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Prevalence and Associated Risk Factors of Intestinal Parasite Infections among Patients Attending Dil Yibza Health Center, North Gondar, Ethiopia

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APPROVAL SHEET OF THESIS

As the thesis advisor, I hereby certify that I have supervised, read, and evaluated this thesis entitled "**Prevalence and Associated Risk Factors of Intestinal Parasite Infections among Patients Attending Dil Yibza Health Center, North Gondar, Ethiopia**" by Ayanew Amogne prepared under my guidance. I recommend that it can be submitted as fulfilling the thesis requirement.

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Student's name	Signature	Date

As a members of the Board of Examiners of the MSc. Thesis open Defense Examination, we certify that we have read and evaluated the thesis prepared by Ayanew Amogne, and examined the candidate. We recommended that the thesis be accepted as fulfilling the thesis requirement for the degree of Master of Science in Bio-Medical Science.

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DECLARATION

I declare that this MSc thesis is my original work that has not been presented in any University for fulfillment of MSc program, and all sources of materials used for this thesis have been duly acknowledged. This thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in biology at the Bahir Dar University. It can be deposited in the University Library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

Ayanew Amogne Alebachew ……………… ………………

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LIST OF ABBREVIATIONS /ACRONYMS

CDC: Center for Disease Control and Prevention

CI: Confidence Interval

IPIs: Intestinal Parasitic Infections

IPs: Intestinal Parasites

SPSS: Statistical Package for Social Sciences

STH: Soil Transmitted Helminthes

WHO: World Health Organization

MOH: Ministry of Health

Masl: Meter above sea level

COR: Crude Odds Ratio

AOR: Adjusted Odds Ratio

RPM: Rotation per Minute

ABSTRACT

Intestinal parasites (IPs) are organisms that live in the intestine of human or animals, take up the nutrition from the host, and cause abdominal discomfort, mechanical irritation of intestinal mucosa, malabsorption syndromes and obstruction. The aim of this study was to assess the prevalence and associated risk factors of intestinal parasitic infections (IPIs) among patients attending Dil Yibza health center, north Gondar zone, Ethiopia. A cross-sectional study was conducted from December 2019 to February 2020. A total of 404 patients were selected using random sampling technique. Approximately 2-3 gram of stool specimen was collected and examined for the presence of intestinal parasite microscopically using direct wet-mount and formal-ether concentration techniques. A structured questionnaire was used to obtain information regarding the socio-demographic characteristics and associated risk factors. Data were analyzed using SPSS version 25. Chi-square ($\chi 2$) test and crude odd ratio were calculated to verify and measure the possible association between IPIs and potential risk factors. P value < 0.05 was taken as statistically significant. Nine species of intestinal parasites were identified from the total of 404 stool samples examined. The overall prevalence of IPIs for at least one parasite was 55.2%. *Entamoeba histolytica/ dispar (*46.5%) was the most predominant parasite followed by *Ascaris lumbricoides (*9.2%), *Giardia lamblia (*2.7%), Hookworm species (1.2%), *Hymenolepis nana (*1.0%), *Trichuris trichiura* (0.7%), *Enterobius vermicularis (*0.5%), and *Schistosoma mansoni (*0.2%) singly or mixed with other parasites. Furthermore, double and triple parasitic infections were observed in 6.7% and 0.2% respectively. Having diarrhea (AOR=4.22, CI=2.57-6.91, p=0.001), absence of hand washing habit after defecation (AOR=4.36, CI=2.83-6.72, P=0.000), habit of eating unwashed vegetable (AOR=5. 430, 4.33-23.77, P=0.000) and dirt matter under the nail (AOR=5.63, CI=2.60-11.32, P=0.001) were found to be significantly associated with IPIs ($p< 0.05$). This study showed a high prevalence of intestinal parasitic infection in the study area. Therefore, regular provision of health education on personal hygiene and environmental sanitation is recommended to prevent and control IPIs in the study area.

Keywords: Dil Yibza, Intestinal Parasitic Infections, Patients, Prevalence, risk factors

1. INTRODUCTION

1.1. Background of the study

Intestinal parasites (IPs) are organisms that live in the intestine of human or animals, take up the nutrition from the host, and cause abdominal discomfort, mechanical irritation of intestinal mucosa, malabsorption syndromes and obstruction (Patel *et al.*, 2014). Intestinal parasitic infections (IPIs) are the major and serious public health problems in developing countries including Ethiopia. Globally, it is estimated that about 3.5 billion and 450 million people are infected and ill with intestinal parasitic infection respectively and majority of these cases are children (WHO, 2013).

Intestinal parasites are parasites that can populate the gastro-intestinal tract, typically protozoa and helminths are the two major types of intestinal parasites. Helminths are worms with multi cells. Nematodes (round worms), cestodes (tape worms), and trematodes (flat worms) are among the most common helminths that inhabit the human gut. There are three major species of intestinal helminthic parasites namely; *Ascaris lumbricoides*, *Trichuris trichiura*, hook worms (Haque, 2007).

Ascariasis, trichuriasis and hookworm infections are the most common global intestinal helminths parasitic infections. These infections are responsible for high levels of morbidity and mortality, nutritional deficiency including iron deficiency, seizures, portal hypertension, chronic diarrhea, and impaired physical development in children (Patel *et al.*, 2014). Globally, it has been estimated that *A. lumbricoides* 1.221 billion, *T. trichiura* 795 million, hookworm 740 million and *Schistosoma mansoni* infects 67 million people (Tadesse Hailu, 2014). In human, most tapeworms and roundworms live in the small and large intestines and lay their eggs there, and then eggs pass out of the body through faeces and can infest others (Admasu Haile *et al*., 2017).

The soil transmitted helminths (STHs) (*A. lumbricoides*, hookworm, and *T. trichiura)* are parasitic nematode worms causing human infections through contact with parasite eggs or larvae that grow in the worm and moist soil of the world’s tropical and subtropical countries (Wegayehu Tadele *et al*., 2013). In developing countries, several studies indicate that the prevalence of STH infection was high in the lower altitudes and *A. lumbricoides* are the most prevalent intestinal parasites in different communities usually occurring together with *Trichuris* and hookworm (Tadesse Getu, 2005). In Ethiopia, the prevalence rate of *A. lumbricoides* was 29% in highlands and 38% in lowlands. The prevalence of hookworm infection was highest in lowlands (15%) compared with the highlands (7%). *T. trichiura* infection exhibited similar prevalence in all altitudinal regions (13%) on the average (Ephrem Tefera *et al*., 2015).

With regard to protozoan infection, especially, in developing countries, protozoan parasites commonly cause more gastrointestinal infection compared to helminthes and cause significant morbidity and mortality in endemic countries (Alemeshet Yami *et al*., 2011). Intestinal protozoa are a diverse group of unicellular organisms inhabiting the intestinal tract of human. The most common intestinal protozoan parasites are: *Giardia intestinalis, E. histolytica,* and *Cryptosporadium* species (Haque, 2007).

Among the protozoan parasites, *Entamoeba histolytica* and *Giardia lamblia* are the most dominant intestinal parasitic infections. More than 500 million people worldwide are infected by *Entamoeba histolytica/dispar* and about 200 million people are infected by *Giardia lamblia* each year. Amoebiasis and Giardiasis are an infection caused by an intestinal protozoa, are the third most common cause of death from parasitic disease (Patel *et al.*, 2014).

Amebiasis is a widespread parasitic disease caused by the protozoa *E. histolytica***.** *E. histolytica* is morphologically identical with the apathogenic *Entamoeba dispar and* the most common manifestation of amebic infection is dysentery and liver abscess, but infections of the lung, heart and brain also occur (Haque, 2007). Giardiasis is caused by infection with the enteric pathogenic intestinal flagellate *G.lamblia,* it is protozoan parasite that infect human and the parasite inhabits the duodenum and upper jejunum where the alkaline pH is favorable for growth (Quihui *et al*., 2006).

Intestinal parasites are one of the most important causes of diarrhea, loss of weight, abdominal pain, nausea, vomiting, lack of appetite, abdominal distention and iron deficiency anemia (Tilahun Workneh *et al*., 2014). In developing countries including Ethiopia , high prevalence of IPIs are associated with factors like increasing population density, poor sanitation conditions, poor public health practices, inadequate toilet facilities, lack of potable water and food, low living standards, unsafe human waste disposal systems and low socio economic status, and climate change (Gehad and Mustafa, 2013).

Recently, in Ethiopia; cross sectional study conducted in Shahura health center, northwest Ethiopia, the overall prevalence of intestinal parasite infection in patient was 56.9%; among the detected parasites, the prevalence of *E. histolytica/dispar* was 32.4% followed by Hookworm species (11.8%), *G. lamblia* (7.4%), *A. lumbricoides* (2.2%), and *S. mansoni* 1.4% (Abiye Tigabu *et al.,* 2019).Similarly, in a study conducted in Jawi, the overall prevalence of intestinal parasite infection in school children was 58%; of these infection parasites, prevalence of *G. lamblia* was the highest (19.95%) followed by hookworm (13.8%),

S. mansoni (10.3%), *E. histolytica*/dispar 5.9%), H. nana (4.2%), Taenia species (3%), and *A. lumbricoides* (0.73%) (Baye Sitotaw *et al*., 2019). Moreover, the overall prevalence of IPIs in Debre Elias Primary School children, Amhara Region, North West Ethiopia was 84.3 % (Tilahun Workneh *et al*., 2014) and in Delgi, North Gondar, Ethiopia, was 79.8 % (Asrat Ayalew *et al*., 2011). According to the reports from the health center in Dil Yibza town (north-west Ethiopia), IPIs are currently listed as the ten top reasons for people visiting the health center. However; there is no previous study conducted on the prevalence and associated risk factors of IPIs in the area. Therefore, the present study was undertaken to assess the prevalence of IPIs and associated factors among patients attending Dil Yibza health center, north Gondar zone, Ethiopia.

1.2. Statement of the problem

Intestinal parasitic infection is one of the major health problems globally and up to 3.5 billion individuals are infected and around 450 million individuals developed diseases due to intestinal parasites (WHO, 2012). The major global parasitic diseases are; *Amoebiasis*, *Ascariasis*, *Hookworm* infection and *Trichuriasis*. The three major soil-transmitted helminths of global health concern are; *Ascaris lumbricoides*, *Trichuris trichiura* and *Hookworm*. They cause over one billion infections and two billions are at risk of infection (WHO, 2018). Intestinal parasites are responsible for extensive morbidity and mortality in Africa. It is estimated that, more than 100 million people are infected with protozoans, and more than 1.5 billion are infected with soil transmitted helminthes (STHs) (Thomas *et al.,* 2003).

In Ethiopia, the most important intestinal parasites predominantly distributed include *A. lumbricoides, G. lamblia,* hookworm, *H. nana, T. trichiura, E. vermicularis, and E. histolytica/dispar*; with varying prevalence in different areas. Heliminthic infections are common in the country and are the second most predominant cause of outpatient morbidity in the country (Amare Mengistu *et al*, 2007).

In this county, intestinal parasitic infection is one of the major public health problems. The factors such as low living standards, poor environmental sanitation, and unsafe human waste disposal systems, inadequate and lack of safe water supply and low socio economic status results in high prevalence rate of IPIs in Ethiopia (Tilahun Workneh *et al*., 2014).

Even if, there are many researches done on prevalence of intestinal parasitic infections on different part of Ethiopia, there is inadequate reliable information on the epidemiology of intestinal parasitic infections among patients attending Dil Yibza health center in Beyeda woreda. According to the reports from the health center in Dil Yibza town (north-west Ethiopia), IPIs are currently listed as the ten top reasons for people visiting the health center. However; there is no previous study conducted on the prevalence and associated risk factors of IPIs in the area. Therefore, the aim of this study was to determine prevalence of intestinal parasitic infections among patients who had been visiting this health center.

1.3. Objectives of the study

General Objective

The general objective of the study was to assess the prevalence and associated risk factors of intestinal parasite infections among patients attending Dil Yibza health center, north Gondar zone, Ethiopia.

Specific Objectives

- ❖ To identify the major intestinal parasite species among patients attending Dil Yibza health center.
- ❖ To determine the prevalence of IPIs among patients attending Dil Yibza health center.
- ❖ To identify the associated risk factors of IPIs among patients attending Dil Yibza health center.

1.4. Significance of the study

The study provides information on the prevalence of IPIs among patients attending Dil Yibza health center. This study could be important in the following aspects.

- ❖ It could generate valuable information on the prevalence of intestinal parasitic infections in the study area.
- ❖ It would provide information on the associated risk factors of intestinal parasitic infections in the study area.
- ❖ It would serve as base line data for those who want to carry out further investigation on intestinal parasitic infections.
- ❖ It provides source of relevant information to the local health center or other concerned bodies/ institutions to develop appropriate prevention and control method of intestinal parasitic infections in the study area.

1.5 Limitation of the Study

The study was limited to only patients attending dil yibza health center and the study was also limited to perform direct wet mount and Formal-ether concentration method. However; Due to resource constraints, we did not perform other sensitive methods specific for some intestinal parasites such as Kato-Katz and McMaster technique method to counte entire parasite eggs on the slide. Moreover, light microscopy fails to identify and discriminate the true pathogenic *E. histolytica from E. dispar* and also *T. saginata* from *T. solium*.

2. LITERATURE REVIEW

2.1. Intestinal parasitic infections

Protozoan and helminthic parasitic infections are global health problems causing clinical illness in 450 million inhabitants in developing countries (Quihui *et al*., 2006). Parasites found in the intestine can be categorized into two groups; as protozoan and helminths. The major intestinal parasites of global public health concern are the protozoan species such as *E. histolytica* and *G. intestinalis*, soil transmitted helminthes *A. lumbricoides*, *T. trichiura*, hookworm and schistosomiasis (WHO, 2018).

Helminthic infections are enhanced by poor socio-economic conditions, lack of sanitary facilitates, improper disposal of human feces, insufficient supplies of potable water, poor personal hygiene, poor housing conditions, and lack of education (WHO, 2015). IPIs and helminths in particular, are associated with increased risks for nutritional anemia, protein energy malnutrition and growth retardation in children, poor increase in body weight in pregnancy, intrauterine growth retardation, and low birth weight (Begna Tulu *et al*., 2014).

Helminths are worms with many cells. Nematodes (roundworms), cestodes (tapeworms), and trematodes (flatworms) are among the most common helminths that inhabit the human gut. Protozoan parasites have only one cell and can multiply inside the human body. There are four species of intestinal helminthic parasites; *A. lumbricoides* (roundworm), *Trichiuris trichiuria* (whipworm), *Ancylostoma duodenale*, and *N. americanicus* (hookworms). These infections are most prevalent in tropical and subtropical regions of the developing world where adequate water and sanitation facilities are lacking (Haque, 2007).

2.1.1. Intestinal parasitic protozoa

Protozoa are Single-celled organisms belonging to the kingdom *Protista*, are multiply in human host. The common protozoan parasites include *E. histolytica/dispar* and *G. lamblia*/intestinalis. Protozoan parasites are known to affect all species of vertebrates and many invertebrates. They are able to adapt to life in virtually all body sites of their hosts (Ngonjo *et al*., 2012). The most common intestinal protozoan parasites are: *G. intestinalis*, *E. histolytica*, and *Cryptosporidium* spp. The diseases caused by these intestinal protozoan parasites are known as giardiasis, amoebiasis, and cryptosporidiosis respectively, and they are associated with diarrhea (Haque, 2007).

.***Entamoeba histolytica***

E. histolytica is a protozoan parasite which causes amoebiasis. Amoebiasis is one of the health issues in many developing countries. It is the second most common cause of death due to parasitic infection after malaria as estimated by the World Health Organization (WHO, 2013). The majority of deaths are consequences of severe complications associated with intestinal invasive parasites. Approximately four to ten percent of the carrier of this amoeba infection develop clinical symptom within a year and amoebic dysentery is considered as the second leading cause of death worldwide next to malaria (Chong *et al*., 2012).

Asymptomatic infection with *E. histolytica* is defined as the presence of cysts in stools in the absence of colitis or extra intestinal infections. These healthy carriers may pass millions of cysts in the stool per day as the trophozoites multiply in the intestinal lumen (Destaw Haftu *et al*., 2014). According to World Health Organization (2015), the prevalence of amebiasis varies with the population of individuals affected, differing between countries and between areas with different socioeconomic conditions. Sometimes up to 50% of the population is affected in regions with poor sanitary conditions. Epidemiological studies have shown that low socioeconomic status and unsanitary conditions are significant independent risk factors for the infection. In addition, people living in developing countries have a higher risk and earlier age of infection than do those in developed regions. For example, in Mexico, 11% of the tested population aged five to six years was infected with amoeba.

There are two stages to the life cycle of *E. histolytica*, the infectious cyst stage and the multiplying, disease-causing trophozoite stage (Figure 1). Infection is acquired primarily through the ingestion of infective cyst forms present in faecally contaminated water and food (Destaw Haftu *et al* 2014). The trophozoite measures 10-50 micro meter and contains a single nucleus; whereas, cyst is 10-15 micrometer in diameter and contains four nuclei. *E. histolytica* cysts are resistant to gastric juices present in the human stomach, chlorination desiccation, and capable of surviving in a moist environment for several weeks (Liza *et al*., 2010).

After ingestion of contaminated water or food, the cyst wall is dissolved in the upper gastrointestinal tract and the organism excysts with in the lumen of the small intestine. During excystation, nuclear division is followed by cytoplasm division, giving rise to eight uni-nucleated trophozoites. Trophozoites of *E. histolytica* epithelial cells line the gastrointestinal tract. Once penetration of the intestinal mucosa is achieved, dissemination to other organs, extra intestinal infections, usually the liver occurs. Trophozoites which dwell in the colon multiply encyst and are passed in the stool from where further spread is possible (Matthys *et al*., 2011).

