PREVALENCE OF INTESTINAL PARASITIC INFECTIONS AND THEIR ASSOCIATIONS WITH ANTHROPOMETRIC MEASUREMENTS OF SCHOOL CHILDREN IN SELECTED PRIMARY SCHOOLS OF HIRNA TOWN, OROMIA REGIONAL STATE, EASTERN ETHIOPIA

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Prevalence of Intestinal Parasitic Infections and their Associations with Anthropometric Measurements of School Children in Primary Schools of Hirna Town, Oromia Regional State, Eastern Ethiopia

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As thesis research advisors, we hereby certify that we have read and evaluated this thesis entitled: **"Prevalence of Intestinal Parasitic Infections and their Associations with Anthropometric Measurements of School Children in Selected Primary Schools of Hirna Town, Oromia Regional State, Eastern Ethiopia"** prepared under our guidance, by **Samuel Dessalegn**. We recommend that it be accepted as fulfilling the requirement.

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As members of the board of examiners of the M.Sc. thesis open defense examination, we certify that we have read, evaluated the thesis prepared by Samuel Dessalegn and examined the candidate. We recommended that the thesis be accepted as fulfilling the Thesis requirements for the degree of Master of Science in Biology.

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DEDICATION

This thesis is dedicated to my mother Woizero Almaz Tefera who sacrificed her own ambitions to put me on the ladder of success; my success would have not been true without her unreserved and extensive support.

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this thesis is my original work and that all sources of materials used in the preparation of the thesis have been agreeably acknowledged. This thesis is submitted in partial fulfillment of the requirements for an M.Sc. degree in Biology at Haramaya University and is deposited at the University's Library to be made available to borrowers under the rules of the Library. I genuinely declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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BIOGRAPHICAL SKETCH

The author, Samuel Dessalegn was born in 1984 in Tullo Woreda, Western Hararghe, Oromia Regional State, Ethiopia. He attended his elementary school at Tullo Primary School and Hirna Number One Primary School. And, he attended his secondary and preparatory education at Hirna Senior Secondary School and Chiro Senior Secondary and Preparatory School, respectively. Then after, he joined Haramaya University in 2004 and graduated in July 2007 with a BEd in Biology.

After six years of services in teaching Biology at Hirna Preparatory School, in 2014, he joined Haramaya University to pursue his study in Master of Science in Biology.

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ACRONYMS AND ABBREVIATIONS

BMI	Body Mass Index
CDC	Center for Disease Control
CI	Confidence Interval
CSO	Central Statistical Office
HAZ	Height-for-Age Z score
IHPIs	Intestinal Helminths Parasitic Infections
IPIs	Intestinal Parasitic Infections
IPPIs	Intestinal Protozoan Parasite Infections
KG	Kindergarten
NCCLS	National Committee on Clinical Laboratory Standards
NCHS	National Center for Health Statistics
NTDs	Neglected Tropical Diseases
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
STHs	Soil Transmitted Helminths
WAZ	Weight-for-Age Z score
WHO	World Health Organization
WHZ	Weight-for-Height Z score

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ABSTRACTS

Intestinal protozoan and soil transmitted helminths infections are among the common leading causes of death worldwide. In developing countries intestinal protozoan and soil transmitted helminths infections are the major health problems where mostly pre-school and school age children are affected and the majority of these cases occur in sub-saharan African countries.The main objective of the present study was to determine the prevalence o f intestinal protozoan and soil transmitted helminths infections and their associations with anthropometric measurements of school children of Oda Belina and Ethiopia Tekdem Primary Schools of Hirna town. A school based cross-sectional study was conducted at Hirna town from April-June, 2017. A total of 384 study participants were selected from grade 1-8 children of the two schools using, stratified, random sampling method. The stool samples taken from the study participants were examined using direct wet mount, Formol-Ether Concentration and Zeihl-neelson methods. Out of the total 384 study participants, 45(11.7%) were infected with Intestinal protozoan and 67 (17.5%) were infected with soil-transmitted helminths. Of these, 11.2% and 12.3% were prevalence of protozoan parasites in males and females, respectively. while, the overall prevalence rate of soil-transmitted helminths parasites was 17.5%. Of these, 18.8% and 16.04% were for males and females, respectively. The prevalence of intestinal protozoan parasites was 7.6%, 3.7% and 0.5% for Entamoeba histolytica, Giardia lamblia and Cryptosporidium species, respectively. On the other hand, the prevalence of intestinal helminth parasite infections was 6.8%, and 8.9%, 1.6%, for Ascaris lumbricoides, hookworms, Trichuris trichiura, respectively. Some risk factors, such as family size and washing hands before meal and after toilet with soap were statistically associated with the prevalence of intestinal parasitic infections ($p < 0.05$). The prevalence of stunting, wasting and underweight for children of 6-9 years was 22(17.3%), 27 (21.3%) and 31(24.4%), respectively. But, for the10-18years age group, the prevalence of underweight was 37.0 %. Generally, the prevalence of intestinal parasitic infection was high among school-children of Hirna town. The local health sector should collaborate with schools to deliver health education to raise awareness, knowledge, attitude and practice of school children towards the transmission and prevention of intestin al parasitic infections through provision of community based health education, mass de-wo rming program, improvement of personal hygiene and environmental sanitation.

Key words /phrases*: Helminths, Protozoan, Risk factors, Hirna town and Undernutrition*

1. INTRODUCTION

Protozoan and soil transmitted helminths cause intestinal parasitic infections which are among the most leading causes of death worldwide (Rashidul, 2007). Globally, it is estimated that about 3.5 billion people are infected with intestinal parasitic infections (Keiser and Utzinger, 2010). Majority of these cases are among children (Brooker *et al*., 2009). In developing countries, typically in sub-Saharan Africa (SSA) countries, intestinal parasite infections (IPIs) caused by protozoan and Soil Transmitted Helminthes are highest among pre-school and school aged children (Harhay *et al*., 2010).

The distribution of intestinal protozoan and STHs parasitic infections is mainly associated with, low standard of living associated with poor socioeconomic status, misdiagnosis of parasitic infections in the laboratory parasitological examinations, poor personal and environmental hygiene, poverty, lack of safe potable water, malnutrition, low literacy, hot and humid tropical climate and ruin health services (Tanduar *et al*., 2015).

The global prevalence of intestinal protozoan infections is reported to be high. The most common intestinal protozoan parasites are: *Giardia lamblia/ intestinalis*, *Entamoeba histolytica*, *Cyclospora cayetanenensis*, and *Cryptosporidium* spp. The diseases caused by these intestinal protozoan parasites are known as giardiasis, amoebiasis, cyclosporiasis, and cryptosporidiosis respectively, and they are associated with diarrhoea (Davis *et al*., 2002). *Entamoeba histolytica* and *Giardia lamblia* are estimated to infect about 60 million and 200 million people worldwide, respectively (Murray *et al*., 2002).

Entamoeba histolytica is found throughout the world. About 480 million or 10% of the world's population is infected with *Entamoeba histolytica*, and in many countries the prevalence of the infections may close to 50%. Humans are the only host of the parasite to pass virulent cysts that are transmitted mainly through ingestions of contaminated water or food through direct or indirect contact (Bethony *et al*., 2006).

Giardia lamblia is another major intestinal parasite prevalent mostly in temperate and tropical countries and known as a common cause of diarrheal disease throughout the world. The prevalence of *G.lamblia* has been estimated to be 2-3% in the industrialized world and

20-30% in developing countries (Escobedo *et al*., 2009). In Ethiopia, the prevalence of giardiasis ranges from 3% to 23% (Haile *et al*., 1994).

Cryptosporidium species is found all over the world. Prevalence rates in Europe and North America range from 1-6%, while rates in Asia and Africa are as high as 20%. It can affect both humans and animals, mainly causing watery diarrhea with or without a persistent cough in immunocompetent hosts (Sponseller *el al*., 2014).

Soil-transmitted helminthiases are a group of parasitic diseases caused by nematode worms that are transmitted to humans by faecally contaminated soil (WHO, 2012). The infections are most prevalent and geographically widespread parasitic infections in the world (Savioli and Albonica, 2004). However, these infections are most prevalent in tropical and sub-tropical regions of the developing world where adequate water and sanitation facilities are lacking and the major causes of cognitive and physical growth impairment and anemia in children (Lammie *et al*., 2006). In addition to considerable mortality and morbidity, infection with intestinal helminths has been found to profoundly affect a child's mental development, growth and physical fitness while also predisposing children to other infectious agents (Elias *et al*., 2001).

The four main species of STHs that infect people are *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (Whipworm), *Ancylostoma duodenale* and *Nectar americanus* (hookworms) (WHO, 2013; Jean *et al*., 2016), and are often called Soil-Transmitted Helminthes (STHs) which referred to their mode of transmission. They are also associated with malnutrition, including anemia, and diseases in children (Hall *et al*., 2008).

About 1.45 billion people in the world were infected with STHs and 5.19 million show associated morbidity in 2010 (Pullan *et al*., 2014). Out of 1.45 billion infections due to STHs, 438.9 were infected with hookworm, 819.0 million with *A. lumbricoides* and 464.6 million with *T. trichiura* (Pullan *et al*., 2014). However, these infections are most prevalent in tropical and sub-tropical regions of the developing world where adequate water and sanitation facilities are lacking and the major causes of cognitive and physical growth impairment and anemia in children (Lammie *et al*., 2006).

Preschool-aged children and school-aged children (including adolescents) tend to harbor the greatest worms and as a result experience stunted growth and diminished physical fitness (Crompton and Nesheim, 2002). Children are predisposed to heavy infections with intestinal parasites since their immune systems are not yet fully developed and they also habitually play in faecally contaminated soils (Ayele *et al*., 2015).

Since protozoan and Soil-transmitted helminths associated with poor socioeconomic class and unsanitary conditions, in Ethiopia intestinal parasitic infections become serious public health concern, which made them the second most predominant causes of outpatient morbidity in the country (Leggese and Erko, 2004). The most important STHs predominant ly distributed in Ethiopia include *A.lumbricoides, A.duodenale,* N. americanus and T. tricur a. The most widely distributed protozoans are *E. histolytica/dispar* and *G. lamblia*. But their distributions vary due to factors like geographical area, age, socio-economic status, cultural practices, low levels of environmental sanitation, and level of contacts with contaminants (Methony *et al*., 2006; Belayhun *et al*., 2010).

The main transmission route for most intestinal parasites is fecal–oral. Protozoan parasites, such as *Giardia lamblia, Entoameba histolytica* and STHs, including *A. lumbricoides*, *Ancylostoma duodenale* and *Nectar americanus* (hookworms) and *T. trichiura*, are transmitted via contaminated water and food (Chan *et al.*, 1994). Enteric pathogens are ingested with contaminated water and food and pass through the entire gastrointestinal tract (Tadesse, 2005).

So far there is no published information on the prevalence of Protozoan and Soil-transmitted helminths infections and their associations with anthropometric measurements of school children in the district. Therefore, the purpose of this research was to determine the prevalence of intestinal protozoan and soil-transmitted helminths infections and their associations with anthropometric measurements of children in Oda Belina and Ethiopia Tikdem Primary Schools of Hirna town, Oromia Regional State, Eastern Ethiopia. The finding of this study would be indispensable to all concerned bodies who will take part in the prevention and control of intestinal parasitic infections.

The general Objective of this study was:

- To determine the prevalence of intestinal protozoan and Soil-transmitted Helminths among children of Oda Belina and Ethiopia Tikdem Primary Schools and ultimately examine the associations with their anthropometric measurements.

The specific Objectives were:

1. To determine the prevalence of intestinal protozoan and soil-transmitted helminths parasitic infections among school children in the study area.
2. To detect the major intestinal protozoan and soil-transmitted helminths species among school children.
3. To identify the major associated risk factors those predispose school children to intestinal parasitic infections in the study area.
4. To determine the anthropometric measurements and to associate with intestinal protozoan and soil-transmitted helminths infections of primary school children in the study area.

2. LITERATURE REVIEW

2.1. Human Intestinal Protozoan Parasitic Infections

The protozoa are extremely diverse group of unicellular organisms occurring in almost all of the ecological niches known to humans, including the bottom of hot springs and the edges of ice flows. The majority of protozoa occur as free living organisms in the soil, moist, marine or fresh water environments. However, a substantial number also exists as mutual, commensal or parasite. Protozoan parasites are known to affect all species of vertebrates and many invertebrates and they are able to adapt to life in virtually all body sites of their hosts (Neva and Brown, 2004).

Intestinal protozoa parasites are transmitted by the fecal-oral route and tend to exhibit similar life cycles consisting of a cyst and trophozoite stages. Fecal-oral transmission involves the ingestion of food or water contaminated with cysts. Some of the trophozoites will develop into cysts instead of undergoing replication. Factors which increase the chance of ingesting materials contaminated with fecal material play a role in the transmission of these intestinal protozoa. In general, situations involving close human-human contact and unhygienic conditions promote transmission (Petri *et al*., 2000). The intestinal protozoan parasites such as *Giardia lamblia/ intestinalis*, *Entamoeba histolytica* and *Cryptosporidium* spp. cause the diseases known as giardiasis, amoebiasis, and cryptosporidiosis, respectively and they are associated with diarrhoea (Davis *et al*., 2002).

2.1.1. The life cycle and transmission of *Entamoeba histolytica* infection

Entamoeba histolytica is the only pathogenic entamoeba species. It has two morphologic forms; trophozoite and cyst. The trophozoite form is the motile and invading stage of the parasite that usually lives as a commensal in the human large intestine where it multiplies by asexual binary fission and eventually differentiates into cyst forms. The cyst form is inactive, non motile, non-invading stage of the parasite, and it is responsible for the transmission of the disease to others through fecal-oral route (Tadesse and Tsehaye, 2008).

The life cycle of *E. histolytica* includes the motile and invasive trophozoites and the infective cyst as shown in figure 1. Infection is acquired primarily through the ingestion of infective cyst forms present in focally contaminated water and food (Petri and Singh, 2009). The trophozoites measures 10-50 µm and contains a single nucleus; whereas, the cyst is 10-15 µm in diameter and contains four nuclei. *E.histolytica* cysts are resistant to gastric juices present in the human stomach, chlorination and desiccation and are capable of surviving in a moist environment for several weeks (Neva and Brown, 2012). In the small intestine, where conditions are alkaline and as a result of nuclear division, eight motile trophozoites are produced. These motile trophozoites settled in the large intestine lumen, where they divide by binary fission and feed on host cells, bacteria and food particles. This is the first chance of the parasite making contact with the mucosa (Neva and Brown, 2012).

