

**RISK FACTORS AFFECTING THE PREVALENCE OF  
INTESTINAL PARASITES AMONG SCHOOL AGE  
CHILDREN IN DENEBA PRIMARY SCHOOL,  
DENEBA TOWN, CENTRAL ETHIOPIA**

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**By**

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## DEDICATION

I dedicated this research manuscript to Eskidir GebreHana and Tsgiedinglen GebreHana

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## ABBREVIATIONS

CDC	Center for Disease Control
CI	Confidence Interval
NCCLS	National Committee on Clinical Laboratory standard
O & P	Ova and Parasite
SPSS	Statistical Package for Social Science
STHI	Soil Transmitted Helminth Infection
WHO	World Health Organization



## ABSTRACT

Intestinal parasites are common health problems in Ethiopia and causes significant morbidity and mortality. Diseases caused by *Enterobius vermicularis*, *Giardia lamblia*, *Hookworm*, *Entamoeba histolytica*, *hymenolopsis nana*, *Ascaris lumbricoides*, *Strogloides* and *Trichuris trichiura* occur in Ethiopia. A cross-sectional study was conducted from December 2015 to January 2016 to estimate the prevalence of intestinal parasitic infections and its associated risk factors among school age children at Deneba primary school of Deneba town, Central Ethiopia. A total of 384 schoolage children were selected from Deneba Primary School by using random sampling technique. The specific objectives of the current study were to determine the prevalence of intestinal parasitic infections, to identify major intestinal parasitic species and to assess the associated risk factors. The overall prevalence of intestinal parasitic infections was 49.7% (191/384). The major intestinal parasites identified in the study area were *Entamoeba histolytica*, *Hymenolepsis nana*, *Giardia lamblia*, *Ascaris lumbricoides* and *Enterobius vermicularis* with prevalence rates of 33.3%, 3.6%, 3.6%, 3.1% and 1%, respectively. The prevalence of intestinal protozoan infections (36.5%) were higher than intestinal helminthic infections (8.1%). The most significant risk factors for the prevalence of intestinal parasitic infections were using of toilet (AOR:2.048; 95% CL: 1.089-3.852; p-value= 0.026) washing hands before eating food (AOR:0.572; 95% CL: 0.304-1.076; p-value=0.043) and washing hands after using toilet (AOR: 4.736; 95% CL: 1.001-22.408; p-value=0.05). The current study revealed that there was relatively high prevalence of intestinal parasitic infections in the study area. Therefore, schoolage children in the study area should use toilet, wash their hands after toilet and before meal with clean water and soap.

**Keywords:** Children, Deneba, Central Ethiopia, Helminths, Protozoa, Prevalence, Risk factors

## 1. INTRODUCTION

Intestinal parasitic infections are the major medical problems throughout the world, especially in developing countries where they cause more morbidity and mortality than other infectious diseases and are the primary cause of death (WHO, 2013). Intestinal parasitic infections are among the most common communicable diseases worldwide and particularly important in developing countries.

The World Health Organization (WHO) has estimated 3.5 billion people of the world have contracted gastrointestinal parasites (GIP). Of this amount, approximately 450 million people which are mostly children are suffering from GIP and 56 million of the infected children have non specific signs such as abdominal pain, nausea, vomiting, loss of appetite, weight loss and abdominal bloat ( Niyiyati *et al.*, 2009; Escobedo *et al.*, 2009).

Intestinal parasitic infections are more prevalent among the poor sections of population. The high prevalence of parasitic infections is closely correlated with poverty, poor environmental hygiene and impoverished health services. They are closely associated with low household income, poor personal and environmental sanitation, and overcrowding, limited access to clean water, tropical climate and low altitude. Intestinal parasitic infections are the top global health problems. Amoebiasis, Ascariasis, Hookworm infections and Trichiuriasis are among the most common infections (WHO, 2015). According to the World Health Organization (WHO, 2011; The End Fund, 2016; Omar M. Amin, 2017) globally, all worm infections account 4.5 billion which is contributed by ascaris 1.0 billion, hookworm 900 million, whipworms 750 million, trichiuriasis 604 million and filarial worms 657 million. Children between the ages of 5 up to 15 years old usually have the highest rates of infection, particularly in developing countries associated with the prevailing conditions of poverty, poor nutrition, inadequate sanitation and absence of potable drinking water and insufficient healthcare (WHO, 2004).

*Entamoeba histolytica* is one of the concerns of health professionals now a days. About 50 million people are currently living with *Entamoeba histolytica* while close to 3 million others are infected with *Giardia lamblia*. Of this, between 40,000-100,000 people are falling ill each year with same (Ali and Hill, 2003; Sah et al., 2013). The prevalence of *Cryptosporidium parvum* ranges between 2-50% globally (WHO, 2006).

The prevalence of intestinal parasites among schoolage children is reported from different countries across the world. The prevalence rates of intestinal parasites reported by some researchers are 44.6 % ( Agha and Teodorescu, 2002), 47.6 % ( Okolo, 2009), 37.2 % ( Nam et al., 2012), 75.51% (Hind, 2012), 52.8 % (Pinar et al., 2004), 68.1 % ( Heidari and Rokni, 2003), 42.9 % ( Williams et al., 2014) and 65.3 % ( Ibrahim et al., 2015)

The prevalence rates of intestinal parasites were recently reported by different researchers from different parts of Ethiopia. Legesse et al. (2010) reported a prevalence rate of 72.9%. Similarly, Legesse and Erko (2004) reported 83.8% among schoolchildren in a rural area close to the southeast of Lake Langano. Furthermore, Amha (2007) reported 35.9% among children in Arb-Gebeya town and Fetlework (2011) reported 46.1% among Schoolchildren in Alemketema town.

The prevalence of *Entamoeba histolytica* reported by Nam et al. (2012) was 30.2%, Abdulla et al. (2014) 29.8% among primary schoolchildren in Erbil Province Kurdistan-Iraq, Hind (2012) 23.87% among rural villages in Basrah marshes regions, Legesse and Erko (2004) 12.7% among schoolchildren in a rural area close to the southeast of Lake Langano, Ethiopia, Narmin and Isra (2012) 30% among schoolchildren in a rural area close to the southeast of Lake Langano, Dawit Ayalew (2006) 33.7% among children in rural part of Dire Dawa, Abd et al. (2010) 20.4% among schoolage children in Al-Azhar and Assiut University, and Nihar et al. (2010) 71.8% prevalence of intestinal parasitic infections in Sharjah, United Arab Emirates.

The prevalence of *Giardia lamblia*, similar to *E. histolytica* was reported by Izabella et al. (2011) to be 27.3%, Hind (2012) 30.93% among rural villages in Basrah marshes regions,

Mehraj *et al.* (2008) 28.9% among children in an Urban Slum of Karachi, Heidari and Rokni (2003) 26.2% among children in Day-care Centers in Damghan – Iran, Teshome *et al.* (2014) 15.65% in children presented to Yirgalem Hospital and Ngosso *et al.* (2015) 35.6 % among under-fives children in Dar Es Salaam, Tanzania.

The prevalence of soil-transmitted disease (STD) was reported from different parts of the world including Ethiopia by Girum (2005) to be 27.2% among school children in Babile town, eastern Ethiopia, Egwunyenga *et al.* (2005) 54.7% among schoolage children in Ethiope East Local Government Area, Delta State, Nigeria, Fayo (2010) 53.5% among Schoolchildren, the Case of Arsi Dodota, Oromia Regional State, Abebe *et al.*(2011) 82.4% among schoolchildren in Zarima town, northwest Ethiopia, Ezeigbo *et al.*(2014) 25.7% among pupils in Mgbidi,Oru-west Local Government Area of Imo state, Nigeria, Mathewos *et al.* (2014) 66.7% infection among children in two primary schools in North Gondar, Northwest Ethiopia, Mokuia *et al.*(2015) 86% among pre-school age children in Elburgon Municipality of Kenya, Shumbej *et al.*(2015) 23.3% among pre-school children in Butajira town, Southcentral Ethiopia, Million *et al.*(2013) 41% among pregnant women and risk factors in Gilgel Gibe dam Area, Southwest Ethiopia, Leykun (2001) 42.9% among schoolchildren from Chilga District, Northwest Ethiopia, Hafeez *et al.* (2003) 44.7% in a rural area of Lahore, Lorina, (2013), Mengistu (2010) 72.9% among students of Atse Fasil General Elementary Schoolazezo, Northwest Ethiopia, Gezahegn (2008) 43.7 % among school children in Abosa around Lake Zway, Southern Ethiopia, Alamneh ( 2014) 44.2% among school children in Tilili town, northwest Ethiopia, Kattula *et al.*(2014) 7.8% among school children in south India, Matthy *et al.* (201) 32% among children from primary schools in western Tajikistan, Sung-Tae *et al.*, (2006) 84.3% in the Republic of Korea, Macchioni *et al.*, (2015) 5.9% in children living in the Chaco region, Bolivia, Andrade *et al.*, (2014) 65% in the City of Portoviejo (Ecuador), Cabada *et al.* (2015) 47% in Paucartambo, Peru, Huong *et al.*, 2007) 71% in schoolchildren in rural Vietnam, Nyakang'o *et al.* (2015) 35.80% among preschool age children in Elburgon municipality, Kenya, Sahet *et al.* (2013) 11.3% among the schoolchildren of Dharan, Eastern region of Nepal, Mugono (2014) 6.73% among school going children at Ukara Island, Northwest Tanzania and Bayeh *et al.*(2013) 51.5% among schoolchildren in Ethiopia.

The prevalence of Ascariasis among schoolage children in different areas of Ethiopia was assessed. Mengistu *et al.* (2010) reported a rate of 28.8% in students of Atse Fasil General elementary school Azezo, Northwest Ethiopia, Amha (2007) 8.3% in schoolage children in Arb-Gebeya town, Alamneh and Endalkachew (2014) 39.7% in Tilili town, Northwest Ethiopia, Mulusew (2014) 15.5% among the primary schoolchildren in Motta town, Western Amhara, Ethiopia, Mathewos *et al.* (2014) 39.8% in North Gondar, Terefe *et al.* (2011) 66.7% in Gorgora and Chuahit town, Tadesse *et al.* (2008) 37.2% in Bushillo village, 39.5 % in Jimma town and the national prevalence is estimated to be 37% (Source to the national prevalence).

*T. trichiura* was found in more than 90% of 50 communities, with a mean prevalence of 49% (Belete and Kloos, 2006) in the central and northern plateau. Prevalence of Trichuriasis among schoolage children reported to be 41.5% in Bushulo village, southern Ethiopia (Ashenafi *et al.*, 2011), 7.8% among schoolchildren in Tilili town, northwest Ethiopia (Alamneh and Endalkachew, 2014), 4.60% among primary schoolchildren in Gorgora, Northwest Ethiopia (Zinaye *et al.*, 2013), 12.7% in Dore Bafeno, southern Ethiopia (Degarege *et al.*, 2014), 23.5% among schoolchildren in Dawro Zone, Southern Ethiopia (Bereket and Zewdneh , 2015), 3.1% among schoolchildren in selected primary schools, Wukro Town, Eastern Tigray, Ethiopia. (Eleni *et al.*, 2014) and 6.0% among children in two primary schools in North Gondar, Northwest Ethiopia (Mathewos *et al.*, 2014).

The prevalence of *H.nana* on the other hand was reported by different scholars, from different parts of Ethiopia at different time. To mention but few, Amare *et al.* (2007) who reported 5% in Babile town, Aschalew *et al.*(2013) who reported 13.8% among schoolchildren at the University of Gondar Community School, Northwest Ethiopia, Tilahun *et al.* (2015) who reported 0.5% and Eleni *et al.* (2014) who reported 1%. By the same talken, Tilahun *et al.* (2015) reported a prevalence rate of *E.vermicularis* to be 1.1%, Million *et al.* (2013) 29.4%, Ashenafi *et al.* (2011) 1.4%), Fayo (2010) and (Tadesse and Tsehaye, 2010) 8.52%.

Schoolchildren in many developing countries including Ethiopia were observed with intense infections due to intestinal protozoan parasites and helminthes (Warren *et al.*, 1993). Therefore, treatment of this age group which is easily accessible through the school system achieves optimal improvements in health status and educational performance. However, the role of intestinal soil transmitted helminthes in causing morbidity and mortality as well as the pathogenesis to other infectious diseases differ from species to species. Similarly, the distribution and prevalence of various species of intestinal parasites also differs from region to region and place to place because of several environmental, social and geographical factors. Hence, study on the prevalence of various intestinal parasitic infections is a prerequisite not only for formulation of appropriate control strategies but also to predict potential risk factors for community members under consideration.

There are still several localities like Deneba town which lack epidemiological information on intestinal helminthes infections although several studies have been conducted on the distribution and prevalence of intestinal parasitic infections in Ethiopia. Therefore, this study was designed to determine the prevalence of soil transmitted intestinal parasitic infections among schoolage children in Deneba town, central Ethiopia.

## **Objective of the study**

### **General Objective**

- ❖ To undertake an epidemiological baseline study of intestinal parasites and their precipitating risk factors among schoolage children in primary school at Deneba town, Central Ethiopia.

### **Specific Objectives**

- To determine the prevalence of intestinal parasites among schoolage children,
- To identify the major intestinal parasitic species among schoolage children, and

- To assess the association of risk factors with the prevalence of intestinal parasitic infections among schoolage children.

### **Significance of the Study**

The study provides information on the prevalence of intestinal parasites among schoolage children, factors associated with intestinal parasitic infections assessed and maternal knowledge, socio-demographic and environmental, practice on the prevention and control of intestinal parasites. The finding is also important for those who are working on the prevention and control of intestinal parasitic infections among the stated age groups in the study area and other similar geographical areas. It also motivates the stakeholders to design and implement appropriate prevention and control measures. In addition, the data obtained is useful for further research.

Intestinal parasitic infections cause abdominal discomfort, diarrhea, loss of appetite and nausea which are the causes of school absentism and decrease their ability of reading for long time. The research helps to create awareness for teachers, local health professionals and student families to take appropriate measures for intestinal parasitic infections. The study also provides baseline information on prevalence of intestinal parasitic infections among schoolage children and their associated risk factors.



## 2. REVIEW OF RELATED LITERATURE

### 2. 1. Intestinal Parasites

Intestinal parasitic infections (IPIs) are globally endemic and have been described as constituting the greatest single worldwide cause of illness and disease (Curtale *et al.*, 1998; Steketee, 2003). IPIs are linked to lack of sanitation, lack of access to safe water and improper hygiene; thus occurring wherever there is poverty. People of all ages are affected by the cycle of prevalent parasitic infections; however, children are the worst affected (Steketee, 2003; Garzon, 2003).

In developing countries, particularly those with tropical climates and at low altitudes, such infections remain a serious medical and public health among the poor, who are negatively affected by low socio-economic conditions, poor personal and environmental hygiene, overcrowding, and limited access to clean water (Mengistu *et al.*, 2007; Obeng *et al.*, 2007). The main transmission route for most intestinal parasites is fecal-oral, through contaminated food or water (Marshall *et al.*, 1997).

#### 2. 1. 1. Intestinal protozoa

The global burden of intestinal protozoan infestation is still huge even though there have been tremendous achievements in the reduction of their prevalence. About 50 million people are currently living with *Entamoeba histolytica* while close to 3 million others are infected with *Giardia lamblia* (Samuel *et al.*, 2001; Ali and Hill, 2003).

##### 2. 1. 1. 1. *Entamoeba histolytica*

There are four species of the protozoan genus *Entamoeba* which are commonly found in the human gastrointestinal tract, namely *E. coli*, *E. dispar*, *E. hartmanni* and *E. histolytica*. *E. histolytica* is the causes of invasive amebiasis and hence the only one with medical

importance (Diamond and Clark, 1993). *Entamoeba histolytica* is the causative agent of amoebic dysentery. Dysentery is a general term that is used to describe a serious inflammatory disorder affecting the intestines that results in intense diarrhoea and is often accompanied by pain and fever. It can result from a variety of causes and amoebic and bacterial dysentery occur in both temperate and tropical regions (Alan and Sarah, 2012).