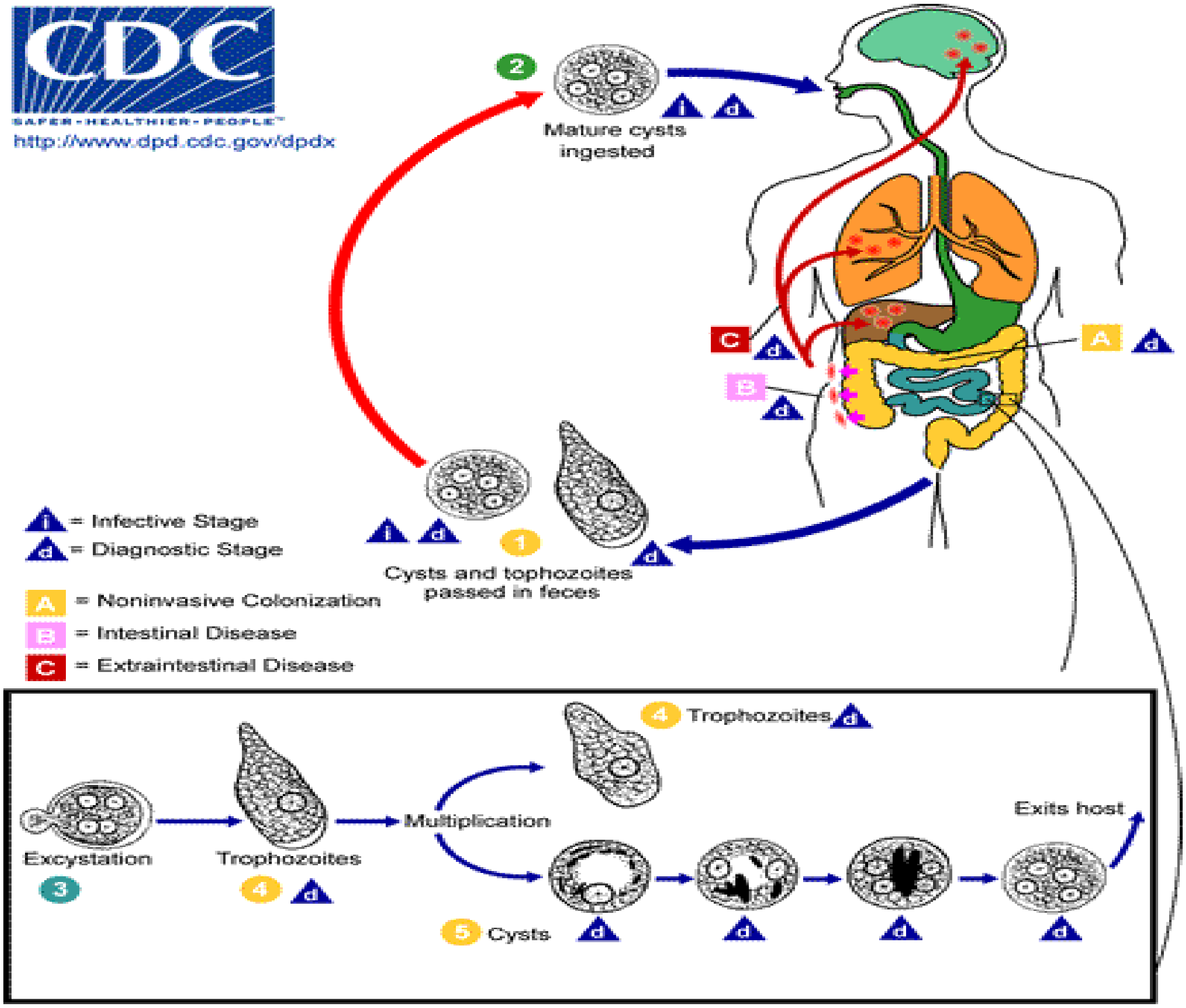

Figure 1: The life cycle of *E. histolytica*.

(Source: Centers for Disease Control and Prevention; CDC, 2017a)
(http://www.cdc.gov/dpdx/amebiasis/index.html)

Giardia lamblia

G. lamblia/intestinalis (also known as *Giardia duodenalis* or *G. intestinalis*) is a unicellular flagellated intestinal protozoan parasite of humans isolated worldwide and ranked among the top 10 parasites of man (Asrat Ayalew *et al*., 2011). Epidemiological studies suggest that the parasite is responsible for about five percent of acute diarrhea and 20% of chronic diarrhea illnesses in the world. The incidence of diarrhea associated with Giardia is generally higher in developing countries in Africa, Asia, South and Central America where access to clean water and basic sanitation is lacking. The prevalence for *G. lamblia* in developed countries is around two to five percent but in developing countries may be up to 20-30% (Tilahun Alelign *et al.,* 2010).

G. lamblia infection usually occurs through ingestion of *G. lamblia* cysts in water (unfiltered drinking-water and recreational water) or food contaminated by the faces of infected humans and animals. Many infections are asymptomatic. When symptoms occur; it results in chronic diarrhea (initially watery, then lose greasy stools), abdominal cramps, bloating, fatigue and loss of weight (WHO, 2018). The round or oval shaped cysts, which are the infective forms of the protozoa, are approximately 11-14 micrometer long and 7-10 micrometer wide. After ingestion the cysts pass unharmed by gastric acid through the stomach to the small intestine. Excystation normally occurs in the duodenum. Infection with Giardia is usually confined to the upper small intestine but also has been observed in the bile duct and gall bladder of ill patients. The structure of the cyst makes the organism very resistant to environmental factors and disinfection and it is the transmittable form that causes the infection. Identification of the parasite is usually made by microscopic examination of direct fecal smear for either trophozoites or cysts in the feces (Ngonjo *et al*., 2012).

G. lamblia requires a single host to complete its life cycle. Cysts are responsible for transmitting of giardiasis. Cysts can survive several months in cold water. Infection occurs by the ingestion of cysts in contaminated water, food or by the fecal-oral rote. Excystation occurs and releases trophozoites. Each cyst produces two trophozoites. Trophozoites replicate longitudinal binary fission, remaining in the lumen of the proximal small bowel where they can be free or attached to the mucosa by a ventral sucking disk. As the parasite transit toward the colon, encystation occurs. Most commonly the cyst is found in non-diarrheal feces (CDC, 2017b).

Trophozoites attach to epithelial cells of the upper intestine, primarily the jejeunum but also the duodenum, where they grow and divide (Figure2). Attachment is required to prevent being swept away by peristalsis and is mediated by the ventral disk of the trophozoite as well as adhesins on the parasite surface. As the intestinal epithelial cell surface is renewed, trophozoites move and reattach to other epithelial cells (Figure2).

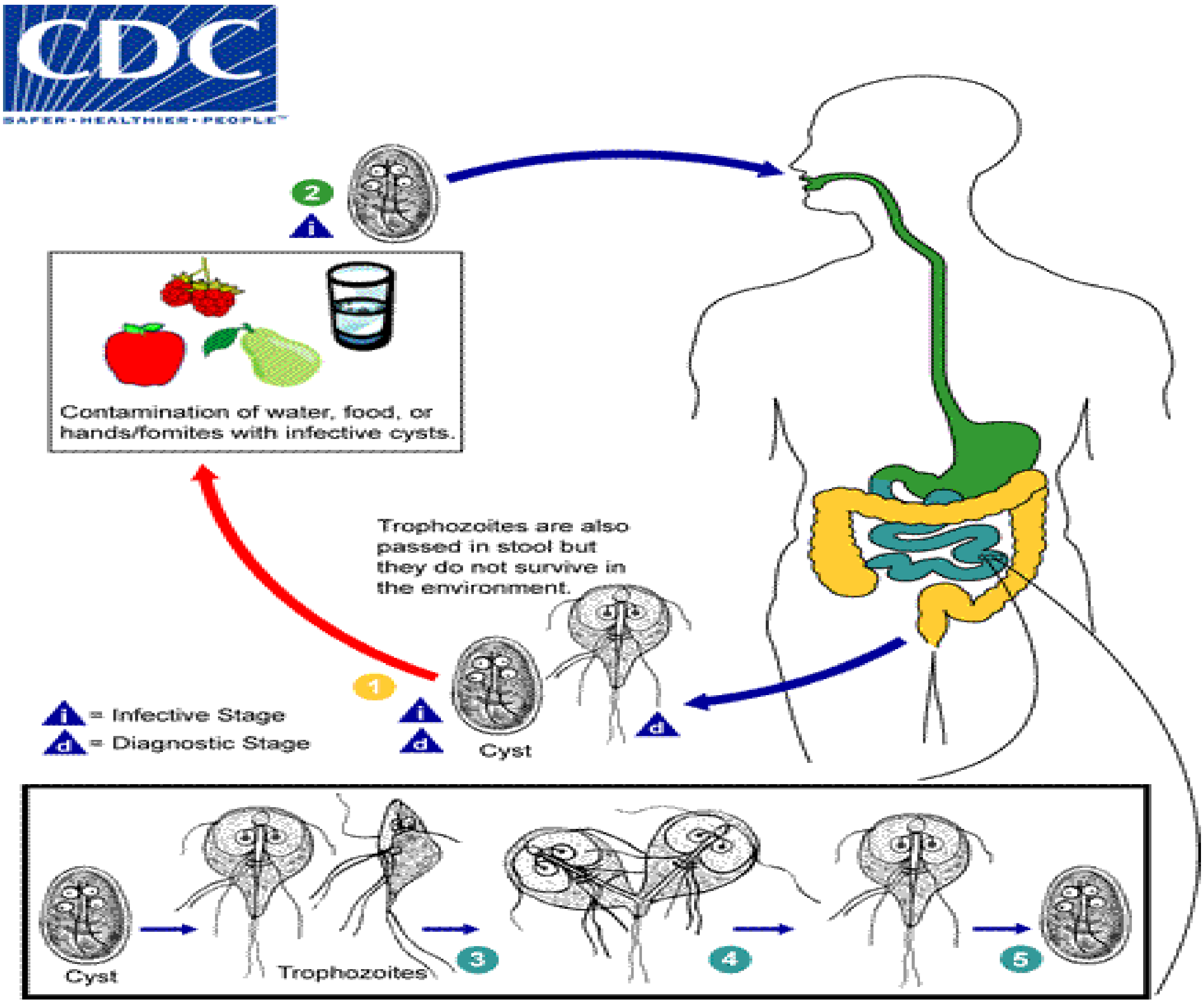

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Figure 2: The life cycle of *G. lamblia.*
(*Source;* CDC, 2017b) (*http://www.cdc.gov/dpdx/giardiasis/index.html*)

Cryptosporidium species

Cryptosporidium species are very small intestinal protozoa. They dwell in the stomach or in the small intestine of mammals, birds and reptiles. This parasite infects humans and animals globally. It can cause gastrointestinal illness in a wide variety of mammals, including humans, cattle, sheep, goats, pigs, and horses worldwide (Mulusew Andualem, 2014).

Cryptosporidium completes its life cycle in a single host and culminates in the shedding of mature oocysts in the faeces. These are immediately infective for another susceptible host. The oocysts are 4–6micrometer in diameter (smaller than many other protozoa), and contain four crescent shaped infective structures of sporozoites. After ingestion the oocyst excysts in the small intestine, releasing the sporozoites (Mohammed *et al*., 2015).

The lifecycle of *Cryptosporidium* can be completed entirely within a single host (Figure3). Human infection occurs by ingestion of cryptosporidium oocysts. These will excyst in the intestine and release the sporozoites (Figure3). The sporozoite attaches to the membrane of the intestinal epithelium and is engulfed to form a vacuole called meront. The sporozoite matures inside the vacuole and undergoes asexual reproduction, producing merozoites (Figure3).

At this point, the merozoites will be released in the intestinal lumen and will infect the intestinal cells again. Then they will either form a new meront, going through asexual reproduction and producing more merozoites. Or they will mature into sexual forms called microgamonts and macrogamonts (Figure3). Later microgametes will be released from the microgamont to fertilize the macrogamont and form a zygote. In the last step of the cycle, the zygote will develop into thick walled oocysts that will be excreted in the stools or will develop into thin walled oocysts that will release sporozoites which will re-infect the host intestinal cells to start a new cycle (CDC, 2019).

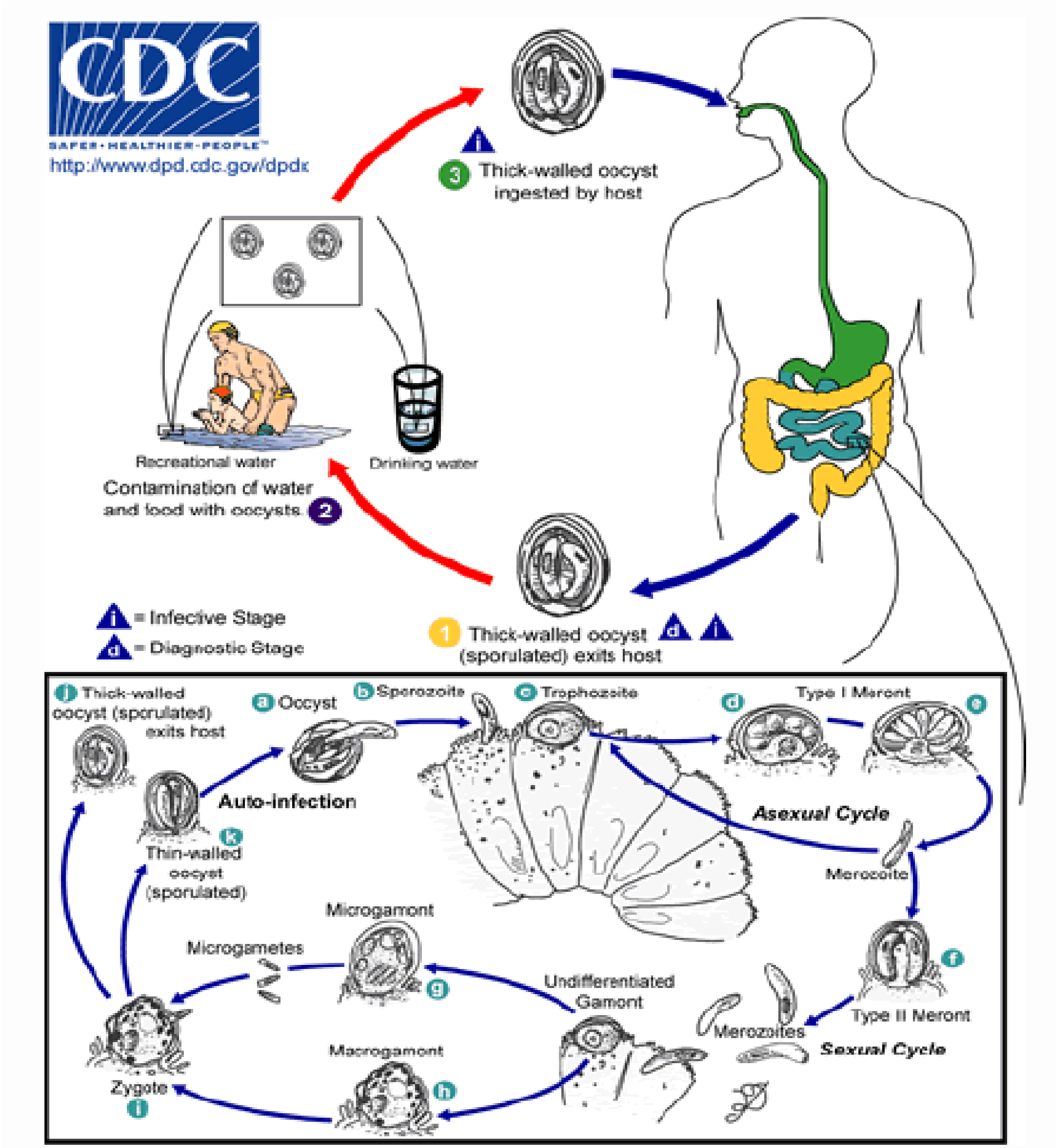


Figure 3: Life cycle of *Cryptosporidium* species.

(Source; CDC, 2019) (*http://www.cdc.gov/dpdx/Cryptosporidiosis/index.html*)

2.1.2. Intestinal Parasitic helminthes

Parasitic helminthes are multicellular worms that infect humans belong to two phyla, *Platyhelminthes* and *Nematodes*. The common intestinal helminthes are trematodes (flukes) includes *Schistosomia mansoni*), nematodes (round worms) includes *A. lumbricoides*, *T. trichiura* and hook worms (*Necator americanus* and *A. duodenale*) and cestodes (tape worms) includes *Hymenolepis nana*, *T.saginata* and *T.solium*. Helminthic infections are enhanced by poor socio-economic conditions, lack of sanitary facilitates, improper disposal of human feces, insufficient supplies of potable water, poor personal hygiene, poor housing conditions and lack of education (WHO, 2015).

Helminths are worms with many cells. Nematodes (roundworms), cestodes (tapeworms), and trematodes (flatworms) are among the most common helminths that inhabit the human gut. Usually, helminths cannot multiply in the human body. There are four species of intestinal helminthic parasites, also known as geohelminths and soil-transmitted helminths: *A. lumbricoides* (roundworm), *T. trichiuria* (whipworm), *A. duodenale*, and *N. americanicus* (hookworms). These infections are most prevalent in tropical and subtropical regions of the developing world where adequate water and sanitation facilities are lacking (Haque, 2007).

According to Masoumeh *et al*. (2012), at global burden, over one billion of the world's population is estimated to be infected with helminthes parasites and over two billion people are at risk. Trematodes: trematodes (flukes) are leaf shaped with an outer cover called the tegument which may be smooth or spiny. Most trematodes are hermaphroditic and most of the body consists of reproductive organs and their associated structures.

Nematodes: nematodes (round worms) are non-segmented helminthes, relatively simple structured organisms. They possess bilateral symmetry and a complete digestive tract with oral and anal openings; they taper to a relative point at both ends. They are also found to have separate sexes, with the male being smaller than the female, ranging in size from a few millimeters to over a meter in length. Nematodes infections have a wide spread distribution being found in both temperate and tropical climates. They can be found in fresh water, in the sea and in soil. About 85% of Nematodes infections are asymptomatic. Among them, *A. lumbricoides*, *T. trichiura*, hookworm spp. and *S. stercoralis* have particular public health relevance because of significant child morbidities (Bayeh Abera *et al*., 2013).

Trichuris trichiura

T. trichiura is commonly known as whip worm, due to the whip-like form of the body. *T. trichiura* infection is estimated to affect around 1049 million persons worldwide. Of these, 144 million are children of pre-school age and 233 million are of school age. These nematodes are most commonly seen in tropical climates and in areas where sanitation is poor (Shahrul *et al* 2012. Within the United States, infections are rare overall but may be common in the rural southeast, where 2.2 million people are thought to be infected. Poor hygiene is associated with trichuriasis as well as the consumption of shaded moist soil, or food that may have been faecally contaminated (de Silva, 2003).

Adult female worms shed 3,000 to 20,000 eggs per day, which are passed with the stool. In the soil, the eggs develop into a 2-cell stage, an advance cleavage stage and then embryonate. It is the embryonated egg that is actually infectious. Environmental factors such as high humidity and warm temperature quicken the development of the embryo. This helps explain the geographic predilection for tropical environments. Under optimal conditions, embryonic development occurs between 15-30 days. Infection begins when these embryonated eggs are ingested (Rohit, 2009**)**. The eggs first hatch in the small intestine and release larvae that penetrate the columnar epithelium and situate themselves just above the lamina propria (Figure4). After four molts, an immature adult emerges and is passively carried to the large intestine. Here, it re-embeds itself into the colonic columnar cells, usually in the cecum and ascending colon. Heavier burdens of infection spread to the transverse colon and rectum (Figure4).

The worm creates a syncytial tunnel between the mouths of crypts; it is here that the narrow anterior portion is threaded into the mucosa and its thicker posterior end protrudes into the lumen, allowing its eggs to escape. Maturation and mating occur here as well (Figure4). The pinkish gray adult worm is approximately 30-50 mm in length, with the female generally being slightly larger than the male. The nutritional requirements of *Trichuris* are unclear; unlike hookworm however, it does not appear that *Trichuris* is dependent on its host’s blood. Eggs are first detectable in the feces of those infected about 60-90 days following ingestion of the embryonated eggs. The life span of an adult worm is about one to three years. Unlike *Ascaris* and hookworm, there is no migratory phase through the lung (Rohit, 2009).

