ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

PREVALENCE OF SOIL TRANSMITTED HELMINTHIASIS AND INTESTINAL SCHISTOSOMIASIS AND ASSOCIATED RISK FACTORS AMONG PRIMARY SCHOOL CHILDREN IN GUDER AND AMBO TOWN WEST SHOWA ZONE, ETHIOPIA

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ADDIS ABABA ETHIOPIA

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List of Abbreviations

CDC	Center for disease control
CI	Confidence interval
CSA	Central statistical agency
DALY	Disability-adjusted life years
EPG	Egg per gram
FMoH	Federal ministry of health
GBD	Global Burden of Disease
NTD	Neglected tropical disease
QALY	Quality adjusted life years
SOP	Standard operating procedure
SPSS	Statistical Package for Social Scientists
STH	Soil transmitted helminthes
WHO	World health organization

Abstract

Background: Soil transmitted helminthes (STHs) and intestinal Schistosomiasis are among the most common cause of human infections and neglected tropical diseases which are distributed throughout the world and cause thousands of avoidable outpatient morbidity and mortality, especially in school-age children. They are also the leading cause of gastrointestinal pain, malnutrition, malabsorption, anemia, mental retardation and other diseases. The prevalence and associated risk factors among primary school children was lacking in the study area.

Objective: The aim of this study was therefore to determine the prevalence of soil transmitted helminthiasis and intestinal schistosomiasis and associated risk factors among primary school children in Guder and Ambo town.

Materials and Methods: Institution based cross-sectional study was carried out from April 2018 to May 2018 among primary school children in Guder and Ambo town. A total of 320 primary school students were selected by simple random sampling technique. The prevalence of STH and intestinal Schistosomiasis was determined by formol-ether concentration technique. Assessment of Socio demographic characteristics of students and associated risk factors was also conducted by well-developed questionnaire. Data analysis was done by using the SPSS version 16 software.

Result: Out of 320 study subjects 57 students (18%) had one or more soil transmitted helminthes and 15 students (4.68%) had *Schistosoma mansoni* infection. From soil transmitted helminths, *A.lumbricoides* was the predominant isolate (13%) followed by *T. trichiura* (3.7%) and hookworms (2.2%).

Conclusion: In this study large Family size, not nail trimming and unavailability of improved latrine were identified as predisposing factor for soil transmitted helminthes infections. All school children enrolled and not enrolled in this study should be treated according to WHO guideline to control the transmission of these parasitic diseases. Access to improved latrine could also help for reduction of soil transmitted helminthes and intestinal schistosomiasis prevalence below the percentage found in this study.

Key words: *S.mansoni*, soil transmitted helminthes, Ambo, Guder, Prymary school children, Ethiopia

1. Introduction

Soil-transmitted helminthiasis is caused by different species of round worms. It is caused specifically by those worms which need soil for larval development to rich infective stage. Three types of soil-transmitted helminthiasis can be distinguished *A. lumbricoides*; the hookworms *Necator americanus* or and *Ancyclostoma duodenale;* and the whipworm *Trichuris trichiuria* respectively (Cheesebrough, 2006).

They are one of the most common neglected tropical diseases (NTD) (WHO, 2014). Soil transmitted helminthiasis mainly causes nutritional imbalances. Commonly they cause a decreased appetite leading to reduced food intake, lethargy, impaired digestion and absorption of nutrients from the diet and thereby poor growth and development of children. Some, like hookworms, are primarily responsible for blood loss leading to iron deficiency and iron deficiency anemia leading to decreased working capacity of adults and impaired neurocognitive development of young children (WHO, 2014).

Soil transmitted helminthes has become the most common parasitic disease of humans worldwide. Approximately two billion people (about a third of global population) are infected as of the latest estimate, and four billion at risk, surpassing even the all-time most prevalent parasitic disease, malaria (WHO, 2014). The largest numbers of cases occur in impoverished rural areas of Sub-Saharan Africa, Latin America, Southeast Asia, and China (WHO, 2010). Its main cause, like for many types of helminthes infections, is lack of sanitation, such as the practice of open defecation and lack of hygiene such as hand washing. It is regarded as one of the world's most important causes of intellectual and physical retardation (Brooker *et al.*, 2006).

The soil transmitted helminthic disease is so named because they need soil for larval development to rich infective stage and infection is transmitted through ingestion of these infective stages in the soil which is contaminated through excrements. Therefore, the disease is most prevalent in warm and moist climates where sanitation and hygiene are poor and water is unsafe, including the temperate zones during warmer months. Soil transmitted helminthes are categorized among neglected tropical diseases because they inflicts tremendous disability and suffering, which can be clinically treated and relatively easily be prevented (primarily through improved sanitation), yet negligible attention has been given for many years (CDC, 2011).

Intestinal schistosomiasis is a chronic and debilitating disease caused by a waterborne digenetic trematode of the genus *Schistosoma* and also known as snail fever and bilharzias (Colley *et al.*, 2014). The disease is one of the most widespread parasitic infections in tropical and subtropical countries where it ranks second to malaria in terms of its socioeconomic and public health significance (Jordan, 2000). Symptoms include abdominal pain, diarrhea, bloody stool, or blood in the urine. Those who have been infected for a long time may experience liver damage, kidney failure, infertility, or bladder cancer. In children it may cause poor growth and learning difficulty (WHO, 2014). Intestinal schistosomiasis owes its clinical significance from its tendency to slowly damage host organs due to granuloma formation around eggs trapped in tissues, resulting in development of chronic inflammation and fibrosis in the liver and spleen causing hepatosplenomegaly that leads to severe portal hypertension, ascites, gastroesophageal varices, gastrointestinal bleeding, cancer, and death (Harrison, 2005)

1.1. **Literature review**

1.1.1 **Ascaris lumbricoides**

Morphology and Life Cycle

Ascaris lumbricoides is one of the important parasites of man and animals with a direct lifecycle (Urquhart *et al.*, 2003). Under normal conditions of temperature and moisture eggs survive in the soil with the larva developing from L1 to L2 stage. When eggs containing L2 larvae are swallowed either with water or food they hatch in the small intestine liberating the L2 larva, these migrate to the liver via the mesenteric lymphatics or venules. The first molt takes place and the L3 formed are transported via the blood stream to the right heart and then to the lungs via the pulmonary artery. Here they undergo their final molt and the L4 larva grows before rupturing out of the pulmonary capillaries into the alveoli. From here they move up the bronchioles and migrate into the glottis, from where they are coughed up and swallowed a second time (Urquhart *et al.*, 2003).

In the small intestine, larva sexually matures into an adult worm especially the jejunum. *Ascaris lumbricoides* exhibit clear sexual dimorphism, mature female (20-40cm) at least two times bigger and longer than the mature male (15-20cm long) (Ukoli, 1990). Freshly expelled *Ascaris* worms are pinkish in colour, measure 12-35cm in length and taper at both ends. The mouth surrounded by three lips.

The tail of the male is curved and has small rod- like projections (spicules). The females lay unembryonated eggs (usually fertilized but occasionally infertile) that are excreted with the faeces measuring 50-70µm long (micrometer long) by 30-50 micrometer wide (Crompton, 1989). Shell is often covered by an uneven albuminous coat (mammilated) and contains a central granular mass which is the unsegmented fertilized ovum. Infertile egg of *A. lumbricoides* is darker in colour and has a thinner wall and more granular albuminous covering. It is also more elongated than a fertilized egg, measuring about 90 to 45µm, and contains a central mass of large granules (Cheesebrough, 2006).

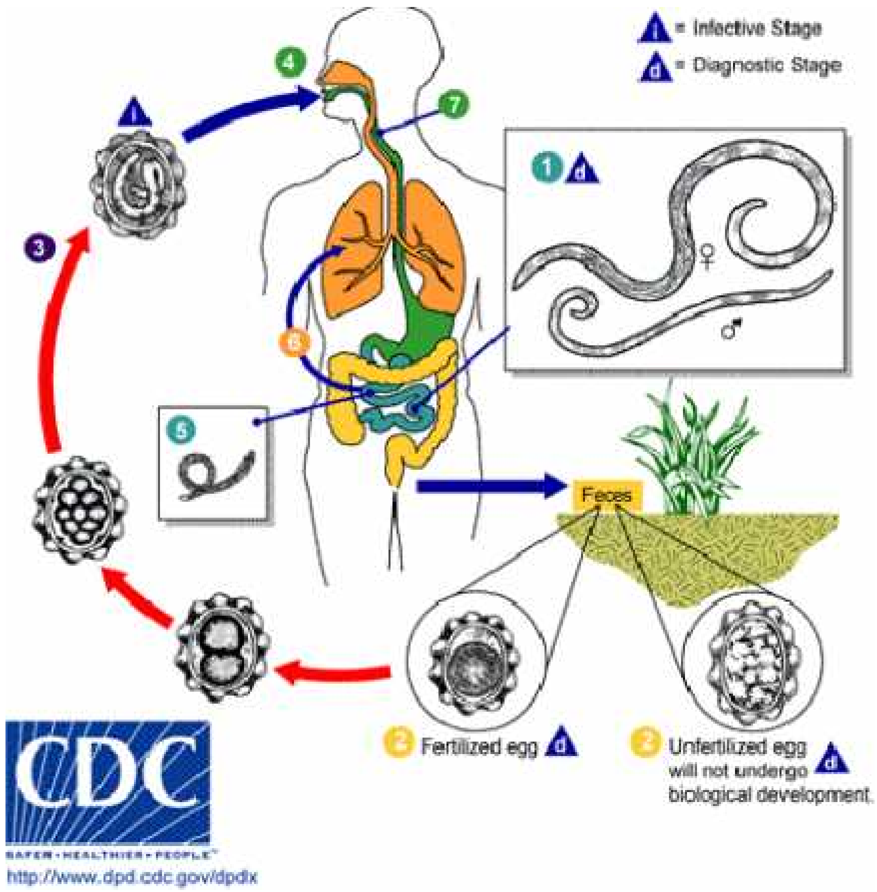


Fig.1 Life cycle of *Ascaris lumbricoides*

The rate of contamination with *A. lumbricoides* eggs is enhanced by open defecation, poor standards of hygiene and inadequate facilities for water supply and sanitation (Asaolu and Ofoezie, 2003).

Epidemiology

Ascaris lumbricoides is universally distributed around the world but is most prevalent in the tropical zones of Africa and Asia especially India and China (Onyeodiri, 2009). It is estimated that over two billion persons are infected around the world at any given moment (WHO, 2012). Global distribution is driven by climatic conditions particularly temperature and humidity.

Clinical Manifestation

Clinical manifestations in ascariasis are related to the consequences of larval migrations (from the intestine to the livers, heart, lungs and finally back to the intestine) and the activities of the adult worms. Detoxification and high oxygen tension in the lungs destroy migrating larvae, the remains of which include most of the eosinophilia seen in ascariasis (Onyeodiri, 2009). In addition fever, cough, dyspnoea and urticarial rash may also occur. Pulmonary manifestation causes a Loeffler's pneumonia-like syndrome may manifest (Arfaa, 1984).

Adult Ascaris could induce mild abdominal pain that is more severe in heavily infected children (Lagundoye, 1972). The patients may be restive and have loss of appetite, occasional vomiting, intermittent loose stools or constipation and may pass several worms through the anus or through the mouth. Colicky pain abdominal distention and abdominal stomach sounds are common symptoms (Asaolu *et al.,* 1991).

Pathology and Pathogenesis

Pathology in ascariasis are varied but are broadly classified into organ damage and host sensitive reactions due to migrating larvae, and the large size and activities of the adult worm. Pathogenesis due to larva migration through the intestinal mucosa, the liver and lungs occur as hypersensitivity reaction of the human host, due to some of the larvae granulomas. In the lungs larval migration from blood vessel into air spaces result in haemorrhage and oedema of the alveoli. Alveolar sacs are filled with serous exudates and peri bronchial tissues become infiltrated with eosinophils and neutrophil aggravating mucous production in the bronchi known as Loeffler's syndrome, this condition gives rise to dry cough high fever and bronchial asthma. The effect is severe when the number of larvae is large (Asaolu *et al*., 1991).

Presence of adult *A. lumbricoides* in the intestine induces disordered changes in the jejunal mucosa and intestinal muscle layers. There is an architectural change in the mucosal folds which may lead to reduced rate of mucous production resulting in hypertrophy of the intestinal muscle layers (Lagundoye, 1972; Stephenson *et al.,* 1983). It also causes intermittent colicky and in severe infections obstruction of the intestine and biliary ascariasis (Lifeschitz *et al.*, 1987). Associated with these problems of ascariasis is protein energy malnutrition as a result of the worms competing for food nutrients with the host (Hadidjaja *et al.*,1998)

1.1.2 **Hookworms**

The hookworms (Ancylostoma duodenale, and Necator americanus) reside in the gut of mammals, reptiles and amphibians. They are characterized by heavily sclenotized mouth parts and are blood feeders. Human hookworms belong to the genera *Ancylostoma* (family *Ancylostomatidae*) and *Necator* (family Uncinariidae) (Humar, 1983).

Morphology and Life Cycle

The eggs which contain segmented ova are passed in faeces, mature and hatch in warm moist soil within 24 to 48 hours liberating rhabdoid (Rhabditiform) larva which molts twice in the 3rd and 5th days, changing into filariform (the infective stage) (Onyeodiri, 2009) . The filariform larvae may remain viable for about 6 weeks depending on the temperature and moisture content of the soil. It actively penetrates human skin and migrates through the lung capillaries into air sacs, ascends the respiratory tract, past the trachea and glottis and is swallowed. Before this stage or on reaching the oesophagus the larva molts a third time and on reaching the small intestine undergoes a fourth and final molt and develops into adult stage. The adult attaches itself to the wall of the small intestine by the help of the mouth. The female worm matures and lays eggs within 6 weeks of initial infection (Crompton, 1989)

Necator americanus is 7-11mm long and 1.7mm in width and it obtains nutrients from the consumption of villous tissues and blood sucked from their site of attachment to the mucosa of small intestine where they can live for 3-5 years. They lay eggs in the small intestine and these are passed out in the faeces. Under favorable environmental conditions the eggs hatch within 5-7 days and develop into motile infectious third stage larvae, L3. The L3 larvae may survive for several months (Dobardzic *et al.*, 2002). But on contact with human skin they penetrate actively (Hotez *et al.*, 1990) migrate to host venules and lymphatic vessels and are swept into pulmonary vasculature, where they rupture the capillary vessels to enter the alveolar spaces. They then migrate to upper respiratory tract then to gastrointestinal tract. Entry into the small intestine stimulates molting of L3 larvae to the L4 stage and then the adult stage. It takes approximately 49-56 days to develop to adult female hookworm capable of laying eggs (Dobardzic *et al.,* 2002).

The major difference between the life cycle of *A. duodenale* and *N. americanus* is that if the larvae of *A. duodenale* perchance reach the small intestine firstly they develop to adults without the pulmonary migration whereas *N. americanus* larvae require the pulmonary migration to attain adult stage. In addition *N. americanus* lives longer (about 5 years) than *A. duodenale* (approximately 1 year) and is more virulent causing more blood loss (0.05 to 0.3ml per worm per day) and producing more eggs per female. *A. duodenale* and *N. americanus* are differentiated on the basis of their unique morphologies as adults and larvae, but the eggs fairly indistinguishable (Dobardzic *et al.,* 2002). Recently developed polymerase chain reaction distinguishes different hookworm species and can detect mixed infections (Hawdon, 1996).

