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Epidemiological Study of Intestinal Parasites among school children in Shendi Locality, River Nile State, Sudan (September 2021 –September 2024)

A thesis submitted for PhD Degree in Zoology (Parasitology).

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استهلال

بسم الله الرحمن الرحيم

قال تعالى:

(اللَّهُ نُورُ السَّمَاوَاتِ وَالْأَرْضِ مَثَلُ نُورِهِ كَمِشْكَاةٍ فِيهَا مِصْبَاحٌ الْمِصْبَاحُ فِي زُجَاجَةٍ الزُّجَاجَةُ كَأَنَّهَا كَوْكَبٌ دُرِّيٌّ يُوقَدُ مِنْ شَجَرَةٍ مُبَارَكَةٍ زَيْتُونَةٍ لَا شَرْقِيَّةٍ وَلَا غَرْبِيَّةٍ يَكَادُ زَيْتُهَا يُضِيءُ وَلَوْ لَمْ تَمْسَسْهُ نَارٌ نُورٌ عَلَى نُورٍ يَهْدِي اللَّهُ لِنُورِهِ مَنْ يَشَاءُ وَيَضْرِبُ اللَّهُ الْأَمْثَالَ لِلنَّاسِ وَاللَّهُ بِكُلِّ شَيْءٍ عَلِيمٌ)

صدق الله العظيم

سورة النور الآية (35)

Dedication

To my beloved mother.
To my all family members.
To my friends and colleagues.

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Abstract

Intestinal parasites infections represent one of the most important global public health problems, especially in the tropical and sub-tropical areas of Africa, Asia, Central and South America. The aim of the present study is to determine the prevalence of intestinal parasites in center and rural areas of Shendi locality. Cross-sectional study was conducted from January2021 to April 2024, sample size was 1200 students, they were provided with labeled clean plastic stool containers to provide a minimal volume of stool.

The overall prevalence of intestinal parasite was (35.9%) and the mean intensity was (12.04 epg) According to the gender statistical analysis insure that no significant variation P> 0.05, similar finding via study area zone. Significant variation in prevalence rate among residential area, age-group, transmissions awareness, hand washing material at school, hand washing after defecation and symptoms of parasitic disease P value < 0.05. While no significant variation in prevalence by father occupation and washing vegetable and fruits, on the other hand washing of hands after defecating and hands washing method, P > 0.05. Also the present investigations determine the detecting species and frequency of the parasites in deferent site. According to diagnostic technique, the result showed slightly high in fecal egg count between two techniques, Flotation and FECT, mean parasite number was 5.1 epg, 7.1 epg in FLO and FECT respectively, some effective measures for combating the investigated parasites were recommended, including implementation of health education and, prevention of infection, improvement of the environmental sanitation and continuous assessment of epidemiological studies. Adopting effective diagnostic methods for stool examination, such as concentration techniques, that were conducted in this study and the need to train workers in the health field on them to obtain more accurate results.

المستخلص:

تمثل الطفيليات المعوية وعدوى الديدان الطفيلية المنقولة بالتربة واحدة من أهم مشاكل الصحة العامة العالمية ، لا سيما في المناطق الاستوائية وشبه الاستوائية في إفريقيا وآسيا وأمريكا الوسطى والجنوبية. الهدف من هذه الدراسة هو تحديد مدى انتشار وشدة الطفيليات المعوية في المناطق الريفية ووسط محلية شندي. أجريت دراسة مقطعية في الفترة من يناير 2021 إلى أبريل 2024 ، وكان حجم العينة 1200 طالب ، وتم تزويدهم بأوعية بلاستيكية نظيفة لجمع الحد الأدنى من عينات البراز.

كان معدل انتشار الطفيليات المعوية35.9%، وبلغ متوسط كثافة الاصابة (12.4)epg وفقًا للتحليل الإحصائي لمعدل الانتشار مقارنةبالجنس ، تأكد عدم وجود اختلاف معنوي($P > 0.05$) ، كذلك الحال عند مقارنة المعدل مع المواقع المختلفةلمنطقة الدراسة. تباين كبير في معدل الانتشار بين القرى المختارة ، والفئة العمرية ،، والتوعية بمصادر العدوي، ومواد غسل اليدين فى المدرسة ، وغسل اليدين بعد التغوط، وأعراض المرض الطفيلي ($P < 0.05$) ، . بينما لا يوجد اختلاف كبير في معدل الانتشارحسب مهنة الاب، وغسل الخضر والفواكه ووجود المراحيض ومستوى تعليم الأب والاصابة السابقة، وفقا لتقنية التشخيص أظهرت النتيجة ارتفاعا طفيفا فى عدد بيض البراز بين تقنيتي الطفو والترسيب وكان متوسط عدد البيض 5.1 epg ، 7.1epg على التوالى. .

بناءً على النتائج ، تمت التوصية ببعض الإجراءات الفعالة لمكافحة الطفيليات التي تم التعرف عليها ، بما في ذلك تنفيذ التثقيف الصحي والمشاركة المجتمعية ، والوقاية من العدوى ، وتحسين الصرف الصحي البيئي والتقييم المستمر للدراسات الوبائية.وإعتماد طرق تشخيص فعالة لفحص البراز مثل تقنيات التركيز ، التى أجريت فى هذه الدراسة وضرورة تدريب العاملين فى الحقل الصحى عليها للحصول على نتائج أكثر دقة.

Abbreviation

IPIs	Intestinal Parasites Infections
WASH	Water, Sanitation, and hygiene
WHO	World Health Organization
MDA	Mass Drug Administration
SSA	Sub-Saharan Africa
MOH	Ministry Of Health
DALYs	Disability-Adjusted Life Years
DFS	Direct fecal Smear
FET	Formal-Ether Technique
KAP	Knowledge, Attitude and Practice
GIS	Geographical Information Systems
WHA	World Health Assembly
IP	Intestinal Parasite

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CHAPTER ONE

INTRODUCTION

1.1. General Introduction

Intestinal parasitic infections (IPIs) are among the most critical public health problems worldwide. Patients infected with theses parasites suffer from significant morbidity and mortality. The intestinal parasites are broadly classified into protozoa and helminthes. Although IPIs are more commonly seen in developing countries, they are also increasingly being seen in developed countries due to the globalization of food, international travel, and migration, (Monjur Ahmed, 2023).

Epidemiology

The prevalence of IPIs varies from country to country. Due to various geographical, social, and environmental factors, they are the most prevalent diseases in developing countries, particularly in sub-Saharan Africa (SSA), Asia, Latin America, and the Caribbean. These include tropical and subtropical climates, overcrowding, inadequate sanitation, insufficient pure water supply, low income, low level of education with poor knowledge about hygiene, food handlers with IPIs, and poor personal hygiene (Kamau, 2012). The life cycle of intestinal protozoa and helminths differs from each other. Protozoa are unicellular and can multiply in the human body, whereas helminths are multicellular and cannot generally multiply in the human body.

Although IPI is mainly seen in developing countries with tropical and subtropical climates, it is virtually distributed worldwide and is increasingly observed in developed countries. In developed countries, intestinal protozoa infections are more common than helminthic infections. Giardiasis is the most common intestinal protozoan infection, and enterobiasis is the most common helminthic infection in developed countries. There are certain similarities in the life cycles of intestinal protozoan infections, (Monjur Ahmed, 2023).

Helminthic parasites are among the most common infections in humans (WHO,2015). Due to the role of contaminated soil in their transmission cycle, infections with *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm (*Ancylostoma duodenale* and *Necator americanus*) are, in public health terms, known as Soil-Transmitted Helminthiasis (STH). These parasites affect more than a quarter of the world's population, and contribute to a substantial burden of human disease and disability (Pullan*et al*.,2014)**.***Strongyloides stercoralis*- which is an important, but often neglected, cause of severe morbidity (Krolwiecki*&* Schar*et al*.,2013). STH primarily affects individuals in communities with limited access to, and use of, water, sanitation, and hygiene (WASH) facilities(Strunz*et al*.,2014), and is the most widespread among the so-called neglected tropical diseases (NTDs)(WHO,2012).

The World Health Organization (WHO) and other partners currently support national governments in STH-endemic countries to implement large-scale, periodic anthelmintic treatment (mebendazole or albendazole) of pre-school-age children, school-age children, and women of reproductive (except in the first trimester of pregnancy)(WHO,2012). The primary, and currently most realistic, aim of such mass drug administration (MDA) is to control morbidity due to STH by reducing infection intensity and ultimately prevalence (WHO,2012). Mass treatment complements clinical case management by preventing or curtailing chronic, high worm burden infections and associated disease, (Pham, & Hotez,2022).

soil-transmitted helminthes (STHs) form one of the most important groups of infectious agents and are the cause of serious global health problems; more than a billion people have been infected by at least one species of this group of pathogens ,(WHO,2005). At a global level, the most important STHs are roundworms *(Ascaris lumbricoides),* whipworms *(Trichuris trichiura)* and hookworms (*Necator americanus* or*Ancylostoma duodenale*) and are estimated to have infected 807 million, 604 million and 576 million people, respectively.(Pham& Hotez,2022) ;(Hotez*et al*.,2008).The greatest numbers of STH infections occur in Sub-Saharan Africa (SSA), East Asia, China, India and South America,(DE Silva*et al*.,2003).

Geohelminthiasis are more prevalent among children living in conditions of poor sanitation, and their impact on morbidity and mortality is more severe in malnourished populations,(Brooker,2006).As adult worms, the soil-transmitted Helminths live for years in the human gastrointestinal tract. Most studies suggest that approximately 70% of the worm population is hosted by 15% of the host population. These few seriously infected individuals are at a higher risk of disease and are also the prime source of environmental contamination(Bundy &DeSilva,1998). Inadequate hygiene and poor healthcare systems and facilities, as well as social indifference, make this situation worse, although STH control is often neglected, even in worm-infested countries. In the developing world, inadequate water supply and sanitation, as well as crowded living conditions, combined with lack of access to health care and low levels of education, make the poor particularly susceptible to infection and disease, including STHs , (DE Silva *et al*.,2003). In the last decade, an increasing number of international initiatives have established the aim to either reduce or to eliminate the disease burden caused by STHs and other helminthic parasites prevalent in the resource poor regions of the world, (Chai & Lee,1998),(Molyneux *et al*.,2003).

Enterobiasis (oxyuriasis) is caused by Enterobius vermicularis, also known as human pinworm or seat worm. It is the most common worm/helminthic infection in the United States. About 40 million people in the USA are infected with *Enterobius vermicularis.* It is most commonly seen in children, institutionalized individuals, homosexual men, and household members of infected persons (Rawla P, 2023), the life cycle of Enterobius vermicularis starts after the ingestion of embryonated eggs. Larvae hatch in the duodenum, and in 1 - 2 months, they develop into adult worms. The adult worms reside mainly in the cecum, ascending colon, and appendix. The male and female adult worms copulate, but the male worms die soon after copulation. On the other hand, the female worm has a life span of about 100 days.

When the host sleeps at night, the gravid female worms migrate to the anal canal, depositing thousands of eggs and causing itching.

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 diarrhoea, (Davis AN, 2002). G. intestinalis is the most prevalent parasitic cause of diarrhoea in the developed 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),(Petri WA,2000). . Spread of these protozoan parasites in developing countries mostly occurs through faecal contamination as a result of poor sewage and poor quality of water. Food and water-borne outbreaks of these protozoan parasites have occurred, and the infectious cyst form of the parasites is relatively resistant to chlorine (Okhuysen PC, 1999). Other species of protozoan parasites can also be found in the human gut, but they are not pathogenic, except Microsporidia sp.

1.3. Importance of the Study

Intestinal parasites are considered as endemic in Sudan, with varying prevalence rates. Information concerning the epidemiology of IP provides an essential background for planning and implementation of the control strategies and tactics. Variation in transmission patterns in different endemic areas makes it almost impossible to set up a "*standard*" control strategy. In fact, real and meaningful control requires recognition of the importance of these diseases, commitment at the Federal, State and local levels to the control programmes, adequate organizational structure and sufficient manpower and financial resources, and even the prevalence rates reported in most states were not calculated on a solid epidemiological basis. Therefore, the Ministry of Health (MOH) was not able to develop an adequate strategy to control and eliminate it from Sudan. The present study is an attempt to investigate the transmission of IP in these areas of Shendi Locality, River Nile State of Sudan.

1.4 Objectives:

The overall objective of the present study is to determine the prevalenceof intestinal parasites in rural areas and center of Shendi locality. This study was designed and conducted to elucidate the following specific objectives:

- To elucidate the infection parameters of the intestinal parasites among the population in the selected residential sites.
- To determine the efficiency level of the direct smear technique, the flotation and formal ether concentration techniques in detecting the parasitic infections of the intestinal parasites.
- Study social awareness about intestinal parasites in the areas through questionnaire.

CHAPTER TWO
LITERATURE REVIEW

2.1 Intestinal Parasites

Intestinal helminthes are common in the developing world; current estimates suggest that one-third of the world's population is infected. Although most infections are light and asymptomatic, they are a significant cause of morbidity in heavily infected individuals and there is evidence that even moderate infections may have profound effects on pregnancy outcome, growth and cognitive function (WHO, 2002).It is estimated that some 3.5 billion people are affected by intestinal parasitic infections, and that 450 million are ill as a result of these infections. Such voracious infections are most common among the poorest and disadvantaged communities and are most intense and frequent in school-age children. These infections are regarded as serious public health problems, as they cause iron deficiency anemia, growth retardation in children and other physical and mental health problems (Stephenson *et al*., 1990; Nokes *et al*., 1992; Stoltzfus *et al.*, 1996; WHO,1998 & 2004). Intestinal parasites of importance to man are the soil-transmitted helminthes (STH), *Enterobius vermicularis*, - *Ascaris lumbricoides*, *Trichuris trichiura*, hookworms (*Necator Americans* and *Ancylostoma duodenale*) and *Strongyloides stercoralis*.And the protozoa, *Entamoeba histolytica* and *Giardia lamblia* (Norhayati *et al.*, 2003).

2.5.3 Epidemiology of Intestinal Parasite:

Epidemiological research carried out in different countries has shown that the socioeconomic situation of the individuals is an important cause in the prevalence of intestinal parasites. In addition, poor sanitary and environmental health and hygiene conditions are known to be relevant in the propagations of these infectious agents (Abu Mourad& Okyay *et al*., 2004). Climatic changes induced through global warming have aided the spread of many parasite diseases, whilst starvation and the breakdown in sanitation that accompanies war have seen the re-emergence of others (Baker& Muller, 2004).

The number of people affected by common intestinal worms is staggering. Infection is found worldwide, but it is most common in tropical and subtropical countries, estimation illustrates that around two billion people harbour these infections, in other words, worms infect more than one-third of the world's total population. More than three hundred million are severally ill with worms and of those; at least 50% are school-age children (WHO, 2003). The highest disease burden with geohelminthes is observed in poor communities with insufficient water-supply, inadequate sanitation, and little health awareness. The greatest morbidity attributable to geohelminthes infections is among children and mothers of childbearing age (Holland *et al*., 1996; Montresor *et al*., 1998 and Savioli *et al*., 1992).Many helminthes exhibit a highly over-dispersed distribution of worm numbers; that is, most infected individuals harbour a few parasites, but a few have heavy burdens. Many factors (social, behavioural and genetic) determine which individuals within a community carry the heaviest infections. Age-intensity relation-ships vary between species; there is an increase in hookworm intensity with age, but peak intensity in childhood for *Ascaris* and *Trichuris* infections (WHO, 2002).

Worm infections aggravate malnutrition and anemia rates which contribute to growth retardation and make the child more vulnerable to other diseases. In terms of learning, high infection leads to more morbidity, thus, the children more often absent themselves from school, even when they are in class, they are less able to learn well (WHO, 2003). Disease accompanying these infections is manifested mainly as nutritional disturbance, with the differing infections having their deleterious effects at different phases during the human life cycle. Reduced food intake, impaired digestion, mal-absorption, and poor growth rate are frequently observed in children suffering from ascariasis and trichuriasis. Poor iron status and iron deficiency anemia are the hallmarks of hookworm disease. The course and outcome of pregnancy, growth, and development during childhood and the extent of worker productivity are diminished during hookworm disease. Less is known about the impact of these infections in children under 2-years of age. The severity of disease caused by soil-transmitted nematodes has consistently been found to depend on the number of worms present per person (Crompton & Nesheim, 2002). Mortality is in fact a rare consequence of these parasitic infections, but because of the massive number of people affected worldwide, the number of deaths is substantial. The death toll due to intestinal parasites may be as high as 155, 000 annually (Crompton, 1999). Based on these considerations, academic institution, medical agencies and public health officers have shown increasing interest in helminthic infections in recent years. These infections are recognized as a priority health problem for large parts of the world's population. The world health organization considered the control of schistosomiasis and intestinal parasites among the top five health priorities within the global massive efforts against poverty, and worked in association with collaboration centers to encourage member states to set up control programs and provide technical assistance (WHO, 2004). The World Health Organization has developed a clear policy for the control of the intestinal parasites (Montresor *et al*., 1998), recommending that any program aimed at controlling morbidity due to these infections should begin with a baseline survey. Baseline surveys provide a sound basis for estimating current status and needs for future interventions and produce essential data to guide the development of control programs at national, regional and district levels (Montresor *et al*., 1998).

2.3Human-infection Parameters

2.3.1 Prevalence of Infection

The prevalence of infection can be explained as the proportion of population (or subgroup) infected at a particular point of time, and it is usually measured as percentage. It is determined by past incidence of infection and rate of loss of infection (Christenson *et al.*, 1987; Ahmed, 1998). The prevalence increases when the rate of infection becomes more than the rate of loss of infection. In order to detect the prevalence, it is important to differentiate between change of prevalence among the same group examined in different times and changes in specific age group at different times. Any failure to determine the variation between both groups immediately shows misconduct of the experiment (Gilles, 1973). However, sometimes accuracy of prevalence detection is directly proportional to the sensitivity of the diagnostic technique (Gryseels & Polderman, 1991).

The following formula is used to calculate the prevalence of infection in a community:

$$\text{Prevalence \%} = \frac{\text{Number infected} \times 100}{\text{Number examined}}$$

Sometimes the prevalence of infection data is used for guiding the community health policy. In such case, school-age children prevalence of infection is used as an index, because community prevalence data are very expensive to collect. Thus, most surveys focus on school-aged children and frequently use them as sentinel population. School-age children prevalence of infection could district national level to identify target areas for control and evaluate the numbers at risk of infection (Guyatt *et al.*, 1999).

2.4.1.2 Intensity of Infection:

Intensity of infection is the numbers of worms (measured directly or indirectly) per infected persons (WHO, 2002). Intensity can be measured directly from a worm count following expulsion treatment, or indirectly (much more conveniently) by egg count. Intensity of infection is generally used to indicate the disease development. Ova output figures, especially from younger group population give valuable data about the overall epidemiological situation. In young infections a correlation exists between the number of ova excreted and the morbidity suffered. Intensity of infection is therefore, might be used for elucidating effectiveness of control measures on the level of transmission (Christensen *et al*., 1987).

Arithmetic and geometric mean methods can be used to compute the intensity of infection. The arithmetic mean obtained by dividing the total number of eggs counted (x), by the number of individuals infected (n):

$$\textbf{Arithmetic Mean} = \frac{\sum(\mathbf{X})}{(\mathbf{N})}$$

The geometric mean method of calculation is preferable when there is light infection or few heavy cases of infections. In such cases the arithmetic mean method, may give exaggerated data (Ahmed, 1998). The geometric mean is computed by obtaining the summation of antilogarithm of ova counted (log x) divided by number of persons examined (n).

$$\textbf{Geometric Mean} = \textbf{Anti Log} \sum \frac{\log(\mathbf{X})}{(\mathbf{n})}$$

However, in some cases the geometric mean calculation results may be variable among the same group according to the sensitivity of the technique used (Jordan & Webbe, 1982). Recently, a mathematical model is proposed to analyze the effects of acquired immunity on transmission of schistosomiasis in the human host. The model showed a good retrieving capacity of real data of the average worm burden per person and the dispersion of parasite per person in the community (Yang, 1998).