The life cycle of *E. histolytica* consists of an infective cyst stage and a multiplying trophozoite stage. Humans are infected by ingesting these infective cysts, which travel through the gut lumen to the small intestine (terminal ileum), where each excysts to form eight daughter trophozoites. The trophozoites are motile forms, which adhere to and invade intestinal epithelial cells which line the gastrointestinal tract. Trophozoites move by extending creeping projections of cytoplasm, called pseudopodia, which pull them along. They also use these projections to surround and engulf food particles. The cytoplasm frequently contains many red blood cells (RBCs) that have been ingested. The trophozoites of *E. histolytica* always have a single nucleus. Trophozoites are easily destroyed in the outside environment, degenerating within minutes. The trophozoite of *E. histolytica* can convert to a precyst form with a nucleus (*E. coli* precysts have two nuclei), and this form matures into a tetranucleated cyst as it migrates down and out of the colon. The precyst contains aggregates of ribosomes, called chromatoid bodies, as well as food vacuoles that are extruded as the cell shrinks to become a mature cyst. It is the mature cyst that, when consumed in contaminated food or water, is infectious. In the process of becoming tetranucleated, the nucleus of the cyst divides twice. Chromatoid bodies and glycogen vacuoles cannot be seen at this stage (WHO, 2009)

Cysts can remain alive outside the host for weeks or months, especially under damp conditions (Markell *et al.*, 1999), but are rapidly destroyed at temperatures under  $-5^{\circ}\text{C}$  and over  $40^{\circ}\text{C}$  and the cysts are not invasive, but trophozoites can penetrate the gastrointestinal mucosa (WHO, 2009). From there, the trophozoites are able to migrate to other organs, causing extra intestinal infections.

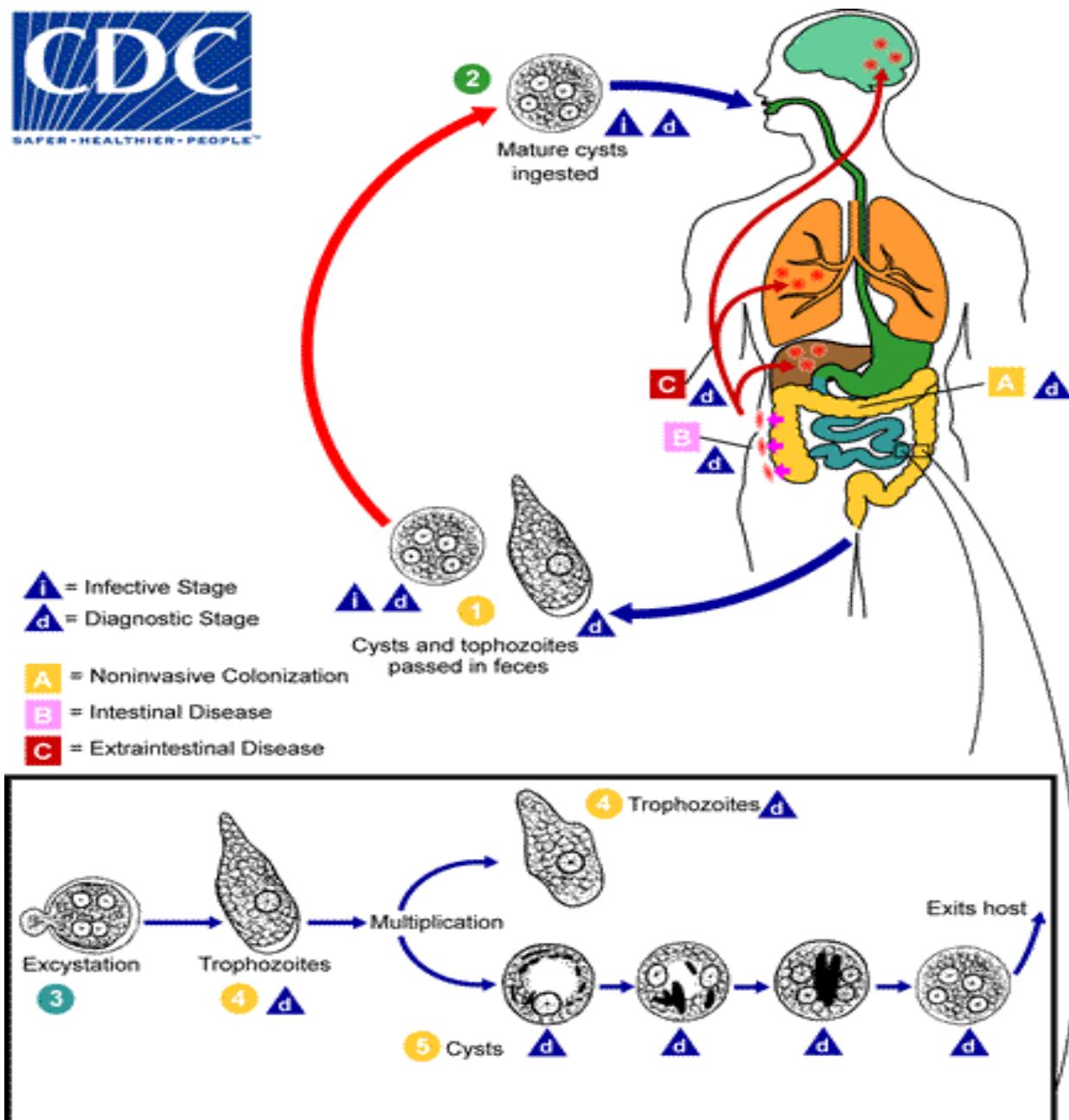


Figure 1. Life cycle of *Entamoeba histolytica* ( source:WHO, 2009)

The prevalence of *Entamoeba histolytica* in the world was reported by different researchers such as Abdulla *et al.* (2014) 29.8% among primary schoolchildren. In Erbil Province Kurdistan-Iraq, Hind (2012) reported 23.87% among rural villages in Basrah marshes regions, Bushra *et al.* (2012) 28.2% in Bashiqa District, Nineveh Governorate, Iraq, Abd *et al.*, (2010) 20.4% in schoolage children in Al-Azhar and Assiut University Hospitals, Nihar *et al.* (2010)

71.8% in Sharjah, United Arab Emirates, Ibrahim *et al.* (2015) among schoolage children in the University hospital of Bobo-Dioulasso, Burkina Faso and Gimba and Dawam (2015) among children attending Gwagwalada township Clinic, FCT-Abuja, Nigeria.

The prevalence of *Entamoeba histolytica* was reported from different regions of Ethiopia by Mengistu and Berhanu (2004) to be 12.7% among schoolchildren in a rural area close to the southeast of Lake Langano, Ethiopia, Alemnesh (2011) 13.6% among patients who attended Tikur Anbessa University Hospital, Ethiopia, Amha (2007) 13.3% in Arb-Gebeya town, Tach\_Gayint Woreda, Dawit (2006) 33.7% among children in rural part of Dire Dawa, Fetlework (2011) among schoolchildren in Alemketema town, Teshome *et al.* (2014) 4.35% Children presented to Yirgalem Hospital, Ethiopia and Mulusew (2014) 17.1% among the primary schoolchildren in Motta Town, Western Amhara.

#### 2. 1. 1. 2. *Giardia lamblia*

*Giardia lamblia* is a flagellate of worldwide distribution. It is more common in warm climates than temporal climates. It is the most common flagellate of the intestinal tract, causing giardiasis. Human beings are the only important reservoir of infection. The infection is most common in parts of the world where sanitation is at its lowest. Giardiasis is an infection of the upper small bowel, which may cause diarrhea. Only *Giardia* spreads disease. The trophozoites of *G. lamblia* are flattened pear shaped and are an average size of 15µm long, 9µm wide and 3µm thick. When stained, the trophozoite is seen to have two nuclei, two slender median rods (axostyles), and eight flagella arising from the anterior end. They have been described as looking like tennis rackets without the handle (they are often seen as having a comical face-like appearance when looking at the front view (Izabella *et al.*, 2011).

The movement of the trophozoites is described as tumbling leaf motility, using their four pairs of flagella for locomotion. They attach themselves to the surface of the jejunal or duodenal mucosa by their disc-like suckers which are found on their ventral surface. They multiply in the gut by binary fission. Once the trophozoites drop off the mucosal surface they are normally carried in the intestinal contents down the gut where they usually encyst.

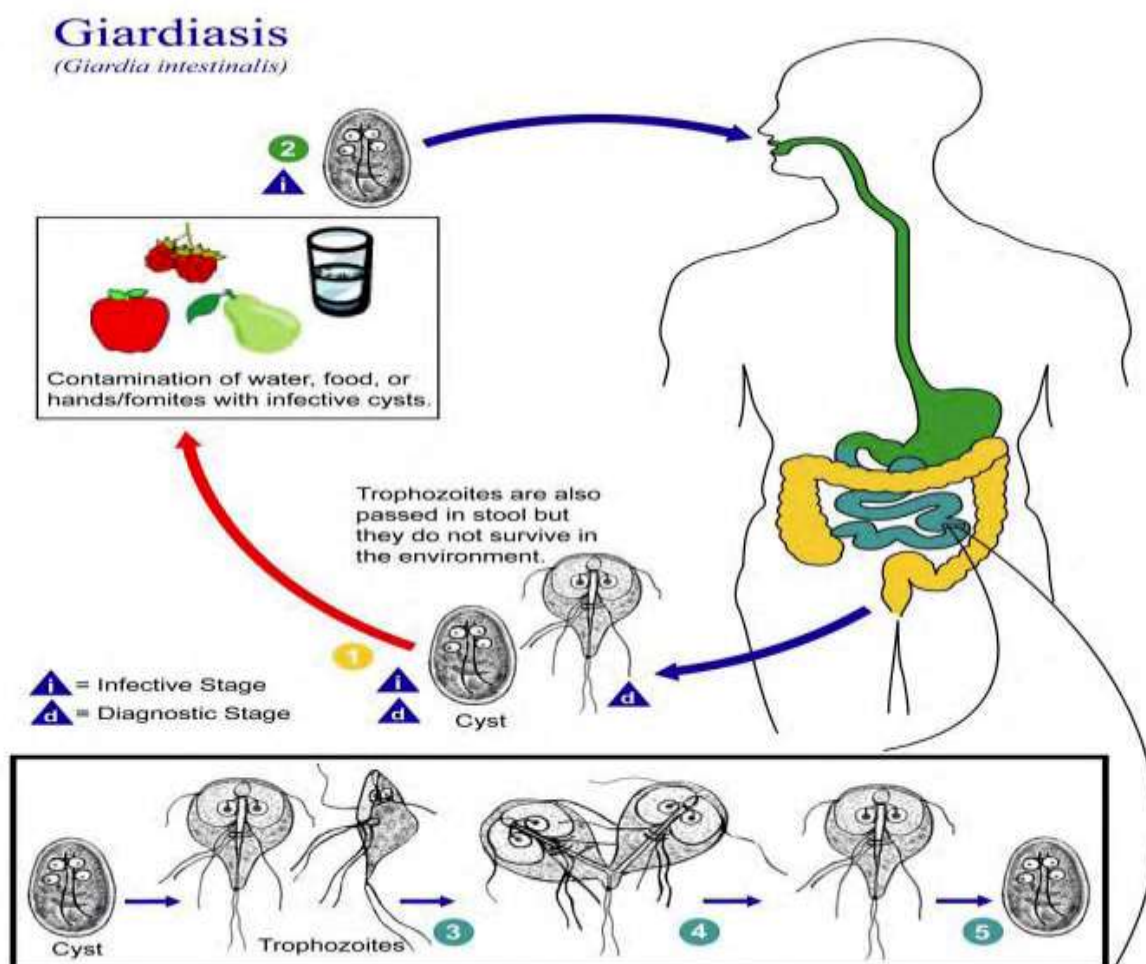


Figure 2. Life cycle of *Giardia intestinalis* (source:WHO, 2009)

The prevalence of *Giardia* spp in different parts of the world was reported by different scholars such as Izabella *et al.* (2011) prevalence among schoolage children in three municipalities of Southeastern Minas, Gerais State, Rostami *et al.* (2012) 9.9% among schoolchildren in Golestan Province, Iran, Basil *et al.* (2006) 9.3% among schoolchildren in Gaza City, Beit-Lahia Village and Jabalia Refugee Camp, Gaza Strip, Palestine, Abdulla *et al.* (2014) 13.1% among primary schoolchildren in Erbil Province, Kurdistan-Iraq, Hind (2012) 30.93% among rural villages in Basrah marshes regions, Mehraj *et al.* (2008) 28.9% among children in an Urban Slum of Karachi, Alyousefi *et al.*(2011) 17.7% among patients in Sana'a City, Yemen, Adnan *et al.* (2008) 10.3% among pre-school children, Gaza, Palestine, Heidari

and Rokni (2003) 26.2% among children in day-care Centers in Damghan – Iran, Williams *et al.* (2014) 16.8% among primary schoolchildren in Urban and peri-urban communities in Kumasi, Ghana, Ngosso *et al.*(2015) 35.6% among under-fives children in Dar Es Salaam, Tanzania and Abdulla *et al.*(2014) 13.1% among primary schoolchildren in erbil province kurdistan-iraq.

The prevalence of *Giardia* spp in Ethiopia was reported similarly by Mengistu and Berhanu (2004) 6.2% among school children in a rural area close to the southeast of Lake Langano, Fetlework (2011) 6% among school children in Alemketema town, Mulusew (2014) 11.8% among the primary schoolchildren in Motta town and Sintayehu (2010) 21.43% among food handlers and microbial safety of ready-to-eat foods in selected orphanage centers in Addis Ababa.

## 2. 1. 2. Intestinal helminth infections

Infections are widely distributed in tropical and subtropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas (is it Latine America?), China and East Asia. More than 1.5 billion people, or 24% of the world's population, are infected with soil-transmitted helminth infections worldwide. Over 270 million pre-schoolage children and over 600 million schoolage children live in areas where these parasites are intensively transmitted, and are in need of treatment and preventive interventions (WHO, 2016).

Soil-transmitted helminths are a group of parasitic nematode worms causing human infection through contact with parasite eggs or larvae that thrive in the warm and moist soil of the world's tropical and subtropical countries. Of particular worldwide importance, STHI are roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), and the anthropophilic hookworms (*Necator americanus* and *Ancylostoma duodenale*). *Strongyloides stercoralis* is also a common STHI in some of these regions, although detailed information on the prevalence of strongyloidiasis is lacking because of the difficulties in diagnosing human infection (WHO, 2006). The life cycles of *Ascaris*, *Trichuris*, and hookworm follow a general pattern. The adult parasite stages inhabit the gastrointestinal tract (*Ascaris* and hookworm in

the small intestine; *Trichuris* in the colon), reproduce sexually, and produce eggs, which are passed in human faeces and deposited in the external environment. STHI is categorized among neglected tropical diseases because it inflicts tremendous disability and suffering, which can be clinically treated, yet negligible attention has been given for many years (WHO, 2012).

### 2. 1. 2. 1. *Hook worm*

Hookworm is an intestinal parasite of humans. The larvae and adult worms live in the small intestine can cause intestinal disease. The two main species of hookworm infecting humans are *Ancylostoma duodenale* and *Necator americanus*. Globally, there are 700 million people infected with hookworm (including 44 million pregnant women), 807 million people infected with ascariasis, and 604 million people infected with trichuriasis. Transmission mainly occurs in tropical climates where sanitation and hygiene are poor (WHO, 2016).

Eggs are passed in the stool, and under favorable conditions (moisture, warmth, shade), larvae hatch in 1 to 2 days. The released rhabditiform larvae grow in the faeces and/or the soil, and after 5 to 10 days (and two moults) they become filariform (third-stage) larvae that are infective. These infective larvae can survive 3 to 4 weeks in favorable environmental conditions. On contact with the human host, the larvae penetrate the skin and are carried through the blood vessels to the heart and then to the lungs. They penetrate into the pulmonary alveoli, ascend the bronchial tree to the pharynx, and are swallowed. The larvae reach the small intestine, where they reside and mature into adults. Adult worms live in the lumen of the small intestine, where they attach to the intestinal wall with resultant blood loss by the host. Most adult worms are eliminated in 1 to 2 years, but the longevity may reach several years. Some *A. duodenale* larvae, following penetration of the host skin, can become dormant (in the intestine or muscle). In addition, infection by *A. duodenale* may probably also occur by the oral and transmammmary route. *N. americanus*, however, requires a transpulmonary migration phase (WHO, 2009).

