PREVALENCE AND ASSOCIATED RISK FACTORS OF SOIL TRANSMITTED HELMINTHS AND *SCHISTOSOMA MANSONI* INFECTIONS AMONG COMMUNITIES ALONG RIVERS IN GUDAR TOWN, WEST SHAWA, WEST ETHIOPIA

A THESIS SUBMITTED TO JIMMA UNIVERSITY INSTITUTE OF HEALTH, FACULTY OF HEALTH SCIENCE, SCHOOL OF MEDICAL LABORATORY SCIENCE IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN MEDICAL PARASITOLOGY

BY

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JUNE 2022

JIMMA, ETHIOPIA

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ABSTRACT

***Background**: Soil-transmitted helminths (STHs) and Schistosoma mansoni (S. mansoni) are among the most common cause of human infections and are distributed throughout developing countries including Ethiopia. However, information is scarce on the current status of these infections to guide intervention in the study area.*

***Objective:** To determine the prevalence and associated risk factors of STHs and S. mansoni infections among communities along rivers in Gudar town from September to October 2021.*

***Methods:** A cross-sectional study was employed from September to October 2021 among communities along rivers in Gudar town, West Shawa, Ethiopia. A total of 279 study participants who fulfilled the inclusion criteria were sampled randomly. A structured questionnaire was used to collect data on the socio-demographic characteristics of the study participants, and associated factors of STHs and S. mansoni infections. For the quantification of STHs and S. mansoni eggs, the stool sample was processed using a single Kato-Katz technique. Data were entered into Epi-info and analyzed using SPSS. Binary logistic regression analysis was done and variables with a p-value ≤ 0.05 were considered statistically significant. Live snails collected in a plastic bucket containing water and weed were transported to the Ambo University for identification and determination of infection.*

***Results:** The overall prevalence of any STHs and S. mansoni was 59(21.2%), of which the prevalence of STHs and S. mansoni accounts for 54 (19.4%) and 10(3.6%), respectively. Among STHs, A. lumbricoides was the predominant parasite detected in 39(14%) followed by T. trichiura 13(4.7%) and hookworms 11(3.9%). Light intensity was found in the majority of study participants infected with STHs and S. mansoni. Having untrimmed fingernails, Lack of washing vegetables and fruit, and open defecation habit were significantly associated with STHs infection while swimming in the nearby river was significantly associated with S. mansoni. A few of the live snails collected were identified as B. pfeifferi and cercariae shading was not detected.*

***Conclusion and Recommendation:** This study showed 19.4 % of STHs and 3.6% of S. mansoni infections. So, case-by-case treatment is recommended to control morbidity associated with STHs and S. mansoni infections in the study area.*

***Keywords**: Prevalence, risk factors, Soil-transmitted helminths, S. mansoni, along rivers, Gudar town*

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LIST OF ABBREVIATIONS AND ACRONYMS

AOR	Adjusted Odds Ratio
COR	Crude Odds Ratio
CI	Confidence Interval
DALYs	Disability Adjusted Life years
EPG	Egg per Gram
MDA	Mass Drug Administration
SSA	Sub-Saharan Africa
STH	Soil-Transmitted Helminth
WHO	World Health Organization

ACKNOWLEDGMENTS

First and foremost, I want to thank Ambo University for sponsoring me and Jimma University for providing financial assistance to undertake this research.

Next, I would like to thank my Advisors, Mr. Tariku Belay and Prof. Zeleke Mekonnen for their helpful comments in the preparation and completion of this paper. My thanks also go to Mr. Mio Ayana and Mr. Gulumma Tadesse for material support.

Similarly, I want to thank the staff of the Medical Laboratory Sciences department at Ambo University, the Guder town Health office, study participants, and the data collectors.

Furthermore, I kindly thank all my friends who supported me in all aspects during the study period.

CHAPTER ONE

INTRODUCTION

1.1 Background

Helminth infections caused by soil-transmitted helminths (STHs) and schistosomes are among the most prevalent parasitic diseases affecting humans living in the developing countries(1). STHs infections are intestinal infections that are transmitted by contamination of soil with human excreta. Infection is caused by four main species of STHs such as *Ascaris lumbricoides* (*A. lumbricoides*), *Trichuris trichiura* (*T. trichiura*), and Hookworms (*Necator americanus* and *Ancylostoma duodenale*)(2,3). STHs infections are common in tropical and subtropical areas, particularly in places with inadequate sanitation and water supplies unsafe(4).

Humans get infected by these intestinal parasites after being exposed to eggs or larvae that hatch in the soil after being passed through feces. The infection can happen when contaminated hands or fingers are placed in the mouth, or while eating vegetables and fruits that have not been thoroughly cooked or washed. Hookworms lay their eggs in the soil and develop into larvae that may penetrate human skin. Hookworm infection is spread mostly by barefoot walking on contaminated soil(5).

Schistosomiasis is a parasitic trematode worm infection caused by the genus *Schistosoma*. It is caused by six species. These are *Schistosoma hematobium* (*S. hematobium*), *Schistosoma japonicum*, *Schistosoma mansoni* (*S. mansoni*), *Schistosoma mekongi*, *Schistosoma guineensis* and *Schistosoma intercalatum*. The most common causes of the disease are *S. mansoni* and *S. hematobium* (6).

Schistosomiasis occurs much more focally, and it is dependent on local environmental factors as well as the presence of water and snail intermediate hosts. Three of the most frequent freshwater snails involved in the transmission of human schistosomiasis are *Biomphalaria, Bulinus*, and *Oncomelania*. *Biomphalaria* species serve as the intermediate host for *S. mansoni*, which causes intestinal Schistosomiasis (7).

Intestinal schistosomiasis due to *S. mansoni* is endemic in sub-Saharan Africa (SSA)(8). In Ethiopia, the most common *Schistosoma* species is *S. mansoni*, which is transmitted by *Biomphalaria pfeifferi* and *Biomphalaria sudanica*. The former has a larger geographical area, whilst the latter is limited (9,10).

Infection is acquired when free-swimming parasitic larvae (cercariae) penetrate the skin of people exposed to contaminated fresh water. It penetrates the host's skin and transforms into schistosomula, which has evolved to exist in the body's higher osmotic environment. After 4 to 6 weeks of infection, the larvae migrate through the skin, blood, and lungs; the worms mature, descend to the liver, mate by paring in the mesenteric veins, and begin to oviposit, which are expelled in the urine or feces. In freshwater, the eggs hatch and release free-swimming miracidia, which infect a specific freshwater snail. Miracidia transform into sporocysts inside the snail, and free-swimming cercariae emerge after two rounds of asexual reproduction(6,11).

While the adult worms of all species reside within the blood vessels of the mammalian hosts, *S. hematobium* is responsible for urogenital schistosomiasis; the other species mainly affect the intestine and the liver. Female worms generate hundreds of eggs when they mate with males, which are expelled in the urine or feces. Others become lodged inside the body, causing damage to crucial organs. Schistosomiasis symptoms are caused by the body's reaction to the worms' eggs. There are two types of the disease: intestinal and urogenital. Diarrhea and blood in the stool are prominent symptoms of intestinal schistosomiasis; enlargement of the liver and spleen and portal hypertension are common in advanced cases(12).

STHs and schistosomiasis rarely cause death. The burden of disease is more related to the chronic and insidious effects on the hosts' health and nutritional status than mortality. Morbidity is directly related to worm burden: the more the number of worms present in an infected person, the more severe the disease. The severity of helminth infection can be determined directly by counting the number of expelled worms following anthelminthic treatment, or indirectly by measuring the number of helminth eggs expelled in stool represented as eggs per gram (EPG). Indirect methods are more appropriate, and more widely utilized than direct approaches(1).

