parasites in relation to respondents' awareness of Environmental hygiene practices

Awareness	No. Examined	No. Mobile Phone Positive	No. Hand Positive	χ2	Df	Odds ratio	C.I.	P value
Toilet Type								
Pit	372	92(24.70)	126(33.90)	0.71	1	0.783	0.44-1.380	0.3979ns
W/System	94	23(24.50)	41(43.60)	0.82	1	0.766	0.432-1.360	0.3642ns
Nil	4	1(25.00)	1(25.00)	0.07	1	0.689	0.071-6.687	0.7915ns
Subtotal	**470**	**116(24.70)**	**168(35.70)**					
Garbage Piles								
Presence	357	89(24.9)	117(32.80)	1.73	1	1.437	0.837-2.466	0.1888ns
Absence	113	27(23.89)	51(45.10)					
Subtotal	**470**	**116(24.70)**	**168(35.70)**					
Animal faeces								
Presence	163	42(25.80)	66(40.50)	0.28	1	0.877	0.538-1.431	0.5993ns
Absence	307	74(24.10)	102(33.20)					
Subtotal	**470**	**116(24.70)**	**168(35.70)**					
Material for cleaning Phones								
Dry	289	72(24.90)	97(33.60)	0.53	1	0.835	0.514-1.355	0.464ns
Moist	46	7(15.20)	18(39.10)	2.32	1	0.499	0.206-1.214	0.1281ns
None	135	37(27.70)	53(39.30)	0.00	1	1.016	0.612-1.689	0.9505ns
Subtotal	**470**	**116(24.70)**	**168(35.70)**					
Frequency of cleaning phone								
Seldom	257	55(21.4)	80(31.1)	0.00	1	0.992	0.617-1.593	0.9728ns
Daily	20	7(35.0)	11(55.0)	0.03	1	0.912	0.355-2.372	0.8615ns
Weekly	19	7(36.8)	11(57.9)	0.03	1	0.912	0.355-2.372	0.8615ns
Monthly	38	10(26.3)	13(34.2)	0.07	1	0.889	0.383-2.063	0.7887ns
Nil	135	37(27.2)	53(39.0)	0.00	1	0.984	0.592-1.654	0.9505ns
Subtotal	**470**	**116(24.70)**	**168(35.70)**					
Agree dirt affect health								
No	31	11(35.50)	15(48.40)	0.03	1	1.068	0.477-2.1418	0.8735ns
Yes	439	105(23.90)	153(34.90)					
Subtotal	**470**	**116(24.70)**	**168(35.70)**					
Hand Washing Day Awareness								
No	200	50(55.00)	66(33.00)	0.41	1	1.71	0.724-1.839	0.5200ns
Yes	270	66(24.40)	102(37.80)					
Subtotal	**470**	**116(24.70)**	**168(35.70)**					

CHAPTER FIVE

5.0 DISCUSSION

5.1 Occurrence

The result obtained from this study revealed that 35.7% of the 470 hands examined from Samaru market had parasite cysts/oocysts/eggs. This is an indication of the degree in which the hands of marketers are contaminated with dirt, particularly with fecal matter. Such hands can be potential source or vehicle in the transmission of parasitic infections (Curtis *et al.,* 2000). The contamination of the hands by parasite cysts/oocysts/eggs reflects the poor hygiene habits of the traders, which is often associated with indiscriminate disposal of human faeces and poor animal husbandry. This observation agrees with Ademola, (2012) who recorded a prevalence of 47.5% from hands of children. The result also supports an earlier work carried out in the same study area by Dyke, (2001) who recovered parasites cysts and eggs under the finger nails of primary school children. The isolation of parasite cysts/eggs/oocysts from the hands of traders has health implication because of the identity and prevalence of these parasites. The parasite recorvered in the present study are common parasites of economic importance which was similarly reported by Nock and Tanko, (2000).

Although the prevalence of cysts and eggs on mobile phones was low when compared to that of hands, the result shows that parasite eggs was present on surfaces of mobile phones particularly those that were dirty and in the casing of such phones, since most people rarely open phone casing and as such dust containing parasite eggs or cysts often accumulate. To the best of our knowledge no study has been carried out on the presence of parasite cysts or eggs on phones although several studies have been conducted on the prevalence of bacteria on mobile phones. Of the 470 of the phones examined from marketers in Samaru, 24.7% phones had parasite eggs and cysts. This is an indication that phones serve as fomites in parasite transmission. The results support the earlier work on computer mouse and keyboard (Ndams and Jimoh, 2006) that observed a prevalence of 5.8% infection on computer keyboards. Computer keyboards are similar to mobile phones because they are electronic devices with keys just as mobile phones for inputting data, and also fomites. Other fomites reported to habour parasite eggs and cysts include Naira notes with a prevalence of 45.6% of parasite eggs and cysts reported (Elom *et al*., 2012). Ajenifuja and Ajibade (2012) also reported that the keyboard and mouse houses a lot of parasite with 95% infection. A reason why the prevalence of parasite on phones is higher than that of keyboards could be because they are more handled and taken along everywhere, thereby making them more exposed to dirt than computers.

Parasites were more prevalent in the phones of people <25 years. This contrasts with Ezeagwu *et al*.,(2010) who discovered the highest prevalence of parasites in older age group. The prevalence of parasites among the younger age group in the present study can be attributed to the increase in the use of mobile phones among this age group and as such they take it along to almost everywhere and this age group spends a lot of time chatting online with friends. The fact that this age group constitutes a larger part of the population in tertiary institution could also account for the high parasite prevalence observed in the present study.

Cryptosporidium parvum had the highest occurrence in both phones and hands, probably due to its highly resistant and ubiquitous nature. *Cryptosporidium parvum* is transmitted by hardy cysts (oocyst), once ingested, encyst in the small intestine and result in infection of the intestinal epithelial tissues. Ademola (2012) reported high frequency of transmission among children who share unhygienic toilet and commonly play in contaminated soil. This was followed by a helminth Hookworm, evidence pointing that contaminated soil is present around the market and is possibly picked up by marketers who display goods on the ground, pick up displaced phones, or other items from the ground. *Ascaris* and Hookworm were the prevalent intestinal parasite observed. Their presence could be attributed to a combination of factors such as poor or lack of toilet facilities, (use of water and soap), poor waste disposal in the environment coupled with indiscriminate defecation. In addition adults are seen, walking barefooted around their shops, thereby predisposing them to hookworm infections.