2.3.2 Incidence of Infection

$$\text{Incidence (\%)} = \frac{\text{Number of positive at second observation}}{\text{Number of positive at first observation}}$$

Annual incidence of infection is considered to be the most informative index, as it provides information about the current level of transmission. It is measured as the frequency of occurrence of new infections in a specific population over a specific period of time (Christensen *et al*., 1987). The most sensitive indicator for transmission is the incidence, which is difficult to measure, due to population movement (Shiff, 1973; Scott, *et al*., 1982), and acquired immunity (Lewert, *et al*., 1984), and also lack of sensitive diagnostic techniques (Farooq & Harison, 1966). Measuring the incidence may be of great worth in the monitoring of control programs aimed at reducing transmission; where the reduction in incidence is a measure of effectiveness (Southgate & Rollinson, 1987). Usually, incidence is measured over one year to allow for seasonal variation in transmission (Pesigan *et al*., 1958; Farooq & Harison, 1966), although a shorter time interval can be used (Shiff, 1973).The incidence rates of infection go up with increasing intensity of transmission which is generally low in the younger age group, but, with increasing water contact, the risk of infection increases with age and incidence rises. It is measured in young children, among whom the rate is likely to vary with age (Scott, *et al*., 1982; Goll &Wilkins, 1984), and also to avoid complication imposed by acquired resistance (Farooq & Harison, 1966). The most appropriate study group comprises children cured for infection by drug treatment; use of uninfected, non-treated children may commonly result in an underestimation of the incidence (Miller *et al*., 1976).Incidence data based on the apparent rate of re-infection after treatment may be unreliable as it is usually impossible to differentiate between an unsuccessful treatment and a re-infection (Jordan & Webbe, 1982).

2.6. Parasitological Diagnostic Techniques

1- Qualitative Technique

Gives information about the species of the parasite(s) present and the technique is useful for clinical practice.

2-Quantitative Technique

Indicates the number of eggs excreted by the patient and expression of the load of infection. This method used in epidemiology, control and drug trails (Simonsen *et a l.*, 1986).

2.6.1 Microscopic Examination of Stool

Diagnosis of the faeces is used to detect intestinal parasites ova and other soil transmitted helminthes, microscopic examination of stool specimens continues to be the standard method for assessing prevalence and intensity of these infections. Routine screening of stool specimens, however, is labour-intensive and expensive, and thus, is not practical in many settings.

2.6.2 Direct Fecal Smear (DFS)

The DFS or the wet mounting is the simplest and the easiest technique for examination of faeces and this method usually performed in all laboratories at the peripheral level. The saline wet mount is the most commonly used method to demonstrate worm eggs, larvae, protozoan trophozoites, and cysts. It can also reveal the passage of red blood cells and white blood cells. It is a fast qualitative method requiring simple equipment. A small portion of the faecal material is usually taken and examined immediately under a microscope. The method could be used for detection of the moderate and heavy infection, but the light infections will be over looked (Salih, 1989).

2.6.3 Sedimentation/Concentration Methods

The sedimentation method was first described by Hoffman *et al.,* (1934). This method based on sedimentation or centrifugation and has been developed for detection of light infection. The method requires minimum equipment and reagents and is suitable for field studies. It involves removal of faecal debris and then the concentration of the eggs in a container. Other concentration methods such as formal either (Ritchie, 1948) and acid either (Hunter *et al*., 1948) techniques involve removal of fat. These techniques have been modified to improve sensitivity but they are in generally not used in the health units since they are time consuming (Simonsen *et al*., 1986).

2.6.4 Sodium chloride flotation technique:

Required: -

Sodium chloride powder, D.W, Test tube of about 15 ml capacity, Pasteur pipette, wooden stick, slide, and cover glass.

Method:-

First: for sodium chloride solution:-

33 gram Nacl powder soluted in 100 ml D.W. until saturated.

Second:-

- Fill the tube about one quarter full with the Nacl solution. Add 1 gram of feces, using a wooden stick, emulsify the specimen in the solution.
- Fill the tube with the Nacl solution.
- Stand the tube in a completely vertical position in a rack using Pasteur pipette add further solution to ensure the tube is filled to the brim.
- Carefully place a completely clean cover glass on top of the tube. Avoid any air bubbles.
- Leave the tube for 30- 45 minutes.

- Carefully lift the cover glass from the tube and place the cover glass on a slide examine the preparation microscopically using 10 x objective then 40 objectives.

Count the number of eggs or cyst to give the approximate number per gram of feces.

2.6.5Formal-ether Technique (FET)

In such technique, utilizing a wooden stick about one gram of the stool sample is put on the fiber-glass mortar with continuous mixing after addition of 10 ml of formalin solution (10%). The mixture will be poured into as centrifugation tube *via* two layers of the surgical gauze (small mish-size) over a glass funnel. Three milliliters of ether (or ethyl acetate or gasoline) will be added to the sieved solution in the glass funnel. The mixture should be thoroughly shacked before being put in hand or electrical centrifuge. The centrifuge should be operated for two minutes with a speed of about 400 - 500 round per minute. Observe the formation of four conspicuous layers – the **first** layer is the ether (or ethyl acetate or gasoline), the **second** is the layer fat remains, the **third** is the formalin and the **fourth** is the precipitate. Via one trial get rid of the upper three layers without mixing or moving the precipitated material. Put the centrifugation tube in a converted manner for 10 seconds so as to get rid of the solution in the precipitated material. Two drops of the Lugol's solution will be added to the precipitated material. Using Pasteur pipette part of the precipitated material will be transferred to glass slide that covered with cover slips, which is now ready to be examined under any stereo binocular microscope, (cited byAhmed, 2009).

Modification of the formol-ether concentration technique by initial measurement of an exact quantity of faeces, the use of a stainless steel sieve instead of gauze, the addition of a 2nd sieve, the use of Triton as a wetting agent, and the addition of a 2nd washing step before the concentration step and a final sedimentation step, made it more sensitive in terms of number of *Schistosoma mansoni* eggs counted. The sediment was smaller and clearer and needed about 15% less time to examine. It was more successful than the Kato technique just in detecting light infections, (Knight*et al*., 2006).

2.6.6 Questionnaires for Rapid Screening

New initiatives are aiming to reduce the global burden of Geohelminthiasis and GI parasites diseases, mainly through the large-scale application of chemotherapy. To target chemotherapy effectively, rapid assessment procedures are needed for identifying high-risk communities that are foci for the disease.

2.7 Control of GI Parasites

A high prevalence of GI parasites, when combined with poor hygiene and malnutrition, is an indicator of a country's future problems, indicating that priority be given to eradicating STHs worldwide, (Bundy& Silva,1998). GI parasites are considered together since it is common for an individual, especially a child living in a less developed country, to be chronically infected with all three worms. Such children experience malnutrition, stunted growth, mental retardation, as well as cognitive and learning deficiencies, (WHO,2005).

Large-scale environmental sanitation programs are complex, making interventions directly aimed at the transmission of STHs challenging to implement, (Barreto *et al*.,2007).

The world health organization (WHO), (WHO,2005) has recommended three interventions to control morbidity due to STH and GI parasites infections: regular drug treatment of high-risk groups for reduction of the worm burden over time, health education and sanitation supported by personal hygiene aimed at reducing soil contamination.

2.7.1 Health Education and Community Participation

For most low socioeconomic communities, intervention on health education is often recommended as a first option to create the enabling environment for other strategies to thrive (Murda, 1985; EKeh&Adeniyi, 1988; WHO, 2002).Changes in the community's **K**nowledge, **A**ttitude and **P**ractice (KAP) with regards to Geohelminthiasis control can be interpreted, as an indication of the impact of the health education delivered during the course of the study. Health education should, therefore, precede programs that require full participation of the community, as this enables the community to make informed decisions regarding their participation (Gwatirisa *et al.*, 1999). The main objective of the health education programmes is to expand the knowledge and to modify the attitudes and perceptions with regard to transmission and control of the disease (El Tash, 2006). Furthermore, health education programme aims to achieve an improvement in water use practices and preventing indiscriminate urination and defecation, at the community level. In addition, health education programme achieves insurance that the community understands the conducted message and can actively participate in control activities (WHO, 1998). An effective health education programme should promote active community participation which range from a community installation of their own latrines to simple cooperation with health authorities (El Tash, 2006).

Many scientists (TheinHlaing*et al.*, 1987; Wilkins, 1989; Albonico*et al.*, 1995; Ofoezie, 2000) suggested that: control outcome can be sustained only by a corresponding reduction in human exposure pattern. For both soil and water-transmitted helminthic infections; this will require a significant reduction in environmental contamination, an improvement in the hygiene practice and conditions of community members and significant modifications in people's behaviour and attitude to social, cultural and environmental risk factors.

The emphasis of the health education message should be on the role of the individual in spreading Geohelminthiasis to his family and the community by lack of hygiene, indiscriminate urination, and defecation, as well as in contracting the disease in contaminated water (Mott, 1987). People are the main reservoirs of infection; thus, their contaminative behavior sustains the transmission of Geohelminthiasis. The fundamental importance of far-reaching changes in human behavior is now widely recognized (Rēe, 1982; Gillett, 1985).Self-administered questionnaire pre-and post-intervention showed a significant increase in knowledge about geohelminthiasis in schools in China, using health education to reduce contact with unsafe water-sources. This change was associated with decrease in contact with unsafe water-sources (Yuan *et al*., 2000). A study of health education intervention impact on *Ascaris lumbricoides* was assessed. Results showed that prevalence of *A. lumbricoides* declined by over 2.6%. Also, the intensity of *A. lumbricoides* reduced by over 35%, as reported by Asaolu and Ofoezie (2003). Communication techniques are the tolls of health education, which should be simple, inexpensive and understood by community individuals (Christensen *et al*., 1987). Esrey *et al*., (1991) reviewed several intervention programs on helminthes infections and concluded that health education and sanitation are the options of choice not only for mitigating helminthes infections but also for sustaining the control outcome of other intervention programs. Educating rural populations to prevent human contamination of, and exposure to, potential transmission sites has little chance of success without provision of safe-water supplies and acceptable means of excreta disposal. It was rapidly concluded in Egypt that such provisions and their maintenance would be impossibly expensive in rural areas (Sturrock, 2001). In order to ensure long-lasting control it is, therefore, necessary to include health education and sanitation improvements in helminthes control programs (WHO, 1999). . Health education programmes are very expensive, but they will have significant effect on the occurrence of the water and/or excreta related disease (Ahmed, 2002 & 2009).

2.7.2 Chemotherapy

Studies have shown clearly the detrimental effects of helminthes infection on educational performance and school attendance, as well as the significant improvements in language and memory development that can be realized following treatment. New initiatives are aiming to reduce the global burden of geohelminthiasis, mainly through the large-scale application of chemotherapy. A strategy of morbidity control through chemotherapy has resulted in successful control in Brazil, the Middle East, China and the Philippines. There is a threat of resurgent transmission in China due to ecological changes owing to the construction of the 'Three Gorges' dam, and in the Philippines owing to inadequate support for public health interventions. Economic development has virtually eliminated transmission of the disease from the Caribbean and Mauritius (Chitsulo et al., 2004). Chemotherapy with a single dose, safe, inexpensive and effective anti-helminthic drugs is the mainstay of control programs aimed at controlling morbidity due to intestinal parasites as a short-term goal (Savioli *et al*., 1992; Handzel, 2003). Several anti-helminthic drugs are recommended by World Health Organization, all are safe highly effective, available in single dose and at low cost .Mebendazole, Albendazole, Pyrantel, Pamoate and Levamisol are drugs for treating soil-transmitted helminthes

Regular treatment with the antihelminthic drugs recommended by the World Health Organization reverses the morbidity resulting from helminthes infection. This is manifested in quantitative improvements in the physical fitness, appetite, and school performance. Deterioration in iron status in arrested by antihelminthic treatment, iron supplementation improves iron status (Albonico*et al*., 1999; Doenhoff *et al*., 2000; WHO, 2002). Infections of *T. trichiura* are the most obdurate but even then egg counts fall significantly indicating the impact of the infection has been reduced (Crompton *et al*., 2003).

Expert evaluation has found no reason to avoid treating pregnant women for hookworm infection provided that the first trimester has passed (WHO, 1996). High infections parameters have been observed among school children and school-age children and therefore, control efforts have focused on this group (Olsen, 1998). Therapy improving the health and development individual, especially of children. Regular treatment of those infected can decrease worm burden and reduce the risk of serious complications laterin life (Handzel, 2003).

Under the World Health Organization guidelines the decision to treat all persons, mass treatment, or only school children and other high-risk groups, selective treatment, depend on the prevalence of infection in a particular region. Epidemiologic tools are thus needed to identify and prioritize communities for mass-treatment programs (Handzel**,** 2003). The three strategies recommended by the World Health Organization for the treatment of STH are:

(A)Universal Mass Treatment: Dispensing of drugs to community irrespective of age, sex, infection status, or other social characteristics.

(B)TargetedMass Treatment: Dispensing of drugs to specific group in the community defined by age, sex, or other social characteristics, irrespective of infection status (*e.g*., children aged 2-14 years).

(C) Individual Treatment:

Treatment based on diagnosis of a current infection**.** Mass chemotherapy forms the mainstay of most of control programs, which aims to reduce morbidity as an urgent but short-term goal (Albonico*et al*., 1999).More important than the interval between treatments appeared to be the number of chemotherapy rounds (Homeida *et al*., 1996).In area of very high prevalence, thrice-yearly mass chemotherapy probably improves health better than twice-yearly treatment (DeSilva, 2003).

In this situation mass treatment should still be considered in highly endemic areas following assessment of prevalence and infection intensity in a representative sample of the population. For the individual patient, diagnosis should be done by stool examination before treatment is instituted (Magnussen, 2003).

2.7.3Sanitation and Water Supply

Although, drug therapy achieved high levels of morbidity reduction through rapid parasite and egg clearance (Arfaa, 1984; Michaelsen, 1985; Elkins *et al.,* 1986; Webbe & Jordan, 1993; Xianmin *et al.,* 1999), the inevitability of re-infection remains unaffected. Therefore, the option of integrated control programs based on chemotherapy in combination with sanitation and health education, together with strong community involvement, must be considered in order to ensure the positive long-term effects of such programs (Massara&Enk, 2004).

Sanitation means disposal of human excreta, sullage and solid waste (Pichford, 1988).It follows that in communities where people live under conditions of poor sanitation human faecal matter may be indiscriminately thrown around. There are many types of latrine facilities available for the management of human excreta: bucket latrines, pit latrines, compost latrines, aqua privies, flush toilets, etc (Kilama, 1985; Sridhar &Oyemad, 1987; Pichford, 1988). Several studies of helminth infection revealed that high prevalence and heavy intensity of infection are associated more with the use of bucket and pit latrines than with aqua privies and flush toilets (Elkins *et al.*, 1986; Bundy *et al.*, 1987; Asaolu *et al.*, 1992). It does not follow that increasing in latrines number in a community reduces environmental contamination and rate of disease transmission (Thomas, 1987; Holland *et al.*, 1988; Huttly, 1990). This is because provision of latrine facilities does not always imply that they are used, or they may not be used properly (Arfaa *et al.*, 1977).

There was clear evidence that access to water supply and sanitation facilities reduces the risk of helminth infections. Thus, decreasing access to water supply and sanitation facilities increased the prevalence of helminth infections, at rates ranging from 27% to as high as 194.5% (Asaolu&Ofoezie, 2003). Rate of reduction due to either sanitation and/or health education is significantly better when combined with chemotherapy, though sanitation and health education alone may not achieve rapid rates of reduction, but they sustain control outcome over long time (Barbosa *et al.*, 1971; Jordan *et al.*, 1982). A number of innovative types of water supply have been tested in endemic areas of Brazil (Sleigh *et al.*, 1986 a & b) and in the Sudan (El Basit& Brown, 1986). The success of sanitation interventions depends on coverage and community acceptance to operational state (Okun, 1988). In order to achieve the required coverage and acceptability, the facilities must be affordable, available in the local market and compatible with local technologies (Asaolu&Ofoezie, 2003).

2.7.4. Monitoring

All serious control activities necessitate the establishment of a system permitting continuous monitoring of the different control inputs implemented, for progress and maintenance of achieved results (Mahmoud, 2001). Control and evaluation activities should be integrated into existing health care delivery services, once the maintenance phase has been achieved. Continuous evaluation concentrating on outcomes contributes to early recognition of problems, and facilitates reinforcement and fine-tuning of intervention strategies (WHO, 1987). The relatively new discipline, geographical information systems (GIS), promises to considerably improve our knowledge regarding geohelminthiasis distribution in the world, and also to provide information on which areas are at risk for becoming endemic. The sensitivity of current Satellite-based surveys has, for example, been evaluated and proved useful for the national control program in Egypt (World bank, 1997).

2.7.5Publichealthcontrol

Current WHO guidelines recommend MDA of benzimidazoles in areas where *A. lumbricoides, T. trichiura* and/or hookworm infection prevalence exceeds 20%; the frequency ranging from one to 482 three times per year depending on STH prevalence.(WHO,2012);(WHO,2011). The WHO's goal for morbidity control for 2020, elimination of STH as a public health problem, is defined as reducing the prevalence of moderate and heavy intensity infections to <1%, based on egg counts(WHO,2012). The current school-based deworming platforms have been shown to reduce intensity and, ultimately, prevalence of infection,(WHO,2012);(Hotez *et al*.,2014);(Truscott& Turner,2015). however, mathematical modelling indicates that additional platforms will be needed to control hookworm, as prevalence and intensity are typically highest in adults.(Truscott& Turner,2015);(Turner *et al*.,2015), (Truscott& Turner,2015). results of a survey of experts suggest that STH elimination may still be aspirational in most endemic areas and that community-wide treatment and increased access to improved WASH will be needed to further control STH.**(**Keenan *et al*., 2013)**.** Recently, reviews conducted by the Cochrane and Campbell Collaborations have questioned the effect of population-level deworming on health outcomes, school performance and cognition in children (Taylor&Robinson*et al*.,2012);(Welch*et al*.,2017).

Public health resolutions endorsed by the World Health Assembly (WHA) have mobilised member states to scale up STH control programmes, and have stimulated interest in the global distribution, clinical management, and evidence-based measures to control STH. Both mebendazole and albendazole are currently donated to the WHO free of charge by Johnson & Johnson and GlaxoSmithKline, respectively, for mass treatment of at-risk school-age children. For pre-school-age children, drugs are purchased by governments or other groups and are often co-administered with vitamin A during child health days (Kumapley, 2015). Only a single dose is normally administered through mass 500 deworming campaigns, resulting in acceptable reductions in infection intensity but suboptimal cure rates, especially in areas with high burden of *Trichuris* and or hookworm infection. At present, *S. stercoralis*is rarely intentionally targetedbySTHcontrolprogrammes, neither through geographical mapping of infection, mass treatment nor monitoring of treatment effect.(Olsen*et al.*, 2009)

Several challenges remain towards reaching the WHO targets for 2020. Firstly, although 63% of school-age children and almost half of pre-school-age children in need of treatment are currently being dewormed for *A. lumbricoides*, hookworm, and *T. trichiura*,(WHO,2015).only 30% and 28% of countries where these children live, respectively, have achieved the 75% treatment coverage target (WHO,2016).

Secondly, strongyloidiasis is not addressed in the WHO's STH strategic plan, although its classification as an STH and the sensitivity of *S. stercoralis* to MDA of ivermectin, provided in LF- and onchocerciasis-endemic areas of Africa should make a strong case for targeting it.((WHO,2012); (Olsen *et al*.,2009). Thirdly, some 60 million school-age children and at-risk women of reproductive age live in LF-endemic areas that currently benefit from albendazole co-administered through the Global Programme to Eliminate LF.(Ottesen*et al*.,2008). Unfortunately, the success of LF elimination and the scaling back of community-based drug distribution could increase their risk of STH unless other drug delivery platforms are put in place.(Mupfasoni *et al*., 2016). Trials are being conducted to determine the feasibility of breaking STH transmission in post-LF MDA settings, and the results may inform a new generation of improved public health control programmes(Dige*et al*.,2017). Finally, some population groups are commonly left out of mass treatment programmes targeting STH, for example non-attending school-age children and women of reproductive age, and such at-risk populations require particular attention in both public health control programmes and individual case management,(Jourdan*et al*.,2018).

2.9 Helminthic infection

Intestinal helminthes are so named because their life history includes a period of obligatory residence in the human alimentary tract or because they induce pathological changes in that site, (WHO,1987).

Not surprisingly, nutritional impairment is often associated with chronic intestinal helminthiasis, with those infected suffering from protein-energy malnutrition, iron deficiency anemia, and vitamin A deficiency(WHO,1987). Although malnutrition is now recognized as having many causes, closely related to socioeconomic factors, available evidence indicates that several of the intestinal helminthiasis contribute to the generation and persistence of malnutrition in developing countries, WHO(1987), estimates of the global prevalence of the intestinal nematode infections transmitted through soil are as follows: 1000 million cases for *Ascaris lumbricoides*; 900 million for hookworms (*Ancylostoma duodenale* and *Necator americanus*); and 500million for *Trichuris trichiura.*

It should be noted, however, that, since many people are likely to be infected by more than one species concurrently, the total prevalence of all nematode infections may be lower than the sum of the above figures, Another perspective of the high prevalences of these infections can be gained by noting that an average prevalence figure for *A. lumbricoides* infection for the population of Africa, extracted from some 300 published studies during roughly the last decade, is 32%, with children (< 17 years old) showing a higher prevalence rate than adults (> 18 years old).