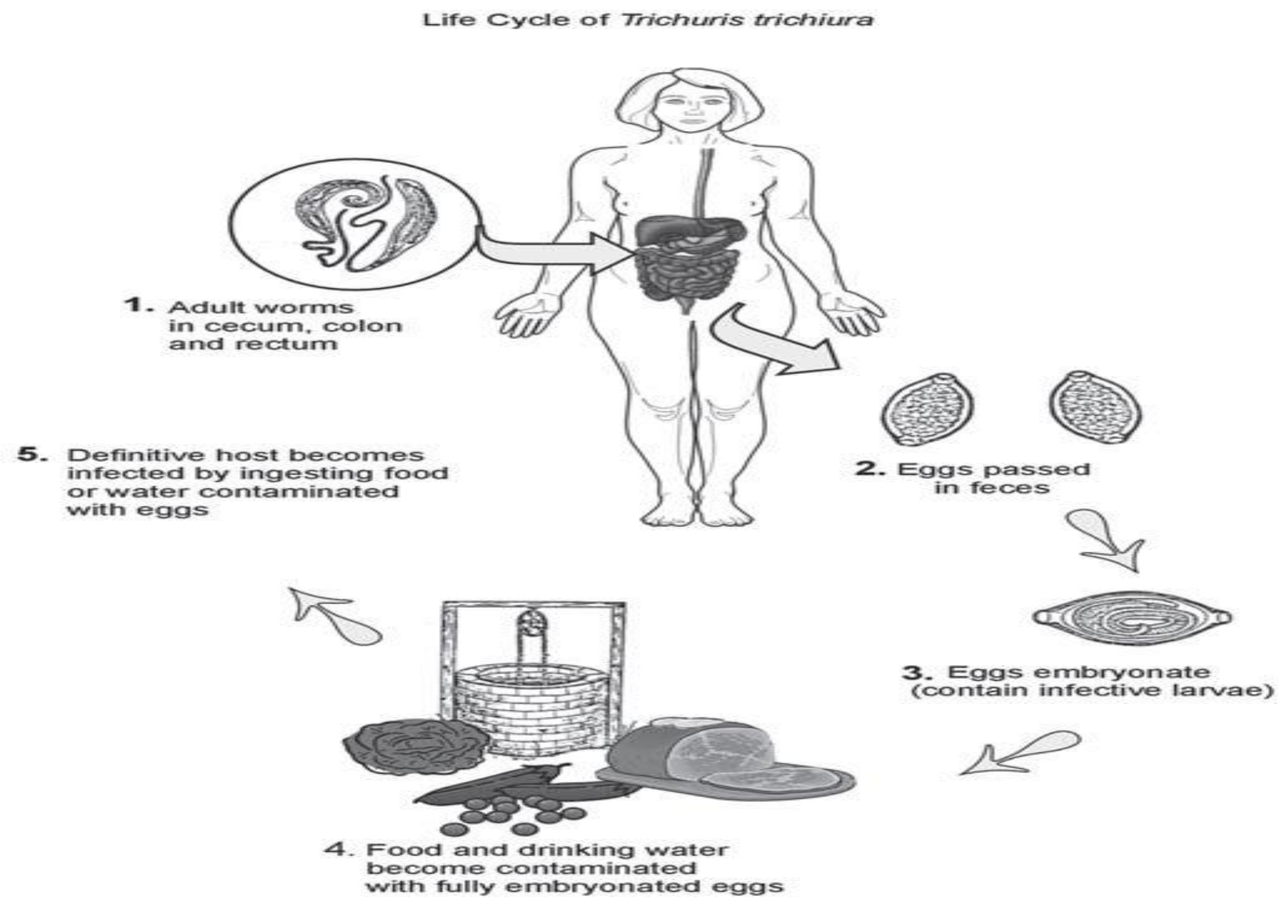


Figure 4: Life Cycle of *Trichuris trichuria* (Source: Rohit, 2009).

Ascaris lumbricoides

A. lumbricoides is the largest of the intestinal nematodes found in man. Annual morbidity associated with the parasite has been estimated by WHO at 60,000 with another 250 million peoples said to be at risk for acquiring the infection (Masoumeh *et al*., 2012). *A. lumbricoides* is a robust parasite. This is due to the resilient nature of its eggs, which are capable of surviving a wide range of hot and cold temperatures, chemicals, chemical disinfectants and other extreme conditions (Ngonjo *et al*., 2012).

A. lumbricoides infections in humans occur when an ingested infective egg releases a larval worm that penetrates the wall of the duodenum and enters the blood stream. From here, it is carried to the liver and heart, and enters pulmonary circulation to break free in the alveoli, where it grows and molts. In 3 weeks, the larvae pass from the respiratory system to be coughed up, swallowed, and thus returned to the small intestine, where they mature to adult male and female worms, fertilization can now occur and the female produces as many as 200,000 eggs per day for a year. These fertilized eggs become infectious after two weeks in soil; they can persist in soil for 10 years or more and cause ascariasis (Matthys *et al*., 2011).

Ascariasis is a disease caused by the parasitic round worm *A. lumbricoides* infections have no symptom in more than 85% of the cases. The symptoms increase with the number of worms present and include shortness of breath and fever in the beginning of the disease. These may be followed by symptoms of abdominal swelling, abdominal pain and diarrhea (Hagel and Giusti, 2010). Many reports illustrated that *A. lumbricoides* is the most prevalent intestinal parasite in different community, usually occurring together with Trichuris infections and Ascariasis is the most common helminthic infection worldwide, with an estimated 1 billion people infected (Cleave e*t al*., 2001).

The adult Ascaris worms reside in the lumen of the small intestine where they feed on predigested food (Figure5).Their life span ranges from 10 to 24 months. The adult worms are covered with a tough shell composed of collagens and lipids. This outer covering helps protect them from being digested by intestinal hydrolases. They also produce protease inhibitors that help to prevent digestion by the host. The adult female worm can produce 200,000 eggs per day (Figure 5). The eggs that pass out of the adult worm are fertilized, but not embryonated. Once the eggs exit the host via feces, embryonation occurs in the soil and the embryonated eggs are subsequently ingested (Figure 5).

There is a mucopolysaccharide on the surface that promotes adhesion of the eggs to environmental surfaces. Within the embryonated egg, the first stage larva develops into the second stage larva (Figure 5). This second stage larva is stimulated to hatch by the presence of both the alkaline conditions in the small intestine and the solubilization of its outer layer by bile salts. The hatched parasite that now resides in the lumen of the intestine penetrates the intestinal wall and is carried to the liver through the portal circulation. It then travels via the blood stream to the heart and lungs by the pulmonary circulation. The larva molts twice, enlarges and breaks into the alveoli of the lung. They then pass up through the bronchi and into the trachea, are swallowed and reach the small intestine once again. Within the small intestine, the parasites molt twice more and mature into adult worms (Afsson, 2009).

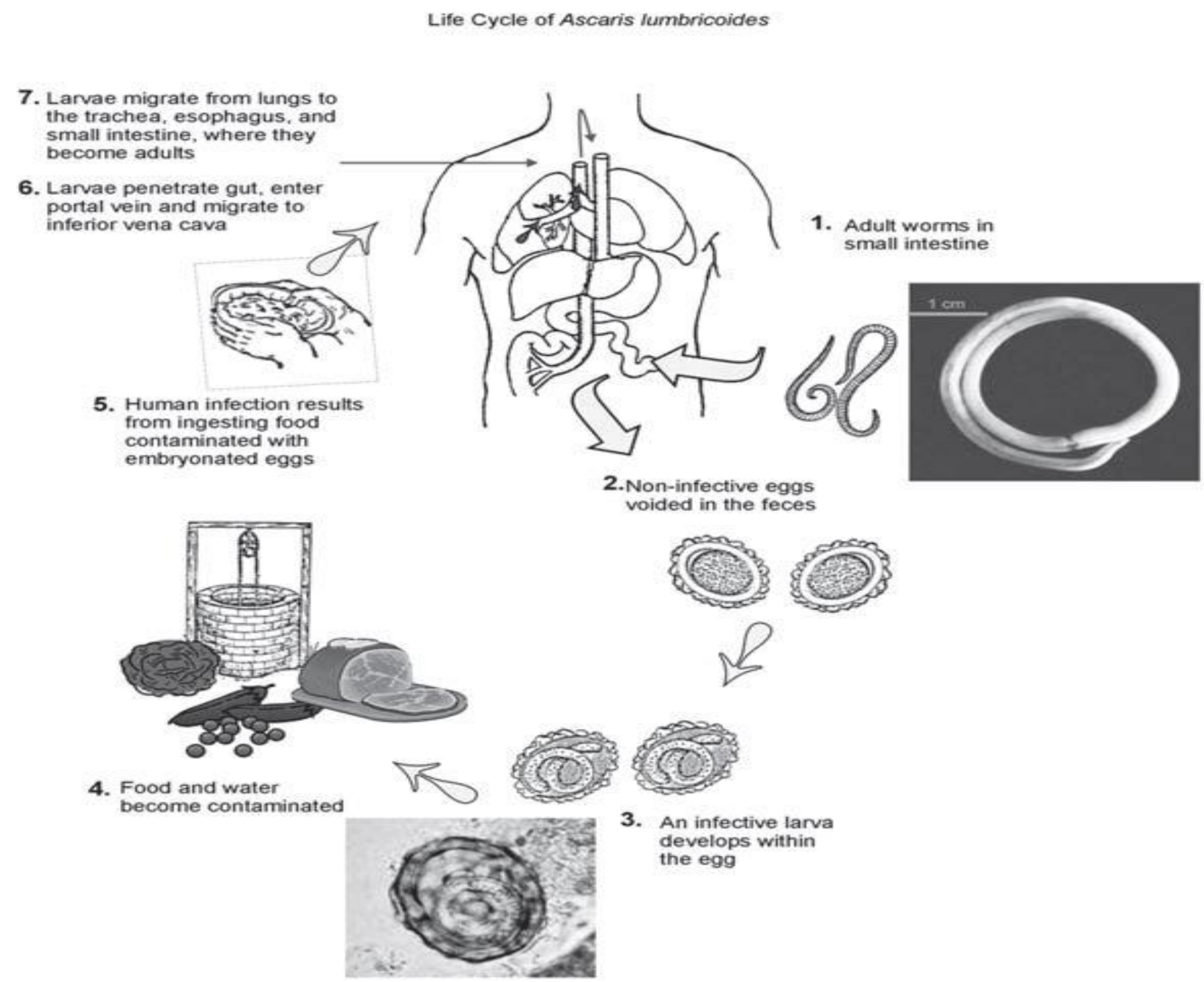


Figure 5: Life Cycle of *A. lumbricoides* (Source: Afsson, 2009).

Hookworm species

Human hookworm infection is a soil-transmitted helminth infection caused primarily by the nematode parasites, *A. duodenale* and *N. americanus,* the former originating in Asia and the latter originating in Africa. Human hookworm infections have been associated with humans in the old world for over 5000 years (Tadesse Zerihun, 2005).

Hookworm disease occurs when the blood loss exceeds the nutrition reserves of the host. Thus result iron-deficiency anemia, zinc-deficiency and protein malnutrition, particularly in pregnant women and children. It contributes to anemia by causing blood loss directly through ingestion and mechanical damage of the mucosa, and indirectly by affecting the supply of nutrients necessary for erythropoiesis (Crompton, 2007). If it is left untreated, hookworm causes internal blood loss leading to iron-deficiency anemia and protein malnutrition, particularly in pregnant women and children. Chronic hook worm infection in childhood contributed to physical and intellectual impairment, learning difficulties and poor school performance (Tilahun Alelign, 2010).

Hookworm transmission occurs when third-stage infective filariform larvae come into contact with skin (Figure 6). Hookworm larvae have the ability to actively penetrate the cutaneous tissues, most often those of the hands, feet, arms and legs due to exposure and usually through hair follicles or abraded skin. Following skin penetration, the larvae enter subcutaneous venules and lymphatic to gain access to the host's afferent circulation. Ultimately, they enter the pulmonary capillaries where they penetrate into the alveolar spaces, ascend the brachial tree to the trachea, traverse the epiglottis into the pharynx and are swallowed into the gastrointestinal tract.

Larvae undergo two molts in the lumen of the intestine before developing into egg-laying adults approximately five to nine weeks after skin penetration. Although generally one centimeter in length, adult worms exhibit considerable variation in size and female worms are usually larger than males (Figure 6). Adult *Necator* and *Ancylostoma* hookworms parasitize the proximal portion of the human small intestine where they can live for several years, although differences exist between the life spans of the two species: *A. duodenale* survive for on average one year in the human intestine whereas *N. americanus* generally live for three to five years (Figure 6).

Adult hookworms attach onto the mucosa of the small intestine by means of cutting teeth in the case of *A. duodenale* or a rounded cutting plate in the case of *N. americanus*. After attachment, digestive enzymes are secreted that enable the parasite to burrow into the tissues of the sub mucosa where they derive nourishment from eating villous tissue and sucking blood into their digestive tracts (Figure 6).

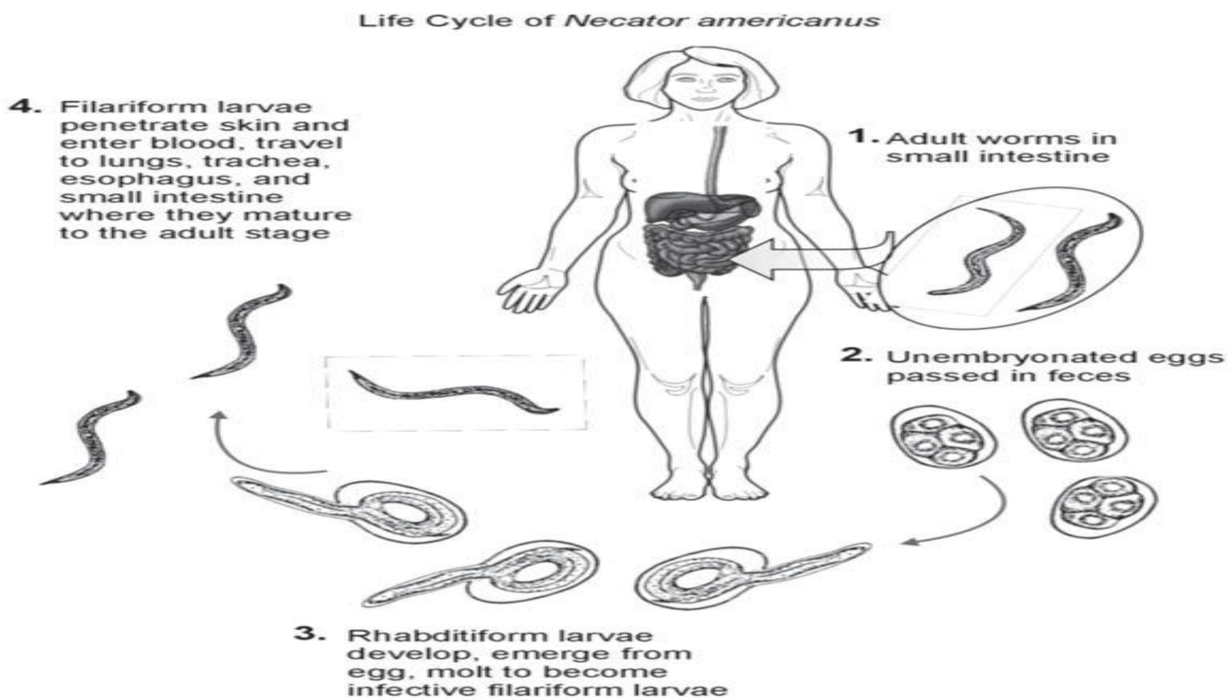


Figure 6: Life cycle of hookworm, *N. americanus* (source: David, 2009)**.**

***Enterobius vermicularis* (pinworm)**

The pinworm (genus Enterobius) is a type of roundworm (nematode) and three species of pinworm have been identified with certainty. Humans are hosts only of *E. vermicularis* (formerly *Oxyurias vermicularis*). Chimpanzees are hosts of *E. anthropopitheci*, which is morphologically distinguishable from the human pinworm. *E. gregorri,* supposedly a sister species of *E. vermicularis* is also claimed to affect humans and has a slightly smaller spicule (sexual organ). Regardless of its status as a distinct species, *E. gregorri* is considered clinically identical to *E. vermicularis. E. vermicularis* spread through human to human transmission, by ingesting infectious pinworm eggs and anal insertion (Totkova *et al*., 2003).

Gravid adult female *E. vermicularis* deposits eggs on perianal folds. Infection occurs via self-inoculation (transferring eggs to the mouth with hands that have scratched the perianal area) or through exposure to eggs in the environment (e.g. contaminated surfaces, clothes, bed linens). Following ingestion of infective eggs, the larvae hatch in the small intestine and the adults establish themselves in the colon, usually in the cecum. The time interval from ingestion of infective eggs to oviposition by the adult females is about one month. At full maturity, adult females measure 8 to 13 mm, and adult males 2 to 5 mm; the adult life span is about two months.

Gravid females migrate nocturnally outside the anus and oviposit while crawling on the skin of the perianal area. The larvae contained inside the eggs develop (the eggs become infective) in 4 to 6 hours under optimal conditions (CDC, 2012).

When swallowed via contaminated hands, food or water, the eggs hatch releasing larvae (Figure7). The larvae develop in the upper small intestine and mature in 5 to 6 weeks without undergoing any further migration into other body cavities. Both male and female forms exist. The smaller male is 2-5 mm in length and 0.3 mm in diameter whereas the female is 8-13 mm long and up to 0.6 mm in diameter (Figure 8). Copulation occurs in the distal small bowel and the adult females settle in the large intestine where they can survive for up to 13 weeks (males live for approximately 7 weeks).

The adult female can produce approximately 11,000 eggs. A gravid female can migrate out through the anus to lay its eggs. This phenomenon usually occurs at night and is thought to be secondary to the drop in host body temperature at this time. The eggs embyonate and become infective within 6 hours of deposition. In cool, humid climates the larvae can remain infective for nearly 2 weeks, but under warm, dry conditions, they begin to lose their infectivity within 2 days. Most infected persons harbor a few to several hundred adult worms (Figure7).

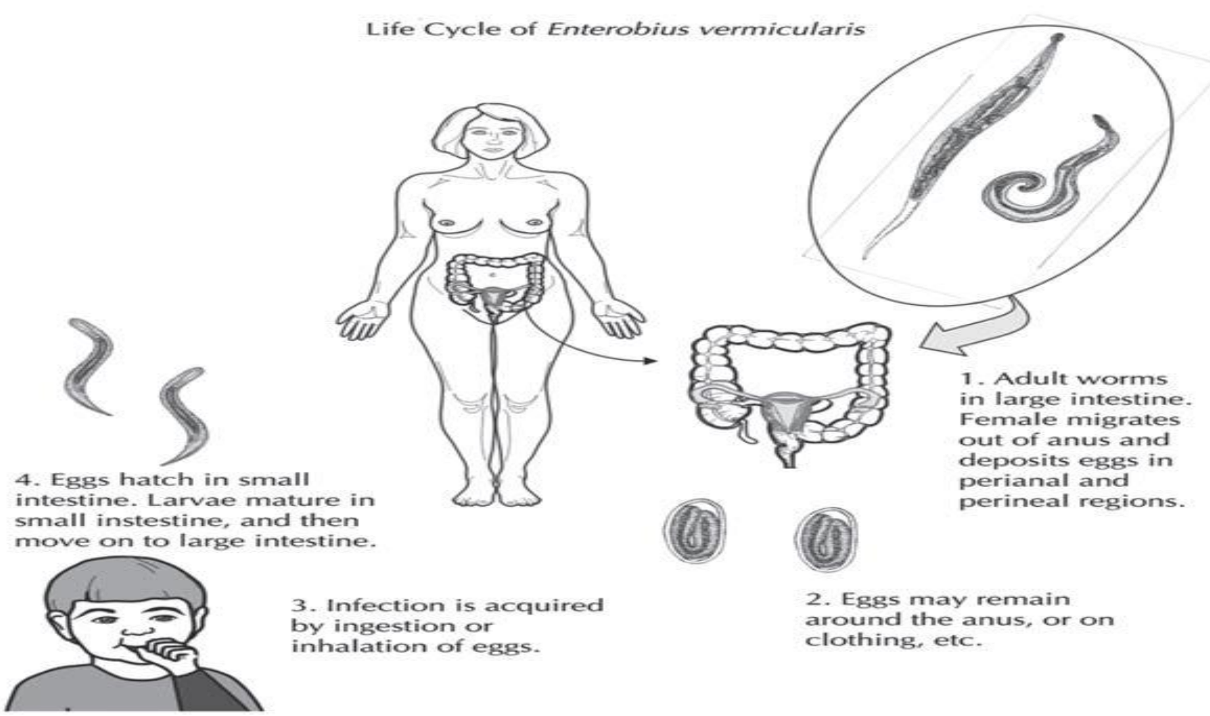


Figure 7: Life cycle of *E. Vermicularis* (Source: Janine, 2009).