Phone and Watch repairers had the highest prevalence of parasites on both hands and phones. The reason for this high prevalence could be because they come in contact with phones from different people and often make use of old phone parts for repairs that accumulated dirt over a long period of time or phones that were disposed in garbage.

There is association between sharing of phone and prevalence of parasite on hands and phones of petty traders. These show that there is a high chance of transmission of pathogenic parasites to individuals sharing a common phone. Ademola (2012) made similar observation and conclusion in Zaria. Those who shared their phones had more prevalence of parasites on their phones 25.1% (105/470) than those who do not, agreeing with the study of Jagadeesan *et al*., (2013) that mobile phones are particularly problematic when compared to immobile devices for it facilitates transmission of micro organisms from one person to another. Studies have shown that unhealthy habit of people can contaminate surfaces, for example 33% (1/27) hospital attendants were observed to have picked their nose within a 1 hour observation period (Hendley *et al*., 1973).

Those who often kept their phones in exposed surfaces such as tables had more parasites on phones (29.2%). There is association between parasite prevalent on phones and hands and phones kept on tables and handbags, probably because hand bags are rarely washed while tables are exposed to contamination. This habit made their phones more susceptible to parasites considering the fact that dusts, particles in the air, from sneezing can contaminate surfaces exposed to their contact. Sneezing can expel an estimated 10,000000 infectious virons per ml of nasal fluid. Nasal secretions can travel a velocity of over 20meter/second and a distance greater than 3meters to contaminate surrounding fomites (Hadley *et al*., 1973).

There is association between traders using their phone in the market and infection of parasites on the hands and phone probably due to the handling of other fomites such as currency notes, infected sales item and dust particles while using their phones.

There is a strong association between prevalence of parasite on hands and phones and the habit of not washing hands before eating. Such contaminated hands can easily lead to ingesting parasite cysts and eggs which could have been picked up while engaging in various activities. The present study conducted also showed that hand washing after toilet is very essential. Not washing hands is associated with the prevalence of parasite on hands and phones.

The high prevalence of parasites on the hands of traders who used soap can be attributed to improper hand washing technique. Abruquah and Lambon (2014) recorded a similar result. Documented hand washing technique includes wetting the hands with clean running water (warm or cold) and applying soap, rubbing the hands together to make lather, scrubbing the hands well, particularly the back of the hands and in between the fingers and nail bed. The rubbing action should be continued for at least 20 seconds. The hands should then be rinsed under cold running water and air dried or using a towel for drying (Carter, 2002).

Those respondents, who have never cleaned their phones before, had the highest prevalence of parasites on both hands and phones. Agreeing with the work by Yazhini *et al*., (2013) who observed that 85% of respondents did not have the habit of cleaning their mobile phones and that 15% who cleaned their mobile phones even at that they used only a dry cloth for the purpose of cleaning and never used any disinfectants.

Only 9.6% (45/470) of the respondents wear hand gloves while selling items, result shows that their hands were positive for parasites ensuring the need to wear gloves while selling particularly ready to eat food items. Those who wear hand gloves while selling had a higher prevalence of parasites on both their hands and phones, than those who did not, this can be attributed to a lack of constancy in the use of hand gloves when carrying out other activities such as counting of money, using the toilet as a result, their hands and phones could be contaminated by these activities. Repeated use of contaminated gloves could lead to infection of trader’s hands and phones with parasites.

Although 20% (94/470) of respondents used an improved system of toilet (water system), the parasite prevalence was high on their hands attributing to the fact that fecal parasites, bacteria and viruses are ejected from the toilet during flushing the droplets settle down on the restroom contaminating it and objects around with fecal micro organisms which will definitely contaminate the hands that touch them. In addition not washing after defecating is probably the cause of high prevalence of respondents hands (Luciano, 2007).

Majority of respondents (87.7%) said they wash their hands after using the toilet but only 33.6% (158/470) actually use soap showing that proper hand washing habit was not practiced. A similar result was observed by Abruquah and Lambon, (2014) where only 60% of respondents washed with water alone after visiting the toilet while 30% washed with soap and water after visiting the toilet. Using the toilet exposes the hands to fecal micro- organisms which may be potentially pathogenic and hence effective hand hygiene practices after using toilet is crucial.

Presence of animal and human feces in the market is in support with various studies carried out in Zaria, (Nock and Tanko, 2000) making the environment a source of contamination to both hands and phones of marketers in the area.

Although 57.4% of respondents are aware of the hand washing day this does not reduce parasite contamination of their hands and phones. This therefore implies that, knowledge level does not correspond to practice in real life situations. Similar result was observed in some previous studies (Badaro and Jones, 2001; Luciano, 2007; Abd Elaziz and Bakr, 2009; Ademola, 2012; Abruquah and Lambon, 2014). It is reasonable to speculate that health education program did not make significant impact on the traders.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Result obtained from this study revealed that 168 hands and 116 phones, out of the 470 hands and mobile phones examined were positive for parasites with a prevalence of 35.7% and 24.7% respectively.

The results from the present study revealed that the prevalence of parasite cysts and eggs is influenced by age and some risk factors and type of item sold by each petty trader, with higher prevalence recorded on phones of young respondents <25 years old, and Mobile phone repairers. Irregular habit of cleaning phones, poor hand hygiene practices, and poor toilet facilities play a role in the prevalence of parasite cysts and eggs on hands of petty traders.

6.2 Recommendations

It is recommended that:

1. Hand hygiene practices should be carried out: The study established unwashed hands and contaminated phones as potential source of transmitting parasites infections and thus recommends that hand washing with water and soap should be practice daily most especially before meal, after meal and every defecation process. Since, according to UNICEF the role of water, sanitation and hygiene is critical for sustainable development.

2. Public health enlightenment programs should be aggressively pursued at all levels, amongst students in public places such as market and other settings. Hygiene, sanitation and hand washing campaign message should be specific on what real hygiene practice encompasses. More especially, the idea that cleanness promotes good health should be reinforced. Adequate hygiene behavior is crucial in preventing diseases; improving infrastructure without improving behaviour results in ineffective disease control.
3. Care should be taken when handling mobile phones: Mobile phones should be handled with clean hands and sharing of phones limited or avoided if possible.
4. Periodic surveys that provide information on the trend of compliance of hand washing with soap and its effects on the health of individuals must be conducted on a regular basis.

