بسم الله الرحمن الرحيم

Sudan University of Science and Technology
College of Graduate Studies

Prevalence rate of intestinal parasites among schools children in Al-kalakla locality- Khartoum state.

معدل إنتشار الطفيليات المعوية وسط اطفال المدارس في منطقة الكلاكلة- ولاية الخرطوم

A dissertation submitted in partial fulfillment for the requirements of the degree of M.Sc. in Medical Laboratory Science (Parasitology and Medical Entomology)

By

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الآيــة

بسم الله الرحمن الرحيم

قال تعالى:

((إِنَّ مَعَ الْعُسْرِ يُسْرًا))

صدق الله العظيم

سورة الإنشراح الآية (6)

DEDICATION

I dedicate this work to.....

The one who covered me with love and support.....
My Mother.

The one who live for making his dreams become true

My Father.

To those who habitually support me and lead me to achieve my dreams

My Aunt.

To those who encourage me and are always around me

My Family and My Friends.

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Abstract

This study was conducted on schools children in Al-kalakla locality in Khartoum state.

In this study, 134 stool samples were collected from students (67 males and 67 females).

The stool samples were processed by wet preparation technique, formal ether concentration technique and saturated sugar floatation technique.

The results revealed that out of the 134 stool samples collected from schools children in Al-kalakla locality in Khartoum state, 48 were found positive for gastrointestinal parasites. This constituted an overall prevalence rate of 35.8%.

The study revealed that the prevalence of gastrointestinal parasites was 38.8% in females while it was 32.8% in males. The results demonstrated that the 6-8, 9-11 and 12-14 years age groups revealed prevalence rates of 26.4%, 36.3% and 53.8% respectively.

The prevalence of different parasites was as follows: *Entamoeba histolytica* (16.4%), *Hymenolepis nana* (10.4%), *Entamoeba coli* (7.5%), *Ascaris lumbricoides* (5.2%), *Schistosoma mansoni* (5.2%), *Giardia lamblia* (3.7%) and *Taenia spp* (1.5%).

The study showed that 28 (20.9%) were infected with single infection and 20 (14.9%) were infected with more than one parasites. The prevalence rates of gastrointestinal parasites by different parasitological techniques were as follows: 35.8% by formal ether concentration technique, 17.9% by wet preparation technique and 16.4% by saturated sugar flotation technique.

Assuming formal ether concentration technique as the gold standard, the sensitivity and specificity of the wet preparation technique were 50% and 100% respectively and the sensitivity and specificity of the saturated sugar flotation technique were 45% and 100% respectively.

مستخلص الدراسة

أجريت هذه الدراسة على أطفال المدارس في منطقة الكلاكلة في ولاية الخرطوم.

في هذه الدراسة تم جمع 134 عينة براز من الطلاب (67 من الذكور و 67 الإناث). تم جهيز عينات البراز عن طريق الإعداد الرطب، وعن طريق التركيز بالإيثرالفورمال والطفو عن طريق محلول السكر المشبع. وكشفت النتائج أنه من أصل 134 عينة براز التي جمعت من أطفال المدارس في منطقة الكلاكلة في ولاية الخرطوم، تم العثور على 48 من الطفيليات المعوية إيجابية. يشكل هذا المعدل الإنتشار العام 35.8%.

وكشفت الدراسات أن الطفيليات المعوية كانت 38.8% في الإناث بينما كانت 32.8% في الذكور.

وضحت النتائج أن معدل الإنتشار في الفئات اللعمرية من 6-8 ، 9-11، 12-14 ، كان 26.4% ، 36.3% ، 53.8% على التوالي.

كان إنتشار الطفيليات المختلفة على النحو التالي:

الإنتمبا هستوليكا (16.4%)، هيمنولبس نانا (10.4%)، الإنتمبيا كولاي (7.5%)، الأسكاريس لمبركويد (5.2%)، البلهارسيا (5.2%)، القربية القولونية (3.7%) و الدودة الشريطية (1.5%).

و أظهرت الدراسة أن 28 (20.9%) أصيبوا بعدوى واحدة و20 (14.9%) أصيبوا بأكثر من طفيل واحد. كان إنتشار الطفيليات المعوية عند إستخدام تقنيات مختلفة على النحو التالي:

35.8% بإستخدام طريقة التركيز بالإيثرالفورمال، 17.9% بإستخدام طريقة الإعداد الرطب و 16.4% بإستخدام الطفو عن طريق محلول السكر المشبع.

على إفتراض تقنية الإيثر فورمال كمعيار قياسي، حساسية ونوعية تقنية الإعداد الرطب 50% و 100% على التوالى وحساسية ونوعية تقنية الطفو عن طريق محلول السكر المشبع 45% و 100% على التوالى.

