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Prevalence and Associated Risk Factors of Soil Transmitted Helminthic Infectionsi In School Children of Liwaye Town, South Gonder Zone, North West Ethiopia

Abraraw, Aseged

Bahir Dar University
Collage of Science
Department of Biology

PREVALENCE AND ASSOCIATED RISK FACTORS OF SOIL TRANSMITTED HELMINTHIC INFECTIONS IN SCHOOL CHILDREN OF LIWAYE TOWN, SOUTH GONDER ZONE, NORTH WEST ETHIOPIA

BY

ABRARAW ASEGED

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ETHIOPIA, BAHIR DAR

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BY

ADVISOR: ABAINEH MUNSHEA (PhD.)

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ABRARAW ASGED BDU1023076

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COLLEGE OFSCIENCE

DEPARTMENT OF BIOLOGY

Approval of thesis for defense

This is my official declaration that I oversaw, read, and assessed Abraraw Aseged thesis, "Prevalence And Associated Risk Factors Of Soil Transmitted Helminthic Infections In School Children Of Liwaye Town, South Gonder Zone, North West Ethiopia." I advise submitting the thesis for defense.

Advisor Name: Abaineh Munshea(PhD) Signature ____________ Date_______________

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DEPARTMENT OF BIOLOGY

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We hereby certify that we have examined this thesis entitled "Prevalence And Associated Risk Factors Of Soil Transmitted Helminthic Infections In School Children Of Liwaye Town, South Gonder Zone, North West Ethiopia" by Abraraw Aseged. We recommend that the thesis be approved for the degree of "Master in Biology".

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Name: - Abraraw Aseged

Signature: ____________________

Institution: Bahir Dar University, Bahir Dar

Date of Submission: ------------------------------

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LIST OF ABBREVIATIONS AND ACRONOMYS

WHO------------------------------------ World Health Organization

STHS-------------------------------------Soil-Transmitted Helminthes

CDC---------------------------------------Center of Diseases Control

SSA--Sub-Saharan Africa

SAC--------------------------------------- School Age Children

GIS--- Geographical information system

SDGs---------------------------------------Sustainable development goals

PC--- preventive Chemotherapy

LIST OF APPENDIX

ABSTRACT

Soil transmitted helminthes (STHs) are parasitic worms that infect humans and spread via oval or larvae-contaminated soil. In order to become infectious, some parasites' immature or undeveloped life-cycle stages (eggs) must first develop or incubate in the soil for a certain amount of time. Round worms (*Ascaris lumbricoides*), whipworms (*Trichuris trichiura), and* hookworms *(Nectar Americans and Ancylostoma duodenale*) are the most prevalent and well-known of these parasites. Due to their shared diagnostic requirements and therapeutic responses, many STH species are typically treated collectively. The objective of this study was to determinethe prevalence of soil transmitted helminthic infections among school children in Liwaye Town, South Gondar zone, northwestern Ethiopia**.**A cross-sectional study aimed at determining the prevalence of soil transmitted helminth infections among schoolchildren was conducted between January 2022 to May 2022. Structured questionnaire was prepared on socio-demographic, economic and recognized risk factors of STH infections and administered to sample children chosen using systematic random sampling in their mother tongues. Stool samples collected were examined with formal ether sedimentation technique to detect STHs positivity. Data were entered into and analyzed using SPSS version 26.The overall prevalence of STH infection was 18.7%, , *Ascaris lumbricoides*45(11.7%)was the most dominant followed by Hookworm18 (4.7%), and *Trichuris trichiura*9 (2.3%). In this study failure to wash after defecation(AOR=3.67(95%CI:1.23-10.89)),practiceofnot trimming fingernails(AOR=15.43(95% CI4.37-54.42)), shoe wearing habit (AOR=5.78(95% CI2.52-13.25)), and unavailability of latrine (AOR=5.79(95% CI2.33-14.40)) were identified as predisposing factor for STHs infections. However, characteristics like sex, grade, age, types of latrine , education level, washing hand practice before meal and contact with the river water were not substantially linked to STH infections. School based deworming for STHs, provision of latrines and awareness creation toward personal hygiene and modes of STH infections are necessary.

Keywords: *Ascaris lumbricoides*, Ethiopia, Hookworm, Liwaye , Schoolchildren, *Trichuris trichiura*

1. INTRODUCTION

1.1Back ground of the study

The term "soil transmitted helminthes" (STHs) refers to parasitic worms that infect humans and are spread via oval or larvae-contaminated soil. In order to become infectious, some parasites' immature or undeveloped life stages (eggs) must first develop or incubate in the soil for a certain amount of time. Round worms (*Ascaris lumbricoides*), whipworms (*Trichuris trichiura*), and hookworms (*Nectar americans* and *Ancylostoma duodenale*) are examples of well-known parasites (Cheesbrough, 2000). Due to their shared diagnostic requirements and therapeutic responses, many STH species are typically treated collectively.

Larger, multicellular organisms known as helminthes (worms) are typically visible to the unaided eye in their adult state (Ashenafi Terefe *et al*., 2011). The bodies of all helminthes are tube-shaped, elongated or flattened eukaryotic invertebrates that have bilateral symmetry (Abera Bayeh *et al.*, 2013*)*. Tropical and subtropical regions of the developing world, particularly Sub-Saharan Africa (SSA), where poor environmental and domestic hygiene predominate, are prone to STH infections (Brooker et al., 2006). Around 2 billion people worldwide have at least one type of STH infection (1 billion owing to *Ascaris lumbricoides*, 800 million due to *Trichuris trichiura*, and 740 million due to hookworm), and 4 billion are at risk of infection (WHO, 2012). Children are less resistant to these species of helminth diseases than adults are because STH infections notably impact children, negatively affecting their growth, intellectual development, and other areas (WHO, 2020). Over 613 million school-age children worldwide are at risk of contracting STH (WHO, 2012).Over 267 million preschool-aged children reside in areas where these parasites are heavily disseminated, and they require treatment as well as preventative measures. Children with the infection have physical and nutritional deficiencies (WHO, 2020).

Children are the age group most frequently afflicted by STHs, which can have a negative impact on their ability to learn, their cognitive abilities, and many other areas of their lives (WHO,2020). Favorable soil types and climatic conditions help helminthes develop, while other factors, including inadequate sanitation, a lack of sources of safe drinking water, poor diet, and overcrowding, help spread the disease (Egwunyenga and Ataikiru, 2005; Adefioye *et al*., 2011). Walking barefoot, warm climates with sufficient moisture, poor health or nutritional condition, lack of personal or environmental hygiene, sanitation, and education, could all contribute to an increased risk of STH infections (Megbaru Alemu *et al*., 2011, Ostan *et al*., 2007, WHO, 2002).Due to their frequent playing habits and low level of awareness, STH infection is highly prevalent among school-age children (Abraham Degarege and Berhanu Erko, 2013, Abraham Degareg *et al*., 2014). Globally, the highest number of estimates of STH infections were also attributed to *A. lumbricoides and T. trichiura* infections, followed by hookworm (Pullan *et al*., 2014). STH infection is a significant public health issue in Ethiopia (Abraham Degarege and Berhanu Erko, 2013). In some areas of the country, the incidence of STH infection can reach up to 83.3% (Mengistu Legesse and Berhanu Erko, 2004). The current investigation will be carried out in order to ascertain the prevalence of STH infections and their related factors among schoolchildren in Liwaye town, northwest Ethiopia.

1.2 Statement of the problem

Infection with soil-transmitted helminths (STHs) is a global public health issue and one of the main causes of human illness, especially in underdeveloped nations like Ethiopia (Getaneh Alemu et al.,2018). Its frequency varies both within and between nations, but it is still more common in sub-Saharan Africa. Children of school age who reside near lakes are particularly vulnerable to soil-transmitted helminth infection and frequently carry greater parasite loads. Due to the existence of numerous risk factors and their weakened bodily resistance to parasite load, these diseases affect youngsters more severely (Brooker *et al*., 2006). It has been claimed that infections with soil-transmitted helminths are linked to both poor academic performance and high rates of sickness and death (WHO, 2015).

In Ethiopia, 11 million (5.6%) people are infected by hookworm and 21 million (13%) people are infected by *T. trichiura*, which are the third and fourth highest burdens of the disease in Sub-Saharan Africa, respectively (Abraham Aseffa *et al*., 2012). When the affected person discharges his/her face into the soil, the larvae or the egg of the parasite are released into the soil, where they can develop into the infective stage(Malavade, 2015). In the study area, the main problems are: using infected feces as a fertilizer, touching body parts with contaminated hands, playing football on contaminated soil, consuming uncooked vegetables and fruits, and walking on bare feet, excreting wastes everywhere , i.e., absence of toilet or types of toilet facility, overcrowded living conditions, and the presence of much uncleaned water in that area. (the report of Towns Health Institute and their communities).This infections often associated with behavioral, environmental and socio economic factors and socio cultural difference .

In particular, Ethiopia has one of the lowest standards for drinking water and latrine coverage worldwide. Various studies provide proof, such as the fact that in 2000, Kenya had 87 percent toilet coverage compared to only 12 percent in Ethiopia (Mengistu Amare *et al*., 2007; Abera Kumie and Ahmed Ali, 2005). Poor academic performance is thought to be linked to soil-transmitted helminth infection, in addition to high rates of illness and death (WHO, 2015).The main problems or gaps in the study area were socio-economic activity; behavioral and cultural differences; and environmental as well as climatic conditions. There is a lack of recent and well documented information about the prevalence of STHs and associated risk factors in the study area. Therefore, this study was aimed to determine the prevalence and determinants of helminth infections among students at three governmental schools in Liwaye primary school, Wulkfit primary school, and Gumara primary school in the south of Gonder, in the north-west part of Ethiopia.

1.3.Research questions

1.What are the three most prevalent forms of intestinal parasite helminthes that infect school age children?

2. What are the most important risk factors for soil-transmitted helminth infection in school-aged children?

1.4 Significance of the Study

The primary goal of this study was to determine the prevalence and risk factors of STH infection among schoolchildren in Liwaye town. The study will also be used as a source for more in-depth research in certain areas. For those focusing on the prevention and control of soil-transmitted helminthic diseases among students in the research area and other nearby geographic areas, the discovery was crucial. It demonstrates how a variety of factors, including behavioral, biological, environmental, socioeconomic, and health system factors, affect helminthic infections. The study's identification of risk factors served as a crucial starting point for intervention in the study area. The results will also serve as a baseline for future studies.

1.5 Objectives

1.5.1 General Objective

The general objective of the present study was to determine the prevalence of soil-transmitted helminthic infections among schoolchildren in Liwaye Town, South Gondar zone, northwestern Ethiopia**.**

1.5.2 Specific Objectives

- To identify the typical soil-transmitted helminthes widespread among schoolchildren in the study area.
- To determine the prevalence of soil-transmitted helminthic infection among children attending three governmental schools around Liwaye town.
- To identify risk factors for STH infections among school children around Liwaye town, South Gondar zone, northwest Ethiopia.

1.6. Limitation of the study

Even though there are four primary schools around Liwaye Town, the researcher selected only three primary schools randomly (Liwaye, Wulkefit, and Gumara primary schools). The biggest obstacles were not evaluating all local schools and children were a lack of resources and time. The other limitation might be students provide false response during interview time.

2. LITERATURE REVIEW

2.1The Soil transmitted Helminthes

The parasitic nematode worms known as "soil-transmitted helminths" infect people when they come into contact with parasite eggs or larvae that live in the warm, damp soil of tropical and subtropical regions of the world (Merem Abdie *et al.,* 2001).*Ascaris lumbricoides, Trichuries trichuria* (whipe worm), and (hookworm) *Ancylostomaduodenale* or *Necatoramericanes* are the three main soil-transmitted helminthes that are regarded as being of global public health significance.Around one billion people worldwide are infected with soil-transmitted parasites, with schoolchildren being the most affected demographic. According to estimates, 770 million people have Trichuris trichiura, 800 million people have hookworm, and over one billion people have Ascaris lumbricoides (Ogbe *et al*., 2002). Helminthes frequently physically and psychologically impair infected schoolchildren, resulting in cognitive deficiencies, learning difficulties, and excessive school absenteeism. Additionally, it causes a high rate of illness, mortality, and economic loss for the nation (Silva *et al*., 2003).

Infections are common in tropical and subtropical regions of the developing world, especially in Sub-Saharan Africa (SSA), where poor domestic and environmental hygiene prevails (Brooker *et al*., 2006). The essential things such as improved sanitation by the supply or provision of modern toilet facilities, health education by enlightenment campaigns, school-based health programs, and regular early deworming of pupils would go a long way in reducing soil-transmitted helminthes. Intervention against STH infection is based on regular anti-helminthic treatment (deworming), improved water supply, sanitation, and health education (Albonico *et al.,* 2006).

Low-cost, high-coverage delivery of anti-helminths treatment has been achieved in some settings (Montreso *et al*., 2007), but improving sanitation is more complex. In Ethiopia, for example, levels of access to improved sanitation in rural areas are very low (5.4%) (Central Statistical Agency and ORC Macro, 2005), making evaluation of other components of intervention important. Intestinal parasitic infections are the major cause of public health problems in sub-Saharan Africa. These parasites, such as helminthes, can be transmitted from person to person by different methods, like contaminated water, food, or soil. When an affected person discharges his/her feces into the soil, the larvae or the egg of the parasite is released into the soil, where it can then be transported into a water body. However, the role of intestinal parasites in causing morbidity and mortality as well as in the pathogenesis of other infectious diseases differs from species to species. Similarly, the distribution and prevalence of various species of intestinal parasites also differ from region to region because of several environmental, social, and geographical factors. Hence, study on the prevalence of various intestinal parasitic infections is a prerequisite not only for formulation of appropriate control strategies but also to predict risk for communities under consideration (Legesse Mengistu and Erko Berhanu, 2004).The soil-transmitted helminths are one of the main causes of physical and intellectual growth retardation in school-age children worldwide, and research has shown that helminthic infection is still one of the leading causes of child suffering and mortality in the modern world (Karshima *et al* ., 2018).

Table 1 Characteristics of the three major soil-transmitted helminths (CDC, 2018).