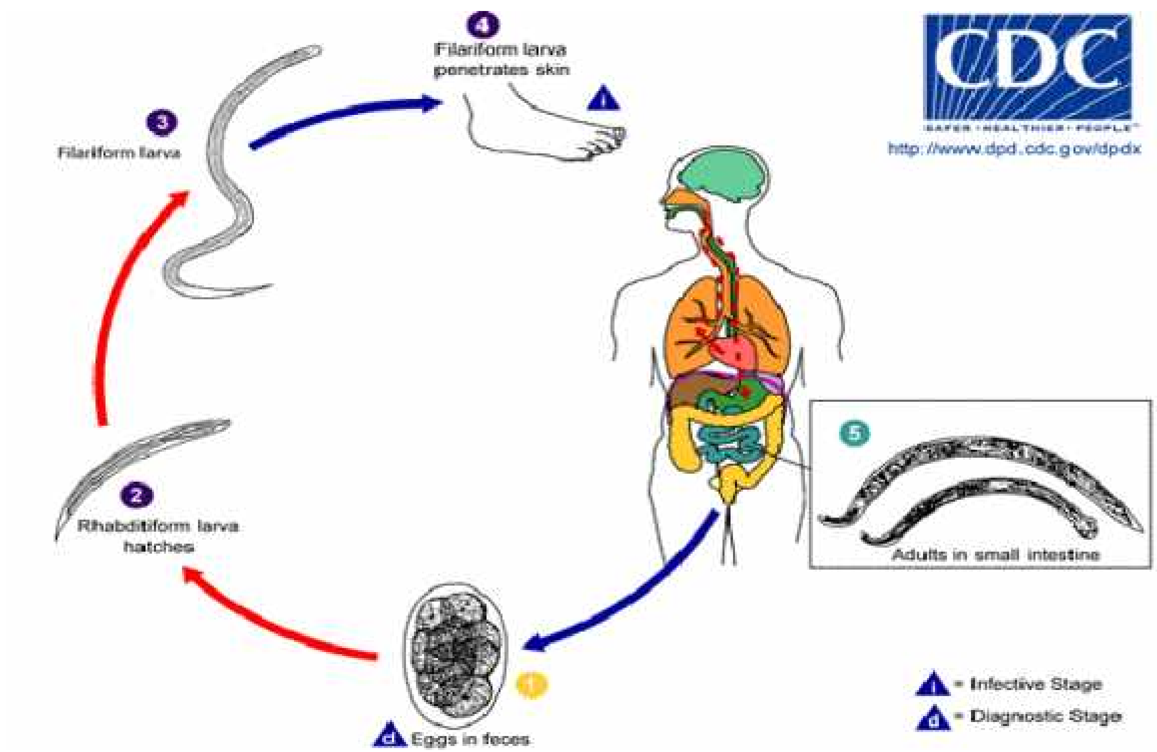


Figure 2 Life cycle of Hookworms

Epidemiology

Hookworm infections are important causes of morbidity in the tropical and subtropical countries between latitudes 45^0 north and 30^0 south where soil and climatic condition are optimal and prospect of contamination is high due to poor clean water supply and sanitation, over a billion people are believed to be infected by the two common species (Hotez *et al.*, 2000).

Epidemiologically, hookworm exhibits patterns that are distinct from the other two major soil-transmitted helminthes, *Ascaris* and *Trichuris* (Dobardzic *et al.*, 2002). The highest *Ascaris* and *Trichuris* worm burdens typically occur among children between the ages of 5 and 15, whereas hookworm burdens increase almost linearly with age in some endemic areas (Gandhi *et al.*, 2001). It has been reported that in many parts of China and Southeast Asia, hookworm is common in both the elderly and children populations. (Dobardzic *et al.*, 2002)

Clinical Manifestation

Clinical features are said to correspond to the life cycle of the parasites and intensity of infection (Strickland, 2000). Initial manifestation is a burning or stringing or ground itch sensation caused by skin penetration of larvae. This is followed by pruritus and a papulovascular rash persisting for 1 to 2 weeks. Pneumonitis is a consequent of migrating *N. americanus* and *A. duodenale* L3 from skin to intestine via lungs. Usual situations are cough and pulmonary infiltrates. The later is a sign of heavy infections. Abdominal colic with diarrhea and worked peripheral eosinophilia (1000 to 4000 cells per mm3) can also develop during larval migrations and subsequent worm maturation in the small intestine. Chronic heavy hookworm infection results in hookworm disease whose hallmark is hypochromic microcytic anaemia. The development and severity of anaemia depend on the intensity of infection, the predominant species of hookworm present, the iron reserves of the host, and the availability of iron in diet. In extreme cases of chronic infections, hypoalbuminemia or kwashiorkor has occurred due to prolonged plasma protein loss (Dobardzic *et al.*, 2002).

Pathology and Pathogenesis

Adult stage hookworms that live attached to the small intestinal wall feed on blood and mucosal contents. Heavy worms load can cause significant plasma protein loss and iron deficient anemia. All ages are said to be susceptible to infection, but children, adolescent and pregnant women are particularly at risk from hookworm morbidity as the physiological demands for iron are high among these groups (Dobardzic *et al.,* 2002). In school aged children and infants, hookworm anemia may retard growth and cognitive development (Oski, 1993.)

1.1.3 *Trichuris trichiura*

Trichuris trichiura or whipworm is a parasite of the human gut worldwide especially in areas where the climate is warm and humid and sanitation standard is poor and precipitating massive environment contaminating with human faeces (Arfaa, 1984; Pawlowski, 1985).

Morphology and Life Cycle

Adult male *T. trichiura* measures from 30-45mm while the female measures from 30 to 50mm in length. The diameter of the anterior portion is 100-150mm and the posterior portion 400-700mm. There is a simple mouth armed with a minute spear. The esophagus, which lies in the long anterior portion, consists of a short muscular part and a long glandular part situated in a row of cells called Stichosomes. The posterior portion contains the intestine, and in both sexes, a single gonad. The male worm is distinguished by the presence of a single spicule surrounded by a spiny sheath at the posterior end. The eggs are unembryonated when released and are ovoid in shape with characteristic plugs at each end measure 50 to 54 by 22 to 24um. In moist soil and at favourable temperature, the eggs embryonate in about 3 weeks and become infective (Onyeodiri, 2009).

Ingestion of eggs by hands or when ingested with food or drink marks the beginning of the life history. The eggs hatch in the small intestine releasing larvae that enter the crypts of Lieberkuhn, develop for about a week and re-enter the intestinal lumen (Asaolu *et al.,* 2002). They migrate to the caucus, attach to the surface of the mucosa by their anterior end and mature to adult males and females. Copulation takes place between the sexes and eggs laid by the female appear in host faeces 70 to 90 days after initial ingestion of eggs. Adults live for several years and a female worm releases from 1000 to 6000 eggs per day through out its lifespan. Under optimal conditions, *Trichuris* eggs can remain available in the soil for 6 years but desiccation and extreme temperatures are detrimental (Asaolu *et al.*, 2002).

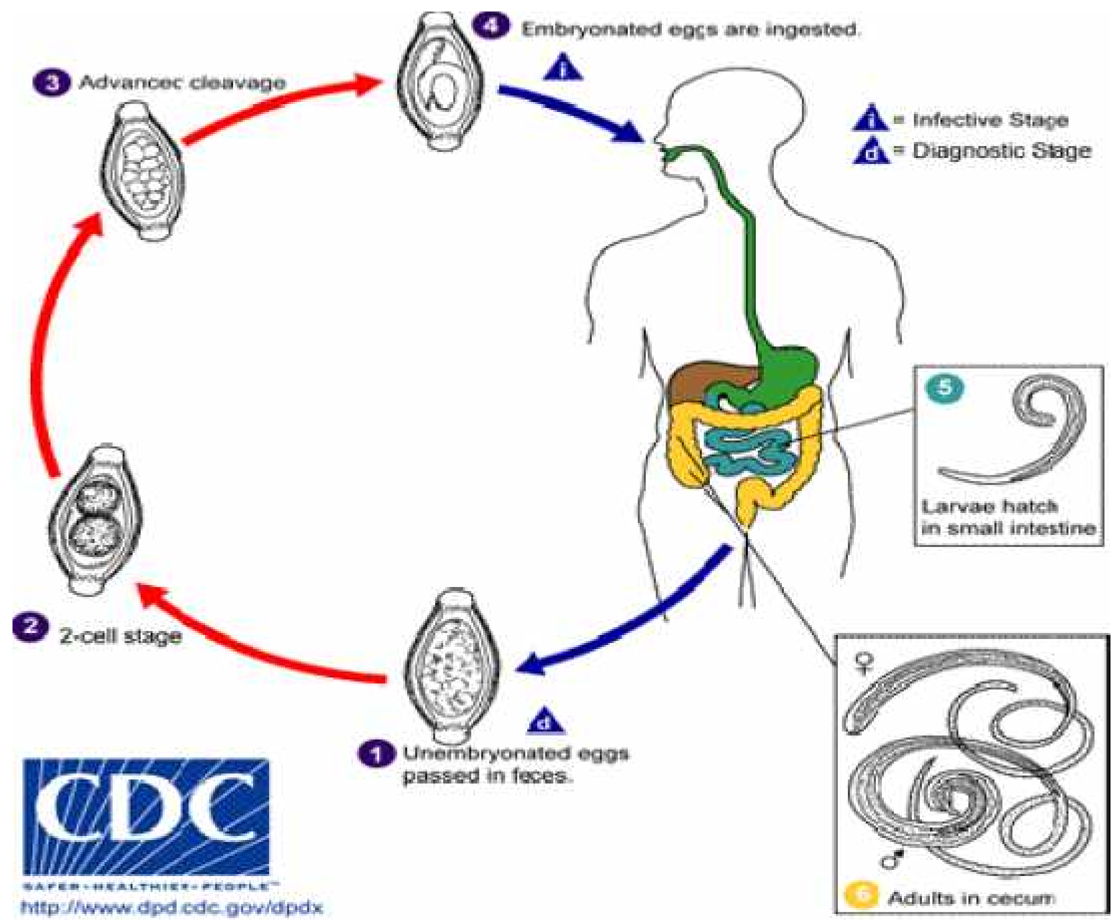


Figure 3. Life Cycle of *T.trichuria*

1.1.4 **The burden of soil-transmitted helminthes**

Single-species infections with soil-transmitted helminths can cause symptoms ranging from abdominal pain, dysentery and physiological abnormalities in the intestinal tract to anaemia, pruritus, skin eruptions and impairment of the development of cognitive abilities (Becker *et al.*, 2011). The level of morbidity is strongly correlated to the numbers of worms the host harbours and individuals afflicted with multiparasitism arguably experience increased morbidities compared to people with single species infections (Brooker, 2010). It is estimated that 300 million people worldwide suffer from severe morbidity due to soil-transmitted helminths, which also causes 10,000-135,000 deaths annually (Lustigman *et al.*, 2012).

Soil-transmitted helminth infections may also lead to nutrient deficiency, which manifests itself as immunodeficiency and impaired physical growth. Worm infections often decrease the appetite of the infected individual, thus leading to a lowered dietary intake (Hadju *et al.*, 1996). This results in deficiencies of essential nutrients, such as protein, iron, iodine, folate, zinc and vitamins A and B12. Moreover, intestinal inflammation leads to decreased nutrient absorption. For example, poor fat absorption due to mucosal damage has been described in individuals infected with *A. lumbricoides*, hookworm and *T. trichiura*. They also compete with the host for nutrients, while obstruction and cellular damage in the liver caused by *A. lumbricoides* reduces the utilization of nutrients in the body (Stephenson *et al.*, 2000).

The presence of soil-transmitted helminths in the host can also increase nutrient loss, frequently in the form of blood loss in the faeces, or by causing diarrhea (Stephenson *et al.*, 1985). Different nutrients are critical for specific immune functions and defenses. When an individual is deficient in any of them, a disruption in the immune integrity will result and eventually lead to increased susceptibility to infections (Gershwin *et al.*, 2000). In terms of macronutrients, proteins are essential for antibody and interleukin formation (Malafaia *et al.*, 2009), while lipids and carbohydrates play important roles in T cell production and function (Gershwin *et al.*, 2000). In addition, a range of micronutrients has also been associated with healthy immune functions. Vitamin A guards the integrity of the epithelium in the respiratory and gastrointestinal tracts. A deficiency in vitamin A results in an increased risk for diarrhoeal infections (Scrimshaw & SanGiovanni, 1997; Katona & Katona, 2008).

Several studies investigated the nutritional status of individuals infected with soil transmitted helminths. In communities where food resources are scarce, stunting (low height-for-age), wasting (low body mass index-for-age) and anaemia are common indicators for undernourishment used for such assessments (FAO, 2012).

Soil-transmitted helminth infections have also been shown to retard the cognitive development of infected children. Studies suggest that different intestinal helminth infections have distinct impacts on a child's cognitive development and children with multiparasitism suffer worse cognitive outcomes than children infected with a single helminth infection (Botelho *et al.,* 2008; Eppig *et al.,* 2010). In the Philippines, Ezeamama and colleagues (2005) reported, in a cohort of children, prevalence of 92%, 74% and 46% for *T. trichiura*, *A. lumbricoides* and *N. americanus*, respectively. These infections were shown to be significantly associated with reduced performance in cognitive tests.

Another study in Jamaica illustrated that when *T. trichiura* infections were cleared in children, gains in auditory short-term memory, and the scanning and retrieval of long-term memory could be observed (Nokes *et al.,* 1992). Similarly, in Indonesia, children were shown to have improved learning ability, eye-hand coordination, and cognitive test scores after *A. lumbricoides* infections were removed following chemotherapy (Hadidjaja *et al.,* 1998). However, a recent randomized controlled trial in Sri Lanka concluded that cognitive test scores did not increase despite a reduction in soil transmitted helminths infections due to successful school-based de worming (Ebenezer *et al.,* 2013).

Studies attempting to correlate reduced school performance and physical fitness with soil-transmitted helminths infections have also been conducted. While children performed better in school after treatment of *T. trichiura* infections in a study in Jamaica (Simeon *et al.,* 1995), another study in Guatemala showed that getting rid of *A. lumbricoides* infections did not lead to improvements in school performance (Watkins *et al.*, 1996). In Kenya, studies have highlighted that reduced physical fitness was correlated with soil-transmitted helminths infections and treatment of these infections led to improved physical fitness in school-aged children (Stephenson *et al.*, 1993; Bustinduy *et al.*, 2011). However, another study in Côte d'Ivoire found no such correlations. Of note, the prevalence and intensity of soil-transmitted helminths infections in that study were very low (Müller *et al.*, 2011).

Due to the limited and sometimes conflicting findings regarding the impact of soil-transmitted helminths infections on cognition, school performance and physical fitness, only morbidities such as anaemia due to hookworm, rectal prolapse due to *T. trichiura*, and bile duct or intestinal obstruction due to *A. lumbricoides*, have been well established and recognized within the scientific community (Lustigman *et al.*, 2012). Indeed, under the Global Burden of Disease Study (GBD), the collective disability weight of intestinal nematode infections, which include soil-transmitted helminthiases, is a mere 0.03 on a scale from 0 (perfect health) to 1 (death) (Salomon *et al.*, 2012).