REFERENCES

Abd Elaziz, K. M. and Bakr, I. M. (2009). Assessment of knowledge, attitude and practice of hand washing among Health care workers in Ain Shams University hospitals in Cairo, *Journal of Prevention and Medical Hygiene*, 50: 19-25.

Abdullahi, I.O. and Abdullazeez, A.J. (2000). Prevalence of intestinal parasites in some human patients in Zaria. *The Journal of Parasitology,* 21: 25-30.

Abruqua, A. A and Lambon, S.P. (2014). Hand hygiene practices- A workplace based survey in Ghana. *International Journal of Development and Sustainibility,* 3(9): 1848-1861.

Abuja, I. (1997). Recovery of helminthes ova and protozoa cysts from the beak of locally raised chickens in six sites in Samaru B.Sc Project, Department of Biological Sciences Ahmadu Bello University, Zaria. Pp 30.

Adeboye, O.C.O and Adedayo A.(2008). Future of Nigeria under exploited indigenous fruits vegetables in era of climate. A review of scientific literature pp: 1-4.

Ademola, B. T., (2012). Prevalence of Parasite cysts and eggs on Hands of Primary School pupils in Zaria, Nigeria. Unpublished Msc. Project, Department of Biological Sciences Ahmadu Bello University, Zaria. pp. 30-47.

Ajayi, A. D., Garba, S. N., Abdul, A. J., and Isa, A. (2006). Impact of Environmental Sanitation on the prevalence of common infections in Lokoja, Kogi State, *Nigeria Biological and Environemental Science Journal for the Tropics*, 3(10):42-48.

Ajenifuja, O.A. and Ajibade, V.A. (2012). Prevalence of Parasitic Eggs and Parasite cysts on Computer mouse and keyboard in School of Science and Computer Studies of Federal Polytechnic Ado-Ekiti, Nigeria. *Global Journal Incorporation,* 12 (4): 3-4

Akinyemi, K.O., Atapu A.D., Adetona, O.O., and Cokers A.O.(2009). The Potential role of mobile phones in the spread of bacterial infections. *Journal infection in Developing countries*, 3: 628-632.

Akogun, O.B. (1989). Some social aspects of helminthes among the people of Gumau District, Bauchi State, Nigeria. *Journal of Tropical medicine and hygiene,* 92 (3): 193-196.

Al-Abdalall, A.H.A. (2010). Isolation and identification of microbes associated with mobile phones in Dammamin Eastern Saudi Arabia. *Journal Family, Community Medicine*, 17:11-14.

Alum, A., Rubino JR, and Ijaz MK (2010). The global war against intestinal parasites--should we use a wholistic approach? *International Journal Infection and Distribution*; 14: 732-738.

Amuta, E.U., Omudu, E. A. and Ahmed, A. S. (2004). Bacteriological and parasitological evidence of soil contamination in relation to sanitary facilities in selected schools in Makurdi, Nigeria. *Nigerian Journal of Pest Disease and Vector Management*. 5:337-347

Arora, D.R. and B. Arora, (2008). *Medical Parasitology* 2nd Edition, CBS Publishers and Distributors. PVT. LTD. India. 3(8): 168-180

Awodi, N. O., Nock, I. H., and Aken'Ova .I., (2000) Prevalence and Public Health Significance of Parasitic Cysts and Eggs on the Nigerian Currency. *The Nigerian Journal of Parasitology*, 22: 137-142

Awoyemi, O. (2008). Keeping sanitation on the school Agenda. Surulere Lagos state, Nigeria.http://tilz-tearfund-org/publications/footsteps+71-80/footsteps+72/ke. (accessed 1st October, 2013).

Badaro, R. and Jones, T.(2001), Control of spread of microorganisms in the hospital—back to the basics of hand washing and glove use. *Brazillian Journal of Infection and disease,* Vol. 5, pp.47-49.

Bartram, J.and Cairncross, S. (2010) Hygiene, Sanitation, and Water: forgotten foundations of health. *Journal publication of Medicine* 7: 1000367

Barry, M. (2002). Handling money and ready to eat food. *Food Service Technology*. 2: 1-3.

Belino, E.D and Dada, B.J. (1997). Prevalence and public health significance of helminth ova in dog faeces deposited on the streets of Zaria. *Nigeria Annals of Tropical Medicine and Parasitology,* 78:89-90.

Bradley, J.E., and Jackson, J.A. (2004). Immunity, immune regulation and the ecology of trichuriasis and ascariasis. *Parasite Immunology*, 26: 429-441.

Brady, G., and Kelly, J., (2000). The assessment of the public health risk associated with the simultaneous handling of food and money in the food industry. *Central Goldfields shine council, money sampling*, pp 1-10.

Brady, R.R.W. Wasson, A., Stirling, I., McAllister, C., and Damani, N. N., (2006). Is your phone bugged? The incidence of bacteria known to cause nosocomial infection on health care workers' mobile phones. *Journal Hospital Infections,* 62:123-125.

Brady, R.R., Fraser, S. F., Dunlop, M. G., Paterson- Brown, S., Gibb, A. P. (2008). Bacterial contamination of mobile communication devices in the operative environment. *Journal Hospital Infections*, 66:397-8.

Canadian Committee on Antibiotic Resistance, (2007). Infection Prevention and Control Best Practices for Long Term Care, Home and Community Care including Health Care Offices and Ambulatory Clinics, pp. 19-28.

Cancrini, G. (2006). Human infections due to nematode helminthes nowadays: epidemiology and diagnostic tools. *Parassitologia*, 48: 53-56.

Carter, J.M. (2002). Importance of hand washing. *Journal National Medical Association*, Vol. 94, A11-12

Cheesbrough, M., (1992). *Medical Laboratory Manual for Tropical Countries* (2ndEd). University Press, Cambridge, pp. 200-327.

Cheesbrough, M., (1998). *Medical Laboratory Manual forTropical Countries.* Part 1. Cambridge, UK: Cambridge University Press, pp. 300-327.

Cox, F.E. (2002). History of human parasitology. *Clinical Microbiology Revision*, 15: 595-612.

Curtis,V.A., Cairncross, S. and Yanli, R. (2000). Domestic Hygiene and diarrhea, pinpointing the problem. *Tropical Medicine and International Health,* 5:22-32.

Dada, B.J.O. and Belino, E.D. (1979). Prevalence and public health significance of helminthes ova in dog faeces deposited in the streets of Zaria, Nigeria. *Annals of Tropical Medicine and Parasitology*, 73: 89-90.