Species	Length (mm)	Daily egg output per female worm	Location in host	Lifespan (years)
Ascaris lumbricoides	150–400	200 000	Small intestine	1
Trichuris trichiura	30–50	3000–5000	Caecum and colon	1.5–2.0
Hookworms*(Necator americanus*	7–13	9000–10 000	Upper small intestine	5–7
Ancylostomaduodenale	8–13	25 000–30 000	Small intestine	5–7

2.2. Global Epidemiology of STH infections

One of the most prevalent infectious diseases in the world, parasitic infections, particularly helminths, cause hundreds of thousands of preventable deaths each year. In the tropics, intestinal helminthes are more common, particularly in underprivileged areas. Intestine-dwelling adult worms expel their eggs or larvae in the feces (WHO, 2012). These parasites are responsible for extensive morbidity and mortality in sub-Saharan Africa, and more than 1.5 billion are infected with STHs (Zewdneh Thomas *et al., 2003).* The geographical distribution of intestinal helminthic infections can be depicted by the results of several articles. According to (Rajini *et al*., 2010), the overall prevalence of intestinal parasitic infection in Saint Lucia (an island in the Eastern Caribbean Sea) was found to be 52.2%. The prevalence of parasites found were: *A. lumbricoides (11.7%), and* hookworm sp. (11.6%).Among the three species of helminthes, Ascaris and hookworm were the most common helminthes identified, with a prevalence of 11.7% and 11.6%, respectively. They were more frequent in the 5–14 age groups. Most infections were single occurrences, and most helminth infections were light. The distribution of these helminthes by sex across the surveyed preschool children was not significantly different, though 20 males (20.6%) were more infected with *Ascaris lumbricoides* infections than females (18.6%). But females 7 (7.2%) were more infected with hookworm than males 5 (5.2%). However, helminth infections were significantly different in other ways, with p values less than 0.05 for ascariasis and coinfections among preschool-aged children aged 0-60 months and children aged 60-72 months (Omitola *et al.,* 2016).

A variety of factors, such as low socioeconomic status, poor sanitation and personal hygiene, a lack of drinkable water, poverty, a low literacy rate, poor hygiene, malnutrition, and a hot and humid tropical climate, influence the distribution of parasitic helminth infection (Bethony *et al*., 2006). Because of the high prevalence of parasitic helminthes infections in Ethiopia, which are major causes of morbidity and mortality, as well as a number of public health issues such as malnutrition, anemia, developmental delays, and increased susceptibility to other infections, recent estimates indicate that more than 614 million school-age children require therapy against these parasites that cause parasitic infection (WHO, 2011).

The 0–5 year old age group similarly had the greatest infection rate for STH (19.58%), followed by the 6–10 year old age group (32.50%), with somewhat higher prevalence rates for females (18.11%) than for males (15.04%) (Ogwurike *et al*., 2010). According to a survey from Nasarawa State, Nigeria, children between the ages of 5-7 had the highest prevalence of helminth infection (78.542%), followed by children between the ages of 8 and 10 (62.94%), and children between the ages of 11 and 13 (55.00%) had the lowest frequency (Eke *et al*., 2015). According to a study conducted in Rwanda on children between the ages of 12 and 14, there were roughly 589,673 cases of *A. lumbricoides* infection, 332,144 cases of *T. trichiura* infection, and 83,749 cases of hookworm infection (Ruberanziza *et al*., 2019). In Ethiopia, STH infection is a significant public health issue (Abraham Degarege *et al.,* 2014). Numerous epidemiological studies revealed that helminthic diseases were widespread throughout the nation in various regions, with prevalence rates ranging from the low single digits to as high as 90% in Ethiopian schoolchildren (Legesse Mengistu *et al*., 2009).

Table 2The Soil-transmitted Helminth infections of School-age children (CDC, 2018).

Species of parasite	Disease	Globaly Infected (millions)	In Ethiopia infected millions	Geographic region	More vulnerable group
Ascaris lumbricoides	Roundworm Infection	807-1221	26	Worldwide	SAC
Trichuris trichiura	Whipworm infection	604–795	21	Worldwide	SAC
Necator americanus AndAncylostoma duodenale	Hookworm infection	576–740	11	Worldwide	SAC

2.3.Epidemiology of STH infections in sub Sahara Africa

Several important factors, such as the environment, population heterogeneity, age, household clustering, genetics, and polyparasitism, have an impact on the epidemiology of STH infections (Hotez *et al*., 2008). For each of the STHs, enough warmth and moisture are essential components. Increased transmission occurs in wetter regions, and STH infections show pronounced seasonality in some endemic regions. Surface temperature, height, soil type, and rainfall have a significant impact on STHs (Brooker *et al*., 2003; Kariuki *et al*., 2004).To better understand helminth ecology and epidemiology and to provide low-cost methods of identifying target populations for treatment, significant progress has been achieved in recent years using geographic information systems (GIS) and remote sensing (RS). The global distribution of STH infections was described using GIS and RS, and the number of infections among school-age children in sub-Saharan Africa was estimated using these tools. Based on this, it was predicted that in 2005, 89.9 million school-age children in Africa had been exposed to one or more STH species (Brooker *et al*., 2006). The frequency of STH infections varies significantly by geography (Brooker *et al*., 2009).

Communities are divided into transmission groups based on the prevalence and severity of infections, allowing for the selection of the most effective mass therapy for each community. Both should be taken into account when evaluating the results of a deworming campaign. Death from STH infections is uncommon. The chronic and sneaky impacts on the host's health, nutritional condition, and development are more closely associated with the burden of disease than with mortality(WHO, 2006).

Childhood malnutrition, iron deficiency anemia, and mental and physical growth retardation are all caused by persistent and severe STH infections (Stephenson *et al*., 2000; Drake *et al*., 2000, Hotez *et al*., 2004; Bethony *et al.*, 2006; WHO, 2002b). In addition to these negative effects on health and physical growth, infected schoolchildren score poorly on cognitive exams. Only in children with severe worm burdens or concurrent dietary deficiencies do treatments show immediate educational and cognitive advantages (Brooker *et al*., 2006a). The majority of side effects quickly disappear with treatment (Hotez *et al*., 2006a). Treatment reduces absences by a quarter, with the youngest students who are most unwell benefiting most from it (Edward Miguel and Michael Kremer, 2004).

Children, women of reproductive age, and pregnant women are typically the ones most prone to developing hookworm anemia due to their underlying poor iron status (Brooker *et al*., 2004).The effects on growth are most pronounced in children with the heaviest infections, but light infections may also contribute to growth deficits if the nutritional status of the community is poor (Stephenson *et al*., 2000).

2.4. The epidemiology of STH in Ethiopia

Millions of people who live in endemic areas are affected by various NTDs, most notably schistosomiasis and soil-transmitted helminthes (Bajiro *et al*., 2016; Dana *et al*., 2014; Legesse Mengistu *et al*., 2011). In Ethiopia, the prevalence of soil-transmitted helminthes ranges between 48 and 52 percent (Ephrem Tefera *et al*., 2017; Sileshi Mekonnen *et al.*, 2016) and 31 to 81 percent (Bamlaku Tadege and Techalew Shimelis, 2017; Bereket Alemayew and Zewdneh Tomas, 2015).

Numerous epidemiological studies in Ethiopia revealed that STH infections were widespread throughout the nation's many regions, with prevalence rates ranging from the low single digits to as high as 90% among school-aged children (Mengistu Legesse *et al*. 2009). According to. (Belyhun *et al.*, 2010), the prevalence of soil-transmitted helminthes (STH) infection was found to be 43.5% (95% confidence interval (CI) 40.2-46.8%) in mothers and 4.9% (95% CI 3.6-6.5%) in children, respectively. *A. lumbricoides* was the second most often found intestinal parasite, with prevalence rates of 8.8 percent in women and 1.5 percent in children. Infection by hookworm was the most common intestinal helminth infection, found in 36.1 percent of mothers and 2.3 percent of children. A third (36.2%) of mothers and 4% of children had just one infection, whereas 6.6% of mothers and 0.4% of children had double infections, and 0.7% of women had triple infections. In a study done in Durbete Town, 211 children were looked at, and roughly 54.9% of them had intestinal helminth infections of some kind (Tilahun Alelign *et al., 2015*).

The common STH infections are as follows. Infections with hookworms, *A. lumbricoides,* and *T. trichiura* were found in 46.9%, 13.9 percent, and 2.3 percent of the youngsters, respectively. Children aged 10 to 14 had a significantly higher likelihood of contracting STH infections than children aged 5 to 9 did. Children who did not wear shoes and did not wash their hands before eating had a higher risk of contracting STH than children who did wear shoes and did not have those behaviors, respectively. The difference in the odds of STH infection between children ages 5 to 9 years and 10 to 14 years or between children who wear shoes and those who do not wear shoes was particularly high in the case of hookworm infection. The result of the study in Lumame town, North West Ethiopia, showed a high prevalence of soil-transmitted helminthes with an over-all infection prevalence of 54% (Melaku Wale and Tesfu Fekensa, 2010).

Another study conducted in the Zegie Peninsula found that 69.1 percent of people had helminthes infection overall (Merem Abdi *et al.,* 2017). Another region of Ethiopia, northern Gondar, likewise showed a high prevalence of helminth infection (66.7%). (Biniam Mathewos *et al*., 2014). According to the study, children between the ages of 11 and 14 in Medebay Zana wereda, North Western Tigray, had a high rate of helminth infection (Tsega Teshale *et al*., 2018). In the other study, children in Durbete Town between the ages of 10 and 14 were considerably more likely to be infected with STH than children between the ages of 5 and 9 were (Tilahun Alelign *et al., 2015*).

In the instance of hookworm infection, the difference in STH infection between children between the ages of 5 and 9 and 10 and 14 or between children who wear shoes and those who do not was particularly significant (Tilahun Alelign *et al., 2015).* Children who lived in homes with cement or earthen floors; those whose families were literate or illiterate; and both males and females were shown to have different intestinal helminth infection rates (Tilahun Alelign *et al*., 2015).

Children who utilized tap water for drinking and a toilet for defecation had an equivalent risk of contracting STH to those who drank water from rivers, springs, or wells or did not have access to latrines. Children from both literate and illiterate families, as well as those who lived in homes with cement or earthen floors, had identical probabilities of contracting intestinal helminthes. Males and females both had identical chances of developing intestinal helminth infection (Tilahun Alelign *et al*., 2015).The community should provide safe water for drinking and cooking purposes because, according to the current study, intestinal helminth infections were more common. The foundation for reducing intestinal helminthes is maintaining community knowledge, with children in particular, of the primary means of transmission. They ought to minimize their water interaction behaviors in the surrounding stream and practice wearing shoes on a daily basis (Megbaru Alemu, 2011).

2.5. Risk Factors Associated with Soil-Transmitted Helminthic infection

2.5.1 Behavior, Household Clustered, and Occupation of schoolchildren's

Specific occupations, household clustering, and behaviors influence the prevalence and intensity of helminth infections (Bethony *et al*., 2001)**.** Hookworm, in particular, has the highest intensities among adults (Brooker *et al*., 2004).

There are a number of host-specific and environmental variables that may have an impact on the likelihood of contracting or harboring heavy-intensity helminth infections. Human helminth infection is caused by overcrowding, inadequate sanitation, bad personal hygiene, and poverty (Abebe Alemu *et al*., 2011). Even though the precise distributions of STH infections and their underlying demographic, socioeconomic, and environmental determinants are still poorly defined, unhygienic sanitation, insufficient water supply, and the use of untreated night soil fertilizer are man-made environmental factors that are particularly favorable for transmission of these helminthes (Bethony *et al*., 2016).

The risk factors that are most closely linked to a higher risk of STH infections in schoolchildren are environmental ones like lack of access to safe drinking water and unsafe sanitation and behavioral ones like insufficient hand washing after feces and before eating (Serkadis Debalke *et al.*, 2013). Since they do not attempt to escape poverty, the world's poorest people, who are frequently sick with ascariasis, trichuriasis, and hookworm illnesses, are a significant contributor to economic underdevelopment (Hotez, 2008).The soil, lack of sanitary facilities, unsafe waste disposal systems, inadequate and insufficient safe water supply, different types of toilets, and human characteristics like age, sex, socioeconomic position, and occupation all have an impact on the geographic distribution of STHs (Quilès, 2006).

The risk factors for children who have been exposed to helminthic infection through soil include habitual finger or nail biting, personal and environmental hygiene, and other factors. There is a link between intestinal parasite infections in children and hand washing before and after using the restroom. Children who did not wash their hands before eating had a higher risk of soil-transmitted helminthic infection than those who did. Helminthes eggs, or infectious larval stages, are shed through the faces and spread into the soil. These stages can infect a child by consuming tainted food and water that has been exposed to the environment for several days or weeks (CDC, 2018). The likelihood of developing a soil-transmitted helminth infection was dramatically increased when there was no toilet or with certain types of toilet facilities. The larvae of the hookworm and *Ascaris lumbricoides* penetrate skin; those with fewer shoe - wearing habits had a significant prevalence of those parasites(CDC, 2018).

Schoolchildren, who represent roughly one billion people globally, are the most commonly affected population with soil-transmitted parasites. The risk of STH infections was considerably higher in children aged 10 to 14 years (Tilahun Alelign *et al.*, 2015). Children who did not wear shoes and did not wash their hands before eating had a higher risk of contracting STH than children who did wear shoes and did not have those behaviors, respectively (Tilahun Alelign *et al.*, 2015). The results of a study carried out in Medebay Zana wereda, North Western Tigray, indicated that the mothers' level of education, the location of their children's defecation, the washing of hands before meals and after defecation, the consumption of unwashed vegetables, and the children's poor personal hygiene were all contributing factors, in general, associated with a higher risk of having intestinal helminthes infection (Tsega Teshale *et al.*, 2018).

Untrimmed fingernails and filthy hand nails were positively correlated with the overall frequency of helminth infection in Bahir Dar, Ethiopia. The frequency and severity of infections caused by soil-transmitted helminthes are influenced by particular actions and behaviors. Occupation likely has a stronger impact on hookworm epidemiology due to the high rates of infection among adults, which makes intestinal helminthes infection more common. For human hookworm infection, arrangement in agricultural detection continues to be a prevalent factor (Hotez *et al*., 2014). The two main categories of risk factors for STH infection in children are environmental and behavioral. Lack of access to safe drinking water and sufficient sanitation are environmental variables that are related to an increased risk of STH infection, as are incorrect hand washing after urinating and before meals (Anuar *et al*., 2014 **).**

2.5.2. Poverty, Sanitation, and Urbanization

About a third of the population in the cities of developing countries lives in slums and shanty towns. By the year 2000, it is estimated that this number will grow to 220 million, and by 2025, about 57% of the population in developing countries will be in urban areas. The prevalence and intensity of *Ascaris lumbricoides* and *Trichuris trichiura* infections may increase among the rural populations who are migrating to these urban and suburban settings owing to the favorable conditions for transmission. Urgent consideration should therefore be given to improving sanitation in deprived urban areas and treating these populations periodically to reduce the worm burden, especially in school-age children. (Crompton and Savioli, 1993).