Trematodes: trematodes (flukes) are leaf shaped with an outer cover called the tegument which may be smooth or spiny. Most trematodes are hermaphroditic and most of the body consists of reproductive organs and their associated structures. Schistosomiasis is chronic water related parasitic disease caused by blood flukes of the genus Schistosoma (Bahmani *et al*., 2017).

Schistosoma mansoni

Schistosoma mansoni is widely distributed. There are an estimated 38.3 million people living in schistosomiasis endemic areas (34.4 million preschool children, 12.3 million school aged children, and 21.6 million adults). The schistosome causing the disease in Ethiopia is *S. mansoni*. Infections by the parasites usually occur in agricultural communities among small streams, irrigation schemes and lakes at altitude ranging from 1300 to 2000 m above sea level for *S. mansoni*. The geographic distribution of various species of Schistosoma depends on availability of suitable snail hosts. *S. mansoni* is the most widespread of the schistosomes and is endemic in Africa, Saudi Arabia and Madagascar (Bereket Alemayehu *et al*., 2017).
Schistosomiasis is a chronic water related parasitic disease caused by blood flukes of the genus Schistosoma. It is the most important disease in terms of its public health and socio economic impact next to malaria, and is still a major helminthes infection at the beginning of the 21st century in many developing countries of the tropics. The disease is endemic in 74 tropical developing countries (Bahmani *et al*., 2017).

Eggs are eliminated with faeces. Under optimal conditions, the eggs hatch and release miracidia, which swim and penetrate specific snail intermediate, hosts (Figure 9). The stages in the snail include two generations of sporocysts and the production of cercariae. Upon release from the snail, the infective cercariae swim, penetrate the skin of the human host, and shade their forked tail, becoming schistosomulae. The schistosomulae migrate through several tissues and stages to their residence in the veins (Figure 9).

Adult worms in humans reside in the mesenteric venules in varies locations, which at times seem to be specific for each species. For instance, *S. japonicum* is more frequently found in the superior mesenteric veins draining the small intestine, and *S. mansoni* occurs more often in the superior mesenteric veins draining the large intestine. However, both species can occupy either location, and they are capable of moving between sites, so it is not possible to state unequivocally that one species only occurs in one location. The eggs are moved progressively towards the lumen of the intestine (*S. mansoni* and *S. japonicum*) and are eliminated with feces (CDC, 2012).

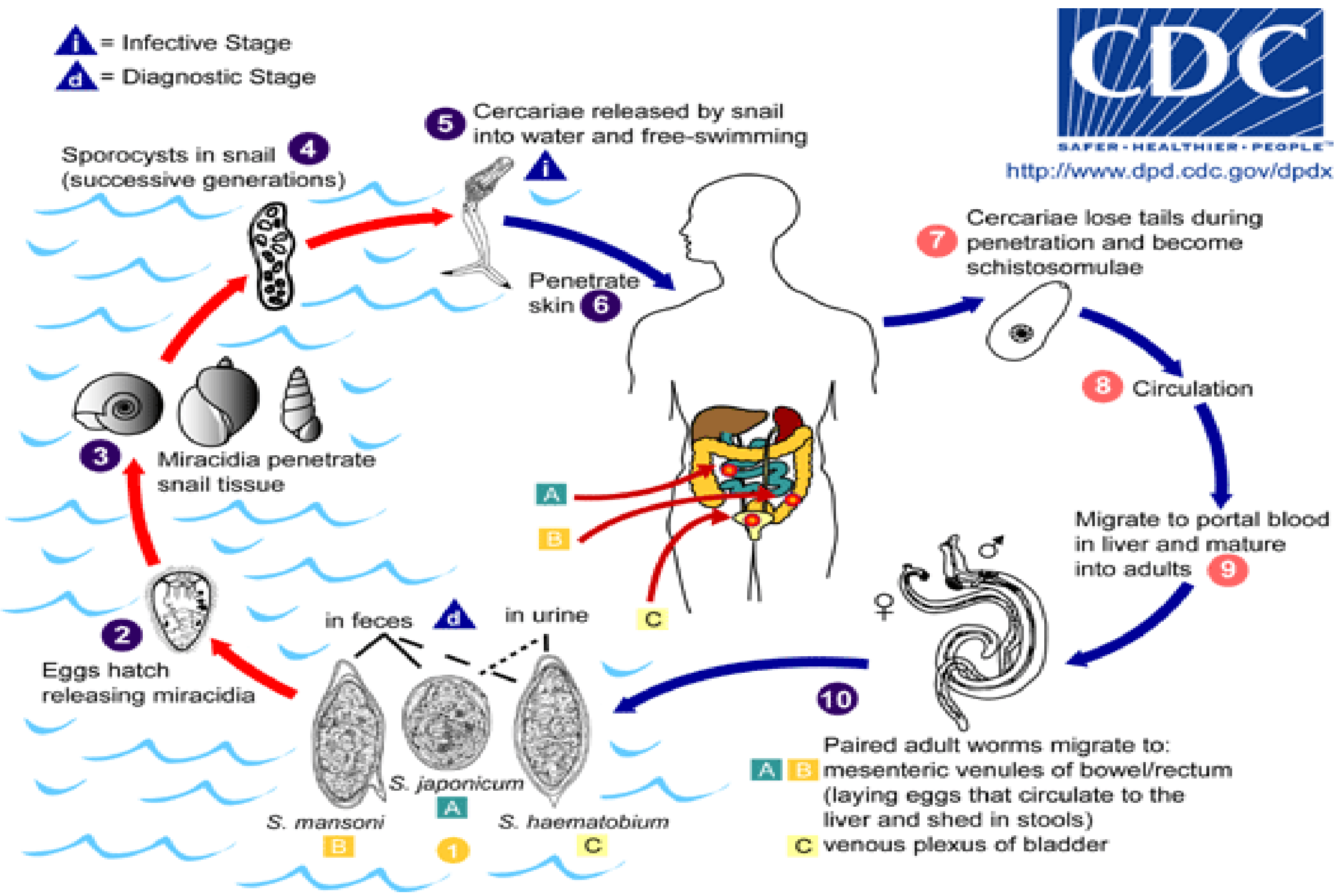


Figure 8: The life cycle of *S. mansoni.*

(Source: Centers for Disease Control and Prevention; CDC, 2012) (http://www.cdc.gov/parasites/schistosomiasis/biology.html)

Cestodes: cestodes are tapeworm, specialized flatworms, looking very much like a narrow piece of adhesive tape. Tapeworms are the largest, and among the oldest, of the intestinal parasites that have plagued humans and other animals since time began. The most important cestodes affecting humans and animals in Ethiopia are *T.saginata*, and *Hymenolepsis nana*, the former due to the custom of eating raw meat and the later due to unhygienic food consumption with contaminated hands and fingers that allow the ingestion of eggs from the faeces of an infected person (Bahmani *et al*., 2017).

Hymenolepis nana

H. nana is found in the intestine, it is very small, only a few centimeters long. The egg is unique in its appearance. It is small, measuring 30-47 μm in diameter with a thin, colorless shell. The membrane surrounding the hexacanth embryo has 4-8 filaments arising from each pole that fills much of the space between the embryo and the shell (WHO, 2015).

H. nana previously known as *Vampirolepis nana, H. fraterna*, and *Taenia nana* is a cosmopolitan species though most common in temperate zones, and is one of the most common Cestodes infecting humans, especially children (Chero *et al*., 2007). Hymenolepiasis is caused by two Cestodes (tapeworm) species *H. nana* (the dwarf tapeworm) and *H. diminuta* (rat tapeworm). *H. diminuta* is a cestode of rodents infrequently seen in humans and frequently found in rodents (CDC, 2017c).

Hymenolepiasis occurs more commonly in children. Most infections are asymptomatic. In heavy infections symptomatology include irritability, diarrhea and abdominal pain, sleep disorders, nausea, loss of appetite and weight, weakness, vomiting and anal itching. The most important complications include bloody diarrhea and behavioral disturbances. Transmission of infection occurs through fecal-oral route by ingestion of eggs from contaminated hands, frequently by contamination of food and water, and rarely from ingestion of food contaminated with fleas harboring the cysticercoid larvae (Becker *et al*., 2011).

The life cycle of *H. nana* is unique among tapeworms in that an intermediate host is optional. When eaten by a person or a rodent, eggs hatch in the duodenum, releasing oncospheres, which penetrate the mucosa and come to lie in lymph channels of the villi. Here each develops in to cysticercoids (Figure10). In five to six days, cysticercoids emerge in to the lumen of the small intestine, where they attach and mature. This direct life cycle is doubtless a recent modification of the ancestral two-host cycle, found in other species of Hymenolepidids, because cysticercoids of *H. nana* can still develop normally with in larval fleas and beetles. One reason for the facultative nature of the life cycle is that *H. nana* cysticercoids can develop at higher temperatures than can those of other Hymenolepidids (Figure10).

H. nana and *H. diminuta* infections are most often asymptomatic. Heavy infections with *H. nana* can cause weakness, headaches, anorexia, abdominal pain, and diarrhea. Personal hygiene, sanitary improvements, using uncontaminated food and water and rodent control are measures for prevention of *H. nana* infection (CDC, 2017C).

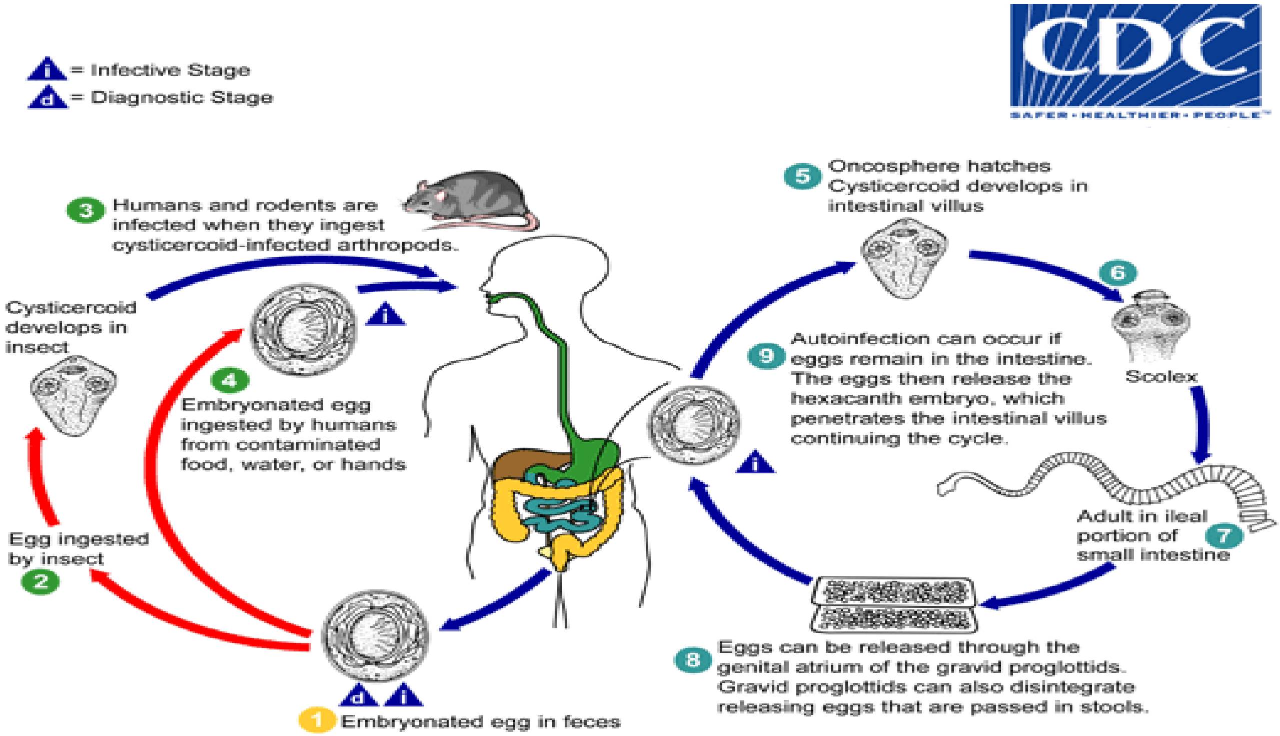


Figure 9: Life cycle of *H. nana.*

(*Source;* CDC, 2017c) (*http://www.cdc.gov/parasites/H./biology.html*)

Taenia species

Taeniasis is a disease resulting from infection with parasitic tapeworms belonging to Taenia species. Approximately 45 species of *Taenia* have been identified; however, the two most commonly responsible for human infection are the pork tapeworm *T.solium* and the beef tapeworm *T. saginata*. Parasitic tapeworm infections occurs worldwide, causing sickness, malnutrition, and often resulting in the death of their host. Infections with adult tapeworms of either *T. solium* or *T. saginata* cause taeniasis in humans. The metacestode or larval stage, of *T.solium* causes the tissue infection, cysticercosis. Clinical manifestations associated with the tapeworm infection can vary greatly and may range from mild forms where patients exhibit little to no symptoms, to severe life-threatening forms which are oft en fatal (Cummings *et al*., 2009).

T. saginata commonly known as the beef tapeworm is a zoonotic tapeworm belonging to the order cyclophyllidea and genus *Taenia*. It is an intestinal parasite in human causing taeniasis (a type of helminthiasis) and cysticercosis in cattle. From humans, embryonated eggs, called oncospheres, are released with faeces and are transmitted to cattle through contaminated fodder. Oncospheres develop inside muscle, liver and lung of cattle into infective cysticercoids. *T. saginata* has a strong resemblance to the other human tapeworms, such as *T. asiatica* and *T. solium*, in structure and biology (Somers *et al*., 2010).

The complete life-cycle of *T. solium* involves two hosts: the pig and the human, whereas that of *T. saginata* involves the cow and the human (Figure 11). Humans act as the definitive host and harbor the adult tapeworm in the small intestine. Infection is acquired either through the accidental ingestion of embryonated eggs passed in the feces of an individual infected with the adult tapeworm, or through the consumption of raw or poorly cooked meat containing cysticerci. The cysticerca develops into an adult worm in the gut; these worms can survive up to 25 years. Depending on the species of *Taenia*, an adult worm can reach lengths between 2-25 meters and may produce as many as 300,000 eggs per day (Figure11).

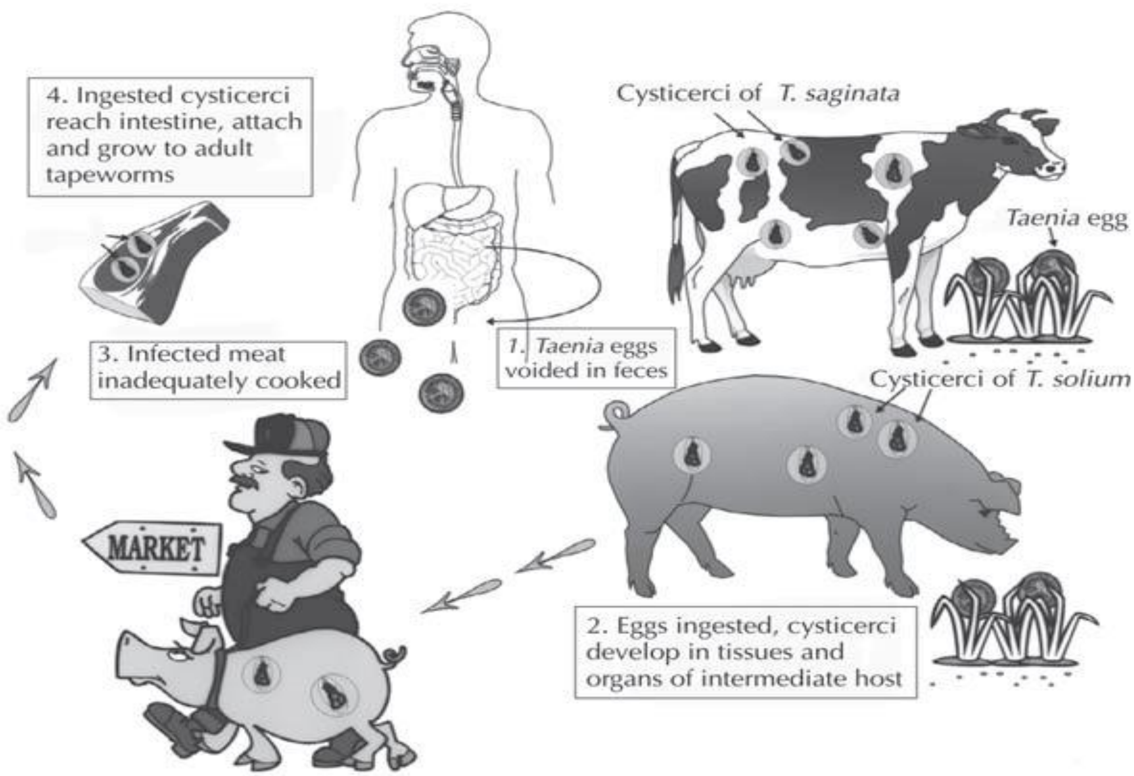


Figure 10: Life cycles of *T. saginata* and *T. solium* (Source: Cummings *et al*., 2009).

2.2. Global epidemiology of intestinal parasitic infection

According to WHO (2000), an estimate of 3.5 million people have been infected and around 450 million children are ill due to intestinal parasitic infection globally. Helminths alone had high global prevalence: estimated 1.5 million cases of *A. lumbricoides,* 1.2 million cases of hookworm, 1.05 million cases of *T. trichiura,* and 200–300 million cases of schistosomiasis had been reported (Ezeamama *et al*., 2005). It was estimated that greater than one-fourth of the world’s people are infected with Hookworm, *A. lumbricoides*, *T. trichiura*, and schistosomes only, which are particularly prevalent among school-age children in developing countries, making *amoebiasis*, *ascariasis*, hookworm and *trichuriasis* among the ten most common infections (Kremer and Miguel, 2001).

The global prevalence and intensity of IPIs in man have shown considerable variation in distribution and in seasonal occurrence due to geographical and climatic factors and to human activities changing the environment. For example, a range of 30-60% estimated intestinal parasitic infection prevalence rates in developing countries of Central America, especially Guatemala, Honduras, and Mexico was very high compared to that ≤ 2% in developed countries (Saab *et al*., 2004).

Helminthic infection is among the most prevalent IPIs of humans from developing parts of the world where there is low coverage of hygiene and sanitation, such as in Latin America, China and East Asia, and Sub-Saharan Africa. This infection is distributed virtually throughout the world and has been causing morbidity most commonly associated with infections of heavy intensity (WHO, 2008).The transmission of most of the intestinal parasites reflects the level of sanitation and the availability and quality of water. For instance, in human communities in which poverty is deep-rooted and clean drinking water, sanitation, health care, and health awareness are inadequate, there has been wide distribution of roundworms, hookworms, and whipworms (Yilmaz *et al*., 2007).

As indicated in table1the global prevalence of IPIs in Nigeria78.1% followed by South Africa 64.8%, India 63.9%, Nepal 58.8%, Kenya 53.8%, Pakistan 52.8%, Saudi Arabia 32.2%, West Malaysia 21.4%, Iran 6.5%.