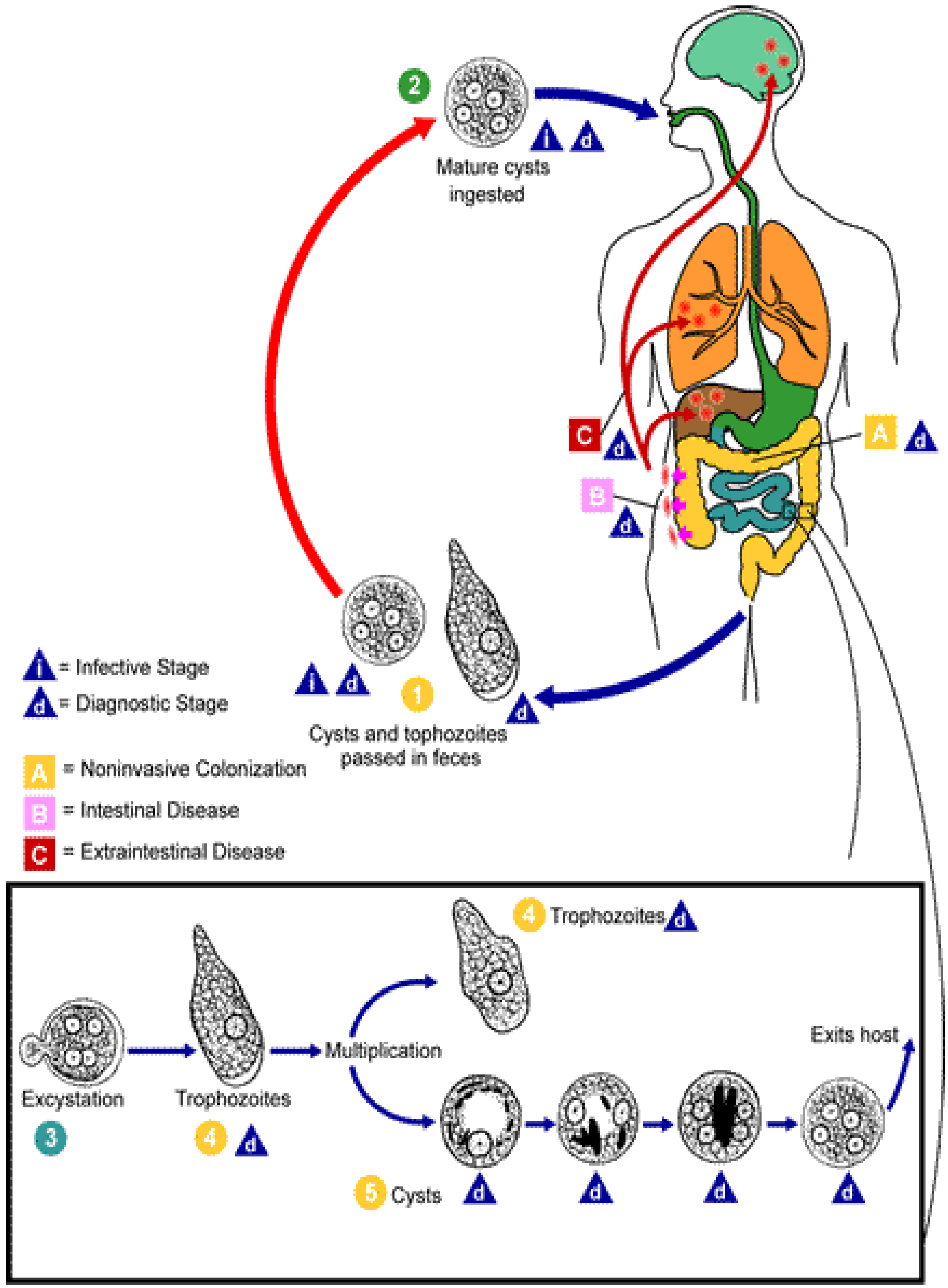

Figure 1: Life cycle of *Entamoeba histolytica* (Source: http//www.dpd.cdc.gov/dpdx)

2.1.2. The life cycle and transmission of *Cryptosporidium* infection

Cryptosporidium can complete its life cycle in as short as 2 days and the infection may be short lived or may be persistent for months, completes its life cycle in a single host and culminates in the shading of mature oocysts in the faeces. These are immediately infective for another susceptible host. The oocysts are 4-6µm diameter (smaller than many other protozoan), and contain four semi-circular shaped infective structures of sporozoites. The sporozoites attach themselves to the gut epithelium, initiating the infection, which develops through further stages of sexual and asexual multiplication, zygote formation, oocyst formation, and sporulation. Each of the stages of the organism's life cycle is found within the cell, and after an incubation period of 2-10 days, the pathogen gives rise to symptoms in humans (Meinhardt *et al*., 2006; Cabada *et al*., 2015).

Crypto is normally a zoonotic infection spread by contaminated water, although food-borne and person-to-person infections have been documented. Many outbreaks can be traced to water run-off carrying animal waste. Endemic transmission usually occurs through contamination of public water sources, such as beaches and pools. It is only in large outbreaks that contamination of the drinking water supply has been implicated. Food-borne transmission has only been reliable documented in one case. Person-to-person transmission is much more frequent, often occurring in nursing homes and day care centers. Crypto has a very low infectious dose (amount needed to establish infection in the host), ranging from 9 to 1000 oocysts, depending on the species of parasite (Sponseller *el al*., 2014).

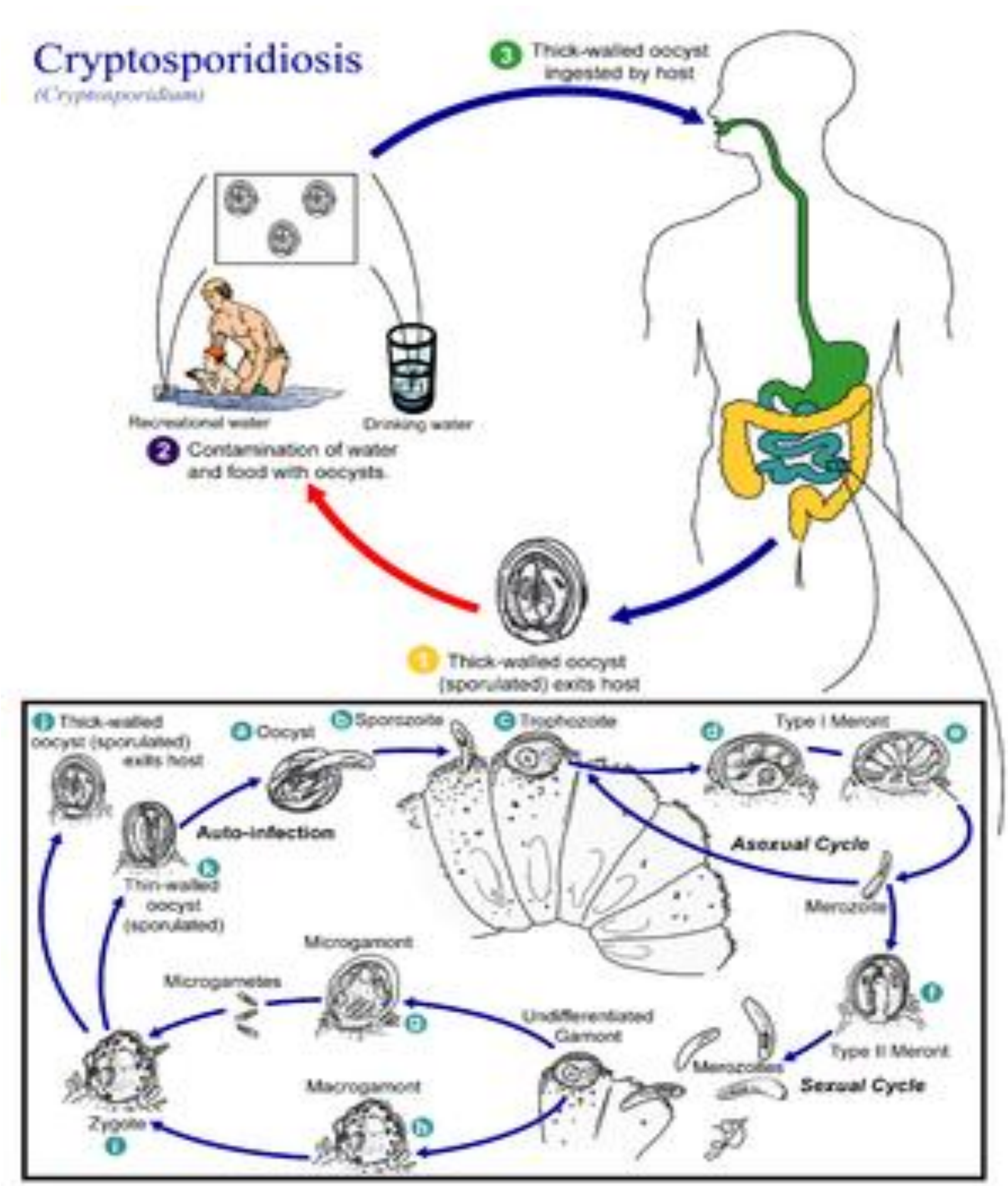

Figure 2: Life cycle of *Cryptosporidium parvum* (Carey *et al*., 2004)

2.1.3. The life cycle and transmission of *Giardia lamblia* infection

Giardia lamblia: is a cosmopolitan parasite with worldwide distribution and the most common Protozoan isolated from gastrointestinal tract (Wallis, 1996). Giardia Reproduces by binary fission which is a type of reproduction in which one cell divides into two new cells by mitosis. *Giardiasis* could be transmitted through drinking contaminated waters or ingestion of contaminated food stuffs. The cyst passes through the stomach and enters the small intestine. The acidic environment of the stomach could not harm the cyst because it has a thin protective wall to protect it until it reaches the alkaline environment, the small intestine (Huang and White, 2006).

Giardia lamblia infection can occur through ingestion of dormant microbial cysts in contaminated water or food, or by the fecal–oral route (through poor hygiene practices). The cyst can survive for weeks to months in cold water, so can be present in contaminated wells and water systems, especially stagnant water sources, such as naturally occurring ponds, storm water storage systems, and even clean-looking mountain streams (Huang and White, 2006).

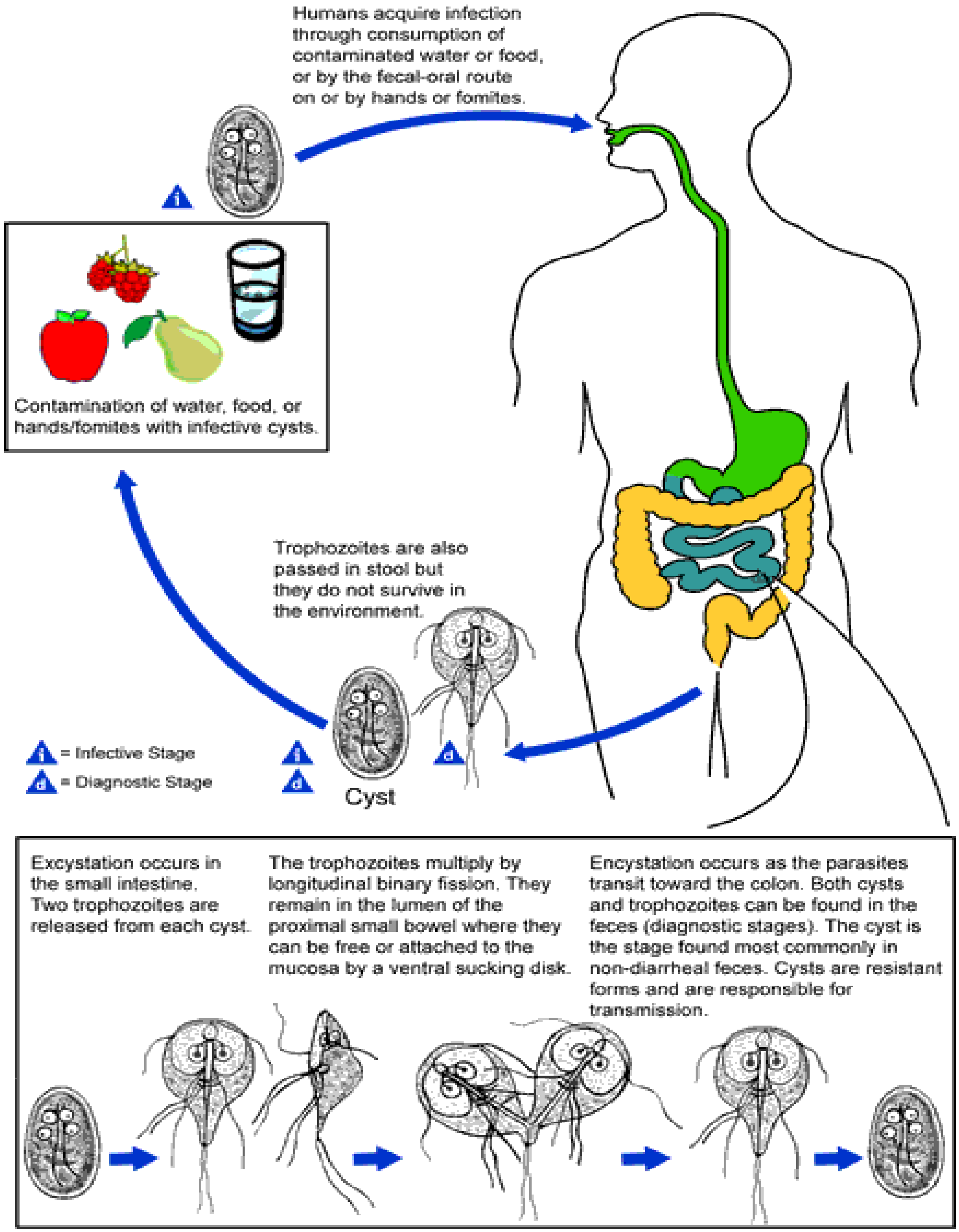

Figure 3. Life cycle of *Gardia lamblia* (Source: http//www.dpd.cdc.gov/dpdx) (Last modified: 12/05/2008)

2.2. Soil Transmited Helminth Parasitic Infections

Helminths, also commonly known as parasitic worms, are multicellular organisms, which when mature can generally be seen with the naked eye. They are often referred to as intestinal worms even though not all helminths reside in the intestine; for example Schistosomes are not intestinal worms, but resides in blood vessels (Samuel, 1996). An infection by a helminth is known as helminthiasis, soil -transmitted helminthiasis, helminth infection or intestinal worm infection. Helminths are feeding on hosts, receiving nourishment and protection, while disrupting their hosts' nutrient absorption and causing weakness and diseases (CDC, 2014). Helminths are able to survive in their mammalian hosts for many years due to their ability to manipulate the immune response by secreting immunomodulatory products and their eggs (Ova) have a strong shell that protects the eggs against a range of environmental conditions (Jirillo *et al*., 2014).