Environments tainted with feces that carry eggs are necessary for the transmission of helminths that are spread through the soil. As a result, helminths are closely related to the lack of clean water, poor sanitation, and poverty. Helminth infection control depends on having access to clean water and better sanitation (Hotez and Kamath, 2009). Environments tainted with feces that carry eggs are necessary for the transmission of helminths that are spread through the soil. As a result, helminths are closely related to the lack of clean water, poor sanitation, and poverty (Lemma Workineh *et al*., 2020).The majority of hygiene issues are behavioral ones, which are influenced by societal norms, practices, and culture. Active actions are possible only with the right mindset and if there is a motivation to prevent sickness (Anuar *et al*., 2014). Current lifestyles should be analyzed in connection to sanitary practice in order to change them to make them conducive to the prevention of infectious diseases. In more than 70 nations now, school water, sanitation, and hygiene education programs are being implemented (Lemma Workineh *et al*., 2020).

2.5.2.1.Poverty and Soil transmitted helminth

The Sustainable Development Goals (SDGs) are a set of seventeen objectives that must be accomplished by the year 2030. The SDGs include eliminating all types of hunger; cutting down on epidemics of waterborne and neglected tropical diseases; and cutting the percentage of people living in poverty by at least half. These three objectives collaborate in a network of multiple causal feedback. The frequency of soil-transmitted helminthiases (STHs), which have definite socio-environmental causes and are more common in situations of economic hardship and poor sanitation, is high. Brazil's STH prevalence rates have seen a declining tendency in line with the nation's recent social advancements. *Strongyloides stercoralis*, *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms (*Necator americanus* and *Ancylostoma duodenale*) are all known to induce STHs. Hookworms are connected to iron deficiency anemia to varying degrees, depending on parasite burdens(Mayron Morais Almeida, 2020).

Intestine obstruction can be brought on by *A. lumbricoides*, dysentery and rectal prolapse are linked to *T. trichiura,* and severe intestinal infection, occasionally with systemic spread, can be brought on by *S. stercoralis*. While hookworm and *S. stercoralis* transmission is more frequently percutaneous, *A. lumbricoides* and *T. trichiura* are orally transmitted. This may be associated with different dynamics and risk factors, with hookworms and *S. stercoralis* being more associated with the inadequate destination of feces in the pre-domestic environment, and *A. lumbricoides* and *T. trichiura* more dependent on the inadequate supply of clean water and consumption of clean food. However, it should be considered that hookworms can also be transmitted orally and their transmission is influenced by the contamination of water and food (Mayron Morais Almeida, 2020).

2.5.3. Weather, Water, and Season Related to STH

For each of the helminths that are transmitted through the soil, enough warmth and moisture are essential. Because *Ascaris lumbricoides* and *Trichuris trichuria* eggs are more resilient than hookworm L3 eggs, they fare better in dry environments (Brooker *et al.,* 2004). Ethiopia, like other developing nations, has unsatisfactory school health programs. Due to these poor sanitary facilities in schools, the frequency of soil-helminthic illness among Ethiopian schoolchildren in diverse regions is relatively high (Temam Ibrahim *et al*., 2018**).**

More than five billion people are at risk of infection from soil-transmitted helminths (STHs), which are caused by the roundworm Ascaris lumbricoides, Trichuris trichiura, and two hookworm species, Ancylostoma duodenale and Necator americanus. According to estimates, 1.4 billion people worldwide were infected in 2010, accounting for 20% of the disability-adjusted life years caused by NTDs. The regions with the highest prevalence rates are those in Sub-Saharan Africa, the Americas, China, and East Asia. Preventive chemotherapy (PC) is currently the only tactic used in STH control programs, and its frequency is dependent solely on prevalence. At least two albendazole or mebendazole medications are supplied annually when the total prevalence of STHs is at least two. When the overall STH prevalence is at least 20% but less than 50%, or bi-annually when the prevalence exceeds 50%, However, this STH prevalence may be affected by climatic and/or seasonal changes, particularly when these are important determinants of the transmission of STH infections(Zeleke Mekonnen *et al., 2019).*

The soil must have sufficient moisture and be warm for egg and larvae growth. For example, eggs of *A. lumbricoides* and *T. trichiura* will not embryonate at low humidity, whereas higher humidity is associated with faster development of eggs, whereby, in turn, these differences in development and survival will affect and influence parasite establishment in the human host and, hence, infection levels (Zeleke Mekonnen *et al.,* 2019).

Pre-parasitic stages of worms may endure throughout wet seasons in an environment that encourages and boosts transmission. A dry climate destroys infective stages that have been deposited on the soil surface, which causes the dynamics of transmission to decrease. According to earlier research, the rainy season had a higher rate of STH infections than the summer, while the winter saw a relatively lower prevalence of STH. Numerous epidemiological studies conducted in various countries have found a link between seasonality and the occurrence of parasitic illnesses, including STHs. It has been described that understanding of the seasonal changes of STHs is important for appropriately time-scheduling of PC, thereby maximizing the cost-effectiveness of these programmes and supporting public health decision-making to launch PC programmes (Zeleke Mekonnen *et al.,* 2019).

2.6. *A.lumbricoides* (Round worm)

The largest human intestinal parasitic nematode is called Ascaris. Male and female mature worms can reach lengths of 15–30 cm and 20–35 cm, respectively. This is why female worms are larger than male worms. Both often reside in the jejunum where they eat the host's partially digested meals (WHO, 2011). *A. lumbricoides* is a helminth that spreads through soil and is thought to infect at least one-fourth of all children worldwide. The fact that *A. lumbricoides* is a powerful parasite in part results from the eggs' resistance to a variety of harsh environmental factors such as chemicals, intense heat, and low temperatures (Tilahun Alelign *et al*., 2015). Ascaris eggs are among the toughest helminth eggs and can stay infectious for a year after being buried in the ground (Lemma Workineh *et al*., 2020).

2.6.1. Ascaris Lifecycle

Ascaris worms can lay up to 200,000 eggs every day in the human gastrointestinal tract, both fertile and infertile, and these eggs leave the body with the feces. However, only fertilized eggs grow into embryos and become infectious when they are exposed to the ideal soil conditions of moisture, warmth, and shade. It may take up to 18 days or many weeks to complete this stage. If these eggs are eaten, the larvae may hatch, infiltrate the intestinal mucosa, and enter the pulmonary alveoli using the portal vein and the body's circulatory system (CDC, 2013). These worms take around two weeks to fully develop. They then pass through the alveolar walls, travel through the bronchial tree, and arrive at the throat where they are swallowed. After reaching the intestine, the larvae become adults. The lifecycle can take about 2-3 months, and an adult worm can survive for 1-2 years in the intestine (Malavade, 2015).

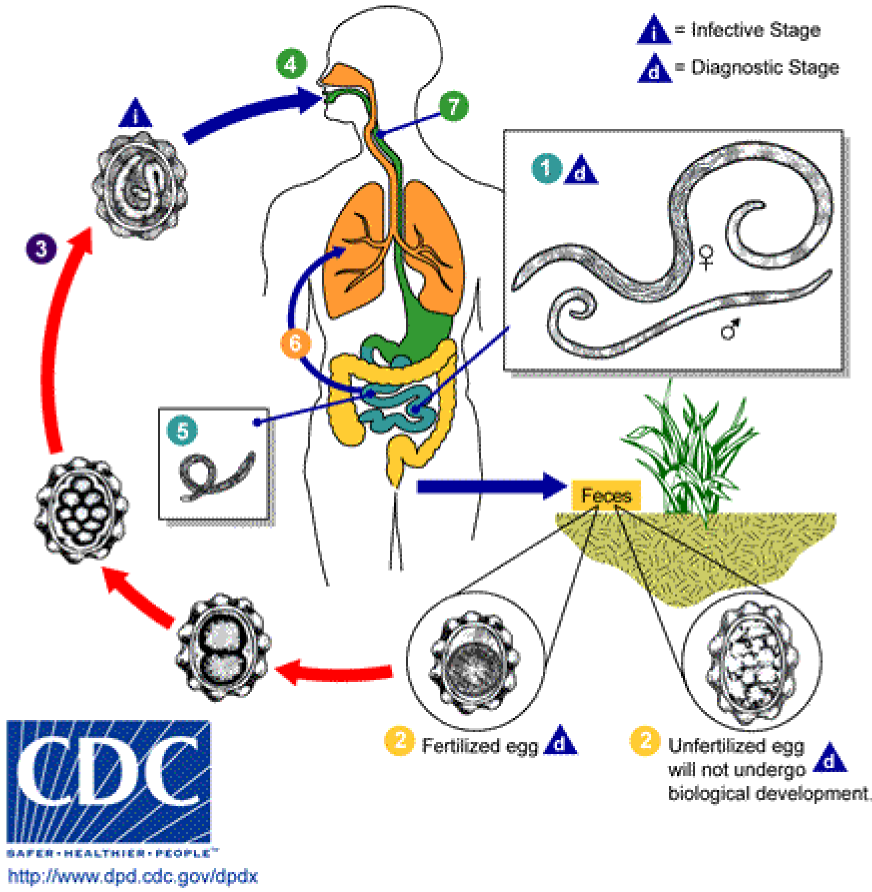

Figure 1: Life cycle of roundworm

2.6.2. Ascaris Diagnosis

It entails collecting a sample of stools to examine under a microscope for the presence of eggs (CDC, 2020b). The specific diagnosis of ascariasis frequently requires a thorough investigation, which may include a travel history or information about the origin of endemic countries when symptoms are present in non-endemic areas, as well as laboratory tests that may include serological, molecular, or image-based diagnosis (Lamberton and Jourdan, 2015).

2.7. *Trichuris trichuria* (Whipworm)

Nematodes of the genus Trichuris called *Trichuris trichuria* are referred to as whipworms because of their characteristic morphology, which is threadlike at their anterior end, which makes up roughly two thirds of the body length, while the posterior one third is abruptly thick (Lemma Workineh *et al*., 2020). They are all parasites of the mammalian gut that infect people all around the world, but particularly in places with warm, humid climates, low cleanliness standards, and a lot of environmental contamination from human feces. The adult male *T. trichiura* is 30 to 45 mm long, whereas the adult female is 30 to 50 mm long (Lemma Workineh *et al*., 2020).Fortunately, the *T.trichiura* "whipworm" is typically harmless despite being highly widespread. It causes anemia and mild dysentery because it dwells in the rectum and cecum. It can cause rectal prolapse and colonic trichuriasis in extreme situations (Staudacher *et al*., 2014). Trichuris, sometimes known as a whipworm due to its distinctive shape, is a helminthes that transmits through soil since its life cycle necessitates the embryonic development of its eggs or larvae (Getaneh Alemu *et al*., 2019).

T. trichiura is the cause of trichuriasis or whipworm infection. *T. trichiura* major host is the human, although it has also been found in certain non-human primates (Yang *et al*., 2018). The mature male and female whipworms reside in the transverse and ascending colons, where they ingest nutrition by enclosing their narrow anterior section in the cells of the host's epithelium. A mature female will lay between 3000-5000 eggs every day. Fertilized eggs found in the feces are immature and must develop into embryos in order to spread infection (Lemma Workineh *et al*., 2020). The maturity of an egg takes between 18 and 25 days. *T. trichuria* infections are spread through the oral fecal channel and are brought on by eating infected eggs from contaminated food, water, and soil (Getaneh Alemu *et al*., 2019).

2.7.1. Whipworm (*Trichuris trichiura*) Lifecycle

Adult whipworm females that have been fertilized can lay undeveloped eggs. These eggs expelled in the stool grow into the advanced cleavage stage, a 2-celled stage, and eventually become embryonated. The eggs need between 15 and 30 days to become infectious. These eggs hatch into larvae in the colon and mature in the mecums when consumed together with food or water. The worms are present and have burrowed their anterior ends into the ascending colon and mesenteric mucosa. After about two months, female worms begin to discharge 3,000–20,000 eggs per day. The worms have a year-long lifespan (Malavade, 2015).

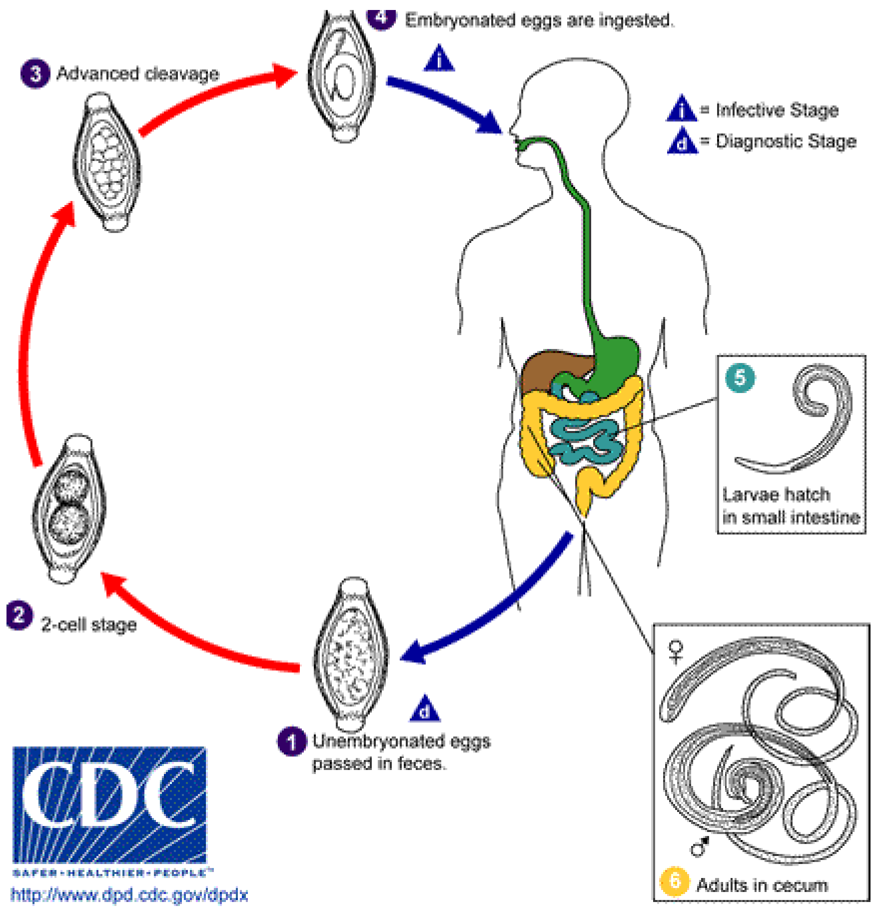

Figure 2: Life cycle of Whipworm (CDC, 2013)

2.7.2.Diagnosis of Trichuris

The *Trichuris trichuria* species of STH is diagnosed by examining the characteristics of eggs. The barrel-shaped Trichuris egg measures 50 x 25 microns. Each pole has a mucoid plug in the thick shell (Dawit Assafa *et al*., 2004).