Estimating the global burden of soil-transmitted helminthiasis

Quantifying the burden of soil-transmitted helminths infections will allow evidence-based decision-making for the allocation of limited health care resources (Nagpal *et al.*, 2013). The first attempt to estimate the burden due to these parasitic worms using the concept of disability-adjusted life years (DALYs), the universal currency for quantifying ill-health, was performed by Murray and colleagues (1994) under the GBD Study in the 1990s (WB, 1993). By defining a disability weight for each unique disease and then weighting the years lived with this disability they were able to estimate the years lost due to the disability. DALYs have since been used effectively to quantify disabilities and pre-mature deaths associated with most diseases (Chan, 1997).

In 1990, all high intensity of soil-transmitted helminths infections were given a disability weight of 0, but intestinal obstruction due to *A. lumbricoides*, rectal prolapse due to *T. trichiura*, and anaemia due to hookworm were assigned disability weights of 0.463, 0.116, and 0.024, respectively (Mathers *et al.*, 2007). Based on these weights, *A. lumbricoides*, *T. trichiura*, and hookworms were calculated to cause a loss of 4.2, 0.9 and 3.9 million DALYs, respectively, giving a collective burden of 9.0 million DALYs (Murray *et al.*, 1994).

One of the limitations of the DALY estimates for soil-transmitted helminths infections is that it is almost impossible to assign accurate individual disability weights to each species due to the worldwide presence of multiparasitism. The use of quality adjusted life years (QALYs) has thus been promoted to more comprehensively capture the impact of soil-transmitted helminths infections on infected individuals.

1.1.5 **Burden of soil transmitted helminths infection in Ethiopia**

In Ethiopia, the number of people living in soil transmitted helminths endemic areas is estimated to be 81 million, which comprised of 9.1 million pre-school-aged children, 25.3 million school-aged children and 44.6 million adults. The number of individuals living in areas qualifying for soil transmitted helminthes treatment is 56.7 million, comprised of 4.6 million pre-school children, 17.7 million school-age children, and 31.3 million adults. The coordinated large-scale mapping of both schistosomiasis and soil transmitted helminths demonstrated that 741 woredas are known to be endemic and 494 woredas require treatment against soil transmitted helminths based on WHO guidelines. Furthermore, 279 woredas require treatment twice a year. Figure 4 exemplifies the widespread prevalence of soil transmitted helminths across all regions of Ethiopia that have been mapped and analyzed thus far (FMoH, 2016).

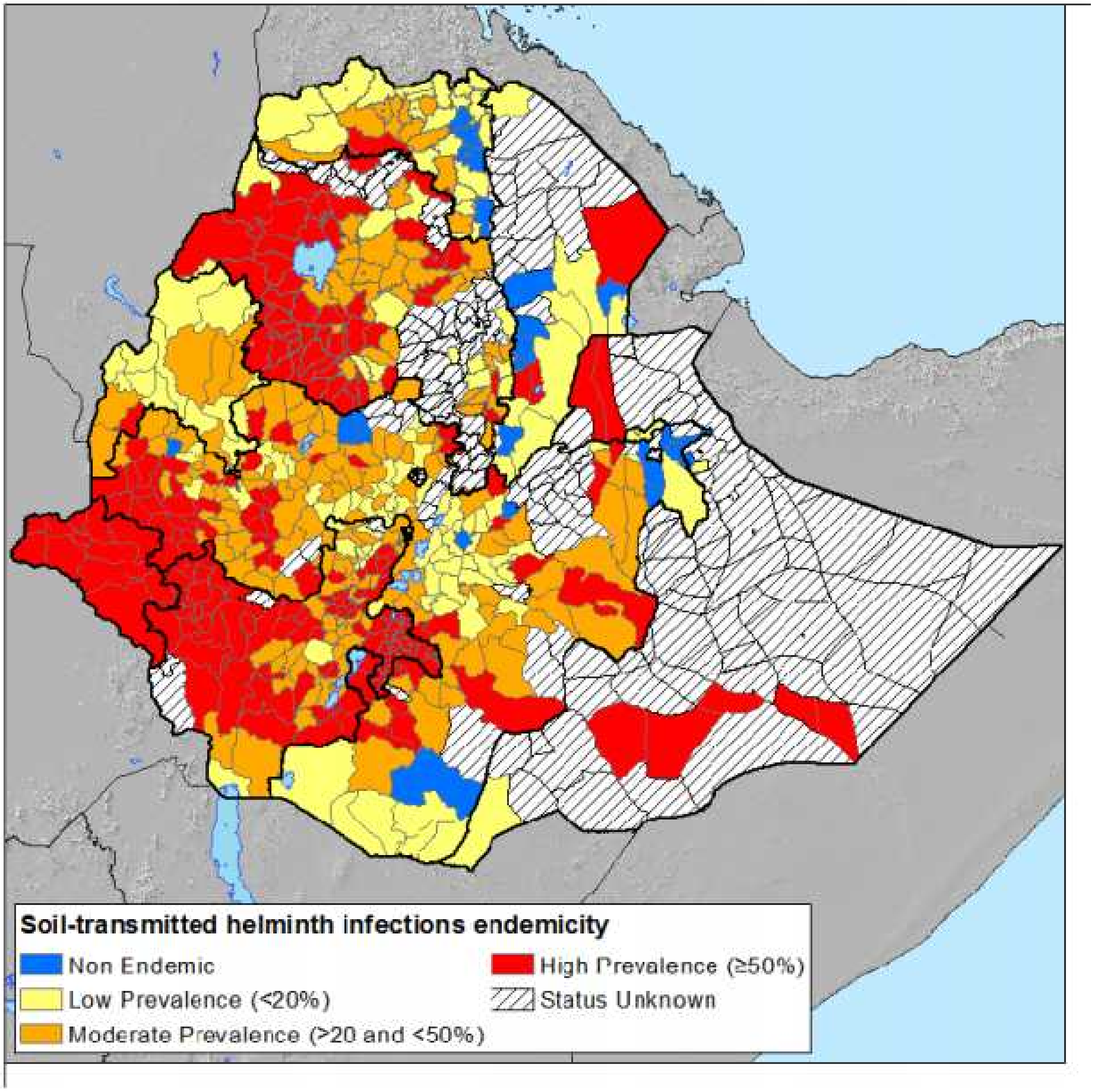


Fig 4 Distribution of STH infection in Ethiopia (FMoH, 2016)

1.1.6 **Schistosomiasis**

The term schistosome or *Schistosoma* means split body and refers to the fact that the males have a ventral groove called gynocophoric canal in which the cylindrical female resides in. They are members of the Platyhelminthes and are generally flashy flat leaf shaped worms. Members of the family show morphological and physiological peculiarities, which distinguishes them from all other trematodes. They are dioecious (male and female have their distinct set organs) and live in the blood stream of warm-blooded hosts, typically in venules around the intestine or bladder depending on the species. Most infections in humans can be accounted for by *Schistosoma haematobium*, *S.japomicum* and *S.mansoni*, together with a minor contribution from *S.intercalcatum and S.mekongi*. Ethiopia is one of the endemic counties for both *S.mansoni and S.haematobium (* Kassa *et al*., 2005).

Life Cycle

The life cycles of all five human schistosome species are similar and involve a snail intermediate host. Human or animals are infected when they come in contact with fresh water contaminated by cercariae, (infective stage) (Strandgaard *et al*., 2001). Upon host contact, the cercariae attach to and penetrate the host skin via glandular secretions (Warren, 1978). The parasites lose their tails as they penetrate the skin, and transform into schistosomula (Strandgaard *et al*., 2001). After spending at least two days in the skin, the parasites burrow through the dermis, penetrate a blood vessel wall, and gain access into the circulatory system (Walker, 2011). The parasites migrate to the lungs and remain there for several days before travelling to the liver were they blood-feed on red blood cells, mature and mate within the liver vessels. Afterwards, they emerge as male-female worm pairs, and inhabit either the portal venules or urinary bladder venous plexus *S.hematobium* (Strandgaard *et al*., 2001).

The female begins to lay eggs which are carried upstream to the liver via the portal veins and its branches and get trapped in the pre-sinusoidal portal venules (Strandgaard *et al*., 2001). Some of the eggs migrate and penetrate the intestines and shed in the stool. Eggs laid in the pelvic venous plexus migrate towards the urinary bladder, pass through the bladder wall, and are excreted in urine. When eggs contact water, they hatch into ciliated larval forms called miracidia that can sense compatible intermediate snail hosts (Ross et al., 2002). Miracidia penetrate the snail by proteolytic activity and mechanical movement (Walker, 2011). Inside the snail host, miracidia undergo asexual development and transform into cercariae which emerge from the snails and seek out the definitive host (McKerrow *et al*., 2002). The parasite life cycle is thus completed (Curwen *et al*., 2003)

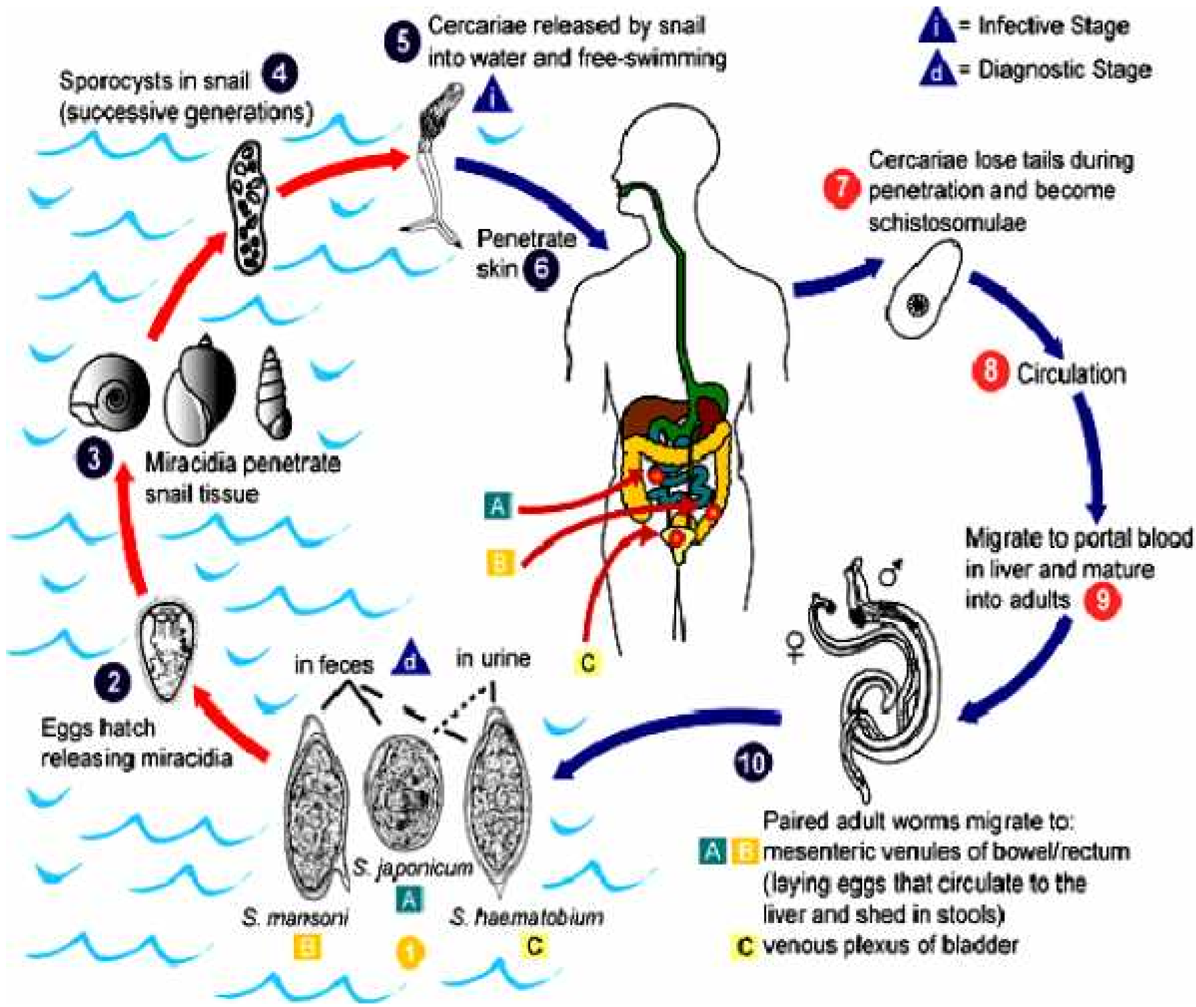


Fig. 5 Life cycle of schistosomes

Pathology and Morbidity

In schistosomiasis, adult worms reside in the mesenteric and pelvic venules in various sites where they lay eggs (Walker, 2011). These sites tend to be specific for each species (e.g. S. japonicum prefers the superior mesenteric veins draining to the small intestine, while S. mansoni prefers the superior mesenteric veins of the large intestine) (Sajid *et al*., 2002). Many eggs are carried upstream where they get lodged in various organs especially in the liver, bowel, and genitourinary tract (Walker, 2011). In acute disease (Katayama syndrome), schistosomula antigens/secretions orchestrate a T helper type 1 (Th1) cell-driven inflammatory response (involving tumour necrosis factor, interleukin-1, and interleukin-6 cytokines) and cause febrile illness (Sajid *et al*., 2002).

As mature female worms lay eggs, products of worm and egg metabolism induce formation of immune complexes resulting to a serum like-sickness called Katayama syndrome (Ross et al., 2002). In chronic disease, eggs are the cause of pathology; they evoke a T helper type 2 (Th2) cell-driven granulomatous reaction (involving interleukin-4, interleukin-5, and interleukin-13 cytokines) resulting in tissue fibrosis and chronic morbidity (Sajid *et al*., 2002). Interleukin-13 has been observed to produce fibrosis in animal models (McKerrow *et al*., 2002). Both Th1 and Th2 arms play a role in granuloma formation, the latter being the dominant player (Sajid *et al*., 2002).

Gastrointestinal schistosomiasis due to *S. mansoni*, *S. japonicum* and *S. mekongi* can cause bowel lesions such as ulceration, pseudo polyps, and micro abscesses. This can be seen clinically as abdominal pain, altered bowel habits, and blood in stools (Ross *et al*., 2002). Liver enlargement and periportal fibrosis are common in advanced cases, and is generally linked with ascites and portal hypertension. Clinical signs including: superficial abdominal blood vessel dilatation, spleen enlargement, and bleeding-prone esophageal varices have been well documented (Ross *et al*., 2002). Patients with severe hepatosplenic schistosomiasis may die from ruptured esophageal varices. Some studies suggest an association of *S.mansoni* and *S. japonica* and cancer development in the liver and colon, but no hard evidence exists to support the association (McKerrow *et al*., 2002).