Damen, J.G., Banwat, D.Z., Egah, I. and Allamana, J.A. (2007). Parasitic contamination of vegetables in Jos, Nigeria. *Annals of Medicine*, 6(2): 115-118.

Datta, P.H., Rani, J. and Chander, V. G. (2009). *Indian Journal of Medical Microbiology*, 7:279-281.

Dyek, N.D. (2001). Prevalence of eggs and cysts of parasites under the finger nails of primary school pupils in Samaru, Zaria, Nigeria. An M. Sc. Thesis ABU. Zaria

Erica, O. (2008). The public Private Partnership of Handwashing, Water and Sanlet Program WSP Columbia January. Soap box Newsletter, pp. 8.

Ekrakene, T., and Igeleke, C. L. (2007). Micro-organisms associated with public mobile phones along Benin-Sapele Express Way, Benin City, Edo State of Nigeria. *Journal Applied Sciences and Research,* 3:2009-2012.

Elom, M.O., Alo, M.N., Ezike A.C., Okeh E.N. and Anyim, C., (2012). Parasitic helminths in Nigerian currency. *Prime Journal of Microbiology Research*, 2(6):165-169.

Ezeagwuna, D.A, Okwelogu, I.S., Ekejindu, I. M and Ogbuagu, C. N. (2010). The prevalence and socio-economic factors of intestinal Helminth infections among Primary school pupils in Nigeria. *The lnternational Journal of Epidemiology*, 9(1):1-8.

Fatma. U., Saban. E., Ahmet, D., Keramettin, Y., Murat, G., Hakan I., and Lable, B. (2009). Are we aware how contaminated our mobile phones with noscomial pathogens? *Annals of clinical Microbiology and Antimicrobials*, 8:7.

Feachem, R. G., Bradley, D. J., Garelick, H. and Mova, D. (1983). *Sanitation and disease:* Health aspects of excreta and wastewater management. World Bank studies in water supply and sanitation. John Wiley and Sons. pp.5

FEPA, (Federal Environmental Protection Agency (2000). National Policy on the Environment) Revised Edition Abuja: *FEPA Publication*, 117-125

FEPA/ UNICEF, (2004). Nigeria Environmental policy for Nigeria: *The Forestry Proceeding of the 18th Forestry Association of Nigeria Conferences*, pp 37-41.

Fewtrell, L., Kaufmann, R.B, Kay, D., Enanoria, W., Haller. L., Colford, J.M., Jr. (2005) Water, sanitation, and hygiene interventions to reduce diarrhea in less developed countries: a systematic review and meta-analysis. *Lancet Infectious Disease*, 5(1):42-52.

Franchot, S. and Nicky, S. (2000) What is a Hookworm infection (Ancylostomiasis) Personal Media Community Medical Contributors. pp. 15

Galadima, M and Olatunde, B. (1987) Prevalence of intestinal parasite infection in children in Samaru, Zaria. *Zaria Veterinarian*, 2: 20-23.

Gerald, I. and Larry, O. (2006). *Foundation of Parasitology*,. 7th edition McGraw Hill education. Asia p.5

Goldblatt, J.G., Krief, I., Haller, T.D., Milloul, V., Sixsmith, D.M., Srugo, I., and Potasman, I., (2007). Use of Cellular telephones and transmission of pathogens by Medical Staff in New York and Israel. *Infection Control in Hospitals Epidemiology*, 28: 500-503.

Guerrant, R.L., (1986). Amebiasis: Introduction, Current Status and research questions. *Revision Infection Diseases*, 8:218-227.

Gundiri, M. A. and Akogun, O. B. (2000). Gastrointestinal and urinary parasitic infections among school children in Rumde, Yola, Adamawa State. *Nigerian Journal of Parasitology,* 21: 117-124

Harhay M.O, Horton J, Olliaro P.L., (2001). Epidemiology and control of human gastrointestinal parasites in children. *Expert Revision and Antibiotic Infection Therapy,* **8**:229-234.

Hendley, J. O., (1973). Epidemic Keratoconjuctivitis and Handwashing. *New England Journal of Medicine*, Volume 289: 1368-1369.

Hoeprich, P.D,. (1975). *Disease. A guide to the Understanding and Management of Infectious Process*in *Infections*. Harper and Row Inc, pp. 673-681.

Hota, B. (2004). Contamination, disinfection and cross-colonization: are hospital surface reservoirs for nosocomial infection? *Clinical Infections and Distribution*, 39: 1182-1189

Hotez, P.J., Brookev S. Bethany J.M., Loukas A. and Xiao S. (2004). Hookworm infection: *The New England Journal of Medicine*, (8)351: 799- 708

Hugh, J. (1975). Book of child care. *USA Journal publication*, Pp. 12-13

Idowu, O.A and Rowland S.A.(2006). Oral fecal parasites and personal hygiene of food handlers in Abeokuta. *Journal of African Health Science Nigeria*, 6(3): 160-164

Ijaz, M.K, Rubino, J.R. (2012) Impact of infectious diseases on cognitive development in childhood and beyond: potential mitigational role of hygiene. *Open Journal Infection and Distribution*; 6: 65-70.

Jagadeesan, Y., Deepa, M., and Kannagi, M., (2013). Mobile phones as fomites in miocrobial dissemination. *International Journal of Science,* 5:6-24.

Jasti, A., Ojha S.C, Singh Y.I., (2007). Mental and behavioral effects of parasitic infections: a review. *Nepal Medical College Journal*, 9: 50-56.

Jeffery, H. and Leech, R. M. (1975). *Atlas of Medical Helminthology and Protozoology*. 2nd Edition. Longman group Ltd. Hong Kong. 121.

Karabay, O., Kocoglu, E., and Tahtaci M., (2007). The role of mobile phone in the spread of bacteria associated with nosocomial infections. *Journal Infection in Developing Countries*, 1: 72-73.

Katheleen, P.T. and Arthur,T. (2002). *Foundation in Microbiology* Fourth Edition, McGraw-Hill, New York. pp.697-706

Kramer, E. (2006). License Biomed Central LTD, How long do nosocomical pathogens persist on inaminate surfaces? *A systematic review of Bio Medical Central infectious Diseases,* 6: 130.