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1.1 Introduction:

Intestinal parasites are parasites that populate the gastrointestinal tract. The term is not merely a collective term but it can include a group of diverse parasites that vary greatly in many aspects e.g.: biology, pathology and epidemiology (WHO, 1985). Gastrointestinal parasites contribute significantly to global levels of mortality. The world Health Organization (WHO) estimates that over two billions in the world are infected with at least one form of enter opathogen, the majority of whom reside in developing countries and in areas of poor hygiene. School age children are particularly susceptible to parasitosis, often carrying higher burdens of parasites than adults (Cook *et al*., 2009). Parasitic infections, caused by intestinal helminthes and protozoan parasites, are among the most prevalent infections in humans in developing countries. In developed countries, protozoan parasites more commonly cause gastrointestinal infections compared to helminthes (Haque, 2007). Protozoa can be directly infectious for man when they are passed in the feces into the environment, but helminthes require a period of maturation while in the soil, where they become infectious. Others such as *Taenia saginata* require the involvement of an intermediate host during their life cycle. Infections of the GI tract account for a high proportion of deaths in infants where the standards of hygiene and nutrition are low. Fecal-oral transmission of the pathogens is the most common mode of GI infections, whereby water, food and hands become contaminated with fecal material which then come in contact with the mouth (Garcia and Bruckner, 1997).

1.2 Intestinal protozoa:

Protozoan parasites that have only one cell can multiply inside the human body. The most common intestinal protozoan parasites are: *Giardia intestinalis, Entamoeba histolytica, Cyclospora cayetanenensis*, and *Cryptosporidium spp*.

The diseases caused by these intestinal protozoan parasites are known as giardiasis, amoebiasis, cyclosporiasis, and cryptosporidiosis respectively, and they are associated with diarrhea (Haque, 2007).

G.lamblia is the most prevalent parasitic cause of diarrhea in the world, and this infection is also very common in developing countries. Amoebiasis is the third leading cause of death from parasitic diseases worldwide, with its greatest impact on the people of developing countries. The World Health Organization (WHO) estimates that approximately 50 million people worldwide suffer from invasive amoebic infection each year, resulting in 40-100 thousand deaths annually (WHO, 1997). Cryptosporidiosis is becoming most prevalent in both developed and developing countries among patients with AIDS and among children aged less than five years. Several outbreaks of diarrhoeal disease caused by *C.cayetanensis* have been reported during the last decade (Herwaldt, 2000).

1.2.1 *Entamoeba histolytica:*

Entamoeba histolytica is an aerobic parasitic protozoan belonging to the genus *Entamoeba* and an etiology agent of amoebasis. *Entamoeba histolytica* infection is one of the most common parasitic infections worldwide, infecting about 50 million people, often in developing countries, resulting in 40,000 to 100,000 death per year. It has long been known that although about 500 million people each year have amoebiasis, only about 10% experience symptomatic disease (WHO, 1997). *E.histolytica* may be observed in the faeces as multiplying trophozoite stage and infective cyst stage (Neva and Brown, 1994). In the majority of cases, infection results from the ingestion of fecally-contaminated water or food that contains *E.histolytica* cysts. Much less often the cyst or the trophozoite forms can be transmitted as a result of oral or oral/anal sexual practices (Abhay *et al*., 2009). *E.histolytica* is pathogenic in the caecum and colon of human being. The term' histolytica literally means "tissue dissolving" referring to the carnivorous habit of the organism. *E.histolytica* is the most unique among the Amoebas because of its ability to hydrolyze host tissue. It can

become a highly virulent and invasive organism causing diarrhea. Acute infection of amoebiasis may be presented with other infection apart from bloody diarrhea such as ulceration of the colonic mucosa, abdominal pain and a palpable mass in corresponding areas of the abdomen. Amoebiasis may give rise to amoebic liver abscess and intestinal pathologies (Aribodor *et al*., 2012).

1.2.2 *Giardia lamblia:*

G.lambila is an aerotolerant anaerobe, etiological agent of giardiasis. *Giardia lambila*, also known as *G.duodenalis* and *G.intestinalis*. *Giardia* was first observed by Anton Van Leuwenhoek in 1681 in a sample of his own diarrheal stool, and later described in greater detail by Vilem Lamble, *Giardia* was initially thought to be commensal and has only been recognized as a pathogen since the mid-1900s (Abhay *et al*., 2009).

G.lamblia is the most commonly isolated intestinal parasite throughout the world. Prevalence rates of 20-40% are reported in developing countries, especially in children (Fraser, 1994). *Giardia lamblia* has a simple life cycle consisting of two stages: trophozoite and cyst, cysts are the transmission stage and are excreted in the feces of infected individuals into the environment where they can survive for weeks (Abhay *et al*., 2009).

Ingestion of water contaminated with *G.intestinalis* is considered to be the major cause of parasitic diarrheal outbreaks in the United States. In addition to contaminated water, *G.intestinalis* may be transmitted by eating contaminated fruits or vegetables. Person-to-person contact through oral-anal sexual practices or via the fecal-oral route may also transfer *G.intestinalis* (Zeibig, 2013). The salient features of *Giardia* cysts that influence disease transmission include their stability in the environment, their immediate infectivity upon leaving the host and the small number of cysts required to cause infection (Abhay *et al*., 2009).