These figures do not take into account such factors as climate and population density. Some countries have overall average Prevalences ranging from 16 to 48 %, and within a country the prevalence rate may range from 0 to over 70%.(WHO, 1987).Humans are infected through; ingestion of infective eggs, cysts, or larvae on contaminate food or hands, or by penetration of the skin by infective larvae that contaminate the soil like hookworms. Re-infection can therefore occur only as a result of new contact with the contaminated environment (WHO, 2002). In tropical and developing countries the following are among the factors that contribute to the spread and increase in incidence of parasitic infection, as stated by Cheesbrough (1999):In tropical and developing countries the following are among the factors that contribute to the spread and increase in incidence of parasitic infection, as stated by Cheesbrough (1999):

- Inadequate sanitation and unhygienic living conditions leading to faecal contamination of the environment.
- Lack of health education.
- Insufficient water and contamination of water supply.
- Failure to control vectors due to ineffective interventions, insecticide resistance, lack of resources, and suspension of control measures.
- Failure of drugs to treat parasitic infections effectively.
- Climatic factors.
- Population migrations causing poor health, loss of natural immunity, exposure to newinfections, and people being forced to live and work closer to vector habits.

Life Cycles :-

- ***Ascaris lumbricoides*:**

Once embryonated eggs in moist soil are ingested, they hatch in the small intestine. The larvae penetrate the mucosa, enter the blood and circulate to the alveolar capillaries, where they burrow through to the respiratory tree. They are carried up the trachea and swallowed for a second time; on reaching the small intestine, adult females lay 200,000 eggs per day. The incubation period from egg ingestion to egg-laying is 60 - 70 days, and adults live for up to two years.

Clinical features – the migratory phase of infection with *A. lumbricoides* (and, less commonly, hookworm, *Strongyloides*) can cause Loeffler's syndrome – a self-limiting illness with cough, fever, dyspnoea, wheeze and eosinophilia. More serious complications of *A. lumbricoides* infection include biliary and intestinal obstruction and migration of worms to other organs; these cause many deaths in developing countries. However, the greatest burden of disease results from the nutritional consequences of heavy worm loads in the small intestine. Several clinical trials have shown improvements in nutritional status and growth following deworming, even at low worm burdens, (Smyth, 1996).

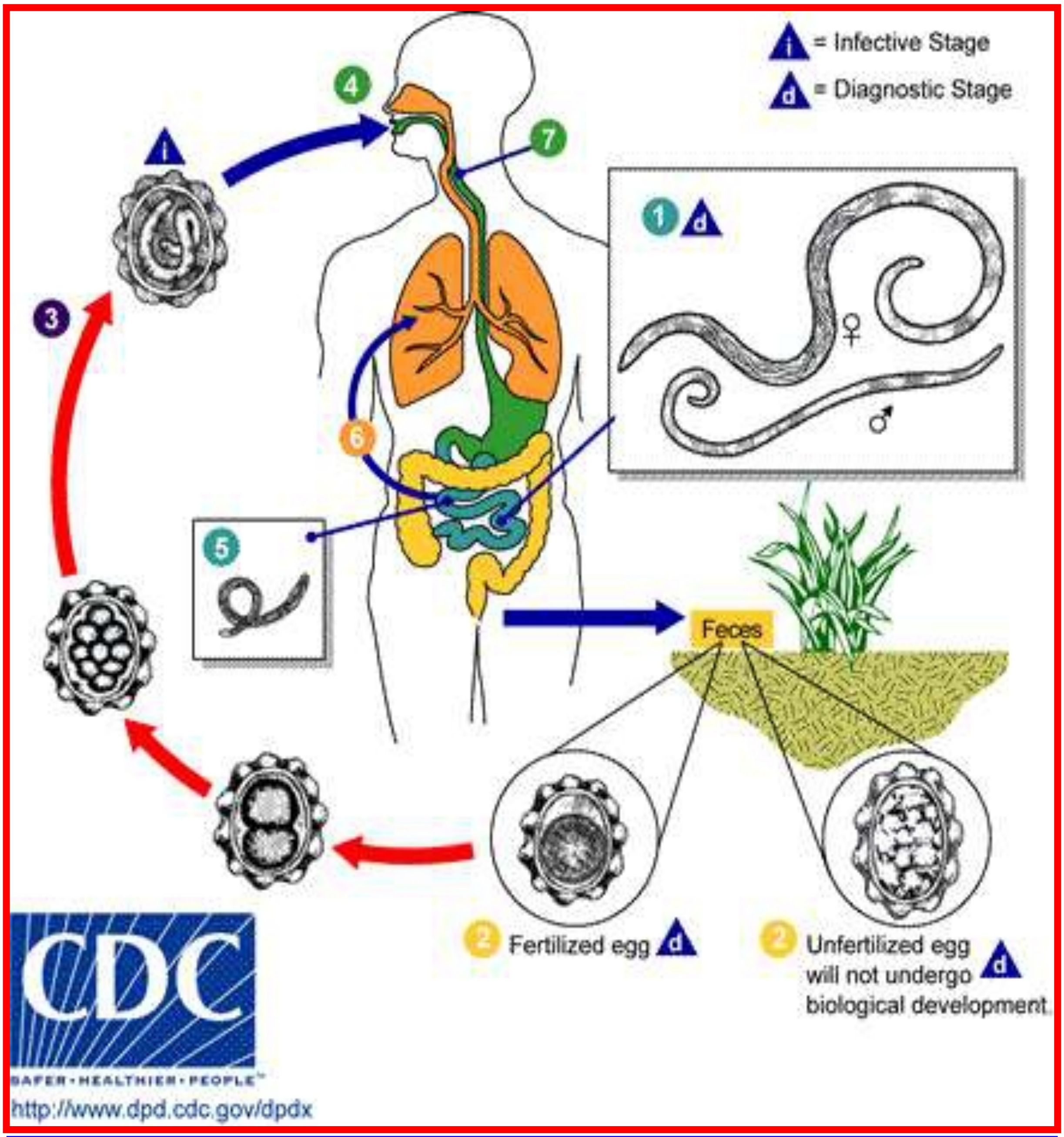


Plate (2-1): Life Cycle of *Ascaris lumbricoides* (CDC, 2007)

❖ **Hookworms:**Two species of hookworms complete their life cycles in humans– *Necator americana* and *Ancylostoma duodenale*. Hookworm larvae in moist soil penetrate exposed skin. Thus, are then carried by the circulation to the lungs; they penetrate the alveolar walls and progress up the trachea, where they are swallowed and carried to their final habitat in the small intestine. The adults attach themselves to the mucosa with their buccal cavities, and after 3 - 6 weeks the females produce up to 30,000 eggs per day (depending on the species), which are passed in the faeces. Adult hookworms live for 1 - 9 years. Clinical features – the main burden of disease attributable to hookworm infection results from iron-deficiency anaemia caused by blood loss from the site of attachment to the mucosa. Whether by anaemia or by other mechanisms, childhood growth, school performance, pregnancy outcome and worker productivity are affected. Several studies have shown the benefits of deworming in childhood and pregnancy, particularly if this is combined with increased iron intake, though the evidence for important benefits on cognitive performance is debated, (Jayaram 2002).

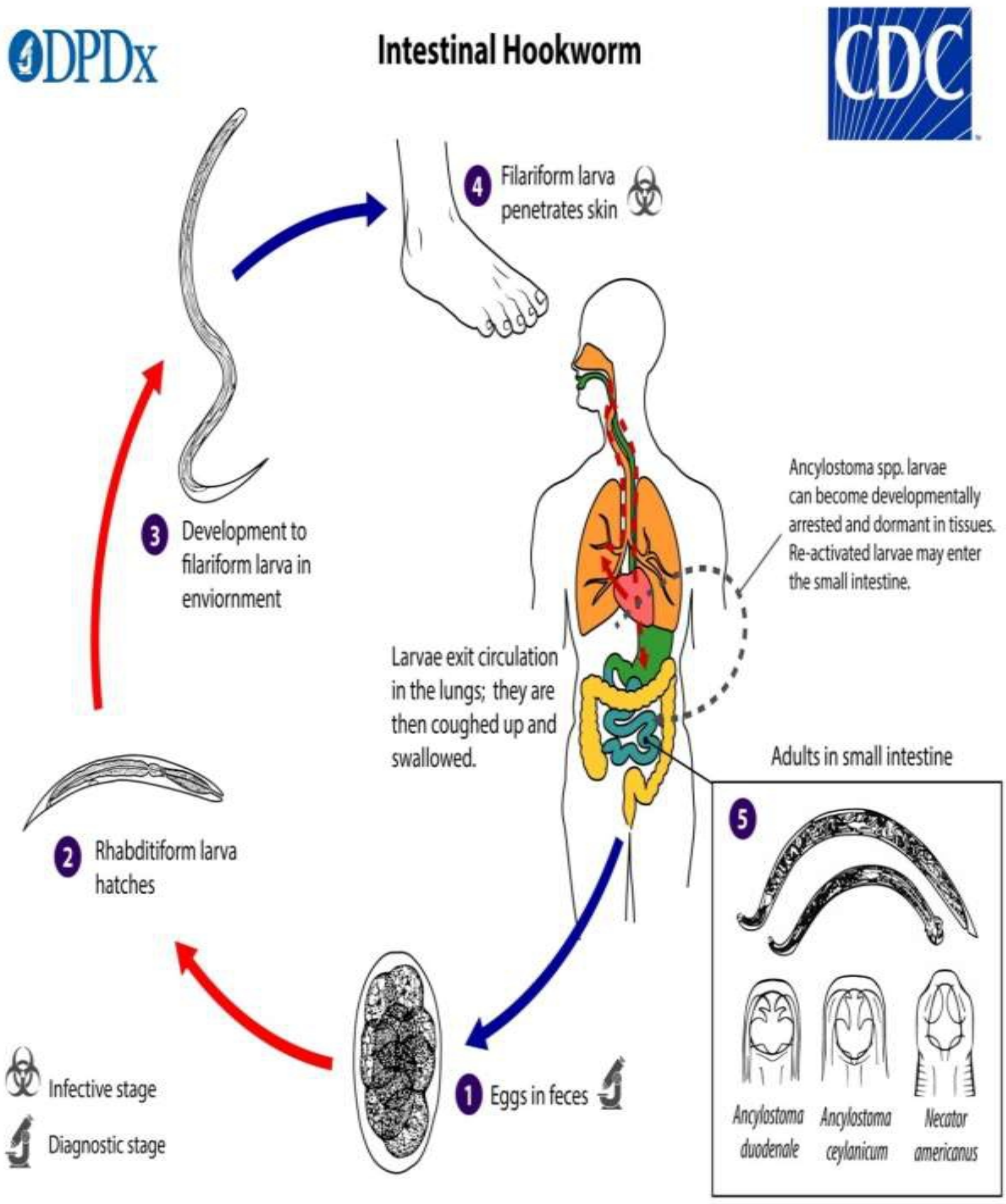


Plate (2-2): Life Cycle of *Ancylostoma duodenale* (CDC, 2007)

❖ ***Enterobius vermicularis*****:** Jayaram (2002) reported that, *E. vermicularis* is the only gastrointestinal helminth that remains widely distributed in temperate climates. Swallowed eggs hatch in the duodenum and the larvae pass to the caecum, where they mature. The females, which are about 1 cm long, lay 10,000 - 15,000 eggs after emerging in the perianal region. The eggs are immediately infectious and therefore do not require a period of maturation in the environment. Children often infect themselves from eggs under their fingernails.

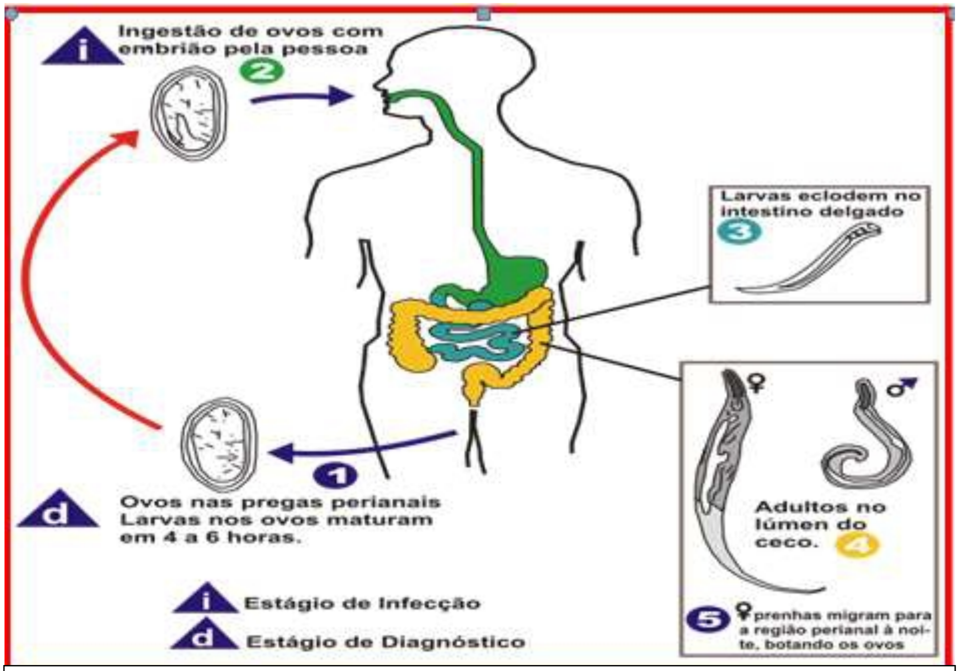


Plate (2-3): Life Cycle of *Entrobius vermicularis* (CDC,

❖ ***Trichuris trichiura*****:**

Embryonated eggs in moist soil are ingested, hatch in the small intestine and invade the mucosa; here, they develop for 1 week before re-entering the lumen and traveling to the caecum, where they invade and attach themselves within the superficial mucosa. Females produce up to 20,000 eggs per day and survive for up to 1 year. Clinical features – most infections are light, but heavy infections cause haemorrhage, dysentery, rectal prolapse and an acute-phase response, which may contribute to reduced iron status and poor growth. Treatment, even of less heavily infected individuals, may be followed by significant improvements in school performance, (Jayaram ,2002).

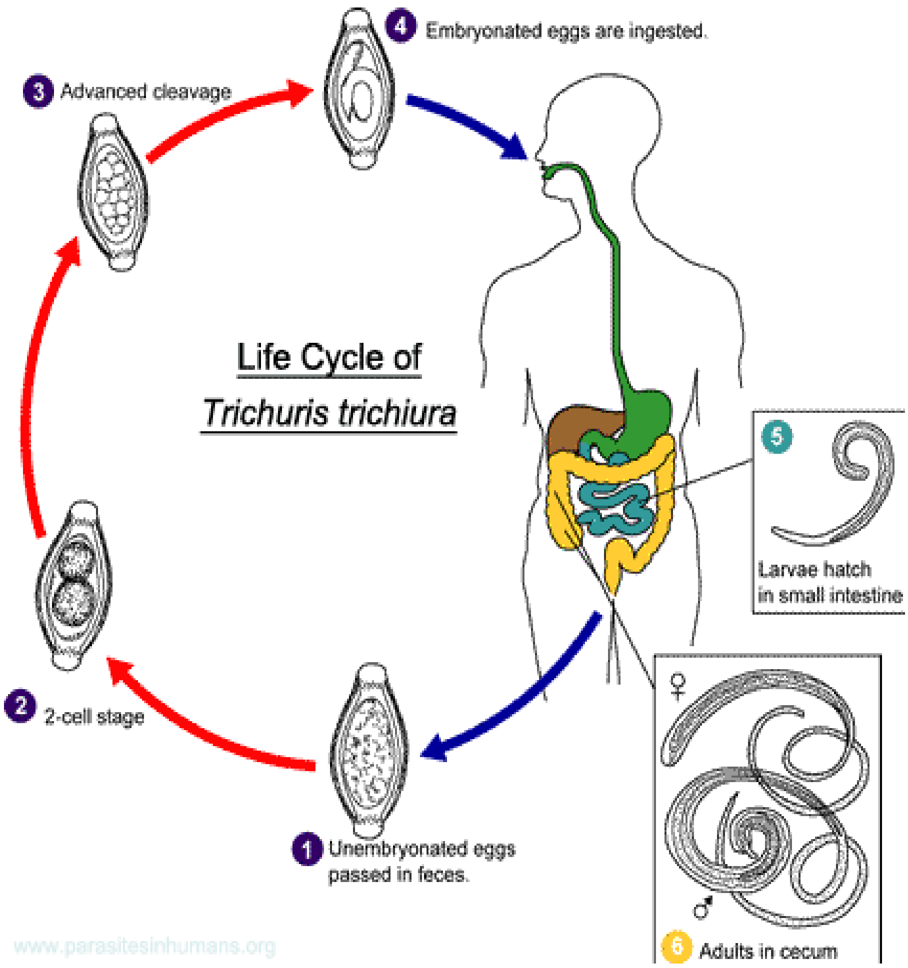


Plate (2-4): Life Cycle of *Trichuris trichiura*(CDC, 2007)

❖ ***Strongyloides stercoralis*:**

The life cycle is complex. Filariform larvae in the soil penetrate exposed skin, pass *via* the blood stream to the lungs, break into the alveolar spaces, ascend the trachea and are swallowed to reach their final habitat in the small intestine, where the adults develop. Females produce eggs that hatch in the mucosa, and the larvae bore through the epithelium into the faeces. At this stage, larvae can develop into free-living adults, which continue their life cycle indefinitely in the soil, or into filariform larvae, directly via three moults. Filariform larvae are usually passed in the faeces, but may re-invade the host in the lower gastrointestinal tract or perianal skin before evacuation. Because of this process of ‘autoinfection’, *S. stercoralis* is one of the few species of helminth that can complete its life cycle and thereby multiply in humans. Clinical features – many infected individuals are asymptomatic, and ongoing, low-level autoinfection means that they may harbour infection for decades after leaving endemic areas. Larva currens (a creeping, pruritic eruption on the skin) and eosinophilic pneumonia are occasional manifestations, (Smyth, 1996).