Kucik. C., Corry. J., Martin, G. L, and Sortor, B. (2006). Communication in intestinal parasites. *America Family Physician*, 69 (5): 2004 – 2020.

Krupp, M.A. and Milton, J.C. (1973). *Current Diagnosis and Treatment*. Lange Medical Publication. Taiwan. Pp.798-824.

Lawande, R.V., (1983). Recovery of soil amoebae from the air during harmattan in Zaria, Nigeria. *Annals of tropical medicine and parasitology*, 77(1): 45-49.

Luciano, G., (2007). Mass technologies and ignorance in the society of knowledge. *Journal of Science communication* 6 (4), pp 112.

Mackintosh, C. A., and Hoffman, P.M., (1984). An Extended model for Transfer of micro organisms through Hand: Differences between organisms and the effect of Alcohol Disinfection. *Journal Hygiene,* 92:315

Matur, B. M., Malann, Y. D. and Edhomeriegue,Y. (2009). Asurvey of parasite cysts, eggs and Bacteria on the Nigerian Currency. *New York Science Journal*, 2(7) 117-183.

Meinhardt, P .L, Casemore, D.P., and Miller, K..B. (1996). Epidemiologic aspect of human Cryptosporidiosis and the role of waterborne transmission. *Epidemiology Revision*, 18:118-123

Naing L, Winn, T., Rushi, B.N. (2006). Practical issues in calculating the sample size for prevalence studies. *Archives of official sciences,* 1: 9-14.

Ndams I.S., and Jimoh, O.L. (2006). Prevalence of parasite eggs and cysts on computer mouse, keyboards and users of internet cafes, in Samaru, Zaria, Nigeria. *The Zoologist*, 1(4): 80-85

Neva, F.A. and Brown, H.W. (2004). *Basic Clinical Parasitology,* (6th Ed.). Prentice Hall International Inc., USA, pp. 356.

Nock, I. H. and Tanko, D. (2000) Prevalence and Public health significance of parasite occysts and eggs on the sole of shoes. A case study in Zaria, Nigeria. *The Nigeria Journal of Parasitology*, 21: 137-142.

Nock, I. H. and Geneve, I. A. (2002). Public Health significance of parasite cysts and eggson water-closed handles. *The Nigerian Journal of Parasitology*, 23: 91-94.

Nock, I.H., Akenova, T. and Galadima M. (2006). Deworming: Adding Public health education. *Trends in Parasitology*, 22(1): 6.

Nwosu, A.B.C. (1979). Helminthic infection in school in children in Enugu. *Annal Tropical Medicine Parasites,* 75:197-203.

Nyarango, R.M., Aloo, P.A., Kabiru, E.W. and Nyanchongi, B.O. (2008). The risk of pathogenic intestinal parasite infections in Kisii municipality, Kenya. *Biomedical Public Health*, 8: 237.

OECD, (2005). System for Environemtal Management: Design and Implementation; OECD Publication, 2(7): 42-78.

Oyero, O.G. and Emikpe, B.O, 2007. Preliminary Investigation on the Microbial Contamination of Nigerian Currency. *International Journal of Tropical Medicine*, 2(2): 29-32.

Pozio, E. (2001). New pattern of Trichinella infections. *Veterinary Parasitology*, 98: 133-148.

Ritter, J. (1997). 4 out of 5 dollar bills show traces of cocaine. *Chicago Sun- times* p.4.

Roche, J. and Benito, L., (1999). Prevalence of intestinal parasite infections with special reference to *Entamoeba histolytica* on the island of Bioko (Equatorial Guinea). *Amplified Journal Tropical Medicine Hygiene,* 60(2): 257-262.

Rutala, W. (2006). Bacterial contamination of keyboards: Efficiecny and functional impact of disinfectants. *Journal of Infection control and Epidemiology*, 27 (4): 231 – 249.

Samba, .M.O. (2005). Socio economic and Behavioural factors affecting the prevalence of Intestinal Parasites in school children in Benue State, Nigeria. *Biological and environment Science Journal for the Tropic*, 2(1): 94-100.

Schimunis, G. A. and Lopez, F. J. (1999). *The world wide importance of parasites*. In Microbiology and Microbial Infections Parasitology: ed Cox, FEC; kriev, JF and Wakelin, pp. 19-38.

Shryock, H. and Swarout, H.O.(1980). *Your Health and You*. The Staborough Press limited. pp. 535-547.

Sanni, P.O. (1997). Recovery of helminth ova and protozoa cysts from door handles. Unpublished B.Sc Project, Department of Biological Sciences Ahmadu Bello University, Zaria. pp. 24.

Soto, R.G., Chu, L.F., Goldman, J.M., Rampil, I.J., and Ruskin, K.J. (2006). Communication in critical care environments: Mobile telephones improve patient care. *Anesthetics Analogy*. 102:535–41.

Stephenson, L.S., Lathan, M.C., Kurtz K.M., Kinoti S.N., Bridham H. (1989). Treatment with simple dose of albendazole improves growth of Kenyan School Children with hookworm, *Trichuris trichiura* and *Ascaris lumbricoides*. *Amplified Journal Medicine Hygiene* 41:78-87.

Stephenson, L.S, Latham, M.C, Ottesen, E.A. (2000). Malnutrition and parasitic helminth infections. *Parasitology*; 121:23-38.

Suleiman, M.M., (2005). Diseases prevalent in tropical Africa: Relationship with poverty and ignorance. *Nigeria Biological and Environmental Science Journal for the tropic,* 3(2):68-82.

Suriptiatutis, S. and Widiastuti, S.M. (2011). Intestinal parasites from fingernails of sidewalk food vendors. *Universa Medicina*, 30(2) 120-5.

Tagoe, D. N. A., Baidoo, S.E., Dadzie, I., Ahator D. S. (2010). A study of Bacterial Contamination of Ghanaian Currency Notes in Circulation. *International Journal of Microbiology,* 8(2):1-3.

Tagoe, D.N., Gyande, V.K., Ansah, E.O. (2011). Bacterial Contamination of Mobile Phones: When Your Mobile Phone Could Transmit More Than Just a Call. *Web medicals Central microbiology*, 2(10): 11.

Tanko, D. (1999). Isolation of parasite ova and cysts from sole of shoes. Unpublished Bsc. Project, Department of Biological Sciences Ahmadu Bello University, Zaria. pp. 51.

Taylor, D.J., Green N.P.O. and Stout G.W. (1997*). Biological science* (third edition) Cambridge University Press. India. pp. 495-505.