STHs and schistosomiasis patients are diagnosed using a variety of techniques. These are based on a combination of clinical symptoms, history of residence in an endemic or non-endemic area, parasitological examinations, serological tests, and ultrasonography(13,14). Serological, immunological, imaging and molecular testing may be beneficial in demonstrating infection exposure and the necessity for a complete assessment and treatment for patients living in low-transmission areas. The Kato-Katz parasitological examination technique is widely used and recommended by the World Health Organization (WHO) for STH and schistosomiasis surveillance and monitoring (13,15).

For the prevention of morbidity associated with these infections, WHO recommends preventive chemotherapy consisting of periodic administration of anthelmintic drugs (Praziquantel for schistosomiasis and albendazole or mebendazole for STH)(16). The major goal is to keep infection levels low to reduce morbidity. Individual prevention involves health education aimed at promoting and reinforcing healthy behavior, access to clean water, and the creation of targeted snail control with molluscicides (17,18).

1.2 Statement of the problem

STHs and Schistosomiasis infections are closely linked to poverty; they result from poverty and markedly contribute to poverty by diminishing the work capacity, and agricultural productivity of adults, and effecting negative impacts on cognitive development and education(19).

According to a global atlas of helminthic diseases, 819 million people are infected with *A. lumbricoides,* 464 million with *T. trichiura,* and 438 million with hookworm. Hookworm is responsible for the majority (62%) of the 5.2 million disability-adjusted life years (DALYs) caused by STHs. Infections are widely distributed in tropical and subtropical countries(20). External environmental factors such as soil, lack of sanitary facilities, unsafe waste disposal system, inadequacy and lack of safe water supply, and human factors such as age, sex, socioeconomic position, and occupation all influence the geographical distribution of STHs(21).

Schistosomiasis is endemic in 70 developing countries, affecting around 200 million people (almost 90% of whom live in SSA), with 20 million of them suffering from severe disease. It is expected to result in 3.3 million DALYs (20). It is mostly linked to poverty, and efforts to alleviate poverty through the development of water-related projects are likely to hasten the spread of infection. Children, women, and farmers in poor rural communities who rely on water contact for recreational, domestic, or occupational purposes are disproportionately affected(22).

In Ethiopia, one-third of the population has *A. lumbricoides*, one-quarter has *T. trichiura,* and one in every eight people has hookworm, according to a systematic review and meta-analysis published in 2012. As a result, Ethiopia has the second-highest ascariasis, third-highest hookworm, and fourth-highest trichuriasis burdens in SSA. More than 5 million people are believed to be infected with schistosomiasis (*S. mansoni* and *S. hematobium*) and more than 37 million are at risk of infection, making the overall prevalence 25% (23). Intestinal schistosomiasis caused by *S. mansoni* infection is common in numerous parts of the country, with prevalence rates as high as 90% in some areas(24). Most of the studies conducted on STHs and *S. mansoni* infections measured the rate of infection in school children, although the epidemiology in the broader population has not been adequately described.

In the current study area, intestinal parasites are one of the top ten diseases affecting the communities (obtained from the health office). In Guder town, STHs and *S. mansoni* infections are documented according to the previous survey conducted (Tafese, unpublished data). The existence of rivers that may hold snail intermediate hosts and in which residents swim, open defecation near rivers, and contaminated drinking water may all contribute to the spread of STHs and *S. mansoni* infections in this area. However, information is scarce on the current status of these infections to guide intervention in the study area. Thus, this study aimed to assess the infection prevalence, intensity, and associated factors of Soil-transmitted helminths and *S. mansoni* among communities nearby rivers in Guder town, West Shewa, West Ethiopia.

1.3 Significance of the study

This study:

- ✓ Provides information about the prevalence, an average number of individual parasites, and associated risk factors of STHs and *S. mansoni* infections in the study area.
- ✓ Determine the existence of *Biomphalaria* species and identify the rivers that contain them.
- ✓ Could provide relevant information to local concerned bodies.
- ✓ The finding of this study will also be used as baseline or secondary data for those who are interested in carrying out further study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Prevalence of Soil-Transmitted Helminths and *S. mansoni* infections

A study in Myanmar found that 27.81 % of study participants had at least one type of STHs infection. The most common STH was *T. trichiura*, followed by hookworm and *A. lumbricoides*. *A. lumbricoides* and *T. trichiura* prevalence peaked in the 5–14 year old age range and declined as people got older. Hookworm prevalence, on the other hand, increased with age, peaking between the ages of 25 and 39. The prevalence of any STH infection was similar in males and females. Males and females had statistically significant differences in prevalence. The distribution of infection intensity among age groups closely resembles the prevalence. Between the ages of 5 and 14, the mean EPG of *T. trichiura* and *A. lumbricoides* increased and decreased in the older age groups. Hookworm intensity peaked in the 25–39 age group at 66.76 EPG (25).

The total prevalence of STHs infection was 59.9% according to a cross-sectional study conducted in Malaysia to give information on the patterns and associated risk factors of STHs infection across five Orang Asli subgroups. *T. trichiura* was the most common species (54.3%), followed by *A. lumbricoides* (26.7%) and hookworm (9.1 %). The prevalence of any STH species was higher in houses where there were no toilet facilities and people defecated anywhere. Except for *A. lumbricoides* infection, there was no significant difference in the prevalence of other STH species between males and females or between children and adults (26).

In a study of school children on the prevalence, the intensity of infection, and associated risk factors of intestinal schistosomiasis and geohelminths in Tanzania, the prevalence of *S. mansoni* was 63.91 %, with an overall intensity of 323.4 EPG. The overall prevalence of STHs was 6.73 %, with hookworms being the most common species (5.69 %). The majority of the children who were affected had a light to moderate infection(27).

A cross-sectional survey was conducted among primary school students in Oduma Community, Enugu State, Nigeria, to assess the pattern of Schistosomiasis and STH co-infection. The overall prevalence of at least one helminth infection was 58.1%. According to this study, *A. lumbricoides* (40.3 %) was the predominant STH, followed by *T. trichiura* (15.3%), hookworm (8.9%), and *S. mansoni* (7.2 %). *A. lumbricoides*, *T. trichiura*, and hookworm infections were most common in children aged 4 to 7. There were also reports of multiple infections, with 22.9% having double and 2.5% having triple infections (28).

According to a study carried out in Kenya, Overall, 12.9 % of people had STH, with 9.7 % having *A. lumbricoides*, 3.6% having *T. trichiura*, 1.0 % having hookworm, and 2.2 % having *S. mansoni*. According to multivariate analysis, the two most important indicators linked to STH infection were family size and not wearing shoes. However, no significant risk factors for schistosomiasis have been identified (29).

STHs and *S. mansoni* infections have been found in Ethiopia in a variety of epidemiological investigations, with varying levels of prevalence. In Tigray, a study of schoolchildren from families who used lands around long-term irrigation found an overall prevalence rate of 26.53% for intestinal parasites, with 5.95 % for *S. mansoni* infection. A total of eight helminth parasite species were identified, with *A. lumbricoides* accounting for the largest percentage (10.45%), followed by *E. vermicularis* (8.52%)(30). A study of the prevalence of intestinal helminths and risk factors among schoolchildren in the Enderta district found 23.9 % of *S. mansoni*(31).

A study in Addiremets, Western Tigray(32), found 26.3% of *S. mansoni* and hookworm 23.1%. The prevalence of intestinal parasites among females and males was 47.3% and 54.1% respectively. Another study, Prevalence of intestinal helminths and associated factors among school children in North Western Tigray, found that 12.7% of the children had intestinal helminths, with *S. mansoni* accounting for 4.9% of the total(33).