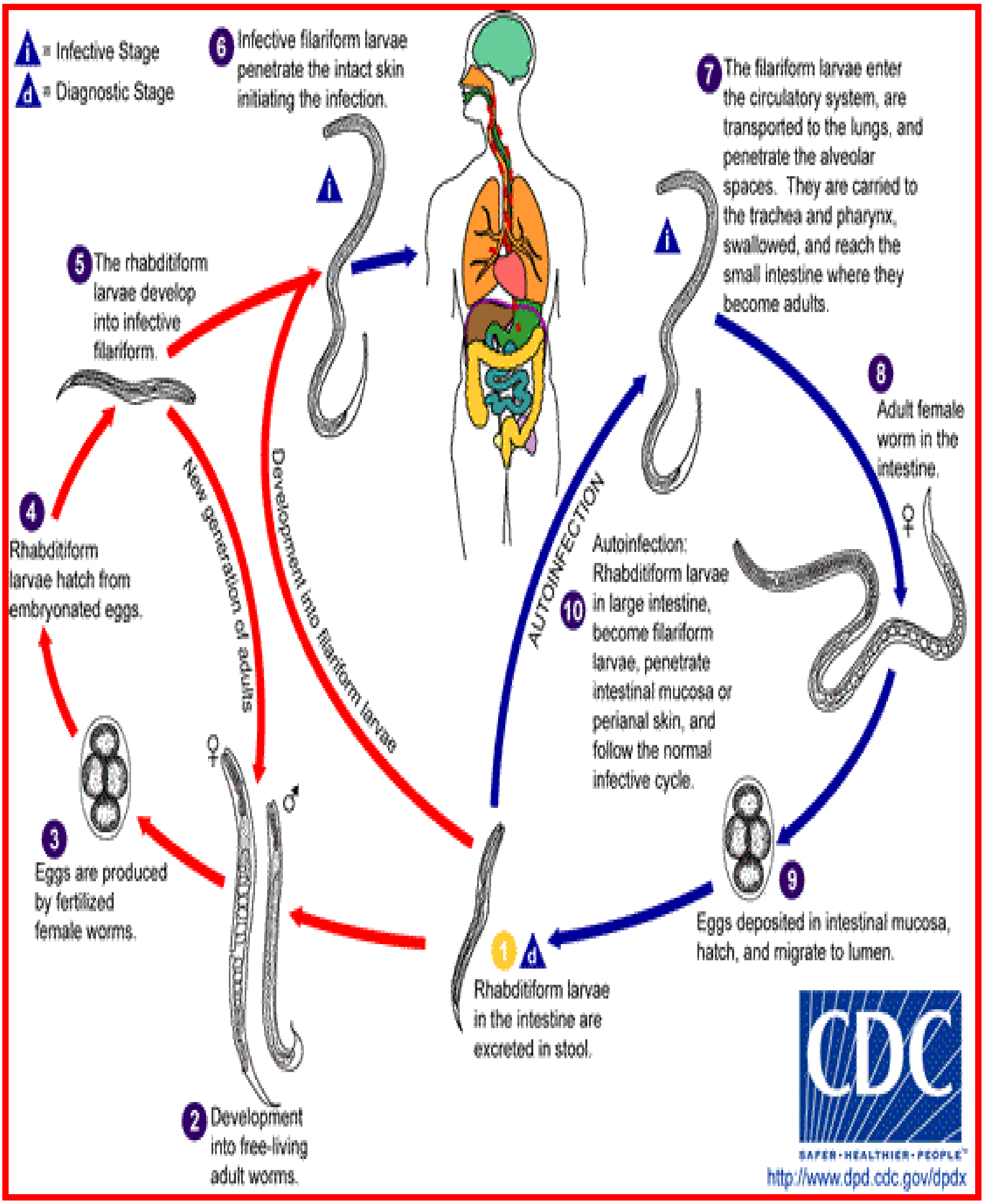
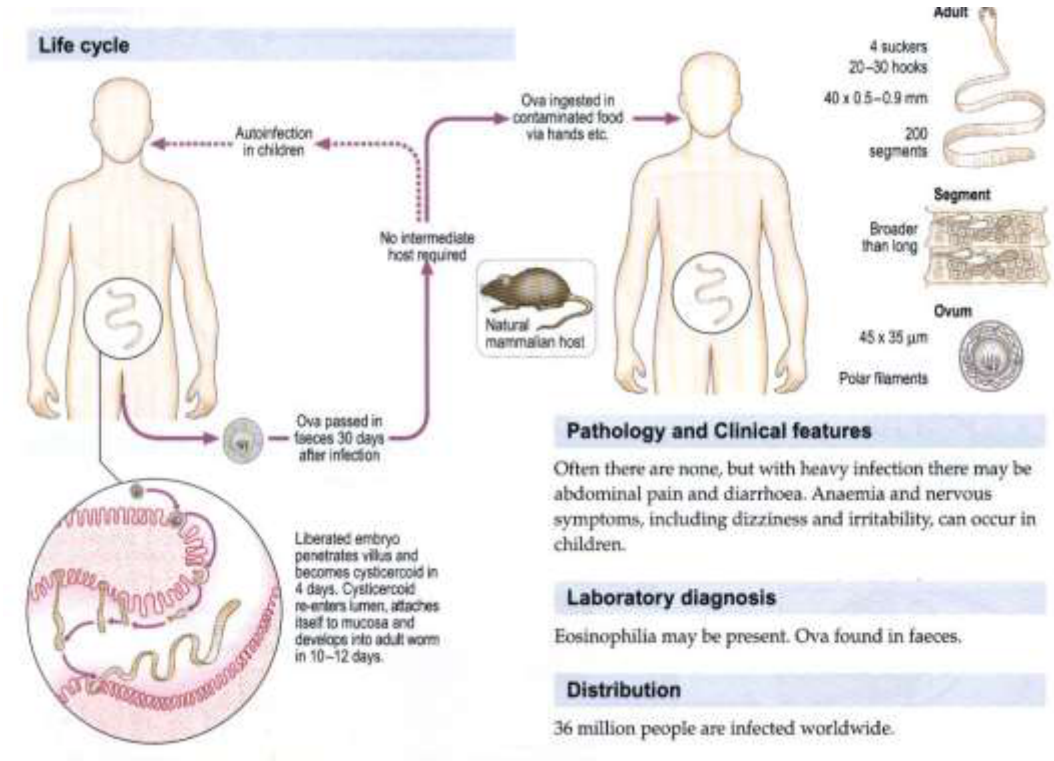


Plate (2-5): Life Cycle of *Strongyloides stercoralis* (CDC, 2007)

There are other helminth infections associated with the intestinal tract that are less widespread in man than the intestinal nematodes transmitted through soil, but which must be mentioned because they already do or may have local or regional public health significance. These include infections caused by Hymenolepis nana, *Taenia saginata*,*T. solium*, *Fasciolopsis buski*,*Angiostrongyluscostaricensis*, and *Capillariaphilippinensis*(WHO,1987).



Plate(2-6): Dwarf tape worm*Hymenolepis nana* (Atlas of medical Helminthology and protozoology, (Chiodini, 2001).

2.8.1 Intestinal Helminthes Parasites in Sudan

Sudan remain as endemic country,(Lo *et al*.,2017).With varying prevalence rates by state (Omer, 2011), there has never been a nationwide survey for these diseases, and even the prevalence rates reported in most states were not calculated on a solid epidemiological basis. Therefore, the Ministry of Health (MOH) was not able to develop an adequate strategy to control and eliminate these diseases in Sudan, including a plan for a nationwide mass drug administration (MDA) intervention. MDA targeting the at-risk population is an essential public health effort for combatting NTDs.(Hotez, 2009). In order to conduct a nationwide MDA program, it should be demonstrated whether a country has surpassed the threshold for intervention set by the World Health Organization (WHO);(Cha *et al*.,2017), in certain administrative units, (Savioli, 2006).

Infection with schistosomiasis and soil-transmitted helminthes (SSTH) constitutes a major health problem worldwide, yet the burden of disease is in the tropical countries. The disease is endemic in River Nile State, Sudan but the exact prevalence rate is unknown, (Elmadhoun, *et al*.,2013). A survey of 2490 pupils in 103 basic schools in River Nile State, Sudan was conducted to determine the prevalence and distribution of SSTH infections, Stool and urine samples were collected and examined for ova of *Schistosoma haematobium*, *S. mansoni* and intestinal worms. Questionnaires were used to obtain demographic data, to quantify exposure to assess the perception of pupils and stakeholders about risk behviours and control strategies. the prevalence rate for intestinal helminthes was 0.1%, (Elmadhoun *et al*.,2013).

In Berber locality, River Nile State, 2017, out of 100 students examined 87.2% had infection with intestinal parasites, the high prevalence of these infections is closely correlated with poverty, poor environmental hygiene and impoverished health services,(Ekpo *et al*.,2008);(Mehraj et al.,2008). The prevalence of intestinal parasite in Berber area primary schools was very high. At Alhag Yousif Area, north of Khartoum the prevalence of20Ascaris lumbricoides was 1.20% in 2017among selected group of primary schoolchildren in Alhag Yousif area(Siddig *et al*.,2017)**.** At central Sudan, the prevalence of *Ascaris* lumbricoides in 2010 was 32.5%, Ancylostoma duodenale, was 7.6%,and Trichuris trichiura was 6.3% among primary school children in ELdhayga(Abdel-Aziz*et al.*,2010).common intestinal helminth species identified in participants stool samples, among Pupils in Basic Schools at Aboshareef Area, Kosti Locality, White Nile State in 2019 , the most common one being hookworm with the prevalence of 24%,followed by *A. lumbricoides* 11%, *Trichuris trichiura* 4.2%,(Elmadani et al.2020)**.**The prevalence of *Ascaris* lumbricoides in Malakal city,in 2016 was 0.7% ,and *Trichuris trichiura* was 0.2%,(Bayoumi, M., *et al*.,2016)**.**The prevalence of STH among an adult population in a war affected area, Southern Kordofan state was, 7.8 %,(Abou-Zeid,2012). Enteroparasitosis infections among renal transplant recipients in Khartoum state were, *Ascaris lumbricoides* 3.12%, *Strongyloides stercoralis*, 1.5%(Mohamed *et al*.,2018).

2.10Protozoaninfection

Infections of the human intestinal tract with the pathogenic protozoa *Entamoeba histolytica*, *Giardia intestinalis*, and Cryptosporidium spp. are a common cause of diarrhoea and have a worldwide distribution, (Chávez*et al*.,1986);(WHO,1985) . The complications of invasive amoebiasis are potentially fatal and giardiasis may cause malabsorption in children. In view of the high prevalence of protozoan intestinal infections and the morbidity the cause, measures aimed at their prevention and control should be strengthened. Although adequate treatment for amoebiasis and giardiasis is available, the diagnosis of the infections presents difficulties, particularly in epidemiological surveys, because the microscopic techniques used require highly skilled personnel seldom available where there infections are most prevalent, (WHO,1987).

Entamoeba coli cysts

Plate (2-7): *Entamoeba coli* cysts (Atlas of medical Helminthology and protozoology), (Ottesen *et al*, and 2008)

2.10.1 Amoebiasis

Invasive amoebiasis is a major health and social problem in western and south-eastern Africa, south-east Asia, China, and Latin America, especially in Mexico. Inadequate sanitary conditions in these regions and the presence of highly virulent strains of Entamoeba histolytica may combine to sustain a high incidence of both intestinal amoebiasis and amoebic liver abscess. At present, on a global scale this infection represents one of the most common causes of death from parasitic intestinal diseases. It has been estimated (Donaldson,1991),(that, in1981, probably 480 million people carried *E. histolytica* in their intestinal tracts and 36 million developed invasive forms of amoebiasis. A thorough review of the literature revealed that at least 40 000 died as a consequence of this infection; fatal amoebiasis is mainly due to fulminating colitis or liver abscess. The mortality from fulminating colitis is almost 70%, and that from liver abscess is up to 10%. Amoebic dysentery and amoebic appendicitis have a fatality rate of 0.5-27%, if not diagnosed properly and treated early, (WHO,1987).

For full recovery, patients with amoebic colitis, amoeboma, and amoebic abscess usually require a few weeks of hospitalization and 2-3 months of convalescence (WHO,1985) .In many regions, amoebiasis is an important cause of diarrhoea and dysentery. In Mexico City, up to 15% of cases of acute diarrhoea and dysentery in children requiring hospitalization were found to be associated with E. histolytica. Amoebiasis may be more severe during pregnancy and lactation, and in persons with immunodeficiency; homosexuals, immigrants from certain tropical countries, and travellers are also especially liable to infection. Urban migration, the deterioration of the economies of certain developing countries, and the increasing size of urban slums with crowded, unhygienic conditions may accelerate the spread of amoebiasis and so result in even greater morbidity and mortality from this infection in the future, (Walsh, 1986).

2.10.2 Giardiasis

Giardia intestinalis (G. lamblia) infection is endemic throughout the world and epidemics of it occur sporadically. Reported prevalence rates range from less than 1% to more than 50%, depending on the geographic location of the population and the prevailing type of Giardia transmission (i.e., indirectly through faecally contaminated hands, water, or food or even by the direct faecal-oral route). It has been estimated (Cattanach,1985), that about 200million infections occur per year in Africa, Asia, and Latin America Surveys of giardiasis may give underestimates of prevalence or misleading results because the irregular release of cysts (the detection of which in stool is the basic test for giardiasis) may result in their not being detected when only one stool sample is examined, (Wolfe, 1992).

In the United States of America and the United Kingdom, giardiasis is the most commonly reported intestinal parasitic infection of man, (WHO,1987).

In 1983, in the USA, Giardia was identified as the cause of 68% of waterborne outbreaks of diarrhoea in which an etiologic agent was known, (Wolfe, 1992). In 1984, more than 250 000 people in Pennsylvania were advised to boil drinking water because the routine chlorination process was not effective against Giardia contamination. In temperate climates, giardiasis can be heavy and persistent in people with some form of immunodeficiency; in some areas even drug resistance has been suspected.(WHO, 1987).

Various factors influence rates of morbidity due to G. intestinalis infections: primary versus secondary exposure, age, concurrent infections, nutritional and immunological status, the infecting dose of Giardia and, possibly, differences in Giardia strains. Although substantial proportion of infections may pass unnoticed, probably about 500 000 people suffer from symptomatic giardiasis every year.

Giardiasis is one of the common causes of acute or persisting diarrhoea in children in developing countries, There is some evidence from population studies that giardiasis interferes with intestinal absorption of nutrients and the growth rate of children, (Farthing, 1996)

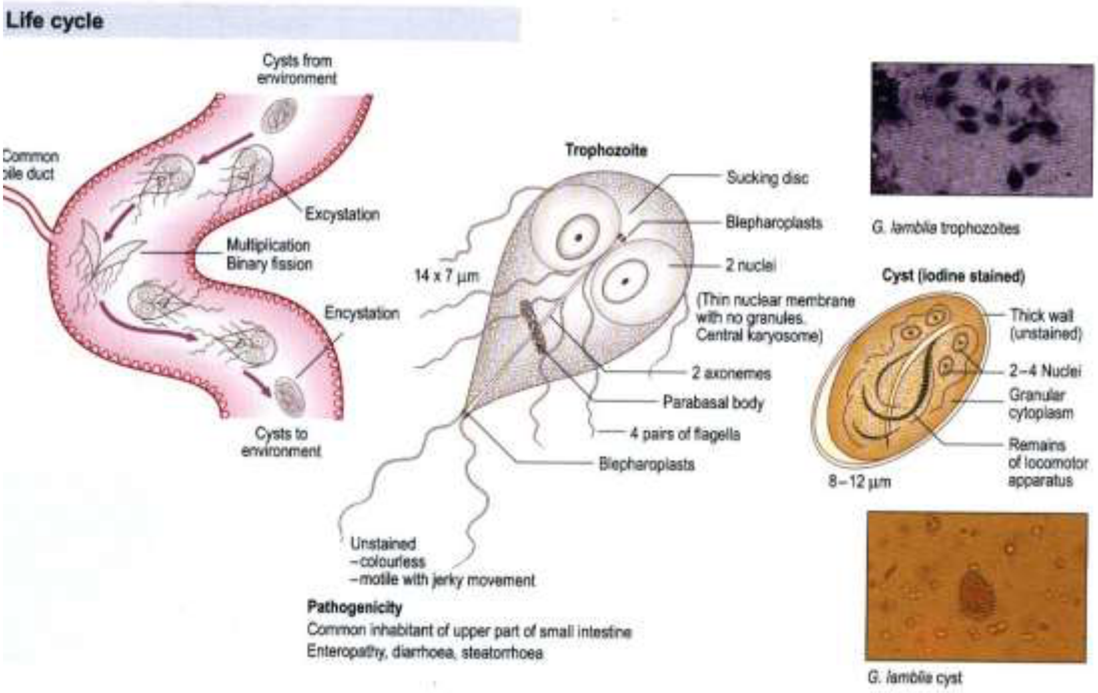


Plate (2-8): *Giardia lamblia* (Atlas of medical Helminthology and protozoology), (Ottesen *et al*., 2008)

Balantidium coli*and*Cryptospordium parvum:

Balantidium coli and *Cryptospordium parvum* are both zoonotic protozoan intestinal infections with some health significance. ***Isospora belli*** is an opportunistic human parasite, (Dr.Abdel Raheam., 2009).*Balantidium coli* parasite primarily of cows, pigs and horses.The organism is a large (100x60 micrometer) ciliate with a macro- and micro- nucleus. The infection occurs mostly bin farm workers and other rural dwellers by ingestion of cysts in fecal materials .Man- to –man transmission is rare but possible. Symptoms and pathogenesis, of balantidiasis are similar to those seen in entamoebiasis, including intestinal epithelial erosion.

Cryptospordium parvum has been found worldwide. It is a small round parasite measuring three to five micrometers which is found in the gastrointestinal tract of many animals and causes epidemics of diarrhea in humans via contaminated food and water.Humans are infected by ingestion of C. parvum oocysts containing many sporozoites. The sporozoites are released in the upper gastrointestinal tract and attach to the gut mucosal cells where they divide to produce merozoites. The merozoites invade other mucosal cells and further multiply asexually.Some of the merozoites differentiate into male and female gametocytes and form an oocyst in which they multiply and differentiate into sporozoites.The mature oocyst is excreted with faecal material and infects other individuals. When a large number of humans in a community have diarrhea, the most likely cause is C. parvum.

Isospora belli:

Worldwide, especially in tropical and subtropical areas, infection occurs in immunodepressed individuals, and outbreaks have been reported in institutionalized groups in the United States. The infective stage of the organism is an oval oocyst which, upon ingestion, follows the same course as C.parvum .The disease produces symptoms similar to those of giardiasis. In normal individuals, mild infections resolve themselves with rest and mild diet and heavier infections can be treated with sulpha drugs.

WHO**,**is fully committed to engage with all concerned partners, and specifically with partners in the (WASH) sector, in order that the necessary tools, guidance, and support is provided to all STH-endemic countries so that the ultimate goal of eliminating morbidity due to STH and strongyloidiasis is achieved by 2030.(WHO,2020).

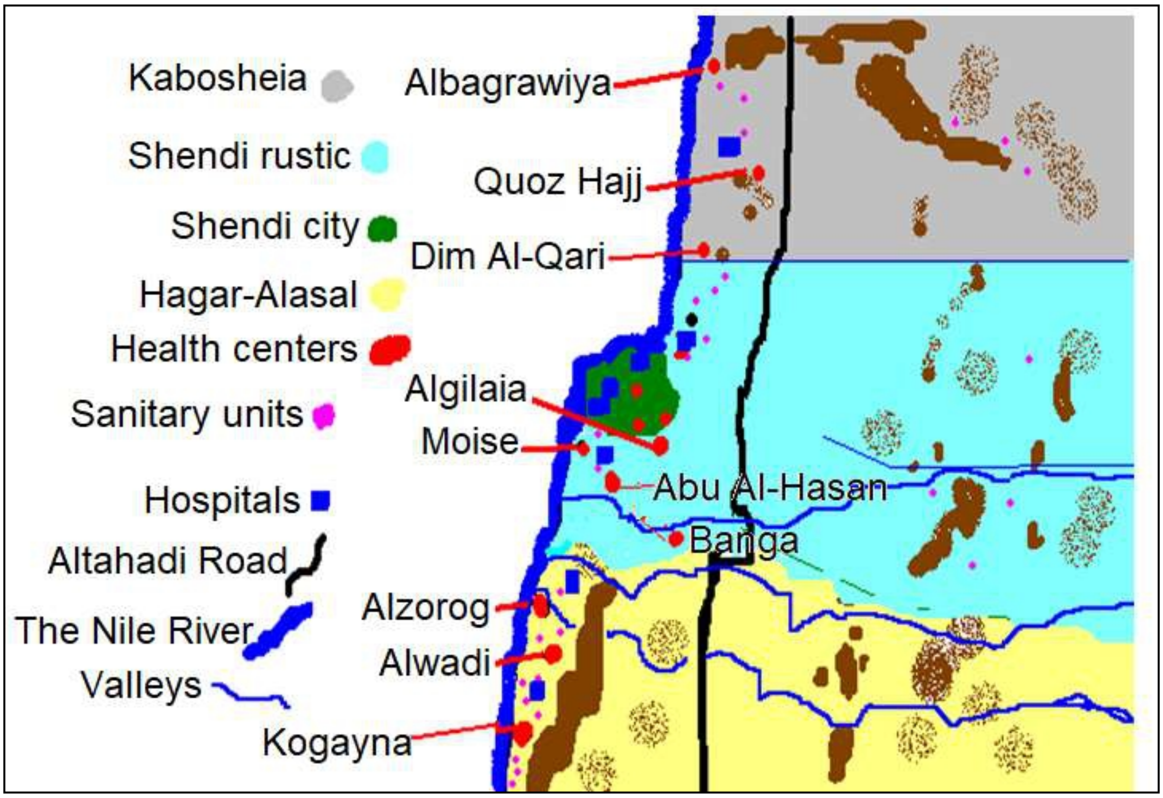
CHAPTER THREE

MATERIALS AND METHODS

3.1 Study area :(rural areas)

Study was rural areas of Shendi locality, Shendi city situated on the east bank of the River Nile, northern Sudan, geo-coordinately between 16 40 52 and 33 25 7 E. Shendi locality is located in the north of Khartoum state, and it is bordered to the north by the village of AL-Dika and to the south by the village of Al-Misikitb in the south. The area has semi-arid climatic features with a very short rain period in August, and a mean annual temperature of 40^{o} C.Shendi locality has a number of rural administrative units, which are the Kaboshia,t district the South Shendi district the North Shendi district, the Al-Basabeer district and the Honey stone unit. The South Shendi unit starts from Algilayaa village to Wad Banaga village, in these areas 48 basic schools, of which 9 are boys schools, 9 are girl's schools, and 30 are mixed schools.

The North Shendi district has number of basic schools, 33 basic schools, of which 10 are for boys and 10 are for girls and 13 are for mixed schools, geographical limits of this north areas start from Alshagalwa village even AL-Dushin village. Most tribes of the population in Shendi locality are AL-Jaaleen, AL-Shaigia, AL-Hassania and AL-Ababda, most of them work in agriculture and trade.



Map (3-1): Source: Shendi Locality

As the prevalence of parasites in general increases in crowded rural areas with low health awareness and underdeveloped in terms of public health.

3.2 Study Design

Cross-sectional study was conducted from January 2021 to April 2024.

3.3 Sample size determination

The study community is the students of basic schools in the northern, southern countryside and center of Shendi locality. The sample size was determined according to the equation:

$$n = \frac{N}{1 + N \times d^2}$$

In northern countryside sample size was 386, in southern countryside it was 400, in center of Shendi locality it was 387, the sample size of 1200 was calculated to reduce the error in sample collection, and the sample size was taken from a total of 40 schools, as follows:

13 schools from both the northern and southern countryside and 14 schools from the center of Shendi locality. Samples were collected from the second, fourth, and first intermediate classes, with a total of 30 samples for each class.