Thompson, T. (2002) £15m of notes tainted by drugs are destroyed. *The observal publication*, pp. 46.

Uneke, C.J., and Ogbu, O. (2007). Potential for parasite and bacterial transmission by paper currency in Nigeria. *Journal of Environmental Health,* 69: 54-60.

UNICEF, (2009). Nigeria Children Join to Encourage Hand washing with Soap of the ever Global Handwashing media. Media center.

World Health Organization (WHO), (1991). *Basic laboratory methods in medical parasitology,* Geneva: Author.

WHO, (1994). Children in the tropics intestinal parasites. Technical report series no 10, WHO, Paris, Pp 14-20.

World Health Organization, (WHO). (2003). Manual of basic techniques for a health Laboratory (2nd ed.). Geneva: Author.

Yusuf , M. and Hussein, A.M.Z. (1990). Sanitation in rural communities in Bangladesh. *Bulletin of World health organisation*, 68(5): 619-624.

APPENDIX 1

Plate I   Coccidia oocyst

Mg   X 100

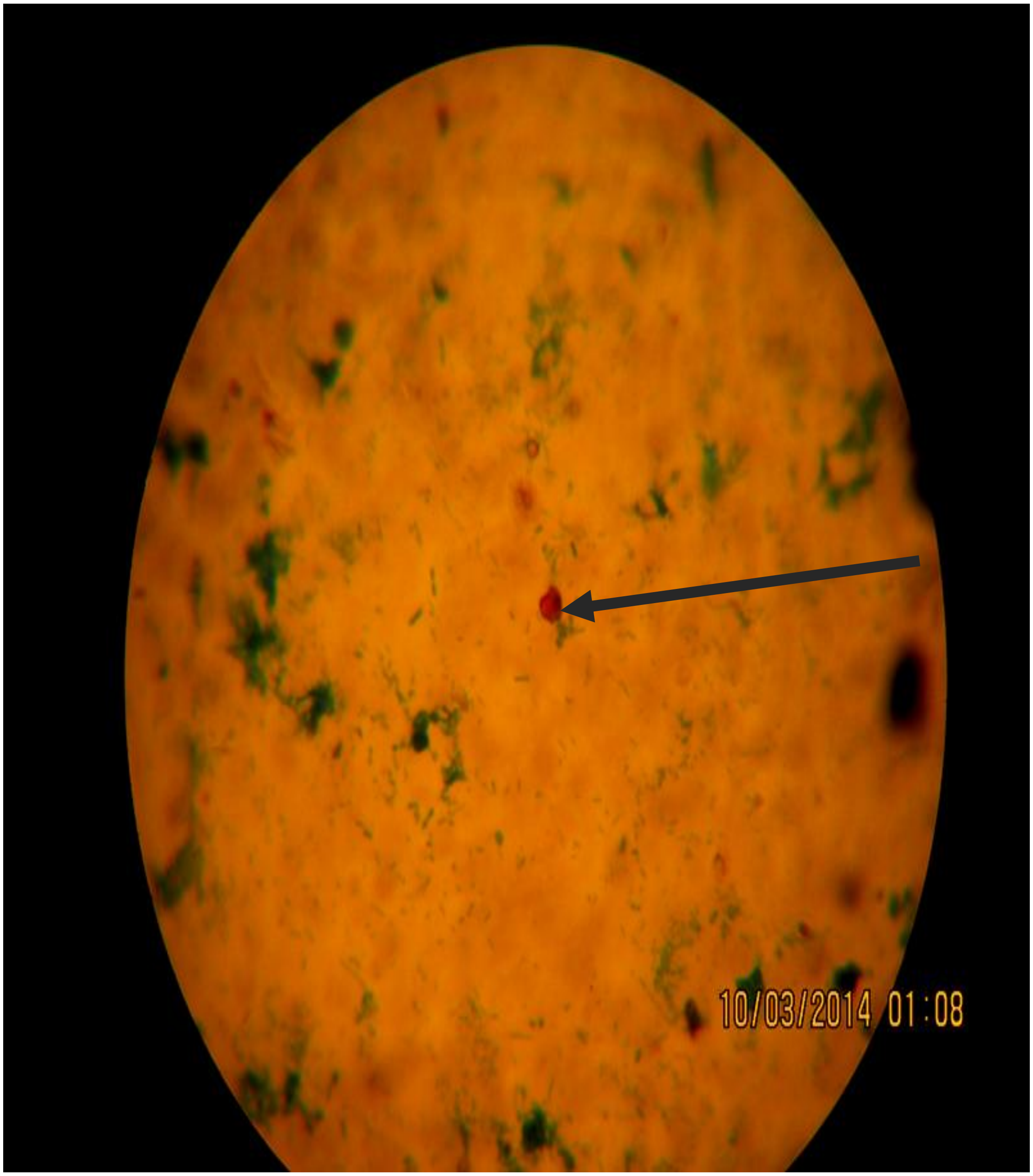

Plate II ***Cryptosporidium parvum*** **oocyst**

Mg X 100

Plate III ***Entamoeba histolytica*** **cyst**

Mg X 100

Plate IV **Taenia ovum**

Mg X 100

Plate V Toxocara ova

Mg X 100