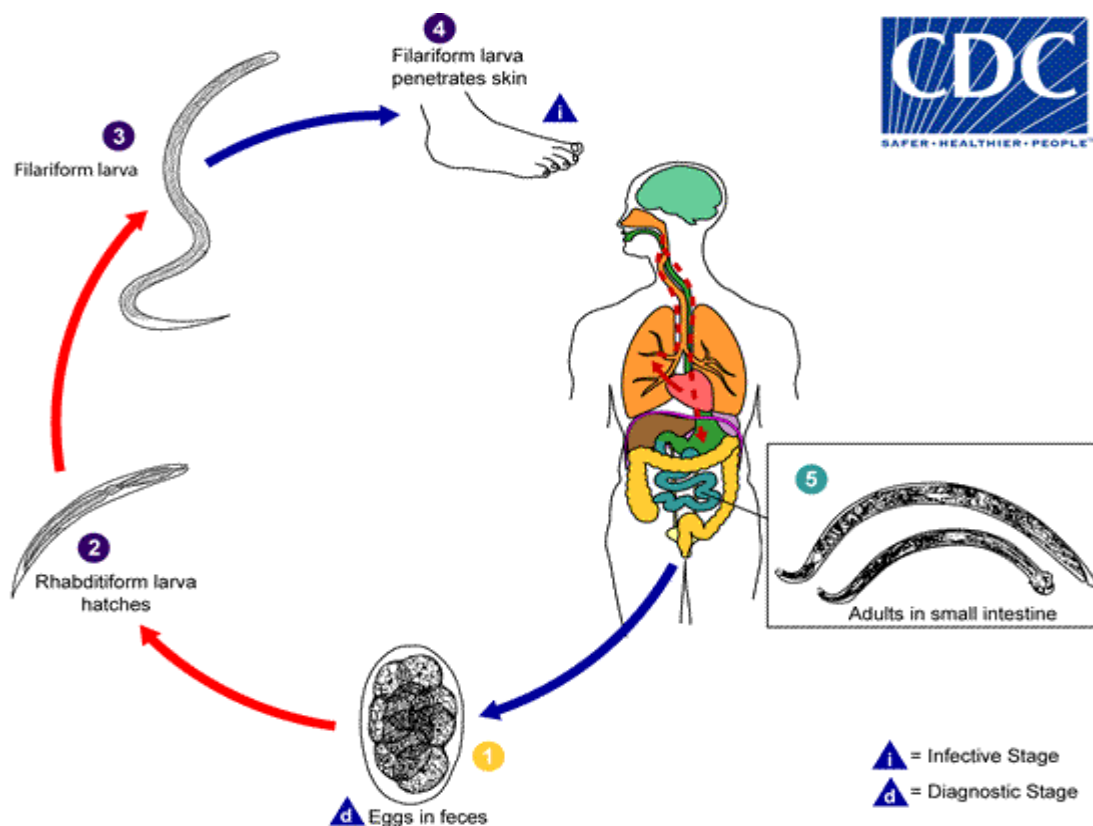


Figure 3. Life cycle of hook worm (Source: CDC, 2016)

The prevalence rate of hookworm varies from countries to countries, from region to region and from developed, developing and under developed locations of the world. Some of the researches who were reported includes: (Egwunyenga *et al.*, 2005) 29.76, (Sunil *et al.*, 2011) 86.36%, (Mary-Theresa, 2012) 15.9% (Saravanakumar *et al.*, 2013) 38%, (Kattula *et al.*, 2014) 8.4%, (Deepthi *et al.*, 2014) 8.4%, (Ezeigbo *et al.*, 2014) 11.7%, (Phoebe, 2014) 10.4%, (Mugono, 2014) 5.69%, (Mokua *et al.*, 2015) 10.06%, (Macchioni *et al.*, 2015) 0.4% and (Ntonifor *et al.*, 2015) 3.5% from different countries of the world (Source).

Hookworm was commonly soil transmitted helminth infection in Ethiopia. Some of the reported research from different regions of Ethiopia were 60.2% by Mengistu and Berhanu (2004), 6.7 % by Girum (2005), 19% by Abebe *et al.* (2011), 28.4% by Ashenafi *et al.* (2011), 1.2% by Gebeyehu (2011), 28.8% by Bayeh *et al.* (2013), prevalence by Zinaye *et al.* (2013), 14.6% by Megbaru *et al.* (2014), 4.9% by Mathewos *et al.* (2014), 3.9% by Eleni *et al.* (2014), 4.21% by Gameda (2014) and 29.4% by Million *et al.* (2013).



### 2. 1. 2. 2. *Ascaris lumbricoides*

Ascariasis, also known as roundworm, is an intestinal infection caused by the parasitic worm *Ascaris lumbricoides*, and is part of a family of parasites known as the soil-transmitted helminths. Ascariasis is most prevalent in warm tropical and sub-tropical climates in sub-Saharan Africa and Southeast Asia, and it flourishes in areas with poor sanitation or where crops are irrigated by improperly treated waste water. Ascariasis is the most common human worm infection. More than one billion people worldwide are infected with ascariasis, and more than 60,000 die from the disease annually (Global network of neglected diseases, 2015).

Ascariasis, a soil-transmitted infection, is the most common human helminths infection. It is an intestinal roundworm and the largest nematode to infect humans. Currently estimates indicated that more than 1.4 billion people are infected worldwide. In United States around 4 million people were infected, primarily in the southeastern states and among immigrants (Stoker *et al.*, 2009).

Important factors associated with an increased prevalence of disease including socio-economic status, defecation practices and cultural differences related to personal and food hygiene as well as housing and sewage systems. Most infections are subclinical; more severe complications occur in children who tend to suffer from the highest worm burdens (Stoker *et al.*, 2009). The adult worms live in the small intestine, attached firmly to the mucous membrane of the gut lining, and feed on blood and tissue. The adult females deposit their eggs whilst in the gut (they can produce up to 20,000 eggs per day), the eggs are then passed out in the faeces. The rhabditiform larvae hatch in warm, damp soil (light sandy loam), feeding on bacteria. After about one week during which they have gone through two moults become infective and climb into a suitable position waiting for a suitable host to pass by. The larvae enter the host by penetrating unbroken skin (it is now recognized that *A. duodenale* can successfully enter man by oral ingestion, this may be more important for this species than skin penetration). The larvae then enter blood vessels and are carried to the heart, lungs and trachea. They are then swallowed and develop into adult worms in the small intestine. Larvae that are initially swallowed may not show this migration (WHO, 2009).

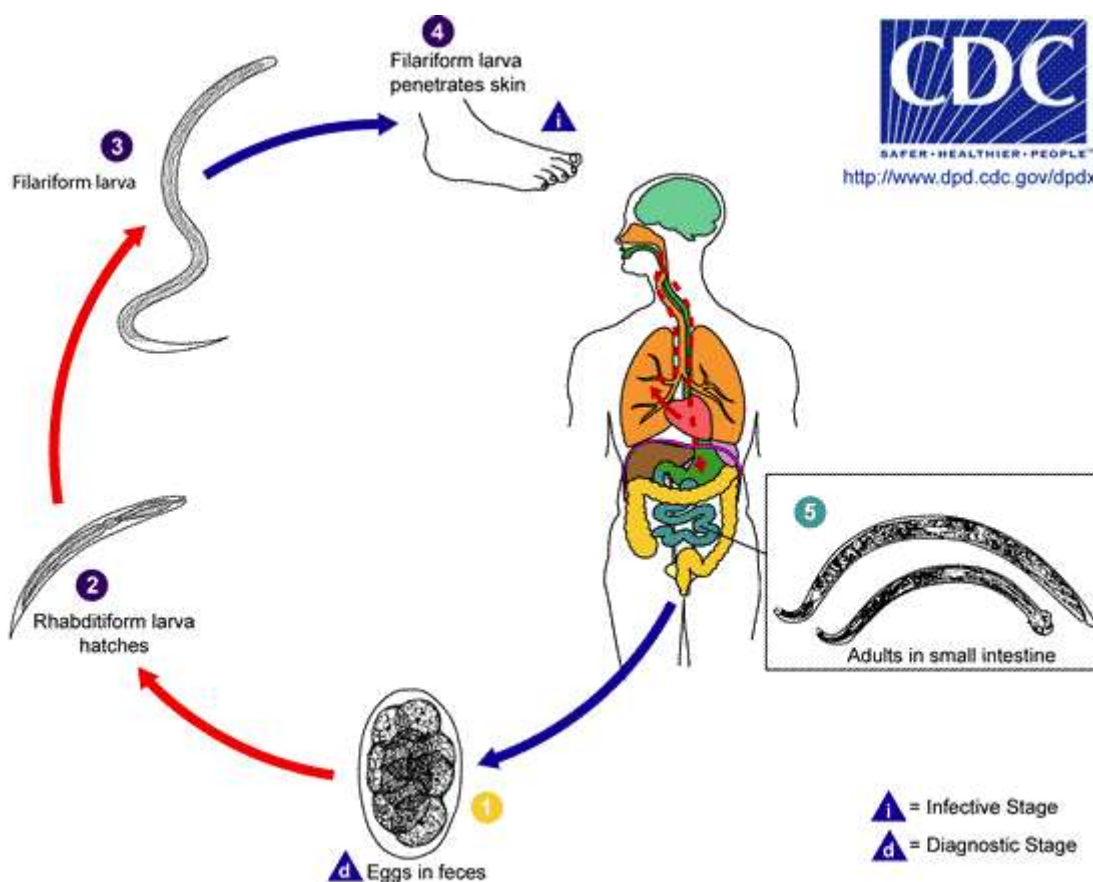


Figure 4. Life cycle of *Ascaris lumbricoides* (Source: CDC, 2016)

The highest prevalence of ascariasis in Nigeria varies from rural community Lagos Suburb, South West Nigeria 67.7 % (Ibidapo and Omolade, 2008), 52.4% reported from primary schoolchildren in Chikun and Kaduna South Local Government areas of Kaduna state (Thomas *et al.*, 2014) to 46% (Lorina, 2013) from rural and semi-urban community members in Nigeria. On the other hand, the lowest prevalence of soil transmitted helminths also varies from 8.0% (Nwoke *et al.*, 2013) in Ebonyi north-central area of Ebonyi State, southeast of Nigeria to 12.8% (Okolo, 2009) in Oraifite, Ekwusigo L.G.A., Anambra State, Southeastern Nigeria and 86% Mokuia *et al.* (2015) among pre-schoolage children in Elburgon Municipality, Kenya (Source).

The prevalence of ascariasis in the world varies from the lowest in southern India 1.5 % (Saravanakumar *et al.*, 2014), 3% (Heidari and Rokni, 2003) in Day-care Centers in Damghan

–Iran, 30% Usuanlele, 2012) among schoolage children from rural community members in Honduras, 17.7% (Miguel *et al.*, 2014) Manu jungle in Peru 60.53% ( Hafeez *et al.*, 2003) a rural area of Lahore and 21.54 % ( Karyl and Jean, 2013) Philippines, 23.81 % ( Ntonifor *et al.*, 2015) Mount Cameroon and 25.14 % ( Mokua *et al.*, 2014) among pre-schoolage children in Elburgon Municipality, Kenya (Source).

The prevalence of *Ascaris lumbricoides* in Ethiopia was reported at different times by different researches. To mention but few, Amare *et al.* (2007) who reported 83% in Awramba and Neighbouring Communities in Wojiarbamba Kebele, South Gondar Zone, Alemnesh *et al.* (2011) 4.4% among patients who attended Tikur Anbessa University Hospital, Ethiopia, Yonas (2011) 4.22% among school children in Tikur Wuha Elementary School, Jiga, Fayo (2010) 18.8% among schoolchildren, the Case of Arsi Dodota, Oromia Regional State, Alamneh (2014) 39.7% among schoolchildren in Tilili town, Tadesse and Tsehaye (2010) 10.45% among schoolchildren in Tigray, Mathewos *et al.* (2014) 39.8% among children in two primary schools in North Gondar, Northwest Ethiopia, Shumbej *et al.* (2015) 14.9% among pre-schoolchildren in Butajira town, Southcentral Ethiopia and Degarege *et al.* (2015) 32.7% in human populations from Dore Bafeno, southern Ethiopia (Source).

### 2. 1. 2. 3. *Trichuris trichiura*

Adult female worms shed between 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. The eggs first hatch in the small intestine and release larvae that penetrate the columnar epithelium and situate themselves just above the lamina propria. After four moults, 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. 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. 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 faeces 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 (Elizabeth, 2013; WHO, 2009).

Infection with *Trichuris* occurs via the oral-faecal route by the ingestion of infective eggs from contaminated food, hand or water. These then pass through the stomach to the small intestine where they hatch. The larvae penetrate the cell of the small intestine coming to lie above the lumina to undergo four moults. The immature adults emerge and are passively transported to the large intestine where they mature and embed their thin whip-like anterior into columnar cell. The adult whipworms develop within 60-90 days after initial infection (Stephenson *et al.*, 2006).

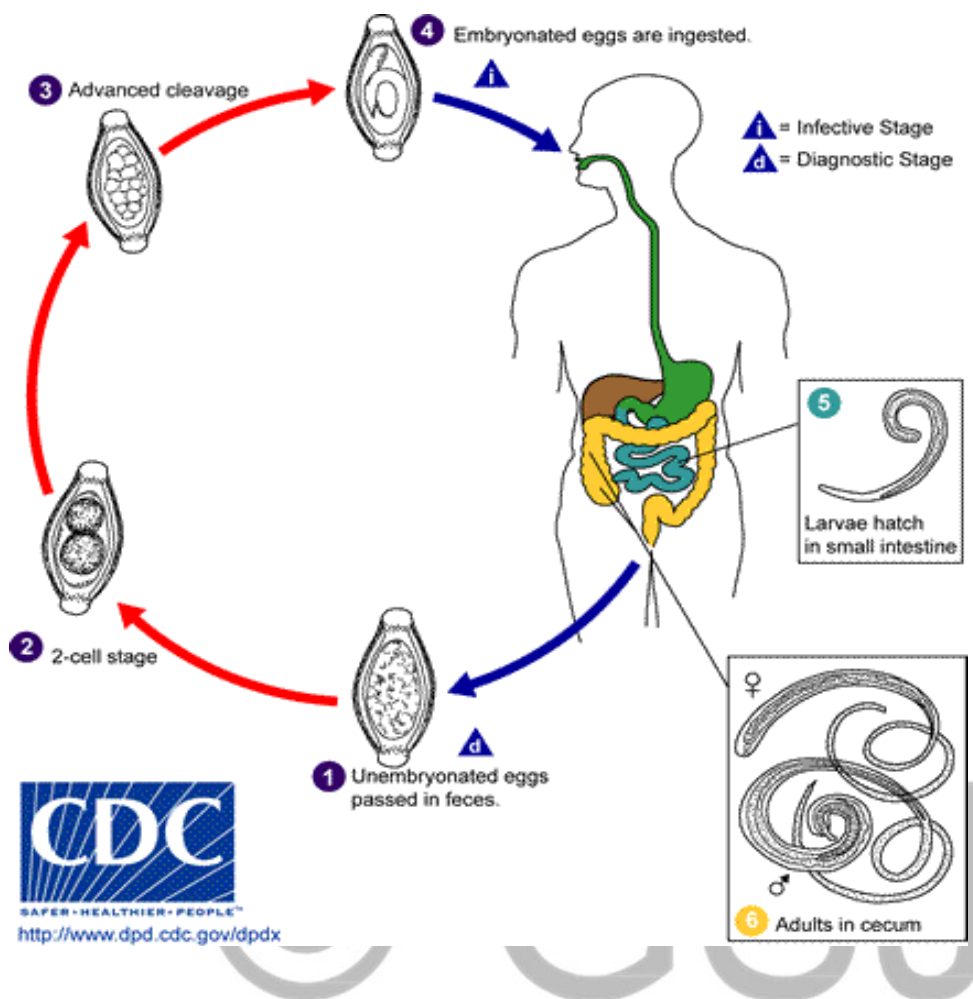


Figure 5. Life cycle of *Trichuris trichiura* (source:cdc, 2013)

The prevalence of *Trichuris trichiura* in the world varies. Knopp *et al.* (2008) were reported prevalence to be 47.9% and Usuanlele (2012) conducted a research among schoolage children from rural communities in Honduras and reported 16% prevalence of *Trichuris trichiura*. Ragnathan *et al.* (2010) were reported 10.8% prevalence of *Trichuris trichiura* infections in schoolchildren in Puducherry, South India. According to the research result reported by Emmy-Egbe *et al.* (2012) and Ezeagwuna *et al.* (2009) prevalence rates of 2.6% and 5.77% *Trichuris trichiura* were reported among students of Ihiala Local Government area of Anambra State and primary schoolpupils in Ozubulu, Anambra State, Nigeria, respectively. However, Salawu, and Ughele (2015) reported 19.5% prevalence in east local Government area, Osun State, Nigeria. Peru was another Latin American country that reported 30.2%

prevalence of *Trichuris trichiura* (Miguel *et al.*, 2014) and Usuanlele (2012) reported 67% in schoolage children from rural communities in Honduras. Hafeez *et al.* (2003) conducted research on incidence and intensity of soil transmitted helminths in a rural area of Lahore and reported 42.10% prevalence of *Trichuris trichiura*. Mokuia *et al.* (2014) reported 50.84% prevalence of *Trichuris trichiura* among pre-schoolage children in Elburgon Municipality, Kenya.