Plate (3-1): Awareness for children at HoshBanga Basic School for girls and the selection of participating in preparation for the collection of samples

Plate (3-2): Questionnaires with children from Wad Alnaseeh Basic school for girls

Plate (3-3): Awareness for children at Algilayaa (A) Basic school for girls and the selection of participating girls in preparation for the collection samples

Plate (3-4): Some of the children selected to participate in survey are from Wad Killian Basic School for Boys

3.4 Ethical consideration

Before the study initiation, an endorsement was obtained from the Ministry of Health and Ministry of General Education, of the River Nile State, and from Managements of Health and General Education of Primary Schools in Shendi Locality. The certifications were granted first from the director of health in the locality and then the director general of education in the locality, as well as the two deputy directors general for each of the schools of the northern, southern countryside, and center of Shendi locality as well as the certifications were granted by the principals of the schools in three areas,

Through the school principals, there was enlightenment for teachers, especially the supervisors of the targeted classes.

Plate (3-5): An interview with the director of health in Shendi locality to obtain permission from the health department to conduct the survey

3.5.1 Stool Sample Collection and Examination

All study participants were provided with labeled clean plastic stool containers with a unique identification number and asked to provide a minimal volume of stool.

The collected samples were transported to Research Laboratory, Shendi University, in an ice –cooled box, where they were examined immediately for IP, or stored at refrigerated temperature (4 C) for a maximum of one day before processing.

3.5.2Microscopic Examination of Stool

The Direct smear examination, Flotation and Formal ether concentration technique were used for the detection of different gastrointestinal parasites.

3.5.3 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

Plate (3-6): Some of the tools used in the diagnosis

3.5.4Formal-ether Technique (FET)

In such technique, utilizing a wooden stick about one gram of the stool sample is put on the fiber-glass mortar with continuous mixing after addition of 10 ml of formalin solution (10%). The mixture will be poured into as centrifugation tube *via* two layers of the surgical gauze (small mish-size) over a glass funnel. Three milliliters of ether (or ethyl acetate or gasoline) will be added to the sieved solution in the glass funnel. The mixture should be thoroughly shacked before being put in hand or electrical centrifuge. The centrifuge should be operated for two minutes with a speed of about 400 - 500 round per minute. Observe the formation of four conspicuous layers – the **first** layer is the ether (or ethyl acetate or gasoline), the **second** is the layer fat remains, the **third** is the formalin and the **fourth** is the precipitate. Via one trial get rid of the upper three layers without mixing or moving the precipitated material. Put the centrifugation tube in a converted manner for 10 seconds so as to get rid of the solution in the precipitated material. Two drops of the Lugol's solution will be added to the precipitated material. Using Pasteur pipette part of the precipitated material will be transferred to glass slide that covered with cover slips, which is now ready to be examined under any stereo binocular microscope, (cited byAhmed, 2009).

Modification of the formol-ether concentration technique by initial measurement of an exact quantity of faeces, the use of a stainless steel sieve instead of gauze, the addition of a 2nd sieve, the use of Triton as a wetting agent, and the addition of a 2nd washing step before the concentration step and a final sedimentation step, made it more sensitive in terms of number of *Schistosoma mansoni* eggs counted. The sediment was smaller and clearer and needed about 15% less time to examine. It was more successful than the Kato technique just in detecting light infections, (Knight*et al*., 2006).

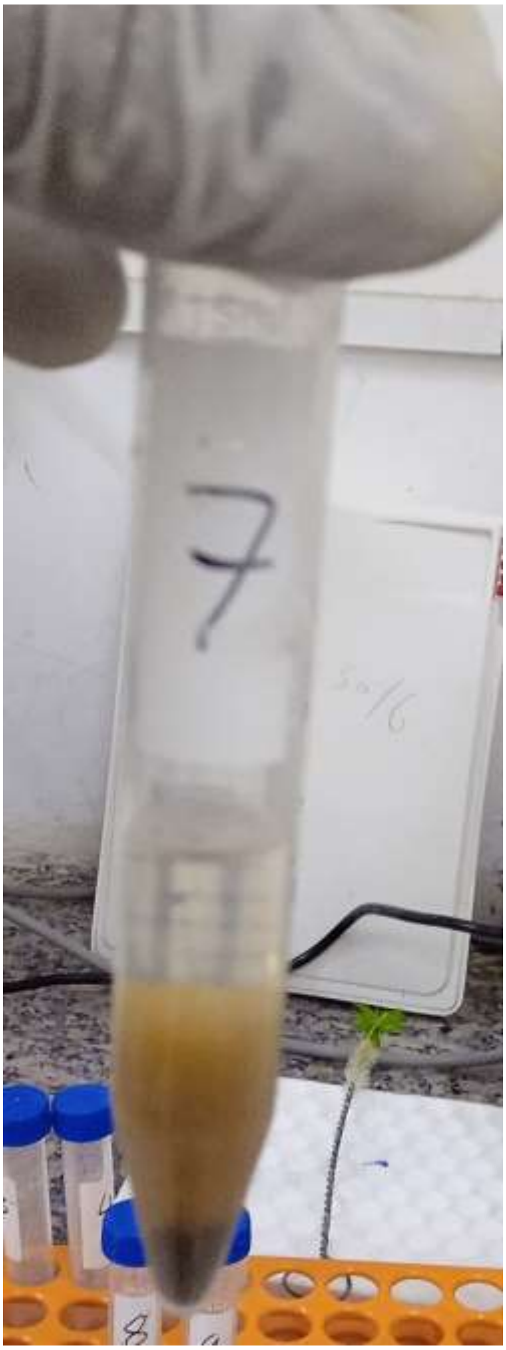


Plate (3-7): Observe the formation of conspicuous layers after centrifugation

Plate (3-8): weigh of salt on the sensitive balance to prepare normal saline

3.5.5 Sodium chloride flotation technique:

Required: -

Sodium chloride powder, D.W, Test tube of about 15 ml cabacity, Pasteur pipette, wooden stick, slide, and cover glass.

Method:-

First: for sodium chloride solution:-

33 gram Nacl powder soluted in 100 ml D.W. until saturated.

Second:-

- Fill the tube about one quarter full with the Nacl solution. Add 1 gram of feces, using a wooden stick, emulsify the specimen in the solution.
- Fill the tube with the Nacl solution.
- Stand the tube in a completely vertical position in a rack using Pasteur pipette add further solution to ensure the tube is filled to the brim.
- Carefully place a completely clean cover glass on top of the tube. Avoid any air bubbles.
- Leave the tube for 30- 45 minutes.
- Carefully lift the cover glass from the tube and place the cover glass on a slide examine the preparation microscopically using 10 x objective then 40 objectives.

Count the number of eggs or cyst to give the pproxinate number per gram of feces.

3.5.6 Questionnaires

A pre-tested questionnaire was conducted to all selected candidates, to obtain demographic data, to quantify exposure to pollution and to assess the perception of pupils and stakeholders about risk behaviors and control strategies.

Plate (3-9): Questionnaire with a girl in Alkhansa Basic School for girls, BirAbudomatvillage

3.5.7 Treatment and health education

All subjects who were found have treated under medical supervision, where the doses of treatment were according to the age and weight of the child and the type of parasite, as follows:

Ascaris lumbricoides, Albendazole tabs 400mg once > 5 years. Mebendazole syrup100mg once < 5 years.

Ancylostoma duodenale, Albendazole tabs 400mg once > 5 years. Mebendazole syrup100mg once < 5 years.

Schistosoma mansoni, Praziquantil tabs 600mg/ 40mg/ kg/ dose- single dose.

Taenia species, Praziquantil tabs 600mg/ 5-10 mg / kg/ dose-single dose.

Or, Albendazole tabs 400mg once daily for 1 week.

Hymenolepis nana, Praziquantil tabs 600mg/ 25mg/ kg/ single dose.

Strongyloides stercoralis, ivermicten 200 mg / kg orally for 2 days, or Albendazole tabs 400mg twice daily for 1 week.

Trichuris trichura,albendazole 5 mg / kg/ day for 1 week, or mebendazole 5 mg/ kg/day for 14 days.

Giardia lamblia, metronidazole 15 mg /kg/day for 5 days.

*Entamoeba histolytica*or*Entamoebacoli* Metronidazole 35-50 mg / kg 8 hourly for 10 days.

Health education

In all the schools visited, there was awareness for children of necessary of personal hygiene, washing hands after defecation and before eating, the necessary of washing vegetables and fruits well before eating them, and the necessary of using toilets instead of open defecation.

3.5.8 Statistical analyses

The data after collected, Statistical analysis was done by using SPSS programme under windows (IBM) computer system. Mean was calculated for comparison between different groups using cross tabulation. Chi-squared test was utilized to determine the level of significance in the differences of infection in the prevalence rates, the confidence limit was 95%, the P value was considered to be significant at value of ≤ 0.05.

CHAPTER FOUR

RESULTS

4.1. Distribution of samples

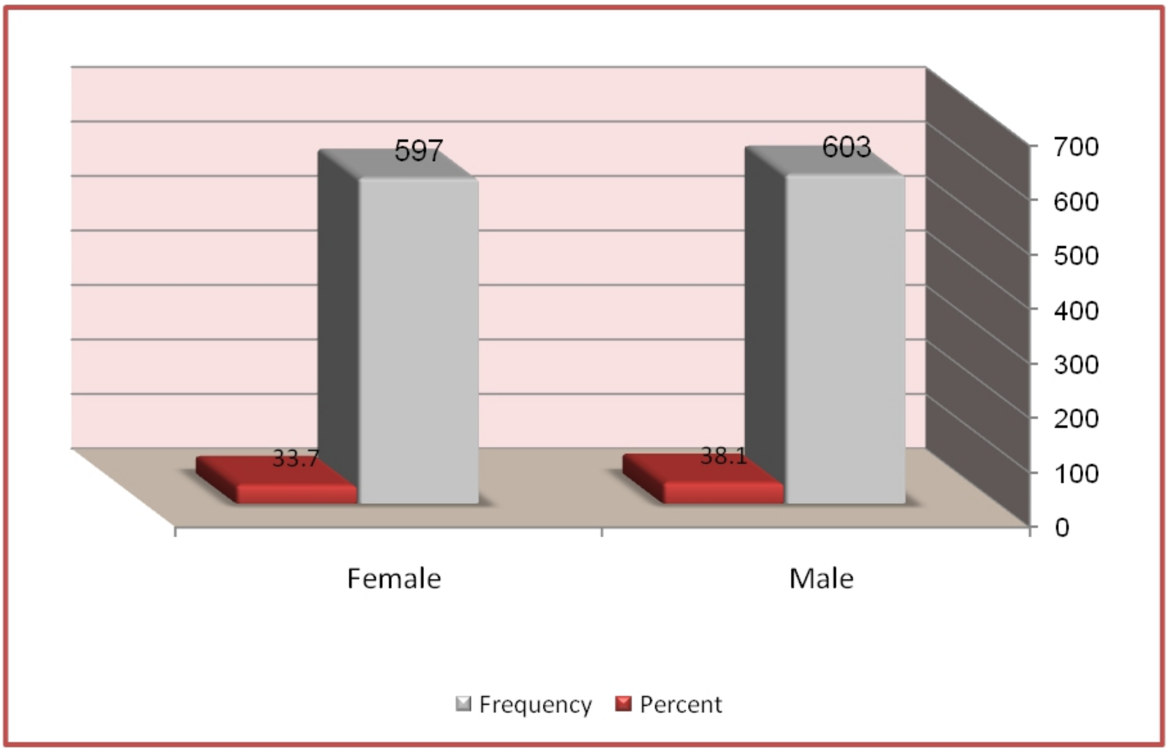


Figure (4-1): prevalence of infection according to gender

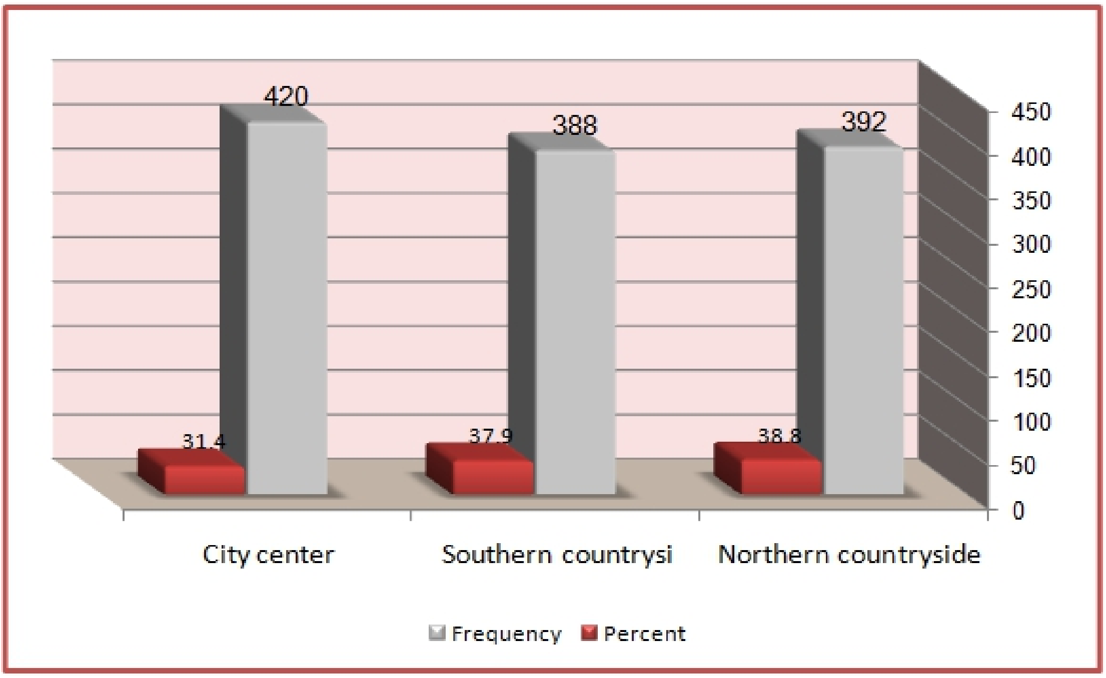


Figure (4-2): prevalence of infection according to residential area

4-2. Intensity of intestinal parasites according to the three different diagnostic techniques:

Table (4-1) illustrate, the highest intensity scored when using Formal- Ether Concentration Technique (Sed) was (7.1), while it was (5.1) via Flotation Technique (Flo), and (0.9), when used wet preparation Technique, (WP). Statistical analysis showed that there was a highly significant rate, ($p < 0.001$)

Table (4-1): Intensity of intestinal parasites according to the three different diagnostic techniques

Parasite species	Flo (n=1200)	Sed (n=1200)	Wp (n=1200)
Entamoeba coli	3.0±0.2	4.3±0.2	0.9±0.01
E. histolytica	5.3±0.7	7.0±0.8	0.9±0.03
Giardia lamblia	4.9±0.7	7.0±0.9	0.9±0.02
Helminths	0	0	0
Enterobius vermicularis	8.0±2.9	11.9±4.8	1.0±0.0
Hymenolepis nana	6.6±0.9	8.1±0.9	1.0±0.0
***Taenia* spp.**	3.0±1.1	4.0±1.4	1.0 ±0.0
Total	5.1±0.8	7.1±1.2	0.9±0.02
Highly significant P value < 0. 001			

4.3Overall infection parameter of intestinal parasites:

In three residential sites**,** of Shendi locality, the participation rate of the randomly selected samples was100%, where 1200 School Age Children (SAC) responded by providing the requested fecal samples, table (4-1). In all collected fecal of the participants the microscopic examination verified that the variations in the infection rates, based on the residential sites, age of children practices and the economic and social status of their families. An overall prevalence of infection of 35.9%, while the overall mean intensity of infection or egg counts per gram (epg) was 12.04.

In the present study, a total of 6 genera of gastrointestinal parasites were identified, of them 3 protozoans namely *Entamoeba coli*, *E. histolytica*, Giardia *lamblia,* and 3 helminthes of them 1nematode namely *Entrobius vermicularis*, and 2 cestodes namely *Hymenolepis nana* and *Taenia spp*. It was observed that the prevalence of *Entamoeba coli* infection was the highest, whereas prevalence of *Taenia spp* parasite infection was lowest,

Table (4-2): Overall infection parameter of intestinal parasites

Parasite species	Frequency	Prevalence %	Mean intensity ±SE
Entamoeba coli	140	11.7	8.4 ±0.4
E. histolytica	105	8.8	13.7±1.6
Giardia lamblia	87	7.3	12.9±1.6
Enterobius vermicularis	31	2.6	20.9±7.7
Hymenolepis nana	56	4.7	15.7±1.8
***Taenia* spp.**	4	0.3	8.0±1.7
Total	423	35.3	12.04±1.9

4-4: Overall prevalence of intestinal parasites among (SAC) in three residential sites, Shendi locality (2023)

The prevalence rate was calculated using the direct smear technique.

Table (4-3):verifies that the prevalence of infection was 38.8%, 37.9%, 31.4% in respectively value of chi square Northern, Southern country sides and city center test is **0.05.** This means that there is statistically significant of prevalence of infection according to residential sites.

Table (4-3): Overall prevalence of intestinal parasites among (SAC) in three residential sites, Shendi locality (2023).

Parasites	Northern countryside (n = 392)		Southern countryside (n = 388)		City center (n = 420)	
	Frequency	Prevalence (%)	Frequency	Prevalence (%)	Frequency	Prevalence (%)
Entamoeba coli	43.0	10.9	40.0	10.3	57.0	13.6
E. histolytica	38.0	9.7	36.0	9.3	31.0	7.4
Giardia lamblia	34.0	8.7	27.0	6.9	26.0	6.2
E. vermicularis	14.0	3.6	14.0	3.6	3.0	0.7
H. nana	19.0	4.8	24.0	6.2	13.0	3.1
***Taenia* spp.**	1.0	0.3	3.0	0.8	0.0	0.0
total	149.0	38.0	144.0	37.1	130.0	30.9
Statistical Significance			**P value < 0.05**			

4-5: Prevalence of infection according to father occupation

Table (4-4) illustrate the prevalence of infection of (GI) parasites among the surveyed samples from (SAC) in rural areas and center of Shendi locality by occupational categories of the students' father the different occupants could be arranged in the following descending order:, , farmer,government employee, self-employee and fishing . P value of chi square test is 0.6 > 0.05, this means that there is no a statistically significant rates.

Table (4-4): Prevalence of infection according to father occupation

Parasites species	Government employee (n = (232)		Farmer (n = (324)		Self-employee (n = 629)		Fishing (n = (15)	
	Frequency	Prevalence %	Frequency	Prevalence %	Frequency	Prevalence %	Frequency	Prevalence %
Protozoans								
Entamoeba coli	30.0	12.9	29.0	8.9	80.0	12.7	1.0	6.7
E. histolytica	21.0	9.1	30.0	9.3	54.0	8.6	0.0	0.0
Giardia lamblia	15.0	6.5	21.0	6.5	49.0	7.8	2.0	13.3
Helminths								
Enterobius vermicularis	6.0	2.6	13.0	4.0	12.0	1.9	0.0	0.0
Hymenolepis nana	10.0	4.3	13.0	4.0	32.0	5.1	1.0	6.7
***Taenia* spp.**	0.0	0.0	1.0	0.3	3.0	0.5	0.0	0.0
Total	82.0	35.3	107.0	33.0	230.0	36.6	4.0	26.7
P value > 0.05								

4-6: Prevalence of infection a according to father education level

Table (4-5)) illustrate the prevalence of infection of (GI) parasites among the surveyed samples from (SAC) in rural areas and center of Shendi locality by father education level categories of the students, the different education levels of father's students could be arranged in the following descending order: illiterate, primary. Secondary and university, P value of chi square test is 0.1 > 0.05, this means that there is no a statistically significant rate.

Table (4-5): Prevalence of infection a according to father education level

Parasite species	Illiterate (n = 52)		Primary (n = 437)		Secondary (n = 424)		University (n = 287)	
	Frequency	Prevalence %	Frequency	Prevalence %	Frequency	Prevalence %	Frequency	Prevalence %
Protozoans								
Entamoeba coli	8.0	15.4	45.0	10.3	46.0	10.8	41.0	14.3
E. histolytica	2.0	3.8	31.0	7.1	46.0	10.8	26.0	9.1
Giardia lamblia	2.0	3.8	35.0	8.0	31.0	7.3	19.0	6.6
Helminths								
Enterobius vermicularis	1.0	1.9	12.0	2.7	14.0	3.3	4.0	1.4
Hymenolepis nana	0.0	0.0	21.0	4.8	24.0	5.7	11.0	3.8
***Taenia* spp.**	0.0	0.0	0.0	0.0	4.0	0.9	0.0	0.0
Total	13.0	25.0	144.0	32.9	165.0	38.9	101.0	35.2
P value > 0.05								

4-7: Prevalence of intestinal parasites by treatment taken after infection

Table (4-6) illustrate the overall prevalence of infection among the surveyed

(SAC) by treatment method, the children who go to the hospital where their prevalence 34.8%,on the other hand, the children reported that they use traditional medicine were41.3%,the children not use traditional medicine were 32.4%, P value of chi square test is 0.2 > 0.05, this means that there is no a statistically significant rate.