2.8. Hookworm

The nematode parasites *N. americanus* "New World" and *A. duodenale* "Old World" Hookworm were the main causes of human hookworm infection, a soil-transmitted helminthic infection (Berhanu Elfu, 2018). Only humans carry the two hookworm species, *N. americanus* and *A. duodenale*. In terms of its effects on mother and child health, it was the second-most significant parasitic infection in the world after malaria (Fikreslasie Samuel *et al*., 2017). Blood loss is the infection's biggest worry. A hookworm uses an organic anticoagulant to help it ingest 0.25 mL of host blood each day. There are no intermediate or reservoir hosts; hookworms do not multiply inside the host, and humans are the only major definitive host for these two parasites. Each female adult worm produces hundreds of eggs per day after mating in the host digestive tract, which ultimately leaves the body in feces (Temam Ibrahim *et al*., 2018). Female worms of A. duodenale typically lay about 28,000 eggs each day, whereas worms of *N. americanus* typically lay about 10,000 eggs per day (Fikreslasie Samuel *et al*., 2017).

2.8.1. Hookworm Lifecycle

After hookworm eggs are passed in feces, they hatch into larvae called the rhabditiform larvae in two days when the soil is under optimum conditions of temperature, moisture, shade, and pH. In about 5–10 days, these larvae develop into the infective filariform larvae and undergo a couple of molts. These filariform larvae can survive for about 3–4 weeks. When they contact the human host, they penetrate the skin and are transported through the bloodstream to the lungs via the heart. Then they penetrate the alveoli into the airways to be swallowed and end up in the small intestine where they mature into adults. Adult worms attach to the intestinal wall, resulting in blood loss of the host. Again, eggs released from an infected human or animal host with feces infect children or other hosts (Malavade, 2015).

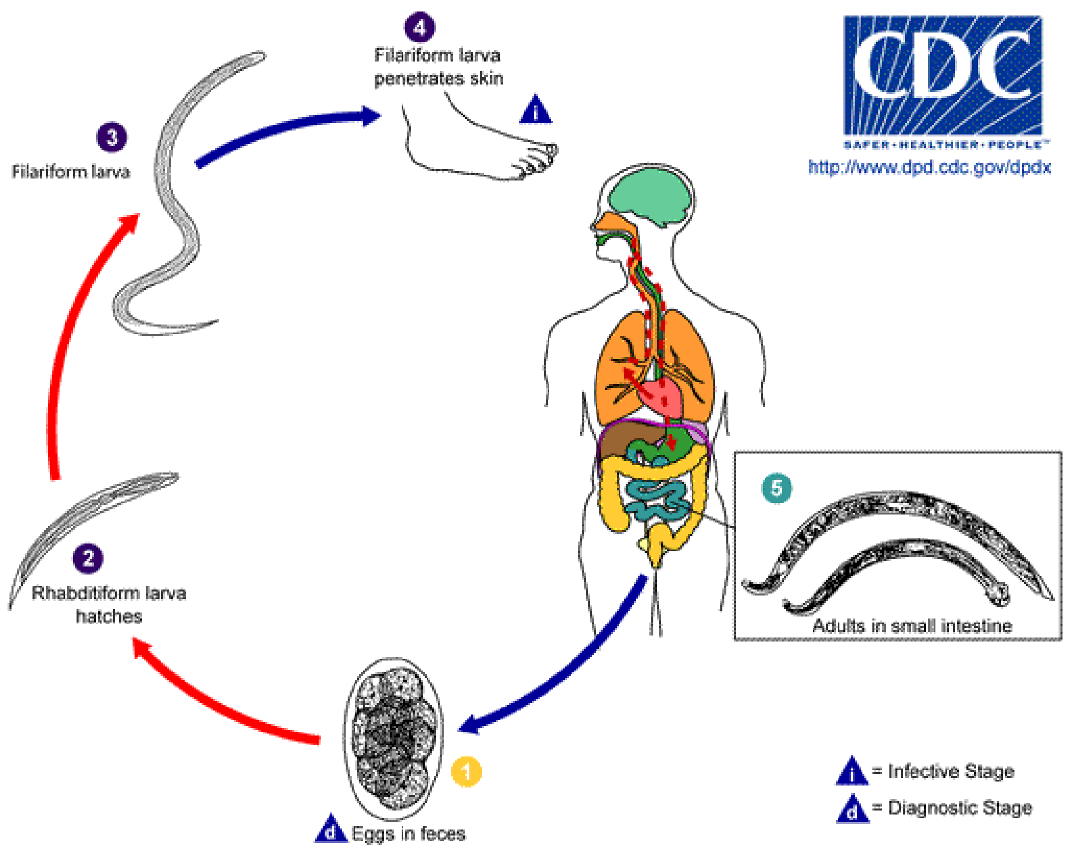

Figure 3 Life cycle of hookworm (CDC, 2013)

2.8.2. Diagnosis of hookworm

The third STH species hookworm was diagnosed by locating hookworm eggs in a stool sample under a microscope, and after proceeding with the procedure, hookworm was diagnosed (CDC, 2019d).

2.9. Impact of STH on Child Growth and Development

Different species have different roles in pathogenesis, morbidity, and mortality caused by intestinal parasites (Megbaru Alemu, 2011). The main morbidities brought on by helminthes are iron deficiency anemia, intestinal obstruction, malnutrition, malabsorption syndrome, chronic diarrhea, poor weight gain, rectal prolapse, and respiratory problems (Bethony *et al.,* 2006). School-aged children have the highest prevalence of STH infections globally (Saboyá *et al*., 2010). Considering the effects that STH infections have on children's growth and development, the nationwide infection rates among Rwandan students ranged from 22 to 38 percent for A. lumbricoides and *T. trichiura* (Owada *et al*., 2017). Children with STH may have delayed cognitive development, slowed growth, and anemia that can be characterized as either chronic or acute (Gall *et al*., 2017). and anemia, which can be classified under the major causes of absenteeism and difficulty in adjusted life years(Ostan *et al.,* 2007).

Intestinal parasite infection is one of the most common causes of anemia (Colon-Gonzalez, 2016). STH infections primarily result in nutritional imbalances in humans at various stages of their lives, including decreased appetite, impaired digestion, and decreased absorption of nutrients from food, which has a negative impact on children's growth and development (Malvade, 2015). The most common helminth to cause blood loss and iron deficiency is the hookworm. Anemia, which is brought on by blood loss and iron deficiency, reduces adults' ability to work as well as young children's impaired neurocognitive development (MC, 2002). When schoolchildren are infected with helminthes, their physical and mental health is frequently harmed, which causes cognitive deficiencies, learning difficulties, and school absences (Eke *et al.,* 2015). Additionally, it causes a high rate of morbidity and death, as well as economic issues for the nation (Sliva *et al*., 2003). When schoolchildren are infected with helminthes, their physical and mental health is frequently harmed, which causes cognitive deficiencies, learning difficulties, and school absences (Eke *et al*., 2015).

2.10. Laboratory diagnosis Technique

Ascaris lumbricoides is diagnosed by microscopic examination of stool samples. *Ascaris lumbricoides* eggs were simple to identify, yet if there weren't many eggs, the diagnosis could be overlooked. Direct wet mount methods and formal ether concentration were used to find and identify *Ascaris lumbricoides* in the stool. These methods are adequate for determining if *Ascaris lumbricoides* is present or absent in feces. If the number of organisms is lower in feces, then wherever possible, stool should be concentrated. The most recommended procedure is the formal-ether concentration (FEC) method. Formalin-ether solution, which has a lower specific gravity than the parasitic organisms, thus concentrating the latter in the sediment, but direct wet mount is less effective. Examine the preparation under a microscope to identify any larvae or helminthic eggs. than formal ether concentration (Cheesbrough, 2009).

Microscopically identifying *Trichuris trichuria* eggs in feces can be used to detect trichuriasis infection. The eggs have a thick shell, a transparent plug at either end, and a flat, lemon-shaped tip that gives them their distinctive appearance. By employing formal ether concentration and direct wet mount procedures, which are effective for determining whether or not Trichuris eggs are present in feces, it was possible to find and identify the eggs in the stool. To determine the sedimentation procedure for the diagnosis of intestinal infection If the number of organisms is lower in feces, then wherever possible, stool should be concentrated. The most recommended procedure is the formal-ether concentration (FEC) method. Formalin-ether solution, which has a lower specific gravity than the parasitic organisms, thus concentrating the latter in the sediment (Cheesbrough, 2009).

2.10.1. Direct wet mount technique

Direct wet mount is frequently used as a reliable diagnosis method for the identification of intestinal parasitic infections generally in Africa and particularly in Ethiopia, despite the availability of a number of diagnostic techniques, including the Kato-Katz and Formal-Ether Concentration (FEC) techniques. The direct wet mount analysis of soft-to-watery fecal samples has the specific advantage of allowing the identification of the motile trophozoite stage of the protozoan species. Fast processing within an hour after the passing of a fresh specimen is not always possible, nevertheless, in a busy clinical laboratory. A different strategy is therefore suggested, such as formal-ether sedimentation techniques (Gebreselassie Demeke *et al*., 2021).

2.10.1.1. Principle of wet mount technique

A stool sample is taken for a stool analysis and given to the lab in a clean container. Microscopical examination, chemical tests, and microbiological tests are all included in laboratory analysis. The color, consistency, quantity, form, and presence of mucus in the stool were all examined. The capacity to recognize the intestinal parasites' motile stage is the wet mount method's key benefit. The wet mount method's drawback is that it has a very low detection rate for parasites in a single stool examination due to its low sensitivity.

2.10.2. Formal ether concentration technique

The most commonly used methods for detecting intestinal parasites from stool examination include, direct and concentration techniques. Studies indicated that of all conventional concentration techniques, the formol- ether concentration technique, which consists of ether as a fat solvent for detecting out parasites from intestinal debris and thus increases the positivity rates, is believed to be superior over the other methods. However, this technique has been considered to be still disadvantageous since the use of ether may be hazardous for health to laboratory personnel. Ether is explosive, contains anesthetic vapours, has potential toxicity such as respiratory irritation, and causes cardiovascular depression and narcosis(Feleke Moges *et al.*, 2010).

2.10.2.1. Uses of Concentration techniques

1. The purpose of concentrating feces is to increase the possibility of finding ova, cyst, or larvae in samples that are not be able to see by direct microscopy.
2. The concentration method may be used to see whether the treatment of the parasites has been successful or not.
3. To find ova of *S. mansoné* or *Taenia* is a few of other ova and cysts if they have not been seen in routine examination (due to being very few) and are suspected to be present.
4. To examine stool specimens from patients who do not come from an area where a particular parasite is found.
5. If the number of organisms in stool specimens is low, the examination of a direct wet mount may not detect parasites. Thus, whenever possible, the stool should be concentrated.

6. The concentration procedure is indicated when the initial wet mount examination is negative despite the clinical symptoms indicating parasitic infection of a patient.

2.10.3.Kato-Katz method

The health of a fifth of the world's population is negatively impacted by helminth infections spread through soil. The Kato-Katz method is suggested to identify soil-transmitted helminth eggs in stool samples, particularly in programmatic settings. But there are still some problems with its methodology. Our study aimed to investigate the effects of time, storage temperature, and stool sample churning on fecal egg counts in storage(Bosch *et al.*, 2021).

2.10.4. Serological technique

Serologic tests are blood examinations that check your blood for antibodies. They could involve a range of laboratory techniques. Different serologic test types are used to diagnose a range of medical issues. All serologic tests have one thing in common. All of them are focused on immune system proteins. By removing outside invaders that could harm you, this vital body system helps to keep you healthy. The process for having the test is the same regardless of the technique the laboratory use during serologic testing. It helps to have a fundamental grasp of the immune system and the causes of sickness to comprehend serologic tests and their value.

2.10.5. Molecular technique

Fecal samples must be collected and stored correctly in order to ensure the accuracy of DNA-based soil-transmitted helminth diagnosis techniques. Previous studies have looked at a variety of preservation techniques to keep fecal samples for later microscopic examination or to determine the total DNA yields after DNA extraction. The preservation of soil-transmitted helminth DNA in feces samples kept at room temperature or kept in a cold chain for protracted periods of time has, however, only received a small amount of research attention (Marina *et al*., 2018).

2.11. Prevention, Treatment & Control Measures of STHs

Regular anti-helminths therapy, better water supply, cleanliness, and health education are the cornerstones of the intervention against STH infection (Albonico *et al*., 2006). In some contexts, it has proven possible to administer anti-helminths treatment at a low cost with high coverage (Montreso *et al*., 2007). The major methods for preventing STH infections include health promotion, good hygiene, and the use of antibiotics such as albendazole and mebendazole (WHO,2020). The best defense against soil-transmitted helminthic illnesses is to consume clean water, prepare meals properly, wash your hands, and wear shoes (Levecke *et al*., 2014). Paid that these environmental elements have been demonstrated to play a substantial influence in the spread of STH infection, consideration should be given to the geological composition and soil types of the specific study areas (Mabaso *et al*., 2003). WHO has indicated that STHs will no longer be a public health issue in children by the year 2020. (WHO, 2012).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

Liwaye is one of the towns in Estie district, South Gondar, North Western Ethiopia. It is located at 36 degrees north and 11 degrees east on the eastern side of Bihar Dar city. Liwaye is 102 kilos away from the capital city, Bahir Dar; 52 kilos away from the zonal capital city,Debre Tabor and 670 kilos away from the national capital, Addis Ababa. The town is found at an altitude of 2300–3200m above sea level. The mean annual rain fall is about 1307 mm at a minimum and 1500 mm at a maximum per year. The temperature of the town rises as high as 8.3 ^{0}C in the winter and 25 ^{0}C in the summer. According to the district's main town, Mekane eyesus, administrative office November 2021 report, the population of the town is estimated to be 41,408, of which 21,529 are males and 19,879 are females (Mekan eyesus Town administrative office, November 2021). The main economic activity of the town is agriculture, and the main products of the area are potatoes, sorghum, and wheat.