The epidemiology of *Trichuris trichiura* was reported by different researchers from different parts of Ethiopia. To mention, Zinaye *et al.* (2013) reported 4.60% among primary schoolchildren in Gorgora, Northwest Ethiopia, Abebe *et al.* (2011) 2.5% among schoolchildren in Zarima town, Ashenafi *et al.* (2011) 41.5% in Bushulo village communities, southern Ethiopia, Mathewos *et al.* (2014) 6.1% among children in two primary schools in North Gondar, Northwest Ethiopia, Shumbej *et al.* (2015) 6.4% among pre-schoolchildren in Butajira town, Southcentral Ethiopia, Leykun (2001) 14.8% in schoolchildren from Chilga District, Degarege *et al.* (2015) 12.7% in human populations from Dore Bafeno, southern Ethiopia and Alamneh and Endalkachew (2014) 7.8% among schoolchildren in Tilili town.

#### 2. 1. 2. 4. *Enterobius vermicularis* (pinworm)

Enterobiasis is by far the commonest helminthic infection in the US in that 18 million cases are encountered at any given time. The worldwide infection is about 210 million. It is an urban disease of children in crowded environment such as schools, day-care centers, etc. Adults may get it from their children. The incidence in whites is much higher than in blacks (WHO, 2009).

Humans are the only known host of *E. vermicularis*. Pinworm infection, which is usually self limiting, is initiated following the ingestion of the infective eggs. The eggs migrate through the digestive tract into the small intestine, where they hatch and release young larvae. The resulting larvae continue to grow and mature, ultimately transforming into adult worms. The adult worms reside in the colon. Following mating of select worms (copulation), including

roundworms, the resulting pregnant (gravid) female worm migrates outside the body to the perianal region, where she may deposit up to 15,000 eggs. Following 4 to 6 hours incubation, the developing eggs achieve infective status. These infective eggs may then become dislodged from the body, caused at least in part by intense scratching of the anal area by the infected person. Once apart from the host, the infective eggs may take up residence in a number of locations, including dust, sandboxes, linens, and clothing. In addition, the eggs may become airborne. The infective eggs may survive for a few days up to several weeks under suitable environmental conditions. The ideal surroundings for thriving infective eggs consist of a moderate temperature accompanied by high humidity. Ingestion of these infective eggs initiates a new cycle (WHO, 2009; Elizabeth, 2013).

A retroinfection, defined in pinworm-specific terms as infective pinworm eggs that migrate back into the host body, develop and reproduce rather than becoming dislodged. Infected individuals may reinfest themselves, known as an autoreinfection, if infective pinworm eggs are ingested via hand-to-mouth contamination (WHO, 2009; Elizabeth, 2013).

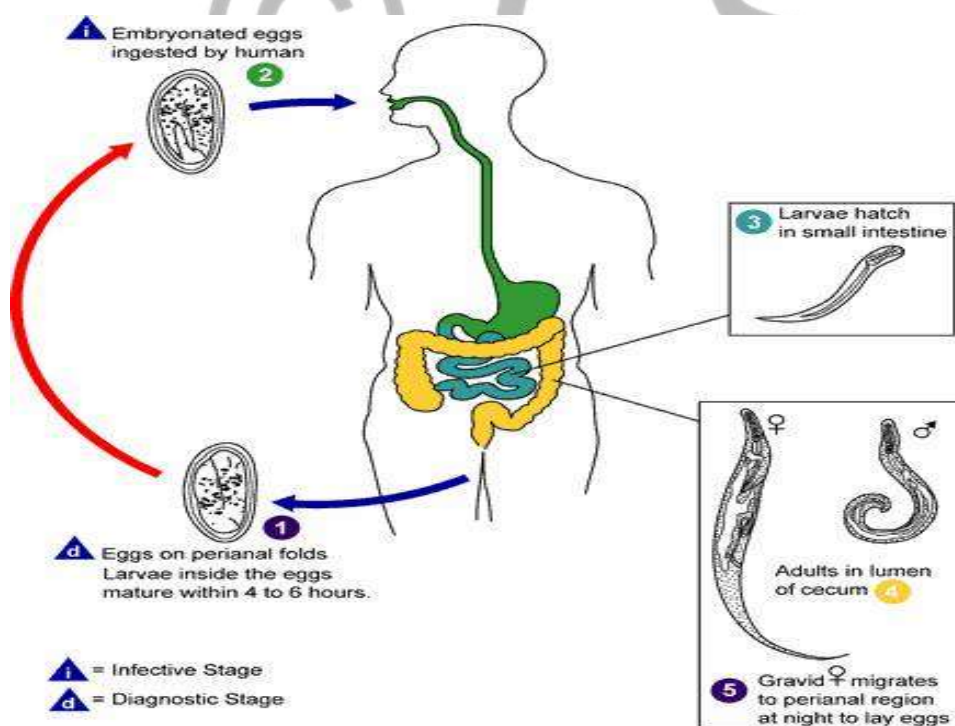


Figure 6. Life cycle of *Enterobius vermicularis* (Source: CDC, 2013)

The prevalence of *Enterobius vermicularis* recently reported from different parts of the world by different researchers would be: Hind (2012) who reported 44.6% to 50.32% among rural villages in Basrah marshes Regions, Sah *et al.* (2013) 0.3% among the schoolchildren of Dharan, Eastern Region of Nepal, Bushra *et al.* (2012) 15.3% in Bashiqa District, Nineveh Governorate, Iraq, Liza *et al.* (2014) 2% among community members of rural Abaye Deneba area, Abd *et al.* (2010) 16.6% among schoolage children in Al-Azhar and Assiut University Hospitals, El-Masry *et al.* (2007) 16.65% among rural schoolchildren in Sohag Governorate, Sundus and Zohair (2012) 92.05 % among patients consulting outpatient clinics in hospitals and health centers in Neinava Governorate and Raihan and Mahendra (2013) 0.40% among schoolchildren of Bhaktapur district, Nepal.

Alemnesh *et al.* (2011) reported a prevalence rate of 0.1% *Enterobius vermicularis* among patients who attended Tikur Anbessa University Hospital, Ethiopia, Gebeyehu (2011) 8.7% in Awramba and neighbouring communities in Wojiarbamba Kebele, South Gondar Zone, Yonas (2011) 0.5% among schoolchildren in Tikur-Wuha elementary school, Jiga, Northwestern Ethiopia, Fayo (2010) 14.1% among school children of Arsi Dodota, Oromia Regional State, Tadesse and Tsehaye (2010) 8.52% among schoolchildren in Tigray, Northern Ethiopia, Ashenafi *et al.*(2011) 1.4% helminthiasis in Bushulo village, southern Ethiopia, Tesfaye (2011) 31.5% schoolchildren in Ejaji primary school, Oromia Region, Western Ethiopia, Mengistu *et al.*(2010) 1.1% among students of Atse Fasil General Elementary School, Azezo, Gondar, Northwest Ethiopia, Bayeh *et al.*(2013) 0.4% among schoolchildren, Eleni *et al.* (2014) 1.3% among schoolchildren in selected primary schools, Wukro town, Eastern Tigray.

#### 2. 1. 2. 5. *Strongyloides stercoralis*

*Strongyloides* is known to exist on all continents except for Antarctica, but it is most common in the tropics, subtropics, and in warm temperate regions. The global prevalence of *Strongyloides* is unknown, but experts estimate that there are between 30–100 million infected persons worldwide. Strongyloidiasis is an intestinal infection caused by two species of the



parasitic nematode *Strongyloides*. The most common and clinically important pathogenic species in humans is *Strongyloides stercoralis* (CDC, 2014).

The *Strongyloides* life cycle is more complex than that of most nematodes with its alternation between free-living and parasitic cycles, and its potential for autoinfection and multiplication within the host. Two types of cycles exist: **Free-living cycle**: The rhabditiform larvae passed in the stool (see "parasitic cycle" below) can either become infective filariform larvae (direct development) or free living adult males and females that mate and produce eggs from which rhabditiform larvae hatch and eventually become infective filariform larvae. The filariform larvae penetrate the human host skin to initiate the parasitic cycle (see below). **Parasitic cycle**: Filariform larvae in contaminated soil penetrate the human skin, and by various, often random routes, migrate into the small intestine. Historically it was believed that the L<sub>3</sub> larvae migrate via the bloodstream to the lungs, where they are eventually coughed up and swallowed. However, there is also evidence that L<sub>3</sub> larvae can migrate directly to the intestine via connective tissues. In the small intestine they moult twice and become adult female worms. The females live threaded in the epithelium of the small intestine and by parthenogenesis produce eggs, which yield rhabditiform larvae. The rhabditiform larvae can either be passed in the stool (see "free-living cycle" above), or can cause autoinfection. In autoinfection, the rhabditiform larvae become infective filariform larvae, which can penetrate either the intestinal mucosa (internal autoinfection) or the skin of the perianal area (external autoinfection); in either case, the filariform larvae may disseminate throughout the body. The occurrence of autoinfection in humans with helminthic infections is recognized only in *Strongyloides stercoralis* and *Capillaria philippinensis* infections. In the case of *Strongyloides*, autoinfection may explain the possibility of persistent infections for many years in persons who have not been in an endemic area and of hyperinfections in immunosuppressed individuals.

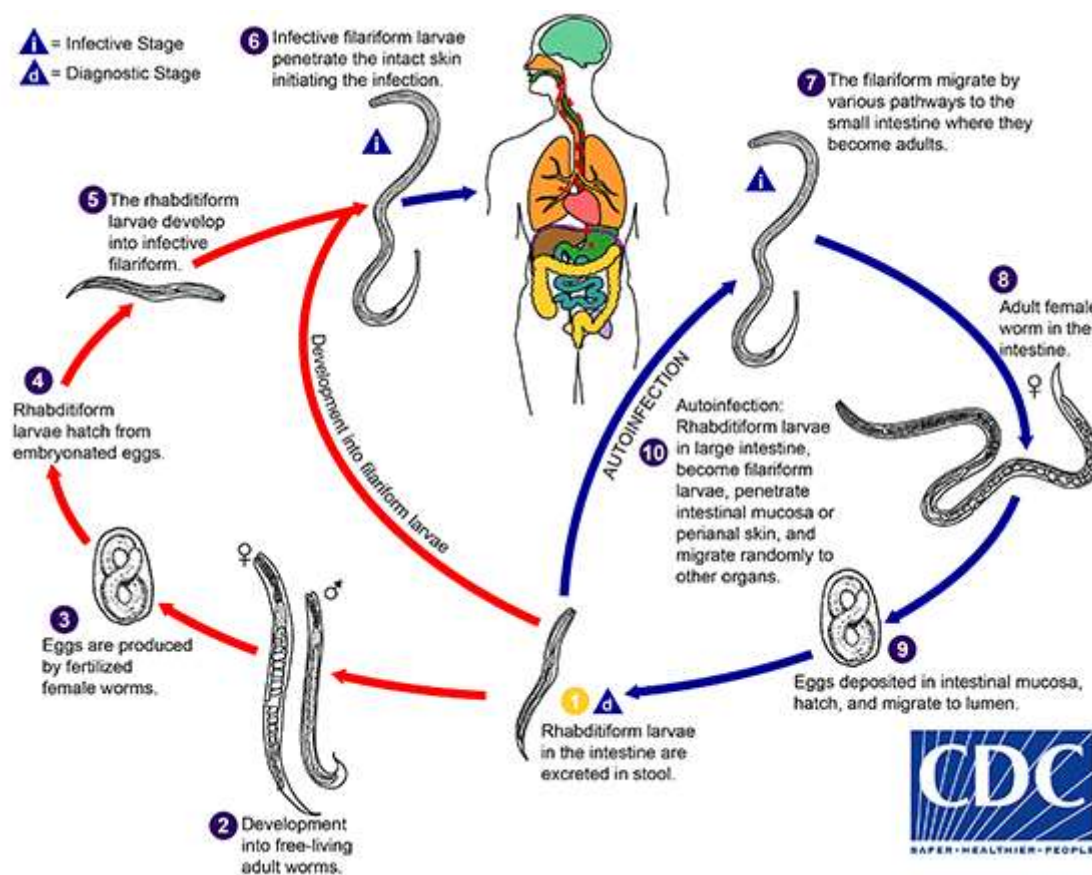


Figure 7. Life cycle of *Strongyloides stercoralis* (Source: CDC, 2014)

The prevalence of *Strongyloides stercoralis* was reported from different parts of the world by comfort and Omolade (2008) to be 18.0% in a rural community, Lagos Suburb, Southwest Nigeria, Lorina (2013) 11% among schoolchildren in rural and semi-urban communities in Nigeria, Okolo (2009) 4.8% among Unity Primary schoolpupils, in Oraifite, Ekwusigo L.G.A., Anambra State, Southeastern Nigeria, Babatunde *et al.* (2013) 7.1% among schoolchildren in rural communities of Moro Local Government Area, Kwara State, Nigeria, Gimba and Dawam (2015) 19.0% in children attending Gwagwalada Township Clinic, FCT-Abuja, Nigeria, Maria and Julia (2013) 5% in Brazil, Virak *et al.* (2014) 2.1% in Takeo Province, Cambodia, Muniswamappa *et al.* (2012) 63% in Karimnagar, Fabian *et al.* (2013) 43.5% global distribution, Raihan and Mahendra (2013) 1.82% among schoolchildren of Bhaktapur district, Nepal, Kwabena *et al.* (2015) 2% at a Ghanaian Orphanage, Alejandro *et al.* (2010) 29.4% in a community-wide study in Northern Argentina and Ngui *et al.* (2016) 2.1% in inhabitants of indigenous communities in Borneo Island, Malaysia. At the same time,

the prevalence of *Strongyloides stercoralis* was reported by Mengistu and Berhanu (2004) to be 5.8% among schoolchildren in a rural area close to the southeast of Lake Langano, Ethiopia, Mulat *et al.* (2013) 1.5% among schoolchildren in Dagi Primary School, Amhara National Regional State, Ethiopia and Aranzazu *et al.* (2016) 54.5% in schoolage children in a rural highland of northwestern Ethiopia.

### 2. 1. 2. 6. *Hymenolepis nana*

*Hymenolepis nana* infection or infection with the dwarf tapeworm is found worldwide. It is most often seen in children in countries in which sanitation and hygiene are inadequate. Although the dwarf tapeworm infection rarely causes symptoms, it can be misdiagnosed for pinworm infection. Hymenolepiasis is the most common intestinal tapeworm infection of humans caused by worm of family cestoda, genus *hymenolepis* and species *nana*. This infection does not require an intermediate host and infection can occur directly from one infected person to another by fecal-oral transmission (Mehraj *et al.*, 2008).