Nematodes: All nematodes are characterized by their elongated, cylindrical, and unsegmented bodies. The sexes are separate, the males typically being smaller than females. More than a million people worldwide are infected with one or more species of intestinal nematodes. These parasites are most common in regions with poor sanitation, particularly in developing tropical and sub tropical countries. Although nematode infections are not usually fatal, they contribute to malnutrition and diminished work capacity. Because most of the helminthic parasites do not self replicate, the acquisition of a heavy burden of adult worms requires repeated exposure to the parasite in its infective stage (larva or egg) or auto-reinfection must occur. They include the four main species of helminths that infect people; these are *Ascaris lumbricoides (round worm)*; *Trichuris trichiura (whipworm);* and *Ancylostoma duodenale* and *Necator americanus* (hookworms) (WHO, 2013). The soil transmitted helminths (STH) such as *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (Whipworm), *Ancylostoma duodenale* and *Nectar americanus* (hookworms) infection still represent a great burden in public health and affect almost two billion people worldwide (WHO, 2012).

Poor people in developing countries endure the burden of disease caused by these four common species of soil transmitted helminths that inhabit the gastro-intestinal tract, especially children and pregnant women are the main sufferers from these parasitic infections (Bethony *et al*., 2006).

Means of exposure include ingestion of undercooked meat, drinking infected water, and skin absorption and the transmission of intestinal parasites usually conducted through directly or indirectly faecal contamination, but their distribution in different geographical location may vary depending on many factors involved in the maintenance of life cycle of each parasite and the majority do not require intermediate hosts and have a wider distributions, while others need obligatory hosts, climatic condition and habitat requirement naturally found or modified by human activities (Birmeka, 2009).

Ascaris lumbricoides are the largest of the intestinal nematodes found in man and cause *Ascariasis* which has a worldwide distribution. It is particularly common in regions with poor sanitation. Annual morbidity associated with the parasite has been estimated by WHO at 60,000 with another 250 million people said to be at risk for acquiring the infection (WHO, 2000). *A. lumbricoide* is a robust parasite because of the resilient nature of its eggs, which are capable of surviving a wide range of hot and cold temperatures, chemicals, chemical disinfectants and other extreme conditions (Neva and Brown, 2012).

Trichuris trichiura: *trichuriasis* is an infection of the human intestinal tract caused by *Trichuris trichuira*, whip worm which is commonly due to the whip-like form of the body. *T. trichiura* infection is estimated to affect around 1049 million persons worldwide. Of these, 144 million are children of pre-school age and 233 million are of school age. These nematodes are most commonly seen in tropical climates and in areas where sanitation is poor (Chan *et al*., 1994).

Hookworms: Hookworm infection is caused by one of the two hookworm species; namely *Ancylostoma duodenale* and *Necator americanus*. Adult hookworms, which are about 1cm long, use buccal teeth or cutting plates to attach to the small bowel mucosa and ingest blood and intestinal fluid (0.2 ml /day per *Ancylostoma* adult) and cause large volume blood loss from intestinal bleeding. One fourth of the world's population is infected with one of the two hookworm species. Hookworm disease develops from a combination of factors such as heavy worm burden, prolonged duration of infection and an inadequate iron intake, and it is characterized by iron deficiency anemia and occasionally hypoproteinemia. *N. americanus* is generally smaller than *A. duodenale* with males usually 5 to 9 mm long and females about 1 cm long. *A. duodenale* worms are grayish white or pinkish with the head slightly bent in relation to the rest of the body. This bend forms a definitive hook shape at the anterior end for which hookworms are named. They possess well developed mouths with two pairs of teeth. While males measure approximately one centimeter by 0.5 millimeter, the females are often longer and stouter. Additionally, males can be distinguished from females based on the presence of a prominent posterior copulatory bursa (Birre *et al*., 2006).

2.2. 1. Life cycle and transmission of *Ascaris lumbricoides* infection

Ascaris lumbricoides infections in human occur when ingested infective eggs releases a larval worm that penetrates the wall of the duodenum and enters the blood stream. From here, it is carried to the liver and heart, and enters pulmonary circulation to break free in the alveoli, where it grows and molts. In three weeks, the larvae pass from the respiratory system to be coughed up, swallowed and thus returned to the small intestine, where they mature to adult male and female. Then, fertilization occurs between them and the female produces as many as 200,000 eggs per day for a year. These fertilized eggs become infectious after two weeks in soil; they can stay in soil for about 10 years or more (Birre *et al*., 2006).

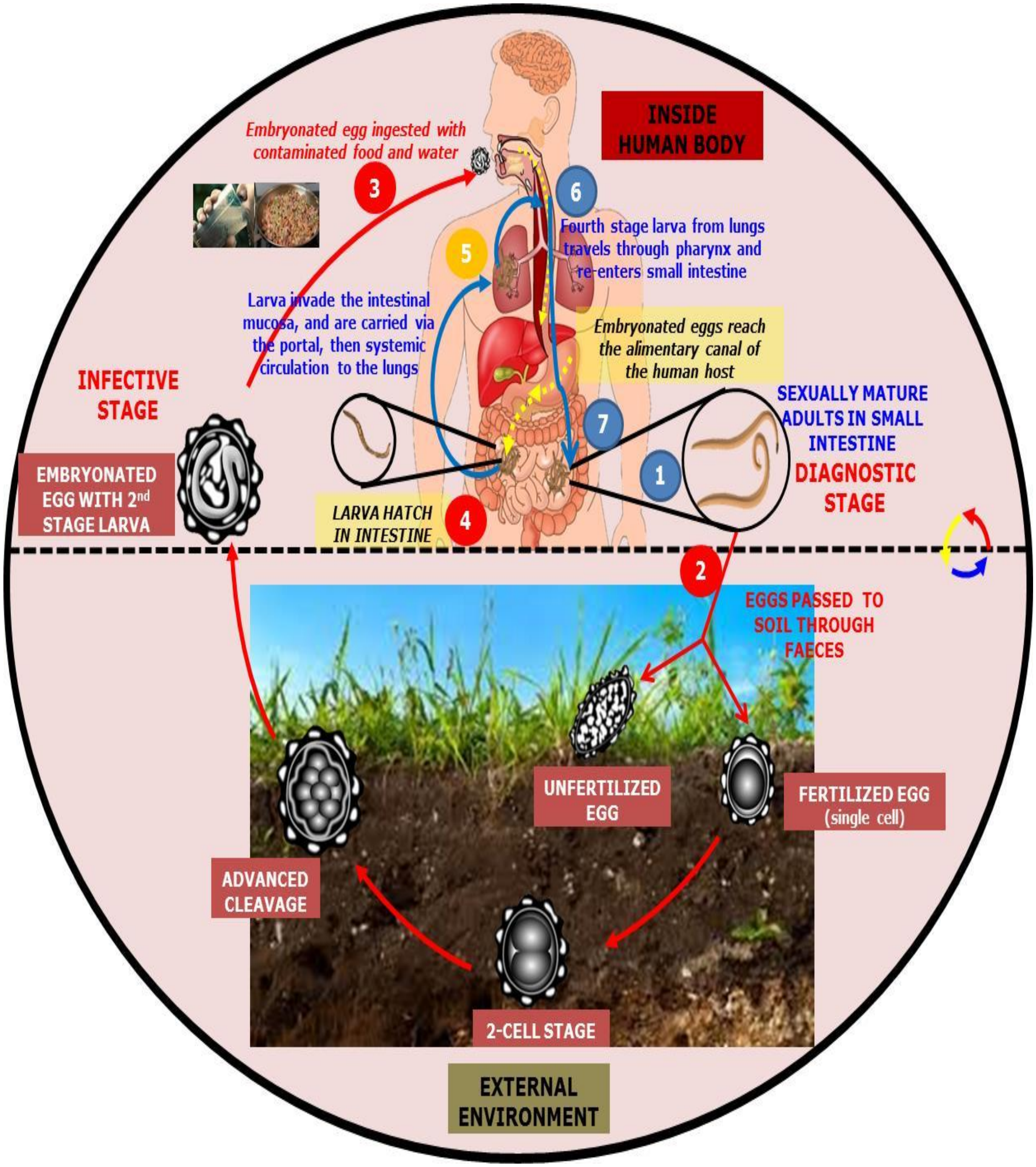

Figure 4. Life cycle of *Ascaris lumbricoide* (Source: http://daveproject.org/duodenum-ascaris-lumbricoides/2004-05-10)

2.2.2. Life cycle and transmission of hookworm infection

*Nectar americanus and A .duodenale (*hookworm) eggs hatch in soil. The larvae molt twice to become infective third-stage larvae, which are non-feeding but motile organisms that seek out higher ground to improve the chance of contact with human skin. After skin penetration, they enter subcutaneous venules and lymphatic vessels to access the host's afferent circulation. Ultimately, the larvae become trapped in pulmonary capillaries, enter the lungs, pass over the epiglottis, and migrate into the gastrointestinal tract (Hotez *et al.*, 2004). About 5-9 weeks are needed from skin penetration until development of egg-laying adults. *A. duodenale* larvae are also orally infective, and lactogenic transmission during breast feeding has been postulated. STHs do not reproduce within the host. This feature is crucial for understanding of the epidemiology and clinical features of soil-transmitted helminth infections, as well as the approaches to their control (Birre *et al*., 2006).

As it is indicated in figure 5, eggs are passed in the stool 1, and under favorable conditions (moisture, warmth, shade), larvae hatch in 1 to 2 days. The released rhabditiform larvae grow in the feces and/or the soil 2, and after 5 to 10 days (and two molts) they become filariform (third-stage) larvae that are infective 3. 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 4. 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 5. 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 transmammary route. *N. americanus,* however, requires a transpulmonary migration phase (CDC, 2014).

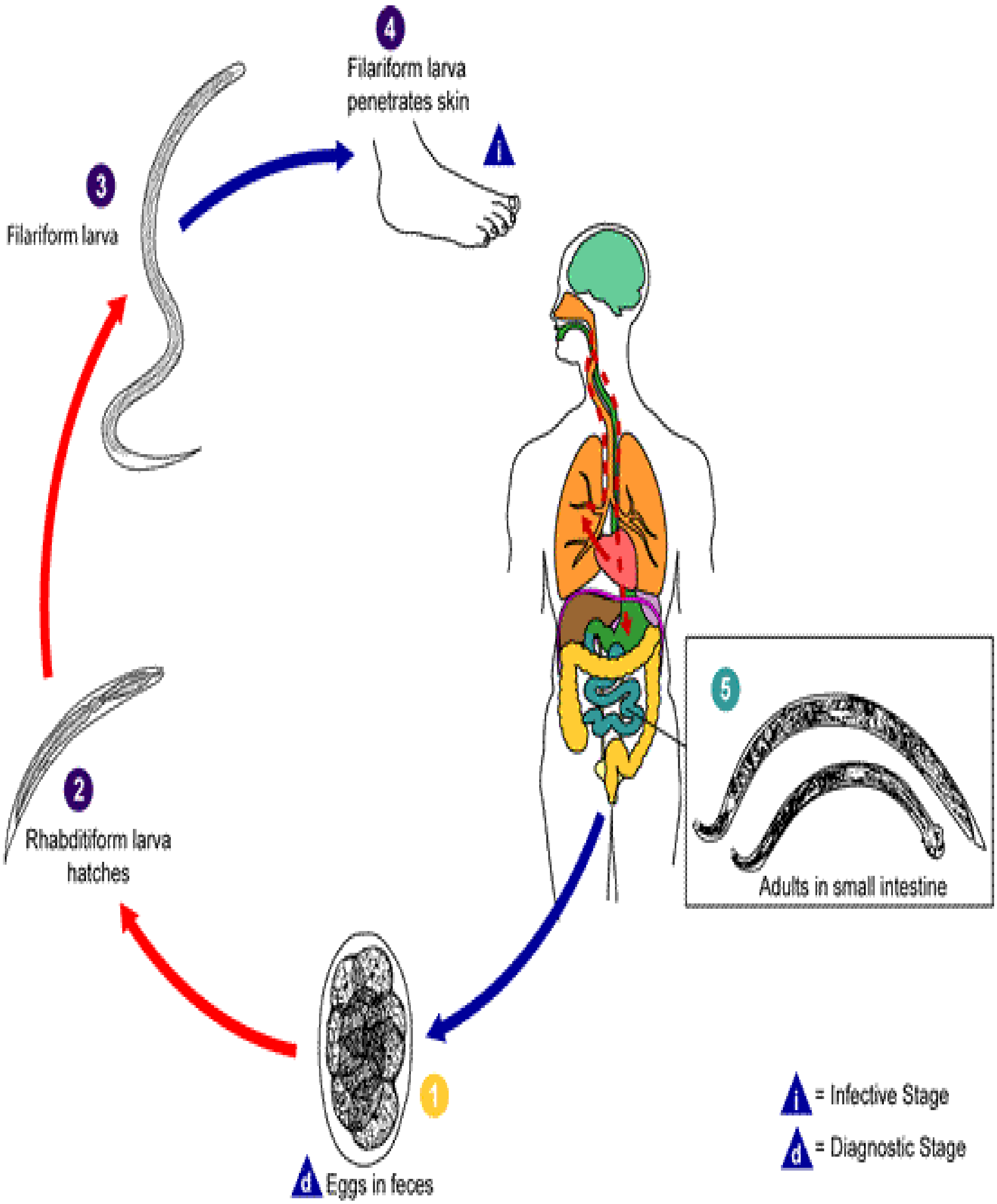

Figure 5. Life cycle of hookworms (Source: https//dpd.cdc.gov/dcs. parasites/hookworm)

2.2. 3. Life cycle and transmission of *Trichuris trichiura* infections

The human whipworm (*Trichuris trichiura or Trichocephalus trichiuris*) is a round worm that causes trichuriasis (a type of helminthiasis which is one of the neglected tropical diseases) when it infects a human large intestine. It is commonly known as the whipworm which refers to the shape of the worm; it looks like a whip with wider "handles" at the posterior end. The female *T. trichiura* produces 2,000–10,000 single-celled eggs per day (Cross and John, 1996*)*. Eggs are deposited from human feces to soil where, after two to three weeks, they become embryonated and enter the "infective" stage. These embryonated infective eggs are ingested and hatch in the human small intestine exploiting the intestinal microflora as hatching stimulus (Hayes *et al*., 2010).