G.lamblia inhabits the duodenum and upper jejunum, where the alkaline pH is favorable. The trophozoites can attach firmly to the intestinal epithelial with their sucking disks, but they may be also found free in the small bowel lumen. *Giardia*

may rarely enter the bile ducts and gall bladder and possibly the pancreas, but invasion of other organs does not occur (Goldsmith and Heyneman, 1989).

Giardia infection may be asymptomatic or it may cause disease ranging from self-limiting diarrhea to a severe chronic syndrome (Meyer, 1990). The length of the incubation period, usually 1 to 3 weeks, depends at least partly on the number of cysts ingested. Normal human hosts with giardiasis may have any or all of the following signs and symptoms: loose, foul smelling stools, steatorrhea (fatty diarrhea), malaise, abdominal cramps, excessive flatulence, fatigue and weight loss or a coeliac disease like syndrome (Washington *et al*., 2006). Although most cases are seen in hosts with some concurrent condition, such as an immune deficiency, protein calorie malnutrition, or bacterial overgrowth of the small intestine, some cases of severe giardiasis occur in apparently normal hosts. Different strains of *G.lamblia* possibly vary in virulence (Smith and Wolfe, 1980).

A small percentage of symptomatic individuals will have chronic infection, lasting months or longer, chronic giardiasis is frequently accompanied by weight loos, which can be significant, and malabsorption of fats, vitamins A and B12, disaccharides, especially lactose, and protein are observed, with malabsorption of fats and lactose being most common (Abhay *et al*., 2009).

1.2.3 The coccidian:

Coccidian parasites are particularly important in the compromised patient and can cause life-threatening disease. These organisms can disseminate from the intestinal tract to other body sites. They may also infect many individuals who have relatively few symptoms. In the immunocompetent patient, symptoms may be minimal or absent; however, in the compromised patient sequelae may be very serious and even life threatening (Garacia, 2009). The important intestinal coccidia include *Cryptosporidium parvum* and *Isospora belli*. They are obligate tissue parasites with sexual and asexual stages in their life cycle (Washington *et al*., 2006).

1.2.3.1 *Cryptosporidium parvum*:

Members of the genus *Cryptosporidium* (Apicomplexa, Cryptosporidiidae) are small coccidian protozoan parasites that infect the microvillus region of epithelial cells in the digestive and respiratory tracts of vertebrates (Palmer, 1990). *Cryptosporidium* has worldwide distribution. Of the 20 species known to exist, only *C. parvum* is known to infect humans. Infection appears to primarily occur by water or food contaminated with infected feces, as well as by person to person transmission. Immunocompromised persons, such as those infected with the AIDS virus, are at risk of contracting this parasite. Other populations potentially at risk include immunocompetent children in tropical areas, children in day care centers, animal handlers, and those who travel abroad (Zeibig, 2013). Symptoms of cryptosporidiosis usually appear within 2 to 10 days, or an average of about a week before symptoms occur, after ingestion of the parasite. Signs and symptoms include watery diarrhea, headache, abdominal cramps, nausea, vomiting, and fever. The respiratory tract may become involved, as well as the gastrointestinal tract. These symptoms sometimes lead to weight loss and dehydration. In healthy individuals, symptoms such as diarrhea are self-limiting and last from one to two weeks, at which time the immune system eliminates the infection. However, in the immunocompromised persons and infants, the infection may continue, progressing to a life-threatening condition (Ridley, 2012).

1.2.4 Life cycle of intestinal protozoa:

Among the protozoa, the process of reproduction may be relatively simple. It is accomplished by repeated sexual and asexual multiplication by binary fission. The parasite passes through a series of developmental stages before the parasite reaches the mature forms. When the organism reproduces, a new cycle of development stages, with at least one stage occurring in a host organism (Cheesbrouth, 1987).

1.2.5 Diagnosis of intestinal protozoa:

Intestinal protozoa are diagnosed by identifying cyst or trophozoites in fecal specimens or histologically by visualizing cysts in biopsy specimens or secretion of intestinal mucosa (Sheehan *et al*., 1979). The conventional direct wet mount preparation for microscopy to identify motile trophozoite and a formalin ethyl acetate concentration step to identify cysts (Qvarnstrom *et al*., 2005). And when appropriately conducted with or without iodine stain, the conventional wet mount establishes the diagnosis of *Giardia lamblia* in up to 70-85% of cases after two stool examinations (Sodeman and William, 1990). The sensitivity of the acid fast stain for oocysts of *Cryptosporidium* in the direct examination of stools is approximately 30% after one sample examination (Sodeman and William, 1990). Serological diagnostic methods have been developed such as the immunofluorescence (IF), enzyme linked immunosorbent assay (ELISA), culture and subsequent differentiation by isoenzyme analysis and the polymerase chain reaction (PCR) (Nunez *et al*., 2001).