1.1.7 **Global Burden of Schistosomiasis**

The World Health Organization estimates that schistosomiasis and geohelmiths represent more than 40% of the global disease burden caused by all tropical diseases, excluding malaria (WHO, 2006). Schistosomiasis is the third most devastating tropical disease globally (after malaria and intestinal helminthiases) and is a major cause of morbidity and mortality for developing countries in Africa, South America, the Caribbean, the Middle East, and Asia (WHO, 2013). In 74 countries where the disease is endemic, an estimated 250 million people are infected and approximately 700 million people are at risk of infection (Ross, 2002). The burden of disease attributable to the three major human schistosome species (*Schistosoma mansoni, S. haematobium, and S. japonicum*) is estimated to be between 24-29 million disability adjusted life years (WHO, 2013).

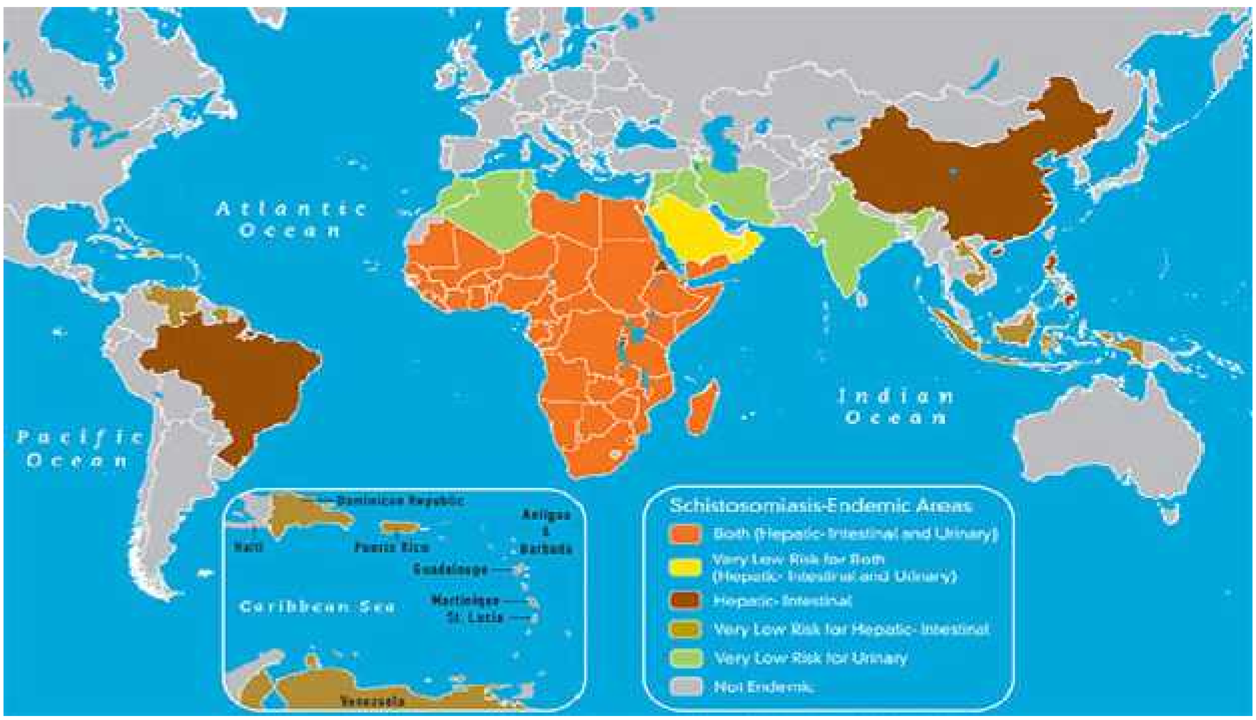


Fig 6. Map of the current global distribution of schistosomiasis. Source: US Centers for Disease Control and Prevention,<http://wwwnc.cdc.gov/travel/yellowbook/2012/chapter-3-infectious-diseases-related-to-travel/schistosomiasis#2696>).

Schistosoma mansoni is widespread in Africa, the Eastern-Mediterranean, the Caribbean, and South America. Almost 300,000 people die annually from schistosomiasis in Africa alone (Werf *et al*., 2003). Approximately 90% of the 250 million people infected worldwide live in Sub-

Saharan Africa where *S. mansoni* is the prevalent species (Werf *et al*., 2003). About 10 million women in Africa are infected during pregnancy (Werf *et al*., 2003). Zoonotic transmission is possible with these species, because the parasite infects not only humans but also wild rodents (Theron *et al*., 2004).

1.1.8 Burden of schistosomiasis in Ethiopia

Ethiopia has conducted Schistosomiasis mapping survey in all regions of the country by Ethiopian Public Health Institute (EPHI). The intestinal form of schistosomiasis caused by *Schistsoma mansoni* is widely distributed while the uro-genital form caused by *S. haematobium* is more restricted in distribution, primarily to foci in the rift valley region. There are an estimated 37.3 million people living in schistosomiasis endemic areas, comprising 3.4 million pre-school children, 12.3 million school-aged children, and 21.6 million adults. In 2013, it was estimated that 35,775,100 cases of schistosomiasis occurred in Ethiopia (FDREMH, 2016). Of the country's 833 districts, 374 are uninfected for both intestinal and urogenital schistosomiasis, 190 have low, 153 moderate endemicity, and 69 high endemicity the remaining districts are yet to be determined (FDREMH, 2016).

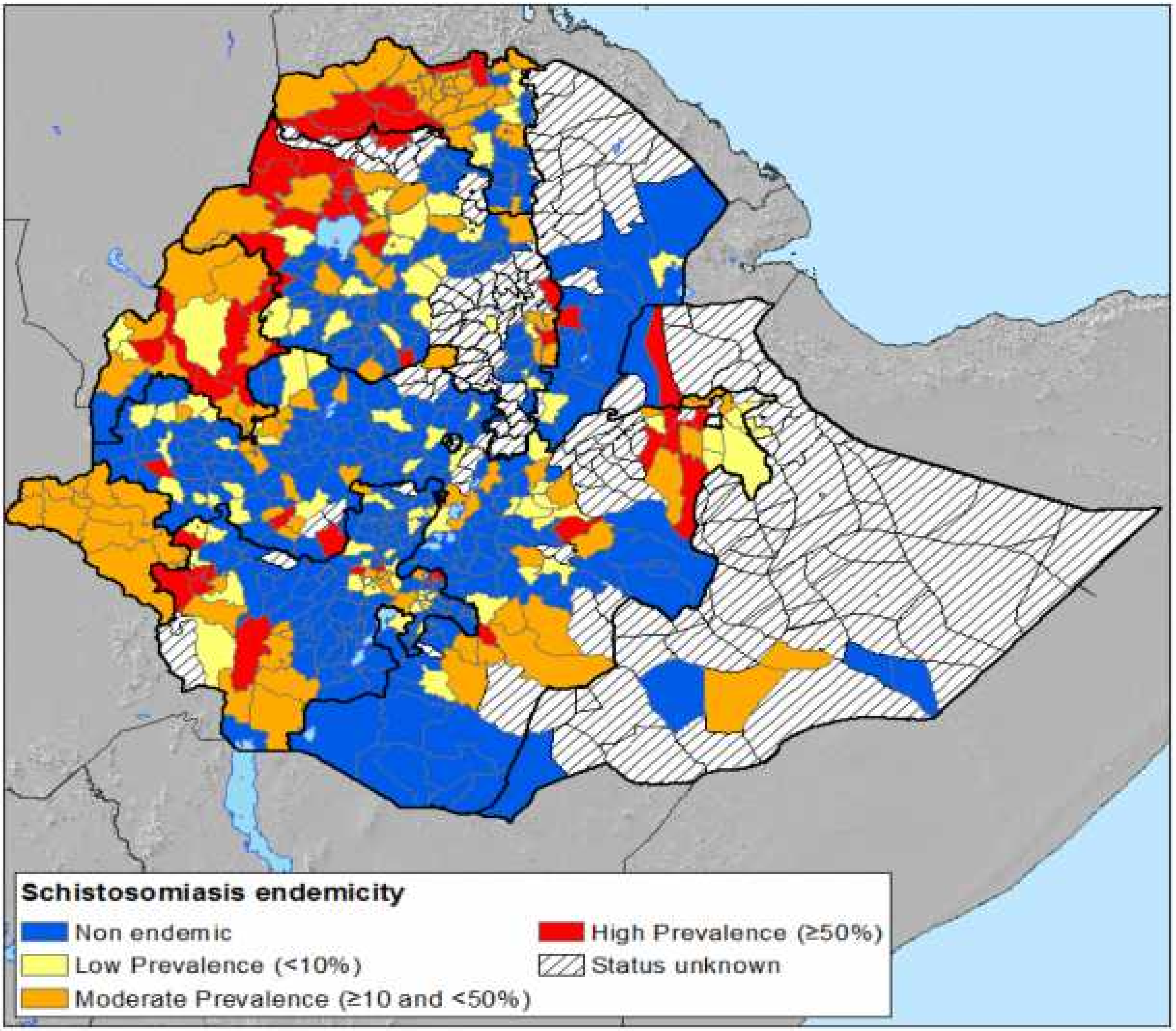


Fig. 7 Distribution of schistosomiasis infection in Ethiopia (FMoH, 2016)

1.1.9 **Risk factors for soil transmitted helminthiasis and Schistosomiasis**

Soil transmitted helminthes infection are distributed worldwide with high prevalence rates in tropical and sub-tropical countries those with lack of adequate sanitary facilities, inappropriate waste disposal systems, lack of safe water supply, and low socio- economic status. School age children mainly are at high risk of these intestinal parasitic infections especially in developing countries like Ethiopia. Schistosomiasis is initiated by exposure to water (while planting, fishing, washing, swimming and so on) containing the free living infective stage of the parasite (cercariea) released from the intermediate host (snail) (Alemu *et al*, 2011).

Two species of fresh water snails (*Biomphalaria pfeifferi* and *B. sudanica)* are responsible for the transmission of *S. mansoni* in the country (Ali *et al.*, 2006). The former is the most dominant and is found in a variety of habitats like pools, sewages, swamps, lakes, small and medium streams, irrigation canals and rivers (Fekadu *et al*., 1998). Peoples living in the area and having contact with the water source will be infected.

1.1.10 **Control and prevention of soil transmitted helminthiasis**

Chemotherapy against soil-transmitted helminthes

Chemotherapy is an essential tool to control soil-transmitted helminths infections. The WHO advocates the use of preventive chemotherapy, where periodic administrations of treatments are carried out in those population subgroups, at highest risk of disease, without prior diagnosis (WHO, 2006). The rationale behind this strategy is to reduce infection intensity and hence, reduce or eliminate morbidities from chronic helminths infections (Gabrielli *et al.*, 2011). Albendazole and mebendazole are the drugs of choice for community-based mass drug administration against soil-transmitted helminths (WHO, 2006).

Both drugs show high cure and egg reduction rates for *A. lumbricoides*, whereas albendaozle is clearly more efficacious against hookworm than mebendazole, and have good safety profiles. On the other hand neither drug shows satisfactory cure rates for *T. trichiura* infections, albeit with reasonable egg reduction rates (Keiser & Utzinger, 2008). The WHO also recommends the use of levamisole and pyrantel pamoate against soil-transmitted helminths. Both are active against *A. lumbricoides* but only levamisole exhibits moderate efficacy against *S. stercoralis,* while pyrantel pamoate is preferably used to treat heavy hookworm infections. Multiple dosing and combination therapy might prove to be valuable strategies against soil-transmitted helminths infections, as they could respectively offer increased efficacy and a wider spectrum of increased activity. Although novel anthelminthic drugs are urgently needed in anticipation of the development of drug resistance, it is also hoped that drug combinations could delay the emergence of drug resistance.

Indeed, combinations of mebendazole, levamisole and pyrantel pamoate have outperformed single dosing of these drugs against soil-transmitted helminths (Utzinger & Keiser, 2004). Furthermore, triple-dose regimens were shown to produce higher cure rates for hookworm and *T. trichiura* as compared to single dose regimens (Steinmann *et al.,* 2011) and a combination of mebendazole and ivermectin against *T. trichiura* was also found to give higher cure and egg reduction rates as compared to a combination of albendazole and ivermectin, albendazole alone and mebendazole alone (Knopp *et al.,* 2010).

As chemotherapy alone is not able to prevent re-infections, it is also important to have non-chemotherapeutic health interventions in place for a more comprehensive and sustainable control of intestinal parasitic infections. These non-chemotherapeutic interventions should also have the capacity to treat under nutrition, impaired cognitive development and other deficits resulting from the condition (Hall, 2007).

Non-chemotherapeutic control strategies

A lack of proper sanitation promotes the transmission of soil-transmitted helminthiases by causing contamination of the environment. In many rural communities worldwide, the concept of sanitation remains elusive and open defecation is practiced widely, but given the right education and motivation, introduction and usage of low cost pit latrines, which can be subsequently improved, can have a protective effect against the parasitic worms (Brown *et al.,* 2013).

In Brazil, households with storm water drains or full waterborne sewage systems were compared to households with neither, and results showed that the prevalence of *A. lumbricoides* decreased by up to 40% when the level of community sanitation increased (Moraes *et al.*, 2004). Furthermore, inadequate sanitation was also shown to be a risk factor for soil-transmitted helminths infections in Côte d'Ivoire (Schmidlin *et al.*, 2013). Proper sanitation does not just reduce environmental contamination of faecal material but they also provide a sense of dignity and security, especially for women, within communities. In particular, their provision should be integrated with mass drug administration under school-based control programmes for soil-transmitted helminthiasis (Freeman *et al.*, 2013).

Health education and behavioral intervention can be useful tools in guiding the targeted populations to understand the health issues they are facing and take individual measures against them. Likewise for soil-transmitted helminthes infections, health education tools can help create awareness for these diseases, especially since symptoms are subtle, and get communities to adopt good hygiene habits, mainly hand washing with soap, wearing protective clothing, using latrines, and eating food and drinking water that have been properly processed, all of which can help reduce the transmission of soil-transmitted helminths infections.

A recent study from Hunan province, P.R. China, illustrated how a comprehensive health education package has led to reductions in *A. lumbricoides* transmission (Bieri *et al.*, 2013). The health education package, which aims to engage school-aged children and impress upon them proper knowledge, attitudes and practices towards soil-transmitted helminths infections, included an attractive cartoon video, drawing and essay competitions, and take-home brochures.

The task of inducing behavioural change is challenging. The WHO has published a step-by-step guide for participatory hygiene and sanitation transformation (PHAST) (WHO, 1998), which can provide the first steps in getting communities to make improvements to their own health. Briefly, the steps include (i) problem identification, where individuals share stories and their perceived health problems of their communities; (ii) problem analysis, where community health and hygiene practices are examined to understand how diseases spread; (iii) planning for solutions, where an action plan is devised to stop the spread of disease; (iv) selecting options, where the community selects for themselves the type of sanitation and hygiene behaviors they want to adopt; (v) planning for new facilities and behaviour change, where tasks are delegated to different members of the community to implement; and (vi) planning for monitoring and evaluation, where progress of the whole transformation is appraised.

The guide focuses on participatory methods, which could embolden individuals, regardless of their sex, age, social class or educational level, to be involved in the health issues and decisions concerning their own communities. Such a process might prove to be more rewarding and sustainable in inducing behavioural change than simply a top-down approach where individuals are told to change their lifestyle and habits from strangers outside of their communities. However, more field-based investigations on the applicability and impact of PHAST are needed to confirm this claim (Musabayane, 2000).