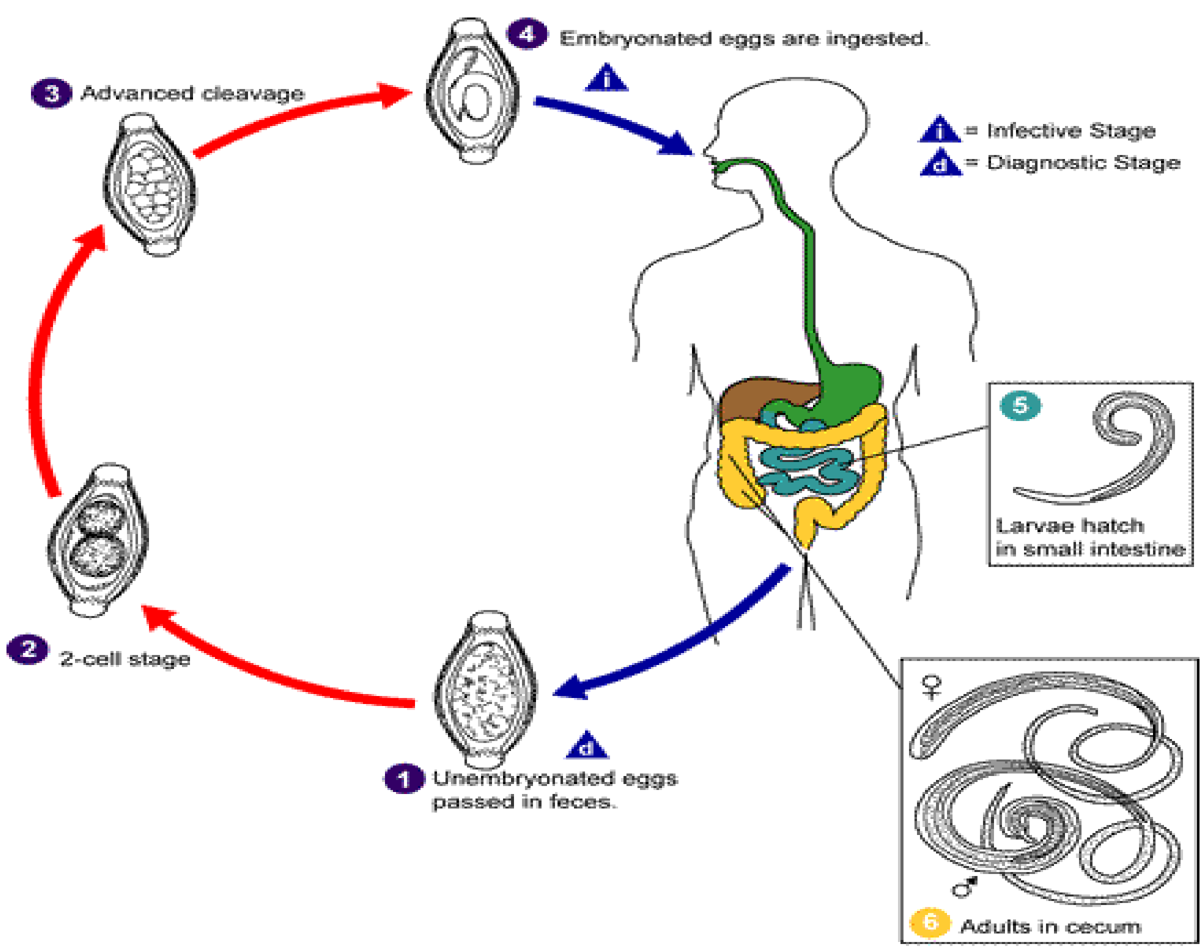

Figure 6. Life cycle of *Trichuris trichiura* (Source: http//www.dpd.cdc.gov/dpdx.)

2.3. Epidemiology of Human Intestinal Protozoan and Soil-transmitted Helminths

2.3.1. Global distribution of human intestinal protozoan and soil-transmitted helminths infections

Gastrointestinal parasites are infectious diseases of poverty. Thus, while still found in North America and Europe, their prevalence is highest in areas of intense poverty in low- and middle-income countries in the tropical and subtropical regions of SSA, Asia and Latin America (Hotez *et al*., 2008). Climate is an important determinant of transmission of the human intestinal protozoan and soil-transmitted helminths infections, with adequate moisture and warm *temptature* essential for larva development in the soil (Brooker *et al*., 2006).

A study estimated that *Ascaris lumbericoid* infects 1,221 million people, *trichuris trichura* 795 million, hookworms infect 740 million. Approximately, 85% of the Neglected Tropical Diseases (NTDs) burden results from protozoa and helminh parasite infections (Hotez and Kamth, 2009). Intestinal protozoan parasitic infections are distributed worldwide and associated with conditions such as lack of access to safe drinking water, impoverished health services, poor environmental and personal hygiene and low sanitation practices. The infections are estimated to affect 3.5 billion people most of whom are children and young living in developing countries. It is estimated that about 200 million infections occur each year in Africa, Asia and Latin America (Feng and Xiao, 2011). Human cases of *Cryptosporidium* sp. have been reported in various parts of the world and the prevalence appears to be highest in the tropics. In USA and UK, giardiasis is the most commonly reported intestinal parasitic infection of man (Davis *et al*., 2002).

2.3.2. The burden of human intestinal protozoan and soil-transmitted helminths infections in Ethiopia

In many part of the world, parasitic worms affect the health of human in developing countries such as Ethiopia. Infections due to protozoan and soil-transmitted helminths, especially in children are still a public health problem (Scrimshaw, 1994). They are more prevalent in the poor parts of the population with low household income, poor handling of personal and environmental sanitations, overcrowding and limited access to clean water. So, as a result of low level standards of living, poor environmental sanitations and ignorance of simple health promoting factors, intestinal parasitism is very high (Amare *et al*., 2007).

The prevalence and distribution of helminths infection varies by place and age in Ethiopia (Belyhun *et al.,* 2010).The previous finding from Wondo Genet, Southern Ethiopia indicated that the prevalence of infection for *A. lumbricoides* was 83.4%, while it was 86.4% for *T. trichiura* among schoolchildren (Berhanu and Girmay, 2003). According to the study conducted by Alemsthet *et al*. (2010) in south western Ethiopia, out of 301 school children who were studied, 68.4% harbored one or more parasites. From the total ten species identified, *Ascaris lumbricoide* was the leading (52.2%) followed by *T. trichiura* (18.6%), while *Shcistosoma mansoni* was the least (0.3%).

2.4. Factors Associated with Intestinal Protozoan and Soil Transmitted Helmiths Infections

Risk factors for intestinal Protozoan parasites: are intimately associated with poverty, poor sanitation and lack of clean water, low socio - economic status, geographical location. They are considered as diseases of the less developed society characterized by poverty, lacking basic services and awareness. Particularly, the scarcity of latrines enhances transmission probabilities through indiscriminate defecation habits. Under poor hygienic condition, faeces and urine often enter water body occurring near human habitations and this enhances transmission (Culha *et al*., 2007). School age children mainly are at high risk of these IPP infections especially in developing countries like Ethiopia, because their immune systems are immature (WHO, 2012).

Risk factors for intestinal Soil-transmitted Helminths parasites: Siol-transmitted helminths infections are associated with factors such as humid environments, low socio - economic status, geographical location, age, environmental and personal hygiene absence of the latrines. Surface water may be contaminated by parasites from fields containing faeces of infected humans, livestock, or wild animals to nearby rivers, streams and other water source. Most infectious diseases are particularly prevalent in areas with warm climates in which man exerts himself least in developing sanitary protection and typically has a low threshold of resistance to invading organisms (Kariuki *et al.*, 2004). Lacking basic services and awareness, particularly, the scarcity of latrines enhances transmission probabilities through indiscriminate defecation habits.

2.5. Impact of Intestinal Protozoan and Soil Transmitted Helmiths on the Health and Development of Child.

Generally, symptoms signaling the presence of gastrointestinal parasitic infections are related to the intensity of infection. Thus, a light protozoan or Soil-transmitted helminths infection is often asymptomatic whereas a mild to heavy infection can be associated with painful and severe symptoms. However, subtle damage and dysregulation (impairment in the regulation of a metabolic process) can occur in the absence of any noticeable infection. For example, it has been observed that minor levels of gastrointestinal infections nematodes impair functions such as milk production in animals. The health impact of gastrointestinal parasites depends on a number of variables including the nutritional status of the host, the species of parasite, the mixture of species, the duration of infection and the number of parasites in the human host (Suarez *et al*., 2009; Charlier *et al*., 2009).

2.6. Anthropometric Measurements

Anthropometry is the single most universally applicable, inexpensive and non invasive method to assess the nutritional status of children (WHO, 2006). The anthropometric measurements, weight and height are measured following the standardized procedures mentioned in Gibson, (2005) and body mass index (BMI) is calculated using the formula, BMI=weight in kg/ [height in m] ^{2}.

Under-nutrition was defined for a child, who had less than -2 Z-scores (-2SD) from the National Center for Health Statistics (NCHS) median reference population values (WHO, 2007). This was used as cut-off point to determine malnourishment. Since wasting for those children with age above 9 years cannot be evaluated through WHO AnthroPlus, Body Mass Index (BMI) (weight/height in metre2) was calculated and a BMI-for-age value less than 5^{th} percentile of reference data was considered as thinness or underweight (WHO, 2009).

These three nutritional indicators, weight-for-age, weight-for-height, and height-for-age indicate different information about growth and body composition, which used to assess nutritional status. Stunting, or low height -for - age, reflect a failure to reach linear growth potential as a result of suboptimal health and/or nutritional conditions; wasting, or low weight-for -height, describes recent and significant Weight loss, usually as a consequence of famine, or sever disease; and underweight, or low weight - for - age, is a synthesis of the current status of body proportion and linear growth. The prevalence of wasting, stunting and underweight, both <-2 SDs and <-3 SDs. Children whose height-for-age Z-score is below minus two standard deviations (-2 SD) from the median of the reference population are considered short for their age (stunted) and are chronically malnourished. Children who are below minus three standard deviations (-3 SD) from the median of the reference population are considered severely stunted. Stunting reflects failure to receive adequate nutrition over a long period of time and is also affected by recurrent and chronic illness. Height-for-age, therefore, represents the long-term effects of malnutrition in a population and does not vary according to recent dietary intake (CSO, 2005; WHO, 2006).

2.7. Prevention, Treatment and Control of Intestinal Parasitic Infections

Children are both the principal sufferers of the effects of gastrointestinal parasites and the source of the continued maintenance of transmission as such children are the targets of disease control interventions. Human intestinal protozoan and STHs parasitic infections need public-health interventions such as community health education, observation of food hygiene, maintenance of functioning sanitation systems, the protection of open wells, springs and rivers from contamination with sewage and feces are essential to long-term control in a community (Lammie *et al*., 2006). However, any health program aiming at controlling morbidity of intestinal parasitic infections should have evidence based estimates of infections problem according to World Health Organization guidelines (WHO, 2002). The risk for infection can also be reduced via the adequate boiling of drinking water or treatment of water with chlorine or iodine. The exterior of raw vegetables and fruits should be washed with soup and soaked in vinegar for some minutes before conception (Petri and Singh, 2009).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The study was conducted at Oda Belina and Ethiopia Tekdem primary schools, Hirna town, which is the largest town of Tullo *woreda* in West Hararghe Zone of Oromia Regional State, Ethiopia (Figure 7). Hirna is located on the main highway between Chiro and Haramaya in the chercher mountains. It is about 374 km away from Addis Ababa and 48km away from Chiro town, the administrative seat of west Harerghe Zone. Hirna is the administrative seat of the Tullo *woreda* with total population of 16794, of whom 8394 and 8400 were males and females, respectively.

Hirna has a latitude and longitude of 9° 13'N 41° 06'E and an altitude of 1763 m.a.s.l. (Figure 7). The rain fall distribution is bi-modal and ranges from 650 to 1200mm, with an average annual precipitation of 750 mm. The temperature of the town ranges from 16 to 33^0C (Tullo *woreda* Agricultural Office).

The town has one preparatory school, one secondary school, four primary schools and three KGs. The town has one primary health central unit and six private clinics. The inhabitants of the town use teff, coffee, sweet potato, vegetables, potato, onion, sorghum and maize which are produced in the *woreda*.