1.3 Intestinal helminthes:

Helminthes are worms with many cells. Nematodes (roundworms), cestodes (tapeworms), and trematodes (flatworms) are among the most common helminthes that inhabit the human gut. Usually, helminthes cannot multiply in the human body. There are four species of intestinal helminthic parasites, also known as geohelminths and soil-transmitted helminthes: *Ascaris lumbricoides* (roundworm), *Trichiuris trichiuria* (whipworm), *Ancylostoma duodenale*, and *Necator americanicus* (hookworms). These infections are most prevalent in tropical and subtropical regions of the developing world where adequate water and sanitation facilities are lacking. Recent estimates suggest that *A.lumbricoides* can infect over a billion, *T.trichiura* 795 million, and hookworms 740 million people. Other species of intestinal helminthes are not widely prevalent (Haque, 2007). Intestinal helminthes rarely cause death. Instead, the burden of disease is related to less mortality than to the chronic and insidious effects on health and

nutritional status of the host (Stephenson *et al*., 2000). In addition to their health effects, intestinal helminthes infections also impair physical and mental growth of children, thwart educational achievement, and hinder economic development (Drake *et al*., 2000).

1.3.1 Cestodes (tapeworm):

Multicellular worms noted for their flat or ribbon-like appearance (Zeibig, 2013).

1.3.1.1 *Taenia* species:

Taenia spp are long, segmented, parasitic tapeworms (family: Taeniidae, subclass: Cestoda). These parasites have an indirect life cycle, cycling between a definitive and an intermediate host (Beaver *et al*., 1984). *Taenia* infections are estimated to affect 100 million people worldwide, with major endemic areas located primarily in the developing countries of South America, Africa, India, China and Southeast Asia. *Taenia* infections are less common in North America; however, neurocysticercosis has been recognized as an important health problem in California. Although this disease is mainly seen in migrant workers from Latin American, it has also been reported in US residents who have not traveled to endemic countries (Abhay *et al*., 2009). Human infection with either *T.saginata* or *T.solium* results from eating uncooked or poorly cooked beef or pork, in the order presented. The *Cysticercus* larvae of the parasite are contained in the meat. Cows and pigs as intermediate hosts eat contaminated food containing eggs, and become infected when the oncosphere hatches from the egg and develops into a Cysticercus larva in the tissues of the animal (Ridley, 2012). Most cases of taeniasis result in the individuals being asymptomatic. If any symptoms occur, they usually include mild diarrhea, abdominal discomfort, indigestion, and mild fever may ensue. If the cysticerci migrate to the brain, however, headaches and seizures may result, and will possibly lead to a life threatening medical condition (Ridley, 2012).

1.3.1.2 *Hymenolepis nana*:

Hymenolepis nana (dwarf tapeworm) is a common human parasite and the smallest tapeworm known to infect humans. *H.nana* does not require an intermediate host to complete its life cycle (Zeibig, 2013). Worldwide, especially in the tropics and subtropics; since about 80 million humans are infested (mainly children), *H.nana* can be considered as the most common tapeworm in humans (Mehlhorn, 2016). Infection in man takes place by ingestion of eggs through contaminated food or drinks. Autoinfection (the onchosphere hatched while the eggs being inside the intestine penetrate the villi and develop into cysticercoids larva that later develop into adult worm) also occurs (Rai *et al*., 1996). Mild gastrointestinal distress may be encountered but the infected individuals are primarily asymptomatic. Mild diarrhea, weight loss, and abdominal cramps and mild pain may be experienced by some. *H.nana* infections can grow worse over time because, unlike in most tapeworms, eggs of this species can hatch and develop without ever leaving the definitive host (Ridley, 2012).

1.3.2 Intestinal nematodes:

The nematodes are unsegmented pseudocoelomate worms (Muller, 2002). Species parasitic in humans (63 species in total here) vary in size from threadlike objects just visible to the naked eye (*Strongyloides, Trichinella*), to elongate string like worms attaining a length of 50 cm (*Dracunculus*) (Muller, 2002).

1.3.2.1 *Ascaris lumbricoides*:

Round worm (*Ascaris lumbricoides*) is the largest of the human intestinal parasites. It lives and matures in the ileum and sometimes jejunum of the small intestine. Worldwide, at least 1.5 billion humans are infected (Mehlhorn, 2016). Roundworm is often regarded as a parasite of children, but people of all ages may be infected (Obeng, 1997). Humans are infected when they ingest embryonated eggs from contaminated soil where feces have been deposited (Ridley, 2012). The greatest prevalence of disease is in tropical regions, where environmental conditions support year round transmission of infection. In dry climates,

transmission is seasonal and occurs most frequently during the rainy months (Abhay *et al.*, 2009). Although infection occurs in all age groups, it is most common in preschoolers and young children. Sub-optimal sanitation is an important factor, leading to increased soil and water contamination (Abhay *et al*., 2009). Adult ascarids normally cause few or no symptoms, but heavy infections may result in nutritional deficiencies, especially in children. In some patients, considerable flatulence (emission of intestinal gas) may be experienced with an infection by *A.lumbricoides*. Migration into the lungs may lead to hemorrhages and inflammatory infiltrations upon which hemoptysis (coughing up of blood) may be observed. The intestinal phase includes abdominal discomfort and bloating along with nausea, vomiting, pains, and diarrhea may occur (Ridley, 2012).