More recently, another method, termed the community-led total sanitation (CLTS), was developed for encouraging change in sanitation behavior (Chambers & Kar, 2008). This approach is similar to PHAST but has an added component of using shame or social stigma as a driver for promoting the adoption of improved sanitation behavior. The use of such a mechanism to induce behavioral change has generated controversies (Pattanayak *et al.*, 2009; Bartram *et al.*, 2012) and the longer-term impact of CLTS on hygiene and sanitation transformation remains to be determined (Schmidlin *et al.*, 2013).

1.1.11 **Control of schistosomiasis**

The main principle of schistosomiasis control is its morbidity control and is implemented through the primary health care system (WHO, 1993). Praziquantel—the drug of choice for all forms of schistosomiasis has become significantly cheaper, and several brands of good quality, generic praziquantel are now available. The average cost of treatment with this drug has fallen to less than a customary user fee, which has clear implications for wider availability of praziquantel. It also implies that both presumptive treatment, based on early clinical symptoms, and universal treatment on the basis of epidemiological criteria have become cost-effective in an increasing number of endemic situations. As praziquantel is a safe drug, it can be provided at the most peripheral levels of the drug delivery system (Guyatt *et al.*, 1994; Carabin *et al.*, 2000).

The integrated control of schistosomiasis advanced considerably with the introduction of praziquantel (PZQ) in the late 1970's. After decades of extensive use, severe schistosome-related morbidities decreased significantly, but high re-infection rates and transmission remained. In addition, to sustain the gains accomplished with PZQ, the agent has to be administered periodically through MDA for an indefinite period of time and without relaxation to prevent rebound of morbidities. Furthermore, continuous and extensive drug use may lead to PZQ-resistant strains of schistosomes (Mohamed *et al*., 1991). Therefore, the search for alternative approaches is vital. Development of new pharmacological agents should be pursued aggressively. Vaccines that can help sustain MDA must be well supported.

Several promising vaccine candidates against schistosomiasis are in various stages of development. Some of the candidates are in the pre-clinical trial stage, and some have entered phase one and phase two clinical trials. These candidates include: GST, Paramyosin, Fatty Acid Binding Protein (FABP), Calpain, Triose-phosphate isomerase, and Tetraspanins. Among the GST candidate vaccine molecules, the 28kDa GST recombinant protein (sSh28GST) from S. haematobium has already been tested in safety, immunogenicity and toxicity clinical trials studies, and Phase I and II trials (Devidas *et al*., 1989) Paramyosin (rSj97) candidate vaccine molecules are undergoing pre-clinical studies. The paramyosin recombinant fragment has been observed to provide protection and immunogenicity in BALB/c mice. On the other hand, the full length recombinant protein, aside from exhibiting protection in mice, has also shown antibody responses in humans associated with re-infection resistance (Capron *et al*., 2005)

More importantly, the full length paramyosin molecule production has been up-scaled, and is now undergoing pre-clinical testing in water buffaloes in the Philippines (Zhang *et al*., 2006) One of the FABP candidate vaccine molecules called Sm14-FABP, as for sSh28GST, has already reached an advanced developmental stage. A noteworthy development with this candidate vaccine is its ability to induce cross-protection against Schistosoma and Fasciola. Up-scaled production of this molecule has been successful and the procedure for its industrial GMPgrade production has been developed. Phase I and II clinical trials are already being planned for Sm14-FABP (Jiz *et al*., 2009)

1.1.12 Epidemiology of Schistosomiasis and soil transmitted helminthiasis globally

Soil transmitted helminthic infections and Schistosomiasis are among the widely spread chronic infections in the world. Globally 2 billion individuals are infected with helminthes, out of these majorities live in resource-poor settings (WHO, 2002). World health organization estimated the common soil transmitted helminthes infections in world as: 250 million cases for Ascariasis, 151 million cases of hookworm diseases, and 45.5 million cases of Trichuriasis (WHO, 2002). Schistosomiasis is also remains one of the most prevalent parasitic diseases in the world. It is endemic in 76 countries and continues to be public health concern in developing countries. Approximately 80% of the 200 million people infected world-wide live in sub-Saharan Africa where Schistosoma mansoni and Schistosoma haematobium are widespread (Davis *et al*., 2003; WHO, 2002).

1.1.13 Epidemiology of Schistosomiasis and soil transmitted helminthiasis in Ethiopia

Ethiopia has one of the lowest quality drinking water supply and latrine coverage in the world (Kumie *et al*., 2005). Because of this and other reasons intestinal parasites have been wide spread in Ethiopia and parasitic helminthic infections are the second most predominant causes of outpatient morbidity in the country. Many reports illustrated that ascariasis is the most prevalent intestinal parasitic infection in different communities usually occurring together with trichuriasis (Woldemichael *et al.*, 1999).

Schistosoma mansoni have significant medical and public health importance. *S. mansoni* is widespread and its presence has been recorded in all administrative regions and is rapidly spreading in connection with water resource development and intensive population movements (WHO, 2002). Two species of fresh water snails (*Biomphalaria pfeifferi* and *B. sudanica)* are responsible for the transmission of *S. mansoni* in the country. Schistosomiasis is common in northern region as compared to south and south west regions of Ethiopia (Haile *et al.*, 1994).

1.1.14 Prevalence and associated risk factors of Schistosomiasis and soil transmitted helminthiasis globally

According to study conducted in Myanmar, 27.81% of participants in the study were infected with at least one type of STH. The most prevalent STH was *Trichuris trichiura* followed by hookworm and Ascaris lumbricoides (Dunn *et al.*, 2017). Most infections were of low intensity, measured by eggs per gram of faeces (EPG). Gender stratification revealed that *A. lumbricoides* prevalence was significantly higher in females, whereas hookworm prevalence was significantly higher in males. The distribution of EPG in the study sample was highly over dispersed, suggesting that most people release few eggs whereas a few people release many eggs. Adults harbor a major proportion of the overall STH burden; 65.15% of STH infections were harbored by adults (Julia *et al*., 2017).

Study conducted in India shows that the prevalence of STH was 7.8 per cent, varying widely in schools from 0 to 20.4 per cent, in 3706 screened children. Hookworm (8.4%) rates were high in rural areas, while *Ascaris* (3.3%) and *Trichuris* (2.2%) were more prevalent among urban children. Consumption of de worming tablets (OR=0.25, P<0.01) offered protection, while residing in a field hut (OR=6.73, P=0.02) and unhygienic practices like open air defecation (OR=5.37, P<0.01), keeping untrimmed nails (OR=2.53, P=0.01) or eating food fallen on the ground (OR=2.52, P=0.01) were important risk factors for STH infection (Deepthi *et al*., 2014).
According to national survey conducted in Malawi, The prevalence of *Schistosoma mansoni* is 0.4% (95% CI 0–1.3%), *S. haematobium* 6.9% (95% CI 1.9 – 11.9%), hookworm 1.3% (95% CI 0.4–2.3%), Ascariasis 0.5% (95% CI 0.1–1.0%) and trichuriasis 0% in year 3 pupils (modal age 10 years of age) (Bowie, 2004).

A cross sectional survey conducted in the Akonolinga health district (Centre Region, Cameroon) to assess the prevalence and intensity of helminthes infections. A total of 334 patients, among which 181 (54.2%) females and 153 (45.8%) males, were examined. The STH of major concern was found in this group of individuals, with overall prevalence equal to 18.0% (95% CI: 14.2–22.4) for *Ascaris lumbricoides*, 43.7% (95% CI: 38.5–49.1) for *Trichuris trichiura*, and 7.5% (95% CI: 5.1–10.8) for *Necator americanus* (Bopda *et al*., 2016).

The study conducted in Kenya in 2015 indicated that infection with *Ascaris lumbricoides* had a predominant prevalence rate of 19.8% among pre-school age children in Marani district followed by *Ancylostoma duodenale* infection with a prevalence rate of 7.8% and the least prevalent worm species was *Trichuris trichiura* (2.8%). Combination infection of helminthes was observed with *Ascaris lumbrocoides*/*Trichuris trichiura* having a prevalence rate of 4.7% followed by *Ascaris lumbricoides*/hookworm (0.9%) (Hotez *et al*, 2008).

Qualitative studies conducted by Albonico *et al*.,2008 to determine the number of soil transmitted helminthes prevalence studies published for the same age group across endemic countries reveals that, *Ascaris lumbricoides* is undisputedly the most dominant infection with the highest prevalence ranging from as low as 3% (in Phillipines rural area) to as high as 88% (in Madagascar). In the same study, *Ascaris lumbricoides* prevalence among preschool children was 20% in Kenya (Riesel *et al*., 2010).

In addition, the published qualitative studies by Albonico *et al*., (2008) established that hookworm infection in Kenya has an average prevalence of 29% as compared to *Ascaris lumbricoides* (20%) and *Trichuris trichiura* (15%) (Riesel *et al,* 2010). From these studies, the noted comparative differences from many soil transmitted helminthes specific parasite prevalence suggest that the surveys were done under different study area environments. Rural villages, semi-urban residential areas and urban slums will tend to show differences in soil transmitted helminthes infection. High hookworm prevalence is often reported from rural farming villages where children accompany their parents to the farm as compared to urban or semi-urban areas, which report high prevalence of *A. lumbricoides* or *T. trichura* (Fleming *et al*., 2006; Alemu *et al*., 2011).

1.1.15 Prevalence and associated risk factors of Schistosomiasis and soil transmitted helminthiasis in Ethiopia

Study conducted in zarima town, northwest Ethiopia shows out of 319 study subjects, 263 (82.4%) of the study participants infected with one or more parasites. From soil transmitted helminths, *Ascaris lumbricoides* was the predominant isolate (22%) followed by Hookworms (19%) and *Trichuris trichiura* (2.5%). *Schistosoma mansoni* was also isolated in 37.9% of the study participants. Hookworm and *S. mansoni* infections showed statistically significant associations with shoe wearing and swimming habit of school children, respectively (Alemu *et al*., 2011). Another study conducted on human intestinal schistosomiasis in communities living near three rivers of Jimma town, south western Ethiopia, The prevalence of *S. mansoni* was 26.3 % with intensity ranging 24 to 936 EPG of stool. Participants in the age group 10-19 years, OR = 2.19 (95% CI; 1.10 – 4.34), and those living near the Awetu River, OR = 2.67 (95% CI; 1.06 – 6.75), had higher risk of *S. mansoni* infection. Moreover water contact while crossing a river, OR = 3.77 (95% CI; 1.79 – 7.95), and swimming, OR = 2.59 (95%CI; 1.37 – 4.91, was significantly associated with infection. *Biomphalaria* snails collected from Chore and Awetu Rivers shaded higher rate of cercariae compared with Kito River (Mengistu *et al*., 2015).

Study conducted on association of community sanitation usage with soil-transmitted helminthes infections among school-aged children in Amhara Region, Ethiopia indicated that prevalence of soil transmitted helminthes infection was estimated as 22% (95% CI: 20–24%) for hookworm, 14% (95% CI: 13–16%) for *A. lumbricoides,* and 4% (95% CI: 4–5%) for *T. trichiura* (Oswald *et al.,* 2017). Adjusting for individual, household, and community characteristics, hookworm prevalence was not associated with community sanitation usage. Households with a latrine in use had lower prevalence of *A. lumbricoides* compared to households without latrines in use only in communities where sanitation usage was ≥ 80% (Oswald *et al*., 2017).

In 2010, study conducted on prevalence and associated risk factors for soil transmitted helminthes among mothers and their infants in Butajira, Ethiopia showed that four species of soil-transmitted helminthes were identified in the stool samples, with the overall prevalence of any soil transmitted helminthes infection being 43.5% (95% confidence interval (CI)) 40.2-

46.8%) in mothers, and 4.9% (95%CI 3.6-6.5%) in children, respectively. Hookworm was the predominant intestinal helminthes infection, detected in 36.1% of mothers and in 2.3% of children, and *A. lumbricoides* was the second most frequently detected intestinal parasite with prevalence of 8.8% in mothers and 1.5% in children. About one third (36.2%) of mothers and 4.4% of children had a single infection, while 6.6% of mothers and 0.4% of children had double infections, 0.7% of mothers had triple infections (Belyhun *et al*., 2010).

Study conducted on epidemiological study of *Schistosoma mansoni* infection in Sanja area, Amhara region, Ethiopia shows that the prevalence of *Schistosoma mansoni* infection using Kato-Katz method was high among male (79.5%) children in Sanja Primary school while it was high among female (75%) children in Ewket Amba Primary school. The prevalence of *Schistosoma mansoni* infection among Sanja Primary school children in the age groups 5–9 and 10–14 years were 84.6% and 75.2%, respectively while in Ewket Amba Primary school, the prevalence was 66% and 77.9% in the age groups 5–9 and 10–14 years respectively (Alebie *et al*., 2014)..

The prevalence of schistosome infection in *Biomphalaria pfeifferi* was 16.9% and 0.027% during February and April, respectively. *S. mansoni* infection was successfully established in laboratory mice and adult worms were harvested after six weeks of laboratory maintenance. Observations made on water contact activities showed swimming, bathing and washing in the river and the stream as the high risk activities for *schistosoma mansoni* infection (Alebie *et al*., 2014).

Study conducted on soil-transmitted helminthes infections and associated risk factors among school children in Durbete Town, Northwestern Ethiopia, in February and March 2010 showed that, about 54.9% (211) of children examined were infected with at least one intestinal helminthes species. *Hookworms*, *A. lumbricoides*, *T. trichiura*, infections were observed in 46.9%, 13.9%, 2.3%, of the children, respectively (Alelign *et al.,* 2015).

Study conducted among elementary school children in Ambo town, western Ethiopia showed that Prevalence of any STHs infection was 12.6%. The respective prevalence of major soil-transmitted helminthes is *A. lumbricoides* (7.8%), *Hookworm* (2.8%) and *T. trichiura*, (2.2%).

This study result shows STHs prevalence varies regards to age, sex, latrine use, family size and nail trimming (Samuel *et al*., 2017).

1.2. Diagnosis of Schistosomiasis and soil transmitted helminthiasis

Stool specimen examination for intestinal parasite is routinely performed by direct examination and concentration technique. In many health facilities of Ethiopia stool sample examination for identification of helminthes is performed by direct stool examination of fresh sample. The direct examination of faeces is essential to detect motile parasites and is usually adequate to detect significant helminthes infections. Important exceptions are *Schistosoma* species because only a few eggs are usually produced even in moderate and severe infections, therefore a concentration technique should be performed when intestinal schistosomiasis is suspected and no eggs are found by direct examination. Concentration techniques may also be required to detect *Strongyloides* larvae, the eggs of *Taenia*, cysts of *G. lamblia*, and to make it easier to detect small parasites, e.g. small fluke eggs, or the oocysts of intestinal coccidia prior to staining, to check whether treatment has been successful and to quantify intestinal parasites (Monica, 2009).

1.3. **Statement of the problem**

Soil-transmitted helminthiases and *Schistosomiasis* inflict tremendous disability and suffering. World health organization estimated the common soil transmitted infections in world as: 250 million cases for Ascariasis, 151 million cases of hookworm diseases, and 45.5 million cases of Trichuriasis (WHO, 2002) Schistosomiasis (*Schistosoma haematobium, S.mansoni* and *S.japonicum*) 207 million (Bethony *et al*., 2006; Hotez *et al*., 2009; Magambo *et al.*, 1998). The worms feed on host tissues, including blood, which leads to a loss of iron and protein. The worms also increase mal absorption of nutrients. In addition, some soil transmitted helminthes cause loss of appetite and, therefore, a reduction of nutritional intake and physical fitness.