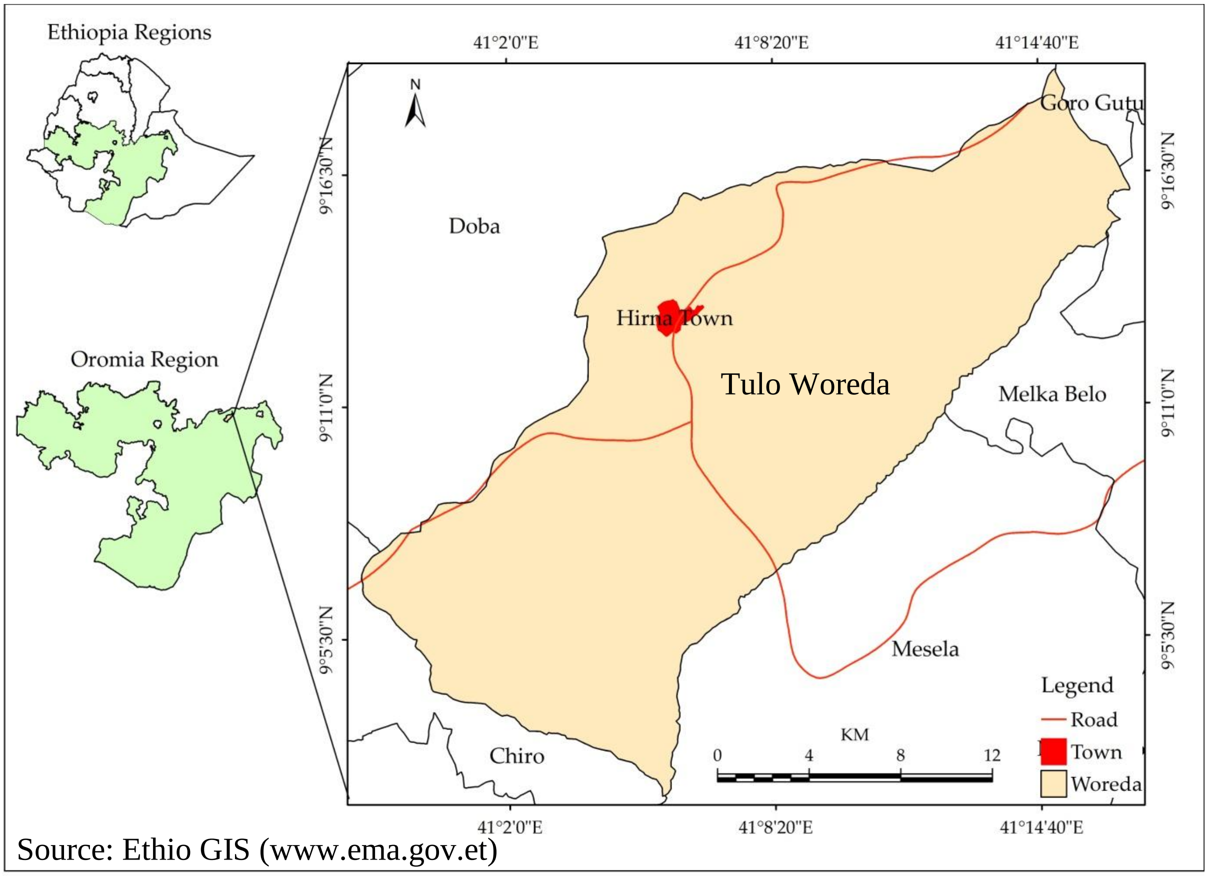

Figure 7. Map of the Study Area

3.2. The Study Design

A school based cross-sectional survey was carried out for the determination of the prevalence of intestinal parasitic infections and their associations with the anthropometric measurements of school children in the selected primary schools at Hirna town. The study was conducted from April to June, 2017 at Oda Belina and Ethiopia Tekdem primary schools.

3.3. Study Population

All students from grade 1 to 8 or their guardians (parents) in the selected schools, who were voluntary to participate and sign the consent form, were included in the study. According to the data obtained from the two primary schools, the total number of students from grade 1 up to grade 8 enrolled in the 2016/2017 academic year were 2571. Of these, 1307and 1264 were males and females, respectively. These constituted the study population of the present study (Table 1).

3.4. Exclusion Criteria

According to the information obtained from the Children and their parents, those who had started medication for intestinal parasitic infections at the time of data collection were excluded.

3.5. Sample Size Determination and Sampling Techniques

The sample size was estimated using the following statistical formula (Naing *et al*., 2007).

$$n = \frac{z^2 p(1-p)}{d^2} = \frac{z^2 pq}{d^2}, \frac{(1.96)^2 \times 0.5(1-0.5)}{(0.05)^2} = 384$$

Where: n = sample required

Z = 95% confidence interval (1.96)

d = Marginal error between the sample and population (0.05)

P = prevalence rate (0.5)

Since the overall prevalence rate (p) of intestinal protozoan and soil-transmitted helminths infection and their associations with anthropometric measurements was not known for the study area, prevalence was taken to be 50%. For calculation, a 95% confidence interval (Z) and a 5% margin of error (d) was used. Therefore, in this study three hundred eight four (384) school-children were chosen to participate in the present study. To select the sample children, the students were first stratified according to their educational level (grade1-4 and grade 5- 8). Proportional sample size was then allocated for students coming from different *kebeles*, 1335 students were rural and 1236 students were urban. Finally, the sample children were selected using random sampling technique (Table 1).

Table 1. The total student population and sample students in Oda Belina and Ethiopia Tikdem primary schools during 2016/2017 academic year.

Name of School	Grade	Total Students			Sample Students Population		
		Male	Female	Total	Female	Male	Total
Oda	1-4	300	277	577	45	35	76
Belina	5-8	270	316	586	41	36	63
Ethiopia Tekdem	1-4	408	416	824	62	66	131
	5-8	329	255	584	49	50	114
Total	1-8	1307	1264	2571	197	187	384

3.6. Methods of Data Collection

3.6.1. Questionnaire survey

To identify the major risk factors for intestinal parasitic infections, structured questionnaires were used for children from grade 5 to 8 and for parents (guardians) instead of children from grade 1 to 4. The questionnaires were prepared in English, and translated into Afan Oromo. Then, the results of the questionnaire were translated back into English. Finally, it was distributed to randomly selected participants of urban and rural area (384) of the study area. Information on socio-demographic data such as age, sex, family size, source of water, presence or absence of latrines in their homes, parents' educational level, personal hygiene, and other information were gathered using close-ended questions after pre-tested outside the study area.

3.6.2. Anthropometric measurements

The weight and height were measured following the standardized procedures mentioned in Gibson (2005) and body mass index (BMI) was calculated using the formula, BMI=weight in kg/ [height in m] ^{2}. Weight was taken without shoes and minimum clothing using weighing scale and was recorded to the nearest 0.1 Kg. The height was measured to the nearest 0.1 cm using a measuring tape. The age of each child was recorded during sample collection. All data were transformed and expressed in Z-scores and calculated using anthropometry calculating software program, AnthroPlus (WHO, 2007).

3.6.3. Stool Sample Collection

Stool samples were collected from the study participants by providing them with small clean plastic sheets and clean wooden applicator sticks. First, the children and their parents (for those children who need assistance) were given specific instructions on handling and avoidance of contamination of the stool sample with water, the seat of latrine or soil and urine. The collected samples were kept in a plastic container and transported to the laboratory for examination within a few minutes. At the time of sampling; date of sampling, age, sex, presence or absence of intestinal parasitic infections, and code number were recorded for each child on the record format. With a marker the identification code on the recording format for each study participants was written at either end of a slide.

3.7. Laboratory Parasitological Examination Procedures

3.7.1. Direct microscopy or wet mount method

Direct wet mount is the commonly used method for diagnosis of intestinal parasitic infections. A direct wet mount with normal saline (0.85% NaCl solution) was prepared at study site and observed for the presence of live motile intestinal parasites, trophozoites and cysts (inactive dormant stage of protozoa) or eggs and larvae of helminths under light microscope at 10X and 40X magnification. Lugol's iodine staining was also used to observe eggs and cysts of intestinal parasites (WHO, 1991). Each of the stool samples of study participants (about 2mg stool) was applied to a small area of a clean microscopic slide, immediately before the specimen dries, 1 or 2 drops of saline was added and mixed with a pipette tip. Then the specimen was covered with a cover slip and observed under the microscope (Lindo *et al*., 1998).

3.7.2. Formol-Ether Concentration Method

The numbers of parasitic forms of protozoan and/or helminth parasites in fecal specimens are often too low to be observed microscopically in direct wet mount. But, the concentration methods increase the sensitivity of microscopic techniques, thus increasing the chance of detecting parasitic organisms. Formalin-ether concentration technique was done using an applicator stick; about 5g of stool sample was placed in a clean 15 ml conical centrifuge tube containing 7 ml formalin. The sample was mixed thoroughly with the applicator stick. The resulting suspension was filtered through a sieve (cotton gauze) into a beaker and the filtrate was poured back into the same tube. The debris trapped on the sieve was discarded. After adding 3 ml of diethyl ether to the mixture and shaking, the content was centrifuged at 1500 rpm for 10 min. The supernatant was discarded and iodine stain preparation was made using the sediment. A 10x and 40x objectives was used to examine the whole of the deposit for cysts and trophozoites by lab technicians (Lindo *et al*., 1998).

3.7. 3. Modified Zeihl -Neelson Method

In the concentration techniques, certain smaller parasitic forms such as the oocysts of *Cryptosporidium* species may not reach the sediment. Modified Zeihl-Neelson staining method is used for detection of *Cryptosporidium* oocysts. In modified Zeihl-Neelson stained smear, oocysts of *Cryptosporidium* would appear small, round to oval, pink red stained bodies measuring 4- 6 µm (Lalancette *et al*., 2012).

In the process of Modified Zeihl-Neelson staining method, two thin smears was prepared directly from fresh stool as well as from sediments of concentrated stool and allowed to air dry. Then the slides were fixed with methanol for 5 minutes and stained with carbol fuchsin for 30 minutes. Then the slides were washed with tap water and decolorized with acid and alcohol (1ml HCl and 99 ml 96% of ethanol) for 1-3 minutes. After washing the slides with tap water, they were counter stained in methylene blue for another 1 minute. Finally the slides were washed in tap water and allowed to air dry. Then the slides were observed under light microscope with high objective power at 1000x magnification (Lalancette *et al*., 2012).

3.8. Data Analysis

Data were analyzed Using SPSS, Windows version 22. The Pearson chi-square (x^2) was used to verify the relationship between independent factors such as age, sex, family size, availability of latrine, educational level of the parents and the like and the outcome variables (prevalence of diseases). The significance of the differences in frequency distribution was tested by using chi-square analyses. P-values less than 0.05 were considered statistically significant. Anthropometric indices were computed using the calculator mode of anthropometry calculating software program AnthroPlus (WHO, 2007). Undernutrition such as wasting, stunting and underweight were defined as Z- score values of less than -2 SD (standard deviation) which was below what is expected on the basis of National Center for Health Statistics (NCHS) (WHO, 2007).

3.9. Data Quality Control (DQC)

To ensure quality control, all the laboratory procedures including collection and handling of specimens were carried out in accordance with standard protocols (WHO, 1991). To ensure general safety, disposable gloves were worn and universal bio-safety precautions (NCCLS, 2002) were followed at all times.

3.10. Ethical Consideration

Data collection was done after clearance letter or permission was obtained from Tullo Woreda Health Bureau. At the beginning of the study the objectives of the study and procedure of sample collection were explained to school principals, teachers, students and parents. Sample collection was carried out using sterile and disposable materials. All activities in clinical examination as well as stool sample collection and laboratory parasitological examination were done by laboratory technicians. The children were assured of confidentiality for the stool sample results and those who diagnosed positive for the intestinal parasitic infections were treated for free with the cooperation of Hirna Health Center.

4. RESULTS AND DISCUSSIONS

4.1. Some Socio-Demographic Characteristics of the School Children

The data related to socio-demographic characteristics of the study participants were summarized and presented in Table 2. As shown in table 2, out of the total 384 study participants, 197 (51.3%) and 187 (48.7%) were males and females, respectively (Table 2). Regarding the age distribution of the study participants, 127 (33.1%), 137 (35.7%) and 120 (31.2%) were in the age group of 6-9, 10-14 and 15-18 years old, respectively (Table 2). With regard to the location of the residence of the study participants, 217 (56.5%) and 167 (43.5%) were living in the rural and urban, respectively (Table 2). Regarding the educational status of school children parents and the care takers was, 144 (37.5%) had no formal education and 240 (62.5%) were literate (Table 2). Out of a total of 384 study participants, 147 (38.3%) had less than four family size and 237 (61.7%) had four and above family size (Table 2).

As indicated in table 2, about 269 (70.1%) of the study participants replied that they used protected water for domestic purpose. However, 115 (29.9%) were using unprotected water. With regard to latrine availability, 286 (74.5%) students' households had latrine at their home and 98 (25.5%) had not latrine (Table 2). About 254 (66.2%) study participants wore shoes regularly while 130 (33.9%) wore shoes sometimes (Table 2). 146 (38.0%) study participants did wash their hands before meal and after toilet with water and soap. However, 238 (62.0%) did not (Table 2). Regarding the households' occupation, 245 (63.8%), 81 (21.1%), and 58 (15.1%) were farmers, self employed and government employed, respectively (Table 2).

Table 2. Socio-Demographic Characteristics of the School Children

Children's socio-demographic characteristic		Frequency	Percent (%)
Sex:	Male	197	51.3
	Female	187	48.7
Age group			
6-9:	Male	62	48.8
	Female	65	51.2
	Total	127	33.1
10-14:	Male	70	51.1
	Female	67	48.9
	Total	137	35.7
		65	54.2
15-18:	Male	55	45.8
	Female	120	31.2
	Total		
Residence:	rural	217	56.5
	urban	167	43.5
Family size:	< 4	147	38.3
	≥ 4	237	61.7
Parents' educational level:			
	Illiterate	144	37.5
	Literate	240	62.5
Source of potable water:			
	Protected water	269	70.1
	Unprotected water	115	29.9
Latrine availability:	present	286	74.5
	Absent	98	25.5
Wearing shoes habit:			
	sometimes	130	33.9
	Always	254	66.2
Washing hands before meal and after toilet:			
	Yes	146	38.0
	No	238	62.0
Main occupation of the household:			
	Agriculture	245	63.8
	Government employed	58	15.1
	Self employed	81	21.1

4.2. The Prevalence of Intestinal Protozoan Parasite Infections among School Children

The overall prevalence of IPPIs among the three age groups was 11.7%, out of which 11.2% and 12.3 % were for males and females, respectively (Table 3).The prevalence of IPPIs for the age group 6-9 years was 15.8%, where 14.5% and 16.9 % were for males and females, respectively (Table 3). Similarly, for the age group 10-14 years it was 13.9%, out of which 14.3% and 13.4 % were for males and females, respectively (Table 3). However, for the age Group15-18 years the prevalence of IPPIs was 10.9%, out of which 4.6% and 5.5% were for males and females, respectively (Table 3). The prevalence of IPPIs was high in the first age group and it occurred in a decreasing manner as the age increased. The reason could be due to slow development of immunity in adults to protozoan parasites and better awareness in washing hands and other personal hygiene measures (Gelaw *et al*., 2014). In the present study no statistically significant associations were found between IPPIs and the sexes ($p > 0.05$).