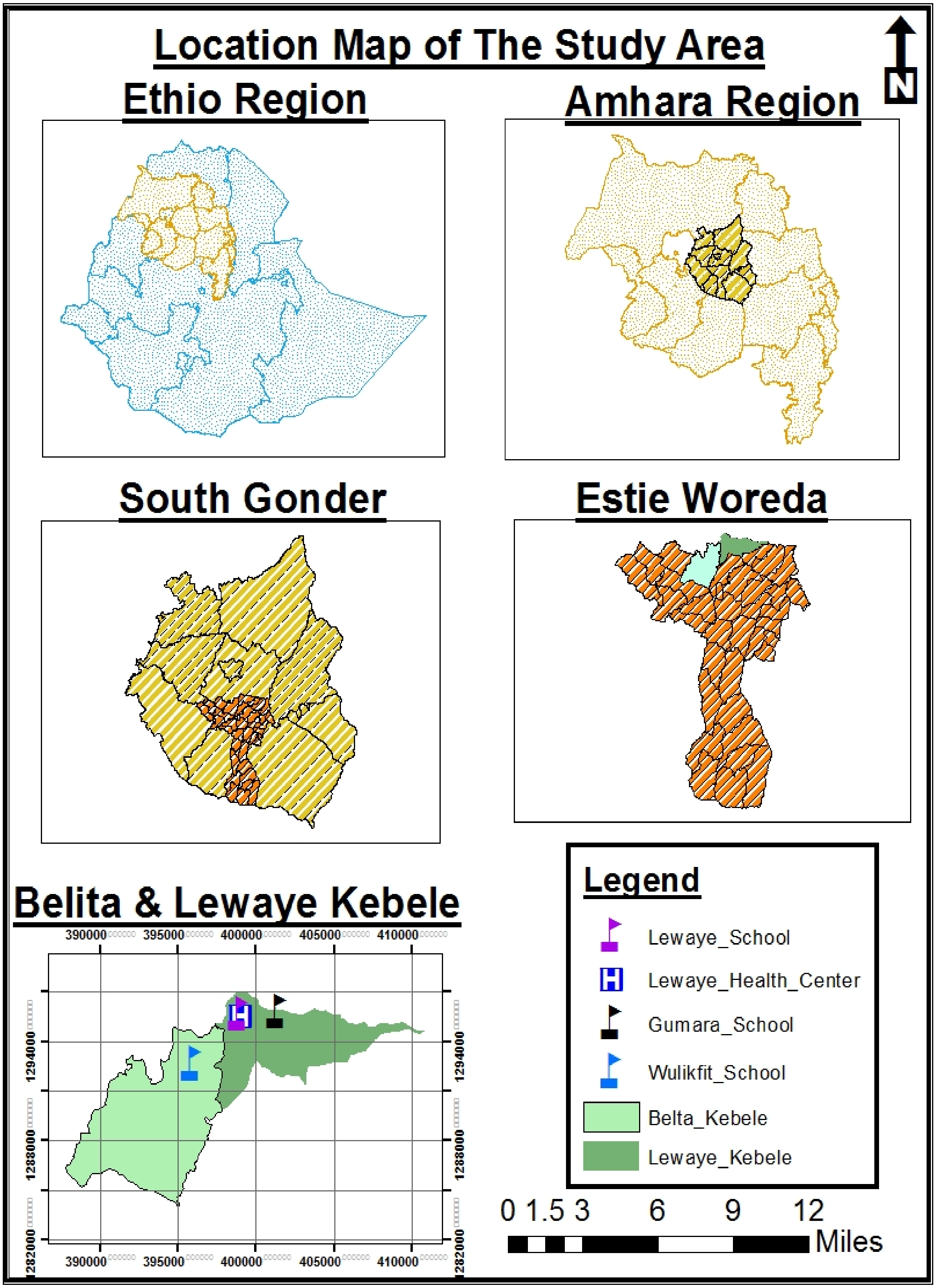

Figure 4 Map of the study area

3.2. Study design and period

A cross-sectional study was carried out from January 2022 to May 2022 to determine the prevalence of soil-transmitted helminth infections among schoolchildren in Liwaye Town.

3.3. Source and study population

3.3.1. Source of population

The source population of this study was all school children enrolled in three schools,namely:Liwaye, Wulkfit, and Gumara primary schools.

3.3.2. Study population

Children who were present in class during sample collection and those who were chosen by random sampling technique were considered as the study population, as well as those whose families or guardians were willing to participate and sign a written consent form.

3.4. Sample size determination and sampling procedure

Sample size was determined using a single proportion formula n= $\frac{Z^2P\ (1-P)}{D^2}$. Since the prevalence of intestinal soil transmitted helminthic infection in the study area is not known, the sample size of the proposed study was calculated as a function of 50% prevalence and5% marginal error.

Where; n=required sample size

Z=confidence level at 95% (standard value of 1.96)

P=prevalence 50%= 0.5

D=margin of error at 5% (standard value of 0.05)

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

To enroll 384 study participants, a method of systematic random sampling was adopted. For each of the chosen primary schools, a quota was assigned using the sample percentage formula. 384/1642=0.234 is the sample size (n) proportionally divided by the total number of students in each school. The multiplier used to multiply the study subjects when a quota is allotted for each grade level is /0.234/. Example: Participants from grades (1-4) totaled 614*0.234=143, while participants from grades (5-8) totaled 1028*0.234=241 from three primary schools. Based on the aforementioned information, participants were chosen from the following three primary schools: Liwaye primary school (1138*0.234=266), Wulkefit primary school (448*0.234=105), and Gumara primary school (56*0.234=13). The study participants were chosen via systematic random sampling from each section (classroom) in each of the chosen primary schools, utilizing the attendance list or roster as a frame at each school and grade level.

The total number of students in the selected three schools were 1642, and this was divided by the calculated sample size of 384 to know the interval for selection (4). The first participant was chosen via lottery, and selection proceeded at four intervals throughout all portions of all the schools.

3.5. Inclusion and Exclusion Criteria

3.5.1. Inclusion Criteria

This study took into account children who voluntarily participated or whose guardians or caretakers agreed to have their children participate in the study and provide stool samples for analysis. Additionally, the study included students who hadn't had anti-helminthic therapy in the previous three weeks.

3.5.2. Exclusion Criteria

School-age children whose guardians/caretakers refused to provide stool samples for testing and children who took medication or deworming for a helminthic infection acquired through soil during the study period or during the previous three weeks were excluded from the investigation.

3.6. Study Variables

3.6.1. Dependent Variable

The frequency of soil-transmitted helminthic infection was the potential dependent variable in this investigation.

3.6.2. Independent Variables

The following factors might have been independent variables in this study: sex, age, grade level, parent's educational attainment, accessibility to latrines, habit of washing hands after and before using the restroom, playing on the ground, habit of wearing shoes, and habit of trimming fingernails.

Table 3: the proportional sample representation of selected primary schools

Schools	All schools	Liwaye Primary School	Gumara Primary School	Wulkefit Primary School
Total number of student	1642	1138	56	448
Sample representation	384	266	13	105

3.7. Data collection and methods

3.7.1. Questionnaire

A semi-structured questionnaire was first developed in the English language and afterwards translated into Amharic, the native tongue of the study area. The questionnaire consisted of socio-demographic data of students or their guardians and other known related factors. Age, education level, monthly income, water supply and availability, sewage, and hygiene practices including boiling water before consuming, hand washing practice, and habitually going barefoot are among the questions on the questionnaire. The study's goals and advantages were laid out for the benefit of the students and their parents. Then, permission was obtained from each student's parent. Interviews were conducted with schoolchildren or their guardians in their native Amharic language.

3.8. Parasitological Testing

The children who volunteered to participate in the study or whose parents gave their consent were given a clean, labeled feces cup and a wooden applicator stick after completing the questionnaire survey. Stool samples were collected immediately, processed using the formalin ether concentration procedure, and then inspected at lower power (10 x) and subsequently higher power (40 x) objectives.

Laboratory Procedure during stool examination:

The formal- ether concentration method was used to concentrate the ova and larvae from the stool samples as follows:

1.One gram (1 g) of feces sample was put in a tube with 10 ml of 10% formalin.

2. The mixture was shaken and allowed to stand for some time.

3. A cotton gauze sieve was used to filter the emulsified mixture into a 15 ml conical centrifuge tube.

4. Three ml of ether was added in the mixture received.

5. The conical centrifuge tube's contents were sealed and given a thorough shaking.

6. After that, it was centrifuged for 5 minutes at 1500 rpm.

7. Layers of ether, detritus, and formalin that were in the supernatant were discarded after centrifugation.

8. The sediment at the bottom of the test tube was re-suspended.

9. After that, a sample from the sediment was moved onto a slide.

10. Finally the slide was examined microscopically under 10× and 40× objective lenses for the presence of ova or intestinal parasite.

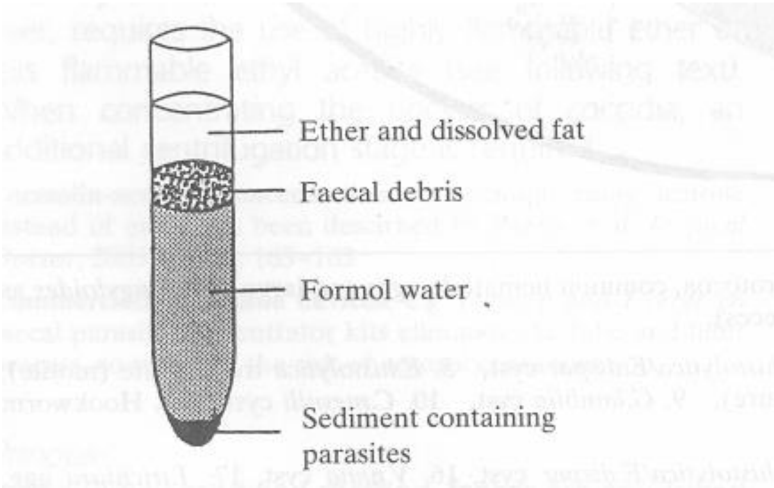

Figure 5 Formalin ether sedimentation technique

3.9. Data management and quality control

The questionnaire was developed based on recognized risk factors from the literature and administered to students in Amharic, their mother tongue, before being translated back into English to ensure accurate and genuine data. The standard operating procedure was followed for the detection of STH infection using Formal Ether Concentration. Laboratory technicians' consistency in identifying STH was evaluated. Before sample preparation and examination, the reagents were tested on known positive and negative samples from the clinic. Another technician in the laboratory was randomly chosen to read the slides for quality purposes.

3.10. Data analysis

The SPSS program version 26 was used to enter and analyze the data that had been gathered. In order to evaluate the relationship between the dependent and independent variables, chi-square and binary logistic regression analysis was utilized. The strong association between STH and associated risk factors were measured as odd ratio using logistic regression. Using odds ratios and 95 percent confidence intervals, the degree of relationship between the putative risk variables and soil transmitted helminthic diseases was examined. A statistically significant association will always be assumed to exist when the p-value is less than 0.05.The prevalence of soil-transmitted helminth parasites was determined using the formula given below:

$$\text{Prevalence (\%)} = \frac{\text{Number of Positives Samples}}{\text{Total Number of Samples Examined}}$$

The Spearman's rho was used to determine the relationship between socioeconomic characteristics and the frequency of intestinal helminthes parasites in children. The significance threshold was set at 0.05.

3.9. Ethical considerations

The ethical review board of the College of Science at Bahir Dar University received the study protocol and consent form in order to approve the proposal. Following ethical approval, letters of support were sent to Liwaye, Gumara, and Wulkefit Primary. Before obtaining the stool samples, the subjects were made aware of the study and all gave their written informed consent. Study individuals were free to withdraw from the study before and after the collection of stool samples without losing any of the benefits they were expected to receive from the school because participation in the study was voluntary. Students who had parasites at the time of the study I was reported them to the health center for treatment with albendazole and mebendazole.

4.RESULT

4.1. Socio-Demographics Characteristics of the Study Participant

A total of 384school children (with 100% response rate)were the current study from the three primary schools. Almost equal number male 190 (49.5%) and female 194 (50%) students were participated**.** From the total number of subjects, 127 (33.1%) school children were between the ages of 5 and 10, 101 (26.3%) 11 and 14, and 156 (40.6%) were above the age of 15 years old. About 266(69.3%) of the total study subjects were from Liwaye primary school, 105 (27.3%) from Wulkfite primary school, and 13 (3.4%) from Gumara primary school. Students belonging to grade levels 1-4 accounted for 143 (37.2%), while those in grades 5-8 were 241 (62.8%).The educational status of the fathers of the children was 338 (88%), 33 (8.6%), and 13 (3.4%), or fathers with no education, primary education, and secondary education, respectively. Again, the percentage of children whose mothers had received no formal education, elementary school, secondary school education was 322 (83.5%), 39 (10.2%),23 (6.3%) respectively. The results for the father and mother's self-employment status were 354 (92.2%) and 343 (89.3%), respectively. About 322 (88%) of the students belonged fathers with no education level. While, students who had fathers with primary education level was about 39 (10.2%) and those with secondary education level was 23 (6.3).

Table 4. 1: Socio- demographic characteristics of the school age children (n=384) around Liwaye Town 2021/2022

Variables	Category	Number and percentage
Gender /sex	Male	190(49.5)
	Female	194(50.5)
	Total	384(100)
Age	5-10	127(33.1)
	11 -14	101(26.3)
	>/=15	156(40.6)
	Total	384(100)
Grade level	1-4	143(37.2)
	5-8)	241(62.8)
	Total	384(100)
Father education	No education	338(88)
	Primary education	33 (8.6)
	Secondary education	13(3.4)
	Total	384(100)
Mother education	No education	322(83.9)
	Primary education	39(10.2)
	Secondary school	23(6.3)
	Total	384(100)
Fathers job	Farmer	354(92.2)
	self-employed	13(3.4)
	Un-employed	17(4.4)
	Total	384(100)
Mothers job	Farmer	343(89.3)
	self-employed	19 (4.9)
	Un-employed	22(5.5)
	Total	384(100)

4.2.Chi square analysis of potential Risk factors and helminthes infection

Chi-square analysis indicated that a statistically significant association between STH infection with the associated risk factors including latrine availability (x^2= 48.646, p = 0.001), hand washing practice before meal (x^2= 60.3, p = 0.001), hand washing practice after using toilet (x^2= 72.24, p = 0.001), playing with the soil (x^2=65.91, p = 0.001), fingernail trimming (x^2= 272.6, p

= 0.001),but the other factors such as types of latrine, contact with the river water, and duration of contact with the river water were not significantly associated with STHs.