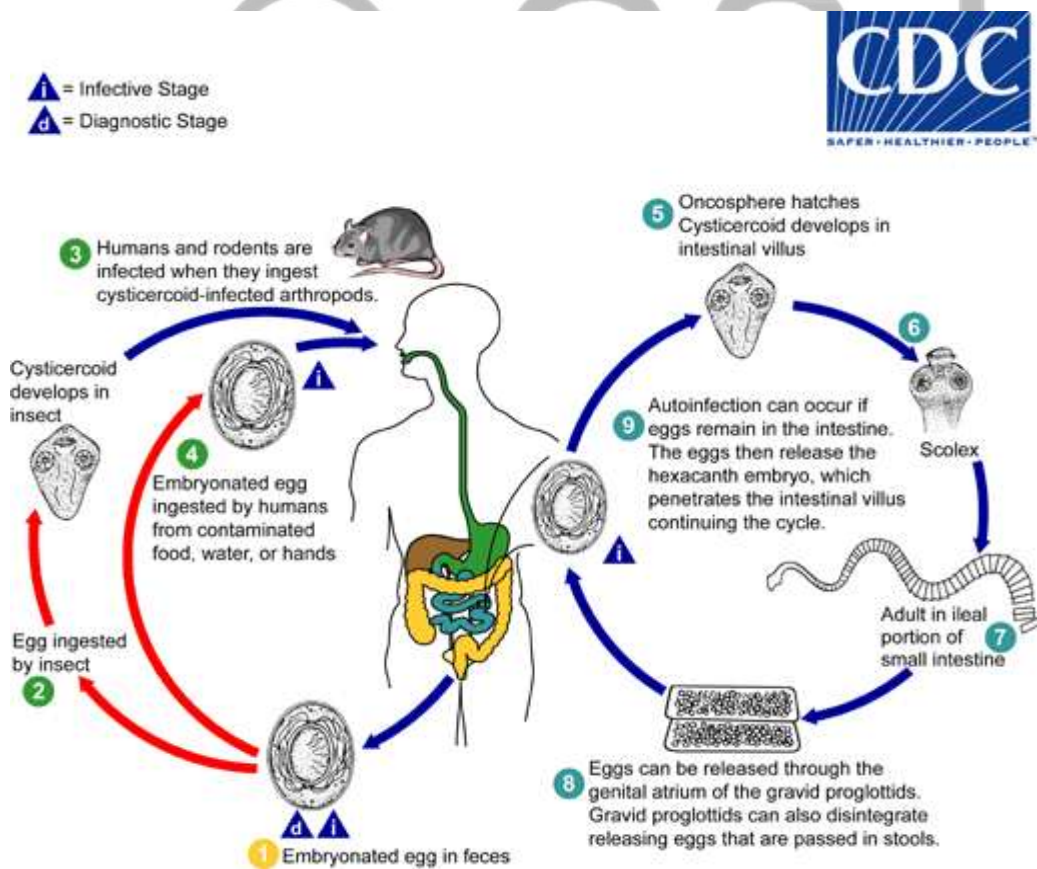


Figure 8. Life cycle of *Hymenolepis nana* (Source: CDC, 2012)

*H. nana* infection has cosmopolitan distribution and most commonly infects humans living under conditions of poor hygiene and poverty. It is prevalent in schoolage children, particularly most common in children aged 4-10 years, in tropical and subtropical climates of the developing world (Willms and Sotelo, 2001; Robert and Tolan, 2009). Humans become infected with *H. nana* by ingestion of water and food contaminated with mouse faeces, and can also transmitted from one child to another by passing infective eggs on dirty hands (Willms and Sotelo, 2001). *H. nana* affects millions of people, worldwide. The majority of infections are asymptomatic in various regions and estimated to range from 0.1-58% (Robert and Tolan, 2009). It is estimated and is probably associated with a low number of parasites. Symptoms are vague and may be associated with abdominal distress in light infections, but this can be accompanied by abdominal pain, nausea, vomiting, weight loss and diarrhea (Willms and Sotelo, 2001). Human infection with *H. diminuta* results from accidental ingestion of insects (immature fleas, flour beetles, meal worms, cockroaches) that carry the parasite in their body cavities (Robert and Tolan, 2009).

The prevalence rates of *H.nana* reported from different parts of the world by different scholars are: Nwoke *et al.* (2015) reported 2.0% (6) in Ebonyi northcentral area of Ebonyi State, southeast of Nigeria, and Khan *et al.* (2004) reported 127.59 % in Bagh (Azad Kashmir). On the other hand , Macchioni *et al.* (2015) reported 5.6% prevalence of *H.nana* in children living in the Chaco Region, Bolivia, Matthy *et al.* (2011) reported 25.8% prevalence of the parasite among children from primary schools in western Tajikistan and Sunil *et al.* (2011) reported 2.44% in a rural population of Puducherry and Mohammed *et al.* (1999) 1 1.3% among primary schoolchildren in Al-Taameem Province, Iraq.

The prevalence of *H. nana* was reported by different researchers like Bayeh *et al.* (2013) 7.4 % among schoolchildren in Ethiopia, Eleni *et al.*(2014) 1% in school children in selected primary schools, Wukro town and Aschalew *et al.*(2013) 13.8% among schoolchildren at the University of Gondar Community School, Northwest Ethiopia.

## 2. 2. Global Distribution of Intestinal Soil Transmitted Helminths

According to WHO (2015), more than 1.5 billion people, or 24% of the world's population, are infected with soil-transmitted helminth infections worldwide. Infections are widely distributed in tropical and subtropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas, China and East Asia. Over 270 million pre-schoolage children and over 600 million schoolage children live in areas where these parasites are intensively transmitted, and are in need of treatment and preventive interventions.

The prevalence of soil-transmitted helminth infection (STHI) in south East Asia varies from 52.8% Urban Slum of Karachi (Mehraj *et al.*, 2008) to 75.51% rural villages in Basrah marshes regions (Hind, 2012). In between these prevalence there are different reports from different countries such as 44.7% in a rural area of Lahore (Hafeez *et al.*, 2003), 39% southern India (Saravanakumar *et al.*, 2014), 42.8% in Aurangabad District (M.S), India (Wahule *et al.*, 2013), 26.16% from Philippines (Karyl and Jean Edwin, 2013) and 68.1% in Damghan – Iran (Heidari and Rokni, 2003).

Africa is another continent highly affected by soil transmitted intestinal helminths. The report varies from country to country, from region to region, from continent to continent. For instance it is 83.3% in rural community Lagos Suburb, South West Nigeria (Ibidapo and Omolade, 2008), 67.3% in Bushulo village, southern Ethiopia (Ashenafi *et al.*, 2011), 53.5% in Arsi Dodota, Oromia Regional State, Ethiopia (Fayo, 2010), 44.79% in Yenagoa Metropolis, Niger Delta (Perekibina *et al.*, 2014), 86% Elburgon Municipality, Kenya (Mokua *et al.*, 2014) and 33.76% around Mount Cameroon (Ntonifor *et al.*, 2015). The prevalence of STH also reported from Peru to be 47% (Miguel *et al.*, 2014), 52.8% in East Kwaio, Solomon Islands (Harrington *et al.*, 2015) and 30.9% in Yemen (Alyousefi *et al.*, 2011).

## 2. 3. Factors that Affect the Epidemiology of Human Intestinal Parasitic Infections

### 2. 3. 1. Intestinal protozoan infections

Intestinal protozoan infection risk is reported to be elevated in infants and children compared to other age groups. In addition, they are reported to disproportionately suffer from the nutritional, health and developmental consequence of intestinal parasitic protozoan infection. Morbidity and mortality caused by intestinal parasitic protozoan infection is usually more pronounced all over the world. This is related with poverty and poor environmental hygiene, lack of safe water supply, contamination of the environment by human excreta and animal wastes, poor environmental sanitation, poor personal hygiene and poor living condition (Stoltzfus *et al.*, 1996).

### 2. 3. 2. Intestinal Parasitic Helminth Infections

Specific occupations, household clustering, and behaviors influence the prevalence and intensity of intestinal parasitic infections particularly hookworms, in which the highest intensities occur among adults. Engagement in agricultural pursuits, for example, remains a common denominator for hookworm infection (Brooker *et al.*, 1999; Hotez, 2000).

STH infections depend for transmission on environments contaminated with egg-carrying faeces. Consequently, helminths are intimately associated with poverty, poor sanitation, and lack of clean water. The provision of safe water and improved sanitation are essential for the control of helminth infections. Although the STH infections are neglected diseases that occur predominantly in rural areas, the social and environmental conditions in many unplanned slums and squatter settlements of developing countries are ideal for the persistence of *A. lumbricoides* (Crompton, 1998).

Adequate warmth and moisture are key features for each of the STHI. Wetter areas exhibit increased transmission, and in some endemic areas, STH infections exhibit marked seasonality. Recent use of geographical information systems and remote sensing has

identified the distributional limits of STHI on the basis of temperature and rainfall patterns (Brooker *et al.*, 2000).

Mortality figures provides only a small window on their health impact of STH infections because it is uncommon for them to kill their human host. Instead, measurements of disease burden using disability-adjusted life years (DALYs) and similar tools portray a more accurate picture for helminth disease burden. WHO (year) estimates the global burden of disease from STH infections on the basis of the enormous number of infected individuals, together with an associated low disability weight (Goek, 2003). However, because an estimated 2 billion people are infected with STH infections, even minor adjustments to the disability weights produce enormous variations in DALYs or other measurements of disease burden.

Helminth infections caused by STH infections are among the most prevalent afflictions of humans who live in areas of poverty in the developing world. The morbidity caused by STH infections is most commonly associated with infections of heavy intensity. Approximately 300 million people with heavy helminth infections suffer from severe morbidity that results in more than 150,000 deaths annually (Crompton, 2000). In addition to their health effects, helminth infections also impair physical and mental growth in childhood, thwart educational advancement, and hinder economic development.

Nutritional status is a key indicator of health assessment (WHO, 1994). Malnutrition results in poor physical development, impaired resistance to infections. An estimated global infection rate for some parasites have primarily been attributed to the appalling unhygienic and environmental condition, poverty and wide spread of parasites within the human communities (Goek, 2003).

#### **2. 4. Diagnosis of Intestinal Parasite Infections**

**Microscopic Examination:** According to Elizabeth (2013) and WHO (1991) to detect the presence of parasites in a stool specimen, microscopic examinations are performed. The microscopic examination of stool for ova and parasites involves three distinct procedures,



direct wet preparations, a concentrated technique resulting in concentrated wet preparations, and a permanently stained smear. All three of these procedures should be performed on a fresh specimen. If the specimen is received in fixative, the direct wet preparation can be eliminated from the ova and parasites procedure; the concentrate and permanent stain techniques are performed.

***Direct Wet Preparation:*** The primary purpose of a direct wet preparation (also known as a direct wet mount), defined as a slide made by mixing a small portion of unfixed stool (stool with no added preservatives) with saline or iodine and subsequent examination of the resultant mixture under the microscope, is to detect the presence of motile protozoan trophozoites. Trophozoite motility can only be demonstrated in fresh specimens, especially those of a liquid or soft consistency. If the specimen is received in the laboratory in a fixative, this procedure can be eliminated from the ova and parasites (O&P) assay. Other parasite stages that might be observed in a direct wet preparation include protozoan cysts, oocysts, helminth eggs, and larvae. Because the diagnostic yield of this procedure is low, most experts agree that technical time is better spent on the concentration procedure and permanent stained smear and recommend only performing the direct wet preparation on fresh specimens. Mixing a small portion of unfixed stool (stool with no added preservatives) with saline or iodine and subsequent examination of the resultant mixture under the microscope, is to detect the presence of motile protozoan trophozoites. Trophozoite motility can only be demonstrated in fresh specimens, especially those of a liquid or soft consistency. If the specimen is received in the laboratory in a fixative, this procedure can be eliminated from the ova and parasites assay. Other parasite stages that might be observed in a direct wet preparation include protozoan cysts, oocysts, helminth eggs, and larvae. Because the diagnostic yield of this procedure is low, most experts agree that technical time is better spent on the concentration procedure and permanent stained smear and recommend only performing the direct wet preparation on fresh specimens (Elizabeth, 2013 and WHO, 1991).

***Formalin-Ether Concentration technique for stool Examination:*** This concentration procedure is efficient in recovering protozoan cyst, helminth egg and larva including operculated and schistosome eggs. The formalinized specimen was thoroughly



stirred and a sufficient quantity was strained through gauze in to a 15ml. pointed centrifuge tube to get the desired amount of sediment. Then saline was mixed and thoroughly mixed and centrifuged at 2000-2500 rpm for 1 minute. The supernatant was decanted and washed again with tape water if desired. 10ml. of 10 percent formalin was added to the sediment and mixed thoroughly. Then 3ml. of ether was added and shaken vigorously in an inverted position for a full 30 seconds, and then the stopper was removed carefully. The resulting solution was centrifuged at 1500 rpm for about 1 minute, and four layers were produced. The three top layers were decanted carefully, and adhering debris were removed from the top with a cotton swab. The remaining sediment was mixed with the small amount of fluid that drains back from the slides of the tube or a small drop of formalin or saline was added. Finally iodine and unstained mounts were prepared for microscopic examination (Peters *et al.*, 1980).

***Kato- Katz technique:*** The Kato - Katz technique facilitates the detection and quantification of helminth eggs that infected subjects pass in their faeces. A thick smear is prepared on a microscopic slide and helminth eggs are enumerated under a light microscope and recorded for each helminth species separately. Subsequently, the prevalence and intensity of helminth infections can be determined (WHO, 1991).

People infected with STH or intestinal schistosomes pass the eggs of the worms through their faeces. In the Kato-Katz technique faeces are pressed through a mesh screen to remove large particles. A portion of sieved sample is then transferred to the hole of a template on a slide. After filling the hole, the template is removed and the remaining sample is covered with a peice of cellophane soaked in glycerol. The glycerol clears the faecal material from around the eggs. The eggs are then counted and the number calculated per gram of faeces (Source). The bench protocol is described in the annex no:

***Modified Ziehl Neelsen staining technique:*** A thin smear of sediment from the concentration technique was prepared, air-dried and fixed in methanol for 2-3 minutes. The slides were stained with cold carbol fuch sine for 30 minutes. The slides were washed with tap water and decolorized with 1% hydrochloric acid-ethanol solution (acid - alcohol) for 2 minutes. The slides were rinsed in distilled water and then counterstained with 1 % methylene-blue for 2

minutes. These were then rinsed in tap water, air-dried, and examined microscopically under a 100x objective oil-immersion lens for *Cryptosporidium* oocyst(Elizabeth, 2013).

**From Kassa:** To Dear Gebre-Hana, Just describe the principles of laboratory procedures in the literature review section. The bench protocols (laboratory procedures) can be annexed the section of annexes / appendices.

- Try to go through the whole of your document to correct minor errors such as ‘ ’ or, and, abbreviations, page number (both roman numerals and Hindu Arabic numbers), similarities of references in the text and reference lists, etc,
- Try to see the whole document for the correct and sequential flow of ideas and coherence of one topic with the other.
- Correct the Reference setion by yourself. To do this I will attach you a guiding document of bibliography.
- Finally I respect, appreciate, and promise to be at your side so that you will realize your internal motives of research. You do have, in my perspectives, a naturally given reading, comprehending, reviewing, writing and demonstrating skills and attitudes. If you are given a window of opportunity then I am definately sure that you are above any caliber and do not have any parallel.

### 3. MATERIALS AND METHODS

#### 3. 1. Description of the Study Area

The current study was conducted at Deneba full primary school of Deneba town. The town is located at an altitude of 1630 meters above sea level (masl). It is situated in North Shoa Administrative Zone in Amhara National Regional State. Deneba is located at 47 km in Northwest direction of Debre Birhan town which is the capital of the Zone. Deneba fars from Addis Ababa by 177 km.

According to Ensarona Wayu district agricultural office report, the mean annual temperature was 17.5<sup>0</sup>C. The area receives maximum average annual rain fall of approximately 1600mm from July-August and minimum average rainfall of approximately 1500mm in June and September. The rainfall is bimodal in distribution which is characterized by a long rainy season extending from July to September, a short rainy season that extends from February to March. There is an extended dry season from October to February.

According to the Central Statistical Agency (2013), Deneba has an estimated total population of 6549, of whom 3505 were males and 3094 were females. Majority of the inhabitants were Government employee and traders. The rest are involved in different careers.