A survey conducted in the town of Libo-Kemkem district, northwest Ethiopia found that 27.9% of the study participants were infected with one or more parasites. With geometric mean egg counts per gram of 122, 1749, 582, and 13 correspondingly, *S. mansoni* was the most often (15.9%), followed by *A. lumbricoides* (11.0%), hookworms (8.2%), and *T. trichiura* (1.6%). Most of the double infections were a combination of *A. lumbricoides* and hookworms (3.6%). The average prevalence and egg count for each helminth were neither age nor sex-related. However, the intensity of *S. mansoni* by age group was statistically significant(34).

According to a study conducted in Chuahit, Dembia district, Northwest Ethiopia on the *S. mansoni* and STHs infection, the prevalence of overall intestinal helminths was reported to be 35.2%. *Ascaris lumbricoides* was the predominant species. The least parasites detected were Taenia species, 2 (0.5 %)(35).

There were also reports from the Southern part of Ethiopia, with varying levels of prevalence. In research conducted in the Wolaita district, the prevalence of *S. mansoni* infection was 58.6 %. The prevalence and severity of *S. mansoni* infections differed by gender. Hookworms (27.6%), *A. lumbricoides* (8.7%), *E. vermicularis* (2.8%), Taenia species (2.6%), *T. trichiura* (1.2%), and *H. nana* were among the other intestinal helminth species found (0.6%) (36).

Research done on the prevalence and intensity of STHs infection among a rural community in Southwest Ethiopia showed 70.3%. The females shared more as compared to males. Of all identified STHs, *T. trichiura* was the predominant infectious agent followed by *A. lumbricoides* and hookworm(37).

The prevalence of helminthiasis was 67.9% in a survey of school children living along the shores of Lake Hawassa. There were seven different forms of helminths found, with *A. lumbricoides* (44.4%) being the most prevalent, followed by *S. mansoni* (31%), *T. trichiura* (11%), and hookworms (7.7 %)(38).

Another study conducted in the Gurage zone showed the overall prevalence of STHs was 57 (9.5%). The most common helminth species found was hookworm (4.2%) followed by *A. lumbricoides* (3%). The prevalence of Taenia species, *T. trichiura*, *H. nana*, and *E. vermicularis* were; 1.2%, 0.5%, 0.7%, and 0.8% respectively. The prevalence of the STHs infection was low and all cases of STHs infections in this study were with low infection intensity(39).

Another study conducted on STHs and intestinal schistosomiasis in Ejaji, west Shewa showed the prevalence of 38.2% and 12.94%, respectively. Most of the children infected with the parasites had light infections (40). A study conducted among elementary school children in Ambo town, western Ethiopia found an overall prevalence of 12.6% STHs infection. The respective prevalence of major STHs is *A. lumbricoides* (7.8%), Hookworm (2.8%), and *T. trichiura* (2.2%). STH prevalence varies by age, sex, latrine use, family size, and nail trimming, according to the findings of this report (21).

2.2 Risk factors for soil-transmitted helminths and *S. mansoni* infections

2.2.1 Socio-Demographic Factors

A cross-sectional study conducted in Umolante district, South Ethiopia indicated that the highest proportion of the STHs and *S. mansoni* was found in the age group of 10-14 years old (41), but the study conducted in Tigray stated study participants in the age group of 10-14 were significantly associated with *S. mansoni* infection (31). According to a study conducted in Bench Maj, gender was significantly associated with STHs(37) while a study conducted in Wolaita indicated that the gender of the study participants was significantly associated with *S. mansoni* infection (42).

2.2.2 Risk Behavior and Practice

According to a study conducted in Malaysia, individuals walking barefoot were 1.8 times more likely to have STHs infection(26). A study conducted in Dembia district showed the habit of not washing hands after the toilet, and wearing shoes were significantly associated with a high prevalence of STHs infection (35). Also, a study conducted in Bench Maj(37) indicated, a lack of vegetables and fruit washing before consumption, and open defecation habit were significantly associated with STHs infection, While another did not (40,43). A study conducted in North-Western Tigray indicated that place of defecation, hand washing before a meal, hand washing after defecationand eating unwashed vegetables were statistically significant with the intestinal helminthic infections(33).

A study done in Ejaji indicated that having untrimmed fingernails was significantly associated with STHs infection (40). Regarding *S. mansoni*, the rate of infection was significantly higher among individuals who had swum and bathing practices in the nearby rivers (38,40). Also, a study in Tigray showed that study participants who worked in agricultural activities and crossed rivers were significantly associated with *S. mansoni* (31).

2.2.3 Environmental factors

According to a study conducted in Malaysia, households with no toilet facility were two times more likely to have STHs infection(26). People who have access to proper sanitation at home have a reduced risk of infection with *S. mansoni*, and STHs, whereas those who do not do so have a higher risk of infection with *S. mansoni*, and STHs (40). According to a study conducted in Bench Maj drinking unsafe water was significantly associated with STHs infection (37).

2.3 Conceptual framework

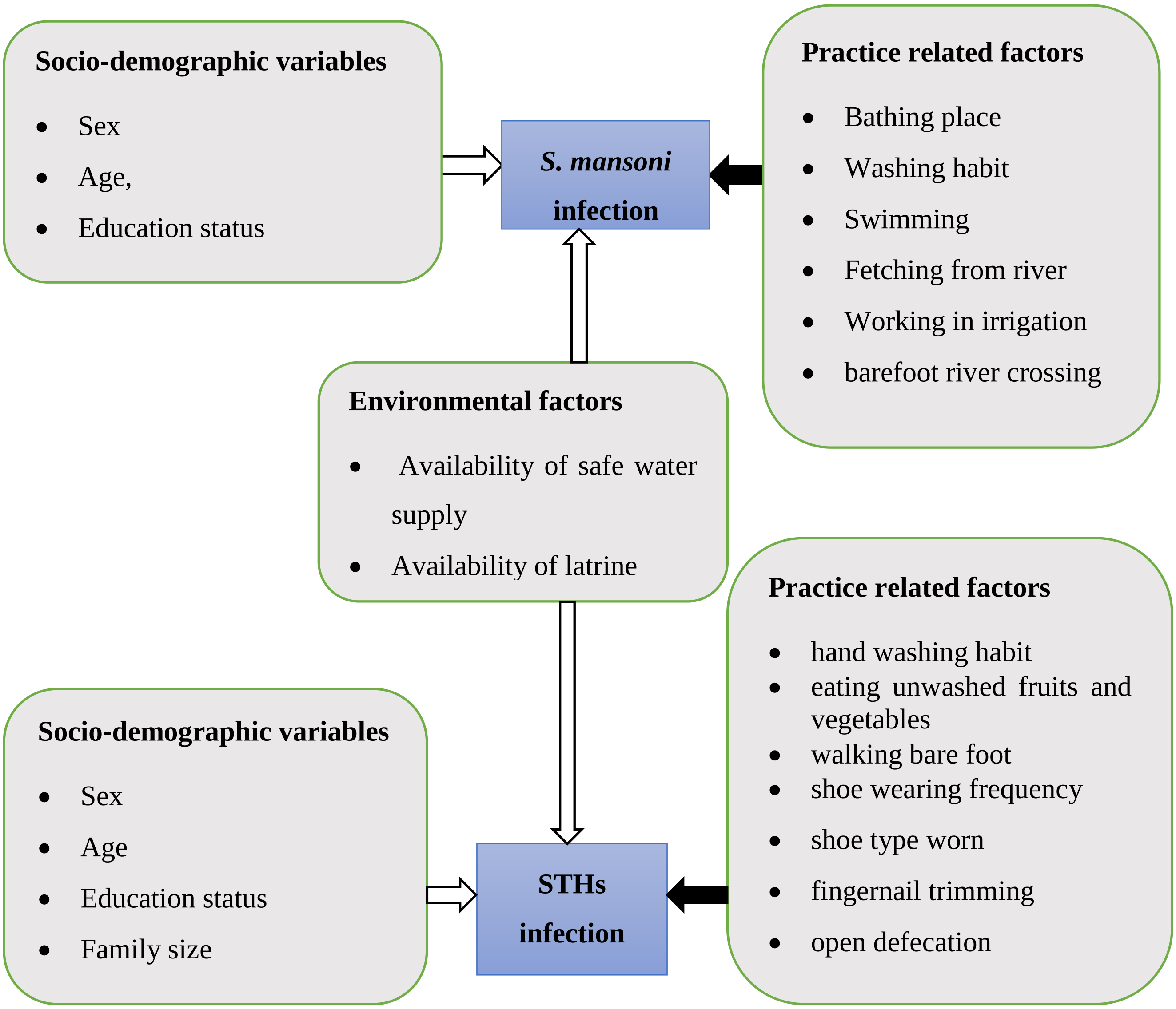

Figure 1: Conceptual framework showing the association between the dependent variables and independent variables

CHAPTER THREE

OBJECTIVES

3.1 General objective

To determine the prevalence, intensity, and associated risk factors of Soil-Transmitted Helminths and *Schistosoma mansoni* infections among communities along rivers in Gudar town, from September to October 2021.