1.3.2.2 Hook worms:

Human hookworm infection is a soil-transmitted helminthes infection caused primarily by the nematode parasites *Necator americanus* and *Ancylostoma duodenale*. It is one of the most important parasitic infections worldwide, ranking second only to malaria in terms of its impact on child and maternal health. An estimated 576 million people are chronically infected with hookworm and another 3.2 billion are at risk, with the largest number of afflicted individuals living in impoverished rural areas of sub-Saharan Africa, Southeast Asia and tropical regions of the Americas. *N.americanus* is the most widespread hookworm globally, whereas *A.duodenale* is more geographically restricted in distribution (Abhay *et al.*, 2009). Infection by hookworm of the host is by the larvae and not the eggs from the adult organism. Although *A.duodenale* can be ingested and cause infection, the most common method of infection is through skin penetration of the larvae. Walking barefoot through contaminated water and soil containing fecal matter almost always results in contraction of the hookworm larvae. The symptoms can be linked to inflammation of the gastrointestinal system that is stimulated by feeding hookworms. Inflammation is accompanied

by nausea, abdominal pain, and intermittent diarrhea early in the course of the disease and a common consequence of hookworm infections is that of progressive anemia that often occurs in prolonged infections. Patients with more severe infections may encounter the above symptoms as well as vomiting related to the nausea along with general fatigue (Ridley, 2012).

1.3.2.3 *Strongyloides stercoralis*:

Strongyloides stercoralis is an intestinal nematode commonly found in warm areas, although it is known to survive in the sub-tropics (hot and humid conditions). The geographic range of *Strongyloides* infections tend to overlap with that of hookworm due to the eggs requiring the same environmental conditions to induce embryonation. This parasite is interesting in that it contains a free-living stage (exogenous) and a parasitic stage (endogenous) where the larvae undergo development in both stages. Strongyloidiasis is transmitted from one host to another host when the skin is penetrated by the infective filariform larvae living in contaminated soil (Ridley, 2012). The most common symptoms experienced by patients suffering from threadworm infection include diarrhea and abdominal pain. These patients may also exhibit urticaria accompanied by eosinophilia. Additional intestinal symptoms may occur, such as vomiting, constipation, weight loss, and variable anemia. Furthermore, patients with heavy infections may develop malabsorption syndrome. The site of larvae penetration may become itchy and red. Recurring allergic reactions may also occur. When the larvae migrate into the lungs, patients may develop pulmonary symptoms. Immunocompromised persons often suffer from severe autoinfections that may result in the spread of the larvae throughout the body, increased secondary bacterial infections, and possibly death (Zeibig, 2013).

1.3.2.4 *Trichuris trichiura:*

Trichuris trichiura is an intestinal nematode in the family Trichuridae, also known as whipworm due to its characteristic shape; *Trichuris* can be classified as a soil transmitted helminthes because its life cycle mandates embryonic

development of its eggs in the soil. It is the second most common nematode found in humans, behind *Ascaris* (Abhay *et al.*, 2009). Both larval and adult whipworms are normally found only in the intestines. They do not undergo tissue migration (Beaver *et al.*, 1984). Recent estimates of infection rates are: 25% in South and Central America, 31% in Africa (with 76% in Nigeria and 70% in Cameroon), 12% in the Middle East, 12% in Southern India, 36% in Bangladesh, 58% in South-East Asia except China and 0.01% in Japan (Muller, 2002). Ingestion of embryonated eggs from both contaminated water and food is the most common route leading to a whipworm infection. But direct infection from the soil contaminated with feces and close contact during activities such as gardening and farming also provides for a major portion of the cases of trichiuris. In addition to placing dirty fingers into the mouth, another common way of becoming infected is the ingestion of *T.trichiura* eggs due to poor preparation of foods (e.g., eating unwashed vegetables from soil that is contaminated). As in the case with hookworm infections, severely heavy numbers of whipworms in humans can cause stomach pain with loss of appetite and iron deficiency, bloody diarrhea, weight loss, rectal prolapse (detached rectum), and fecal incontinence (Ridley, 2012).

1.3.2.5 *Enterobius vermicularis*:

Enterobius vermicularis is called a pinworm due to its long pointed tail that resembles a straight pin in the adult worm (Ridley, 2012). *E.vermicularis* is found worldwide, particularly in temperate areas. Pinworm is considered by many to be the most common helminth known to cause infection in the United States (Zeibig, 2013). The infection is spread via the fecal-oral route by ingestion or inhalation of embryonated ova. The disease may also be transmitted by fomites (inanimate objects that are contaminated by organisms) and from soiled fingers, dirty bed linens, toilet seats, and clothing. The disease is found throughout the world and spreads quickly through families and groups in close contact with each other, such as in day care centers for young children (Ridley,

2012). Most common symptoms experienced by individuals infected with pinworm include intense itching and inflammation of the anal and/or vaginal areas. These symptoms may be accompanied by intestinal irritation, mild nausea or vomiting, the irritability, and difficulty sleeping. Additional symptoms known to occur with much less frequency consist of minute ulcers as well as mild intestinal inflammation and abdominal pain (Zeibig, 2013).

1.3.3 Intestinal trematodes:

The trematodes (or flukes) are leaf shaped.