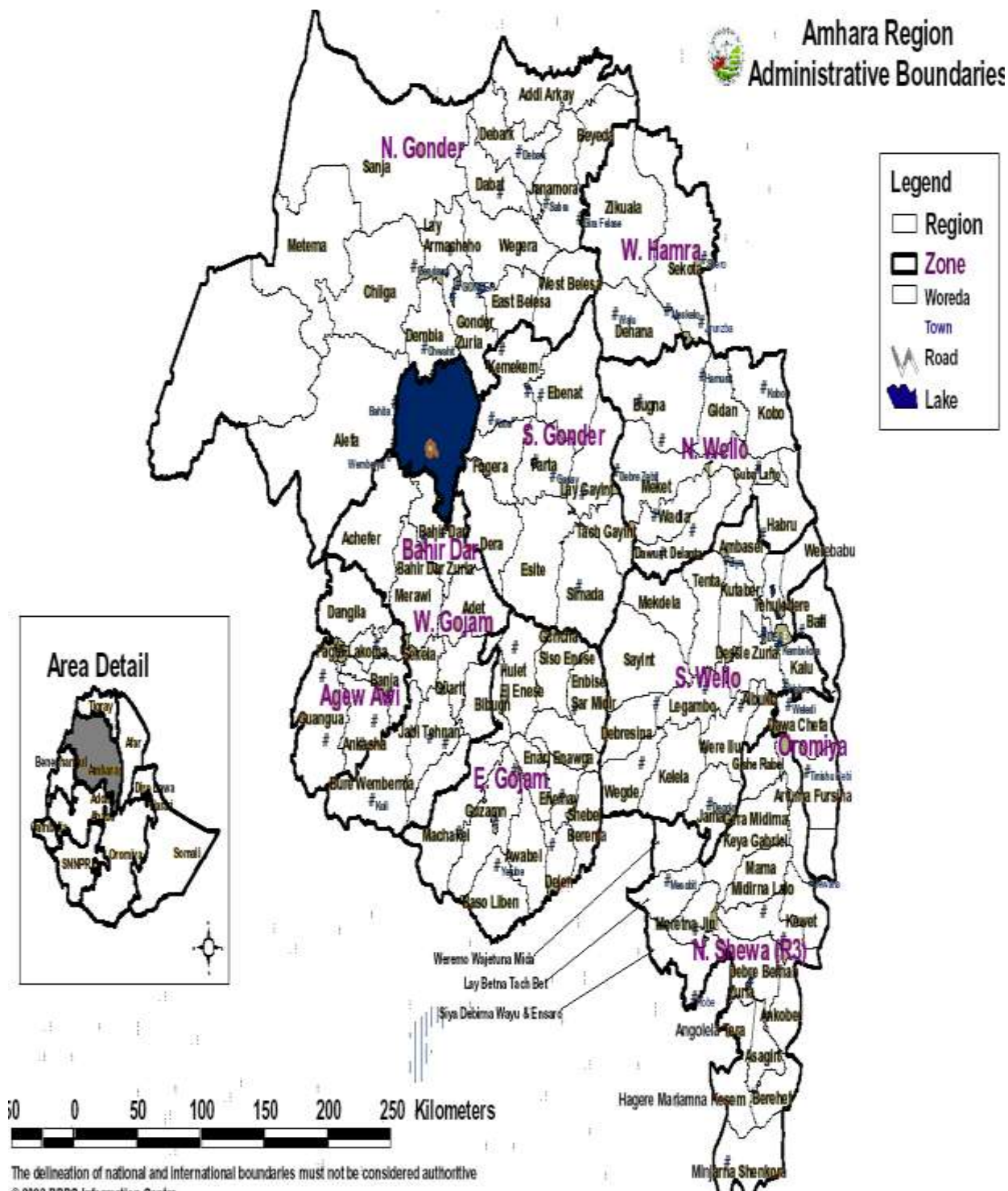


Figure 9. Map of Amhara Region



Figure 10. DENEBA

### 3. 2. Study Design

The study design was involved cross-sectional parasitological survey of intestinal parasitic infections in primary schoolchildren of Deneba Town, Central Ethiopia. The prevalence and the associated risk factors were determined. The study was conducted from December to January/ 2015 at selected primary schools of Deneba town.

### 3. 3. Study Population and Sampling Techniques

#### 3. 3. 1. Study population

The total population of grade 1-8 students enrolled during 2015/2016 academic year in Deneba primary school is 983. Of these, 506 and 477 are female and males, respectively.

#### 3. 3. 2. Sample size and sampling technique

First the students were categorized into two strata based on their sex. Then, the sample children will be selected using systematic random sampling technique by using class rosters as the sample frame. Samples were then drawn proportionally from each grade and each class room. Since the prevalence rate (p) was unknown in the study areas, maximum prevalence (P = 50%) was assumed, with a marginal error of 5% and 95% confidence interval. For non-response rates, 5% of the sample size was included. The minimum number of the sample size (n) was determined using the statistical formula of sample size calculation (Danile, 1995):

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

Where: n = the number of students to be sampled, Z = 1.96 at 95% confidence interval and d= margin of error assumed to be (0.05 or 5%) and P - Prevalence rate of intestinal helminthes

$$n = \frac{1.96^2 0.5(1-0.5)}{0.05^2}$$
$$n = 384$$

In total **384** students of various age groups and sections will be sampled and included in the current survey.

### **3. 4. Stool Sample Collection**

Disposable plastic cups and spoons were distributed to each study subject along with brief instructions on how to collect the stool. They were also advised to fill up the disposable plastic cup by approximately 2g of fresh stool using disposable spoon that was given with the container. The unique code of the student was labeled on the container.

### **3. 5. Parasitological Examination Procedures**

Stool samples were diagnosed for the presence of intestinal parasites using direct wet-mount. The processed stool samples were checked for the presence of intestinal parasitic ova or cysts under light microscopy using objectives 10X and 40X. 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 (Cheesbrough, 1990, Elizabeth, 2013).

#### **3. 5. 1. Direct wet mount technique**

Direct smears were prepared with normal saline for microscopic observation (Garcia, 1999; WHO, 1991, Elizabeth, 2013). About 2g of stool samples were emulsified with 3-4 ml normal saline, and a drop of emulsified sample was placed on a clean microscopic glass slide, then a few drops of iodine solution was added and covered with a cover slip. The smear was first examined under 10X objective lens, then 40X for detailed identification of the species of parasites species.

#### **3. 5. 2. Formalin ether concentration**

About 7 ml of 10 % formalin was added to approximately 1 g of faeces and mixed using an applicator stick. The stool sample was sieved with cotton gauze and transferred to 15 ml centrifuge tube Falcon®. After adding 3 ml of diethyl ether to the mixture and hand shaking, the content was centrifuged at 2000 rpm for 3 min. The supernatant was poured and a drop of sediment was transferred to slide. Finally, the entire zone under the cover slip was

systematically examined using 10X and 40X objective lenses to observe ova, cyst and larvae of different intestinal parasites according to the protocol of Ritchie (Ritchie, 1948; Lindo *et al*, 1998, Elizabeth, 2013 ).

### **3. 6. Questionnaire Survey**

The questionnaire survey was planned to collect data on the risk factors. Data related to socio-demographic characteristics of the study subjects such as educational background, personal and environmental hygiene, source of water, and access to latrine in the close vicinity of their home was gathered using structured questionnaire which was prepared for the currnt study and pre- tested by non-study subjects outside the study area for clarity and incorpration of the relevant points. Then, the questionnaire format was adjusted for final use in the field. During the time of conversation there is observing of finger nail status and wearing habit of shoes. The data were collected with trained and experienced data collectors. The data were filled in questionnaire format. Moreover, observations and interview were employed to collect the best-fit data. There was daily checking of filled questionnaires for completeness and clarity at the end of each day by the principal investigator.

### **3. 7. Inclusion and Exclusion Criteria**

#### **3. 7. 1. Inclusion criteria**

The study included all schoolchildren who were willing to provide stool sample for the parasitological examination. Those who were willing to provide informed consent and had no treatment for the previous one month were included in the study.

#### **3. 7. 2. Exclusion Criteria**

According to the information obtained from the children themselves, those who sick and were treated for any intestinal parasitic infections for the last three months at the time of survey was excluded from this study.



### **3. 8. Data Analysis**

The data were computerized using Excel 2007, cleaned and checked against original document before analysis. All statistical analyses were performed using SPSS 16 statistical package software. The prevalence of intestinal parasites was determined by Pearson chi-square ( $\chi^2$ ) test verifying the relationship between independent factors and the outcome variable. Binary logistic regression analysis (Odds ratios, OR) was used to determine association of independent variables with the intestinal parasitic infections. The 95% CI was used to show the accuracy of data analysis. Probabilities less than 5% ( $P < 0.05$ ) was considered statistically significant.

### **3. 9. Data Quality Control (QC)**

To ensure quality control, all the laboratory procedures including collection and handling of specimens was carried out in accordance with standard protocols (WHO, 1991; NCCLS, 1997). All the reagents were checked for contamination each time they were used. To ensure general safety, the damaged gloves were disposed and universal bio-safety precautions (NCCLS, 2002) were also followed at all times.

### **3. 10. Ethical Considerations**

This study was approved by the research and ethics committee of Addis Ababa University. At the beginning of the study, the objectives and the purpose of the study was explained to the school principal, other concerned authorities and students. Informed consent was obtained from parents or legal guardians before sample collections. In this research, specimen collection was done using sterile and disposable materials. The stool samples and all the laboratory examinations were done by the principal investigator assisted by laboratory technicians. Individuals diagnosed positive for intestinal parasitic helminth infections were treated free of charge with appropriate anti-parasitic drugs by the right health personnel.

## 4. RESULTS AND DISCUSSION

### 4.1 Demographic Characteristics of the Study Subjects

The study populations were 983 students enrolled during 2015/2016 academic year in Deneba Primary and Junior Secondary School. Of these, 506 and 477 are female and males, respectively. A sample population of 186 ( $186/384 = 48.4\%$ ) males and 198 ( $198/384 = 51.6\%$ ) females) were selected randomly for parasitological investigations (Table 1). The sample study subjects were divided into four age groups: 7-9 years ( $117/384 = 30.5\%$ ), 10-12 years ( $102/384 = 26.6\%$ ), 13-15 years ( $139/384 = 36.2\%$ ) and 16 and above ( $26/384 = 6.8\%$ ). Moreover, ( $193/384 = 50.3\%$ ) from grade 1-4 and ( $191/384 = 49.7\%$ ) from grade 5-8 children were selected for this study (Table 1).

Table 1. Sociodemographic characteristics among Deneba Primary and Junior Secondary Schoolchildren, Central Ethiopia in 2015|16

Variables	Total (n =384, %)	
Sex	Male	186 (48.4)
	Female	198 (51.6)
Age	7-9	117 (30.5)
	10 -12	102 (26.6)
	13 -15	139(36.2)
	16 and above	26(6.8)
Grade interval	1 - 4	193(50.3)
	5 - 8	191(49.7)

#### 4. 2. Prevalence of intestinal parasitic infections

Table 2. Overall prevalence of intestinal parasitic infections in relation to different sociodemographic variables, type of infection and stool consistency in Deneba town during 2015/2016

Variables		No. examined (%)	Positive (%)	Negative (%)	$\chi^2$	P - Value
Sex	Male	186 (48.4)	90 (48.4%)	96 (51.6%)	0.607	0.264
	Female	198 (51.6)	101 (51.0%)	97(49.0%)		
	Total	384 (100%)	191 (49.7%)	193 (50.3%)		
Age	7 - 9	117 (30.5)	64 (54.7%)	53 (45.3%)	3.296	0.348
	10 - 12	102 (26.6)	52 (51%)	50 (49%)		
	13 -15	139 (36.2)	61 (43.9%)	78 (56.1%)		
	16 and above	26 (6,8)	14 (53.8%)	12 (46.2%)		
Residence	Urban	140 (36.5%)	74 (52.9%)	66 (47.1%)	0.857	0.355
	Rural	244 (63.5%)	117 (48.0%)	127 (52.0%)		
Grade interval (education level of students)	1	45 (11.7%)	17 (37.8%)	28 (62.2%)	20.519	0.005
	2	50 (13.0%)	38 (76%)	12 (24%)		
	3	57 (14.8%)	26 (45.6%)	31 (54.4%)		
	4	41 (10.7%)	22 (53.7%)	19 (43.3%)		
	5	46 (12.0%)	25 (54.3%)	21 (45.7%)		
	6	41 (10.7%)	16 (39.0%)	25 (61.0%)		
	7	41 (10.7%)	17 (41.5%)	24 (58.5%)		
	8	63 (16.4%)	30 (47.6%)	33 (52.4%)		
	total	384 (100%)	191 (49.7%)	193 (50.3%)		
Type of infection	protozoan infection	143 (37.2%)	140 (97.9%)	3 (2.1%)	3.647	0.000
	STD infection	33 (8.6%)	31 (93.9%)	2 (6.1%)		
	Double infection	20 (5.2%)	20 (100%)	-		

The prevalence of intestinal parasitic infections among schoolage children was reported in different parts of the world including Ethiopia. As shown in table 2, 48.4% (186/384) of males and 51% (101/198) females were infected with one or more intestinal parasites. The

association between sex with intestinal parasitic infection was statistically insignificant ( $\chi^2 = 0.607$ ;  $p$ -value  $>0.05$ ) which means that both males and females were equally likely affected.

The current study result revealed that prevalence of intestinal parasites insignificantly associated with sex of schoolage children ( $p>0.05$ ) (table 2). This result was in disagreement with the research reported by Iizabella *et al.*(2011) who reported intestinal parasites were more prevalent in males than females with statistically significant value ( $p<0.05\%$ ). Williams *et al.*(2014) were also reported that intestinal parasites prevalence was significantly higher in males than females with rates of 51.0% among primary school children in Urban and peri-urban communities in Kumasi, Ghana and Aschalew *et al.*(2013) were reported the prevalence rate was 43 (32.1%) for male and 61 (35.9%) for female among among schoolchildren at the University of Gondar Community School, Northwest Ethiopia: a cross-sectional study . While agree Odo *et al.* (2016) who reported the prevalence of intestinal parasites in relation to sex showed no significant difference ( $p<0.05$ ) as they have equal exposure among school children in uzo-uwani local governeemnt area of Enugu state.

The highest prevalence rate of intestinal parasitic infections was observed in an age category of 7-9 (64/117 = 54.7%), followed by age category  $\geq 16$  (14/26 = 53.8%), next 10-12 (52/102 = 51.5%) and the lowest was in age category of 13-15 (61/139 = 43.9%). The association between age categories with prevalence of intestinal parasites was statistically insignificant ( $P > 0.05$ ).

The result of the current study was in agreement with Bishnu *et al.* (2013) that was reported the insignificant association between age intervals of school age children among School Children of Dadeldhura District, Nepal. While disagree with Abdullah *et al.* (2016) who was indicated the significant association of age group intervals with intestinal parasites infection, the highest prevalence of intestinal parasites in the age group of 5 to 8 years (13.7%) and least in the age group of 13-15 years (3.88%) among Children in District Anantnag of Kashmir Valley, India and Okolo (2009) who was stated the significant association between intestinal parasites infections and age interval with the prevalence of pupils in the age-group 10-14 years had the highest prevalence value (61.4%) while those in age-group 5-9 years had

the lowest prevalence value (24.1%). In addition, Umeh *et al.* (2015) were indicated as age group between 3 – 5 years had the highest prevalence (66.2%) while age group between 12 – 14 years had the lowest prevalence (20.7%) and the infection reduced as age increased but there were a significant difference between prevalence of infection and age ( $P < 0.05$ ).