3.2 Specific Objectives

- To determine the prevalence and intensity of Soil-Transmitted Helminths infection.
- To determine the prevalence and intensity of *Schistosoma mansoni* infection
- To identify risk factors associated with Soil-Transmitted Helminths.
- To identify risk factors associated with *Schistosoma mansoni* infections.
- To identify *Biomphalaria* species and assess the rate of species shading cercariae.

CHAPTER FOUR

METHODS AND MATERIALS

4.1 Study area

The study was conducted in Gudar town, the capital city of Toke Kutaye district, which was bordered on the west by Cheliya district, on the east by Ambo district, on the north by Midakegn district, and on the south by Tikur Inchini district. Gudar town is 126km from Addis Ababa, and 12 km from Ambo city.

The town has an altitude of 1850 m above sea level with an average annual temperature of 20.9°C, and total annual rainfall of 1,000 mm. Agriculture is the main occupation of the population of the area. Farmers at Gudar grow potatoes, onion and tomato, cabbage, garlic, sugarcane, and various tropical fruit trees using irrigation. Agricultural activities are mostly mixed, with livestock and crop cultivation occurring simultaneously.

Based on the information obtained from the health office, Gudar town has a total population of 22306 of whom 10,800 are men and 11,506 are women, and 4,647 households with an average family size of 4.8. In Gudar town, there are three main rivers (Chole, Gudar, and Indris) that flow persistently throughout the year. Residents living nearby these rivers were surveyed.

In Guder town, there are two villages (01 and 02). There are two elementary schools (Gudar primary school and Gudar catholic primary school), and one high school and preparatory (Gudar high school and preparatory school) in the town. Besides, the town has one governmental hospital, one health center, and four private clinics.

4.2 Study period

This study was conducted from September to October 2021 among communities along rivers in Gudar town, West Shawa, West Ethiopia.

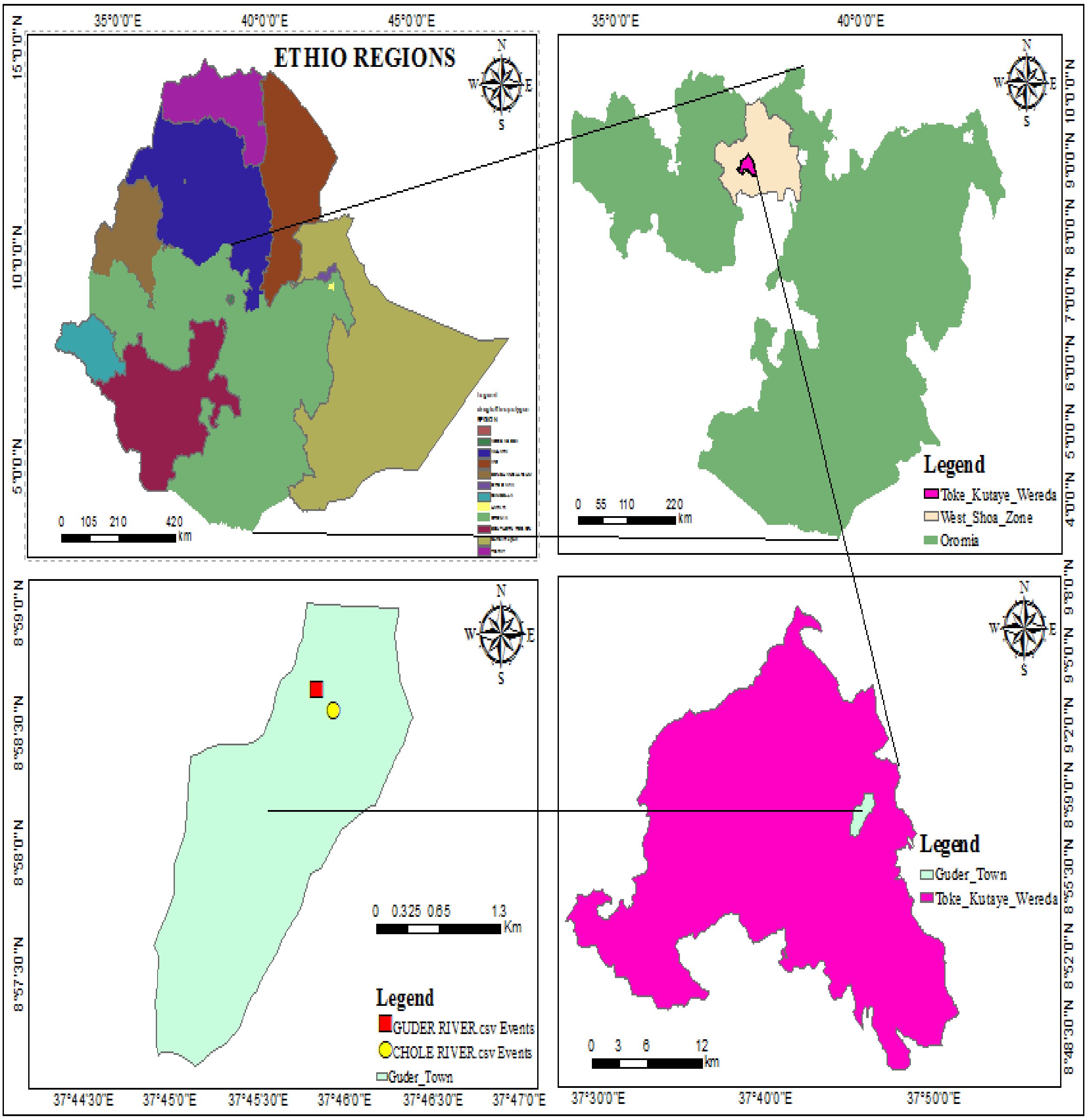

Figure 2: Map of Gudar town

4.3 Study design

A community-based cross-sectional study was conducted.

4.4 Population

4.4.1 Source population

All individuals who live nearby Chole, Indris, and Gudar rivers.

4.4.2 Study population

All individuals of the selected households near the Chole, Indris, and Gudar rivers.

4.4.3 Study unit

Individuals from the selected household who meet the inclusion requirements are chosen at random.

4.5 Eligibility criteria

4.5.1 Inclusion

Individuals above five years, who lived 6 months and above in the village and consented to participation and to provide specimens were enrolled in the study.

4.5.2 Exclusion criteria

Individuals who were on anthelminthic treatment in the last two months before screening, had watery diarrhea, were seriously ill, and cannot provide the required information.