Table 4. 2 Chi- square analysis for potential risk factors of STH infections among Liwaye Town 2021/2022

Risk factors	Categories	STHs		χ^2 value	*P*-value
		Positive No(%)	Negative No (%)		
Latrine availability	Yes	43 (13.06)	286 (87)	48.646	0.001*
	No	29 (52.7)	26 (47.3)		
Types of latrine	Private	20 (16.9)	98 (83.1)	0.363	0.547
	Common	52 (19.5)	214 (80.5)		
Washing hands after defecation	Yes	22 (8)	252 (92)	72.24	0.001*
	No	50 (45.5)	60 (50.5)		
Washing before meal	Yes	35 (11.3)	276 (88.7)	60.3	0.001
	No	37 (50.7)	36 (49.3)		
shoe Wearing habit	Yes	36 (11.7)	270 (88.3	48.31	0.001*
	No	36 (47.2)	42 (52.8)		
Playing with the soil	Yes	54(41.2)	77(58.8)	65.905	0.001*
	No	18(7.1)	235(92.9		
Making contact with the river water	Yes	39(17.2)	188(82.8)	0.898	0.343
	NO	33(21.0)	124(79)		
Duration of contact with the river water	Always	5 (15.2)	28 (84.8)	1.925	0.382
	Occasionally	30 (1.9)	125 (98.1)		
	Sometime	4 (10.3)	35 (89.7)		
Fingernail trimming	Yes	7 (2.3)	300 (97.7)	272.6	0.001*
	No	65 (84.4)	12 (15.6)		

4.3.The Prevalence of STHs Infection

In the study area, 72 cases of soil-transmitted helminthic infection (18.7%) were reported. While 31 (43.05%) of the STH infections were in males, 41 (56.9%) of these infections were in females. The most prevalent *A. lumbricoides* STH infection was found in 45 (11.7%) of the study participants, followed by hookworm infection in 18 (4.9%). The least frequent helminthic species found in this study was *T. trichiura*, which was found in 9 (2.3%) of the study participants.

Table 4. 3: The prevalence of soil- transmitted helminthes in the study subject (n=384) among Liwaye Town South Gonder Zone northwest Ethiopia 2021/2022

Soil transmitted helminthes	No. of infection	Percentage (%)
Ascaris lumbricoides	45	11.7%
Hookworm	18	4.7%
Trichuris trichuria	9	2.3%
Total	72	18.7

The percentage of the three helminth in three selected school were also reflected by pi-charts with their results were discovered.

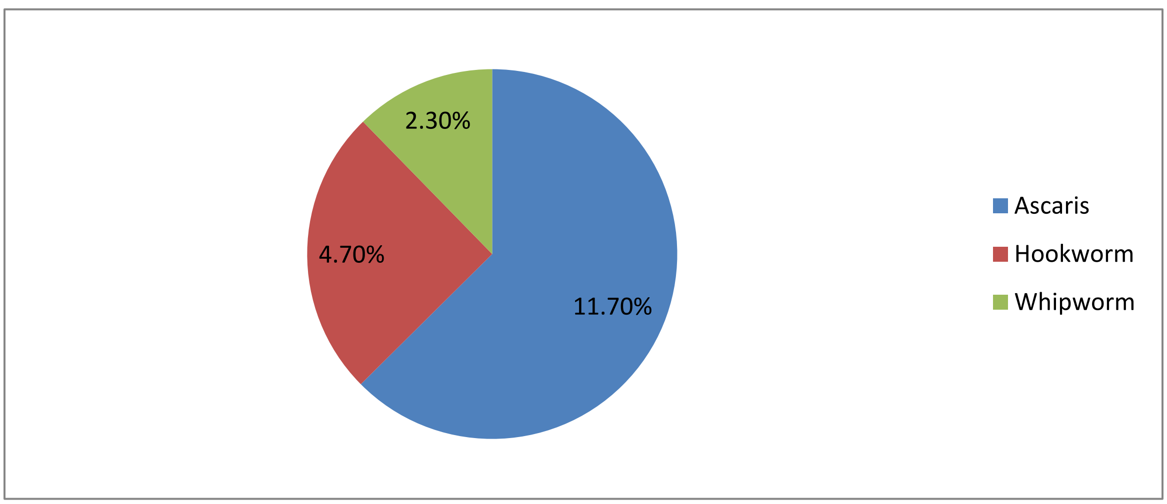

Figure 6 percentage of the three helminthes infection

4.4.Soil transmitted helminthes identified and its overall prevalence among the primary schools in Liwaye Town

A. lumbricoides was the most common parasite species discovered in the study region, with a prevalence of 45 (11.7%), followed by Hookworm 18 (4.7%) and *T. trichiura* 9 (2.3%). Liwaye school had the greatest infection rate (at 44.1%), followed by Wulkefit school (at 25.7%), and the lowest infection rate (4.2%) was among students at Gumara primary school, according to an analysis of the distribution of STH infections among the three primary schools.

Table 4. 4: STH identified among three governmental primary school children (n=384) around Liwaye Town 2021/2022

Name of schools	**Types of STHs**			
	A.lumbricoides No(%)	Hookworm No (%)	*T.trichuria* No(%)	Total No (%)
Liwaye	29(64.4)	9(50)	6(66.6)	44(61.1)
Wulkefit	14(31.1)	8(44.4)	3(33.3)	25(34.7)
Gumara	2(4.4)	1(5.5)	-	3(4.2)
Total	45(11.7)	18(4.7)	9(2.3)	72(18.7)

4.5.Univariateand multivariate Logistic Regression Analysis of Socio-Demographics Factors with STH Infection among school children in Liwaye.

Univariate logistic regression model was used to assess the strength of associations of the overall STHs infection with the socio-demographic factors. There was no statistically significant correlation between Socio- demographic variables and STH infection in Univariate as well as multivariate logistic regression analysis. An example in which socio- demographic variables did not linked with STH like no formal education were COR= 3.5(0.81-15.18,p= 0.94), primary education were COR= 2.78(0.88-8.78, p= 0.18). Generally, variables such as sex, age, grade level, age, education level and degree of job were did not associated with STH infection.

Table 4. 5 Univariate and Multivariate logistic regression analysis for socio- demographic factors associated with STH around Liwaye 2021/2022

Factors	**Categories**	**STHs**		**COR(95%,CI,p value)**	**AOR(95%CI,P value)**
		Positives No (%)	Negative No (%)		
Sex	Male	31 (16.3)	159 (83.7)	1	-
	Female	41 (21.3)	153 (78.9)	2.374 (0.820-2.304),0.228	-
Age	5-10	23 (18.1)	104 (81.9)	1.833 (0.443-1.566),0.571	-
	11-14	21 (20.8)	80 (79.2)	1	-
	>15	28 (17.9)	128(82.05)	3.989 (0.538-1.819),0.972	-
Grade	1-4	27 (18.9)	116 (81.1)	1	-
	5-8	45 (18.7)	196 (81.3)	1.945 (0.597-1.721),0.96	-
Father education	No education	62 (18.3)	276 (81.7)	3.5 (0.81-15.18),0.94	-
	Primary education	5 (15.2)	28 (84.8)	2.78 (0.87-8.78),0.18	-
	Secondary education	5 (38.4)	8 (61.5)	1	-
Mother education	No education	60 (18.6)	262 (81.4)	1.72 (0.351-4.589),0.716	-
	Primary education	7 (17.9)	32 (81.1)	1.231(0.433-3.397),0.713	-
	Secondary education	5 (21.7)	18 (79.3)	1	-
Father job	Farmer	66 (18.6)	288 (81.4)	2.18 (0.619-5.338),0.0277	-
	Un employed	5 (29.4)	12 (61.6)	1.50 (0.506-49.438),0.169	-
	Self- employed	1(7.7)	12(92.3)	1	-
Mather job	Farmer	66(19.2)	277 (81.0)	2.84 (0.149-4.764),0.846	-
	unemployed	3 (13.6)	19 (86.4)	1.66 (0.190-2.306),0.518	-
	Self- employed	3(15.8)	16(84.2)	1	-

Note:*Statistically significant at p< 0.05; 1= Reference value; COR= crude odd ratio, AOR= adjusted odd ratio

4.6.Univariate and Multivariate logistic regression analysis of potential risk factors and STH infections around Liwaye Town, 2021/22

The results of the binary logistic regression analysis demonstrated a highly significant association between the prevalence of STH infections and the variables like availability of latrines, hand washing habit after defecation, hand washing practice before meal, habit of wearing shoes, playing with the soil , and fingernail trimming.

Students who had no latrine facility were almost seven times more likely to contract STHs than those without latrine to use (COR = 7.419, 95%CI = 3.995–13.775, p = 0.01). There was a significant difference in the infection rate of STHs between SAC who wash and those who did not wash their hands after defecation. Schoolchildren who never washed their hands after the toilet use were about nine times (COR = 9.545, 95%CI = 5.371-16.965, p = 0.000) more likely to acquire STH infection than children who wash their hands after defecation. School children who never washed their hands before meal were seven times(COR= 7.748,95% CI= 4.430-13.5521,p= 0.01) more likely to be infected with STH infection than children who had the habit of washing their hands before meal. Those who did not wear shoes at all were six times (COR = 6.429, 95% CI = 3.654-11.310, p = 0.000) more likely to be infected with STHs than those who wore shoes. Those who did not trim their fingers were 232 times (COR = 232.143, 95%CI = 88.006–612.350) more likely to be infected with STHs than those who trimmed their fingernail.

In multivariable logistic regression analysis, latrine availability, hand washing before meal hand washing after toilet, practice of wearing shoes, playing with the soil, fingernail trimming practice were found to be statistically significant (p< 0.05). Schoolchildren who did not wash their hand after defecation were about three times (AOR = 3.662, 95% CI = 1.231 – 10.890,p= 0.02) more likely to be infected with STHs than those children who washed their hand after defecation. School children who did not wear shoe were about five times(AOR=5.780,95% CI=2.521-13.25,p=0.01)more likely to be infected by STHs than those children who wear shoe regularly. The other significant risk factor associated with prevalence of STHs among schoolchildren around Liwaye Town was the practice of fingernail trimming. SAC who had no trimmed finger were (AOR=15.43,95% CI= 4.375-54.429,p=0.01) more likely to be infected with STHs than schoolchildren who had trimmed fingernails.

The likelihood of being infected with STHs was the almost the same (AOR= 1.07,95% CI= 0.078-0.356,p= 0.02)between schoolchildren who played with the soil and those who did not play with the soil. There was five times more likelihood of being infected with STHs among schoolchildren who had no latrine facility (AOR = 5.798,95% CI= 2.34-14.40),as compared with those children who had latrine facilities. In multivariable logistic regression analysis those variables which were not associated with the prevalence of STHs include latrine availability, contact with the river water, duration of contact with the river water and types of latrine .

Table 4.6Univariate and Multivariate logistic regression analysis for risk factors of STH infections among SAC around Liwaye 2021/2022

Risk factors	**Categories**	**STHs** Positive n (%)	Negative n(%)	**COR(95%,CI, p)**	**AOR(95%CI,P)**
Latrine availability	No	42 (12.7)	287 (87.2	7.419 (3.995-13.775),0.01	5.79 (2.33-14.40),0.01*
	Yes	30 (54.5)	25 (45.5)	1	1
Types of latrine	common	52 (19.5)	214 (79.5)	2.11 (0.074-2.102),0.54	1.70 (0.373-1.6),0.48
	private	20 (16.9)	98 (83.1)	1	1
Washing hands after defecation	No	50 (16.5)	252 (83.5)	9.545 (5.371-16.965),0.01	3.67 (1.23-10.89),0.02*
	Yes	22 (26.8)	60 (73.2)	1	1
Contact with the river water	No	39 (17.2)	188 (86.8)	2.23 (0.766-2.149),0.34	
	Yes	33 (21)	124 (79)	1	-
Duration of contact with the river water	Always	5 (15.2)	28 (84.8)	1.06 (0.157-1.443),0.19	
	Occasionally	30 (19.4)	125 (88.6)	1.60 (0.157-2.610),0.53	-
	sometimes	4 (10.3)	35 (89.7)	1	
shoe Wearing habit	No	37 (12)	271 (88)	6.429 (3.654-11.310),0.01	5.78 (2.52-13.25),0.01*
	Yes	35 (44.3)	41 (55.7)	1	1
Playing on the soil with friends	No	54 (41.1)	77 (58.8)	1.09 (0.060-0.197),0.01	1.700 (0.08-0.36),0.01*
	Yes	18(7.1)	235(92.9	1	1
Finger nail trimming	No	66 (17.9)	301 (82.1)	14.20 (5.06-39.88),0.01	15.43 (4.37-54.42),0.01*
	Yes	6 (35.3)	11 (64.7)	1	1
Hand wash before meal	No	46 (15.3)	254 (83.7)	7.748 (4.430-13.52,0.01*	6.7 (3.04-15.2) 0.01
	Yes	26 (30.9	58 (69.1)	1	1

5.DISCUSSION

The term "soil transmitted helminthes" (STHs) refers to parasitic worms that infect humans and are spread via oval or larvae-contaminated soil. In order to become infectious, parasites' immature or undeveloped life stages (eggs) must first develop or incubate in the soil for a certain amount of time. The fundamental goal of the majority of studies on the prevalence of helminth infection in various regions or localities is to identify high-risk communities and develop effective intervention strategies (Brooker *et al.*, 2000).In line with this view, the current study attempted to determine the prevalence of STHs (*Ascaris lumbricoides*, *Trichuris trichuria*, and hook worm) infections in Liwaye Town schoolchildren, South Gondar, northwestern Ethiopia.

In this study, the overall prevalence of STH infection was 18.7%. It is lower than prevalence rate reported among school age children in the Tigray region, where the overall prevalence of the infection was 28.6% (Tadesse Dejenie and Tsehay Daniel, 2008), and a report from Eastern Ethiopia, where the prevalence was 27.2% (Tadesse Girum, 2005). However, the total prevalence of this study was higher than reports from Western Kenya (12.4%) (Odiere *et al*., 2012), North Western Tigray (12.7%) (Teshale *et al.,* 2018), Wetet-Abay (12.22%) (Mohammed Seid *et al.* (2015), and Babile town (13.8%) (Ephrem Tefera *et al*, 2015).

The higher prevalence of STH infection in current study might be due to environmental risk factors. However, STH prevalence in this study was substantially lower than those reports of studies in North-Western Tanzania, where the prevalence was estimated to be 38% (Mazigo *et al*., 2012), and from South-East Nigeria, where the prevalence was reported to be 42.2%. (Olufemi *et al.*, 2007).In addition, the prevalence of soil transmitted helminthic infection among schoolchildren in Liwaye town was significantly lower than those reports from Lucia (an island in the Eastern Caribbean Sea), where it was 52.2% (Rajini, 2010), 54% (Melaku Wale and Tesfu Fekensa, 2010), 54.9% (Tilahun Alelign *et al* (2015), a record of 69.1% from the Zegie Peninsula (Merem Abdi *et al*., 2016. Factors like, difference in personal hygiene and environmental sanitation, pure water supply, latrine availability, socioeconomic status, educational status, practices and habit towards hand washing after defecation and before meal, and awareness toward risk factors of STH infections, might contribute to the differences in the prevalence and distribution of soli transmitted helminthic infections.