This finding was in line with the previous findings reported by Gelaw *et al*. (2014) and Tadese (2013) which revealed 13.9% and 13% prevalence of IPPIs, respectively. However, much more lower than that reported by Nam *et al*. (2012), where prevalence of IPPIs was 30.1%. These differences in the prevalence of IPPIs are mainly related to the access of clean potable water, poor environmental sanitation and personal hygiene**,** host immune response and epidemiology (Mulu *et al*., 2015).

Table 3 .Prevalence of intestinal protozoan parasitic infections among school children.

Age	Male		Female		Both Sexes		χ^2	P-value
	sa.examined	+ve (%)	sa.examined	+ve (%)	sa.examined	+ves (%)		
6-9	62	9(14.5)	65	11(16.9)	127	20(15.8)	0.139	0.710
10-14	70	10(14.3)	67	9(13.4)	137	19(13.9)	0.038	0.845
15-18	65	3(4.6)	55	3(5.5)	120	6(10.9)	0.044	0.834
Total	197	22(11.2)	187	23(12.3)	384	45(11.7)	0.433	0.511

Key: +ve= Number of Positive

4.3. The Prevalence of Soil Transmitted Helminths Parasitic Infections among School Children

The overall prevalence of STHIs of all age groups was 17.5 %, out of which 18.8 % and 16.04 % were for males and females, respectively (Table 4). The prevalence rate of STHIs for the age group 6-9 years was 26.8 %, out of which 30.7% and 23.1 % were for males and females, respectively (Table 4). While for age group 10-14 years the prevalence of STHs was 20.4 %, out of which 21.4 % and 22.4 % were for males and females, respectively (Table 4). However, for the age group 15-18 years, the overall prevalence of STHIs was 4.2%, out of which 4.6 % and 3.6 % prevalence were for males and females, respectively (Table 4). Generally, this finding indicated that the prevalence of STHs infections was different among the different age groups because the distributions of intestinal parasitic infections vary according to different geographical area, the host immune systems and age groups and highest prevalence at the first age group due to the fact that children of this age have not yet fully developed the body resistance, play in poor sanitation environments, very active and touch many contaminated objects, so exposed to too many source of infections (Albonico, 1999; Oguntibeju, 2006; Rashidul, 2007).

There is no statistically significant associations between STHIs and the sexes in all age groups (χ^2 = 0.500, p = 0.480). This finding comparatively lower than the earlier reports from Babile town (Tadesses, 2005), Hossana town (Babullo, 2012) which reported 27.2% and 27.9%, respectively.

Table 1: .Prevalence of intestinal protozoan parasitic infections among school children.

Age	Male		Female		Both Sexes		χ^2	P-value
	sa.examined	+ve (%)	sa.examined	+ve (%)	sa.examined	+ves (%)		
6-9	62	19(30.5)	65	15(23.1)	127	34(26.8)	0.927	0.336
10-14	70	15(21.4)	67	13(22.4)	137	28(20.4)	0.086	0.769
15-18	65	3(4.6)	55	2(3.6)	120	5(4.2)	0.072	789
Total	197	37(18.8)	187	30(16.04)	384	67(17.5)	0.500	0.480

4.4. Major Intestinal Protozoan and Soil-transmitted Species Detected among School Children

In the present study, three different protozoan parasites species were identified from the total stool samples (384) examined with an overall prevalence of 11.7% (Table 3). *E.histolytica*, *G.lamblia* and *Cryptosporidium spp*. were the three protozoan parasites species detected in the examined stool samples of children with an overall prevalence of 7.6%, 3.7 % and 0.5 %, respectively (Table 5). On the other hand, five intestinal helminth parasites species with an overall prevalenc of 17.5% was detected among all age g roups of the examined school children (Table 4). *A. lumbericoides*, *T. trichiura,* hookworm were the soil-transmitted helminths identified. Totally, six intestinal parasites species were identified from the examined pupils with an overall prevalence of 29.2 % in the study area (Table 5).

In the present study, infection with *E. histolytica* (7.6%), *G. lamblia* (3.7%) and *Cryptosporidium spp.* (0.5%) was the highest, second and third prevalence of occurrence, respectively (Table 5). The prevalence of *E. histolytica* (7.6%) among all age groups in the present study was high, but not statistically significant (x^2 =, 0.115 = 0.735) (Table 5).

The prevalence of *G. lamblia* (3.7%) observed in this study was in line with the prevalence of 3.6% from south west Ethiopia by Amare *et al*. (2007) and also it was similar with the prevalence of 3.6% from Gonder by Gelaw *et al*. (2014). The prevalence of *Cryptosporidiu m spp.* (0.5%) in the present study was with the lowest proportion compared to the other protozoan parasites species. Generally, the variations in the prevalence of infections of protozoan parasite species indicated were largely due to the fact that poor personal hygiene, environmental sanitations, and unsafe drinking water (Mulu *et al*., 2015).

Out of the total 67(17.5%) number of individuals positive for STHs parasites infections, the detected parasite species were: *A. lumbericoides,* hookworms, and *T. trichiura* with an overall infection rate of 6.8%, 8.9%, 1.6%, respectively (Table 5). The prevalence of *A. lumbericoides* (6.8%) in the present study was the second highest helminth parasite, but not statistically significant (x^2= 0.412, P = 0.521). It was in line with the prevalence of 7.8% in the previous study reported by Teklu *et al*. (2013). However, much lower than the prevalence of *A. lumbericoides* (12.7%) reported from peninsula, northwest Ethiopia by Merem *et al. (*2017). On the other hand, relatively higher than the previous study from Babile town, Eastern Ethiopia (Tadese, 2005) which revealed 3.9% prevalence of the same parasite species.

Infection with hookworm (8.9%) among all age groups was the highest in the present study, but not statistically significant (x^2 = 0.569, P= 0.451) (Table 5) and it was comparable with the previous study by Jean *et al*. (2016) which reported 7.5% prevalence of infection. The prevalence of *T. trichiura* (1.6%) in the present study was a little bit higher than the prevalence of 0.4% reported by Ashenafi *et al*. (2014) from Enderta district Tigray. However, much more lower than the prevalence reported in the previous study from Lake Langano (Legese and Erko, 2004).

Generally, the variations observed between the present study and various findings from different parts of the country in the prevalence of helminth parasites infections could be attributed to the sensitivity between the diagnostic methods used and the use of single stool sample, environmental contamination and inability of the helminth eggs to withstand diverse temperature, malnutrition and poor health services (Mazigo *et al.,* 2010).

During parasitological microscopic stool examination very few samples were found to be positive for more than one parasitic infection with an overall prevalence of 0.8 % (Table 5). As shown in table 5, out of 112 (29.2%) total children positive for IPIs, 3 children were infected with two or three parasites (co infections). Of these, 2 (0.5%) children were found to be positive for double infections whereas only 1 (0.3%) individual was infected with triple parasites. Thus, the prevalence for single, double and triple infections was 28.4%, 0.5% and 0.3%, respectively (Table 5) and was contradict to the previous study reported from Aksum town, northern Ethiopia by (Mulu *et al*., 2015) which was 37.4%, 6.9% and 0.2% for single, double and triple infections, respectively.

Table 5. Major Intestinal Protozoan and Soil Transmitted Helminths Species by age and sex among Oda belina and Ethiopia tikdem Primary Schools Children from April-June, 2017

Age sex		Number examined	Parasite species: Protozoan parasites species: Eh/d No. of Samples +ve(%)	Gl No. of samples +ve(%)	Cp No. of samples +ve(%)	STHs parasites species: Al No. of samples +ve(%)	Hw No. of samples +ve(%)	Tt No. of samples +ve(%)	Multiple infections No. of samples +ve(%)
6-9:	M	62	5(8.1)	3(4.8)	1(1.6)	10(16.1)	7(11.3)	2(3.2)	-
	F	65	8(12.3)	3(4.6)	-	7(10.8)	6(9.2)	2(3.1)	1(1.5)
10-14:	M	70	6(8.6)	3(4.3)	1(1.4)	6(8.6)	9(12.9)	-	2(2.9)
	F	67	5(7.5)	4(6.0)	-	4(6.0)	7(10.5)	2(3.0)	-
15-18:	M	65	3(4.6)	-	-	-	3(4.6)	-	-
	F	55	2(3.6)	1(1.8)	-	1(1.8)	1(1.8)	-	-
All age group:		197	14(7.1)	6(3.1)	2(1.0)	16(8.1)	19(9.5)	2(1.0)	2(1.0)
		187	15(8.0)	8(4.3)	-	12(6.4)	14(7.5)	4(2.1)	1(0.5)
Total of males and females		384	29(7.6)	14(3.7)	2(0.5)	28(7.3)	33(8.9)	6(1.6)	3(0.8)
x^2			0.115	0.888	1.908	0.412	0.569	0.788	0.286
p-value			0.735	0.346	0.167	0.521	0.451	0.375	0.593

Key: Eh/d→ *Entamoeba histolytica/dispar* Al→*Ascaris lumbricoides* Hn→ *Hymenolepis nana*
Gl→ *Giardia lamblia* Tt→ *Trichuris trichuria* Sm→*Shistosoma mansoni*
Csp→ *Cryptosporidium parvum*

4.5. Major Associated Risk Factors those Predispose the School Children to Intestinal Protozoan and Soil-transmitted Helminths in the Study Area

As shown in table 6, the results of the questionnaire survey for risk factors and their associations with the intestinal parasitic infections in the school children were analyzed and presented in (Table 6).

In the present study, among 147 (38.3%) study participants examined whose family size less than 4, 12(8.2%) and 23(15.7%) were found to be positive for protozoan and STH parasites infections, respectively. However, out of 237(61.7%) study participants who had family size ≥4, 33(13.9%) and 52(21.9%) were found to be positive for protozoan and STH parasites, respectively (Table 6). According to the present study, children's family size was one of the major risk factors which was significantly associated with IPIs (p=0.013).

Regarding parents' educational level, out of 144 (37.5%) study participants whose parents had no formal education, 21 (14.6%) and 32 (21.5%) were found to be positive for protozoan and STH parasites infections, respectively. However, out of 240(62.5%) study participants whose parents were literate, 24(9.9%) were positive for protozoan and 43(17.8%) samples positive for STH parasites (Table 6). Out of 115(29.9%) study participants who used unprotected water for domestic purpose, 12(10.4%) and 31(27.0%) study participants were found to be positive for protozoan and STH parasites, respectively. However, among 269 (70.1%) study participants who used protected water, 33(12.3%) and 44(16.4%) samples were found to be positive for protozoan and STH parasites, respectively (Table 6).

Another statistically significant risk factor in the present study was personal hygiene (washing hands before meal and after toilet) (p=0.002), where out of 238(62.0%) study participants who did not wash their hands before meal and after toilet with water and soap, 34(14.3%) and 54(22.7%) children were positive for protozoan and STH parasites, respectively. Nonetheless, out of 146(38.0%) study participants who regularly wash their hands before meal and after toilet with water and soap, 11(7.5) and 21(14.4%) samples were found to be positive for protiozoan and STH parasites, respectively (Table 6).

Regarding the latrine availability, out of 98(25.5%) study participants who did not have latrine at their home, 17(17.4%) and 21(21.4%) samples were positive for protozoan and STH parasites respectively. However, out of 286 (74.5%) who had latrine at their home, 28(9.8%) and 54(18.9%) samples were observed to be positive for protozoan and STH parasites, respectively (Table 6). Wearing shoes was the other risk factor, where out of 130 (33.9%) samples who did not wear shoes regularly, 8(6.2%) and 27(20.8%) samples were positive for protozoan and STH parasites, respectively. However, Among 254 (66.1%) study participants who did wear their shoes always, only 18(7.1%) and 67(26.4%) children were positive for protozon and STH parasites, respectively (Table 6).

Generally, the associations between prevalence of intestinal parasitic infections and some risk factors such as family size and washing hands before meal and after toilet with soap and water were statistically significant ($X2 = 6.137, p = value = 0.013$). Thus, these factors were deduced as the major risk factors associated with the prevalence of IPIs infections among children of both schools (Table 5). This finding was in line with similar study done on school children in Wukro town, by Eleni *et al*. (2014).

Table 6.The Associations between Intestinal Parasitic Infection and Some Risk- factors among Children of both Schools from April-June, 2017

Risk factors	Number of respondents Examined, frequency (%)	Intestinal parasites species			OR(95%, CI)	X^2	p-value
		IPPIs	STHs	IPPIs & STHs			
		No. of samples +ve, Prevalence (%)	No. of samples +ve, Prevalence (%)	No. of samples +ve, Prevalence (%)			
Family size :< 4	147(38.3)	12(8.2)	23(15.7)	35(23.8)			
≥ 4	237(61.7)	33(13.9)	52(21.9)	85(35.9)	0.559(0.352-0.888)	6.137	0.013
Residence: Rural	217(56.5)	23(10.6)	52(24.0)	75(34.6)			
Urban	167(43.5)	17(10.2)	28(16.8)	45(27.0)	1.432(0.921-2.227)	2.548	0.11
Parents educational Level: Illiterate	144(37.5)	21(14.6)	32(21.5)	53(36.8)			
Literate	240(62.5)	24(9.9)	43(17.8)	67(27.6)	1.504(0.968-2.337)	3.31	0.069
Source of water: protected	269(70.1)	33(12.3)	44(16.4)	77(28.6)			
unprotected	115(29.9)	12(10.4)	31(27.0)	43(37.4)	0.672(0.423-1.065)	2.882	0.09
Washing hands with water and soap before meal and after toilet:							
yes	146(38.0)	11(7.5)	21(14.4)	32(21.9)			
no	238(62.0)	34(14.3)	54(22.7)	88(37.0)	0.478(0.298-0.767)	9.549	0.002
Latrine availability							
Present	286(74.5)	28(9.8)	54(18.9)	82(28.7)			
Absent	98(25.5)	17(17.4)	21(21.4)	38(38.8)	0.635(0.393-1.026)	3.468	0.063
Wearing shoes							
Sometimes	130(33.9)	8(6.2)	27(30.8)	35(40.8)			
Always	254(66.1)	18(7.1)	67(`26.4)	85(26.4)	1.365(0.856-2.178)	1.713	0.191

4.6. Anthropometric Measurements of School Children

Nutritional indicators are a tool to measure and quantify the severity of malnutrition and provide a summary of the nutritional status of all children in the measured group. It provides a method by which the nutritional status of a group can be compared easily over time or with other groups of interest (WHO, 2006).