4.6 Sample size determination and sampling technique

4.6.1 Sample size determination

The sample size was calculated using the single population proportion formula given by

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

Where n is the sample size, Z is statistics for the level of confidence, P is expected prevalence or proportion, and d - measures the Precision of the estimate.

we have used a P value of 23.9%(31), and a margin of error of 5% to calculate the sample size

$$n=\frac{(1.96)^2 \times (0.239 \times 0.761)}{(0.05)^2} = 279.$$

4.6.2 Sampling technique

The research took place in both villages (01 and 02). Of the total households 1162 (estimated total population of 5578) living along the three rivers, 639 households were from 02 villages and 523 households were from 01 (Information obtained using a survey). The sample size was proportionally allocated to the villages depending on the number of households nearby rivers. The sample sizes for villages 01 and 02 were 126 and 153, respectively. A systematic sampling technique was applied to select households in the town.

The number of households for this study was 279(279/1) (126 and 153 from 01 and 02 villages, respectively). Based on this, the ‘‘K” value became 4 (1162/279) and 279 individuals were selected. The first household was selected using a lottery method and every 4^{th} house number was included. In each household, one individual who fulfilled the inclusion criteria was recruited randomly. If no eligible candidate or volunteer is located in a chosen household, the next household was chosen, with the interval staying constant.

4.7 Methods of data collection

4.7.1 Demographic data

To collect sociodemographic information and risk factors, a pre-tested semi-structured questionnaire was used. The interview included information like age, sex, educational status, occupation, family size, source of drinking water, the existence of latrines in their compound, habits of latrine usage, hand washing habits, fingernail trimming, and yes or no questions for activities in the nearby rivers such as washing clothes, swimming, and bathing. The questionnaire was prepared originally in English and translated into the Afan Oromo (local language) (Annex III). Then, one trained clinical nurse and one laboratory technician interviewed the study participants and took the stool samples.

4.7.2 Collection and examination of stool specimen

Before the collection of stool specimens, the research benefits were explained to the study participants. Then each selected study participant was provided with a labeled clean stool cup with a piece of an applicator stick and a newspaper. The stool cup had a code number and the name of the study participant. This was to avoid the accidental exchange of specimens among study participants. The study participants were instructed that, once they go to the latrine, defecate on a piece of paper provided, to avoid contamination from the toilet environment, and then using an applicator stick they should pick up about 2 gm of the stool and put it into the clean plastic container provided and deliver it. Using the name written on the questionnaire with their corresponding code number, stool specimen was collected. The number on the container was compared with the number recorded when they were provided the container to check if it was the right container. The collected samples were then immediately sent to the nearest health center for slide preparation and hookworm examination, although *S. mansoni* and other helminths were examined after 24 hours.

4.7.2.2 Examination of stool specimens

The stool samples were processed by the single Kato Katz method using a template holding 41.7 mg of stool. Examination for hookworm was performed within 30-60 min of Kato Katz slide preparation. We left the slides for 24 hours to make it easier to visualize the eggs of *S. mansoni* and other helminths. Twenty-four hours later, two experienced laboratory technicians examined each slide individually, and finally, the results were checked by the principal investigator in the case where the results were discordant, and the results of the third expert reader were considered the final results. The infection intensity of the STHs and *S. mansoni* was estimated by multiplying the total number of eggs counted by 24, which gives the EPG of feces. In addition, the intensity of STHs and *S. mansoni* were classified as light, moderate, and heavy according to the intensity classes set by WHO (44). Finally, the results of the laboratory examination were recorded in a format prepared for this purpose.

4.7.3 Malacological Survey

In the study area, all the water contact sites where people used to collect water, wash clothes, bathe, and swim, cross the river were surveyed. A standard scoop net with a mesh size of 300 mm, that was supported by a metal frame (45) and handpicking with a glove was used to collect snails. The sampling time was set at 20 min per site.

4.7.3.1 Identification of Snails

After collection, the snails were transported to Ambo University, Biology department lab in an open plastic bucket with a small amount of water and weeds for identification and infection determination. The collected snails were identified to species level based on shell morphology before the infection is determined. After genus and species identification, snails were tested for *Schistosoma* cercariae shedding. Each species were placed in a separate glass beaker bearing labels showing the location of the collection; the name of the species and the date of collection. Ten snails were placed in each beaker at 500 ml capacity. One hundred (100 ml) of water were added before exposing them to sunlight for 30 minutes to facilitate the shedding of cercariae by the snails. Then, the water in the snail containers was examined for cercariae under a dissecting microscope(46,47).

4.8 Study variables

4.8.1 Dependent variables

Soil-transmitted helminths and *S. mansoni* infections.

4.8.2 Independent variables

Sex, age, educational level, family size, the household water source for domestic use, eating unwashed vegetables and fruits, handwashing habit, a habit of washing cloth in the river, swimming, frequency of shoe wearing, type of shoe worn, bathing place, latrine use, open defecation, fingernail trimming, fetching water, working in agricultural activities.

4.9 Operational term definition

Households nearby rivers: purposively selected households near the rivers at an estimated distance of less than 600m.

The intensity of *S. mansoni* was classified as light infection (1-99 EPG), moderate (100- 399 EPG), and heavy (greater than 400 EPG). Similarly, the classification for *A. lumbricoides*: light infection (1-4999 EPG), moderate (5000-49999 EPG) and heavy (greater than 50,000 EPG); *T. trichiura*: light infection (1-999 EPG), moderate (1000-9999 EPG), and heavy (greater than 10,000 EPG) and for hookworm: light infection (1-1999 EPG), moderate (2000-3999 EPG) and heavy (greater than 4,000 EPG) were made according to the standard(44).

4.10 Data Quality assurance

The training was given to the data collectors on the objective of the study and each item on the questionnaire. A pre-test was conducted to check the structure of our questionnaires on a small number of individuals (5%). Any error, incompleteness, and inaccuracy were corrected accordingly. For quality purposes, the proper Kato-Katz technique was prepared using a standard amount of reagents used for preparation and examined within a given time. The standard operating procedure was followed during specimen processing and diagnosis. Malachite green and microscope were checked by known positive and negative samples before sample preparation and examination. Medical laboratory technologists who were experienced in the kato-Katz technique processed and examined the samples and 10% of them were randomly selected every day and rechecked by a third person who was blind for the first examination result. Finally, the result of the laboratory examination was recorded in a well-prepared format carefully and it was attached to the questionnaire.

4.11 Data processing and analysis

The data were entered into Epi info version 7.2, cleaned, and imported to SPSS version 26 for statistical analysis. Descriptive analyses like frequency and mean were used to summarize the demographic characteristics of the study participants. Prevalence and intensity of the parasites were determined in percent and EPG of stool, respectively. The average EPG became calculated using an arithmetic mean. The intensity of the parasites was graded as low, moderate, and heavy infection intensity according to the WHO guideline (44). The association between STHs and *S. mansoni* infections and associated risk factors were statistically tested using binary logistic regression. Candidate variables for multivariable analysis were selected based on the p-value result during binary logistic regression ($P < 0.25$). Then, p-values ≤ 0.05 have been taken into consideration as statistically significant and the magnitude of association was measured using an adjusted odds ratio (AOR), at 95% CI. Finally, the findings of the result were presented using tables and graphs.

4.12 Ethical consideration

The Ethical clearance and letter of permission were obtained from the Institutional Review Board of Jimma University, and a supportive letter was obtained from Gudar Town Health Office. Moreover, informed written consent and assent form were obtained from the study participants after clarifying the importance of the study. The study participants were informed about the nature and aims of the study and were also informed that their participation was only voluntary. After permission was obtained, participants were interviewed and a stool sample was collected. Individuals who were positive for intestinal helminth infections were linked to the health center.

CHAPTER FIVE

RESULTS

5.1 Socio-demographic characteristics of the study participants

A total of 279 individuals participated in the study and provided a stool sample for parasitic examination. The age of the study participants ranged from 5 to 72 years old with a mean age of 18.29 years. Out of these, 165 (59.1 %) were females. The highest number of study participants were selected from 5-9 (30.8%) years and village 2(54.8%). Most of the study participants were a student (55.6%), enrolled in primary school (61.6%), and had 2-4 family sizes (49.1%) (table 1).