Ascaris lumbricoides was found to be the dominant helminthic parasite in the study area, showing a prevalence of 45 (11.7%), of which 27 (7.03%) was detected among females and the remaining 18 (4.7%) was in male schoolchildren**.** This is in agreement with the 13.9% prevalence of the infection reported from Durbete Town (Tilahun Alelign *et al.,* 2015**).**But, the present finding was much lower than other previous prevalence reports , 23.4% in Jima town (Zeleke Mekonnen *et al*., (2019), 26.67% in Nasarawa State, Nigeria(Eke *et al*., 2015), and the 37% prevalence rated observed in Rwanda (Ruberanziza *et al*., 2019). But it was higher than the *Ascaris lumbricoides*, infection prevalence of 3% in Guragie Zone (Weldesenbet *et al*., 2019).However, it was higher than a 3% *Ascaris lumbricoides* infection prevalence reported from Guragie Zone's (Weldesenbet *et al*., 2019).

Suitability of environmental conditions (soil) for survival and development of eggs, poor sanitation and personal hygiene practices, poverty and lack of clean portable water in this study area and high fecundity of the parasite could be the probable reasons for the higher prevalence of *Ascaris lumbricoides* infection noted in this study. In the present study, hookworm infection was detected among 18 schoolchildren (4.7%)in about 9(2.3%)males and females each. It is comparable with the prevalence rates of the same parasite, (4.2%) and 4.14% reported from Guragie Zone (Habtamu Weldesenbet *et al.*, 2019) and North Western Tigray (Tsega Teshale *et al.*, 2018. However, it is considerably lower than prevalence rates reported from different parts of Ethiopia, including 40.8% in Asendabo, Jimma Zone, South West Ethiopia (Fekadu *et al*., 2008), 46.9% in Durbete Town Tilahun Alelign *et al,* (2015), and 64.7% in Langano (Mengistu Legesse and Berhanu Erko, 2004).It is also lower than 9.9% rate of hookworm infection reported in Jima Town (Zeleke Mekonnen *et al.*, 2019).

With regard to the prevalence of *Trichuris trichuria* in this study, it was found in 9(2.3%) of the schoolchildren , which is similar to the 2.3% prevalence rate reported from study conducted in Durbete Town(Tilahun Alelign *et al*., 2015). But, it is almost higher than the *T. trichiura infection rate of* 0.5% in the Guragie Zone (Habtamu Weldesenbet *et al*., 2019). In contrast, the prevalence obtained in this study was lower than the prevalence of 8.13%in Nasarawa State, Nigeria(Eke *et al.,* 2015), 35.5% in Jima Town (Mekonnen *et al*., 2019) and the 23% infection rate of the parasite in Rwanda (Ruberanziza *et al.,* 2019). The observed variations among studies could be due to difference in environmental factors that could favor or deny ova development, lack of awareness about modes of transmission , socioeconomic status and personal hygiene and environmental sanitation**.**

In the current study, schoolchildren in age group of 15 and above years old were the most infected 28 (7.3%) with helminth infections followed by those in age groups 5–10 years old , 23(5.1%)**.**This is in line with (Tilahun Alelign *et al.* (*2015*) who also reported the highest soil transmitted helminthic infection among school aged children 10 to 14from Durbete Town , Saint Lucia among children aged 5 to 14 (Rajini, 2010), North Western Tigray among children aged 11 to 14 (Teshale *et al*., 2018), and rural Brazil among children aged 11 to 15 (Rajini, 2010). (Fiona *et al*., 2006). In contrast to these findings, higher helminthic infections were reported among children under lower , 0–5 year age categories in Plateau State, Nigeria (Ogwurike *et al***.,** 2010), 5–7 age group in Nasarawa State, Nigeria(Eke *et al*., 2015), and among 6 year old children in Gurage zone (Habtamu Weldesenbet *et al.,* 2019).

In the present study, the odds of STH infection was nearly six folds higher among schoolchildren who had no latrine in their home as compared with those who had latrine in their home **(**p0.05**).**This agrees with the finding of study conducted by Abossie and Seid (2014)in Chencha town, Southern Ethiopia who also demonstrated that children without latrine in their home were more affected than who have the latrine. Children who did not wash their hands before meal were 110 (.6%) and that wash their hands did wash were 274 (71.2%).

It is consistent to the STH infection reported from Durbete Town with Children who did not wear shoes and did not have the habit of washing hands before eating had higher chance of being infected with STH than children who wear shoes and had the habit of washing their hands before eating (Alelign *et al*., 2015). But in study area the most infected one was children be not able to perform good personal hygiene in your surroundings. The reason was the deceptive report of participants at the time of doing questionnaire examination. Children who wore shoes were higher than children who did not wear shoes, at 306 (79.7%) and 78 (20.3%) respectively. In this study, school aged children with trimmed fingernails 307 (79.9%) were less infected than school children with untrimmed fingernails 77 (20.05%). .Besides, schoolchildren with untrimmed fingernail were more likely to be infected with STH infections compared with schoolchildren with trimmed fingernails. In support of the present study, studies conducted in Bahir Dar and Butajira Town were also showed a positive association between overall prevalence of helminthic infection and dirty hand and untrimmed fingernails(Bayeh Abera *et al.*,2013;Teha Shumbej et al.,2015). This might be the presence of an appropriate environment, climate, and level of moisture.

In the current study, STH infection was significantly associated with lack of hand washing habit after defecation, the odds of STH infection were 3.67times higher was a significant association between infection among children who do not wash their hands after defecation. Similarly, there was STH infection with lack of hand washing habit before meal, the likelihood of STH infection was about six fold higher infection among children who lack hand washing habit before meal. This is in concordance with the studies of Bayeh Abera et *al*. (2013) and Teha Shumbej *et al*. (2015). This could be contamination of hands with the infective stages of STHs, which increases the chances of being infected.

Furthermore, the habit of wearing shoe was significantly associated with the risk of STH parasite infection ($P<0.05$). Schoolchildren who had shoe wearing habit were at 5.78 (95% CI: 2.52,13.25) times increased risk of STH infections than those who had shoe wearing habit. This in agreement the findings of a study by Bayeh Abera and his colleagues , who reported a positive association between lack of footwear with intestinal helminthic infection among schoolchildren (Bayeh Abera *et al*., 2013).

The odds of being afflicted by *Ascaris lumbricoides* were 5.2 (95% CI: 2.117, 12.744), 2.7 (95% CI: 1.072, 6.597), and 2.23 (95% CI: 1.23, 5.374) times higher in those schoolchildren who did not have access to latrines, lack hand washing habit after toilet use, and in those with untrimmed finger nail, respectively. This is consistent with the outcomes seen in Mexico (Quihui *et al*.,2006). This might be the turning moment for the ecosystem and the climate. 22.8 (95% CI: 1.908, 272.905) respondents from the factor finger nail trimmed had *T. trichuria* infection. The results were better than those seen in Jimma (Ephrem Tefera et al., 2017). This can be due to the weather, the time of year, or sanitary concerns.

6. CONCLUSION AND RECOMMENDATION

6.1.Conclusion

Among the three governmental primary schools that were chosen, soil-transmitted helminths are a serious public health concern. Even the Ethiopian government's deworming program for schoolchildren has been running and is progressing. As the present study was implies that STH commonly known as Ascaris, hookworm and whipworm infections were prevalent and distributed in Liwaye primary school children Infection with *Ascaris lumbricoides* predominated among the three helminth species, followed by infections with hookworm and *T. trichuria,* which were discovered to be STH parasite species during the investigation. The majority of the town's youngsters under the age of 15 and students in the second cycle of grade levels were impacted by helminthes infections. Females were more frequently infected than males by STH infections, Females were more frequently infected than males by STH infections .In addition, failure to wash hands before meal and after defecation, practice of not trimming fingernails, shoe wearing habit, and unavailability of latrine, playing on the soil were identified as predisposing factor for STHs infections

6.2.Recommendation

Based on the conclusions of this study, the following recommendations were made.

- School based deworming for soil-transmitted intestinal worms should be conducted every six months.
- Awareness about personal hygiene and STH infections and associated risk factors should be created among primary school children in particular and the community by large.
- Construction and provision of latrines by local authorities and NGOs for public utilization should be advocated.
- At schools, hand washing day dedicated to increasing awareness and understanding about the importance of hand washing with soap and water should be celebrated.
- Student families should take initiative to reduce saddle during long farming days without shoes.
- Community members and school students should continue the trends of preventing the spread of helminthes infection

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8. APPENDIX

Bahir Dar University

Collage of science

Department of Biology
Appendix A. Questionnaire/In English/

1. socio- demographic characteristics related question

1.1 Name of school----------------------------
1.2Grade /section of student------------------------
1.3 Age--
1.4 Sex 1. Male ☐ 2. Female ☐
1.5Religion-------------------------------------- and status--------------------------------
1.6 Name of the care givers of the child ………………………………………...
1. Educational level of care givers: Father – No education, primary(not completed) primary education(completed), secondary post-secondary collage other specify……………………...
2. Mother: No education, primary education(not completed) ,primary education(completed) , secondary post-secondary collage other specify……………………...
3. Job of the care givers father: farming ☐ self-employed ☐ unemployed ☐ other specify………………
4. Mother: farming ☐ self employed ☐ un employed ☐ other specify………………

2 .Behavioral ,personal hygiene and environmental sanitation related question

1. Do you have latrine available?

Yes ☐ No ☐

1.1 If yes is it? Private ☐ Common ☐

1.2If No where do you defecate and dispose feces?

Near the streams ☐

Open field ☐

Using pits and disposes to the streams ☐

2. Do you wash your hands after defecation? Yes ☐ No. ☐

3. Do you make contact with the river water?

Yes ☐ No ☐

4.1If yes how often? Always ☐ Occasionally ☐ Some times ☐

5. Do you wear shoe? Yes ☐ No ☐

6. Where do you bath? Stream ☐ Home ☐

6.1.1If the answer is stream which stream? Gumara ☐ woyzerya ☐

6.2If the answer is home, where do you obtain the water? Stream ☐ pipe ☐ other specify_______________

7.Do you play with the soil ?

Yes ☐ No ☐

3.Information through observation

1. Are finger nails of the student trimmed?

Trimmed ☐ Not trimmed ☐ other specify----------------

2.finger nail status clean ☐ not clean ☐

3.Hand status clean ☐ not clean ☐

4.Laterine at school available ☐ not available ☐

5. water at school: available ☐ not available ☐

ባህርዳር ዩኒቨርሲቲ

የሳይንስ ኮላጅ

የባዮሎጂ ክፍል

አባሪ B: ማጠይቅ/In Amharic/

1. የሶሺዮ-ስነ -ሕዝብባህሪያትተዛማጅጥያቄ

1.1 የትምህርትቤትስም-------------

1.2 የተማሪክፍል ------------

1.3 ዕድሜ----

1.4 ጾታ 1. ወንድ..... 2. ሴት......

1.5 ሃይማኖት - - - - - -

1.6የልጁእንክብካቤሰጪዎችስም……………………………………

1. የእንክብካቤሰጭዎች.........አባት......... የትምህርትደረጃ፡ - ምንምትምህርትየለም..... የመጀመሪያደረጃ (ያጠናቀቀ) የመጀመሪያደረጃ (ያላጠናቀቀ)፣ ሁለተኛደረጃትምህርትቤትኮሌጅሌላይገለጽ …………………………………

2. እናት........ የትምህርትደረጃ፡ የመጀመሪያደረጃ (ያልተጠናቀቀ)፣ የመጀመሪያደረጃትምህርት (የተጠናቀቀ)፣ የሁለተኛደረጃ................ ድህረ-ሁለተኛ ደረጃ ኮሌጅ ሌላ ይገልፃል ……………………………………

3. የተንከባካቢውሥራአባት፡ በራሱየሚተዳደር......... ሥራአጥ......... ሌላ ይገለጻል …………………

4. እናት፡ - በግብርና ሥራ ተቀጣሪ.......... ሌላ ተቀጥራለች ……

2 .የባህሪ፣ የግል ንፅህና እና የአካባቢ ጽዳትና የግል ንፅህና አጠባበቅ ጥያቄ

1. ሽንትቤትአለህ? አ☐ አ☐

1.1 አዎከሆነ ? የግ☐ የጋ☐

1.2አይ ከሆነ ሰገራን የትነ ውየምታጸዳው?

☐በጅረቶች አቅራቢያ

☐ክፍትሜዳ

☐ጉድጓዶችን በመጠቀምእና ወደ ጅረቶች ይጣሉ

2. ከተፀዳዱበኋላ እጅዎን ይታጠባሉ?☐ዎ ☐

3.ወንዙ ጋር ግንኙነት ትፈጥራለህ? ☐ አዎ ☐

4.1 አዎ ከሆነ በየስንት ጊዜው? ☐ ጊዜ አ ☐ አልፎ አ ☐ ንድጊዜ

5. ጫማ ትለብሳለህ? አ ☐ አ ☐

6.በወንዞቹ ውስጥ ልብሶችን ታጥባለህ? ☐ አዎ ☐ አይ

6.1 አዎ ከሆ ☐ ☐ ጉ ሚራ ወይዘር
የሌላ፣ ይግለጹ________

7. የትነ ውየ ሚታጠቡት? ማ ሻኸረት

7.1ሜል ሱጅረ ትከሆነ የየ ትኛ ውጅረት? ☐ ሚራ ☐ ይዘ ርየ

7.2 ሜሉ ሱቤትከሆነ ውሃ ውን ከየ ትያገ ኛ ☐ ከኸረት ☐ ቧንቧ
ሌላ ይግለጹ___________

8.ከጓደኞችህ ጋር አፈር ላይ ትጫወታለህ? ☐ አዎ ☐ አይ

3.በ መሜልከት ሚ ጃ

1. የ ተሚ ዉየ ጣት ጥፍር ተቆርጧል?

የ ተከረከመ ☐ ያልተከረከ ☐ ሌላ ይግለጹ..................

2.የ ጣት ጥፍር ሁኔ ታ ንጹህ ☐ ንጹህ አይደለም ☐

3.Hand status ንፁህ ☐ ንጹህ አይደለም ☐

4.Laterine በትምህርት ቤት ይገ ኛ ☐ አይገ ኝ ☐

5. ውሃ በትምህርት ቤት፡ ይገ ☐ ል አይገ ኝ ☐

Appendix C: Consent form/In English/

Title:-prevalence and associated risk factors of soil transmitted helminthes infections in school children of Liwaye town, south Gondar zone, North West Ethiopia

For participation as volunteer in research undertaking.