The nutritional impairment caused by soil transmitted helminthes is recognized to have a significant impact on growth and physical development (Magambo *et al.,* 1998). Children of school age are mainly at risk of infection from soil transmitted helminthes in developing countries like Ethiopia (WHO, 2008). Though there are previous data on prevalence and associated risk factors of soil transmitted helminthiasis among primary school children in different areas of Ethiopia, it was unknown in Guder town. In Ambo town research on the prevalence of soil transmitted helminthes among primary school children has been done before three years and MDA was being implemented twice a year. But there was no recent report on the prevalence of soil transmitted helminthes. So this research was aimed to assess the prevalence and associated risk factors among primary school children and the effect of de-worming program that has been done in Guder and Ambo town.

1.4. **Significance of the study**

Intestinal schistosomiasis and soil transmitted helminthes infections (STIs) are among the major public health problems in the world, especially in developing countries like Ethiopia, causing physical and intellectual growth retardation in children leading to attention deficits, learning disabilities, school absenteeism and higher dropout rates. Although soil-transmitted helminthiases and schistosomiasis inflict tremendous disability and suffering, they can be controlled or eliminated based on the periodic single-dose Albendazole (400 mg) or Mebendazole (500 mg) and Praziquantel de worming of at-risk population living in endemic areas. In Ambo town de worming program has been implemented by MDA twice a year. So, this study has helped to know the burden of soil transmitted helminthes in the proposed study area. This result has provided useful information that will help the health authority to know the associated risk factors for the infection and properly manage the problems that arise from soil transmitted helminthes and *Schistosomia* infection and improve the hygiene and sanitation of the community to reduce the infection in future time.

1.5. Research Questions

- What is the prevalence of STH and intestinal schistosomiasis in primary school children in Guder and Ambo town?
- What are the risk factors responsible for the transmission of soil transmitted helminthes and intestinal schistosomiasis in primary school children in Guder and Ambo town?

2. Objective

2.1. Genera objective

To assess the prevalence of soil transmitted helminthes and intestinal schistosomiasis in primary school children in Guder and Ambo towns

2.2. Specific objective

To assess the prevalence of soil transmitted helminthes infection in primary school children in Guder and Ambo towns

To determine the prevalence of intestinal schistosomiasis in primary school children in Guder and Ambo towns

To determine the risk factor in the transmission of soil transmitted helminthiasis and intestinal schistosomiasis

3. Materials and methods

3.1. Study area

The study was conducted among primary school children at Guder and Ambo town. Guder town is located in West Shewa Zone, Oromiya Region 126 km from Addis Ababa and 11 km west of Ambo town and has an altitude and longitude of $8^0$58'N 37^0 46'E, with an elevation of 2101 meters above sea level. Guder is famous for its Guder river falls and year- round fruit production, using plentiful water resources in the vicinity. Based on figures from the Central Statistical Agency in 2005, Guder has an estimated total population of 17,084 of whom 8,272 are men and 8,812 are women.

Ambo town is also located 115 km from Addis Ababa in West Shewa Zone, Oromia Region. It situated at latitude and longitude of 8°59′N 37°51′E and an elevation ranges from 1900 to 2275 m above sea level. The population size was 76,774, of whom 39,155 are males and 37,619 are females and are ethnically mixed. It has an annual rainfall and temperature ranging from 800 to 1000 mm and 20-29 °C respectively (CSA; 2000). Agriculture is the main occupation of the population of the area. The agricultural activities are mainly mixed type with cattle rearing and crop production under taken side by side (AARDB; 2006). There are nine government and eleven private elementary schools in the town. Besides, one governmental hospital, two health centers and 20 private clinics are found in the town, serving the community to improve the health problem.

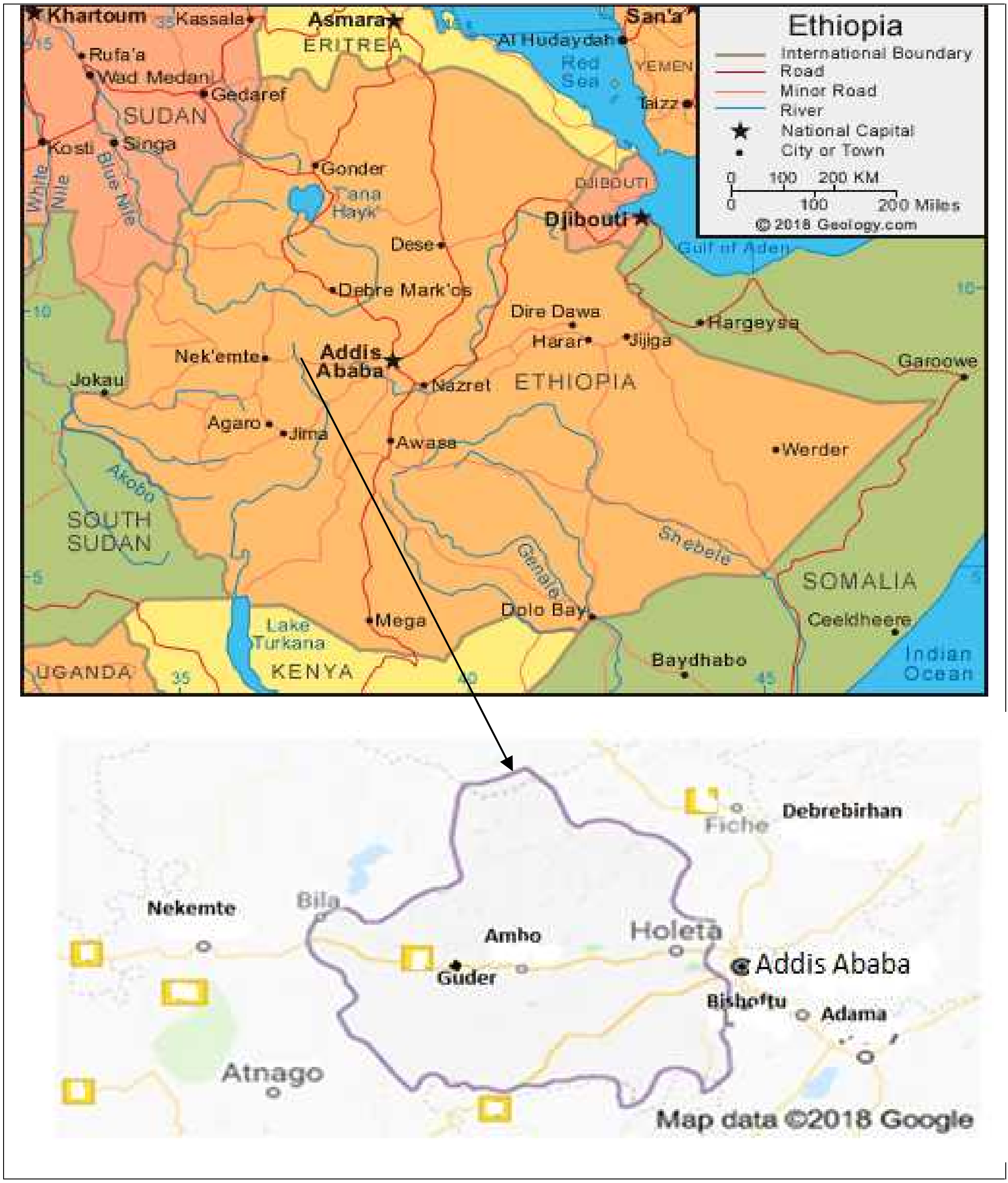


Fig. 8 Map of west shewa zone

3.2. Study design and period

A cross sectional study was conducted from April 2018 to May 2018 among primary school children in Guder and Ambo town.

3.3. Population

3.3.1 Source of population

All students who were in elementary school at Guder and Ambo town

3.3.2 Study population

All students in the selected primary schools from Guder and Ambo Town

3.3.3 Study participants

All students in the selected classroom who were interviewed by questionnaire and requested stool sample for the study

3.4. Inclusion criteria

All students who were willing to participate in the study and provided written informed consent from their parents

3.5. Exclusion criteria

Students treated for intestinal schistosomiasis and/or soil transmitted helminthes in the past one month

3.6. Variables of the study

3.6.1 Dependent variables

Infection of soil transmitted helminthiasis and intestinal schistosomiasis

3.6.2 Independent variable

Associated risk factor such as

- Type of latrine
- Finger nail trimming
- Age and sex
- Family size
- Swimming water

3.7. Sampling technique and sample size determination

The sample size for the study was calculated by using single proportion formula at 95 % confidence interval (CI) level ($Z_{1-\alpha/2}$=1.96). $n = z^2p(1-p)/d^2$ (Daniel, 2004); with the prevalence rate of 12.6% from the previous study conducted in Ambo town in 2004 (Samuel *et al.*, 2014). Where n = the sample size, z=1.96 at 95% confidence interval (CI), d= margin of error at 5% (standard value of 0.05).

There for the sample size was calculated as

$$n= (Z1- \alpha/2)^2 P (1-P)/d^2 \; 1.96^2 \times 0.126 (1-0.126)/0.05^2= 169.$$

By adding 10% non-respondent rate 186 study participants were selected from each study area. Then the total samples of 372 participants were selected for the study. To determine the proportion of students who participated in the study, schools were selected with simple random sampling technique from each study area. Similarly from the selected schools, grades and sections were selected by lottery method. Finally, study subjects from each section were selected by systematic random sampling technique using student registration book as sampling frame.

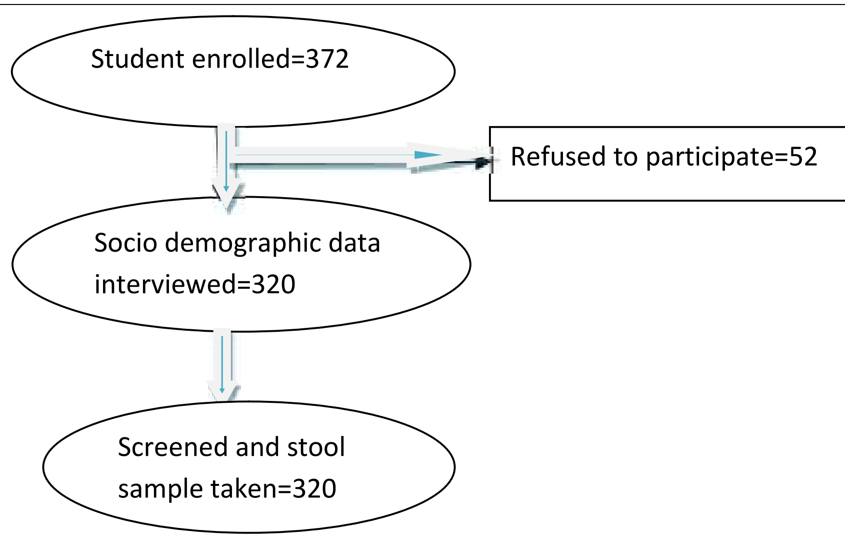
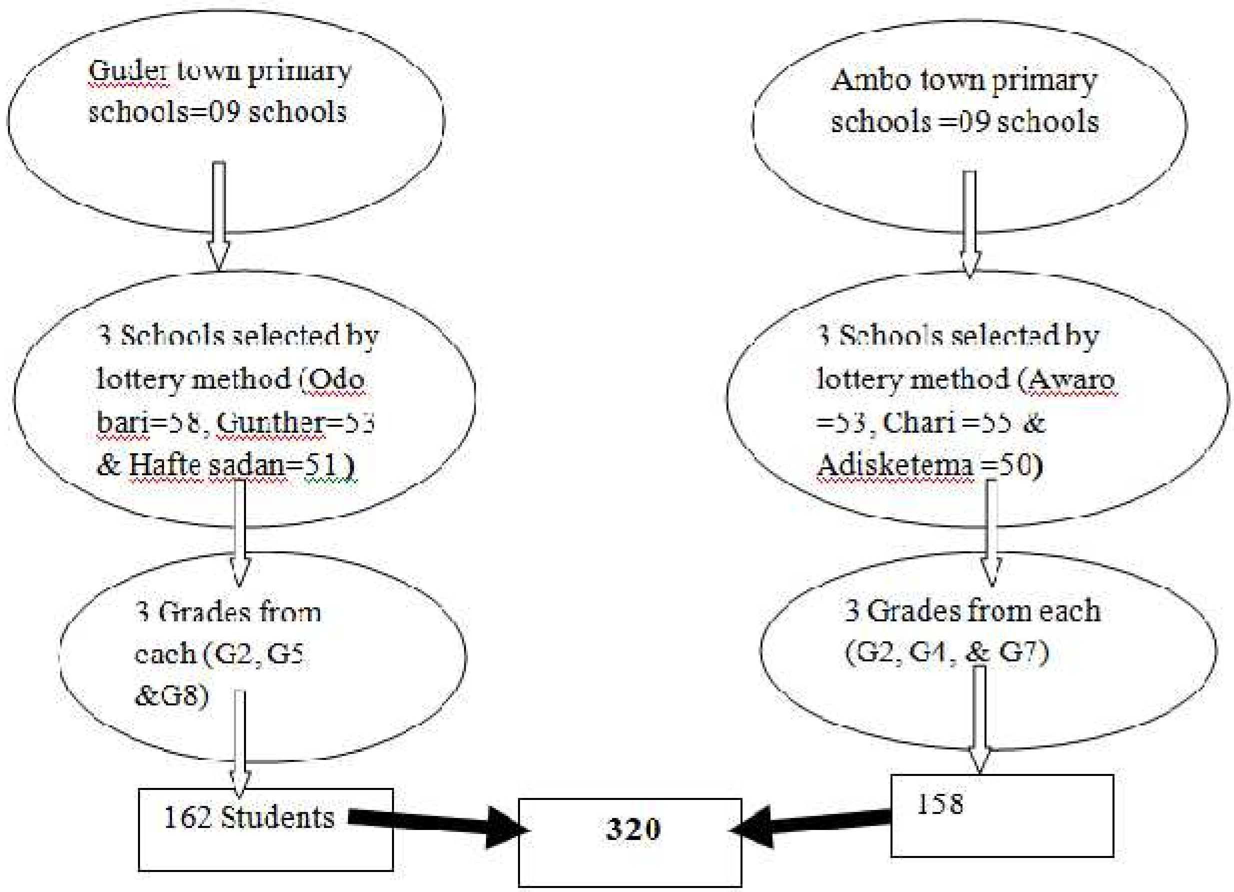


Fig. 9 Selecting study subjects for soil transmitted helminthiasis and schistosomiasis and associated risk factor assessment among elementary school children in Guder and Ambo town, 2018

Fig 10 Stratified sample collection of study subjects



3.8. Data collection

3.8.1 Stool sample collection and examination

After interviewed, the students were then given labeled stool containers with tight covers bearing serial numbers of the study subjects and were asked to put about 5 g of stool. The sample was collected by experienced lab technologist following the standard operating procedure (SOP) for sample collection and examined by formol-ether concentration technique. In the formol-ether technique, Using a rod or stick, an estimated 1 g (pea-size) of faeces was emulsified in about 4 ml of 10% formol water which is prepared by diluting 10 ml of 37% formaldehyde in 90 ml of distilled water. The suspension was strained to remove large faecal particles, diethyl ether was added, and the mixed suspension was centrifuged. Eggs and larvae were fixed and sedimented and the faecal debris was separated in a layer between the ether and the formol water. Finally the sediment was examined microscopically for the presence parasite.