The anthropometric measurements of school children in the study area were compared with an international reference population defined by the U.S. National Centre for Health Statistics (NCHS) and accepted by the U.S. Centers for Disease Control and Prevention (CDC) (WHO, 2007). The three nutritional indicators such as WHZ (wasting), WAZ (underweight) and HAZ (stunting) were expressed in standard deviation units (Z-scores) from the median of the reference population for children whose age in between 6-9 years old (Table 7).

As shown in table 6, the prevalence of stunting, wasting and underweight for children 6-9 years was, 22(17.3%), 27 (21.3%) and 31(24.4%), respectively. Of whom 16.1% and 18.5% were for males and females, respectively for stunting (Table 6). 24.2% and 18.5% were for males and females, respectively for wasting (Table 6), Whereas 25.8% and 21.5% were for males and females, respectively for underweight (Table 7).

Generally, an overall prevalence of undrenutrition for children of 6-9 years was 63.0% and was in line with the previous study by Abebech Tiruneh (2014) from Chelenko town, Eastern Ethiopia which reported an overall prevalence of 67.5%. However, higher than the finding reported by Babulo (2012) which revealed 42.8% prevalence of undrenutrition.

Table 7. Prevalence of Wasting (weight-for-height), stunting (height-for-age) and Underweight (weight-for-age) among Children of 6-9 years old.

Age group sex		Number of study subjects measured	The three nutritional indicators					
			Stunting		wasting		underweight	
			Yes	no	yes	no	yes	no
6-9:	M	62	10(16.1)	52(83.9)	15(24.2)	47(75.8)	17(25.8)	45(72.6)
	F	65	12(18.5)	53(81.5)	12(18.5)	53(81.5)	14(21.5)	51(78.5)
Total		127	22(17.3)	105(82.7)	27(21.3)	100(78.7)	31(24.4)	96(75.6)
x^2			0.121		0.595		0.623	
p-value			0.728		0.441		0.430	

However, weight-for-age (underweight) for children10-18 years of age is not a good indicator as it cannot distinguish between height and body mass in an age period where many children are experiencing the pubertal growth spurt and may appear as having excess weight (by weight-for-age) when in fact they are just tall. So, BMI-for-age is the recommended indicator for assessing thinness, overweight and obesity in children 10-19 years old (WHO, 2009).

The overall prevalence of underweight among age group 10-18 years in the present study was 30.7%, where 37.0 % and 23.8 % in males and females, respectively (Table 8). This finding was a little bit lower than a cross-sectional study among school children from Northwest Ethiopia, (Tilahun, 2010) which reported 34.5% prevalence and from Southern Ethiopia (Birmeka, 2007) which reported 36%. The prevalence of underweight between male and females in the present study was statistically significant (x2 = 5.298, p=0. 022).

Table 8. The Prevalence of Underweight (weight-for-age) or thinness for the age group 10 - 18 years by Age and Sex among Children of both Schools by BMI.

Age group	sex	Number of samples measured (%)	Nutritional indicator			
			BMI-for-age < 5^{th} percentiles	BMI-for-age 5^{th}-85^{th}	x^2	p -value
10-18:	Male	135(52.5%)	50(37.0%)	85(63.0%)		
	Female	122(47.5%)	29(23.8%)	93(76.2%)	5.298	0.022
Total		257(66.9%)	79(30.7%)	178(69.3%)		

4.7. Associations between Anthropometric Measurements and Prevalence of Intestinal Protozoan and Soil-transmitted Helminths Infections among School Children

As shown in table 9, the prevalence of malnutrition was associated with the prevalence of intestinal parasite infections. In the present study, out of 22 stunted children of 6-9 years old, 9 were infected with intestinal parasitic infections (Table 9). Similarly, among 31 underweight and 27 wasting school children of 6-9 years old, 13 and 11 were positive for intestinal parasitic infections, respectively (Table 9). Generally, the overall prevalence of IPIs among undernutrition children of 6-9 years old was 45.0%, where 11.3% and 33.8% for protozoan and helminths, respectively (Table 9). But no significant association was found between undernutrion and IPIs. Among all nutritional indicators for the age group 6-9 years, the highest prevalence of IPIs (41.9%) was in underweighted children (Table 9). In the present study, out of 79 (30.7%) underweighted children, 19(24.1%) were infected with parasites. But, no statistically significant association was observed and in accordance with the previous study by Tesfaye (2011) which reported 31. 7% prevalence of underweight.

Table 9. The Associations of Anthropometric Measurements of School Children with Intestinal PPIs and STH Parasitic Infections

Nutritional Indicators	number of Samples examined (%)	Intestinal parasite infections: Samples +ve for IPPIs (%)	Samples +ve for STHI (%)	Sum of Samples +ve for IPPIs and STHI (%)	OR (95%, CI)	x^2	p-value
Age group: 6-9	127(33.1)	20(15.8)	34(26.8)	54(42.5)			
stunted	22(17.3)	2(9.1)	7(22.7)	9(40.9)	0.923(0.363-2.348)	0.028	0.867
Not stunted	105(82.7)	18(17.1)	27(27.6)	45(42.9)			
Underweight	31(24.4)	4(16.1)	9(29.0)	13(41.9)	0.969(0.427-2.2)	0.006	0.94
Normal weight	96(75.6)	16(15.6)	25(26.0)	41(42.7)			
wasted	27 (21.3)	3(6.7)	11(40.7)	14(51.9)	0.911(0.384-2.162)	0.044	0.833
Not wasted	100(78.7)	17(20.7)	23(23.0)	40(40.0)			
Total under nutrition:	80 (63.0)	9(11.3)	27(33.8)	36(45.0)			
Age group:10-18,	257(66.9)	25(9.7)	33(12.9)	58 (22.6)			
Underweight							
Yes (<5th)	79 (30.7)	7(8.9)	12(15.2)	19(24.1)	0.722(0.385-1.355)	1.035	0.309
No (5th - 85th)	178(69.3)	18(10.1)	29(16.3)	49(27.5)			

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary

The objective of the present study was to determine the prevalence of intestinal protozoan and Soil-transmitted helminths infections among children of Oda Belina and Ethiopia Tekdem Primary Schools and ultimately examine the associations with their anthropometric measurements. A school based cross-sectional survey involving a study population from grade one to grade eight in Oda Belina and Ethiopia Tikdem Primary Schools who were enrolled in 2016/17 academic year during April-June was designed.

A total of 384 study samples were selected randomly from the two primary schools at Hirna town from April-June, 2017. The stool samples were collected from the samples population and examined using direct wet-mount technique, formol-ether concentration and modified zeihl neelson. After screening 384 stool specimens, the overall prevalence of intestinal protozoan and soil-transmitted helminths was 11.7% (11.2% for males and 12.3% for females) and 17.5% (18.8% for males and 16.04% for females), respectively. In the present study, the prevalence of protozoan parasite infections was 7.6%, 3.7% and 0.5% for *E. histolytica, G. lamblia* and *Cryptosporidium spp.*, respectively. While the prevalence of STHs parasitic infections for *A. lumbricoides,* Hookworm, and *T. trichiura* was 6.8%, 8.9%, 1.6 %, 0.5 % and 1.6 %, respectively.

Anthropometric measurements of children were done and their associations with intestinal parasitic infections were analyzed. The overall prevalence of IPIs among undernutrition children of 6-9 years old was 45.0%, where 11.3% and 33.8% for protozoan and STHs parasitic infections, respectively. However, in the present study no statistically significant associations between anthropometric measurements and intestinal parasite infections were found.

5.2. Conclusion

As the research demonstrated, intestinal Protozoan and soil-transmitted helminths infections are prevalent among Oda belina and Ethiopia tikdem primary schools children of Hirna town. Nutritional indicators such as stunting, wasting and underweight were identified among children of both schools. The major intestinal parasite species detected from the stool samples of both primary schools children were *E. histolytica*, *G.lamblia*, *Cp.parvum*, *A.lumbricoides,* Hookworm, *T. trichiura*. Some risk factors such as family size, personal hygiene, availability of latrine, source of water, residence. Level of education and shoe wearing habit were identified to be associated with the prevalence of protozoan and STHs parasitic infections.

5.3. Recommendations

The following main points are recommended to control and prevent the transmission of parasitic infections. Present study indicated that intestinal parasitic infections and undernutrition among children of both schools were prevalent. Therefore, based on the findings of the present study, the researcher recommended the following major points.

- The local health sector should collaborate with schools and other concerned bodies to deliver community based health education to raise the knowledge, attitude and practice of school children towards the transmission and prevention of intestinal protozoan and STHs infections.
- School based Regular de-worming programme for school children should be given to control STHs Infections.
- Proper treatment and provision of clean water supply.
- Improvements of the school environment hygiene.
- Provide community based health education toward good personal hygiene and environmental sanitations.

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7. APPENDICES

7.1. Appendix I

Written Consent form **(** English Version of written consent form).

Dear parents, the purpose of this particular research project is to determine the Prevalence of intestinal parasitic infections and their associations with anthropometric measurements of school children in selected primary schools of Hirna town, Oromia Regional State, Eastern Ethiopia and the result of this research project will be used as a base line to all concerned bodies to take any measures toward prevention, control and treatments of intestinal parasitic infections. I am asking for your consent to take stool samples from your child for parasite examination and to get information about some socio-demographic characteristics. However, I want you to be sure about the information and data in the survey will be handled with strictly confidential and used only for the specified study and When your children are found positive for intestinal parasites they will receive standard drugs free of charge.

The participation you will have in this study is thoroughly voluntary and you may withdraw yourself from the study at any time. Since I, the undersigned have been informed about the study objectives and recognized that all the information is to be kept confidential. Therefore, with full understanding of the study objective, I agree to give the informed consent voluntarily to the researcher to identify the intestinal parasites of my children and to receive any other information.

Name of the parent ______________________Signature ________,date_______

Name of the child_______________________Signature ________,date_______

Name of the researcher ___________________Signature ________,date_______

Afan Oromo Version

Xalayaa Walii Galtee

Kabajamoo matii barattootaa, kayoon qoronnoo kanaaa, babal’ina raammoolee garaafi walitti dhufeenyii isaan antirooppoomeetirik meezyarmantii barattoota manneen baruumsa sadarkaa tokkooffaa Odaa balinaa fi Ethiopia tikdam, magaalaa Hirnaatti, waliin qaban addaan baasanii beekuufi dha. Bu’aan qoronnoo kanaas baball’inaa fi tamsaasina rammoolee garaa ittisuu fi ta’achuuf akka ragaa bu’uraati waan gargaaruuf ragaalee fakkeenyaaf sagaraa akkasumaas odeeffannoolee wanneen dhibee raammoo garaatiif nama saaxilan barattoota keessan irraa fudhachuuf haayyama keessa akka nuuf keennitan isin gaafanna. Garu, ragaaleen argaman hundinuu iccitiidhaan akka eegamu onnee guutuun isinii ibsuu barabaada.. Ijoolleen raammoo garaa qaban bilisaan qorsi ni kennamaaf.

Hirmaannaan isin qorannoo kana keessatti gootan fedha keessaniin kan ta’ee fi yeroo barbaaddaniitti dhiisuu akka dandeechani. Ani maqaan koo akka armaan gadiitti eerame, galma qorannoo kanaa waaniin hubadheef akkasumaas icitini odeeffanno akka eegamu waaniin beekeef odeeffannoon barbaachisaa ta’ee akka fudhatamuufi raammoon garaa daa’ima kiyya keessa jiru fudhatamee akka ilaallamu qorataa waliin walii galuu kiyya akka armaan gaditti mallattoo kiyyaniin mirkanneessa.

Maqaa maatii_____________________mallattoo _______ guyyaa_________

Maqaa barataa ____________________mallattoo _______ guyyaa_________

Maqaa qorataa_____________________mallattoo _______ guyyaa_________

7. 2. Appendix II

Table 1. Anthropometric measurements data collecting format

Number	Name	Age	Sex	Height in cm	Weight in kg	Height - for - age (stunting)	Weight-for-age (underweight)	Weight-for-height (wasting)	Rural or urban	Remark

BMI= weight in kg/ [height in m] ^{2}.

7.3. Appendix III

Table 2. Laboratory data collecting format

Number	Name	Sex	Code	Rural or urban	Type of parasites observed																	
					Protozoa					Helminths									Type of infections			Remark
					Gl	*Eh*	*Cp*			*Al*	Hw	Tt	Sm	Hn								

Double infection with________and________

Triple infection with _________, ______and________

7.4. Appendix IV

English and Afan Oromo Versions Questionnaires for some socio-demographic characteristics data

English Version for grade 5-8 children

Dear respondents, the main purpose of this questionnaire is to collect and then determine the major risk factors that predispose school children to the intestinal parasitic infections in the study area. Therefore, I kindly request you to give your authentic response for each question.

1. Age: ____
2. Sex: A. Female B. Male
3. Area of residence, A. Rural B. Urban
4. The number of members of your family, A. < 4 B. ≥ 4
5. How many times do you eat a day? A. 2 times B. 3 times and above
6. Your family's educational level is A. Illiterate B. primary education or Above
7. Does your family have a latrine? A. Yes B. No
8. Do you wear shoes? A. some times B. always C. never
9. Do you wash your hands with soap and water before meal and after toilet? A. yes B. No
10. Your parents' job A. farmer B. government employee C. self employed
11. The source of water for drinking and preparing food A. unprotected B. protected
12. Do your parents boil drinking water? A. yes B. No
13. Have you ever been treated for intestinal parasitic infections in the last three months?
    A. yes B. No

English Version for parents of grade 1-4 children

Dear respondents, the main purpose of this questionnaire is to collect and then determine the major risk factors that predispose school children to the intestinal parasitic infections in the study area. Therefore, I kindly request you to give your authentic response for each question.