Table (4-6): Prevalence of intestinal parasites by treatment taken after infection

Parasite species	Go to hospital (n = 135)		Use traditional medicine (n = 300)		Use non-traditional medicine (n = 139)	
	Frequency	Prevalence %	Frequency	Prevalence %	Frequency	Prevalence %
Protozoans						
Entamoeba coli	17.0	12.6	27.0	9.0	17.0	12.2
E. histolytica	15.0	11.1	31.0	10.3	7.0	5.0
Giardia lamblia	6.0	4.4	27.0	9.0	11.0	7.9
Helminths						
Enterobius vermicularis	3.0	2.2	21.0	7.0	2.0	1.4
Hymenolepis nana	5.0	3.7	14.0	4.7	6.0	4.3
***Taenia* spp.**	0.0	0.0	3.0	1.0	1.0	0.7
Total	46.0	34.1	123.0	41.0	44.0	31.7
P value > 0.05						

4-8 Prevalence of intestinal parasites according to parasite transmissions awareness

Table (4-7) show the prevalence infection of (GI) parasites among (SAC) by children`s awareness of the ways intestinal parasites are transmitted ,the prevalence rate among (SAC) who said that transmission occurs through contaminated food and drink was 33.4%, and between those who said it occurs through water was 27.5%, as for the children who have no information, the prevalence of infection was 44.9%, P value of chi square test is 0.01 < 0.05,this means that there is a statistically significant relationship between children`s awareness and prevalence of infection.

Table (4-7): Prevalence of intestinal parasites according to parasite transmissions awareness

Parasite species	Contaminated food and drinks (n = (658)		Water contact (n = 80)		No information (n = 138)	
	Frequency	Prevalence %	Frequency	Prevalence %	Frequency	Prevalence %
Protozoans						
Entamoeba coli	72.0	10.9	8.0	10.0	18.0	13.0
E. histolytica	56.0	8.5	5.0	6.3	14.0	10.1
Giardia lamblia	40.0	6.1	2.0	2.5	19.0	13.8
Helminths						
Enterobius vermicularis	14.0	2.1	4.0	5.0	1.0	0.7
Hymenolepis nana	29.0	4.4	3.0	3.8	8.0	5.8
***Taenia* spp.**	4.0	0.6	0.0	0.0	0.0	0.0
Total	215.0	32.7	22.0	27.5	60.0	43.5
Statistical Significance	**P value < 0.05**					

4-9: Prevalence of infection according to hand washing material at school

Table (4-8), shows a high prevalence among (SAC) who do not wash their hands at school it was 38.5%, while the children who wash their hands with water only, it was 37.5%, children who wash their hands with water and soap have shown a lower incidence of infection 26.3%, P value of chi square test is 0.01 < 0.05, this means that there is a statistically significant relationship between (presence of disease), and washing material at school and prevalence rate.

Table (4-8): Prevalence of infection according to hand washing material at school

Parasite species	Water and soap **(n = (171)**		Water only **(n = (1016)**		No wash **(n = 13)**	
	Frequency	Prevalence %	Frequency	Prevalence %	Frequency	Prevalence %
Protozoans						
Entamoeba coli	24.0	14.0	115.0	11.3	1.0	7.7
E. histolytica	9.0	5.3	95.0	9.4	1.0	7.7
Giardia lamblia	7.0	4.1	79.0	7.8	1.0	7.7
Helminths						
Enterobius vermicularis	2.0	1.2	27.0	2.7	2.0	15.4
Hymenolepis nana	3.0	1.8	53.0	5.2	0.0	0.0
***Taenia* spp.**	0.0	0.0	4.0	0.4	0.0	0.0
Total	45.0	26.3	373.0	36.7	5.0	38.5
Statistical Significance P value < 0.05						

4-10: Prevalence of infection according to washing of vegetables and fruits prior eating

Table (4-9) illustrate the overall prevalence of infection among the surveyed **(SAC)** by washing of vegetables and fruits before eating, the prevalence of infection among children who are washing vegetables and fruits before eating all times was 35.5%, while the children who were washing vegetables and fruits before eating Sometimes the prevalence was 44.4%, P value of chi square test is 0.2 > 0.05, this means that there is no a statistically significant rate.

Table (4- 9): Prevalence of infection according to washing of vegetables and fruits prior eating

Parasite species	**Washing (n = 1146)**		**Sometimes washing (n = (54)**	
	Frequency	Prevalence %	Frequency	Prevalence %
Protozoans				
Entamoeba coli	131.0	11.4	9.0	16.7
E. histolytica	97.0	8.5	8.0	14.8
Giardia lamblia	86.0	7.5	1.0	1.9
Helminths				
Enterobius vermicularis	27.0	2.4	0.4	7.4
Hymenolepis nana	54.0	4.7	2.0	3.7
***Taenia* spp.**	4.0	0.3	0.0	0.0
Total	399	34.8	20.0	37.0
P value > 0.05				

4-11: Prevalence of infection according to hand washing after defecating

Table (4-10) show the prevalence infection of (GI) parasites among (SAC) in rural areas and center of Shendi locality by washing of hands after defecating. The prevalence rate among children who were washing their hands after defecation was 29.5%, on the other hand children who did not wash their hands after defecating, the prevalence rate was 46.1%, while the children who were washing their hands after defecation, sometimes the prevalence was 45.3%. %, P value of chi square test is 0.001 < 0.05, this means that there is a statistically significant relationship between hand washing after defecating and prevalence rate.

Table (4- 10): Prevalence of infection according to hand washing after defecating

Parasite species	**Washing (n = 718)**		**No washing (n = 102)**		**Sometimes washing (n = 380)**	
	Frequency	Prevalence %	Frequency	Prevalence %	Frequency	Prevalence %
Protozoans						
Entamoeba coli	82.0	5.9	6.0	13.7	52.0	11.4
E. histolytica	54.0	7.5	16.0	15.7	35.0	9.2
Giardia lamblia	38.0	5.3	10.0	9.8	39.0	10.3
Helminths						
Enterobius vermicularis	10.0	1.4	9.0	8.9	12.0	3.2
Hymenolepis nana	20.0	2.8	5.0	4.9	31.0	8.2
***Taenia* spp.**	1.0	0.1	0.0	00	3.0	0.8
Total	205.0	28.6	46.0	45.1	172.0	45.3
Highly significant P value < 0.001						

4-12: Prevalence of intestinal parasites by age groups

Table (4-11) verify the prevalence rates increased to reach (47.0)%,at the age-group(5-7) years, and then declined to reach (33.8)% at the age-group(8-10) years, and reach(27.0)% at the age-group (11-13) years. P value of chi square test is 0.001 < 0.05 which is less than the level of significance, it means that there is a statistically significant relationship between age and infection prevalence.

Table (4-11): Prevalence of intestinal parasites by age groups

Parasite species	**5-7 ys (n = 400)**		**8-10 ys (n = (402)**		**11-13 ys (n = (398)**	
	Frequency	Prevalence %	Frequency	Prevalence %	Frequency	Prevalence %
Protozoans						
Entamoeba coli	49.0	12.3	50.0	12.5	41.0	10.3
E. histolytica	46.0	11.5	32.0	8.0	27.0	6.8
Giardia lamblia	52.0	13.0	24.0	6.0	11.0	2.8
Helminths						
Enterobius vermicularis	26.0	6.5	5.0	1.3	0.0	0.0
Hymenolepis nana	13.0	0.3	21.0	5.3	22.0	5.5
***Taenia* spp.**	0.0	0.0	1.0	0.3	3.0	0.8
Total	186.0	46.5	133.0	33.3	104.0	26.0
Highly significant P value < 0.001						

4-13: Prevalence of infection according to gender

Table (4-12) show that the prevalence of infection, 38.1%, 33.7% for males and females, respectively value of chi square test is 0.1> 0.05, the result means that there is no statistically significant relationship between sexes and infection rates.

Table (4-12): Prevalence of infection according to gender

Parasite species	**Male (n = 603)**		**Female (n = 597)**	
	Frequency	Prevalence %	Frequency	Prevalence %
Protozoans				
Entamoeba coli	74.0	12.3	66.0	11.1
E. histolytica	58.0	9.6	47.0	7.9
Giardia lamblia	45.0	7.5	42.0	7.0
Helminths				
Enterobius vermicularis	19.0	3.2	12.0	2.0
Hymenolepis nana	29.0	4.8	27.0	4.5
***Taenia* spp.**	2.0	0.3	2.0	0.3
total	227.0	37.6	196.0	32.8
P value > 0.05				

4-14: Prevalence of intestinal parasites by symptom of the infection

Table (4-13) verify that the prevalence of infection was 72.1%,for children who show symptoms of infection, whereas asymptotic children was 99.2%, P value of chi square test is 0.001 < 0.05 which is less than the level of significance, it means that there is a statistically significant relationship between symptom and infection rates.

Table (4-13): Prevalence of intestinal parasites by symptom of the infection

Parasite species	Symptomatic (n = 86)		Asymptomatic (n = 371)	
	Frequency	Prevalence %	Frequency	Prevalence %
Protozoans				
Entamoeba coli	3.0	3.5	136.0	36.7
E. histolytica	13.0	15.1	92.0	24.8
Giardia lamblia	21.0	24.4	66.0	17.8
Helminths				
Enterobius vermicularis	23.0	26.7	8.0	2.2
Hymenolepis nana	2.0	2.3	54.0	14.6
***Taenia* spp.**	0.0	0.0	4.0	1.1
Total	62.0	72.1	360.0	97.0
Highly significant P value < 0.001				

4-15: Prevalence of intestinal parasites according to previous infection

Table (4-14) show the prevalence infection of (GI) parasites by previous infection, the prevalence rate of infection in children who were previously infected was 37.9%, and for those who were not infected, the prevalence rate was 34.1%, P value of chi square test is 0.2 > 0.05, this means that there is no a statistically significant rates .

Table (4-14): Prevalence of intestinal parasites according to previous infection

Parasite species	Previously infected (n = 575)		Not infected (n = 625)	
	Freque ncy	Prevalence %	Frequency	Prevalence %
Protozoans				
Entamoeba coli	61.0	10.6	79.0	12.6
E. histolytica	54.0	9.4	51.0	8.2
Giardia lamblia	44.0	7.7	43.0	6.9
Helminths				
Enterobius vermicularis	26.0	4.5	5.0	0.8
Hymenolepis nana	25.0	4.3	31.0	4.9
***Taenia* spp.**	4.0	0.7	0.0	00
total	214.0	37.2	209.0	33.4
P value > 0.05				

4-16: Prevalence of intestinal parasites according to Latrine Accessibility

Table (4-15) show the prevalence infection of (GI) parasites by Latrine Accessibility, the prevalence rate among (SAC) who had latrines was 36.0%. The statistical analysis verified that the variation of the prevalence infection by latrine accessibility, were not significant, P value of chi square test is 0.1 > 0.05.

Table (4-15) Prevalence of intestinal parasites according to Latrine Accessibility

Parasite species	Have a toilet (n = (1196)		No toilet (n = 4)	
	Freque ncy	Prevalence %	Frequency	Prevalence %
Protozoans				
Entamoeba coli	140.0	11.7	0.0	0.0
E. histolytica	105.0	8.8	0.0	0.0
Giardia lamblia	87.0	7.3	0.0	0.0
Helminths				
Enterobius vermicularis	31.0	2.6	0.0	0.0
Hymenolepis nana	56.0	4.7	0.0	0.0
***Taenia* spp.**	4.0	0.3	0.0	0.0
total	423.0	35.4	0.0	0.0
P value > 0.05				

CHAPTER FIVE

DISCUSSION

Intestinal parasites are of international health concerns, infecting approximately one-fourth of the whole world population. Many control programs had been conducted for combating these infections in heavily affected communities, but the obtained success was not so encouraging. The World Health Organization (2002) expounded the failure to the re-infection upon renewed exposure of the victims to the intestinal parasites.

The results presented in this survey reveal the prevalence of various gastrointestinal parasites, among SAC in rural areas and center of Shendi locality. In this study, the overall prevalence of intestinal parasitic infection was 35.9%, while the overall mean intensity of infection or egg counts per gram (epg) was 12.04.

In the diagnosis of intestinal parasites a lot of techniques can be employed. Selection of a particular technique will depend on its affordability, easy to carry out, its effectiveness and level of professionalism involved Some of these methods are DNA probes, PCR, and direct fluorescent antibody methods (Parija, 1999), which offer high sensitivity, but are expensive for use in the developing world. Direct stool smear, formol-ether, and salt floatation techniques in the form of stool microscopy offers many advantages over other diagnostic methods for detecting intestinal parasites. If performed correctly, it is sensitive, simple, and economical (Parija, 1999), The evaluation was conducted on direct smear and formol-ether concentration techniques using fresh stool samples collected from a population known to be endemic with intestinal parasites and the result of the study confirmed that human parasitic infections existed in the population studied.

Prevalence estimates of the three diagnostic methods revealed the distinctive superiority of formol-ether concentration technique over direct smear ($p<0.05$).

This is in agreement with the work of Amal *et al*., (Amal, 2003) whose work shows 10.7% and 5.35% for formol-ether concentration and direct smear methods respectively. Their work also found that the sensitivity of formol-ether concentration was higher than direct smear; the age group 5-7 had the highest prevalence of IP infection. This is in agreement to the study of Mbanugo and Okakpu, (Mbanugo, 2004), where the peak of infection was in the age group 5-8 years. This study has also shown that formol-ether concentration is a very useful method in diagnosing intestinal helminths. . This complied with the findings of Knight et al., (Knight, 1976) where they posited that the modified formol-ether concentration technique is more successful in detecting light infections. It revealed both protozoal and helminthic parasites with formol-ether concentration again showing a greater preference to direct smear technique. On the contrary, the current study prevalence of intestinal parasites was lower than previously reported results from different regions of Ethiopia such as in Dagi primary school (. Alamir M, 2013) in Delgi, North Gondar (.Ayalew AT Debebe, 2011) in Chencha town, Southern Ethiopia (Abossie A, 2014). The low rate of detection of intestinal parasites observed in this study may be due to differences in the method of sample collection, isolation and identification of differences in climatic conditions, environmental sanitation, economic and educational status of the study subjects, and previous control efforts in these different areas. On the other hand, the prevalence of intestinal parasites in the current study was higher than studies reported from, Arba Minch town, Southern Ethiopia, (. Haftu D, 2014) in Debre Birhan, Ethiopia, (Zemene T, 2018). This high prevalence could be due to the living and the socioeconomic nature of the study subjects or may be associated with the local endemicity of the parasite and geographic condition of the study area. The other possible reason for the difference might be due to differences in awareness of the people on personal and environmental hygiene from the continuous health education made by the different health educators in the different health institutions against intestinal parasites. The present study showed that hand washing habit of before meal, and finger nail cleanness were strongly associated with the presence of intestinal parasitic infection, this agreement with (Andualem M, 2014) from Ethiopia and Saudi Arabia (Al-Mohammed H, Amin T,2010). Even though high proportions, 99.6% of the school children in this study use latrine always, about 36.0% of them harbored one or more intestinal parasite. This might be explained by the improper usage and poor quality, of the latrines. Similar findings were reported by Tadesse and Beyene (Tadesse, D. and P. Beyene, 2009), who stated the presence of toilet alone by itself is not enough unless used properly. Risk factor strongly associated with intestinal parasite infection in this study was habit of washing hands after defecation. Our findings agree to the recent studies by Berhanu et al. (Berhanu, 1995) and Wördemann et al. (Wördemann, 2006) who have reported a range of environmental, social and behavioral risk factors to be associated with the intestinal parasite infections. No statistically significant difference was observed between male and female students. , the outcome of the study was in line with the studies done in Glomekeda district, Northern Ethiopia, (Dessie, 2019), this finding disagreement inNour, Beshehr in Iran (Ashrat Bighom K, 1997), showed a higher prevalence of infection in females than in males. This may be explained by environmental factors as more women are occupied in farming in this area.

This study shows Formal ether concentration technique , has a better sensitivity compared to Simple salt floatation ,wet mount, which is in constrast to study by Hersh Ahmed et al (Hersh Ahmad et al, 2015)where salt floatation technique, followed by Formal ether concentration technique an wet mount. This may be due to Flotation technique permits the separation of protozoan cysts and certain helminthes eggs from excess debris through the use of a liquid with a high specific gravity, where the parasitic elements are recovered from the surface film and the debris remains in the bottom of the tube. This technique yieldsa cleaner preparation and morphology of the parasites than the sedimentation procedure, on the other hand this study agreement with (Parameshwarappa et al, 2012) showed that the formol-ether concentration technique was more sensitive as compared to the other methods. This may be due to that Sedimentation procedure leads to the recovery of all protozoa, eggs and larvae present. However, the preparation contains more debris than the flotation procedure, though Ethyl acetate is used as an extractor of debris and fat from the faeces and leaves the parasites at the bottom of the suspension. Concentration by formalinethyl acetate sedimentation is recommended because it is the easiest to perform, allows recovery of the broadest range of organisms and is the least subject to technical error. In our study the direct wet mount showed the lowest sensitivity from the concentration methods, but the advantage of this method is to provide a quick diagnosis of a heavily infected specimen, to check organism motility and to diagnose parasites that may be lost in concentration techniques (Hersh,2015),(Neimeister,1987).

Conclusion

The results demonstrate the value of using both sedimentation and flotation procedures in the analysis of fecal specimens for parasitic infection, in addition to macroscopic examination.

In this study, formal-ether concentration technique has showed a high sensitivity and specificity. Its implementation along with routine method, will improve the diagnostic accuracy of stool examination to detect the intestinal parasites.

The current study found that the magnitude of the intestinal parasite was health problems among the study area, which needs great effort to reduce this prevalence. The prevalence of intestinal parasites is also associated with, poor hand washing habits before eating and after defecation, untrimmed finger, and properly trimming their finger, proper washing of their hand before eating, and regular use of toilets may be decreasing the magnitude of the problems.

The concentration technique was weighed down with some shortcomings like cost of running the test, which involves the need for a centrifuge, constant electric supply, a well-ventilated work space, adequate water supply, a standard light microscope and reagents (which are expensive as such), but still is reserved as the best method for diagnosing intestinal parasites in resource-poor countries like Sudan.

Recommendations

- Early intervention strategies like deworming should be designed and implemented by governmental organizations.
- The health care provider should be giving programmed health education and awareness creation about the transmissions, prevention, and control strategies of intestinal parasitic infection within the community.
- Education campaigns to raise awareness as well as regular deworming.
- Preventive measures should be taken for high-risk populations by increasing their level of knowledge about personal and community health and hygiene.
- Stool samples analysis requires the application of multiple diagnostic techniques.

References

Ahmed, A. A. (1998). Epidemiology of *Schistosoma mansoni* Infection in Gunaid Sugar Cane Scheme, Gezira State, Ph.D. thesis, Department of Zoology, Faculty of Science, University of Khartoum, Sudan.

Amal, M.N., Azza, H.A., Hager, A.S., and Ayman, A.E. Evaluation of parasep (faecal parasite concentrator) for detection of Giardia lamblia in faeces. Sci. Med. J. ESCME; 2003; 15(3): 1-4.

Ahmed, A.A; Ayoub, A; Mahgoub, H. M; Gasim. I. M; Adam, I. (2009). Artosunate plus Sulfadoxine/pyrimethamine versus Praziquantel in the treatment of *Schistosoma mansoni* in eastern Sudan.*Transactions of the Royal Society of tropical Medicine and Hygiene*, **11471-3**.

Ashrat Bighom K, Hossin H, Erag M. Assessment of human intestinal parasites in Iran during the last 50 years. Abstracts of the 2nd National Congress of Parasitic Diseases, Tehran, Islamic Republic of Iran, October 19–22, 1997:137.

Albonico, M; Smith, P. G; Ercole, E; Hall, A; Chwaya, H. M; Alawi, K. S; Savioli, L. (1995).Rate of reinfection with mebenazole or albendazole in highly endemic area. *Transactions of the Royal Society of Medicine and Hygiene*, **89**, 538 – 541.

Al-Mohammed H, Amin T, Aboulmagd E, Hablus H, Zaza B. Prevalence of intestinal parasitic infections and its relationship with socio-demographics and hygienic habits among male primary schoolchildren in Al-Ahsa, Saudi Arabia. Asian Pac J Trop Med. 2010:906–12.