Table 1: Socio-demographic characteristics of communities along rivers in Gudar town, West Shawa, West Ethiopia, 2021.

Variables	Responses	Frequency (%)	Variables	Responses	Frequency (%)
Sex	Female	165(59.1)	Village	Village 1	126(45.2)
	Male	114(40.9)		Village 2	153(54.8)
Age in year	5-9	86(30.8)	Occupation	Unemployed	70(25.1)
	10-14	66(23.7)		Daily laborer	4(1.4)
	15-19	37(13.3)		Student	155(55.6)
	20-24	13(4.7)		Merchant	6(2.2)
	≥25	77(27.6)		Housewife	25(9.0)
Family size	2-4	137(49.1)		Farmer	4(1.4)
	5-6	112(40.1)		Employed	15(5.4)
	≥7	30(10.8)			
Educational status	Illiterate	67(24)			
	Primary	172(61.6)			
	Secondary	40(14.3)			

5.2 Study participants' responses to associated risk factors

Respondents who had untrimmed fingernails were 22.6%, 219(78.5%) had latrines and 60(21.5%) had open field defecation habits. The majority 221(79.2%) of the study participants used soap for handwashing after the toilet. The habit of always washing hands before a meal was practiced in 188 (67.4%) subjects. Respondents who used to wear shoes always and sometimes were; 81.7%, and 18.3%, respectively. Of the total respondents, 24.0% swim in rivers and 72.4% had contact with rivers while crossing barefoot (table 2).

Table 2: Study participants' responses to associated risk factors

Associated risk factors	**Responses**	**Frequency (%)**
Fingernail trimming	No	63(22.6%)
	Yes	216(77.4%)
Latrine availability	No	60(21.5%)
	Yes	219(78.5%)
Open defecation	No	219(78.5%)
	Yes	60(21.5%)
handwashing with soap after toilet	No	58(20.8%)
	Yes	221(79.2%)
Eat unwashed vegetables and fruits	No	167(59.9%)
	Yes	112(40.1%)
Frequency of hand washing before a meal	Sometimes	91(32.6%)
	Always	188(67.4%)
Bathing place	Home	191(68.5%)
	River	88(31.5%)
Washing clothes in the river	No	108(38.7%)
	Yes	171(61.3%)
Frequency of wearing shoe	Sometimes	51(18.3%)
	Always	228(81.7%)
Contact with river water	No	77(27.6%)
	Yes	202(72.4%)
Type of shoe	Closed	140(50.2%)
	Open	139(49.8%)
Swim in the river water	No	212(76.0%)
	Yes	67(24.0%)
using river water for household	No	203(72.8%)
	Yes	76(27.3%)
Habit of fetching water	No	220(78.9%)
	Yes	59(21.1%)

5.3 Prevalence of Soil-transmitted helminths and *Schistosoma mansoni* among communities along rivers in Gudar town, West Shawa, West Ethiopia, 2021

The overall prevalence of any helminth infection (STHs and *S. mansoni*) was 59(21.2%), of which STHs and *S. mansoni* account for 54 (19.4%) and 10(3.6%), respectively. Regarding STHs, *A. lumbricoides* was the predominant parasite detected in 39(14%) followed by *T. trichiura* 13(4.7%) and hookworms 11(3.9%). The prevalence of STHs and *S. mansoni* co-infection was 4 (1.43%). Other intestinal parasites identified were *H. nana* 6(2.2%), *Taenia* species 2(0.7%), and *E. vermicularis* 1(0.4%). *A. lumbricoides* and hookworm combination was the dominant recorded co-infection in 6/279(2.2%) followed by a co-infection of *S. mansoni* and *A. lumbricoides* in 3/279(1.1%). Of the total study participants, 46 (16.5%), 12 (4.3%), and 1 (0.4%) were infected with single, double, and triple infections respectively (Figure 7).

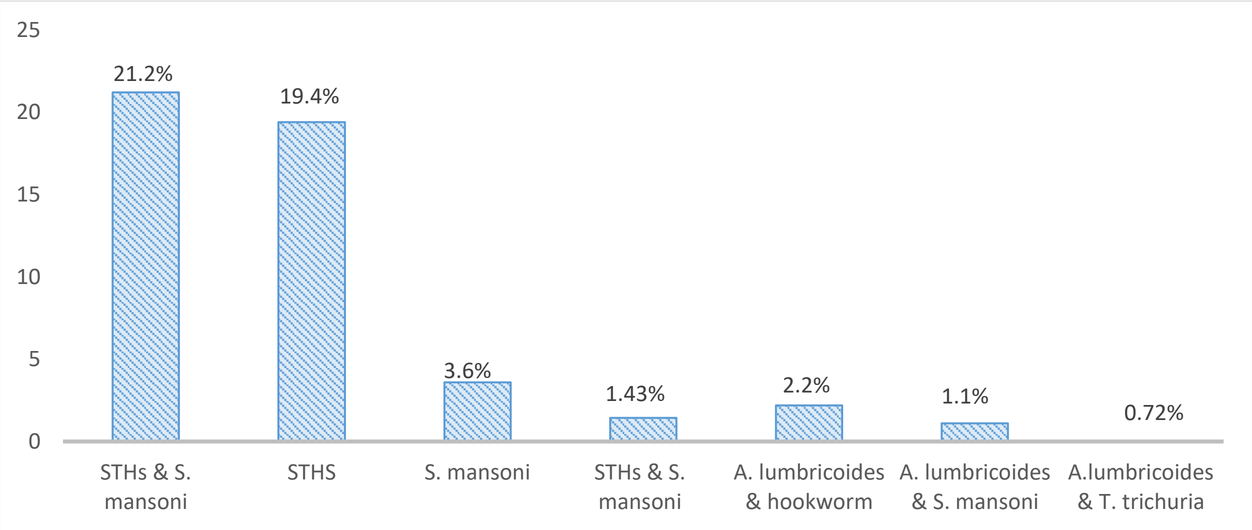

Figure 3: prevalence of Soil-transmitted helminths and *Schistosoma mansoni* infections among communities along rivers in Gudar town, West Shawa, 2021.

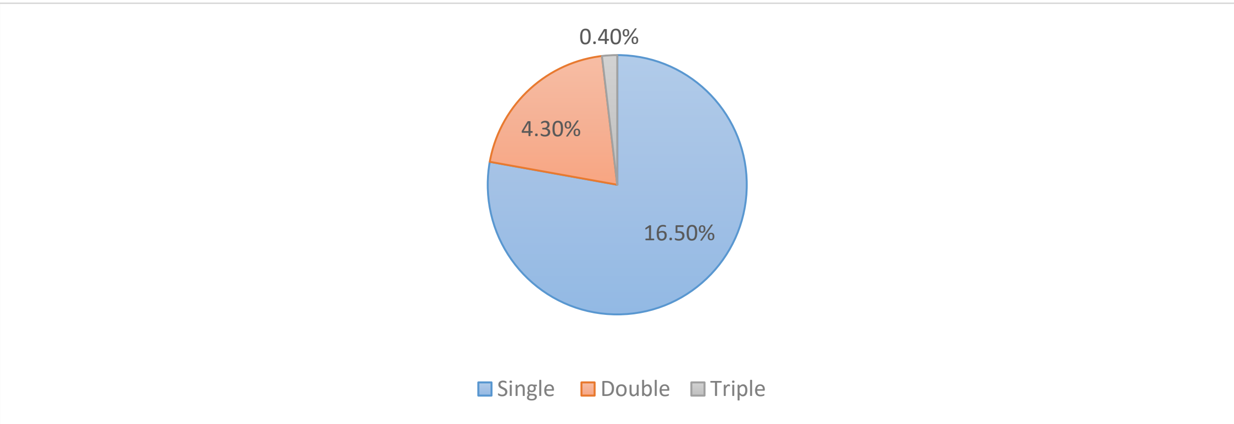

Figure 4: prevalence of single, double, and triple intestinal helminths infection

5.4 Infection intensity of Soil-Transmitted Helminths and *Schistosoma mansoni*

Out of 39 *A. lumbricoides* positives, light infection was observed in 26(66.7%) and moderate infection in 13(33.3%). Out of 11 hookworm positive samples, light infection was observed in 10(90%) and for *T. trichiura* all of the cases were light. out of 11 *S. mansoni* positive samples, light infection was observed in 9(90%) and moderate infection in 1(10%). Arithmetic mean among the study participants for *S. mansoni*, *A. lumbricoides*, hookworms, and *T. trichiura*, was 67.2, 3457, 547.6, and 90.46 EPG respectively (table 3).