3.8.2 Socio demography and risk factor assessment

Structured questionnaire based on the known risk factors for STHs and Schistosoma was locally developed specifically in English version. It was later translated into the Afaan oromo, local language of the study area. The questionnaires address students' socio-demographic information, hand washing and swimming habit, presence of latrine and its usage, water source for domestic use and other risk factors around. A pretest was conducted among five percent of the total sample size on which cross sectional study was conducted by trained data collectors and any ambiguous questions and repetitive ideas were corrected. When the children were identified, the purpose, objectives and benefits of the study were explained to the parents and consent for participation sought. Those who consented were interviewed at the school.

3.9. Data management and analysis

After data collection process, the data were checked for completeness and entered into a computer using SPSS (16 version) statistical packages. Prevalence the parasite in the study area was computed according to socio demographic characteristics of study subjects. Univariate association between each exposure and the presence of infection was assessed using the Chi-squared test and odds ratios with 95% CI were computed as measures of association. P-value less than 0.05 were taken as statistical significant association between dependent and independent variables.

3.10. **Quality control**

All the test procedures and the interpretation of results were accomplished based on standard operating procedures (SOP). Questionnaire data quality control was assessed by conducting pre-test before data collection period. And, any error, incompleteness and inaccuracy were corrected accordingly. Before data entry the returned questionnaires were checked for completeness and corrective measures was taken. The result of laboratory examination was recorded on well prepared format carefully and finally it was attached with the questionnaire.

3.11. **Ethical Consideration**

Ethical letter DERC/17/18/02 was obtained on March 20, 2018 from Ethical Committee of College of Medicine, School of Health Sciences, Addis Ababa University and supportive letter was obtained from Ambo and Guder Town Health Office, Educational Bureau and School Principals. Additionally, after explaining the importance of the study briefly an informed written consent was obtained from parents of the study subjects. The study participants were clearly informed about the nature and aims of the study and were also informed that their participation was only voluntarily. Understandable written consent was signed by their parents to allow them take part in the study. After permission was obtained, participants were interviewed and stool sample was collected

4. Results

4.1. Socio-demographic characteristics of study subjects

From the total of 320 school children participated in the study 152(47%) students were females and 168 (53%) students were males. The age range of children was 6 to 16years with median of 12 (± 1.2SD) years. As described in the following table, 33(20%) students participated in the study from Guder primary schools, were within the age range of 6-10 years, 129(80%) were within the age range of 11-16 years, 86(53.%) were male and 76(47%) were female. Out of the study subject selected from Ambo town primary school children 33(21%) of them were within the age range of 6-10 years, 125(79%) of them were within the age range of 11-16 years, 82(52%) were male and 76(48%) were female.

Table 1 Socio-demographic characteristics of study subjects

		Guder town primary schools				**Ambo town primary schools**				**Total**
		Odo Bari	Ghuntar	Hafte Sadan	**Total (%)**	Addis Ketema	Chari	Awaro	**Total (%)**	Number
Age	6-10	11	8	14	**33(20)**	10	12	11	**33(21)**	**66(21)**
	11-16	47	45	37	**129(80)**	38	44	43	**125(79)**	**254(79)**
Sex	Male	30	26	30	**86(53)**	27	27	28	**82(52)**	**168(53)**
	Female	28	27	21	**76(47)**	23	28	25	**76(48)**	**152(47)**
Total		58	53	51	**162**	48	56	54	**158**	**320**

4.2. **Prevalence of soil transmitted helminthes and *Schistosoma mansoni* infection**

Out of 320 study subjects 57 students (18%) had one or more soil transmitted helminthes and 15 students (4.68%) had *schistosoma mansoni* infection. *A.lumbricoides* was the predominant isolate (13%) including mixed infection followed by *T. trichiura* (3.7%) and hookworms (2.2%). On the other hand more males than females were affected by *T.trichiura* and *S.mansoni*. 16% of them had infected with single parasite where as 1.87% had infected with double parasite and no triple infection have been found.

Table 2 Overall prevalence of parasite according to age and sex of study subjects

Parasite	Age group			P-values	Sex group			P- values
	6-10 n=66(%)	11-16 n=254(%)	Total n=320(%)		Male n=168(%)	Female n=152(%)	Total n=320(%)	
A. lumbricoid	5(7.6)	31(12.2)	36(11.25)	0.534	15(8.9)	21(13.8)	36(11.25)	0.086
Hook worm	2(3)	5(2)	7(2.18)	0.997	3(1.8)	4(2.6)	7(2.18)	0.804
T. trichuria	1(1.5)	7(2.8)	8(2.5)	0.053	5(3)	3(2)	8(2.5)	0.886
S.mansoni	1(1.5)	12(4.7)	13(4.06)	0.480	10(6)	3(2)	13(4.06)	0.644
Mixed infection								
A. lumbricoid &*S.mansoni*	0	2(0.8)	2(0.6)	0.997	2(1.2)	0	2(0.6)	0.996
A. lumbricoid &*T.trichuria*	0	4(1.57)	4(1.25)	0.997	1(0.6)	3(2)	4(1.25)	0.920
Total positive	9(13.6)	61(24)	70(21.8)		36(21.4)	34(22.3)	70(21.8)	

In this study the result showed that infection by *A.lumbricoid* was higher in those students with age group of 11-16 years old (12.2%) than those with age of 6-10 years old (7.6%). Infection by *S. mansoni* was higher (4.7%) in study subjects with age group 11-16 years old than those with age group 6-10 years old (1.5%). *A.lumbricoides* , and hook worm infection was slightly higher in female (13.8% and 2.6% respectively) than in male students (8.9% and 1.8%) respectively. Higher *S.mansoni* infection was observed in male students (6%) than in female students (2%). Mixed infection by *A.lumbricoides and S. mansoni* was seen in male students than in female students. None these differences were statistically significant.

To compare between the study subjects from the two towns 186 students from Ambo town primary schools were calculated to be included in the study and 28 of them refused to participate and 158 selected by systematic random sampling technique. Out of these study subjects 07 students (4.4%) had infected with one soil transmitted helminthes and 5 students (3.16%) had *schistosoma mansoni* infection only. From soil transmitted helminths, *A. lumbricoides* was the highest (5.7%) including mixed infection followed by *T. trichiura* (2.53%) and hookworms (0.63%). *S. mansoni* was also isolated in 3.8% of the study participants including mixed infection. This result showed that the prevalence of soil transmitted helminthes is lower than that of the report from other parts of Ethiopia and the results reported in the same area in 2014 (Samuel *et al.*, 2014).

Table 3 Prevalence of soil transmitted helminthes and *S. mansoni* among primary schools in Ambo town.

Type of parasite infection	Infection among schools			Total
	Adis ketema n=50 (%)	Chari n=55 (%)	Awaro n=53 (%)	n=158(%)
A.lumbricoides only	0 (0)	2 (3.6)	3 (5.6)	5 (3.16)
T.trichuria only	0 (0)	0 (0%)	1(1.88)	1(0.6)
Hookworm only	0 (0)	1 (1.81)	0 (0)	1(0.6)
S. mansoni only	2 (4.0)	2 (3.36)	1(1.88)	5(3.16)
A. lumbricoides &S.mansoni	0 (0)	1 (1.81)	0 (0)	1 (0.6)
A. lumbricoides & T.trichuria	1 (2)	2 (3.36)	0 (0)	3(1.89)
Total (%)	3(5)	8(14.5)	5(9.4)	16(10)

In the same way 186 students were enrolled from Guder town primary schools to be included in the study but 14 of them refused to participate. Then out of 162 study subjects who were randomly selected by systematic random sampling technique, 45 students (27.7%) had one or more soil transmitted helminthes and 9 students (5.5%) had *schistosoma mansoni* infection. From soil transmitted helminths, *A.lumbricoides* was the highest (20.3%) followed by *T.*

trichiura (5%) and hookworms (3.7%) and *S. mansoni* was also isolated in 5.5% of the study participants.

Table 4 Prevalence of soil transmitted helminthes and *S. mansoni* among primary schools in Guder town.

Type of parasite infection	Infection among schools			Total
	Odo bari n=58(%)	Gunthar n=53(%)	Hafte sadan n=51(%)	n =162(%)
A.lumbricoid only	14(24.1)	7(13.2)	10(19.6)	31(19)
T.trichuria only	3(5.1)	1(1.88)	3(5.88)	7 (4.3)
Hookworm only	3(5.1)	1(1.88)	2(3.9)	6 (3.7)
S. mansoni only	4(6.89)	1(1.88)	3(5.88)	8 (4.9)
Ascaris & S.mansoni	1(1.72)	0(0)	0(0)	1 (0.6)
Ascaris & T. trichuria	0(0)	0(0)	1(1.96)	1 (0.6)
Total	25(43.0)	10(18.8)	19(37.0)	54(33.0)

4.3. **Association between socio demographic risk factors and the prevalence of *S.mansoni* and soil transmitted helminthes in Guder and Ambo town primary schools**

The distributions of the socio-demographic factors of the study subjects are shown in Table 5. In bivariate analyses, no statistical significant associations were observed in parasite prevalence between sexes of the study subjects. The highest proportion of parasites was reported among the 8age group of 11-16 years old subjects (24%) followed by the age groups 6-10 years with infection rates of (13.6%) (Table 5)

Table 5 Association between socio demographic characteristics and the prevalence of *S.mansoni* and soil transmitted helminthes in Guder and Ambo town primary schools

Socio-demographic characteristics		STH & S. mansoni status		Bivariate analysis		Multivariate analysis	
		Negative n (%)	Positive n (%)	P-value	COR (95.0%C.I)	p- value	AOR (95% CI)
Age	6-10 (n=66)	57(86.0)	09(13.6)	0.198	1.620(.777, 3.378)	0.203	1.612(.773,3.363)
	11-16 (n=214)	193(76.0)	61(24.0)	0.198	0.617(.296, 1.287)	0.203	0.620(0.297,1.294)
Sex	Male (n=168)	132(78.6)	36(21.4)	0.383	1.271(0.741, 2.810)	0.397	1.264(.736,2.170)
	Female (n=152)	118(77.6)	34 (22.3)	0.383	0.787 (.459, 1.349)	0.397	0.791(.461,1.359)

According to bivariate analysis family size, latrine use and finger nail trimming habits of students were statically significant with parasite infection (soil transmitted helminths and *S. mansoni*). Study subjects with the habit of not finger nail trimming were about 10 times more likely to have infected by parasite than those who have habit of finger nail trimming [COR=10.062(95% CI: 4.914-20.603)] (Table 6)

The variables which have p vlue < 0.25 in bivariate analysis were entered into multivariate analysis. Accordingly family size, latrine use and finger nail trimming variables entered in to multi varate to reduced confounfing factors. Finally only finger nail trimming variables were statically significant. Individuals with habit of not finger nail trimming were about 9 times more likely to have infected by parasite than those who have the habit of finger nail trimming [AOR 9.337 (95% CI: 4.506-19.348) (Table 6)

Table 6 Association between risk characteristics and the prevalence of *S.mansoni* and soil transmitted helminthes in Guder and Ambo town primary schools

Risk factors		STH and *S.mansoni*			Bivariate analysis	Multivariate analysis	
		Negative n (%)	Positive n (%)	p-vaue	COR (95.0% CI)	P- value	AOR (95% CI)
Family size	One parent & one child	2 (100.0)	0	0.061	0.272(.101, .735)	0.999	1.827 (.944, 3.157)
	Two parent & one child	133(82.0)	29 (18.0)	0.027	0.536(0.309, 0.930)	0.079	1.714(.939, 3.131)
	Two parent &> two child	115(73.7)	41(26.3)	0.013	0.536(0.309, 0.930)	0.076	1.727(.944, 3.157)
Latrine use (Have latrine)	Yes	241(79.5)	62(20.5)	0.010	0.272(.101, .735)	0.075	.364(.119, 1.107)
	No	9(53.0)	8(47.0)	0.010	3.676(1.361, 9.932)	0.075	2.750(.904, 8.368)
Swimming water	Yes	106(75.7)	34((24.3)	0.531	0.841(.490, 1.444)	0.250	1.426(.779, 2.610)
	No	144(80.0)	36(20.0)	0.531	1.189(.693, 2.040)	0.250	.701(.383, 1.283)
Finger nail trimming	Yes	239(84.4)	44(15.5)	0.000	0.099(.049, .204)	0.000	.107(.052, .222)
	No	11(29.7)	26(70.3)	0.000	10.062(4.914, 20.603)	0.000	9.337(4.506,19.348)

As indicated in table 7, 94.7% of the study subjects use latrine for defecation where as 5.3% of them do not use latrine. From those using latrine 46% of them use pit traditional latrine where as 49% of them use well ventilated latrine. From those students who use latrine (pit-traditional and well ventilated) for defecation, 20% have been infected with soil transmitted parasite while from those who do not use latrine for defecation, 47% have been infected. 37.8% of the students swim water twice a week and 3.1% swim once a weak in nearby river. No significant association has been observed in parasite prevalence and swimming habit of the study subjects. Even though 97.8% study subjects wash their hands before eating, 51.5% of them use soap for washing their hands always while 46% of them use soap some times for washing their hands. Out of those students who trimmed their finger nail 15.5% were infected by the parasite where as out of those who don't trimmed their finger nail 70% has been infected by the parasite.

Table 7 Prevalence of STH and *S. mansoni* according to socio-demographic characteristics of study subjects

Socio-demographic characteristics		n (%)	Positive (%)	Total
Latrine use for defecation	Pit traditional	147(46)	60(20)	320
	Well ventilated	156(49)	0	
	No latrine	17(5)	7(47)	
Use soap for washing hand	Always	165(51.5)	24(14.5)	320
	Some times	148(46)	38(25.6)	
	Not use	7(2.2)	5(71.4)	
Swimming water	Once a week	10(3.1)	0	320
	Twice a week	121(37.8)	28(23.1)	
	Not swiming	189(59.1)	39(20.6)	
Finger nail trimming	Alwaays	283(89.6)	44(15.5)	320
	Not trimming	37(11.5)	26(70)	

5. Discussion

The result of this study indicated that the overall prevalence of soil transmitted helminthes infection was 18% and *S. mansoni* infection was 4.68%. From soil transmitted helminthes *A. lumbricoid* was the predominant parasite 42(13%) including mixed infection followed by *T.trichuria* 12(3.7%) and hook worm 7(2.2%). Risk factors like not nail trimming, large family size and open defecation (*P*=0.00, *P*=0.013 and 0.010 respectively) was found as associated risk factors for the transmission of these infections in the study area.