Alamir M, Awoke W, Feleke A. Intestinal parasites infection and associated factors among school children in Dagi primary school, Amhara National Regional State, Ethiopia. Health. 2013;5(10);5 Google Scholar

Ahmed, A.A (2002). Microepidemiological factors influencing transmission pressure of Schistosomiasis in Gunaid Scheme, Sudan. *Journal of Natural Sciences*.**Vol 2 (B).**

Albonico, M; Crompton, D.W.T; Savioli, L. (1999). Control strategies for human intestinal nematode infections. *Adv. Parasitol.***42**, pp. 277–341.

Andualem M. Parasitic infection and associated factors among the primary school children in Motta town, western Amhara. Ethiopia Am J Public Health Res. 2014;2(6):248–54.

Arfaa, F. (1984). Selective primary health care: Strategies for control of disease in the developing trichuriasis. X11. Ascariasis and trichuriasis. Rev. Infect. Dis. **6**, 364 – 373.

Asaolu, S. O., Holland, C. V., Jegede, J. O., Freser, R. C., Crompton, D. W. T., 1992. The prevalence and intensity of soil- transmitted helminthiasis in south western Nigeria. *Annals of Tropical Medicine and Parasitology*, 86, 297 – 287.

Arfaa, F., Sahba, G. H., Farahmandian, J., Jalali, H. (1977). Evaluation of the effect of different methods of control of soil- transmitted helminthes in Khuzestan, southwest Iran. *American Journal of Tropical Medicine and Hygiene*, 26, 230-233.

Asaolu, S.O.; Ofoezie, I.E. (2003).The role of health education and sanitation in the control of helminth infections .*Acta Tropica*, 86, 283-294.

Abdel-Aziz, M.A.,*Intestinal protozoa and intestinal helminthic infections among schoolchildren in Central Sudan.* Asian Pacific Journal of Tropical Medicine, 2010. **3**(4): p. 292-293.

Abou-Zeid, A.H.A., T.A. Abkar, and R.O. Mohamed, *Schistosomiasis and soil-transmitted helminths among an adult population in a war affected area, Southern Kordofan state, Sudan.* Parasites & vectors, 2012. **5**(1): p. 1-8.

Abdel Raheam Hassan Ali ., Fundamentals Of Parasitology 2009- 1430.

A. Dessie, T. G. Gebrehiwot, B. Kiros, S. D. Wami, and D. H. Chercos, "Intestinal parasitic infections and determinant factors among school-age children in Ethiopia: a crosssectional study," BMC Research Notes, vol. 12, no. 1, p. 777, 2019.

Abrar Ul Haq K, Gul NA, Hammad HM, Bibi Y, Bibi A, Mohsan J, 2015. Prevalence of Giardia intestinalis and Hymenolepis nana in Afghan refugee population of Mianwali district, Pakistan. Afr Health Sci 15: 394–400.

Abate, B. Kibret, E. Bekalu et al., "Cross-sectional study on the prevalence of intestinal parasites and associated risk factors in Teda health center, northwest Ethiopia," ISRN Parasitology, vol. 2013, Article ID 757451, 5 pages, 2013.

Abossie A, Seid M. Assessment of the prevalence of intestinal parasitosis and associated risk factors among primary school children in Chencha town, Southern Ethiopia. BMC Public Health. 2014; 14: 166. PubMed| Google Scholar

Ayalew AT Debebe, Worku A. Prevalence and risk factors of intestinal parasites among Delgi school children, North Gondar, Ethiopia. J Parasitol Vector Biol. 2011;3(5): 75-81.

Brooker, S., A.C. Clements, and D.A. Bundy, *Global epidemiology, ecology and control of soil-transmitted helminth infections.* Advances in parasitology, 2006. **62**: p. 221-261.

Bundy, D. and N.R. de Silva, *Can we deworm this wormy world?* British Medical Bulletin, 1998. **54**(2): p. 421-432.

Baker, J.R. and Muller, R.(2004). Advances in Parasitology. (Eds). Academic Press, London.**P, 225.**

Berhanu, E.,M.Girmay and B. Hailu, 1995.Intestinal parasitic infection in Bahir Dar and risk factors for transmission. Trop. Med., 37: 73-78.

Bundy, D. A. P., Cooper, E. S., Thompson, D. E., Didier, J. M., Simmons, 1., 1987. Epidemiology and population dynamics of Ascaris Lumbricocodes and Trichuris in the same community.Tropical Medicine Hygiene.**81**, 987-993.

Barbosa. F. S; Pinto, R; Souza, O. A.(1971). Control of *Schistosoma mansoni* in a small northeast Brazilian. Community. *Transactions of the Royal Society of Medicine and Hygiene*, **65:** 206-213.

Bayoumi, M.,*Intestinal parasitic infections in school students in Malakal city, Upper Nile State, South Sudan.* SOJ Microbiol Inf Dis, 2016. **4**(1): p. 1-5.

B. Sitotaw and W. Shiferaw, "Prevalence of intestinal parasitic infections and associated risk factors among the first-cycle primary schoolchildren in Sasiga district, southwest Ethiopia," Journal of parasitology research, vol. 2020, Article ID 8681247, 13 pages, 2020.

B. Tulu, S. Taye, Y. Zenebe, and E. Amsalu, "Intestinal parasitic infections and nutritional status among primary school children in delo-mena district, south eastern Ethiopia," Iranian Journal of Parasitology, vol. 11, no. 4, pp. 549–558, 2016.

B. Sitotaw,H. Mekuriaw, and D. Damtie, "Prevalence of intestinal parasitic infections and associated risk factors among Jawi primary school children, Jawi town, north-west Ethiopia," BMC Infectious Diseases, vol. 19, no. 1, p. 341, 2019.

Buch NA, Ahmad SM, Ahmed SZ, Ali SW, Charoo BA, Hassan MU, 2002. Recurrent abdominal pain in children. Indian Pediatr 39: 830–834.

Biu, A. A. and Kofur, I. (2010).Prevalence of human gastrointestinal parasites in Biu, Borno state, Nigeria. Animal research international, 7(2): 1223–1225.

Chai, J. and S. Lee, *Successful implementation of the nation-wide control programme of ascariosis in Korea.* Parasitology International, 1998(47): p. 94.

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

Crompton, D.W. (1999). How much human helminthiasis is there in the world.*Journal of Parasitology*.**85,** 397-403.

Christensen, N.O.; Furo, P.; Simonsen, P.E. (1987). Aims and strategies in the control of human African schistosomiasis.*Notes of Danish Bilharziasis Laboratory, Charlottenlund, Denmark.*

Chitsulo L, **Loverde P**, **Engels D**.(2004).**Schistosomiasis.** National Review Microbiology. 2004 Jan; **2(1)**:12-3.

Crompton, D.W.T.; Engels, D.; Montresor, A.; Savioli, L.; Neira, M. (2003).Preparing to control Schistosomiasis and soil –transmitted Helminthiasis in the Twenty –First Century.*Acta Tropica*, 86,121-124.

Cheesbrough, M. (1999).District Laboratory Practice in Tropical Countries. Cambridge University Press, United Kingdom. 454 pp.

Cha, S.,*Nationwide cross-sectional survey of schistosomiasis and soil-transmitted helminthiasis in Sudan: study protocol.* BMC public health, 2017. **17**(1): p. 1-10.

Chávez, B., *Giardia lamblia: electrophysiology and ultrastructure of cytopathology in cultured epithelial cells.* Experimental parasitology, 1986. **61**(3): p. 379-389.

Cattanach, B.M. and M. Kirk, *Differential activity of maternally and paternally derived chromosome regions in mice.* Nature, 1985. **315**(6019): p. 496-498.

Chaudhry, Z.H., AFZAL, M. and MALIK, M.A., 2004. Epidemiological factors affecting prevalence of intestinal parasites in children of Muzaffarabad district. Pakistan Journal of Zoology, vol. 36, no. 4, pp. 267-271.

De Silva, N.R., *Soil-transmitted helminth infections: updating the global picture.* Trends in parasitology, 2003. **19**(12): p. 547-551.

Davis AN, Haque R, Petri WA, Jr. Update on protozoan parasites of the intestine. Curr Opin Gastroentrol 2002; 18:10-4.

Doenhoff , M.; Kimani, G., Ciioli, D.(2000). Praziquantel and the control of schistosomiasis .*Parasitology today* 16,364-366.

De Silva. N.R (2003).Impact of mass chemotherapy on the morbidity due to soil -transmitted nematodes.*Acta Tropica*, 86,197-214.

Donaldson, C. and G. Mooney, *Needs assessment, priority setting, and contracts for health care: an economic view.* BMJ: British Medical Journal, 1991. **303**(6816): p. 1529.

Damen, J.G., Luka, J., Biwan, E.I., Lugos, M 52, issue 1, 2011 of Nigerian Medical Journal.

Dessie, T. G. Gebrehiwot, B. Kiros, S. D. Wami, and D. H. Chercos, “Intestinal parasitic infections and determinant factors among school-age children in

Ethiopia: a crosssectional study," BMC Research Notes, vol. 12, no. 1, p. 777, 2019

Ekeh, H. E., Adeniyi, J. D. (1988). Health education strategies for Tropical disease control in school children. *Journal of Tropical Medicine and Hygiene*. 91, 55 – 59.

El Tash, L.A. (2006). Socioeconomic analysis of malaria burden in Gezira and Khartoum State, Ph.D. thesis in Economics, University of Khartoum, Sudan.

Esrey, S.A.; Potash, J.B.; Roberts, L.; Shiff, C. (1991).Effects of improved water supply and sanitation on ascariasis, diarrhea, dracunculiasis, hookworm infections, schistosomiasis and trachoma. Bulletin World Health Organization, **69**, 609-621.

Elkins, D. B.; Haswell-Elkins, M.; Andreson, R. M. (1986). The epidemiology and control of intestinal helminthes in the pulicat lake region of Southern India. I. Study design and pre-and post-treatment observations on *Ascaris Lumbricoides* infection. *Transactions of the Royal Society of Medicine and Hygiene*, 80, 774-794.

El Basit, S; Brown, D. (1986). Slow and filter for the Blue Nile health project. Waterlines 5, 29-31.

Elmadhoun, W.M., *Situation analysis of schistosomiasis and soil-transmitted helminthes in River Nile State, Sudan.* Transactions of The Royal Society of Tropical Medicine and Hygiene, 2013. **107**(3): p. 195-199.

Ekpo, U.F.,*Helminthiasis and hygiene conditions of schools in Ikenne, Ogun State, Nigeria*. PLoS Neglected Tropical Diseases, 2008. **2**(1): p. e146.

Elmadani, M.,*Prevalence of Intestinal Helminths Infestation and Associated Risk Factors among Pupils in Basic Schools at Aboshareef Area, Kosti Locality, White Nile State, Sudan, 2019.* 2020.

E. Achi, O. Njoku, A. Nnachi et al., "Prevalence of intestinal parasitic infections among under five children in Abakaliki local government area of Ebonyi state," Ejpmr, vol. 4, no. 4, pp. 218–222, 2017.

Elmadani, M.,*Prevalence of Intestinal Helminths Infestation and Associated Risk Factors among Pupils in Basic Schools at Aboshareef Area, Kosti Locality, White Nile State, Sudan, 2019.* 2020.

Erko B, Medhin G, Birrie H (1995). Intestinal parasitic infection in Bahir Dar and risk factors for transmission. Trop. Med., 37: 73-78.

Farooq, M. and Hairston, N.G.(1966). The epidemiology of *Schistosoma haematobium* and *Schistosoma mansoni* infection in Egypt- 49 project area .4. Measurement of incidence of Bilharziasis.*Bulletin of World Health Organization*, **35: 331-338**.

Farthing, M.J., *Giardiasis.* Gastroenterology Clinics, 1996. **25**(3): p. 493-515.**18**(1): p. 1-8.

F. Bahrami, A. Haghighi, G. Zamini, M. B. Khadem-Erfan, and E. Azargashb, "Prevalence and associated risk factors of intestinal parasitic infections in Kurdistan province, northwest Iran," Cogent Medicine, vol. 5, no. 1, Article ID 1503777, 2018.

Gilles, H. M. (1973). Results of a seven year snail control project on the endemicity of *Schistosoma haematobium* infection in Egypt. *Annals of Tropical Medicine and Parasitology*, **67:** 45-65.

Gryseels, B. and Polderman, A. M. (1991).Morbidly due to *Schistosoma mansoni*, and its control in sub-saharan Africa. Parasitology Today**, 7:** 244-248.

Guyatt, M. L.; Brooker, S.; Donnelly, C. A. (1999**).** Can prevalence of infection in school-aged children be used as index for assessing community prevalence.Parasitology.**118 (**pts**): 257-268**.

Goll, P.H. and Wilkins, H.A. (1984). Field studies on *Bulinus senegalensis* Muller and the transmission of *Schistosoma haematobium* infection in a Gambian community. *Annals of Tropical Medicine and Parasitology*, **35**, 29-36.

Gwatirisa, P.R; Ndamba, .J; Nyazema, N.Z. (1999) The impact of health education on the knowledge, attitudes and practices of a rural community with regards to schistosomiasis control using a plant molluscicide, *Phytolacca dodecandra*. *Cent Afr J Med*.; 45(4):94-7.

Gillett, J.D. (1985). The behaviour of *Homo sapiens*, The forgotten factor in the transmission of tropical disease.*Transactions of the Royal Society of Medicine and* Hygiene, 79, 12-20.

G. Alemu, A. Abossie, and Z. Yohannes, "Current status of intestinal parasitic infections and associated factors among primary school children in Birbir town, Southern Ethiopia," BMC Infectious Diseases, vol. 19, no. 1, p. 270, 2019.

Golias.,Sangeetha, K.T. VASUDHA, C.L., 2014. Prevalence of parasitic infections among primary school children in Bangalore. International Journal of Basic and Applied Medical Sciences, vol. 4, no. 1, pp. 356-361.

Hotez, P.J., *Helminth infections: the great neglected tropical diseases.* The Journal of clinical investigation, 2008. **118**(4): p. 1311-1321.

Holland, C.V.; Asaolu.S.O.; Compton, D.W.T.; Whitehead, R.R., andCoombs, I.(1996).Targeted anthelminthic treatment of school children: effect of frequency of application on the intensity of *Ascaris lumbricoides* infection in children from rural Nigerian villages.*Parasitology*, 113, 87-95.

Hoffman,W.A; Pons,J.A. and Jancer,J.L.(1934). The sedimentation concentration method in *Schistosoma mansoni*.Puerti Rico Journal of public health and Tropical Medicine, 9 , 285-291.

Haftu D, Deyessa N, Agedew E. Prevalence and determinant factors of intestinal parasites among school children in Arba Minch town, Southern Ethiopia. Am J Health Res. 2014;2(5): 247-4. Google Scholar

Hersh Ahmad et al, Evaluation of Different Techniques of Stool Examination for Intestinal Parasitic Infections in Sulaimani City - Iraq Int.J.Curr.Microbiol.App.Sci (2015) 4(5): 991-996

Handzel, T. (**2003).**Geographic distribution of Schistosomiasis and Soil- transmitted Helminthes in Western Kenya: Implications for anthelminthic mass treatment. *American Journal of Tropical Medicine and Hygiene*, 69(3), pp. 318-323.

Homeida, M.A.; El Tom, I.; Magdi, M.A.; Suliaman, S.M.; Elobeid, E.A.; Mansour, M.; Saad, A.M.; Bennett, J.L. (1996). The effectiveness of annual vs. biennial mass chemotherapy in reducing morbidity due to Schistosomiasis: aprospective study in Gezira-Managil, Sudan. *American Journal of Tropical Medicine and Hygiene*, 54, 140- 145.

Holland , C. V.; Taren, D. L.; Compton, D. W. T.; Nesheim, M. C.; Sanjur, D.; Barbeau, I.; Tuker, K.; Tiffany, J.; Rivera, G.(1988).Intestinal helminthiasis in relation to the socio-economic environment of Panamanian children. *Soc. SCi. Med*. 2b, 209-213.

Hotez, P.J.,*Mass drug administration and integrated control for the world's high‐ prevalence neglected tropical diseases.* Clinical Pharmacology & Therapeutics, 2009. **85**(6): p. 659-664.

H. M. Li, C. H. Zhou, Z. S. Li et al., "Risk factors for Enterobius vermicularis infection in children in Gaozhou, Guangdong, China," Infectious diseases of poverty, vol. 4, no. 1, p. 28, 2015

Hutly, S. R. A. (1990). The impact of inadequate sanitary conditions on health in developing centuries.*Rep. Trim. Stat. Sanit. Mond*. 43, 118-126.

Jordan, P.H. & Webbe, G. (1982).Schistosomiasis, epidemiology, treatment and control.Williams Heinmann Medical Books, Ltd., London.

Jourdan, P.M.,*Soil-transmitted helminth infections.* The Lancet, 2018. **391**(10117): p. 252-265.

Jayaram C.K. (2002). Text book of medical parasitology, **5th ed**, Japee Brothers medical publisher (D) Ltd, New Delhi, India, **5**, 164 - 173.

JASTI, A., OJHA, S.C. and SINGH, Y.I., 2007. Mental and behavioral effects of parasitic infections: a review. Nepal Medical College Journal, vol. 9, no. 1, pp. 50-56. PMid:17593680.

Kamau Aloo-Obudho P, Kabiru E, Ombacho K, Langat B, Mucheru O, Ireri L. Prevalence of intestinal parasitic infections in certified food-handlers working in food establishments in the City of Nairobi, Kenya. J Biomed Res. 2012; 26(2):84-89. Doi pubmed pmc.

Krolewiecki, A.J., *A public health response against Strongyloides stercoralis: time to look at soil-transmitted helminthiasis in full.* PLoS neglected tropical diseases. 2013. **7**(5): p. e2165

Knight, W.B; Hiatt, R.A; Cline, B.L; Ritchie, L.S (2006).A modification of formal-ether concentration technique for increased sensitivity in detecting *Schistosoma mansoni* egg.CABI abstract, *American Journal of Tropical Medicine and Hyhiene.*

Kilama, W. L. (1985). Sanitation in the control of ascariasis. In: Compton, D. W. T., Nesheim, M. C., Pawlowski, Z. S. (Eds.), Ascariasis and its public Health significance. Taylor Nad Fracis, London, pp. 229 – 237.

Keenan, J.D., *Elimination and eradication of neglected tropical diseases with mass drug administrations: a survey of experts.* PLoS neglected tropical diseases, 2013. **7**(12): p. e2562.

Kumapley, R.S., R. Kupka, and N. Dalmiya, *The role of child health days in the attainment of global deworming coverage targets among preschool-age children.* PLoS neglected tropical diseases, 2015. **9**(11): p. e0004206.

Knight, W.B., Hiatt, R.A., Cline B.L., and Ritchie, L.S. A modification of the formolether concentration technique for increased sensitivity in detecting Schistosoma mansoni eggs. Am. J. Trop. Med. Hyg; 1976; 25(6): 818-23.

Kefale Shiferaw *et al.*,Journal of Tropical Medicine Volume 2021, Article ID 6694809, 6 pages https://doi.org/10.1155/2021/669480

K. Ismail, “Prevalence of intestinal parasitic infection among school children in Taif,” Insights Biomed, vol. 3, no. 2, p. 10, 2018.

Kabatende, J.; Mugisha, M.; Ntirenganya, L.; Barry, A.; Ruberanziza, E.; Mbonigaba, J.B.; Bergman, U.; Bienvenu, E.; Aklilu, E. Prevalence, intensity, and correlates of soil-transmitted helminth infections among school children after a decade of preventive chemotherapy in Western Rwanda. Pathogens 2020, 9, 1076. [CrossRef] [PubMed].

Lewert, R.M., Yogore, M.G., and Blas, B.L. (1984). Seroepidemiology of schistosomiasis Japonicum by ElISA in the Philippes.II.Unreliability of stool examination in the measurements of incidence.*Annals of Tropical Medicine and Parasitology*, **33**, 872-881.

Lo, N.C.,, ***A** call to strengthen the global strategy against schistosomiasis and soil-transmitted helminthiasis: the time is now.* The Lancet infectious diseases, 2017. **17**(2): p. e64-e69.

L. Quihui-Cota,G. G. Morales-Figueroa, A. Javalera-Duarte, J. A. Ponce-Mart´ınez, E. Valbuena-Gregorio, and M. A. L´opez-Mata, "Prevalence and associated risk factors for Giardia and Cryptosporidium infections among children of northwest Mexico: a cross-sectional study," BMC Public Health, vol. 17, no. 1, p. 852, 2017.

Monjur Ahmed, Gastroenterol Res 2023; 16(3): 127-140.

Molyneux, D.H., Mass drug treatment for lymphatic filariasis and onchocerciasis.Trends in parasitology, 2003.19(11):p.516-522

Montresor, A.; Crompton, D.W.T.; Bundy, D.A.P.; Hall, A.; Savioli, L. (1998). Guidelines for the evaluation of soil- transmitted helminthiasis and Schistosomiasis at community level. Geneva, World Health Organization, 1998 (document WHO/ CDS/SIP/ 98.1).Who, Geneva.