Table 1: Prevalence of IPIs in some African and Asian countries

Global/ Nation	Title	Prevalence of IPIs	Significant Predicators of IPIs in the study area	Sources
West Malaysia	Prevalence and Risk Factors of Intestinal Parasitism in Rural and Remote West Malaysia	21.4%	Participants age ≤12years, low household income, using untreated water and indiscriminate defecation	Ngui *et al*., 2011
Pakistan	Prevalence and factors associated with intestinal parasitic infection among children in an urban slum of Karachi	52.8%	Age and living in rented households	Mehraj *et al*., 2008
Nigeria	Prevalence and pattern of intestinal parasites among pupils of private and public primary schools in an urban Centre, Nigeria	78.1%	Socioeconomic status and source of water	Ajayi *et al*., 2017
South Africa	Prevalence of intestinal parasites in primary school children of Mthatha, Eastern Cape province, south Africa	64.8%	Parents' unemployment and lower education	Nxasana *et al*., 2013
Kenya	Prevalence and intensity of IPIs and factors associated with transmission among school going children	53.8%	Age 11-15 years, eating food without spoon, consuming raw vegetables, untrimmed finger nails and source of drinking water	Kamande *et al*., 2015
Saudi Arabia	Intestinal parasitic diseases in Riyadh,-Saudi-Arabia: prevalence, sociodemographic and environmental associates	32.2%	Age<12 years, educational level below secondary school, tanker as a source of water and open sewage disposal	Al-Shammari *et al*., 2001
India	Prevalence of intestinal parasitic infection in school going children in Amalapuram, Andhra Pradesh, India	63.9%	Rural residence, mother education less than primary school and no hand wash with soap after toilet	Ashok *et al*., 2013
Nepal	Prevalence and factors associated with intestinal parasitic infection among children in an urban slum of Nepal	58 8%	Using direct tap water, untrimmed nail and washing hands with mud instead of soap	Yadav Khushbu and Prakash Satyam, 2016
Iran	Prevalence of intestinal parasitic infection among primary school children in Southern Iran	6.5%	Parents' job and parents' educational level less than high school diploma	Turki *et al*., 2016

2.3 Epidemiology of intestinal parasitic infections in Ethiopia

Number epidemiological studies in Ethiopia showed that IPIs were widely distributed.in several localities of the country with varying magnitudes of prevalence. Intestinal parasitic infection has cosmopolitan distribution. (Tilahun Workneh *et al*., 2014)

A cross-sectional survey, involving 404 faecal samples examined, among school children of Axum town, northern Ethiopia. The overall prevalence of IPIs in the study area was 44.6%, the most common intestinal parasites identified were *E. histolytica* (17%), followed by *G. lamblia* (14%) and *A. lumbricoides* (9%). The overall infection rate was highest among the 9-14 years' age group (24.3%) followed by 5-9 years' age group (20%). Only 0.2% of children from 15-19 year age group were infected. But there was no significant difference. In this study the multivariate logistic regression analysis indicates low household income, habit of washing hands after defecation and before, practice of eating unwashed/uncooked vegetables were the independent predicators of IPIs in the study area (Mulu Gebreslassie *et al*., 2015).

In addition, Mengistu Legesse and Berehanu erko (2004) reported that 83.8%, of 259 surveyed students, had one or more intestinal parasites which include hookworm(60.2%), *S. mansoni* (21.2%), *T. trichuria* (14.7%), *Taenia* species (13.9%), *E. histolytica/dispar* (12.7%), *A. lumbricoides* (6.2%), *G. duodenalis* (6.2%) and *S. stercoralis*(5.8%) from rural area close to the southeast of Lake Langano, Ethiopia. Moreover, Amare Mengistu *et al.* (2007) showed that *T. trichiura*, *A. lumbricoides*, *E. histolytica/dispar*, *G. lamblia*, *S. stercoralis*, *H. nana*, intestinal *schistosome*, *T. saginata*, *E. vermicularis* and hookworm with prevalence of 60.9%, 40.9, 17.1% 13.9%, 17.5%, 2.1% 5.0%, 2.3%, 14.8% and 1.1%respectively were diagnosed from study groups in Jimma, southwestern Ethiopia.

In studies conducted in four primary schools in Debre Elias, East Gojjam Zone, northwest Ethiopia, the overall prevalence of IPIs was 84.3%. The leading intestinal parasite in this study was hookworm (71.2%) followed by *E. histolytica/dispar* (6.7%) (Tilahun Workneh *et al*., 2014). Out of 434 examined subjects in Jimma town, Ethiopia, the overall prevalence of IPIs was 48. 2percent. *A. lumbricoides* was the predominant parasite detected in 120 (27.6%) of the study participants followed by *T. trichiura*. *E. histolytica/dispar* was the predominant protozoan parasite detected 24 (5.5%) of the study participants. Age group less than 10 years, illiteracy, estimated family income of less than 500 Ethiopian Birr, and irregular washing of hands before meal were the independent predicators for IPIs in the study area (Ayalew Jejaw *et al*., 2014).

According to a cross sectional-study conducted among school children in Yadot Primary School children of Delo-Mena district, Bale Zone (south eastern Ethiopia); ten species of intestinal parasites were identified with an overall prevalence of 26.2%. The most prevalent parasites were *S. mansoni* 12.6% followed by *E. histolytica/dispar* 5%, *A. lumbricoides* 4.7% and *H. nana* 4.4%. Double infection, triple infection and quadruple infections were observed in 4.7%, 1.2% and 0.3% of the study subjects respectively (Begna Tulu *et al*., 2014).

In another study conducted among school children of Homesha District in Benishangul-Gumuz Regional State (western Ethiopia), the overall prevalence of IPIs was 35.44%. *E. histolytica/dispar* was the most prevalent intestinal parasite 56 (14.17%) followed by *G. lamblia* 50 (12.65%) and hookworm 40 (10.2%). In this study the most significantly associated risk factors for the occurrence of IPIs were: hand washing habit, eating unwashed/under cooked vegetation, waste disposal habit, shoe wearing habit and practice of finger nail trimming (Gebremichael Gebretsadik, 2016).

A cross sectional study, involving 704 school children was conducted at Delgi Elementary and Junior Secondary in North West of Gondar (north Ethiopia). In this study ten species of intestinal parasites were identified with an overall prevalence of 562 (79.8%). The most prevalent intestinal parasites identified were *A. lumbricoides* (48%), *G. lamblia* (41.9%), *E. histolytica/dispar* (27.3%), *S. mansoni* (15.9%) and hookworm (11.5%). In the study area, intestinal parasite prevalence was higher in children with less educated mother; in children who have habit of eating raw/unwashed vegetables; drinking unprotected well/spring water and who do not have hand washing practice before meal (Asrat Ayalew, 2011).

The findings of the study which was conducted among school in Adigrat town, northern Ethiopia, indicates 50.81% of the study subjects were found to be infected with one or more intestinal parasites. The most predominant intestinal parasite was *A. lumbricoides* (19.1%), followed by hookworm (10.03%). In this study, multiple logistic regressions revealed that not practice of finger nail trim; unprotected well water source and rural residence were independently associated with IPIs (Dinku Senbeta, 2017).

2.4. Risk factors of IPIs

The high prevalence rate of IPIs in developing countries depends on several factors. Socio-demographic variables associated with poverty such as reduced access to adequate sanitation, scarcity of potable water, unsafe human waste disposal systems, open field defecations and unavailability of sufficient health care as well as the prevailing bad climatic and environmental conditions is the most important risk factors (Baye Sitotaw, 2019).

Several previous studies have identified numerous risk factors which are associated with the high prevalence and intensity of IPIs. These include demographic such as age, gender; socioeconomic such as poverty, sanitation and environmental such as climate, season and behavioral factors which form a web of causation for IPIs (de Silva *et al.*, 2003).

2.4.1. Poverty and sanitation

The transmission of parasitic infection is higher in environments contaminated with egg-carrying feces. Consequently, intestinal parasites are intimately associated with poverty, poor sanitation, and lack of clean water. The populations in developing countries live in conditions that are highly conducive to the acquisition of parasitic infestation. Poor hygiene, crowded household conditions, dietary habits, education level of the community and deficient sanitation mark their day-to-day life (Valiathan *et al.*, 2016).

2.4.2. Climate, water and season

IPIs are highly prevalent in warmer and moister areas. This is because hook worm, Ascaris, Trichuris and *S. mansoni* ova require humid environments Many helminths infections are more common in children than in adults. In addition to this, multiple infections can also play a role because children tend to live more closely with nature and with their pets (Valiathan *et al*., 2016). Ascaris and Trichuris eggs have shells which are thicker than hookworm eggs, and therefore survive drier climates better. However, the rates of infection are low in dry climates for all IPIs. The number of risk factors increasing hookworm infections are contact with contaminated soil or sand, especially when walking barefoot, travel in an area with poor sanitation,, where human fecal matter contaminate the soil, people exposed to poor sanitation management and hygiene, especially waking barefoot or with skin to soil contact (Brooker,, 2011).

IPIs are more prevalent among the poor segment of population. They are closely associated with limited access to clean water, tropical climate. There are many factors that predispose to disease development, including host and parasite factors. The host factors include age, level of natural immunity at the time of infection, life style, and presence of co-existing disease or a condition which reduces immune responses, e.g. pregnancy, under nutrition or malnutrition (Aschalew Gelaw *et al*., 2013).

2.4.3. Age

The high prevalence rate of intestinal infection in children is attributed to many factors, particularly environmental and personal hygiene. For reasons not well understood, school aged children (including adolescents) and pre-school children tend to harbor the greatest number of intestinal worm. As a result they experience growth stunting and diminished physical fitness as well as impaired memory and cognition (Valiathan *et al*., 2016).

Several previous studies revealed that the age-dependency prevalence of IPIs. Although heavy hookworm infections still occur among children in some tropical areas, the peak prevalence and intensities for hookworm occurs in individuals in middle age (15-30), or even over the age of 50 Moreover, many previous studies showed higher prevalence and intensity of *Ascaris* and *Trichuris* infections among young children (age below 10 years) when compared to their older counterparts (Brooker, 2011).

2.5. Impacts of IPIs

Negative effect of intestinal protozoan parasite includes vitamin A deficiency, mal absorption of vitamin B12 and fat and nutritional deficiencies in children; these might be associated with *G. lamblia*, which may lead to serious organ damage. Giardia is one of the most causes of protozoan diarrhea worldwide and leads to significant morbidity and mortality in both the developing and developed countries (Alemnesh Tesema, 2013).

The amount of harm caused by intestinal protozoan parasites to the health of communities depends on several factors such as species, prevalence and intensity of infection, the infection between the parasite and simultaneous infections, the nutritional and immunological status of the population and numerous socio-economic factors. The public health importance of intestinal parasites is always measured by the prevalence, intensity of the infection and association of these infections with human nutrition, growth and development of children and work productivity in adults (Caccio *et al.,* 2005). The consequence of malnutrition in children also includes poor physical development and limited intellectual ability that diminish their working capacity during adulthood. This related with socio-economic and demographic factors (WHO, 2012).

Protozoan and helminthic infections are the most important human parasites at global scale. Morbidity and mortality due to IPIs are usually more pronounced in children compared to adults due to their higher nutritional requirements and less mature immune systems (Aschalew Gelaw *et al*., 2013).

Preschool children and infants are reported to be the most vulnerable to the adverse nutritional effects of the IPIs. The main reason of this is that, they often suffer from an increased IPIs burden associated with a greater exposure to these infections' agents by virtue of unsanitary practices associated with child development, such as playing in contaminated dirt and water, sucking on dirty fingers and other objects. Growing children also have high nutritional requirements (Strunz *et al.,* 2014).

2.6. Prevention and control of IPIs

According to World Health Organization guidelines (WHO, 2018), any health program aiming at controlling morbidity of IPIs should have evidence based estimates of this problem. Human intestinal parasitic protozoan infections can be controlled through proper treatment and disposal of row swage and maintaining clear water supply including the protection of open wells, springs and rivers from contamination with swage and feces. The risk for infection can also be reduced via the adequate boiling of drinking water or treatment of water with chlorine or iodine. The exterior of row vegetables and fruits should be washed with soup and soaked in vinegar for some minutes before conception (Shahrul *et al*., 2012).

A well-structured control strategy needs to be based on local and accurate data concerning the epidemiology, definition of targets, definition of appropriate chemotherapy and health education campaigns, sanitation, monitoring and evaluation programs (WHO, 2015)

2.6.1. Improved sanitation

Prevent faecal contamination of the environment by using latrine and protecting water supply from faecal contamination. Control programs based on sanitation aim to reduce or interrupt transmission, prevent reinfection and gradually reduce worm loads (Bahmani *et al*., 2017). However, to be effective in a short period of time they need to be combined at their first stage with chemotherapy. Long term sanitary control programs need to add elements to improve the economic conditions of a region, to ensure a reliable and permanent sanitation system and have permanent health education programs (Aschalew Gelaw *et al*., 2013).

2.6.2. Health education

Health education and promotion of healthy behaviors can play a key role in reducing the incidence of human IPIs. However, the effectiveness of those activities in reducing transmission of infection varies according to different reports. In some cases, health education can decrease costs, increase levels of knowledge, and decrease reinfection rates. Health education efforts can build trust and engage communities in aspects that are crucial to the success of public health initiatives (Mbae*et al*., 2014).

2.7. Diagnostic technique of IPIs

Over the last several years, we have seen new approaches to the diagnosis of intestinal protozoan parasites. Antigen-detection tests are now commercially available for the diagnosis of all three major intestinal protozoan parasites. Diagnosis of *E. histolytica* cannot be done any longer by microscopy, since this parasite is morphologically similar to the non-pathogenic parasite *E. dispar*. *E. histolytica*-specific antigen-detection test is now commercially available for the detection of *E. histolytica* antigen in stool specimens (Haque, 2007).

The laboratory diagnosis of IPIs is done by the detection of their characteristic eggs and/or larvae in stool samples collected from infected individuals. The following are some diagnostic techniques which are commonly used for stool examination to detect intestinal parasite eggs and larvae:

i. Direct smear technique: It should be performed on every stool samples received in the laboratory. The motile larvae of *S.* or hookworm can be detected as well as the eggs of other species (Megbaru Alemu *et al*., 2018).

ii. Formalin-ether sedimentation technique: It is the method of choice for all IPIs including STH especially in light infections. The method involves using formalin which is a fixative reagent and prevents any further development of the stages (Megbaru Alemu *et al*., 2018).

iii. Kato-Katz technique: It is the gold standard technique recommended by the WHO for the diagnosis of STH infections. It is very useful in egg counting in order to evaluate the intensity of infections (WHO, 2002). In this technique, cellophane tape soaked in malachite green solution is used as a clearing agent (Odongo-Aginya *et al.,* 2007). A known size of fecal material is used and the eggs in the whole slide are to be counted.

iv. McMaster technique: It is used for detecting and counting STH eggs in fecal samples. Egg counting is done using a counting chamber which enables a known volume of fecal suspension to be examined microscopically (Barda *et al.,* 2014).

v. FLOTAC technique: It has been recently developed as an innovative direct method for the diagnosis of IPIs. In this method, a cylindrical device with two 5-ml flotation chambers (FLOTAC apparatus) which enables up to 1 g of stool to be prepared for microscopic examination. This Technique is useful as it can be used on fresh or preserved fecal samples (Knopp *et al.,* 2009).

2.8. Stool examination techniques

Stool samples were diagnosed for the presence of intestinal parasites using direct wet-mount method and formal ether concentration techniques. The processed stool samples were checked for the presence of intestinal parasite ova or cysts under light microscopy using objectives10x and40x. Identification of the parasite species was done on the basis of morphology and size by the principal investigator assisted by experienced laboratory technicians and referring the parasitological laboratory manual.

Direct wet mount technique

Wet mounting is the simplest and easiest technique for the examination of faeces. Direct wet mount technique was used to assess the overall prevalence of IPIs in the study area. The direct wet mount was processed by conventional iodine to identify the presence of motile intestinal parasites, cycts, egg and trophozoite under light microscope at 10X and 40x magnification. Saline was used to observe cysts of intestinal parasites. Fresh stool samples (approximately 2 mg) were put on a slide with wooden applicator, emulsified with a drop of physiological saline (0.85%), and covered with cover slide and examined at 10x and 40x microscopic objectives (Megbaru Alemu *et al*., 2018).

Formal-ether concentration technique

Each stool sample is processed by formal-ether concentration technique and examined microscopically by using standard procedures. In formal-ether concentration technique**,** approximately 0.5g of faeces is mixed with 10 ml of normal saline and the mixed stool was strained via gauze in to a funnel. The strained contents were collected into a centrifuge tube. About 2.5 ml of 10% formaldehyde and 1 ml of ether were then added and centrifuged at 1000 g for 3 minutes. The Supernatant was removed and a drop of the sediment was covered with cover glass for microscopic investigation (Megbaru Alemu *et al*., 2018).

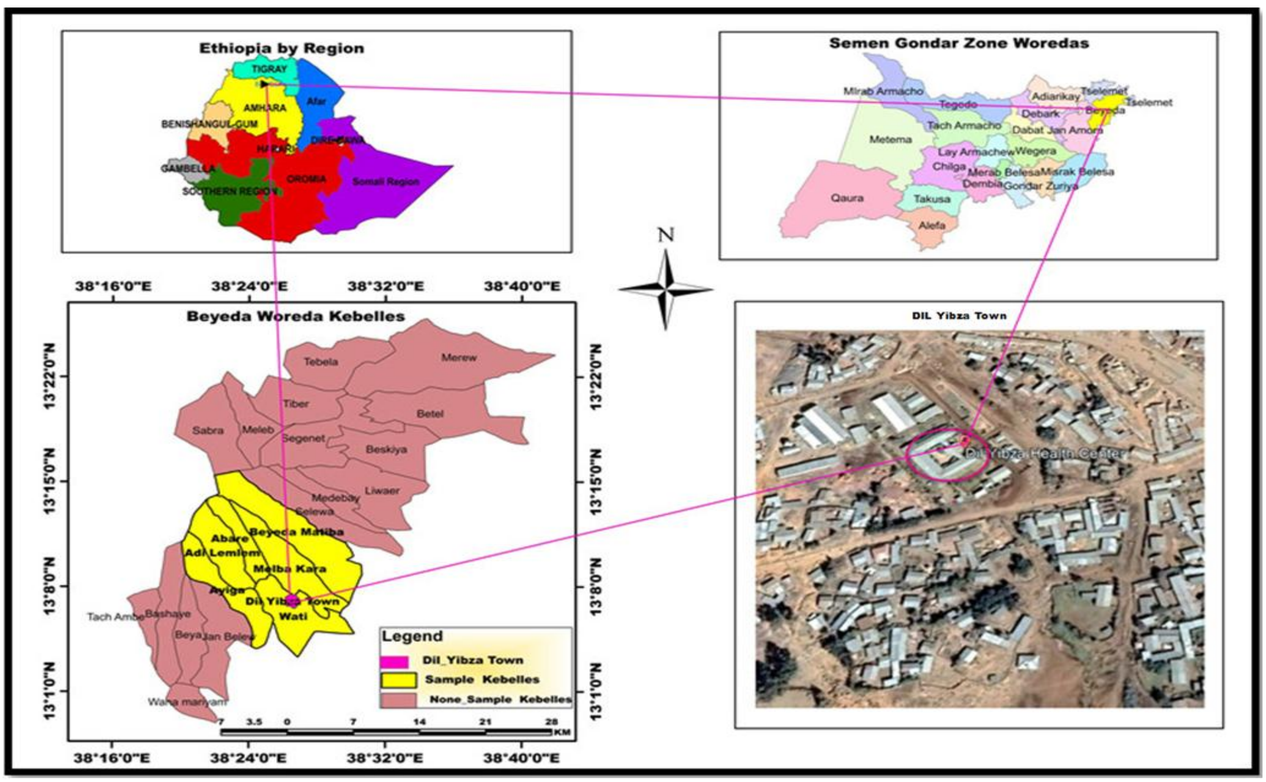
The supernatant was discarded and the sediment re-suspended in 10 ml of saline solution. It was again centrifuged and the supernatant was discarded. Then the sediment was re-suspended in 7 ml of 10% formalin and allowed to stand for 10 minutes, then 3 ml of ether was added and the tube was closed and mixed and hand shaken the content was centrifuged at 2000 rpm for two minutes. Four layers (the top layer consisted of ether, second layer plug of debris, the third layer, formalin and the fourth, and sediment) became visible and the upper three layers were poured off. The sediment remained in the conical test tube and it was used for slide preparation. Finally, the entire areas under the cover slip were systematically examined using 10x and 40x objective lenses of microscope (Megbaru Alemu *et al*., 2018).