Table 3: Intensity of soil-transmitted helminths and *Schistosoma mansoni* infections

Intestinal Parasite	Arithmetic mean	Class of infection intensity	
		Light	Moderate
S. mansoni	67.2	9(90%)	1(10%)
A. lumbricoides	3457	26(66.7%)	13(33.3%)
Hookworm	547.6	10(90%)	1(10%)
T. trichiura	90.46	13(100%)	0

5.5 Associated risk factors for soil-transmitted helminths and *Schistosoma mansoni* infections

5.5.1. Risk Factors associated with Soil-Transmitted Helminths infection

Having untrimmed fingernails, the habit of eating unwashed vegetables and fruits, and open defecation were identified as risk factors for the acquisition of STHs. Study participants with the untrimmed fingernails were about five times more likely to be infected by STHs than those who had trimmed fingernails [AOR: 5.0(95% CI: 1.9, 13.8)], and study participants who had a lack of washing vegetables and fruits [AOR: 13.8 (95% CI: 5.7, 33)] were more likely to acquire the infection. Infection by STHs was 2.5 times more likely to happen in those who had open defecation [(AOR= 2.5 (1.0, 5.9)] (Table 4)..

Other variables such as age, sex, education status, occupation, family size, handwashing habit, shoe-wearing frequency, latrine use, shoe type worn, and using river water for domestic purposes had no statistically significant association with STHs infections (Table 4).

Table 4: Association between Soil-Transmitted Helminths infection and risk factors among communities along rivers in Gudar town, West Shawa, West Ethiopia 2021.

Risk factors		No (%) STHs positive		COR(95 % CI)	p-value	AOR(95 % CI)	P-value
		Yes	No				
Age groups	5-9	20(23.3)	66(76.7)	1.5(.674, 3.2)	.334		
	10-14	14(21.2)	52(78.8)	1.3(.564, 3.02)	.535		
	15-19	6(16.2)	31(83.8)	.94 (.331, 2.75)	.906		
	20-24	1(7.7)	13(92.3)	.37(.049, 3.4)	.362		
	≥25	13(16.9)	63(83.1)	1(ref.)			
Sex	Male	31(27.2)	83(72.8)	2.3(1.26, 4.22)	.007	.56(.26, 1.2)	.142
	Female	23(13.9)	142(86.1)	1(ref.)		1(ref.)	
occupation	Daily laborer	1(25)	3(75)	2.2(.12, 11.58)	.662		
	Unemployed	11(15.9)	58(84.1)	1.23(.20, 5.37)	.960		
	Farmer	1(25)	3(75)	2.2(.12, 11.58)	.662		
	housewife	5(20)	20(80)	1.63(.208, 7.5)	.807		
	Merchant	1(20)	4(80)	1.63(.058, 8.2)	.814		
	Student	33(21)	124(79)	1.73(.31, 6.93)	.631		
	employed	2(13.3)	13(86.7)	1(ref.)			
Education	non enrolled	11(16.2)	57(83.8)	.93(.327, 2.6)	.885		
	primary	36(21.2)	134(78.8)	1.25(.51, 3.05)	.628		
	secondary	7(17.1)	34(82.9)	1(ref.)			
Fingernail trimmed	No	30(47.6)	33(52.4)	7.3(3.8, 13.95)	.000	5(1.9, 13.8)	**.001***
	Yes	24(11.1)	192(88.9)	1(ref.)		1(ref.)	
Family size	2-4	29(21.2)	108(78.8)	1(ref.)			
	5-6	21(18.8)	91(81.2)	.86(.46, 1.6)	.636		
	≥7	4(13.3)	26(86.7)	.57(.19,1.77)	.334		
Latrine use	No	19(31.7)	41(68.3)	2.4(1.27, 4.7)	**.008**	1.6(.73, 2.8)	.088
	Yes	35(16)	184(84)	1(ref.)		1(ref.)	

Open defecation	Yes	22(36.7)	38(63.3)	3.4(1.78, 6.5)	**.000**	2.5(1.0, 5.9)	**.016***
	No	32(14.6)	187(85.4)	1(ref.)		1(ref.)	
hand wash using soap	No	20(34.5)	38(63.5)	.89(1.5, 5.56)	.001	.9(.35, 2.37)	.849
	Yes	34(15.4)	187(84.6)	1(ref.)		1(ref.)	
unwashed vegetables	Yes	47(42)	65(58)	16.5(7.1,38.5)	**.000**	13(5.7, 33)	**.000***
	No	7(4.2)	160(95.8)	1(ref.)		1(ref.)	
hand wash before meal	sometime	36(39.6)	55(59.4)	6.2(3.3,11.75)	**.000**	.68(.28 ,1.7)	.403
	Always	18(9.6)	170(90.4)	1(ref.)		1(ref.)	
wearing	sometime	18(35.3)	33(64.7)	2.9(1.48,5.72)	**.002**	1.2(.39, 3.6)	.752
Shoe	Always	36(15.9)	192(84.1)	1(ref.)		1(ref.)	
shoe type	Open	31(22.3)	108(77.7)	1.46(.8,1.3)	**.216**	1.3(.56, 2.9)	.570
worn	Closed	23(16.4)	117(83.6)	1(ref.)		1(ref.)	
Using river water	Yes	18(23.7)	58(76.3)	1.44(.76,2.7)	.264		
	No	36(17.7)	167(82.3)	1(ref.)			

***** Statistically significant at $p < 0.05$ in multivariate logistic regression analysis

5.5.2. Risk factors associated with *Schistosoma mansoni* infection

Male study participants had higher *S. mansoni* prevalence than female study participants. The highest proportion of *S. mansoni* was observed among the 10 - 14 years old study participants (7.6 %%). The swimming habit of the study participants in the rivers was statistically significant with *S. mansoni* infection. Study participants with the habit of swimming in the rivers were more likely to be infected by *S. mansoni* than those who hadn't a habit of swimming in river water [AOR=6.69 (95% CI: 1.5, 26.02)] (table 5).

Other variables such as age, sex, education status, working in agricultural activities, fetching water from rivers, bathing place, washing clothes in the river, crossing rivers barefoot**,** and using river water for domestic purposes had no significant association with *S. mansoni*.

Table 5: Association between *Schistosoma mansoni* infection and risk factors among communities along rivers in Gudar town, West Shawa, West Ethiopia, 2021.