The prevalence of intestinal parasitic infections were studied in relation to urban and rural dwellers of schoolage children. In the finding, the prevalence of intestinal parasitic infections was more prevalence in urban ( $74/140 = 52.9\%$ ) dwelling schoolage children than the prevalence in rural residing schoolage children (48.0%). It is apparent that urban dweller schoolage children were more infected with intestinal parasites than rural dwellers ( $117/244 = 48.0\%$ ). The association between residence of schoolage children with the prevalence of intestinal parasites was statistically insignificant ( $\chi^2=0.857$ ,  $p=0.355$ ). **This result was not supported by Shrestha (2001), Agha and Teodorescu (2002), Abdulla *et al.* (2014) and Abdullah *et al.*(2016) who reported intestinal parasites were more prevalent among rural dwellers than urban dwellers. These figures were lower than 83.8% prevalence of intestinal parasites among schoolchildren reported by Legesse and Erko (2004) in a rural area close to the southeast of Lake Langano. Similarly, Mengistu *et al.* (2010) had reported a prevalence rate of 72.9% among students of Atse Fasil General Elementary School at Azezo, Amare *et al.* (2007) reported 83% among urban dwellers in southwest Ethiopia. But, the current prevalence of intestinal parasites among schoolage children is a little bit higher than 34.5%, 46.1% and 36.52% reported by Alemnesh (2011), Fetlework (2011) and Teshome *et al.* (2014), respectively in different primary schools of Ethiopia.**

Urban population pressure (people movement from rural to urban is the current reality in search of job opportunity due to expansion of agro-industries) currently observed in most towns in Ethiopia are severely contaminating towns due to overpopulation and improper disposal of human excreta, shortage or absence of public toilets, shortage of water and lack of awareness on how to dispose excreta without contamination of the environment. These phenomena were also observed at Deneba town.

The children infected with intestinal parasites were 76% (38/50, 54.3% (25/46) and 53.7% (22/41) were observed among grade two, five and four schoolchildren. The association between the grade levels of schoolchildren and their infection with intestinal parasites was statistically significant ( $p < 0.05$ ). **Explanation and comparison of findings if you need some more.**

The overall prevalence of intestinal parasites in the current study was 49.7 % (Table 2). This result was lower than 83.8% prevalence of intestinal parasites among schoolchildren in a rural area close to the southeast of Lake Langano (Mengistu and Berhanu, 2004), Mengistu *et al.* (2010) also reported 72.9% among students of Atse Fasil general elementary School Azezo, Amare *et al.* (2007) reported 83% among urban dwellers in southwest Ethiopia. But, a little bit higher than Alemnesh (2011), Fetlework (2011), Teshome *et al.* (2014) were reported 34.5%, 46.1% and 36.52% prevalence of intestinal parasites among school age children in different primary schools of Ethiopia, respectively.

The prevalence of double intestinal parasitic infections in the present study was 100% (20/20). This result was higher than Mulusew (2014) who reported 18.4% among the primary schoolchildren in Motta town and Raihan and Mahendra (2013) who reported 18.98% among schoolchildren of Bhaktapur district, Nepal. Phoebe (2014) and Kisavi (2014) also observed 38.6% and 22.58 % prevalence rates of intestinal parasites among primary schoolchildren in Kikumuni sub-location, Machakos County, Kenya, respectively.

The prevalence of protozoan intestinal parasitic infections in the current study was 97.9% (140/143). This result was supported by the observation of Alyousefi *et al.* (2011) who were reported 30.9% among among Patients in Sana'a City. Narmin and Isra (2012) were also reported 30% among children in Erbil Province, Kurdistan Region-Iraq. In addition, Williams *et al.* (2014) were estimated 42.9% among primary school children in Urban and Peri-urban communities in Kumasi, Ghana, Kavili (2014) among the children attending primary schools in Kyuso Zone, Kyuso District, Kitui County, Kenya and Ngosso *et al.* (2015) 41% among under-fives children in Dar Es Salaam, Tanzania.

As shown in table 2, the prevalence of protozoan intestinal parasitic infections in the current study was 97.9% (140/143) and STD was 93.9% (31/33). The association of types of infections with the prevalence of intestinal parasites was statistically significant( $\chi^2 = 3.647$ ;  $P < 0.05$ ).

The prevalence of protozoan parasites in the current study 97.9% (140/143) higher than the research result reported by

The prevalence of STD was 93.9% (31/33) was found lower than the research result reported by Girum (2005), Abebe *et al.*(2011), Mathewos *et al.*(2014), Bayeh *et al.* (2013) and Shumbej *et al.* (2015) 27.2%, 82.4%, 66.7%, 51.5%, and 23.3% among school age children of different regions of Ethiopia, respectively. This difference in prevalence might be due to the altitude of the study area and the time of data collection.

Table 3. Major Types of intestinal parasites in Deneba primary school in 2015/16

Name of parasites	Frequency	Percent (%)
<i>A. lumbricoides</i>	12	3.1
<i>Enterobius vermicularis</i>	4	1
<i>Trichuris trichiura</i>	1	0.3
<i>Hymenolepsis nana</i>	14	3.6
<i>Entamoeba histolytica</i>	129	33.6
<i>Giardia lamblia</i>	14	3.6
Doble infection	20	5.2
Negative	190	49.5
Total	384	100

The major parasites in the study area were *Entamoeba histolytica*, *Hymenolepsis nana*, *Giardia lamblia*, *A. lumbricoides* and *Enterobius vermicularis* with prevalence rates of 33.6%, 3.6%, 3.6%, 3.1% and 1%, respectively. The lowest prevalent intestinal parasite in the study area was *Trichuris trichiura* (0.3%).

The highest prevalence of *Entamoeba histolytica* (33.6%) in the current study was higher than Mulusew (2014) who reported 17.1% prevalence of intestinal parasitic infection among primary school children in Motta Town, Western Amhara, Ethiopia. Moreover, Legesse and Erko (2004) reported prevalence rate of 12.7% among schoolchildren in a rural area close to the southeast of Lake Langano, Ethiopia, Fetlework (2011) who reported 16.4% among schoolchildren in Alemketema Town, Odo *et al.*(2016) who reported 10.5% among schoolchildren in Uzo-Uwani Local Governemnt Area of Enugu State and Ntombizodumo *et al.* (2016) who reported 14% among school children in Mthatha, South Africa.

The prevalence rate of *H. nana* in the current study was lower (3.6%) than the research result 27.59 % reported by Khan *et al.* (2004), 10.1% reported by Girum (2005), 13.8% reported Aschalew *et al.* (2013) and 5.35% reported by Abdulla *et al.*(2014).

The current prevalence of *Giardia lamblia* in the study area was (3.6%). This result was lower than the research result reported by Legesse and Erko (2004) who reported 6.2%, Dawit (2006) who reported 38%, Haileeyesus and Beyene (2009) who reported 165 (is it 16.5% or other wise?), Sintayehu and Bedaso Daba (2010) who reported 21.4%, Fetlework (2011) who rported 6%, Mulat *et al.* (2013) who reported 22.8%, Teshome *et al.* (2014) who reported 15.65% and Mulusew (2014) who reported 11.8% from different parts of Ethiopia.

The prevalence rate of *A. lumbricoides* in the current study was 3.1%. This result was lower than the studies conducted in Ethiopia by Legesse and Erko (2004) who reported 6.2%, Amare *et al.* (2007) who reported 5.8%, Amha (2007) who reported 8.3%, Million *et al.*(2013) who reported 15%, Alemnesh (2011) who reported 4.4%, Gebeyehu (2011) who reported 9.4%, Fetlework (2011) who reported 8.1%, Mulusew (2014) who reported 15.5%, Desta *et al.*(2014) who reported 10.2%, Alamneh and Endalkachew (2014) who reported 39.7%, Mathewos *et al.* (2014) who reported 39.8%, Degarege *et al.* (2015) who reported 32.7% and Bereket and Zewdneh (2015) who reported 47.3% from different regions of Ethiopia.



Table 4. The prevalence of different types of intestinal parasitic infections in relation to sex, age group and residence in Deneba town in 2015/16

Characteristics		Intestinal parasitic infections								$\chi^2$ (p-value)
		As.l (%)	<i>H.nana</i> (%)	E.v (%)	T.t (%)	Enta (%)	Gardia (%)	Double infection (%)	Negative	
Sex	M	4(33.3%)	8(57.1%)	1(25%)	0	64(49.6%)	8(57.1%)	7(35%)	94(49.5%)	5.364(0.616)
	F	8(66.7%)	6(42.9%)	3(75%)	1(100%)	65(50.4%)	6(42.9%)	13(65%)	96(50.5%)	
Age interval	7-9	8(66.7%)	10(71.4%)	0	0	43(33.3%)	4(28.6%)	1(5%)	117(30.5%)	45.905(0.001)
	10-12	1(8.3%)	1(7.1%)	1(25%)	0	39(30.2%)	2(14.3%)	8(40.0%)	102(26.6%)	
	13-15	3(25%)	3(21.0%)	2(50%)	1(100%)	40(31.0%)	7(50.0%)	6(30%)	139(36.2%)	
	16 and above	0	0	12(5%)	0	7(5.4%)	1(7.1%)	5(5%)	26(6.8%)	
Residence	Rural	4(33.3%)	2(14.3%)	2(50%)	0	52(40.3%)	6(42.9%)	9(45%)	65(34.2%)	6.030(0.536)
	urban	8(66.7%)	12(85.7%)	2(50%)	1(100%)	77(59.7%)	8(57.1%)	11(55%)	125(65.8%)	

Key:As.l- *A. lumbricoides*,H.nana- *Hymenolepis nana*,E.V.- *Enterobius vermicularis*, Enta- *Entamoeba histolytica*  
Gardia- *Giardia lamblia*, T.t- *Trichuris trichiura*

*Entamoeba histolytica* was the highest (Male 64 (49.6%) and female (65(50.4%)) while *Trichuris trichiura* was the lowest (male 0% and female 1 (100%)) prevalent intestinal parasites in male and female. The association between sex and types of parasites was statistically insignificant ( $\chi^2=5.364$ ,  $P=0.616$ ).

The highest prevalence of intestinal parasitic infection was in age category of 7-9 and named in order of abundance as *Entamoeba histolytica* 64 (49.6%), *Hymenolepis nana* 10 (71.4%), *A. lumbricoides* 8 (66.7%) and *Giardia lamblia* 4 (28.6%). The next highest prevalent intestinal parasite in order of occurrence in the age interval of 10-12 were also *Entamoeba histolytica* 39 (30.2%), double infection 8 (40.0%) and *Giardia lamblia* 2 (14.3%). On the other hand the third highest in order of occurrence were observed in the age interval of 13-15 and described as *Entamoeba histolytica* 40 (31.0%), *Giardia lamblia* 7(50.0%), double infection 6 (30%) and *Trichuris trichiura* 1 (100%). In the last age interval, the highest prevalent intestinal parasites were *Enterobius vermicularis* 12 (5%), *Entamoeba histolytica* 7(5.4%) and double infection 5 (5%). The highest prevalent intestinal parasite in the study sample was *Entamoeba histolytica* but the prevalence varies with age interval (7-9=43 (33.3%), 10-12=39 (30.2%), 13-15=40 (31.0%) and 16 and above=7(5.4%)). The association between age interval with the prevalence of intestinal parasites was statistically significant ( $\chi^2=45.905$ ,  $P=0.001$ ).

The highest prevalent intestinal parasites in the rural residence in order of magnitude of occurrence were *Entamoeba histolytica* (52 (40.3%)), double infection (9(45%)), *Giardia lamblia* (6(42.9%)), *Hymenolepis nana* and *Enterobius vermicularis* with prevalence rates of (2 (14.3%)) and (2 (50%)), respectively. *Entamoeba histolytica* was the highest prevalent intestinal parasite in both rural (52 (40.3%)) and urban (77 (59.7%)) residences. The association of different intestinal parasites between rural and urban residence was statistically insignificant ( $\chi^2=6.030$ ,  $p=0.536$ ).

Table 5. Univariate Logistic Regression Analysis for Sociodemographic Factors Potentially Associated With intestinal parasitic Infection among Deneba Junior School Children in 2016

Risk factors		n	Positive (%)	Negative (%)	COR, 95%CI, p-value
Sex	Male	186	16(8.6)	170(91.4)	1.13,0.56-2.27,0.74
	Female	198	20(10.1)	178(89.9)	1
Age group	7-9	117	18(15.4)	99(84.6)	0.46,0.1-2.1,0.32
	10-12	102	6(5.9)	96(94.1)	1.33,0.25-7.02,0.73
	13-15	139	10(7.2)	129(92.8)	1.2,0.25-5.92,0.82
	≥16	26	2(7.7)	24(92.3)	1
Residence	Rural	140	9(6.4)	131(93.6)	1.74,0.79-3.82,0.17
	Urban	244	27(11.1)	217(88.9)	1
Grade interval	1-4	193	21(10.9)	172(89.1)	0.65,0.32-1.32,0.32
	5-8	191	15(7.9)	176(92.1)	1
Father educational level	Illiterate	110	6(17.1)	104(29.8)	0.4,0.05-3.45,0.4
	Primary	163	24(68.6)	139(39.8)	0.14,0.02-1.03,0.05
	Secondary	58	3(8.6)	55(15.5)	0.43,0.04-4.24,0.45
	Others	9	1(2.9)	8(2.3)	0.19,0.01-3.29,0.25
	Certificate and above	44	1(2.9)	43(12.3)	1
Mother educational level	illiterate	145	11(31.4)	134(38.4)	1.74,0.45-6.76,0.42
	Primary	142	14(40.0)	128(36.7)	1.31,0.35-7.94,0.69
	secondary	69	7(20.0)	62(17.8)	1.27,0.3-5.34,0.75
	Others	4	0(0)	4(1.1)	2.3E8,0.00-0.00,0.99
	Certificate and above	24	3(8.6)	21(6.0)	1
Occupation of parents	Government employees	48	4(11.4)	44(12.6)	1
	Trader	139	18(51.4)	121(34.7)	0.00,0.00-0.00,0.99
	Farmer	148	9(25.7)	139(39.8)	0.00,0.00-0.00,0.99
	Manual worker	30	4(11.4)	26(7.4)	0.00,0.00-0.00,0.99
	others	19	0(0)	19(5.4)	0.00,0.00-0.00,0.99
Family size	6 and above	124	7(20.0)	117(33.5)	0.36,0.09-1.32,0.12
	5	106	11(31.4)	95(27.2)	0.35,0.11-1.11,0.07
	4	85	7(20.0)	78(22.3)	0.66,0.23-1.98,0.46
	3	41	6(17.1)	35(10.0)	0.52,0.19-1.38,0.19
	Below3	28	4(11.4)	24(6.9)	1

Table 5. Univariate Logistic Regression Analysis for Sociodemographic Factors Potentially Associated With intestinal parasitic Infection among Deneba Junior School Children in 2016 (CONT....)

Variables		No. examined (%)	Positive (%)	Negative (%)	COR	95% CI, p-value
Where you defecate	Toilet	330(85.9%)	156(40.6%)	174(45.3%)	1	
	Near the river	11(2.9%)	7(1.8%)	4(1.0%)	0.512	0.147-1.783,0.293
	Shady area	21(5.5%)	14(3.6%)	7(1.8%)	0.448	0.176-1.139,0.092
	Open field	20(5.2%)	13(3.4%)	7(1.8%)	0.483	0.188-1.2441, 0.131
	others	2(.5%)	1(0.3%)	1(0.3%)	0.897	0.056-14.455,0.939
Using of toilet	Yes	335(87.2%)	159(41.4%)	176(45.8%)	1.00	
	No	49(12.8%)	32(8.3%)	17(4.4%)	0.480	0.257-0.898, 0.022
Do you wash your hand after using toilet?	Yes	373(97.1%)	182(47.4%)	191(49.7%)	0.212	0.045-0.993,0.049
	No	11(2.9%)	9(2.3%)	2(0.5%)	1	
Do you eat your food before washing?	Yes	47(12.2%)	29(7.6%)	162(42.2%)	0.575	0.307-1.074,0.043
	No	337(87.8%)	18(4.7%)	175(45.6%)	1	
Where do you get water for your drinking?	Tap water	254(66.1%)	126(32.8%)	128(33.3%)	1	
	Stream	1(0.3%)	1(0.3%)	0	0.000	0.000
	River	4(1.0%)	3(0.8%)	1(0.3%)	0.328	0.034-3.197,0.337
	Underground Water	125(32.6%)	61(15.9%)	64(16.7%)	1.033	0.673-1.585,0.883
Is there dirty matter in your finger nails?	Yes	137(35.7%)	75(19.5%)	62(16.1%)	0.732	0.481-1.113, 0.145
	No	247(64.3%)	116(30.2%)	131(34.1%)	1	
Do you wear shoes?	Yes	382(99.5%)	189(49.2%)	193(50.3%)	1	
	No	2(0.5%)	2(0.5%)	0	0.000	0.000

The associations of intestinal parasitic infections with sex, age, residence, grade interval, educational level of both father and mother, occupation of parents, family size, place to defecate, water availability for drinking and the presence of dirty matter in finger nails were statistically insignificant ( $P > 0.05$ ). On the other hand, hand washing after toilet and before eating food were significantly associated ( $p < 0.05$ ) with intestinal parasitic infections.