1.3.3.1 *Schistosoma mansoni*:

Internationally, *Schistosoma mansoni* is the most prevalent of the schistosome species that affect the intestines and liver. An estimated 62 million persons are infected worldwide. *S.mansoni* is known to occur in 52 countries, including sub-Saharan Africa (where around 85% of the global burden is concentrated), North African and Eastern Mediterranean countries and South American countries as well as several Caribbean countries (Abhay *et al.*, 2009). Humans enter the water where snails have become infected by the miracidia of one species of *Schistosoma*. The miracidia, which develop into cercariae, are released from the snail and penetrate the skin of the human host (Ridley, 2012). Repercussions of schistosomiasis infections include the initial inflammatory reaction at the site where the metacercariae penetrate the skin and is commonly called swimmer's itch. Abdominal pain and weight loss are common and bloody diarrhea may occur along with eosinophilia and hepatosplenomegaly (enlargement of the liver and spleen) (Ridley, 2012).

1.3.4 Life cycle of intestinal helminthes:

There are three morphologic forms that exist in the typical cestode life cycle-egg, one or more larval stages, and adult worm. In the intestinal tapeworm life cycle, human ingestion of an egg or larval stage results in an adult worm eventually emerging in the intestine. An intermediate host is required for the development of the larval form in certain life cycles. There are several other life cycle notes of

importance. Because tapeworms are hermaphroditic, human ingestion of a single egg will usually initiate a new life cycle. Autoreinfection is known to occur in the life cycle of *Hymenolepis nana*. Most cestodes require at least one intermediate host for their life cycles to continue. Development of a cyst in tissue occurs in the intestinal extraintestinal cestode species *Echinococcus granulosus* (Zeibig, 2013). The life cycle of the nematodes may be direct or indirect. In both cycles, the larvae hatching from the eggs progress through a series of stages in their development. Beginning with first stages, each one is separated by a molting of the cuticle. There are five larval stages, followed by the adult. The third larval stage is the infective to the final host. There are 5 larval stages and 4 moltings as follows: Egg → (L1+ M1) → (L2+ M2) → (L3+M3) → (L4+M4) → (L5+M5) →Adult (Schmidt, 1992).

1.3.5 Diagnosis of intestinal helminthes:

Although clinical signs may evoke the suspicion of helminthiasis, diagnosis is still dependent upon the isolation and identification of helminthes from the feces. Adult worms or their segments can also be demonstrated macroscopically when the adult worm is spontaneously passed in stool or vomitus; administration of an antihelminthic drug may result in expulsion of the worm. The definitive methods usually involve microscopic detection of helminth eggs from fecal preparations via smears or after concentration. Microscopy, however, requires trained experts, has low sensitivity for detection of light and moderate infections, and may result in misdiagnosis leading to delayed or inadequate treatment (Verweij *et al.*, 2007). Numerous flotation and concentration methods are available, such as the Kato-Katz, formol ethyl acetate sedimentation and zinc sulphate flotation technique techniques (Martin and Beaver, 1968). Harada-Mori filter paper strip technique or charcoal culture method is the method of choice to distinguish the larvae of *A.duodanale* and *N.americanus* on epidemiological ground (Cooper, 1999).

1.4 Treatment:

There are several options for treating parasitic infections. There are a variety of antiparasitic medications available. Many of these drugs are toxic to the host and care should be exercised when selecting the proper course of treatment. Therapies such as a change in diet, vitamin supplements, fluid replacement, blood transfusion, and bed rest may be indicated solely or in addition to chemotherapy. Treatment for nonpathogenic parasitic infections is usually not indicated (Zeibige, 2013).

1.5 Prevention and control:

Prevention and control measures may be taken against every parasite infective to humans. Preventive measures designed to break the transmission cycle are crucial for successful parasite eradication. Include the following: education programs, use of insecticides and other chemicals, protective clothing, protective netting, proper water treatment, good personal hygiene, proper sanitation practices, proper handling and preparation of food, and avoidance of unprotected sexual relations. The vast capital expenditures required to accomplish these measures are not available in many endemic countries in the world. The problem of eradicating parasites is an ongoing process and is a key goal of international health groups such as the World Health Organization (WHO) and Doctors Without Borders (Médecins Sans Frontières [MSF]) (Zeibige, 2013).

Rationale

School age children are particularly susceptible to parasitosis often carrying higher burden of parasites than adult. In Sudan, school age children are continuously screened for parasitic infection so the aim of this study is to determine the prevalence of gastrointestinal parasites among school age children in order to increase good hygiene and decrease morbidity and mortality.

Objectives

General objective:

To determine the prevalence rate of intestinal parasites among schools children in Al-kalakla locality, Khartoum state.

Specific objectives:

- To determine the prevalence of gastrointestinal parasites among school children according to gender and age groups.
- To identify the frequency of each parasite detected.
- To compare between different parasitological techniques used in the diagnosis of gastrointestinal parasites.

Chapter two

Materials and methods

Chapter two

Materials and methods

2.1 Study design:

It is a cross sectional study.

2.2 The study area:

The study was performed in different schools in Al-kalakla locality in Khartoum state.