3. MATERIALS AND METHODS

3.1. Study area description

The study was conducted at Dil Yibza town Health Center in Beyeda Woreda. The town is 386 kms away from Bahir Dar, the Capital city of Amhara Region. It lies between 13°6′55″N latitude and 38°26′27″E longitude with an elevation of 3209 masl. The total population of the town is 3292 (1371 males and 1921(females) (Beyeda District Administrative Office unpublished data, 2017). The town has one Health Center which provides different health services to the dwellers of Dil Yibza town and surrounding rural Kebeles population.

Beyeda Woreda (district) is one of the woredas in Amhara region of Ethiopia, located in the easternmost point of the north Gondar zone, Beyeda is bordered by the Wag Hemra zone (South), Jan Amora (West), Tselemt (North), and Tekeze River (East).It has four health centers and 17 health stations. The main sources of dirking water in the woreda are stream water, Tanker water, and pipe water (Beyeda District Administrative Office unpublished data, 2017).



Figur 11: The map of dil yibza town (Source: Beyeda District Administrative Office unpublished data, 2019).

3.2. Study design and period

A cross-sectional parasitological study design was conducted to assess the prevalence of IPIs and associated risk factors among patients attending Dil Yibza Health Center from December 2019 to February 2020.

3.3. Population

3.3.1.Source of population

The source population in this study was people living in Dil Yibza town and surrounding rural Kebeles population.

3.3.2.Study population

The study population of this study was people visiting in Dil Yibza health center north Gondar zone during the study period.

3.3.3.Inclusion and exclusion criteria

Inclusion criteria: patients, who had no history of anti-intestinal drug in the two weeks prior to screening and those who had an ability to give stool samples during the study period.

Exclusion criteria: patients, who were talking any anti-intestinal parasitic drug within two weeks

3.4. Study variables

3.4.1.Dependent variable

The dependent variable of the study was prevalence of intestinal parasites

3.4.2. Independent variables

The independent variables were socio-demographic characteristics including; sex, residence, marital status, education status, occupation, monthly income and the associated risk factors including latrine availability, drinking water source, shoe wearing habit, hand washing habit, eating raw meat, eating unwashed vegetables, and dirty materials in the finger.

3.5. Sample size determination and sampling technique

3. 5.1.Sample size determination

The sample size (n) requires was determined using single population proportion formula for cross sectional study (Naing *et al.,* 2006).

$$n= z^2*p\ (1-p)/d^2$$

Where; n= required number of sample size; z= standard value; p= expected prevalence of IPIs in the study area; d=marginal error, at 95% confidence interval Z= 1.96 and d= 5%.

Since there was no similar study previously conducted in the study area, 50% prevalence rate of IPIs was taken assuming that IPIs is significantly prevalent among patients attending Dil Yibza health center north Gondar zone northwest, Ethiopia. Therefore the required number of sample size (n) was calculated as:

$$n= z^2*p\ (1-p)/d^2$$

$$n= (1.96)^2*0.5\ (1-0.5)/\ (0.05)^2 = 384.$$

To compensate for the non-respondents and to minimize errors arising from non-compliance, 5% of the sample size was added giving a final sample size of 404 study participants.

3.5.2. Sampling technique

Random sampling technique was employed to include all study participants who met the inclusion criteria until the achievement of the expected sample size in Dil Yibza health center north Gondar zone during the study period.

3.6. Data collection methods

3.6.1.Stool sample collection procedure

Fresh stool samples were collected from 404 study subject in the study area. The participants were instructed properly and give clean labeled stool collection cups along with applicator sticks, and informed to bring 2-3gram of stool sufficient enough for direct saline wet mount technique. At the time of collection, date of sampling, the name of the participant, age and sex were recorded for each subject on a recording format.

3.6.2. Questionnaire survey

A structured questionnaire based on known associated risk factors were developed in English and translates into Amharic (local language) and then, the responses were translated back into English. Socio-demographic characteristics and associated factors were collected using a structured questionnaire from 404 study subjects by face to face interview. The questionnaire was pretested and revised before administering to the real data collection process. Variables like sex, age, occupation, education level, marital status, monthly income and other associated factors such as pattern of latrine usage, sources of drinking Water, residence and hygienic practices were collected during the patient visit.

3.7. Laboratory examination procedure

3.7.1. Direct wet mount method

In this method, a small portion (size of pea) of stool samples were emulsified with normal saline (0.85%NaCl solution) and a drop of emulsified sample was placed on a clean microscopic glass slide, then a few drops of iodine solution was added on stool sample mixed with this reagent and then it was covered with a cover slip at an angle of 45◦. Finally, the presence of motile intestinal parasites, cysts, egg and trophozoites were examined under compound light microscope using 10x and 40x objective lenses by experienced laboratory technologists at Dil Yibza health center and the remaining was preserved 10% formalin for later examination.

3.7.2. Formal-ether concentration method

A portion of preserved stool sample was processed by formal-ether concentration technique. In brief using applicant stick, about1-2gram of stool sample was placed in a clean 15 ml conical tube containing 7 ml of 10% formalin. The sample was suspended and mixed thoroughly with applicant stick. The resulting suspension was filtered through a sieve (cotton gauze) into a beaker and the filtrate pour into the same tube. After adding 3 ml of diethyl ether to the mixture and hand shaken the content was centrifuged at 2000rpm for 3 minutes. Iodine stain preparation was made from the sediments. Finally, the entire area under the cover slip was examined using 10x and 40x objective lenses and ova and cyst of different parasite was observed under microscope.

3.7.3. Data quality control

Structured face to face interview was developed in English and translated into Amharic (local language) and then back-translated into English to check for any inconsistencies or distortions in the meaning of words and concepts. Questionnaires were pre-tested on patients before the actual data collection date in the study area.

To ensure the quality control, first the questionnaire was pretested. The pretested was conducted in 5% of the participants at randomly selected districts away from the study subject. For quality assurance, instruments and reagents were checked for reliability and reproducibility of the test before any test is started. Stool examination results were reported and every collected sample test result was registered in the appropriate format. Finally, the data was analyzed and interpreted accordingly.

3.8. Data analysis

The collected data were coded and entered in to SPSS software version 25 to perform the statistical analysis. Results were expressed using descriptive statistics to summarize demographic profile of the study participant. The association between risk factors and the presence of IPIs was assessed using Chi-square test. Crude Odds Ratio (COR) and Adjusted Odd Ratio (AOR) were using in univariate and multivariate logistic regression to measure the strength of association between risk factors and the presence of IPIs respectively. Variables with $p < 0.25$ in univariate logistic regression were selected for subsequent analysis in multivariate logistic regression analysis. In all cases a 95% confidence interval was used and P-values less than 0.05 were considered to be statistically significant.

3.9. Ethical consideration

The official permission letter for ethical clearance was obtained from Bair Dar University Research Ethics Committee from the department of biology. Before the data collection period, a letter was written by Bahir Dar University about the objective of the study to organizations and individuals who were involved the study for their willingness to give information. Consent was obtained from Dil Yibza health center and laboratory staffs. The respondents were informed about the objective and purpose of the study and verbal consent was obtained from each respondent before starting the interview. The information obtained at each course of study was kept confidential.

4. RESULTS

4.1. Socio-demographic characteristics of the study participants

A total of 404 subjects; 210 (52%) males and 194 (48%) females were participated in this study. Seventy-two (17.8%), 133 (32.9%) and 199 (49.3%) of the study participants were in the age groups 5-14 years, 15-24 years, and ≥ 25 years, respectively. One hundred sixty-eight (41.6%) of the study subjects were urban and 236 (58.4%) rural residents. Regarding to their marital status, 124 (30.7%), 243 (60.1%), 28 (6.9%) and 9 (2.2%) of the study participants were single, married, divorced, and widowed, respectively. From the total of 404 respondents, 204 (50.5%), 95 (23.5%), 57 (14.1%), 48 (11.9%) respondents were illiterate, attended primary school, secondary school, and diploma and above, respectively. Eighty (19.8%), 28 (6.9%), 196 (48.5%), 22 (95.4%), and 78 (19.3%) of the study participants were government employees, merchants, farmers, house wives, and students, respectively. One hundred sixty-two (40.1%), 176 (43.6%), 39 (9.7%), and 27 (6.7%) had family sizes ≤ 3, 4-6, 7-9 and > 9, respectively (Table 2).

Table 2: Socio-demographic characteristics factors among patients (n = 404) attending Dil Yibza health center, Northwest Ethiopia from December 2019-February2020.

Characteristics	Categories	Frequency(n)	Percentage (%)
	Male	210	52
Sex	Female	194	48
	5-14	72	17.8
Age group	15-24	133	32.9
	≥ 25	199	49.3
	Urban	168	41.6
Residence	Rural	236	58.4
	Single	124	30.7
Marital status	Married	243	60.1
	Divorced	28	6.9
	Widowed	9	2.2

Characteristics	Categories	Frequency(n)	Percentage (%)
Education level	Illiterate	204	50.5
	Primary school	95	23.5
	Secondary school	57	14.1
	Diploma &above	48	11.9
Occupational status	Government employer	80	19.8
	Merchant	28	6.9
	Farmer	196	48.5
	House wife	22	5.4
	Student	78	19.3
Family size	≤ 3	162	40.1
	4-6	176	43.6
	7-9	39	9.7
	>9	27	6.7
Income level	Lower (<1000)	216	53.5
	medium (1000-3000)	96	23.8
	High (>3000)	92	22.8
Religion	Orthodox tewahdo	394	97.5
	Muslim	10	2.5

4.2. Prevalence of intestinal parasitic infections among the study participants

Based on the microscopic examination of stool specimens, a total of nine different species (two protozoans and seven helminthes) of intestinal parasites were identified. In this study, out of the 404 study subjects, (49%) were positive for intestinal protozoan and (13.4%) for helminthic species. The overall prevalence of intestinal parasitic infection for at least one parasite was 55.2% (223/404). As can be seen from Table 3, *E. histolytica/ dispar*, (46.5%, 188/404) was the most common parasite followed by *A. lumbricoides* (9.2%, 37/404), *G. lamblia* (2.7%, 11/404), hookworm species (1.2%, 5/404), *H. nana* (1.0%, 4/404), *T. trichiura* (0.7%, 3/404), *E. vermicularis* (0.5%, 2/404), and *S. mansoni* (0.2%, 1/404).

Furthermore, double and triple parasitic infections were observed. From the total infections, 27 (6.7%) of the individuals had double infections and 1(0.2%) triple infection. The most prevalent intestinal parasites in double infections were *E. histolytica/dispar* and *A. lumbricoides* (4%, 16/404), followed by *E. histolytica/dispar* and *H. nana* (0.7%, 3/404); *E. histolytica/dispar* and *E. vermicularis* (0.5%, 2/404*)*. The least encountered intestinal parasites in the double infections were *E. histolytica* and hookworm, *E. histolytica and S. mansoni*, *E. histolytica* and *G. lamblia*, *E. histolytica* and *T. trichiura*, *G. lamblia* and hookworm, *G. lamblia* and *T. trichiura* each observed in a single individual (0.2%). *E. histolytica, G. lamblia,* and *T. trichiura* triple infection was found in one individual (0.2%).

The overall intestinal parasite prevalence was slightly higher among males (28.7%) than females (26.5%).The overall prevalence rate of protozoan parasite infections and helminthic parasite infections among patients of both sexes and all age groups were 195(49%) and 54(13.4%), respectively. The prevalence rate of double intestinal parasitic infection in male study subjects was greater than that of females. To the contrary, the prevalence rate of triple intestinal parasitic infection was observed only in a single female. The prevalence of *E. histolytica/dispar* was the highest in females and age groups of ≥ 25 years old. In the present study, *Taenia* species infection was observed only in male study subjects. In the same way, the highest percentage of *E. histolytica* prevalence was found also in male participants (Table3).

Table 3: Distribution of intestinal parasite species by sex and age group among patients (n = 404) attending Dil Yibza health center, Northwest Ethiopia, December 2019-February 2020.

Types of intestinal parasites	Sex			Age			
	Male +ve (%)	Female +ve (%)	Total +ve (%)	5-14 +ve (%)	15-24 +ve (%)	>25 +ve (%)	Total +ve (%)
Single infection (n=195)							
E.histolytica/dispar	77(19.1)	85(21)	162(40.1)	25(6.2)	58(14.4)	79(19.6)	162(40.1)
G.lamblia	5(1.2)	2(0.5)	7(1.7)	1(0.2)	2(0.5)	4(1.0)	7(1.7)
A.lumbricoides	15(3.7)	6(1.5)	21(5.2)	4(1.0)	7(1.7)	10(2.5)	21(5.2)
Hookworm	1(0.2)	2(0.5)	3(0.7)	0	1(0.2)	2(0.5)	3(0.7)
H.nana	1(0.2)	0	1(0.2)	1(0.2)	0	0	1(0.2)
Taenia species	0	1(0.2)	1(0.2)	0	1(0.2)	0	1(0.2)
Double infection(n=27)							
E.histolytica+A.lumbricoides	10(2.5)	6(1.5)	16(4.0)	5(1.2)	3(0.7)	8(2.0)	16(4.0)
E.histolytica +H.nana	0	3(0.7)	3(0.7)	1(0.2)	1(0.2)	1(0.2)	3(0.7)
E.histolytica +Hookworm	1(0.2)	0	1(0.2)	0	0	1(0.2)	1(0.2)
E.histolytica +S.mansoni	1(0.2)	0	1(0.2)	0	1(0.2)	0	1(0.2)
E.histolytica +G.lamblia	1(0.2)	0	1(0.2)	0	1(0.2)	0	1(0.2)
E.histolytica+E.vermicularis	1(0.2)	1(0.2)	2(0.5)	0	1(0.2)	1(0.2)	2(0.5)
E.histolytica +T.trichiura	1(0.2)	0	1(0.2)	0	0	1(0.2)	1(0.2)
G.lamblia +Hookworm	1(0.2)	0	1(0.2)	0	0	1(0.2)	1(0.2)
G.lamblia + T.trichiura	1(0.2)	0	1(0.2)	0	0	1(0.2)	1(0.2)
Triple infection (n=1)							
E.histolytica +G.lamblia + T.trichiura	0	1(0.2)	1(0.2)	0	0	1(0.2)	1(0.2)
Total	116(28.7)	107(26.5)	223(55.2)	37(9.2)	76(18.8)	110(27.2)	223(55.2)

4.3. Overall prevalence of intestinal parasitic infections in relation to different sociodemographic characteristics

As indicated in Table 4, there was significant positive association between infection of intestinal parasites and socio-demographic characteristics of the study participants including marital status (x^2=7.97, p=0.047), educational level (x^2=9.34, p=0.025) and residence (x^2=3.90, p=0.048). However, there was no statistically significant association between IPIs and socio-demographic characteristics of the study participants including sex (x^2=0.00, p=0.987), age (x^2=0.63, p=0.731), occupation status (x^2=4.07, p=0.396), family size (x^2=2.77, p=0.429), monthly income level (x^2=3.57, p=0.168), religion (x^2=0.96, p=0.328), and ethnicity (x^2=1.26, p=0.262).

Table 4: Overall prevalence of intestinal parasitic infections in relation to different sociodemographic factors among patients attending Dil Yibza health center, December 2019-February 2020.

Risk factors	Categories	N (%)	Positive (%)	Negative (%)	x^2, p –value
Sex	Male	210(52)	116(28.93)	94(23.3)	0.00, 0.987
	Female	194(48)	107(26.5)	87(21.5)	
Age group	5-14	72(17.8)	37(9.2)	35(8.7)	0.63, 0.731
	15-24	133(32.9)	76(18.8)	57(14.1)	
	≥25	199(49.3)	110(27.2)	89(22.1)	
Residence	Urban	168(41.6)	83(20.5)	85(21)	3.90, 0.048*
	Rural	236(58.4)	140(34.7)	96(23.8)	
Marital status	Married	243(60.1)	135(33.4)	108(26.7)	
	Single	124(30.7)	62(15.3)	62(15.3)	7.97, 0.047*
	Divorced	28 6.9)	22(5.4)	6(1.5)	
	Widowed	9(2.2)	4(1.0)	5(1.2)	
Educational Level	Illiterate	204(50.5)	106(26.2)	98(24.3)	
	Primary	95(23.8)	53(13.1)	42(10.4)	9.34, 0.025*
	Secondary	57(14.1)	28(6.9)	29(7.2)	
	Diploma and above	48(11.9)	12(3.0)	36(8.9)	
Income level	< 1000	216(53.5)	124(30.7)	92(22.8)	3.57, 0.168
	1000-3000	96(23.8)	45(11.1)	51(12.6)	
	> 3000	92(22.8)	38(9.4)	54(13.4)	

Table4 cont.

Risk factors	Categories	N (%)	Positive (%)	Negative (%)	x^2, p –value
Family size	≤3	162(40.1)	79(19.6)	83(20.5)	2.77, 0.429
	4-6	176(43.6	99(24.5)	77(19.1)	
	7-9	39(9.7)	23(5.7)	16(4)	
	>9	27(6.7)	18(4.5)	9(2.2)	
Occupation status	Government employers	80(19.8)	37(9.2)	43(10.6)	4.07, 0.396
	Merchants	27(6.7)	15(3.7)	3 3.2)	
	Farmers	196(48.5)	116(28.7)	80(19.8)	
	House wives	22(5.4)	13(3.2)	9(2.2)	
	Students	78(19.3)	42(10.4)	36(8.9)	
Religion	Orthodox	394(97.5)	219(54.2)	175(43.3)	0.96, 0.328
	Muslim	10(2.5)	4(1)	6(1.5)	
Ethnicity	Amhara	399(98.8)	219(54.2)	180(44.6)	
	Agew	5(1.2)	4(1)	1(0.2)	1.26, 0.262

* Statistically significant association between socio-demographic factor and IPIs ($P < 0.05$)

4.4. Risk factors associated with intestinal parasitic infection

4.4.1. Univariate logistic regression of associated factors

Sociodemographic factors

In the univariate analysis of the socio-demographic characteristics of the study participants, patients coming from rural areas were seven times more likely to be infected with IPIs than patients coming from urban areas (COR=6.70, CI= 4.49-9.98, P=0.049). Regarding to marital status, divorced patients were three times more infected with IPIs than those who were married (COR=2.73, CI=1.03-7.19, P=0.009); illiterate patients were three times more likely to be infected with IPIs than patients who attended diploma and above (COR=2.77, CI=1.37-5.63, P=0.005), patients who attended primary school were two times (COR=2.37, CI=1.10-5.13, P=0.027), and patients who attended secondary school were three times (COR=3.10, CI=1.35-7.16, P=0.008) more likely to have parasite infection than patients who were diploma and above, respectively (Table 5).