The overall prevalence of soil transmitted helminthes infection found in these two study areas was (18%) which is relatively lower than prevalence reported from previous study conducted in other parts of Ethiopia (Alelign *et al*., 2015 (54.9%); Shumbej, 2005 (27.6%)) and in Kenya (Albonico *et al*., 2006 (35.8%.)); in Honduras (72.5%): The possible reason for these differences could be due to difference in study design i.e. institution based cross-sectional study design was used in this study whereas community-based cross-sectional study design was used in that of Shumbej, 2005; the examination method (formol-ether concentration technique) used in this study while MiniParasep technique was used in that of Albonico *et al*., 2006 and single Kato-Katz thick smear and microscopic examination for ova of intestinal helminths in the field was used in Alelign *et al*., 2015.

In contrast, prevalence of soil transmitted heminthes in this study was higher than the prevalence of STHs in Babile town, eastern Ethiopia (0.47%) (Tefera *et al*., 2015).This difference could be because of difference in the examination technique that McMaster Method for egg count was used in Tefera *et al*., 2015 where as the formol-ether concentration technique was used in this study to examine the stool sample of the study subjects.

The overall prevalence of STH and *S. mansoni* indicated in this research (18%) of which *A.lumbricoides* 13%, *T. trichiura* (3.7%), hookworms (2.2%) and *S. mansoni* 4.68% was also lower than the report of the study conducted by Alemu *et al*., 2011in which the report showed 26.9% and the predominant parasites were hookworm 59(14.6%) and *S.mansoni* 51(12.6%). Prevalence of *S.mansoni* infection was significantly higher in males (p=0.006) whereas hookworm infection was significantly higher in females (P=0.015) (Alemu *et al*., 2011) in contrary to the result of this study. This explanation this difference could be due to the difference in the study design, sample size and examination method used for examining stool sample of the study subjects. In this study the methods used was formol -ether concentration technique which is widely used technique to recover helminthes eggs but more diagnostic when used together with other technique such as kato-katz method for identifying *S. mansoni* egg (Monica, 2009).

On the other hand the prevalence of soil transmitted helminthes in the present study (18%) was slightly comparable to that of the report from the study conducted in Amhara region which estimated the prevalence as 22% (Oswald *et al.*, 2017). But it was lower than the report from Durbete Town, Northwestern Ethiopia, which indicated that 54.9% of children examined were infected with at least one intestinal helminth species. Hookworms, *A. lumbricoides*, and *T. trichiura*, infections were observed in 46.9%, 13.9%, and 2.3%, of the children, respectively (Alelign *et al*., 2015). In contrary, the prevalence of *A.lmbricoides* found in Guder primary schools of the present study was slightly higher (20.3%). This difference might be also due to difference in epidemiology of parasite, study area and examination methods used as kato-katz together with formol-ether concentration was used in Alelign *et al*., 2015 where as formol-ether concentration alone was used in this study.

However, the result of this study showed that the prevalence of STH was higher than the result reported from south india 7.8%, of which *A.lmbricoides* (3.3%) and *T. trichiur* (2.2%) were more prevalent among urban children (Kattula *et al*., 2012). This difference could be because of the Consumption of deworming tablets (OR=0.25, $P<0.01$) which offered protection as stated in the research by Kattula *et al*., 2012

Factors like Personal hygiene, water supply, latrine type, and family size of the community contribute to the differences in the prevalence and distribution of these helminths. In the present study, *A. lumbricoides* (13%) was found to be the pre dominant STHs, this is related with many studies (Leykun, 1999; Aklilu *et al*., 2006; Mohammed, 2003), *T. trichiura* (3.7%), Hookworm (2.2%) and *S. mansoni* (4.7%). Such variations in prevalence of helminth infections are attributable to several risk factors including poor personal hygiene household clustering, poor quality latrine usage and source of drinking water as well as absence of latrine could also contribute for different positive cases (Brooker *et al.*, 2000).

In the present study risk factors like nail trimming habit of the study and open defecation subjects have been associated with the infection of the parasite (P=0.00 and 0.010 respectively). This indicated comparable result with that of the result from south India which indicated open defecation and keeping untrimmed nail were risk factors for the infection of soil transmitted helminthes (*P*=0.02 and *P*=0.01 respectively) (Kattula *et al*., 2014).

In this study even though there was no statistical association between the prevalence of the *S. mansoni* and the sex of the study subjects, male students have been infected than female students. This difference might be due to the swimming habit of male students in nearby river than female students which is similar to the report from the study conducted among primary school children in Umolante district, South Ethiopia (Alemu *et al*., 2014).

6. Conclusion

The results of the present study indicated that the percentage of positive finding for soil transmitted helminths and *S. mansoni* in Guder and Ambo town primary school children were low compared to other studies conducted in other parts of Ethiopia. However the result obtained from Guder primary school children was higher (27.7%) than that of the result identified among Ambo town primary school children (4.4%) which indicated that much attention has to be given for the control of the parasite in this study area. In both study areas large Family size, not nail trimming, and unavailability of improved latrine were identified as predisposing factors for soil transmitted helminths and *S. mansoni* infections.

7. Recommendation

Prevalence of soil transmitted helminthiasis and *S. mansoni* infection in the study area shows the need of integrated control programme including periodic deworming, improving sanitation to control transmission of these parasites. All school children enrolled and not enrolled in this study should be treated according to WHO guide line to control the transmission of these parasitic diseases. Access to improved latrine could also help for reduction of soil transmitted helminthes and *S.mansoni* prevalence below the percentage found in this study. So families of study participants should learn how to construct improved latrine and they should learn effect of using latrine for defecation to control these parasites. To aware the students for protection against these parasites health education has to be given by responsible health professionals on how to improve personal hygiene, environmental sanitation and control the transmission of these parasites.

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9. Annexes

Annex 1: English informed consent form

Dear sir/madam,

№________________

My name is Mesganu Tafese. I am MSc student of Medical Parasitology at Department of Microbial, Immunology and Parasitology, College of health science and medicine, Addis Ababa University (AAU). I am here to conduct study about the Schistosomiasis and soil transmitted helminthiasis associated risk factors among primary school children in Guder and Ambo town for my MSc Thesis. In order to design and implement cost-effective Shcistosomiasis and soil transmitted helminthiasis control interventions, up-to-date information on the prevalence and distribution; and identifying risk factors of the disease is very important. The aim of this study is to assess the current status of Schistosomiasis and soil transmitted helminthiasis associated risk factors among primary school children in Guder and Ambo town. The study will involve collecting your child's stool sample by medical lab technologist and your child will be interviewed to gather relevant data using a structured questionnaire. If your child have had heminthic parasite, anti-heminthic parasite treatment is freely available as per national guideline. Please be assured that any information pertaining to your child's result will be confidential through codification of the data. Your child is free to accept or decline this invitation to participate in the study. Your willingness is totally based on your own decision by signing this form. At any time you are free to ask the investigator anything about this study.

You will not receive any payment for your participation in this research study.

Do you agree? __________ (yes or No)

Signature____________ Date______________

Name (investigator)________________________Signature____________Date________

Annex 2

Oromic consent form

Guyyaa_______________

Walii galtee

Ani maqaankoo Mesgaanuu Taaffasee kanan jedhmuu fi Univarsitii Finfinneetti barata'Msc parasitology fayyaa' kanan ta'e magaalaa Amboo fi Gudar irratti qorannoo fayya 'Schistosomiasis and soil transmitted helminthiasis associated risk factor' jedhamuun dhibee fayyaa naannoo kanatti argamu qoranoo geggeessaan jira. Qorannoon kun dhibeewwan kana to'achuu fi mala ittiin ittsaa qopheessuuf qorannoo yerootti ta'e waan argamsiisuuf uummata naannoosaatiif faayidaa guddaa qaba. Kanaaf qorannoo kana geggeessuf gafannowwan bifa unkaatiin qophaa'anif deebii sirrii ta'e keennuu fi bobbaa qorannoo kanaaf barbaachisu mucaakeessanirraa fuudhuu barbaachisa. Bua'aan qorannoo kanaatiin dhibeen fayyaa kana yo mucaa keessnairratti argame yaaliin fayyaa bilisaan godhamaaf. Odeefannon mucaakeessanirraa fudhamu hundi iccitiidhaan akka qabamu mirkana'aa ta'uu dandeessu. Qorannoo kana irratti hirmaachuufis ta'e dhiisuuf mirga qabda. Qorannoo kun kan mucaakeessanirratti geggeefamu fedhii keetin ta'uu isaa ibsuuf waligaltee kanarratti erga mallatteesitee boodadha.
Qorannoo kan irratti hirmaachuukeetif kanfaltiin siif kanfalamu hinjiru.

Qoranoo kanaaf walii galtaa?___________________ Eeyyee/Lakki

Mallattoo______________ Guyyaa_____________

Maqqq Qorataa_______________________Mallattoo_________Guyyaa______________

Annex 3: English version of Questionnaire based interview

Schistosomiasia and soil transmitted helminthiasis Indicator Participant Questionnaire

Questionnaire № ___________

Date __________________

Kebele ______________________________

1. Age___________________
2. Sex___________________
3. family size____________________________
4. Do you attend any of the following mass media?

   A. Radio B. Television C. Internet D. No E. Other specify____________

5. Have you seen or heard any education concerning soil transmitted helminthiasis or Schistomiasis from any source?

   A. Yes B. No

6. If yes for the above question, from which source you got education?

   A. health workers B. mass media C. religious institutions D. other specify______________________

7. Have you taken before anihelmenthic drug? A. Yes B. No
8. If yes for the above question, how many times a year? A. One times B. Two times a year C. Not at all
9. Do you have latrine? A. Yes B. No
10. If yes for the above question, what type latrine do you have?

    A. Traditional pit latrine B. Ventilated improved C. Water flash

11. Do you have water supply? A. yes B. No

12. If yes, what type of water do you have? A. Tap water B. Pit water

13. Do you wash your hand after toilet use? A. Yes B. No

14. If yes how often do you do it? A. always B. Some times

15. Do you wash your hand before eating food? A. Yes B. No

16. If yes, how often do you do it? A. always B. Some times

17. Do you use soap when washing your hand? A. Yes B. No

18. If yes, how often do you do it? A. always B. Some times

19. Do you swim in water? A. Yes B. No

20. If yes, how often do you do it? A. daily B. Once a week C. Once a month

21. Do you trim you finger nail? A. Yes B. No

Annex 4 : Oromic version of questionnaire-based interview

Unka gaaffiiwwan qorannoo ‘STH and Schistosomiasis associated risk factor’ fi qophaa’e

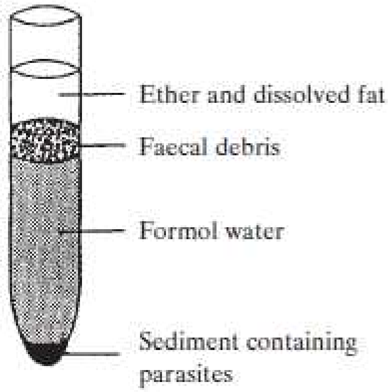
Guyyaa________________________ Lakk. Gaaffii____________________

1. Saala______________________
2. Umurii____________________
3. Ganda___________________
4. Baayyina Maatii______________
5. Meeshaa sub-qunnqmtii armaan gadii ni ordoftaa? A. Raadiyoo B. Televizyinii C. Interneetii D. Tokkoyuu hinordofu
6. STH ykn Schistomiasis ilaachisee barumsa argattee beektaa? A. Eyyee B. Lakki
7. Yo eeyyee jette eenyuu irraa argattee beekta? A. Ogeessa fayyaa irraatii? B. Barsiisota amantii irraatii? C. Namoota kan biraa irraati?
8. Qoricha dhibee fayyaa raammoo garaatiif kennamu fudhattee beektaa? A. Eyyee B. Lakki
9. Yo eeyyee jette ammam ammamiin fudhatte? A. Waggaatti sia’a tokko B. Waggaatt yero lama
10. Mana booliitti ni fayyadamtaa? A. Eeyyee B. Lakki
11. Yo eeyyee jette manni boolii keessanii kan attamiiti? A. Qulqull fi qilleensa kan galchu B. Boddetti hafaa fi bishaan kan hinqabne C. Qulqulluu fi bishaan kan qabu
12. Tajaajila bishaanii qabduu? A. Eeyee B. Lakki
13. Yo eeyee jette kan attamii qabdu? A. Bishaan boollaa B. Bishaan boonbaa
14. Nyaata dur harkakee ni dhiqattaa? A. Eeyyee B. Lakki
15. Yom yom dhiqatta? A. Yeroo hunda B. gaaf tokko tokko
16. Harkakee dhiqachuuf samunaa ni fayyadamtaa?
17. Yom yom kana goota? A. Yeroo hunda B. gaaf tokko tokko
18. Bishaan ni daaktaa? A. Eeyyee B. Lakki
19. Yom yom kana daakta? A. Guyyaa guyyaadhaan B. Torbanitti si’a tokoo C. Torban lamatti si’a tokko
20. Qeensa qubakeetii niqorqttaa? A. Eeyyee B. Lakki
21. Yo eeyyee jette, yom yom qoratta A. Yeroo hunda B. darbee darbee

Annex 5: Sop for Formol ether concentration technique

This is recommended for use in district laboratories because it is rapid and can be used to concentrate a wide range of faecal parasites from fresh or preserved faeces. Risk of laboratory acquired infection from faecal pathogens is minimized because organisms are killed by the formalin solution. The technique, however, requires the use of highly flammable ether or less flammable ethyl acetate (Cheesbrough, 2009)

Materials required
1. Formol water, 10% 2. Diethyl ether or ethyl acetate. When using ethyl acetate, greater care needs to be taken when discarding the faecal debris layer to prevent remixing with the sediment. Insoluble particles of ethyl acetate may form under the cover glass. 3. Sieve (strainer) with small holes, preferably 400–450_m in size (Cheesbrough, 2009).
Method
1. Using a rod or stick, emulsify an estimated 1 g (pea-size) of faeces in about 4 ml of 10% formol water contained in a screw-cap bottle or tube. **Note***:* Include in the sample, faeces from the surface and several places in the specimen.
2. Add a further 3–4 ml of 10% v/v 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 (centrifuge) tube made of strong glass, copolymer, or polypropylene. Add 3–4 ml of diethyl ether or ethyl acetate.
5. Stopper the tube and mix for 1 minute.
6. With a tissue or piece of cloth wrapped around the top of the tube, loosen the stopper
7. Centrifuge immediately at 750–1 000 g (approx. 3000 rpm) for 1 minute.



Formal ether sedimentation concentration technique, after centrifugation (Cheesbrough, 2009).

8.Using a stick or the stem of a plastic bulb pipette, loosen the layer of faecal debris from the side of the tube and *invert* the tube to discard the ether, faecal debris, and formol water. The sediment will remain.

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 resuspend and mix the sediment. Transfer the sediment to a slide, and cover with a cover glass.

10. Examine the preparation microscopically using the 10x objective with the condenser iris *closed sufficiently* to give good contrast. Use the 40x objective to examine small cysts and eggs. To assist in the identification of cysts, run a small drop of iodine under the cover glass.

*Although the motility of *Strongyloides* larvae will not be seen, the non-motile larvae can be easily recognized.

11. If required, count the number of each species of egg in the entire preparation. This will give the approximate number per gram of faeces.

DECLARATION

I the undersigned declare that, this MSc research report is my own work of that all sources of materials used for the research work have been dully acknowledged.

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Date of Submission:_________________