2.3 Study population:

The study was carried out on134 students randomly selected. The students were categorized according to gender and age groups (6-8, 9-11, 12-14) years old.

2.4 Study duration:

The study started in December and ended in May, 2017.

2.5 Sample size:

134 Stool samples were collected from students under study.

2.6 Sampling collection:

Each selected student was provided with a labeled container which was transparent, clean and with wide mouth for faecal sample collection.

2.7 Data collection:

A questionnaire was designed to collect data on gender and age (appendix).

2.8 Methodology:

Intestinal parasites were detected in stool samples using:

2.8.1 Direct smear examination:

Wet preparation was made by mixing small portion of stool taken with an applicator wooden stick with a drop of normal saline on slide and covered with cover slip and examined systematically under microscope using 10X and the high magnification 40X for observation of more details.

2.8.2 Formal ether concentration technique:

Approximately, one gram of feces was collected from different parts of the specimen and emulsified in 5 ml of formal saline in glass beaker. Further 5 ml from same solution was added and mixed. The resulting suspension was strained through the sieve. The filtered sample was poured back into a centrifuge tube and then equal volume of ether was added. The tube was mixed for one minute and then centrifuged for 5 minutes at 2000 rpm. All upper 3 layers were discarded and the sediment was transferred into slide which was covered with cover slip and examined under microscope using 10X and 40X magnifications.

2.8.3 Saturated sugar flotation technique:

Sheather's sugar solution was placed in cup. One gram of stool was added to the solution. The fecal sample was mixed with the flotation solution. The fecal debris was screened into another cup; the excess fluid was squeezed out. The filtered preparation was poured into a tube. Fecal flotation solution was added to the top of the tube. Cover slip was placed on the top of the tube. The tube was left undisturbed for 15 minutes and carefully the cover glass was placed on a slide and examined microscopically (www.loudoun.nvcc.edu).

2.9 Data analysis:

The data was analyzed using statistical package for social science (SPSS) computer program version 16. Then data were presented in tables.

2.10 Ethical consideration:

Approval was taken from the school's managers and students.

Chapter three

Results

Chapter three

Results

The results showed that out of the 134 stool samples collected from schools children in Al-kalakla, Khartoum state, 48 were found positive for gastrointestinal parasites. This constituted an overall prevalence rate of 35.8% (table 3.1).

The study revealed that the prevalence of gastrointestinal parasites was 38.8% in females while it was 32.8% in males. The difference in rates between gender was found to be statistically insignificant at p = 0.471 (table 3.2).

The results demonstrated that the 6-8, 9-11 and 12-14 years age groups revealed prevalence rates of 26.4%, 36.3% and 53.8% respectively. These differences in rates were statistically insignificant at p = 0.057 (table 3.3).

The prevalence of different parasites was found as follows: *Entamoeba histolytica (*16.4%), *Hymenolepi snana (*10.4%), *Entamoeba coli* (7.5%), *Ascaris lumbricoides* (5.2%), *Schistosoma mansoni* (5.2%), *Giardia lamblia* (3.7%) and *Taenia spp* (1.5%) (table 3.4).

The study showed that 28 (20.9%) were infected with single infection and 20 (14.9%) were infected with more than one parasites (table 3.5).

The prevalence of gastrointestinal parasites by different parasitological techniques was as follows: 35.8% by formal ether concentration technique, 17.9% by wet preparation technique and 16.4% by saturated sugar flotation technique. The difference between techniques was found to be statistically significant at p = 0.000 (table 3.6).

Assuming formal ether concentration technique as the gold standard, the sensitivity and specificity of the wet preparation technique were 50% and 100% respectively (table 3.7) and the sensitivity and specificity of the saturated sugar flotation technique were 45% and 100% respectively (table 3.8).

Table 3.1: The overall prevalence rate of gastrointestinal parasites among schools children in Al-kalakla, Khartoum state

Number examined	Number positive	Prevalence (%)
134	48	35.8%

Table 3. 2: The prevalence rate of gastrointestinal parasites among schools children in Al-kalakla, Khartoum state according to gender

Gender	Number examined	Number positive	Prevalence (%)
Males	67	22	32.8%
Females	67	26	38.8%
Total	134	48	35.8%

p = 0.471

Table 3.3: The prevalence rate of gastrointestinal parasites among schools children in Al-kalakla, Khartoum state according to age groups

Age group (years)	Number examined	Number positive	Prevalence (%)
6-8	53	14	26.4%
9-11	55	20	36.3%
12-14	26	14	53.8%

p = 0.057

Table 3.4: The prevalence rate of detected gastrointestinal parasites among schools children in Al-kalakla, Khartoum state

Parasite	Number examined	Number positive	Prevalence (%)
E.histolytica	134	22	16.4%
H. nana	134	14	10.4%
E.coli	134	10	7.5%
A.lumbricoides	134	7	5.2%
S.mansonia	134	7	5.2%
G.lamblia	134	5	3.7%
Taenia spp.	134	2	1.5%

Table 3. 5: The prevalence of mixed and single infection with gastrointestinal parasites

Type of infection	Number examined	Number positive	Prevalence (%)
Single	134	28	20.9%
Mixed	134	20	14.9%