The univariate logistic regression analysis revealed that no use of toilet, eating food without hand wash, getting water from stream to drink and fail to wear shoes were important risk factors ( $p < 0.05$ ) to facilitate the occurrence of intestinal parasitic infections in schoolage children in the current study area.

The current finding was in agreement with Izabella *et al.* (2011) and Bushra *et al.* (2012) who reported that, fail to wash hands before eating was the risk factor to facilitate the occurrence of intestinal parasitic infections. Mulusew (2014), Ashenafi and Mohammed (2014), Eleni *et al.* (2014) and Abdullah *et al.* (2016) also observed hand washing practices, toilet availability and using of toilet reduce the prevalence of intestinal parasitic infections.

Table 6. Multivariate Logistic Regration Analysis for Enviromental and Life Style Factors Potentially Associated With intestinal parasitic infections among Deneba Junior Secondary School Children in 2015/2016

Variables		COR (95%CI)	p-value	AOR(95%CI)	p-value
Using of toilet	Yes	1.00	0.022	2.048(1.089-3.852)	0.026
	No	0.480 (0.257-0.898)		1	
Do you wash your hand after using toilet?	Yes	0.212 (0.045-0.993)	0.049	4.736(1.001-22.408)	0.05
	No	1.00		1	
Do you eat your food before washing?	Yes	0.575 (0.307-1.074)	0.043	0.572(0.304-1.076)	0.043
	No	1.00		1	

All socio-demographic variables, hygienic issues, environmental and life styles related factors, those factors significantly associated ( $p < 0.05$ ) and conceptual framework describing hierarchial relationships with the prevalence of intestinal parasitic infections in univariate analysis were selected entered for multivariate logistic regression analysis to identify the most important predictors of intestinal parasites. Multivariate logistic regression analysis for socio demographic, environmental and factors of life style factors such as use of toilet (AOR (95% CI)=2.048 (1.089-3.852),  $p$ -value= 0.026) washing hands before eating food (AOR (95% CI)=0.572 (0.304-1.076),  $p$ -value=0.043) and wash hands after using toilet (AOR (95% CI)=4.736(1.001-22.408),  $p$ -value=0.05) were the factors responsible to reduce the prevalence of intestinal parasites in the study area.

The current study result revealed that the risk factors for the occurrence of intestinal parasites in the study area were no use of toilet, eating food without hand washing, getting water from stream to drink and no wearing shoes. Izabella *et al.* (2010) reported that lack of sanitary infrastructure ( $p = 0.015$  and Mulusew (2014) fail to wash hands before meal and after toilet, absence of toilet availability and open defecation practices were the risk factors facilitating the occurrence of intestinal parasites which is in line with the current finding. On the other hand, Begna *et al.* (2014) [(AOR=0.20, 95% CI=0.10-0.40),  $p < 0.001$ ], Tamirat and Getye (2014) (AOR: 7.8, 95% CI: 2.8, 24.8) and Desta *et al.* (2014) [AOR = 5.7; 95% CI (3.4, 9.7)] reported that hand washing before meal was the risk factor reducing the prevalence of intestinal parasites. This finding is in agreement with the current result in that using toilet ( $P = 0.026$ ) reduces the prevalence of intestinal parasitism in schoolage children.

## 5. CONCLUSION AND RECOMMENDATIONS

### 5. 1. Conculusion

The prevalence of intestinal parasitic infections vary from place to place. The major intestinal parasites in the study area were *Entamoeba histolytica*, *Hymenolepsis nana*, *Giardia lamblia*, *Asacaris lumbricoides* and *Enterobius vermicularis*. Eating food without hand washing, no use of toilet, fail to wash hands after toilet, getting water from stream to drink and no wearing of shoes were important risk factors ( $p < 0.05$ ) to facilitate the occurrence of intestinal parasitic infections in schoolage children in the current study area. Moreover, our finding further pointed out that using toilet ( $P = 0.026$ ) reduces the prevalence of intestinal parasitism in schoolage children.

### 5. 2. Recommendations

To avoid or minimize the risk of intestinal parasitic infestation among schoolage children in Deneba primary school, the following measures should be recommended:

- 🌿 Teachers, local health personells and any concerned individuals should create awareness to school comminity members and the parents of children about the risk and transmission of intestinal parasites.
- 🌿 Children and members of the comminity should learn the proper use of latrine. Once they started to us then it is expected of them to scale-up the proper use of laterin.
- 🌿 Children should improve proper hand washing after toilet and before food (meal).

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## 7. APPENDICES

### Appendices 1. Parasitological investigation procedure

#### A. Formol-ether concentration technique

1. Using a stick, emulsify an estimated 1g of faeces in about 4ml of 10% formol water contained in a screw –cap bottle or tube.
2. Add further 3-4ml of 10% formol water, cap the bottle and mix well by shaking.
3. Sieve the emulsified faeces, collecting the sieved suspension in a beaker.
4. Transfer the suspension to a conical tube and add 3-4 ml of diethyl ether.
5. Stopper the tube and mix for 1 minute.
6. With a piece of wrapped around the top of the tube, loosen the stopper.
7. Centrifuge immediately at 3000 rpm for 1 minute.
8. Using a stick, loosen the layer of faecal debris from the side of the tube and invert the tube to discard the ether, fecal debris and formol water.
9. Return the tube to its upright position and allow the fluid from the side of the tube to drain to the bottom. Tap the bottom of the tube to re-suspend and mix the sediment.
10. Transfer the sediment to the slide, and cover with cover glass. To assist the identification of cysts run a drop of iodine under the cover glass.
11. Examine the preparation microscopically using the 10x objective with the condenser closed sufficiently to give good contrast. Use 40 x objectives to examine cysts.

#### Annex.

1. Label a glass slide with the sample number and then place a plastic tepplate on top of it.
2. Scoop approximately 2 -3 grams (g) of a fresh faecal sample onto a piece of aluminum foil, and press a piece of wire or plastic mesh on top to sieve it.
3. Using a small plastic spatula, scrape the sieved material off the mesh and completely fill the hole in the Kato -Katz template. To remove excess faecal material, level the content of the hole with the spatula.

4. Vertically remove the template without disturbing the faecal material now adhering to the microscope slide.

The template and spatula can be cleaned in water with detergent, rinsed in clean water, and reused.

5. Place a piece of pre-soaked cellophane over the faecal sample on the microscope slide.

6. To spread the faecal material into a thick smear, gently press a clean microscope slide against the sample slide, evenly distributing the material within a circle of a diameter slightly smaller than the width of the microscopic slide.

7. Allow the slide to clear for 30-60 minutes (min), during which the slides must be kept away from direct sunlight. When hookworm is present in the community under investigation (in all 4 study countries), it is essential to read the slides shortly after a clearing time of 30 min, with a maximum clearing time of 60 min. In Côte d'Ivoire and Mali, examine each slide again within the next 12-24 hours for detection of *Schistosoma mansoni* eggs. Examine the thick smear under a light microscope (40-100x magnification). Count the number of helminth eggs and records them for each helminth species separately.

## **B. Direct examination of fecal specimens/wet mount smears preparations procedure**

1. Place one drop of 0.85% NaCl on the slide.
  2. Take a small amount of fecal specimen and thoroughly emulsify the stool in saline.
  3. A drop of emulsified sample placed on a microscopic slide and then a few drop of iodine solution was added.
  4. Place a 22 mm cover slip at an angle into the edge of the emulsified fecal drop. Push the cover slip across the drop before allowing it to fall into place.
  5. Systematically scan the entire 22mm cover slip with overlapping fields with the 10x objective.
  6. Switch to high dry 40x objective for more detailed study of any suspect egg or larvae.
- Under Table 2.

## **Appendices 2. Consent Form (English Version)**

### **For participation as volunteer in research undertaking**

Full Name: \_\_\_\_\_

I the above mentioned \_\_\_\_\_ have been told that I may have intestinal parasitic disease and would like get my stool specimen for identification of parasites.

I am requesting your and/or your child's genuine response to an interview on some related issues and collection of stool. There is no any health related risk in participating. When you or your children are found positive for intestinal parasitic infestations, you will receive standard drugs free of charge. Information and data in the questionnaire survey will be handled with strictly confidential and used only for the specified study.

The participation of your child in this study is completely voluntary and he/she can refuse to participate or free to withdraw him/herself from the study at any time. If you have understood the explanation well enough, I am requesting you to your signature as illustrated below:

I the undersigned have been informed and understood that the purpose of this particular research project is to find out the associations of intestinal parasitic infestations and potential risk factors in Deneba primary school children. I have been told that I can refuse my child from participating in the study at any time. Hence, with this understanding, I am hereby giving my agreement to participate my child in this research voluntarily.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

### **Appendices 3. Questionnaire (English version)**

This questionnaire is about socio-demographic health status of the community. It will help the researcher to find out study subject characteristics, knowledge, attitude and practice of the study participants towards parasites. All information given in the questionnaire will be handled confidentially.

Subject code \_\_\_\_\_

#### 1. General information

- 1.1. Name of the school \_\_\_\_\_  
1.2. Name of the student \_\_\_\_\_  
1.3. Sex \_\_\_\_\_  
1.4. Age \_\_\_\_\_  
1.5. Grade/section of the student \_\_\_\_\_  
1.6. Address           A. Rural                           B. Urban  
1.7. Religion   A. Orthodox   B. Muslim   C. Catholic           D. Protestant           E. Other
2. Information on risk factors
- 2.1. What is your mother's educational level?  
A. Illiterate                           B. Primary school educated           C. Secondary School educated  
D. Certificated and above           E. Others
- 2.2. What is your father's educational level?  
A. Illiterate   B. Primary school educated           C. Secondary School educated  
D. Certificated and above           E. Others
- 2.3. Do you use latrine? A. Yes                           B. No
- 2.4. If the answer for question number 2.3 is no, where do you defecate and dispose the faeces?  
A. Near the river   B. Shady area           C. Open field           D. Others
- 2.5. Do you wash your hands after toilet? A. Yes                           B. No
- 2.6. Do you wash your hands before handling and eating food?  
A. Yes                           B. No
- 2.7. From where do you fetch water for drinking and cooking?  
A. From tap   B. From stream           C. From river   D. Others
- 2.8. Is there any dirt in your finger nails (both your right and left finger nails)? Interviewers inspect it.  
A. Yes                           B. No
- 2.9. What is your parent's occupation?  
A. Trader                           B. Farmer                           C. Government employee  
D. Manual worker                           E. Others
- 2.10. How many members are there in your family?  
A. Below Three   B. Three   C. Four   D. Five   E. Six and above
- 2.11. Do you wear shoes?

A. Yes B. No If no, skip to question number 2.12.

2.12. If your answer to question number 2.11 is yes , how often are you wearing of shoes?

A. Sometimes B. Regularly

2.13. Do you eat raw meat? A .yes B. No

መላያ ኮድ:-----

**Appendices 4. AMHARIC QUESTIONNAIRE በተመራዎች የሚሟሟ መጠየቅ?**

ወድ ተመራዎች :- የአንጀት ጥገኛ ትላትሎች በህብረተሰቡ ላይ በተለይም እድሜያቸው ለትምህርት የደረሱ ልጆች ዘንድ ያለውን ስርጭት ለማወቅና ለስርጭቱ በማጠናከር አጋላጭ ምክንያቶችን ለማወቅና ስርጭቱ የሚታገድ መንገድ ለመጠየቅ ነው፡፡ በተጨማሪም የአንጀት ትላትሎች የሚደርሱትን ጉዳት ለመቀነስ ይረዳ ዘንድ መጠየቁን እያነበባችሁ በተማኝነትና በቅንንት ትሞላልኝ ዘንድ በሚከበር እጠይቃለሁ፡፡ ለጥናቱ ወጠቃሚ ት ይህ የእናተ እገዛ በጣም አስፈላጊ በመሆኑ ቀና ትብብራችሁን በአክብሮት እጠይቃለሁ፡፡

1. አጠቃላይ መረጃዎች:
  - 1.1 የትምህርት ቤቱ ስም -----
  - 1.2 የተመራው ስም -----
  - 1.3 ጾታ -----
  - 1.4 እድሜ -----
  - 1.5 የክፍል ደረጃና ሴክሽን -----
  - 1.6 የመኖሪያ አድራሻ ሀ/ ገጠር ለ/ ከተማ
  - 1.7 ሃይማኖት ሀ/ ኦርቶዶክስ ተዋህዶ ለ/ እስልምና ሐ/ ካቶሊክ  
መ/ ፕሮቴስታንት ሠ/ሌላ
2. ባጋላጭ ሁኔታዎች ላይ የሚከበሩት መረጃ
  - 2.1. የእናት የትምህርት ደረጃ  
ሀ/ ማንበብና መጻፍ የማይችሉ ለ/ አንደኛ ደረጃ ትምህርት የጩሱ  
ሐ/ የሁለተኛ ደረጃ ትምህርት የጩሱ መ/ ሰርተፍኬትና ከዛ በላይ ሠ/ ሌላ
  - 2.2. የአባት የትምህርት ደረጃ  
ሀ/ ማንበብና መጻፍ የማይችሉ ለ/ አንደኛ ደረጃ ትምህርት የጩሱ  
ሐ/ የሁለተኛ ደረጃ ትምህርት የጩሱ መ/ ሰርተፍኬትና ከዛ በላይ ሠ/ ሌላ
  - 2.3. ሽንት ቤት ትጠቀማለህ/ ሽ/  
ሀ/ አዎ ለ/ አልጠቀምም
  - 2.4. ተራቁጥር 2.3 መልስህ /ሽ/ አልጠቀምም ከሆነ አብዛኛውን ጊዜ የምትጸዳዳት የት ነው?  
ሀ/ ወንዝ ዳር ለ/ ጥላ ስር ሐ/ ማዳ ላይ መ/ሌላ
  - 2.5. ሽንትቤት ከተጠቀም /ሽ/ በኋላ እጅህን /ሽን/ በሳሜ ትታጠብለህ /ሽህ/?  
ሀ/ አዎ ለ/አልታጠብም
  - 2.6. እጅህን /ሽን/ በሚገባ ሳትታጠብ/ቢ/ ምግብ ትመግባለህ /ሽ/?  
ሀ/ አልመግብም ለ/ እመግባለሁ

- 2.7. ለመጠጥ የግሥን ወሃ ከየት ታገኛለህ /ሸ/ ?  
ሀ/ ከባንባ ለ/ ከምንጭ ሐ/ ከወንዝ መ/ ከጉድጓድ
- 2.8. በእጅ ጥፍሮችህ/ሸ/ ላይ ቆሻሻ አለ?  
ሀ/ የለም ለ/አለ
- 2.9. የቤተሰብ የስራ ሁኔታ  
ሀ/ ንግድ ለ/ ግብርና ሐ/ የመንግስት ስራተኛ መ/ የጉልበት ስራ ሰ/ ሌላ
- 2.10 የቤተሰብ አባላት ስንት ነው?  
ሀ/ ከ3 በታች ለ/ ሶስት ሐ/ አራት መ/ አምስት ሰ/ ስድስትና ከዛ በላይ



### Appendices 5. Laboratory Data Collecting Format

code	Name of students	sex	age	+ve or -ve for parasites	Types of parasites										remark			
					Al	Hw	Ts	Ev	H.nana	Strog	Double infestation	Triple infestation	Multiple infestation	Others				

**Key:** Al= *Ascaris lumbricoides*      Ts= *Taenia saginata*      Hw= Hok worm      Tt= *Trichuris trichiura*  
H.nana= *Hymenolepsis nana*      Strong= *Strongyloides stercoralis*