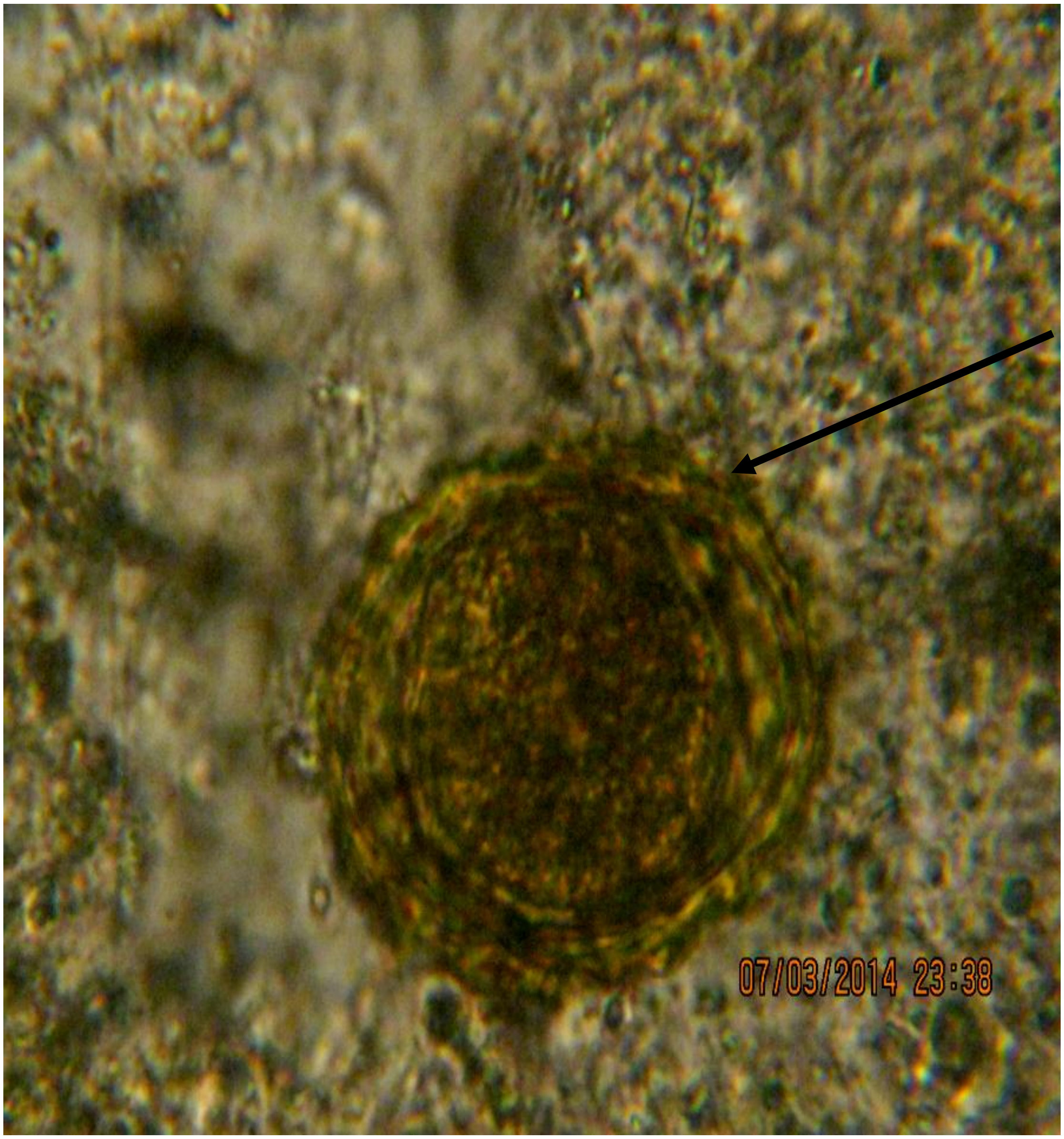

Plate VI Ascaris egg

Mg X 100

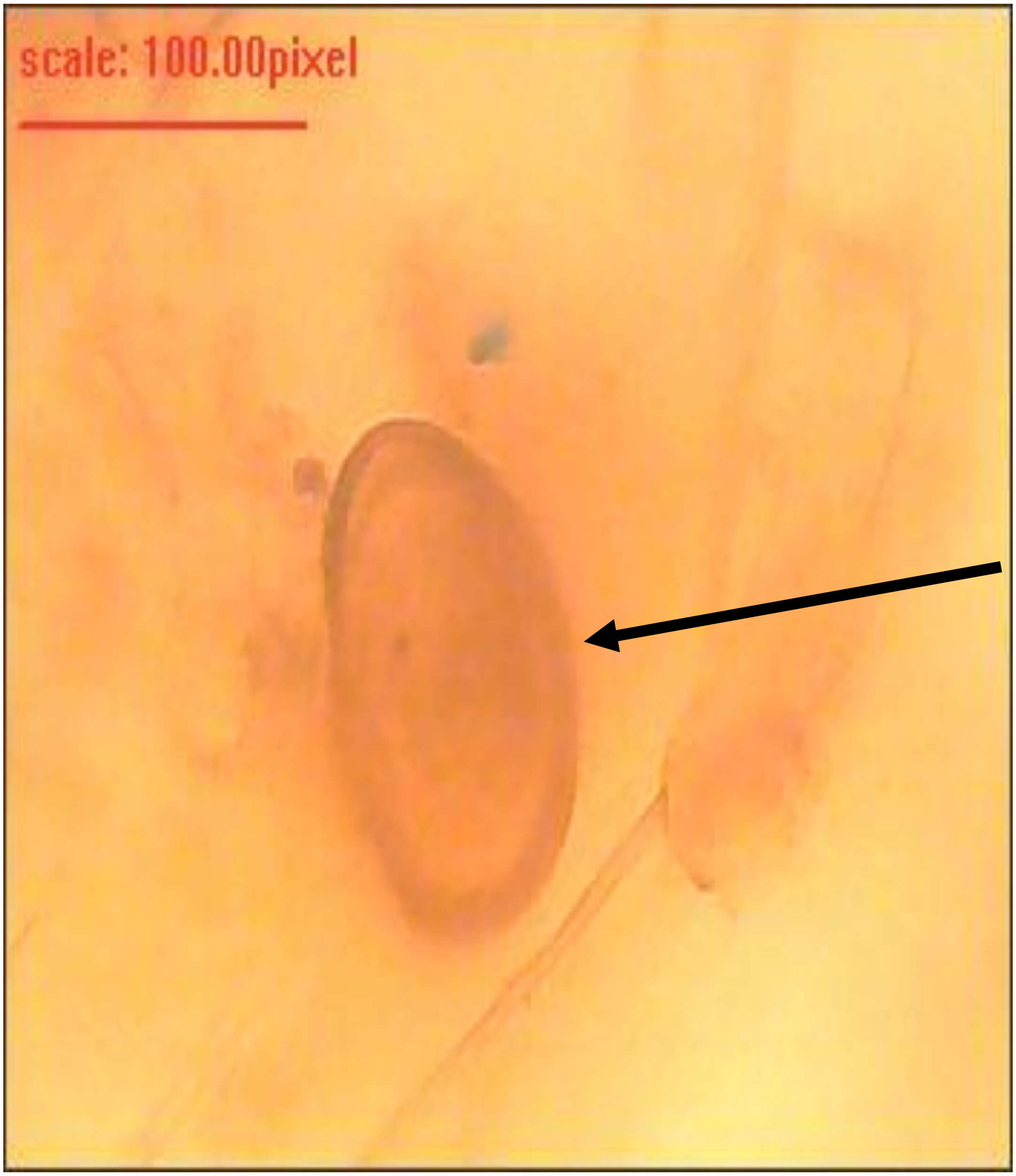

Plate VII ***Enterobius* ova**

Mg X 100

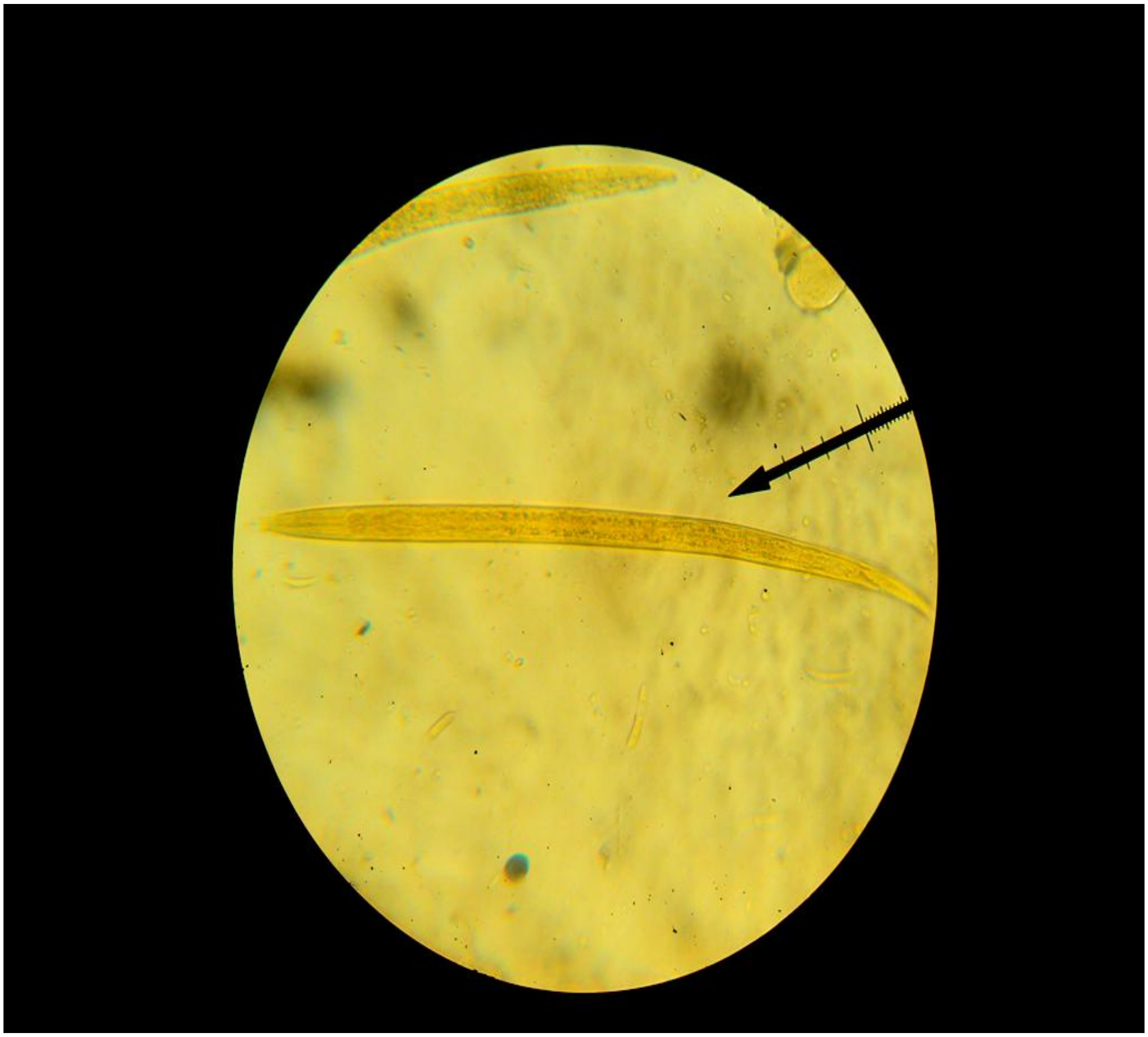

Plate VIII Larvae of *Strongyloides*

Mg X 100

Plate IX **Hookworm egg**

Mg X 100

Plate IX ***Strongyloides*** **egg**

Mg X 100

APPENDIX 2

QUESTIONNAIRE FOR RESEARCH

SECTION A

Dear Respondent,

I am a post graduate student of the department of Biological sciences, Faculty of Science, Ahmadu Bello University Zaria. I am working on the research topic: Isolation and characterization of parasitic Eggs from mobile phones and users in Zaria, Nigeria.

Kindly fill the Questionnaire as honest as you can. All the information you give, will be treated confidentially and used for the purpose of this research work only. Thank you for your cooperation.

Section A (Demographic data)

Sex:

Age:

Level of Education Primary school { }, Secondary school { }, Tertiary Institution { }

Category of trade:

SECTION B (Please indicate your answer by ticking in the bracket)

1. Do you have a mobile phone? Yes {}, No{}
2. Do you share your phone with others? Yes {}, No{}
3. Who do you share your phone with? Friends {}, Family members {}, others {}.
4. Where do you keep your phone when it's not in use? Table {}, Handbag {}, Others {Specify}
5. Do you use your phone when in the market? Yes { }, No { }
6. Do you wash your hand *BEFORE* using your phone? Yes {}, No {}.
7. Do you wear gloves when selling your items? Yes { }, No { }.
8. Do you always wash your hands *BEFORE* eating? Yes { }, No { }.
9. Whether water and soap are always made available. Yes { }, No { }
10. Type of toilet in the market. Pit latrine {}, Water system {}
11. Do you wash your hands after using the toilet Yes { }, No { }
12. Presence of garbage piles around the market. Presence { } Absence {}
13. Presence of human feces in and around the market Absence {}, Presence{}
14. Have you ever cleaned the surface of your phone? Yes {}, No {}.
15. How frequent do you clean your phone? Daily{ },Weekly{} Monthly{ },Seldom{}
16. When cleaning your phone, what do use? A piece of dry material{}, Moist material{}
17. Do you agree that dirt on hands can affect the health? Yes { }, No { }.
18. Are you aware of the campaign on hand washing? Yes { }, No { }