Table 3.6: The prevalence rate of intestinal parasites among schools children in Al-kalakla, Khartoum state according to the techniques used

Parasitological technique	Number examined	Number positive	Prevalence
Wet preparation technique	134	24	17.9%
Formal ether concentration technique	134	48	35.8%
Saturated sugar flotation	134	22	16.4%

P = 0.000

Table 3.7: Sensitivity and specificity rates of wet preparation technique

		Formol ether concentration technique		
		+ve	-ve	Total
Wet preparation technique	+ve	24	0	24
	-ve	24	86	110
	Total	48	86	134

Sensitivity = 50% and specificity = 100%

Table 3.8: Sensitivity and specificity rates of saturated sugar floatation technique

		Formol ether concentration technique		
		+ve	-ve	Total
Saturated sugar floatation technique	+ve	22	0	22
	-ve	26	86	112
	Total	48	86	134

Sensitivity = 45% and specificity = 100%

Chapter four

Discussion

Chapter four

Discussion

From the results, it was obvious that the overall prevalence of gastrointestinal parasites among schools children in Al-kalakla locality was high (35.8%). This rate was found to be higher than the rate reported by Muhajir *et al*. (2017) in Al-kalakal (30%). However, our rate was found to be lower than the rate reported by Gabbad and Elawad (2014) in Elengaz (64.4%).

The study revealed that females had a slightly higher prevalence rate of gastrointestinal parasites (38.8%) than males (32.8%). This finding was not in agreement with Muhajir *et al*. (2017) in Al-kalakla, who found higher rates of infection in males (16.5%) compared with females (13.5%).

In this study, the highest prevalence rate (53.8%) was reported among the 12-14 years age group. This rate was not in agreement with Magambo *et al*. (1998) who reported that the age group 6-10 years was the most affected.

The finding of this study indicated that the common gastrointestinal parasites in schools children were *Entamoeba histolytica* (16.4%), *Hymenolepis nana* (10.4%), *Entamoeba coli* (7.5%), *Ascaris lumbricoides* (5.2%), *Schistosoma mansoni* (5.2%), *Giardia lamblia* (3.7%) and *Taenia spp* (1.5%), while Muhajir *et al*. (2017) in Al-kalakla reported that the most prevalent gastrointestinal parasites were *Entamoeba histolytica* (15.5%), *Giardia lamblia* (12.5%), *Hymenolepis nana* (1.5%) and *Schistosoma mansoni* (0.5%). Gabbad and Elawad (2014) in Elengaz found that the prevalent gastrointestinal parasites were *Giardia lamblia* (33.4%), *Hymenolepis nana* (26.4%), *Taenia saginata* (8.6%), *Enterobius vermicularis* (6.2%), *Schistosoma mansoni* (4.4%) and *Entamoeba histolytica* (3.6%).

As far as the detection rates for the 3 techniques used, it was obvious that the highest detection rate (35.8%) was reported for the formal ether concentration

technique and the lowest rate (16.4%) was reported for saturated sugar floatation technique, while the wet preparation technique showed a rates of 17.9%.

Our result for the formal ether technique did not agree with Eisa (2005) in Keryab Village who reported 90% detection rate. However, the detection rate reported in our study was lower than the detection rate reported by Eman (2005) (44%).

The study revealed that the detection rate for the wet preparation (17.9%) was lower than the detection rate reported by Eman (2005) (41.4%).

The detection rate for the saturated sugar floatation technique (16.4%) was lower than the detection rate obtained by Duria (2005) (58.6%).

Out results, surprisingly demonstrated a sensitivity of 50% and high specificity (100%) of the wet preparation technique and a 45% sensitivity and high specificity (100%) of saturated sugar floatation technique. This might probably be attributed to heavy infections with the intestinal parasites among subjects examined in this study.

Chapter five

Conclusion and Recommendation

Chapter five

Conclusion and Recommendations

5.1 Conclusion:

From the results, one can conclude the following: Gastrointestinal parasites are highly prevalent among schools children in Al-kalakla locality in Khartoum state. The prevalence rate was slightly higher among females. The highest infection rate was reported in the 12-14 years age groups. Formal ether concentration technique proved to have high sensitivity rate of detection of different gastrointestinal parasites.

5.2 Recommendations:

Based on this work, it is recommended that:

- Improving of the sanitary condition of all school children in Al-kalakla locality.
- Spread health awareness among students.
- Periodic examination of students and treatment of parasitic diseases.
- Emphasis should be put on increasing the sample size to avoid errors in interpretation of the results.
- The use of formal ether concentration technique as it is the most reliable technique for detection of different parasitic infections instead of the wet preparation used in routine diagnosis.

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Appendix

Sudan University of Science and Technology

College Of Graduate Studies

Questionnaire

A dissertation submitted in partial fulfillment for the requirements of the degree of M.Sc. in Medical Laboratory Science (Parasitology and Medical Entomology)

Prevalence rate of intestinal parasites among schools children in Al-kalakla locality, Khartoum state.

Name: ……

Gender: □ Male □ Female.

Age: …….. Years.