Table 5: Univariate logistic regression analysis for sociodemographic factors associated with IPIs among patients attending Dil Yibza health center, December 2019-February 2020**.**

Risk factors	Categories	N (%)	IPIS Positive (%)	IPIS Negative (%)	COR, 95%CI, P-value
Sex	Male	210(52)	116(28.7)	94(23.3)	1.00, 0.68-1.49, 0.987
	Female	194(48)	107(26.5)	87(21.5)	1
Age group	5-14	72(17.8)	37(9.2)	35(8.7)	0.79, 0.45-1.41, 0.429
	15-24	133(32.9)	76(18.8)	57(14.1)	0.86, 0.49-1.47, 0.571
	≥25	199(49.3)	110(27.2)	89(22)	1 0.731
Residence	Urban	168(41.6)	83(20.5)	85(21)	1
	Rural	236(58.4)	140(34.7)	96(23.8)	6.70, 4.49-9.98, 0.049*
Marital status	Married	243(60.1)	135(33.4)	108(26.7)	1 0.061
	Single	124(30.7)	62(15.3)	62(15.3)	0.80, 0.52-1.23, 0.313
	Divorced	28(6.9)	22(5.4)	6(1.5)	2.73,1.03-7.19, 0.009*
	Widowed	9(2.2)	4(1.0)	5(1.2)	1.25, 0.32-4.88, 0.748
Educational	Illiterate	204(50.5)	106(26.2)	98(24.3)	2.77, 1.37-5.63, 0.005*
	Primary	95(23.8)	53(13.1)	42(10.4)	2.37, 1.10-5.13, 0.027*
	Secondary	57(14.1)	28(6.9)	29(7.2)	3.10, 1.35-7.16, 0.008*
	Diploma and above	48(11.9)	12(3.0)	36(8.9)	1 0.032
Income level	< 1000	216(53.5)	124(30.7)	92(22.8)	1.05, 0.64-1.73, 0.834
	1000-3000	96(23.8)	45(11.1)	51(12.6)	1.61, 0.90-2.87, 0.105
	> 3000	92(22.8)	38(9.4)	54(13.4)	1 0.170
Family size	≤3	162(40.1)	79(19.6)	83(20.5)	1 0.434
	4-6	176(43.6)	99(24.5)	77(19.1)	1.90, 0.81-4.49, 0.141
	7-9	39(9.7)	23(5.7)	16(4)	1.56, 0.66-3.65, 0.310
	>9	27(6.7)	18(4.5)	9(2.2)	1.39, 0.50-3.87, 0.527
Occupation status	Government employers	80(19.8)	37(9.2)	43(10.6)	1 0.401
	Merchants	27(6.7)	15(3.7)	13(3.2)	0.75, 0.32-1.77, 0.505
	Farmers	196(48.5)	116(28.7)	80(19.8)	0.59, 0.35-1.00, 0.051
	House wives	22(5.4)	13(3.2)	9(2.2)	0.59, 0.23-1.55, 0.289
	Students	7819.3)	42(10.4)	36(8.9)	0.74, 0.39-1.38, 0.340

Note: 1 = reference value, * = statistically significant at p < 0.05, COR = Crude odds ratio, N=Total. The p-value for the variable more than two categories in front of reference value for the comparison to entered for multivariate analysis.

Life style related factors

As indicated in table 6, life style related factors such as habit of eating unwashed vegetables and frequency of shoe wearing had statistically significant associations with IPIs. However, life style related factors such as the habit of hand washing before eating food, frequency of hand washing before eating food, habit of shoe wearing, habit of soil contact, and eating raw meat were not significantly associated with the prevalence of IPIs among patients. The study subjects who ate unwashed vegetables were five times more likely to be infected with IPIs than those who did not eat unwashed vegetables (COR=4.90, CI=3.28-7.32, P=0.000). Similarly, study subjects who sometimes wore shoes were six times more likely to be infected with IPIs than those who always wore shoes (COR=5.73, CI=3.72-8.83, P=0.012).

Table 6: Univariate logistic regression analysis for personal life style associated with intestinal parasitic infection among patients attending Dil Yibza health center, December 2019-February 2020.

Risk factors	Categories	N (%)	IPIS		COR, 95% CI, P-value
			Positive (%)	Negative (%)	
Hand washing before food	Yes	393(97.3)	177(43.8)	216(53.5)	1
	No	11(2.7)	7(1.7)	4(1)	0.69, 0.20-2.42, 0.570
Frequency of hand washing before food	Always	223(55.2)	110(27.2)	113(28)	1
	Sometimes	170(42.1)	103(25,5)	67(16.6)	0.67, 0.45-1.00, 0.51
Shoe wearing habit	Yes	394(97.5)	215(53.2)	179(44.3)	1
	No	10(2.5)	8(2)	2(0.5)	0.30, 0.63-1.43, 0.131
Frequency of shoe wearing	Always	264(65.3)	132(32.7)	132(32.7)	1
	Sometimes	129(31.9)	82(20.3)	47(11.6)	5.73, 3.72-8.83, 0.012*
Habit of soil contact	Yes	181(44.8)	109(27)	72(17.8)	0.69, 0.465-1.03, 0.068
	No	223(55.2)	114(28.2)	109(27)	1
Habit of eating unwashed vegetable	Yes	184(45.5)	119(29.5)	65(16.1)	4.90, 3.28-7.32, 0.000*
	No	220(54.5)	116(28.7)	104(25.7)	1
Habit of eating raw meat	Yes	100(24.8)	53(13.1)	47(11.6)	1.13, 0.72-1.77, 0.610
	No	304(75.2)	170(42.1)	134(33.2)	1
Habit of water Contact	Yes	347(85.9)	197(48.8)	150(37.1)	0.64, 0.36-1.12, 0.118
	No	57(14.1)	26(6.4)	31(7.7)	1

Note: 1 = reference value, * = statistically significant at $p < 0.05$, COR =Crude odds ratio, N=Total.

Hygiene related factors

Hygiene related factors such as presence of dirty matter under nails, presence of latrine at home, feeling of stomach pain, presence of diarrhea in stool, habit of hand washing after using toilet, and frequency of hand washing after using toilet were significantly associated with IPIs (Table7).

Patients who had dirt matter under their finger nails were five times more likely to be infected with IPIs than those who did not have dirt matter under their finger nails (COR=5.17, CI= 3.43-7.78, P=0.002); patients who did not have latrine at home were five times more likely to be infected with IPIs than those who had latrine at home (COR=5.46, CI=3.66-8.17, P=0.003); patients who were feeling stomach pain were six time more likely to acquire IPIs than those who did not feel stomach pain (COR=5.67, CI=3.49-9.21, P=0.022). Similarly, those patients who did not wash their hands after using toilet were five times more likely to acquire IPIs than those who washed their hands after using toilet (COR=4.63, CI=3.11-6.90, P=0.000); patients who had diarrhea in their stools were five times more likely to be infected than those who did not have diarrhea in their stools (COR=4.58, CI=2.86-7.33, P=0.001).

Table 7: Univariate logistic regression analysis for personal hygiene associated with intestinal parasitic infection among patients attending Dil Yibza health center, December 2019-February 2020.

Variables	Categories	N (%)	IPIS		COR, 95% CI, P-value
			Positive (%)	Negative (%)	
Dirty matter under the nail	Yes	162(40.1)	105(26)	57(14.1)	5.17, 3.43-7.78, 0.002*
	No	242(59.9)	118(29.2)	124(30.7)	1
Presence of latrine at home	Yes	164(40.6)	76(18.8)	88(21.8)	1
	No	240(59.4)	147(36.4)	93(23)	5.46, 3.66-8.17, 0.003*
Frequency of use latrine at home	Always	64(15.5)	25(6.2)	39(9.7)	1
	Sometimes	100(24.8)	51(12.6)	49(12.1)	0.62, 0.33-1.17, 0.136
Feeling stomach pain	Yes	320(79.2)	186(46)	134(33.2)	5.67, 3.49-9.21, 0.022*
	No	84(20.8)	37(9.2)	47(11.6)	1
Presence of diarrhea in stool	Yes	106(26.2)	73(18.1)	33(8.2)	4.58, 2.86-7.33, 0.001*
	No	298(73.8)	150(37.1)	148(36.6)	1
Personal hygiene	Good	190(47)	93(23)	97(24)	1
	Poor	214(53)	130(32.2)	84(20.8)	6.20, 4.17-9.20,0.018*
Habit of hand washing after using toilet	Yes	192(47.5)	87(21.5)	105(26)	1
	No	212(52.5)	136(33.7)	76(18.8)	4.63, 3.11-6.90, 0.000*
Frequency hand washing after using toilet	Always	21(5.2)	9(2.2)	12(3.0)	1
	Sometimes	170(42.1)	93(23)	77(19.1)	0.91, 0.36-2.26, 0.832

Note: 1 = reference value, * = statistically significant at p < 0.05, COR =Crude odds ratio.
N=Total

4.4. 2. Multivariate logistic regression analysis of selected variables

Multivariate logistic regression was performed to identify the most important predictors of IPIs. To do this, all sociodemographic characteristics, hygiene issues and life style related factors in univariate logistic analysis with $p < 0.25$ were selected and run for multivariate logistic regression analysis. Among the potential risk factors, education status, habit of hand washing after using toilet, presence of diarrhea in stool, habit of eating unwashed vegetable, and presence of dirt matter under finger nails were significantly associated with IPIs ($p < 0.05$). The odds of being infected with IPIs in those divorced patients were three times more infected with IPIs than those who were married (AOR=3.21, CL=1.15-8.96, p= 0.03). Regarding to education level, illiterate patients were three times more likely to have parasite infection than patients who were diploma and above (AOR= 2.61, CI=1.24-5.49, P=0.011); patients who attended primary school were two times (AOR=2.3, CI=1.029-5.143, P=0.042), and patients who completed secondary schools were three times (AOR=3.44, CI=1.43-8.30, P= 0.006) more likely to have IPIs than patients who were diploma and above (Table 8).

Participants who had diarrhea in their stools were four times more likely to be positive for IPIs than those who did not have diarrhea in their stools (AOR=4.22, CI=2.57-6.91, p=0.001). Those participants who did not wash their hands after using toilet were four times more likely to acquire IPIs than their counterparts (AOR=4.36, CI=2.83-6.72, P=0.000). With regard to the feeding habit, study subjects who ate unwashed vegetables were five times more likely to acquire IPIs than those who did not eat unwashed vegetables (AOR=5. 430, CI =4.33-23.77, P=0.000) (Table 8). Similarly, patients whose finger nails contained dirt materials were six times more likely infected with IPIs than those who did not have dirt materials in their finger nails (AOR=5.63, CI=2.60-11.32, P=0.001)). Moreover, participants who had poor personal hygiene were seven time more likely to acquire IPIs than those who had good personal hygiene (AOR=7.01, CI=4.35-8.95, P=0.015) (Table 8).

Table 8: Multivariate logistics regression analysis of selected risk factors associated with IPIs among patients attending Dil Yibza health center, December 2019-February 2020.

Risk factors	Categories	N (%)	IPIS		AOR, 95%CI, P-value
			Positive (%)	Negative (%)	
Marital status	Married	243(60.1)	135(33.4)	108(26.7)	1
	Single	124(30.7)	62(15.3)	62(15.3)	0.92, 0.57-1.49, 0.739
	Divorced	28(6.9)	22(5.4)	6(1.5)	3.21, 1.15-8.96, 0.030*
	Widowed	9(2.2)	4(1.0)	5(1.2)	1.47, 0.35-6.20, 0.602
Educational level	Illiterate	204(50.5)	106(26.2)	98(24.3)	2.61, 1.24-5.49, 0.011*
	Primary	95(23.8)	53(13.1)	42(10.4)	2.30,1.03-5.14, 0.042*
	Secondary	57(14.1)	28(6.9)	29(7.2)	3.44, 1.43-8.30, 0.006*
	diploma and above	48(11.9)	12(3.0)	36(8.9)	1
Income level	< 1000	216(53.5)	124(30.7)	92(22.8)	0.834, 0.485-1.432, 0.510
	1000-3000	96(23.8)	45(11.1)	51(12.6)	1.470, 0.780-2.769, 0.233
	> 3000	92(22.8)	38(9.4)	54(13.4)	1
Presence of diarrhea in stool	Yes	106(26.2)	73(18.1)	33(8.2)	4.22, 2.57-6.91, 0.001*
	No	298(73.8)	150(37.1)	148(36.6)	1
Habit of hand washing after using toilet	Yes	192(47.5)	87(21.5)	105(26)	4.36,2.83-6.72, 0.000*
	No	212(52.5)	136(33.7)	76(18.8)	1
Habit of eating unwashed	Yes	224(55.4)	119(29.5)	65(16.1)	5.430, 4.33-23.77, 0.000*
	No	220(54.5)	116(28.7)	104(25.7)	1
Dirty matter under	Yes	162(40.1)	105(26)	57(14.1)	5.63,2.60-11.32, 0.001*
	No	242(59.9)	118(29.2)	124(30.7)	1
Reason of water contact	Swimming	56(13.9)	27(6.7)	29(7.2)	1
	Washing cloth	136(33.7)	70(17.3)	66(16.3)	0.912, 0.470-1.769, 0.784
	Irrigation	64(15.8)	42(10.4)	22(5.4)	0.428, 0.19-0.94, 0.035*
	Washing body	148(36.6)	84(20.8)	64(15.8)	0.499, 0.26-0.98, 0.042*
Personal hygiene	Good	190(47)	93(23)	97(24)	1
	Poor	214(53)	130(32.2)	84(20.8)	7.01, 4.35-8.95, 0.0145*

Note: 1 = reference value, * = statistically significant at $p < 0.05$, AOR = adjusted odds ratio (multivariate regression model), N=Total

5. DISCUSSION

Understanding the distribution of IPIs and identifying their risk factors in a given community is a prerequisite for planning intervention programs. In line with this view, the present study attempted to assess the prevalence of different IPIs and associated risk factors among patients attending Dil Yibza health center. In this study, the overall prevalence of IPIs among patients was 55.2%. This prevalence was comparable to the findings of the studies conducted in Shahura Health Center, Northwest Ethiopia (Abiye Tigabu *et al.,* 2019), Axum town (Mulu Gebreslassie *et al*., 2015), and Jawi town, northwest Ethiopia (Baye Sitotaw *et al*., 2019) which revealed overall prevalence of 56.9%, 44.6% and 58%, respectively.

The overall prevalence of this finding was lower than the previous studies conducted in Lake Langano area (Mengistu Legesse and Berehanu Erko, 2004), Nigeria (Ajayi EO *et al*., 2017), Debre Elias, East Gojjam zone (Tilahun Workneh *et al*., 2014), and Delgi, North Gondar Ethiopia (Asrat Ayalew *et al*., 2011) with the prevalence rates of 83.8%, 78.1%, 84.3%, and 79.8%, respectively. Furthermore, it was lower than studies conducted in Nepal by Yadav K and Prakash S, 2016 (58.8%), South Africa by Nxasana N *et al*., 2013 (64.8%), and India by Ashok R *et al*., 2013 (63.9%). These variations may be due to differences in conducting the survey time, living conditions of the study participants, level of environmental sanitation, drinking water source, and geographical factors in the study areas.

Compared to the present findings, lower prevalence of intestinal parasites has been reported in studies conducted in Axum town, by Mulu Gebreslassie *et al*., 2015 (44.6%), in Jimma town, by Ayalew Jejaw *et al*., 2014 (48.2%), in South Eastern Ethiopia, by Begna Tulu *et al*., 2014 (26.2%), in Benishangul-Gumuz Regional State, Western Ethiopia, by Gebremichael Gebretsadik *et al*., 2016 (35.4%), in Adigrat town, by Dinku Senbeta, 2017 (50.8%) and in university of Gondar hospital, by Yetemwork Aleka *et al*., 2015 (17.3%). The relatively higher rates of IPIs among patients in Dil Yibza health center compared to the mentioned studies may be due to poor personal and environmental hygienes, habit of eating raw meat, eating unwashed vegetables, lack of latrine per home, and poor habit of hand washing after using toilet.

In the present study, *E. histolytica/dispar* (46.5%) was the most predominant intestinal parasitic infection. This prevalence was in agreement with the reports by Abiye Tigabu *et al.,* (2019) in Shahura Health Center, Northwest Ethiopia (32.4%). In both findings, the most significantly associated risk factors for the occurrence of *E. histolytica/dispar* were; hand washing habit, eating unwashed vegetables and dirt matter under finger nails. It too was comparable with the findings of the studies conducted in Benishangul-Gumuz Regional State, Western Ethiopia (Gebremichael Gebretsadik *et al*., 2016) , and Axum town, Northern Ethiopia (Mulu Gebreslassie *et al*., 2015), in which the prevalence of *E. histolytica/dispar* was 14.17% and 17.3%, respectively. But this was higher than previous reports 27.3%, 12.7%, and 6.7% from Delgi, North Gondar Ethiopia (Asrat Ayalew *et al*., 20110), in Lake Langano area (Mengistu Legesse and Berehanu Erko, 2004), Debre Elias, East Gojjam zone (Tilahun Workneh *et al*., 2014), respectively. The possible reasons for these variations might be due to contamination of potable water, poor hand washing habit after using toilet, contamination of food, and eating food without washing hands. On the other hand, it was lower than the findings of the studies conducted in Bereka medical center southeast Ethiopia (53.8%) (Solomon Taye and Awel Abdulkerim, 2014) and in Axum St. Marry hospital (50.79%) (Daniel Getachew *et al*., 2017).

The second most prevalent parasite in this study was *A. lumbricoides* (9.2%). Its prevalence was much lower than the prevalence rate reported in Delgi, North Gondar Ethiopia (Asrat Ayalew *et al*., 20110) (48%), Jimma town (Ayalew Jejaw *et al*., 2014) (27.6%), and in Adigrat town (Dinku Senbeta, 2017) (19.1%). This difference might be due to the availability of tap water for drinking and hand washing habit before eating food. In contrast, the prevalence rate of the present study was higher than the findings in Shahura Health Center, Northwest Ethiopia (2.2%) (Abiye Tigabu *et al.*, 2019); Axum town, Northern Ethiopia (9%) (Mulu Gebreslassie *et al*., 2015); in Lake Langano area (6.2%) (Mengistu Legesse and Berehanu Erko, 2004); and in Delo-Mena, South Eastern Ethiopia (4.7%) (Begna Tulu *et al*., 2014). This might be due to the consumptions of contaminated food and water.

The third most prevalent parasite in the present study was *G. lamblia* (2.7%). The prevalence rate of the present study was much lower than the prevalence observed in Teda health center, northeast Ethiopia (12.4%) (Abraraw abate *et al*., 2013); in chelaleki health center east wollega zone (9%) (Addis Adera *et al*., 2015); in Bereka medical center southeast Ethiopia (23.7%) (Solomon Taye and Awel Abdulkerim, 2014); and in Axum St. Marry hospital (32.7%) (Daniel Getachew *et al*., 2017).

Hookworm species (1.2%) and *H. nana* (1.0%) were the fourth and fifth most prevalent parasite in this study. These were lower than the reports from Teda health center northeast Ethiopia (Abraraw abate *et al*., 2013) [hookworm species (6.6%) and *H. nana* (1.5%)] and the study conducted in Axum town, Northern Ethiopia (Mulu Gebreslassie *et al*., 2015) [(hookworm species (2.7%) and *H. nana* (6.2%). However, they were higher than that of the studies conducted in Bereka medical center southeast Ethiopia (Solomon Taye and Awel Abdulkerim, 2014) [hookworm species (0.9%)] and Chelaleki health center east wollega zone (Addis Adera *et al*., 2015) [*H. nana* (0.3%)].