I'm a graduate student at Bahir Dar University's faculty of natural sciences. I'm here to research the STHs infection situation right now. In order to participate in this study, your child and others must answer questions about related topics in an interview and provide stool samples. He/she will maintain the confidentiality of the information provided during the interview and the findings of the laboratory inquiry. The results of the laboratory tests would be utilized to start your child on the right course of therapy for the infections in question. The study findings would also be used to design and implement control strategies in the study area in the future. In the end of the study, a report would be compiled and presented to the Faculty. The reports will not bear any information relating to your child personality. You have also the right to decline to co cooperate in the study. If you have understood the explanation well enough, I am requesting you to your signature as illustrated below. I, the, undersigned have been informed about the study objectives. I have also been informed that all the information within the questionnaire is to be kept confidential and that I have the right to decline from or to cooperate in the study. Therefore, with full understanding of the study objective I agree to give the informed consent voluntarily to the researcher to identify the parasites from my child’s stool specimen and requesting for his /her appropriate treatment.

Name of parent (guardians) ______________________Signature_________Date_______

አባሪ D:የ ፍቃድቅጽ

ርዕስ፡ -

በደቡብጎ ንደርዞ ንበሰሜን ምዕራብኢትዮጵያበልዋዬከተማበትምህርትቤትልጆችላይየ አፈርተላ ላፊሄልማቲክኢንፌክሽንስርጭትእና ተያያዥአደጋምክንያቶች

<u>በምር ምር ሥራየ በጎ ፈቃደኞችተሳትፎ።</u>

በባህርዳርዩኒቨርሲቲየ ተፈጥሮሳይንስፋኩልቲየ ድህረ ምረ ቃተማሪ ነ ኝ። እኔ እዚህየ መጣሁትየ S THs

ኢንፌክሽንያለበትንደረጃለማጥና ትነ ው። በዚህ ጥና ትላይልጅዎንእና ሌሎችእንዲሳተፉእ ጠይቃ ለሁይህ ምክ አንዳንድተያያዥጉዳዮችእና በር ጩምማሳ ብሰብላይለተደረገ ቃለ ማጠይቅየ ሱን/ሷንም ላሽያስፈልገ ዋል። እሱ/ሷበቃለ ማጠይቁወቅትየ ሚሰ ጡትሚ ጃእና የ ላብራቶሪ ምር ሚራውጤቶችበሚ ስጥርይያዛሉ። የ ላብራቶሪ ግኝቶቹለተጠቀሱትየ ልጅዎኢንፌክሽኖችተገ ቢውን ህክምና ለ መጀመር ጥቅምላ ይይውላሉ። የ ጥና ትግኝቶቹምወደፊትበጥና ትአካባቢየ ቁጥጥርስልቶችንለመን ደፍእና ለ መተግበር ይጠቅማሉ። በጥና ቱ ሜጨረ ሻ ምሪ ፖርትተዘጋጅቶለፋኩልቲውይቀርባል። ሪፖርቶቹየ ልጅ ዎንስብዕና በተማላ ከተምን ምእ ይነ ትሚ ጃአይሸከ መም። በጥና ቱውስ ጥለ መተባበርአለ መቀበልም መብትአልዎት። ማብራሪያውን በበቂሁኔ ታከተረዱት፣ ከዚህበታችእ ንደተገ ለጸውፌርማዎንእንዲ ያማላክቱእ ጠይቃለሁ። እኔ ፣ በስሩየ ተፈረ ምኩትስለ ጥና ቱዓላ ማዎችተነ ግሯል። በተጨሚ ምክ መ ጠይቁውስ ጥያለ ውሚ ጃሁሉበ ሚስ ጥርእንዲጠበቅእና በጥና ቱላይላለ መቀበልወይም መተባበር መ ብትእ ንዳለኝተነ ግሮኛል። ስለዚህየ ጥና ትአላ ማውን ማሉበ ማሉበ ሚ ዳትለተሚራሚ ውክልጄሰገ ራና መና ውስ ጥጥገ ኛተሕዋስያንንለማላየ ትእና ተገ ቢውን ህክምና እንዲሰ ጠውለ ማጠየ ቅበፍቃደኝ ነ ትለተሚራሚ ውለ ማስ ጠትተስ ማምቻለሁ።

ስምውላጅ (አሳዳጊ) ________________________ ፊርማ____________ ቀን ________

Appendix E: Ethical clearance Approval Form

ንስ ኮሌጅ
ምረቃ፣ምርምርና
አገልግሎት ም/ዲን
ር ዩኒቨርሲቲ
ር - ኢትዮጵያ

The Graduate, Research & Community
Services Vice Dean, Science College
Bahir Dar University
Bahir Dar - Ethiopia

☎ 251 (588) 209997
bsite: www.bdu.edu.et ✉ 79 Fax: 251 (582) 220- 20- 25

Ref.No PRCSVD/287/2014

Date 14 Feb. 2022

Ethical Clearance Approval Form

pplicant's Name: Abraraw Aseged

Research Title	Prevalence and associated risk factors of soil transmitted helinthic infections in school children of Liwaye town, South Gondar Zone, northwest Ethiopia
Researcher (s) Name (s)	Abraraw Aseged

hank you for submitting your application for ethical clearance, which was considered at the College of cience Research Ethics Committee meeting on 14 February 2022. The committee has reviewed your hical application, issues pertaining to participants, consent form, debriefing, and relevant uestionnaires.

he researcher should keep the confidentiality of the identity of research participants and data that will e obtained from them. Any serious adverse events or significant changes which occur in connection ith this study and /or which may alter its ethical consideration must be reported immediately to the ommittee for a possible ethical amendment.

Ve are therefore pleased to inform you that the College's Ethical Clearance Committee has approved our study from an ethical point of view.

Vith kind regards

Tsegaye Kassa (PhD)
he Graduate, Research and Community Services V/Dean
ollege of Science

ባሕር ዳር ዩኒቨርሲቲ ሳይንስ ኮሌጅ ምርምርና ማህበረሰብ አገልግሎት ጽ/ቤት
Office of Research & Community Services
Bahir Dar University College of Science

CC//

- Dean office
- The Graduate, Research and Community Services V/Dean
- Department of Biology

College of Science

Appendix F: participant Picture

Participants Gallery during distributing questionnaires paper

Participants gallery during stool collection

Appendix G: Apparatus were needed in stool examination

Centrifuge

Filter

Test tube

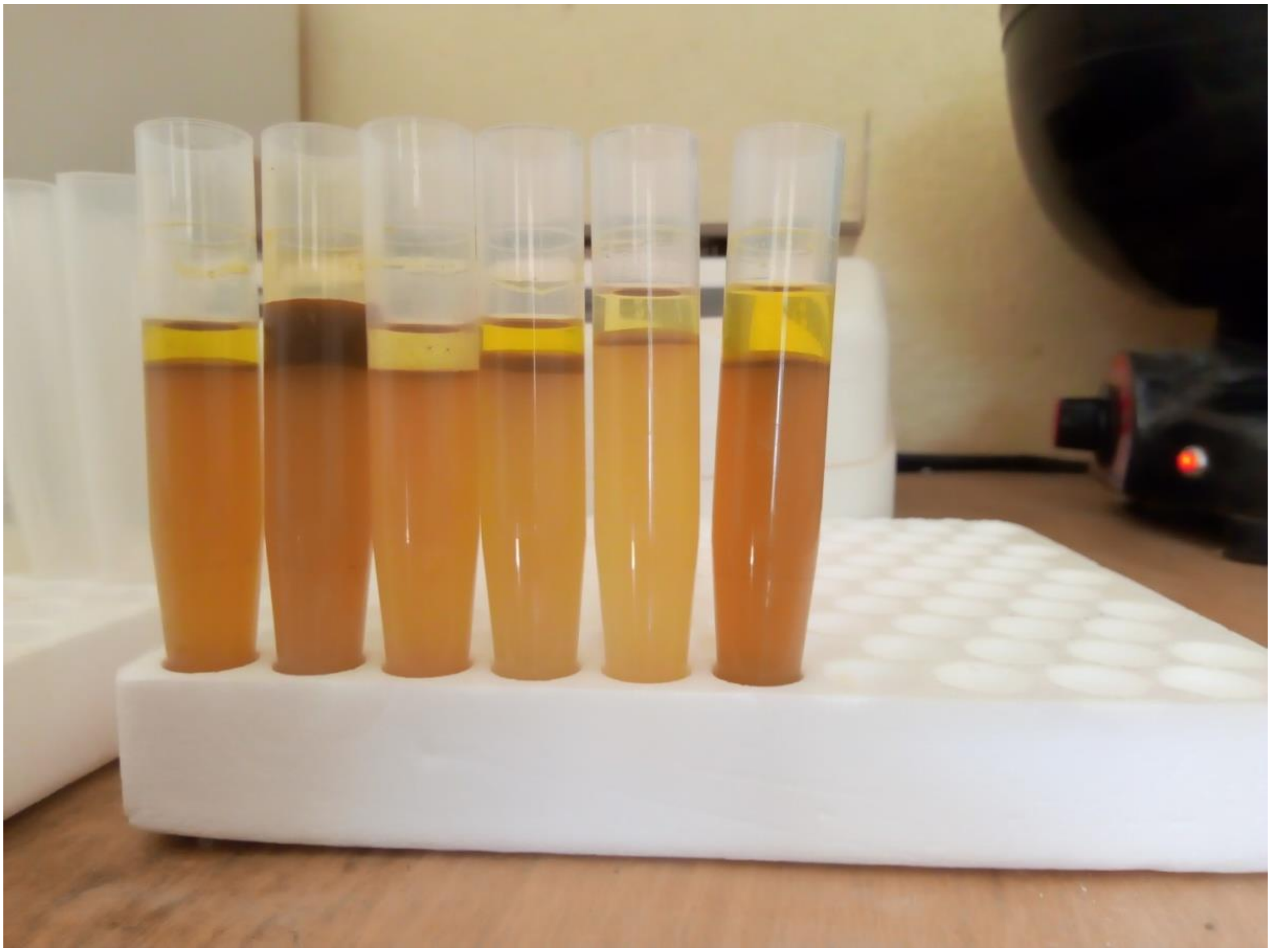
Beaker

Sticker

Protective Glab

Syringe

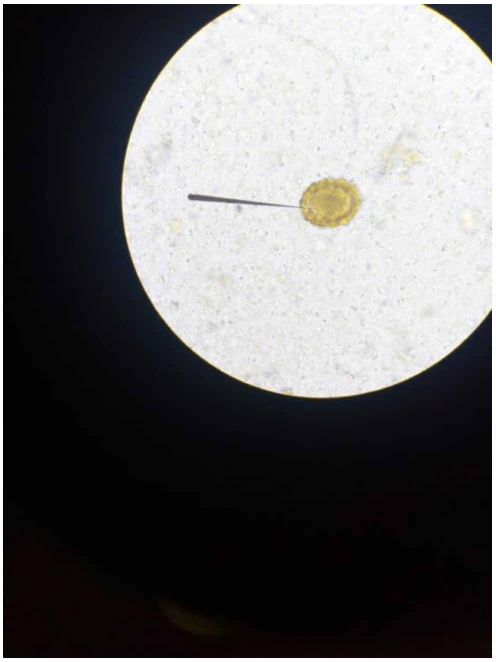
Stool cup



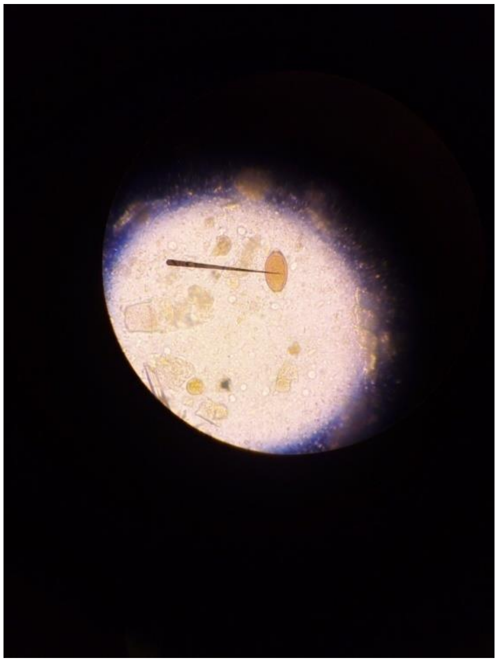
THE RESULT OF THE FOUR LAYERS(ETHER,DEBRIS,FORMALIN,AND SEDIMENTES

Collected stool

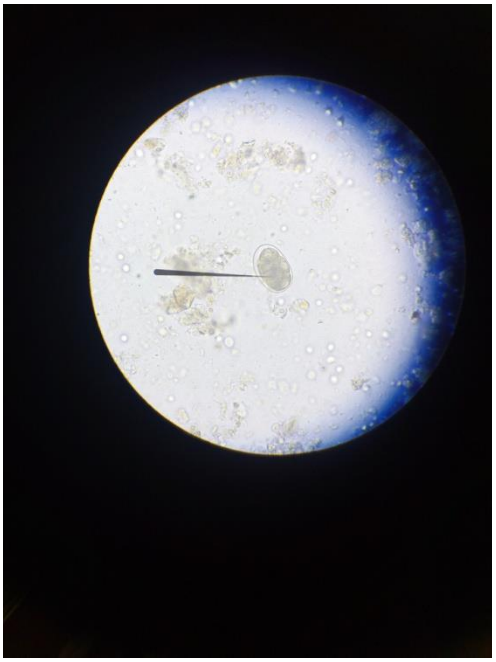
Appendix H:Identified parasite



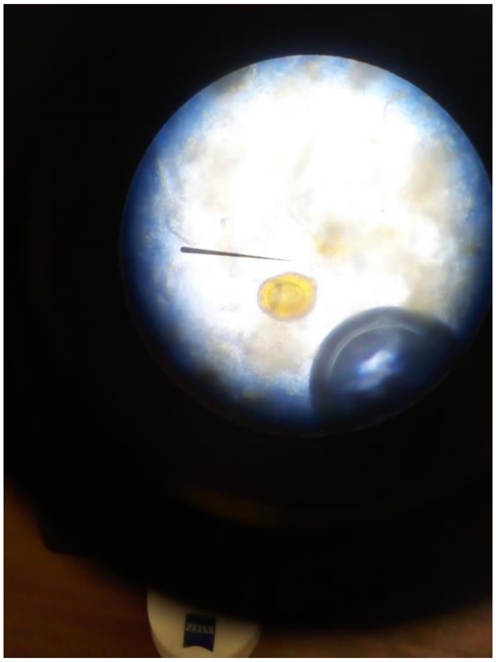
Ascaris



whipworm



Hookworm



Fertilized Ascaris

Appendix I: image shows processes of stool examination