Miller, R.D.; de Moor, P.P.; Kvalsvig, J.D.; Moerdyck, A. (1976).The influence of infection with *Schistosoma heamatobium* on behavior and mental performance of African school children. In "Medicine in a Tropical Environment'' (Gear, J.H.S.; ed). pp. **728-739**. Balkema, Cape Town, Rotterdam.

Murda, A. G. A. (1985).Evaluation of a health education program in Tayba Quarashi village, Central Sudan during 1983.*Journal of Tropical and Medicine Hygiene*, 88, 111-113.

Mbanugo, J.I., and Okakpu, V.O. Epidemiological survey of helminthic infections in primary school children in southeastern Nigeria. Journal of Environmental Health; 2004; 1(2): 64-8.

Mott, K.E. (1987). Schistosomiasis control. In: the biology of schsitosomes from genes to latrines. Rollinson, D. and Simpson, A.J.G. (editor). Academic Press Ltd. London, pp. 431-450.Parasitol.Today, 5, 83-88.

Magnussen, P. (2003). Treatment and re-treatment. Strategies for schistosomiasis control in different epidemiological settings: a review of 10 years' experiences. *Acta Tropic* 86, 243 – 254.

Michaelsen, K. F. (1985) .Hook Worm infection in K weneng District, Botswana. A prevalence survey and a controlled treatment trail. *Transactions of the Royal Society of Medicine and Hygiene*, 79, 848 – 851.

Massara, C.L.; Enk, M. J. (, 2004). Treatment options in the management of Ascaris lumbricoides. *Expert Opin Pharmacother*. Mar;5(3):529-39.

Mahmoud, A; Pasvol, G; Hoffman, S.L., (2001)**.** Schistosomiasis Tropical Medicine and Practice Volume 3.Singapore: Imperial College Press.

Mupfasoni, D.,*The impact of lymphatic filariasis mass drug administration scaling down on soil-transmitted helminth control in school-age children. Present situation and expected impact from 2016 to 2020.* PLoS neglected tropical diseases, 2016. **10**(12): p. e0005202.

Mehraj, V., *Prevalence and factors associated with intestinal parasitic infection among children in an urban slum of Karachi.* PloS one, 2008. **3**(11): p. e3680.

Mohamed, N.S., *Enteroparasitosis infections among renal transplant recipients in Khartoum state, Sudan 2012–2013.* BMC Research Notes, 2018. 11(1): p. 1-6.

Muhsen K, Levine MM, 2012. A systematic review and metaanalysis of the association between Giardia lamblia and endemic pediatric diarrhea in developing countries. Nephrol Dial Transplant 55 (Suppl 4): S271–S293.

Mugono, M.;Konje, E.; Kuhn, S.; Mpogoro, F.J.; Morona, D.; Mazigo, H.D. Intestinal schistosomiasis and geohelminths of Ukara Island, North-Western Tanzania: Prevalence, intensity of infection and associated risk factors among school children. Parasit.Vectors 2014, 7, 612. [CrossRef] [PubMed].

M. Suliman, A. Magboul, H. Mohammed, A. Tamomh, and H. Bakhit, "Prevalence of intestinal parasitic infections and associated risk factors among school children in white Nile state, Sudan," Journal of Infectious Diseases & Diagnosis, vol. 4, no. 125, p. 2, 2019.

Nokes ,C.; Grantham-McGregor, S.M.; Sawyer, A.W.; Cooper, E.S.; Robinson, B.A..; Bundy, D.A.(1992).Moderate to heavy infections of *Trichuris trichiura* affect cognitive function in Jamaican school children. *Parasitology*. 104 (Pt 3):539-47.

Norhayati, M.; Fatmah, M.S.; Yusof, S.; Edariah, A.B. (2003). Intestinal parasitic infections in man: a review. *Medical Journal Malaysia*.**58** (2): 296-305.

Neimeister, R., Logan. A L., Gerber, B., Egleton, H., and Kieger, B. 1987. Hemo-De as a substitute for ethyl acetate in formalinethyl acetate concentration technique.J.Clin. Microbiol.25:425–426

Okhuysen PC White AC, Jr. Parasitic infections of the intestine. Curr Opin Infect Dis 1999; 12:467-72

Ofoezie, I. E. (2000).Patterns of reinfection following praziquantel treatment of urinary Schistosomiasis at a period of low transmission.*Acta Trop,*

Olsen, A. (1998). The proportion of helminth infections in a community in western Kenya which would be treated by mass chemotherapy of school children.*Transactions of the Royal Society of Tropical Medicine and Hygiene*, **92(2):** 144-8

Okun, D. A., (1988). The value of water supply and sanitation in development: an assessment. *American Journal ofpublic Health*, 78, 1463-1467.

Ottesen, E.A.,*The global programme to eliminate lymphatic filariasis: health impact after 8 years.* PLoS neglected tropical diseases, 2008. **2**(10): p. e317.

Omer, A.M. The role of *technical* scientific research *education sustainable* development and conservation *in the republic* of the Sudan in *1st International Technology, Education and Environment Conference*. 2011.

O. E. Tunbosun, L. Rampal, H. A. Rahman, and R. A. Majid, "Prevalence and predictors of intestinal worm infections among semai aboriginal tribe school children in tapah, Malaysia," Malaysian Journal of Medicine and Health Sciences, vol. 13, no. 1, pp. 27–34, 2017.

Pullan, R.L., *Global numbers of infection and disease burden of soil transmitted helminth infections in 2010.* Parasites & vectors. 2014. **7**(1): p. 1-19.

Pham, **K. and P.J. Hotez**, *Vietnam: Neglected tropical diseases in an emerging and accelerating economy.* PLOS Neglected Tropical Diseases, 2022. **16**(2): p. e0010140.

Parameshwarappa KD et al. Infestations and the Evaluation of Different Concentration Techniques of the Stool Examination Journal of Clinical and Diagnostic Research, 2012 September (Suppl), Vol-6(7): 1188-1191

Petri WA, Jr., Haque R, Lyerly D, Vines RR.Estimating the impact of amoebiasis on health.Parasitol Today 2000;16:320-21.

Pesigan, T.P., Farooq, M., Hairston, G.H., Davrequi, J.J., Carica, E.G., Santos, B.C.and Besa, A.A. (1958).Studies on *Schistosoma japonicum* infection in the Phlippines. I. General considerations and epidemiology. *Bulletin of the World Health Organization*, **18**, 345-355.

Pichford, R. J., (1988). Rural sanitation and development. Water- lines 6, 2-6.

Pezzani BC, Minvielle MC, de Luca MM, Córdoba MA, Apezteguía MC, Basualdo JA, 2004. Enterobius vermicularis infection among population of General Mansilla, Argentina. World J Gastroenterol 10: 2535–2539. Pezzani BC, Minvielle MC, de Luca MM, Córdoba MA, Apezteguía MC, Basualdo JA, 2004. Enterobius vermicularis infection among population of General Mansilla, Argentina. World J Gastroenterol 10: 2535–2539.

Pasaribu, A.P.; Alam, A.; Sembiring, K.; Pasaribu, S.; Setiabudi, D. Prevalence and risk factors of soil-transmitted helminthiasis among school children living in an agricultural area of North Sumatera, Indonesia. BMC Public Health 2019, 19, 1066. [CrossRef] [PubMed].

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

Rawla P, Sharma S. Enterobius vermicularis. In: StatPearls. Treasure Island (FL). 2023. Pubmed

Ritchie, L.S. (1948). An ether sedimentation technique for routine stool examination.*Bulletin of United State Army Medical Department*, **8**, 326-331.

Rée, **G.H. (1982).**Schistosomiasis and Human Behaviour. Ecology of Diseases, Vol. **1**, 131-133

Romero-Cabello R**,** Godínez-Hana L, Gutiérrez-Quiroz M, 1991. Clinical aspects of hymenolepiasis in pediatrics. Bol Med Hosp Infant Mex 48: 101–105.

Schär F, *Strongyloides stercoralis: global distribution and risk factors.* PLoS neglected tropical diseases. 2013. **7**(7): p. e2288.

Strunz, E.C., *Water, sanitation, hygiene, and soil-transmitted helminth infection: a systematic review and meta-analysis.* PLoS medicine.2014. **11**(3): p. e1001620.

Stephenson, L.S.; Latham, M. C.; Kinoti, S.N.; Kurz, K. M.; Brigham, H. (1990). Improvements in physical fitness of Kenyan schoolboys infected with hookworm, *Trichuris trichiura* and *Ascaris lumbricoides* following a single dose of albendazole. Trans R Soc Trop Med Hyg. 84(2):277-82.47.

Stoltzfus, R. J, Albonico, M.; Chwaya, H.M.; Savioli, L.; Tielsch, J.; Schulze, K.;Yip, R.(1996**).** Hemoquant determination of hookworm-related blood loss and its role in iron deficiency in African children. *American Journal of Tropical and Medicine Hygiene*, 55(4):399-404.

Savioli, L., Bundy, D.A.P. and Tompkins, A.(1992). Intestinal parasitic infections: a soluble public health problem. *Transactions of the Royal Society of Tropical Medicine and Hygiene***,** 86, pp. 353–354.

Shiff, C. J., V. de V. Clarke, A.C. Evans and G. Barnish. (1973). Molluscicide for the control of schistosomiasis in irrigation schemes.A study in Southern Rhodesia. *Bulletin of the World Health Organization*, 48: 299-307.

Scott, D., Senker, K. and England, E.C. (1982).Epidemiology of human *Schistosoma haematobium* infection around Volta Lake, Ghana, 1973-75.*Bulletin of the World Health Organization,* 60, 89-100.

Soulhgate, V. R. and Rollinson, D. (1987).Natural history of transmission and Schistosome interactions in: “the biology of Schistosomes from genes to latrines" (Rollinson, D. and Simposn, A. J. C, eds), pp 347-378, Academic press, London

Simonsen, P. E., Christensen, N. O., and Gocthe, G. (1986).Diagnosis of schistosomiasis.Notes of Danish Bilharziasis Laboratory, Charllotenlund, Denmark.

Salih, A.A. (1989). Comparative diagnostic methods in the assessment of urine and faecal egg count. M.Sc. thesis, University of Khartoum.

Sturrock, R.F. (2001). Schistosomiasis Epidemiology and Control: How Did We Get Here and Where Should We Go? Mem. Inst. Oswaldo Cruz .96 suppl.: 17-27.

Sridhar, M. K. C.; Oyemage, A. (1987).Potential health risk at sewage treatment plants in lbadan, Nigeria. J. Inst. Water Eviron. Manage. 1, 129 – 135.

Sleigh, A. C.; Orr, T. W. ; Siva de Olivetra, T. (1986 a). Soil cement water tanks for Brazil. Water lines 5, 25-28

Smyth J.D. (1996). Animal parasitology, **3rded**, Cambridge University press, CB2 2RU, UK, **3**, 388 - 404.

Savioli, L., H. Smith, and A**.** Thompson, *Giardia and Cryptosporidium join the 'neglected diseases initiative'.* Trends in parasitology, 2006. **22**(5): p. 203-208.

Siddig, H**.S.,***Prevalence of intestinal parasites among selected group of primary school children in Alhag Yousif Area, Khartoum, Sudan.* International Journal of Medical Research & Health Sciences, 2017. **6**(8): p. 125-131.

Sale, M.; Midala, L. Soil transmitted helminths among School aged Children in Hong local government area of Adamawa State, Nigeria. Afr. J. Online 2022, 19, 4318–4323.

Soren L. Becker, *et* alJOURNAL OF CLINICAL MICROBIOLOGY, June 2011, p. 2183–2190 1137/11/$12.00 doi:10.1128/JCM.01035-10 Copyright © 2011, American Society for Microbiology. All Rights Reserved.

Thein Haing, T.; Saw, T.; Lwin.M. (1987).Reinfection of people with Ascaris Lumbricoides following single, 6-month and 12-month.Interval mass chemotherapy in Okoo village Bunrma, *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 81, 140-146.

Thomas, J. D. (1987).an evaluation of the interaction fresh water pulmnate snail hosts of human schistosomes and macrophytes. *Philosophical Trans Action of the Royal Society London*, B315, 75-125

Truscott, J., H. Turner, and R. Anderson, *What impact will the achievement of the current World Health Organisation targets for anthelmintic treatment coverage in children have on the intensity of soil transmitted helminth infections?* Parasites & vectors, 2015. **8**(1): p. 1-12.

Turner, H.C., *An economic evaluation of expanding hookworm control strategies to target the whole community.* Parasites & vectors, 2015. **8**(1): p. 1-11.

Taylor- Robinson, D.C., *Deworming drugs for soil- transmitted intestinal worms in children: effects on nutritional indicators, haemoglobin and school performance.* Cochrane Database of Systematic Reviews, 2012(11).

T. Hailegebriel, "Prevalence of intestinal parasitic infections and associated risk factors among students at Dona Berber primary school, Bahir Dar, Ethiopia," BMC Infectious Diseases, vol. 17, no. 1, p. 362, 2017.

T. E. Kwenti, F. A. Nkume, A. T. Tanjeko, and T. D. B. Kwenti, ".e effect of intestinal parasitic infection on the clinical outcome of malaria in coinfected children in Cameroon," PLoS Neglected Tropical Diseases, vol. 10, no. 4, p. e0004673, 2016.

Tadesse, D. and P. Beyene, 2009.Irrigation practices and Intestinal helminth infections in Southern and central Tigray.Ethop. J. Health Dev., 23: 48-56.

V. Nasiri, K. Esmailnia, G. Karim, M. Nasir, and O. Akhavan, "Intestinal parasitic infections among inhabitants of Karaj City, Tehran province, Iran in 2006-2008," Korean Journal of Parasitology, vol. 47, no. 3, p. 265, 2009.

WHO,*Investing to overcome the global impact of neglected tropical diseases. Third WHO 794 report on neglected tropical diseases.* 2015.

WHO, *Accelerating work to overcome the global impact of neglected tropical diseases. A roadmap for implementation.* 2012.

WHO., *Deworming for health and development: report of the Third Global Meeting of the Partners for Parasite Control*. 2005, World Health Organization

WHO .Amoebiasis.WHO Weekly Epdemiol Rec 1997; 72:97-100.

WHO, (2002). Schistosomiasis, much of the information in this document is provided by generous permission of the World Health organization, Division of control of Tropical Diseases.

WHO, (1998). Schistosomiasis control.Division of control of Tropical Diseases, WHO. Fact Sheet No. **115**. (WHO Home Page, In the Internet, http://www.who. Christenson/).

WHO, (2004). Prevention and control of schistosomiasis and soil-transmitted helminthiasis.Geneva, (WHO/CDS/CPE/PVC/2004.9).

WHO, (2003).Action against worms, report series, 2003- ISSUE1.

WHO, (**1999**). Monitoring helminthes control programmes. Geneva: WHO. (Document WHO/ CDS/ CPC/SIP/99.1).

WHO, (1996**)** *Report of the WHO informal consultation on the use of chemotherapy for the control of morbidity due to soil-transmitted nematodes in* *humans*.Geneva: WHO

WHO, (1987). Atlas of global distribution of Schistosomiasis (Sudan part) P. 51-58. CEGET-CNRS/O.M.S.-W.H.O.

World Bank (1997). World Development Report 1997. New York, Oxford University Press.

WHO, *Helminth control in school-age children: a guide for managers of control programmes*. 2011: World Health Organization.

WHO, *Summary of global update on preventive chemotherapy implementation in 2015.* Weekly Epidemiological Record= Relevé épidémiologique hebdomadaire, 2016. **91**(39): p. 456-45

WHO,*Soil-transmitted helminthiases: eliminating as public health problem soil-transmitted helminthiases in children: progress report 2001-2010 and strategic plan 2011-2020.* 2012.

WHO,*Prevention and control of intestinal parasitic infections: report of a WHO Expert Committee [meeting held in Geneva from 3 to 7 March 1986].* 1987.

WHO,*Amoebiasis and its control.* Bulletin of the World Health Organization, 1985. **63**(3): p. 417

WHO, the global progress of soil-transmittedhelminthiases control in 2020and World HealthOrganization targets for 2030. PLoS Negl Trop Dis
14(8): e0008505.

WHO, the global progress of soil-transmittedhelminthiases control in 2020and World HealthOrganization targets for 2030. PLoS Negl Trop Dis
14(8): e0008505.

Wördemann, M., K. Polman, L.T. Menocal Heredia, R.J. Diaz, A.M. Madurga, F.A. Núñez Fernández, R.A. C ordovi Prado, A.R. Espinosa, L.P. Duran, M.B. Gorbea, L.R. Rivero and B. Gryseels, 2006. Prevalence of intestinal parasite infections and their risk factors in Cuba children. Trop. Med. Int. Health, 11: 1813-1820.

Wilkins, H.A. (1989). Reinfection after treatment of schistosome's infections .Parasitol.Today, 5, 83-88.

Webbe, G., Jordan, P. (1993). Control. In: Jordan, P., Webbe, G., Sturrock, R. F. (Eds.), Human schistosomiasis. CAB. International, Wallingford, pp. 405-451.

Welch, V.A., *Mass deworming to improve developmental health and wellbeing of children in low-income and middle-income countries: a systematic review and network meta-analysis.* The Lancet Global Health, 2017. **5**(1): p. e40-e50.

Walsh, J.A., *Problems in recognition and diagnosis of amebiasis: estimation of the global magnitude of morbidity and mortality.* Reviews of infectious diseases, 1986. **8**(2): p. 228-238

Wolfe, M.S., *Giardiasis.* Clinical microbiology reviews, 1992. **5**(1): p. 93-100.

Xianmin, Z., Weidung, P., Crompton, D. W. T., Jiangain, X. (1999).Treatment of biliary ascariasis in China. Trans. R. Soc. Trop. Med. Hyg. 93, 561- 564.

Yuan, L.; Manderson, L.; TempongKo, M. S.; Wei, W.; Aiguo . P. (2000).The impact of education video tapes on water contact behaviour of primary school student in the dongting lake region, china. Tropical Medicine. Int .health, 5(8)538-544

Younas M, Shah S, Talaat A, 2008. Frequency of Giardia lamblia infection in children with recurrent abdominal pain. J Pak Med Assoc 58: 171–174.

Zemene T, Shiferaw MB. Prevalence of intestinal parasitic infections in children under the age of 5 years attending the Debre Birhan referral hospital, North Shoa, Ethiopia. BMC research notes. 2018;11(1): 58. PubMed| Google Scholar

APPENDIXES

A Questionnaier Designed for Prevalences of Intestinal parasites, In the North and South countrysides and the center of Shendi locality

River Nile State

Village…………………. District……………………….

Name…………………….. Number……………………..

Number of sample……………..

1- Diagnosis **:** A – Positive ( ) B- Negative ( )

Type of parasite …………….. …………………

4-Symptoms for the current condition:

A- Present ( ) B- not present ( )

5-Exisiting symptoms

……

Section one: Personal informations:

1-Gender: A- Male ( ) B- Female ( )

2-Age : A- (5- 7) years B- (8- 10) years C-(11-13) years

3-Residence:

A-Northern countryside **B**-Southern countryside **C**-City center

4-Educational level of father

A-Illiterate **B**- Primary **C**- Secondary **D**-University

5-Father occupation

A-Government employee B- Farmer

C-Freelance work D-Fishing

6- Source of drinking water

A-Public water network B-Tank point C-From cart

7- Have you or any family member been infected with intestinal parasites?

A-Yes B-No

8- If the answer is yes, what did you do?

A-Went to the doctor

B-Took traditional medicine

C-Went directly to the pharmacy and took the medication

Part two: Risk factors

1-Is there a bath room in the house?

A- Yes B- No

2- If the answer is no, where do you relieve yourself?

A- In the canal
B- Near the Nile

C-At school, or in the mosque

3- Is there a canal near the residence?

A-Yes B- No

4-Do you go to the canal?

A-Yes B-No

5-If the answer is yes, what is the purpose of going to the canal?

A-Bathing B-Fetching water C-Washing D-Playing

6- Do you urinate or defecate in the canal, while bathing, Fetching water, washing or playing

A-Yes B- No

Section three: Knowledge and Information:

1-Do you know anything about intestinal parasites?

A-Yes B-No

2- If the answer is yes, how do they transmit to the humans?

A-Contaminated food and drink

B-Contact with water

C- I do not know

3-Do you think it can be eliminated with treatment?

A-Yes B-No

2- Where did you get this information from?

A-Family B-Health worker C-Teacher D-Other

Section Four: Practices and Behaviors

1- What do you use to wash your hands at school?

A-Water and soap-Water only. C-I do not wash it.

2- Do you wash vegetables and fruits before eating them?

A-Yes B- No C-Sometimes

3- Do you wash your hands after using the toilet?

A-Yes B-No C-Sometimes