In this study, the least encountered IPIs were *E. vermicularis* and *S. mansoni* with the prevalence rates of 0.5% and 0.2%, respectively. However; the prevalence rate of *E. vermicularis* was higher than the study conducted in Axum town, Northern Ethiopia (0.2%). Double and triple parasitic infections were also observed in the present study. From the total infections, 27 (6.7%) individuals had double infections and 1(0.2%) individuals had triple infection which was higher than the findings of the study conducted in Bereka medical center southeast Ethiopia (5.6%) (Solomon Taye and Awel Abdulkerim, 2014) and in Axum St. Marry hospital (0.69%) (Daniel Getachew *et al*., 2017). The difference in the prevalence of double infection might be due to the level of environmental contamination, level of awareness about parasitic infections, and socio economic factors.

E. histolytica/dispar and *A. lumbricoides* (4%) was the most frequent double infection, followed by *E. histolytica/dispar* and *H. nana* (0.7%), which were higher than the findings of the studies conducted in Shahura Health Center, Northwest Ethiopia (0.8%) (Abiye Tigabu *et al.,* 2019), and in Rural School Children, Northwest Ethiopia (1.1%) (Megbaru Alemu *et al*., 2018). The least encountered double infections were *E. histolytica* and hookworm; *E. histolytica* and *S.mansoni*; *E. histolytica* and *G. lamblia*; *E. histolytica* and *T. trichiura*; *G. lamblia* and hookworm; *G. lamblia and T. trichiura* with prevalence rates of 0.2% each. *E. histolytica, G. lamblia,* and *T. trichiura* (0.2%) triple infection also occurred. This may probably be due to favorable environmental conditions and methods of transmission that allowed these parasites live together.

The current study also assessed the potential association of IPIs with the possible risk factors among patients attending Dil Yibza health center. Even though, there were many factors associated with intestinal parasites, the logistic regression analysis in the present study indicated that some of them shown statistically significant association with intestinal parasites. The determinant factors of IPIs in the study subjects were rural residence, marital status, education level, habit of eating unwashed vegetables, presence of dirt matter under nails, presence of latrine at home, feeling of stomach pain, presence of diarrhea in stool, habit of hand washing after toilet visit, and frequency of hand washing after using the toilet. In this study IPIs were significantly associated with residence, feeling of stomach pain, and presence of diarrhea in stool. This is similar to a report in Shahura Health Center, Northwest Ethiopia (Abiye Tigabu *et al.,* 2019).

The likelihood of acquiring IPIs among patients coming from rural areas was seven times higher than patients coming from urban areas. This was in agreement with a study conducted in Chelaleki health center east wollega zone (Addis Adera *et al*., 2015) This might be due to poor personal hygiene, over-crowding, and the frequent contamination of water bodies, and close contact with animals in the rural than urban community. Similarly, the likelihood of acquiring IPIs among patients having stomach pain were six time higher than those who have no stomach pain and patients who had diarrhea in their stool were five times higher than those who did not have diarrhea in their stools. Similar associations of IPIs with patients having stomach pain and diarrhea in their stool were reported in Shahura Health Center, Northwest Ethiopia (Abiye Tigabu *et al.,* 2019). This might be due to the abdominal cramps, bloating, nausea, watery diarrhea during parasitic infections and diarrhea causing nature of intestinal parasites.

The other significant factor associated with IPIs was observed in hand washing practices after defecation (using toilet) with IPIs. Those participants who did not wash their hands after defecation were four times more likely to acquire IPIs than those who washed their hands after defecation (AOR=4.36, CI=2.83-6.72, P=0.000). This was similar to reported from a study conducted in Teda Health Center, Northwestern Ethiopia (Abraraw abate *et al*., 2013). This might be due the habit of washing their hands using only water and inappropriate handling of readymade foods and drinks. With regard to the feeding habit, study subjects who ate unwashed vegetable were five times more likely to acquire IPIs than those who did not eat unwashed vegetables (AOR=5. 430, 4.33-23.77, P=0.000). This is similar to a report in Benishangul-Gumuz, Western Ethiopia by Gebremichael Gebretsadik, 2016. This might be due to contamination of vegetables with fecal materials in the farm and contamination of the vegetation with waste in home.

Dirt matter under the nails was another significant factor associated with IPIs in the present study. The risk of being infected with IPIs were increased by six folds among patients whose finger nails contained dirt material than those who did not have dirty material in their finger nails (AOR=5.63, CI=2.60-11.32, P=0.001). Similar association of IPIs with dirt matter under finger nails was reported in in Rural School Children, Northwest Ethiopia (Megbaru Alemu *et al*., 2018). This might be due to that their fingers might be easily contaminated with soil that contains cysts and eggs of parasitic organisms that leads to intestinal infections.

The other factor that exposed patients for IPIs in this study was education status. Illiterate patients were three times more likely to have parasite infection than patients who were diploma and above (AOR= 2.61, CI=1.24-5.49, P=0.011). This finding disagreed with the finding of a previous study conducted in Teda Health Center, Northwestern Ethiopia by Abraraw Abate *et al*., 2013 where the prevalence of IPIs was not significantly associated with illiterate patients. Higher level of education is usually associated with higher level of hygiene which might reduce the prevalence of parasitosis (Abraraw Abate *et al*., 2013).

In the present study, there existed no significant differences between IPIs and hand washing practices before food ($P > 0.05$). This was in agreement with a study conducted in Delgi, Northern Gondar (Asrat Ayalew *et al*., 2011). The proportions of males with IPIs (28.7%) were higher than that of females (26.5%). Similar results were reported by Ayalew Jejaw *et al*., 2014 in Jimma town Ethiopia. The higher prevalence in males might be due to everyday participation of males in outdoor activities than females which makes them more vulnerable to parasitic infections.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

The overall prevalence of intestinal parasitic infection among patients attending Dil Yibza health center was 55.2%. The proportions of infection were higher for protozoa (49%) compared to helminthes (13.4%). *Entamoeba histolytica/dispar* (46.5%) among the protozoans and *A. lumbricoides* (9.2) among the helminths were the predominant intestinal parasites. According to the multivariate logistic regression analysis of this study, dirt matter under the nail (AOR=5.63; 95%CI=2.60-11.32; P=0.001), hand washing habit after using toilet (AOR=4.36; 95%CI=2.83-6.72; P=0.000), the habit of eating unwashed vegetables (AOR=5. 430; 95%CI=4.33-23.77; P=0.000) , having diarrhea in stool (AOR=4.22; 95%CI=2.57-6.91; p=0.001), and illiteracy (AOR= 2.61; CI=1.24-5.49; P=0.011) were the predictor variables associated with the occurrence of intestinal parasitic infections among patients attending Dil Yibza health center.

6.2. Recommendations

Based on the findings of this study, the following points are recommended to avoid or reduce the risk of IPIs among patients attending at Dil Yibza health center:

- ❖ Community should be provided with health education program on personal hygiene, improved sanitation, avoiding eating unwashed vegetable and raw meat, and proper nail trimming.
- ❖ Community should be provided with safe water for drinking and cooking.
- ❖ There is a need of creating awareness in the community towards the transmission and effective prevention methods of IPIs which is the basis for controlling them.
- ❖ There is a need for integrated control programs including periodic de-worming, creating awareness regarding the importance of washing hands after defecation and impact of using contaminated water to have a lasting impact on transmission of IPs.

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8. APPENDICES

Appendix A: English version of consent form

I have been informed about the objective of the study entitled “The prevalence and associated factors of intestinal parasite infection among patients attending Dil Yibza health center north Gondar zone, Ethiopia.

” I am also informed that all information contained within the questionnaire is to be kept confidential. Moreover, I have been well informed of my right to refuse information, decline to cooperate and drop out of the study if I want and none of my actions will have any bearing at all on my overall health care. Therefore, with full understanding of the situations I agree to give the entire necessary information stool sample for laboratory analysis. I have had the opportunity to ask questions about the project and received clarification to my satisfaction in a language I understand. I was also told that results for the stool analysis will be given to the health facility and that I may ask the information if I want.

I ________________________ hereby give my consent for giving of the requested

Information and specimen for this study

Signature: __________________

Date: __________________________

Appendix B: Amharic version of consent form

የፈቃደኝነት ማረጋገጫ ቅጽ

የአንጀት ጥገኛ ትላትሎች ስርጭት እና ተዛማጅ አባባሽ ችግሮች በድል ይብዛ ጤና ጣቢያ ለሚጎበኙ ታካሚዎች በሚል ርዕስ ላይ ለማጥናት በተመለከተ በሚደረገዉ ጥናት ላይ ልሳተፍ መሆኑን የጥናቱ አላማና ጥቅም ተገልፆልኛል፡፡ በመጠየቁ ላይ ያለዉ ሙሉ መረጃም በሚስጥር እንደሚያዝ ተገልፆልኛል፡፡ በተጨማሪም ጥናቱ ዉስጥ አለመሳተፍ መብቴ እንደሆነና በማንኛዉም ጊዜ ከጥናቱ በራሴ ዉሳኔ መዉጣት እንደምችልና በዚህም ምክንያት ምንም አይነት መጉላላት እንደማይደርስብኝ በሚገባ ተረድቻለሁ፡፡

ስለሆነም ሁኔታዉን በሚገባ ተረድቸ በፍቃደኝነት በምርምሩ ላይ ለመሳተፍ ለተመራማሪዉ ፍቃደኝነቴን ሰጥቻለሁ፡፡ በተጨማሪም የምሰጠዉ የሰገራ ናሙና ለተጠቀሰዉ ጥናት ብቻ እንደሚዉል ተነግሮኝ ተስማምቻለሁ፡፡ ማንኛዉንም ያልገባኝን ነገር የመጠየቅ እድል ተሰጥቶኝ በሚገባኝ ቋንቋ መልስ አግኝቻለሁ፡፡ በተጨማሪም የሁሉም የላብራቶሪ ምርመራ ዉጤቶች በጊዜዉ ክትትል ለሚያደርግልኝ ጤና ባለሙያ እንደሚሰጠዉ እና ዉጤቱን ማወቅ ከፈለግሁ ማግኘት እንደምች ተነግሮኛል፡፡

እኔ---------------------የተባልሁ ግለሰብ ይህን ሁሉ በመገንዘብ በምርመሩ ላይ ስለ እኔ መረጃና የሰገራ ናሙና ለመስጠት ተስማምቻለሁ፡፡

ፊርማ-------------------------ቀን----------------------------

Appendix C: English Version Questionnaires

Bahir dar University College of science department of biology for the study of the prevalence and associated factors of intestinal parasite infection among patients attending Dil Yibza health center north Gondar zone, Ethiopia, from December 2019 to February 2020. I request kindly to give appropriate response for each question. Your response will be kept confidential.

Patient code (to be assigned by the investigator): ________________________

Data collection date: _________________

Data collectors name _____________Sign_______________

Direction: Choice your correct opinion and circle one from a given alternatives

Part I: information on Socio-demographic characteristics

1. Sex: 1. Male 2. Female
2. Age: 1. 5-14 2. 15-24 3. ≥ 25
3. Residence: 1. Urban 2. Rural
4. What is your marital status? 1. Single 2. Married 3. Divorced 4. widowed
5. Level of education: 1. Illiterate 2. Primary school 3. Secondary school 4. diploma and above
6. What is your occupational status? 1. Government employer 2. Merchant 3. Farmer 4. House wife 5. student
7. Number of Family size: 1. ≤3 2. 4-6 3. 7-9 4. >9
8. Monthly income: 1. Lower (<1000) 2. Medium (1000-3000) 3. Higher (>3000)
9. What is your Religion? 1. Protestant 2. Orthodox tewahdo 3. Muslim 4. Catholic
10. What is your ethnicity? 1. Qimanint 2. Agew 3. Felasha 4. Amhara 5. Other---

Part II: information on risk factor

11. Do you have a habit of hand washing before eating food? 1. Yes 2. No
12. If the answer in question 11 is yes, how often do you wash? 1. Always 2. Sometimes
13. Do you have a habit of shoe wearing? 1. Yes 2. No
14. If the answer in question 13 is yes, how often do you wearing shoe? 1. Always 2. Sometimes
15. Do you play /contact/ with soil? 1. Yes 2. No
16. Is there a dirty material under finger nail? 1. Yes 2. No
17. Do you have a latrine at home? 1. Yes 2. No
18. If the answer in question17 is yes, how often do you use? 1. Always 2. Sometimes
19. Do you feel stomach pain? 1. Yes 2. No
20. Is there diarrhea in your stool? 1. Yes 2. No
21. What is your personal hygiene? 1. Good 2. Poor
22. Do you have habit of contact with water bodies? 1. Yes 2. No
23. If the answer in question22 is yes, what are your reasons for water contact?
    1. Swimming 2. Washing cloth 3. For irrigation 4. Washing your body
24. Do you have a habit washing hands after using toilet? 1. Yes 2. No
25. If the answer in question 24 is yes, how often do you wash? 1. Always 2. Sometimes
26. What is the source of water use for drink?
    1. Tuncker water 2. Wheel water 3. Stream water 4. Pipe water
27. Is there a habit of eating unwashable vegetable? 1. Yes 2. No
28. Is there a habit of eating raw meet? 1. Yes 2. No

III. Laboratory results: 1. *E. histolytica/dispar* *2.Hookworm* 3.*G. lamblia* 4.*Trichostrongyloides species,* 5. *A. lumbricoides* 6.*S. mansoni* 7.*H. nana* 8.Taeniasis 9.*Enterobius vermicularis* 10. *Trichuris trichiura*

Appendix D: Amharic version of questionnaires

ቃለ መጠየቅ በአማረኛ

በባህርዳር ዩኒቨርስቲ በተፈጥሮ ሳይንስ ኮሌጅ በባዮሎጂ ትምህርት ክፍል የአንጅት ጥገኛ ትላትሎች ስርጭት እና አባባሽ ተዛማጅ ችግሮችን በድል ይብዛ ጤና ጣቢያ ከተህሳስ 2012 ዓ.ም እስከ ይካቲት 2012ዓ.ም ለሚጎበኙ ታካሚዎች የአንጅት ጥገኛ ትላትሎች እና አባባሽ ተዛማጅ ችግሮችን ለማወቅ የሚደረግ ጥናት ምርምር ሲሆን ተሳታፊ በመሆንዎ እያመሰገን ለእያንዳንዱ ጥያቄ ተገቢዉን መልስ እንዲሰጡ በትህትና እንጠይቃለን ምስጢራዊነቱ የተጠበቀ ነዉ፡፡

የታካሚ መለያ በመርማሪዉ የሚሰጥ፡--------------------

የመረጃ ሰብሳቢዉ ስም፡---------------------------ፊርማ-----------

ሀ. የማህበራዊ መረጃን በተመለከተ

ትክክለኛ ሃስብዎን ለመግለፅ ከተሰጡት አማራጮች ዉስጥ አንዱን መርጠዉ ያክቡ

1. ፆታ፡ 1. ወንድ 2. ሴት
2. ዕድሜ: 1. 5-14 2. 15-24 3. 25 እና ከዚያ በላይ
3. ነዋሪነት፡ 1. ከተማ 2. ገጠር
4. የጋብቻ ሁኔታ፡ 1. ያላገባ/ች 2. ያገባ/ ች 3. የፈታ/ች 4. የሞተበት/ ባት
5. የትምህርት ደረጃ፡ 1. ያልተማረ/ች 2. አንደኛ ደረጃ ያጠናቀቀ/ች 3. ሁለተኛ ደረጃ ያጠናቀቀ/ች 4. ዲፕሎማ እና ከዚያ በላይ
6. የስራ ሁኔታ፡1. የመንግስት 2. ነጋዴ 3. አርሶ አደር 4. የቤት እመቤት 5. ተማሪ
7. የቤተሰብ መጠን፡ 1. ≤3 2. 4-6 3. 7-9 4>9
8. ወርሃዊ የገቢ መጠን፡ 1. ዝቅተኛ (<1000) 2. መካከለኛ (1000-3000) 3. ከፍተኛ (>3000)
9. ሀይማኖት፡ 1. ፕሮቴስታንት 2. ኦርቶዶክስ ተዋህዶ 3. ሙስሊም 4. ካቶሊክ
10. ጎሳ፡ 1. ቅማንት 2. አገዉ 3. ፈላሻ 4. አማራ 5. ሌላ-------

ለ. የአንጀት ጥገኛ ተዋስያን የሚያባብሱ ሁኔታችን በተመለከተ

11.ከመመገብዎ በፊት እጅዎን ይታጠባሉ? 1. አዎ 2. የለም

12.ለጥያቄ ቁጥር 11 መልስዎ አዎ ከሆነ ልምን ያህል ጊዜ ይታጠባሉ

1. ሁልጊዜ 2. አልፎ አልፎ

13.ጫማ የመልበስ ልምድ አለዎት? 1. አዎ 2. የለም

14.ለጥያቄ ቁጥር 13 መልስዎ አዎ ከሆነ ልምድዎ ምን ይመስላል

1. ሁልጊዜ 2. አልፎ አልፎ

15.ከአፈር ጋር ንክኪ አለዎት 1. አዎ 2. የለም

16.ጥፍርዎ ዉስጥ ቆሻሻ አለ? 1. አዎ 2. የለም

17.ሽንት ቤት አለዎት? 1. አዎ 2. የለም

18.ለጥያቄ ቁጥር17መልስዎ አዎ ከሆነ የመጠቀም ልምድዎ ምን ይመስላል?

1. ሁልጊዜ 2.አልፎ አልፎ

19.የሆድ ህመም ስሜት አለዎት? 1. አዎ 2. የለም

20.ሰገራዎ ተቅማጥ አለዎት? 1. አዎ 2. የለም

21.የግል ንፅህናዎ ምን ይመስላል? 1. ጥሩ 2. አናሳ

22.ከዉሃ ጋር የመነካካት ልምድ አለዎት? 1. አዎ 2. የለም

23.ለጥያቄ ቁጥር 22 መልስዎ አዎ ከሆነ የሚነካኩበት ምክንያት ለምንድን ነዉ?

1. ለመዋኘት 2.ልብስ ለማጠብ 3.ለመስኖ ስራ 4. ገላን ለመታጠብ

24.ከሽንት ቤት መልስ እጅዎን ይታጠባሉ? 1. አዎ 2. የለም

25.ለጥያቄ ቁጥር 24 መልስዎ አዎ ከሆነ ለምን ያህል ጊዜ ይታጠባሉ

1. ሁልጊዜ 2. አልፎ አልፎ

26.የሚጠጣ ዉሃ ከየት ነው የሚጠቀሙት?

1. የታንከር ዉሃ 2. የጉድጓድ ዉሃ 3. የምንጭ ዉሃ 4. የቧንቧዉሃ

27.ያልታጠበ አትክልት የመመገብ ልምድ አለዎት? 1. አዎ 2. የለም

28.ጥሬ ስጋ የመመገብ ልምድ አለዎት? 1. አዎ 2. የለም

III. የምርመራ ዉጤት: 1. *E. histolytica/dispar* 2.*Hookworm* 3.*G. lamblia*

4. *Trichostrongyloides species* 5. *A. lumbricoides* 6.*S. mansoni* 7.*H. nana*

8. Taeniasis 9. *Enterobius vermicularis* 10.*Trichuris trichiura*