1. Age of your child: ____
2. Sex: A. Female B. Male
3. Area of residence, A. Rural B. Urban
4. The number of members of your family A. < 4 B. ≥ 4
5. How many times do you feed your child per day? A. 2 times B. 3 times and above
6. Your educational level is A. Illiterate B. primary education or Above
7. Do you have a latrine in your home? A. Yes B. No
8. Does your child wear shoes? A. some times B. always C. never
9. Does your child wash his/her hands with soap and water before meal and after toilet? A. yes B. No
10. Do you follow your child's hygiene? A. yes B. No
11. Your job A. farmer B. government employee C. self employed
12. The source of water for drinking and preparing food A. unprotected B. protected
13. Do you boil drinking water in home? A. yes B. No
14. Has your child ever been treated for intestinal parasitic infections in the last three months? A. yes B. No

Afan Oromo Version

Gaafannoo Afaan Oromoo barattoota kutaa 5-8 tiif

Kabajamoo Hirmaattoota qoranno kanaa, kaayoon gaafannoo kanaa iddoo qoronnoon kun ittii gaggeeffamuutti wantoota raammoolee dhibee garaa barattootaatiif sababa tahan addaan basanii beekuufi. Kanaafuu, gaafilee armaangadii huundumaaf deebii keessan akka nuuflaattan kabajaan isiin gaafanna.

1. Umrii ________
2. Saala A. dubara B. dhiira
3. Iddoo jireenyaa A. baadiyyaa B. magaalaa
4. Baayyinnii miseensoota maatii keessanii $A.\ \leq 4$ B. ≥ 5
5. Guyyatti si'a meeqa nyaatta? A. ≤ 2 B. ≥ 3
6. Sadarkaan barnoota maatii keessanii A. Hinbarannee B. sadarkaa tokkoffaa C. sadarkaa lammaffaa D. diipiloomaa fi sanaa ol
7. Matiin keessan mana fincaanii niqabuu? A. Eeyyee B. miti
8. Koophee ni uffattaa? A. yeroo tokko tooko B. yeroo mara C. hinuffadhu
9. Nyaata dura fi eerga mana fincaaniitii deebitan harka keessan saamunaafi bashaaniin nidhiqattuu? A. Eeyyee B. miti
10. Hojiin maatii keessanii maali? A. qotee bulaa B. hojjataa mootumaa C. hojiidhunfaa
11. Bishaan dhugaatiifii nyaata ittiin bilcheeffttan?

A. Bishaan qulqulluu hintane B. bishaan qulqulluu/ujommoo

12. Bishaan dhugaatii maatiin keessan ni danfisuu? A. Eeyyee B. miti
13. Ji'oota sadan darban keessatti wal'aansa dhibee raammoo garaa fudhattee jirtaa?

A. Eeyyee B. miti

Afan Oromo Version

Gaafannoo Afaan Oromoo maatii barattoota kutaa 1-4 tiif

Kabajamoo Hirmaattoota qoranno kanaa, kaayoon gaafannoo kanaa iddoo qoronnoon kun ittii gaggeeffamuutti wantoota raammoolee dhibee garaa barattootaatiif sababa tahan addaan basanii beekuufi. Kanaafuu, gaafilee armaangadii huundumaaf deebii keessan akka nuuflaattan kabajaan isiin gaafanna.

1. Umriin daa'ma keessanii: ________
2. Saala A. dubara B. dhiira
3. Iddoo jireenyaa A. baadiyyaa B. magaalaa
4. Baayyinnii miseensoota maatii keessanii $A. \leq 4$ B. ≥ 5
5. Guyyatti si'a meeqa daa'ima keessan nyaachiiftu? A. ≤ 2 B. ≥ 3
6. Sadarkaan barnoota keessanii A. Hinbarannee B. baradhee
7. Mana fincaanii niqabuu? A. Eeyyee B. miti
8. Daa'imni keessan Koophee ni uffattaa? A. yeroo tokko tooko B. yeroo mara
9. Daa'imnii keessan nyaata duraafi eerga mana fincaaniitii deebi,ee harka isaa/ishee saamunaafi bashaaniin nidhiqattuu? A. Eeyyee B. miti
10. Qulqullina daa'ima keessanii nii hordaftuu? A. Eeyyee B. miti
11. Hojiin keessanii maali? A. qotee bulaa B. hojjataa mootumaa C. hojiidhunfaa
12. Bishaan dhugaatiifii nyaata ittiin bilcheeffttan Eessaa waraabdu?

B. Bishaan qulqulluu hintaane B. bishaan qulqulluu/ujommoo

13. Bishaan dhugaatii ni danfistuu? A. Eeyyee B. miti
14. Ji'oota sadan darban keessatti daa'imni keessan wal'aansa dhibee raammoo garaa fudhatee/ttee jiraa/tii? A. Eeyyee B. miti

7.5. Appendix V

Table 3. Classification of malnutrition for weight-for-height, height-for-age, and weight-for-age based on Z-scores.

Classification	Z-score values
Adequate	-2 < Z-score < + 2
Moderately malnourished	-3 < Z-score < - 2
Severely malnourished	Z-score < - 3

Source: Patrick Webb and Rita Bhatia Nutrition Service WFP, Rome July 2005

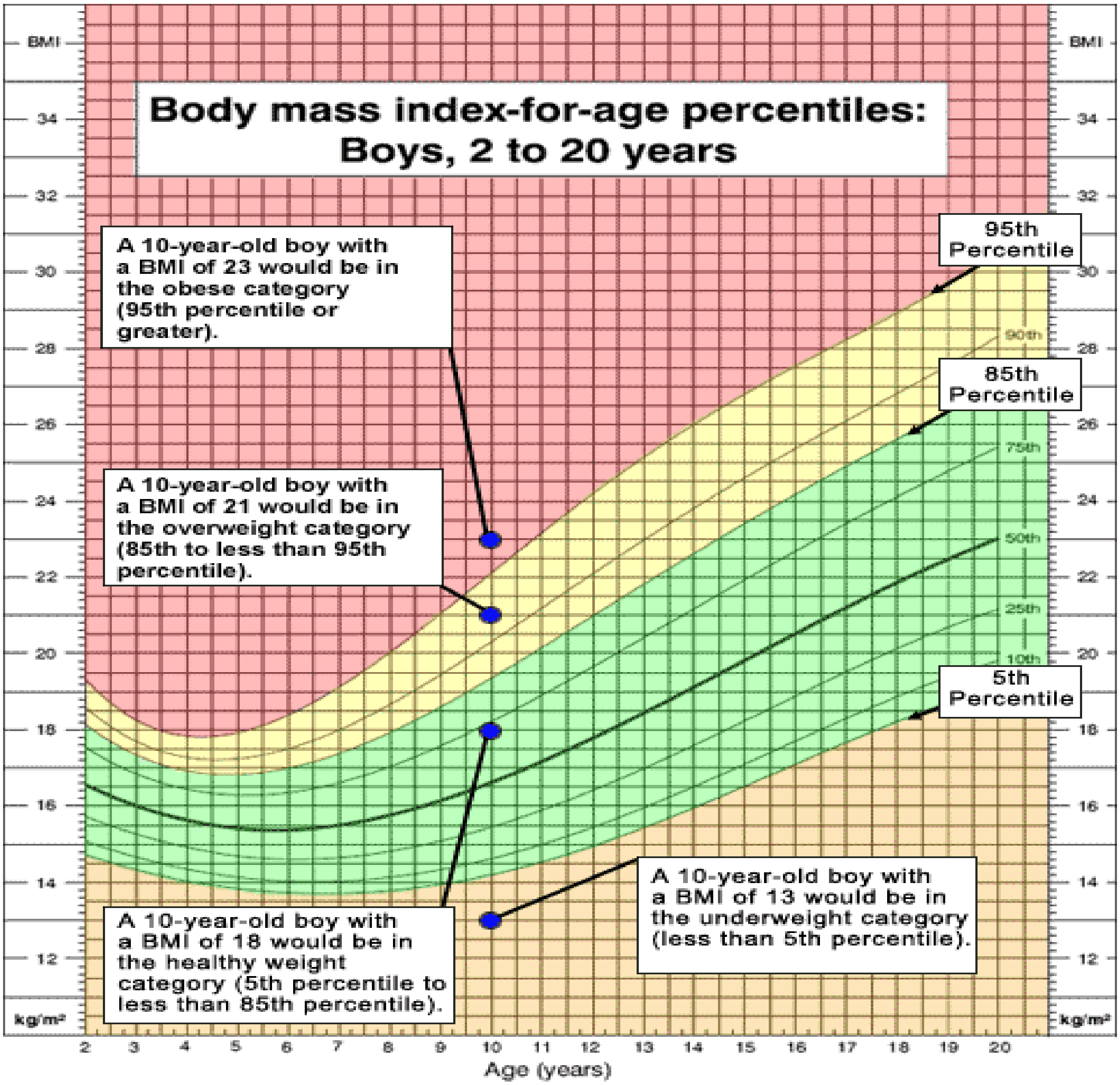
Table 4.Weight status Category for the calculated BMI-for-age percentile

Weight Status Category	Percentile Range
Underweight	Less than the 5th percentile
Healthy Weight	5th percentile to less than the 85th percentile
Overweight	85th percentile to less than the 95th percentile
Obese	Equal or greater than the 95th percentile

7.6. Appendix VI

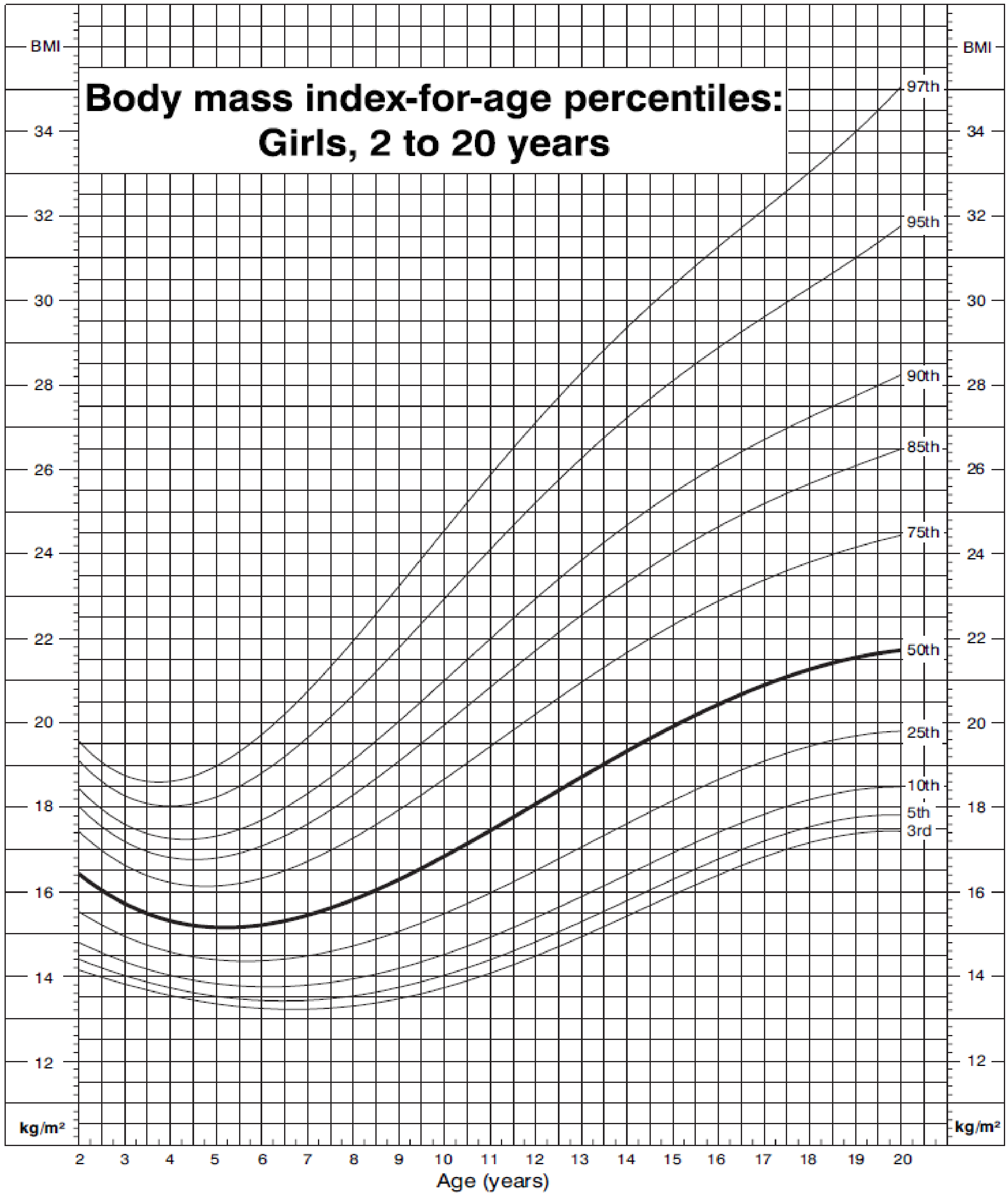
Weight status Category for the calculated BMI-for-age percentile.

Figure 1. Body Mass Index- for-age Percentiles GrowthChart for boys 2 to 20 years.



Source:http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html.

Figure 2. Body mass index-for-age percentiles of girls aged from 2-20 year developed by



Published May 30, 2000.
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

Ethical Clearance Letter

Ref. No- WU/E/F/Abx/1757/2009
Date- 19 - 7 - 2009

Biiroo ... Oromiyaa
Qajeelcha ... Xulloo

To Hirna Health centre

Hirna

Issue: <u>Giving Ethical clearance and support letter for a Research</u>

Application Title: Prevalence of Intestinal Parasitic Infections and their Associations with Anthropometric Measurements of school Children in selected Primary Schools, Hirna town, West Harage Zone, Oromia Regonal State, Eastern Ethiopia.

Department: Biology

Programme: Msc in Biology

University: Haramaya University

Research ethics exist to ensure that the principles of justice, respect and avoiding doing harm are upheld by using agreed standards. So, here was an application attached with Research Proposal inquiring research ethical clearance letter and it was revised by Tulo Woreda Health office management committee and has got acceptance. Here by, we feel happy when we recommend Mr. **Samuel Dessalegn Wondimagegnehu** to get the necessary collaborations and assistances such as materials, equipments and etc. from the health center management as well as from any concerned body in the health center as much as possible. However, our office strictly requires getting one copy of the final research result to use it as a base line in the future health planning, to take the necessary controlling measures and to amend and ensure the societies health services.

Sincerely

Jamaal Yuusuf
I/A/W/E/F/Aa/Xuulloo

CC

Samuel Dessalegn.