Risk factors		No (%) *S. mansoni* Pos	Neg	COR(95 % CI)	P-value	AOR(95 % CI)	P-value
Age groups	5-9	2 (2.3)	84(97.7)	1.78(.159, 12)	.639		
	10-14	5(7.6)	61(92.4)	6.15(.67, 14)	.101		
	15-19	1(2.7)	36(97.3)	2.1(.13, 11.3)	.607		
	20-24	1(7.1)	13(92.9)	5.77(.34, 18)	.225		
	≥25	1(1.3)	75(98.7)	1(ref.)			
Sex	Male	5(4.4)	109(95.6)	1.47(.42, 5.2)	.552		
	Female	5(3)	160(97)	1(ref.)			
Working in agriculture	Yes	1(2.0)	48(98%)	.5 (.34, 4.13)	.530		
	No	9(3.9)	221(96.1)	1(ref.)			
Education	Non enrolled	1(1.5)	67(98.5)	.597(.21, 6.9)	.718		
	Primary	8(4.7)	162(95.3)	1.98 (.24, 2.6)	.527		
	secondary	1(2.4)	40(97.6)	1(ref.)			
Fetching water	Yes	4(6.8)	55(93.2)	2.59(.70, 9.5)	**.151**	1.55(.33, 7.3)	.582
	No	6(2.7)	214(97.3)	1(ref.)		1(ref.)	
Bathing place	River	7(8)	81(92)	5.42(1.4, 21.5)	.016	3.5(.76, 16.1)	.107
	Home	3(1.6)	188(98.4)	1(ref.)		1(ref.)	
Washing clothes	Yes	8(4.7)	163(95.3)	2.6(.542, 12.5)	**.232**	1.94(.31, 12)	.483
	No	2(1.9)	106(98.1)	1(ref.)		1(ref.)	
Swimming in river	Yes	7(10.4)	60(89.6)	8.13(2, 32.3)	**.003**	6.69(1.5, 26)	**.012***
	No	3(1.4)	209(98.6)	1(ref.)		1(ref.)	
crossing rivers barefoot	Yes	9(4.5)	193(95.5)	3.54(.44, 28.5)	**.234**	1.6 (.05, 8.4)	.716
	No	1(1.3)	76(98.7)	1(ref.)		1(ref.)	
Using river water	Yes	5(6.6)	71(93.4)	2.8(.784, 9.92)	**.113**	1.7(.38, 7.8)	.482
	No	5(2.5)	198(97.5)	1(ref.)		1(ref.)	

* Statistically significant at $p < \mathbf{0.05}$ in multivariate logistic regression analysis

5.6 Malacological survey

Snail collection has been carried out for identifying *Biomphalaria* species and water bodies that are transmission sites for schistosomiasis. Snails were collected by scooping method and handpicking with gloves. Identified mollusks were *Biomphalaria* and *Physa* species. Based on shell morphology, 4% (12/ 300) of the live snails collected were identified as *B. pfeifferi*. *Biomphalaria* species shading cercariae was not detected. It was observed that Chole River 9/300(3%) was more infested with *B. pfeifferi* compared to Guder River. No *B. Pfeifferi* was collected from the Indris River.

During the snail survey, the physical characteristics of the rivers revealed that the water was turbid. It has a low volume and speed throughout the dry season but increases its volume and speed after that. Human activities such as swimming, bathing, irrigation, washing clothes, and fetching water for other uses were seen along the rivers during the malacology survey. There was grass in the surrounding areas. Around these rivers, there were also human behaviors such as open defecation and urination. Ecological observations near the "Chole" stream revealed that the stream is suitable for the existence of snail intermediate hosts. The slow flow of the stream, muddy or swampy nature together with the wide coverage of aquatic weeds along the stream are ideal ecological conditions for the snail species.

CHAPTER SIX

DISCUSSION

The study determined the prevalence, intensity, and associated risk factors of STHs, and *S. mansoni* infections among communities in the Gudar town along the Chole, Indris, and Guder Rivers, as well as a Malacological survey. The town's topography depicts a land with streams and rivers, which are frequently used for domestic and other uses by the town's population. There are bushes and weeds around the rivers, in which some people defecate openly. So, residents living along these rivers are more susceptible to STHs and *S. mansoni* infections while washing, playing, walking, fetching, swimming, and crossing rivers.

The overall prevalence of any STHs in the study area was 19.4%, which is low according to the WHO guideline(44). This low prevalence could be due to ecological factors limiting STHs infective stages dispersion and development, such as soil Physico-chemical properties(48). This low prevalence of STHs is comparable to studies conducted in Ukara Island, North-Western Tanzania (6.73%)(27), rural setting of Busia County, Western Kenya (12.9%)(29), Ambo town, western Ethiopia (12.4%)(49), Gurage zone, and South Central Ethiopia (9.5%)(39). In contrast, reports from Nigeria (64.5%)(28), Myanmar (27.81%)(25), Malaysia(59.9%), and other parts of Ethiopia like Wondo Genet (54.7%)(50), Bench Maj (70.3%)(37), Dembia district, Northwest Ethiopia (23.1%)(35), Hawassa (52.4%)(38) and West Shewa, Ejaji (38.2%)(40), showed moderate and high prevalence. These differences could be due to geographical variations, soil moisture, and relative humidity, and as well might be sociodemographic and socioeconomic differences.

The most common STH found in the study area was *A. lumbricoides*, which accounted for 39(14%). This could be because *A. lumbricoides* eggs are less affected by extreme environmental circumstances and can survive for several months in the soil after aestivation, allowing them to survive in unusual and harsh weather conditions such as excessively hot and dry weather (51). This finding is related to the number of investigations (28,35,38,50). In contrast to research from Nigeria(40.3%), Southern Ethiopia (45%), and Hawassa (44.4%)(28,38,50), the current study found a lower prevalence of *A. lumbricoides*. The prevalence of *T. trichiura* infection found in this study was higher than that seen in studies conducted in Ambo town(49) and Gurage (39). In addition, the prevalence of hookworm and *T. trichiura* was higher in this study than in a report from Dembia district (35).

According to our study findings, STHs infection was higher in those study participants in the age group of 5-9 years old and males. This could be due to younger children having poor personal hygiene since they play in the dirt soil, eat without washing their hands, and put their fingers in their mouths(52). Similarly, reports from Bench Maj (37) and Addiremets, western Tigray(32) revealed that intestinal parasites were more prevalent in younger children and males.

In this study, the overall prevalence of *S. mansoni* observed was 3.6%, which is low according to WHO(44). This low prevalence could be attributed to the low presence of snail intermediate host and environmental factors that favor snail dispersion in the area. This study agrees with those in Nigeria (7.2%)(28), Kenya (2.2%)(29), Babile town, with a prevalence of 4.3%(53), 4.9% from north Western Tigray(33), and Ambo town, Western Ethiopia (0.9%)(49), all of which had low prevalence. Even though the prevalence of these studies is low according to the WHO, they differ in their prevalence.

In contrast, the present study was low compared to the prevalence of 12.94% from Ejaji district, Western Ethiopia (40), 11.2% from Dembia district Northwest Ethiopia (35), and 11.8% from Kenya(54). This variation could be due to water source expansion in those areas, water contact behavior of study participants, differences in climatic conditions of the area, awareness of the study participants, and the presence of fast-running rivers (in the present area) leading to low availability of vector snails, which prefer slow-moving water bodies(55).

Polyparasitosis was also identified in the study participants, with a prevalence of 4.3% (12/279). The most frequently encountered parasites combination was *A. lumbricoides* and hookworm, which accounted for 2.2% (6/279). This might be due to an exposure individual to an area where a high contamination rate of the two parasites exists such as sandy soil(48). This is consistent with a study conducted in Libo-Kemkem District, Northwest Ethiopia(34) and Jimma(56).

The severity of infection in STHs and *S. mansoni* is associated with morbidity. The current study showed that the majority of the intensity of STHs was under the category of light infection 49(78%). No heavy infection in any of the STHs and *S. mansoni* was observed.

This finding was consistent with prior studies, which found that most people infected with STHs generally discharge a small number of eggs (27,37). The result of this study was not in line with the result of the rural Malaysian community(26) where *T. trichiura* and *A. lumbricoides* were heavily infected. However, a study in the Gurage zone (39) found that all of the cases had light intensity. This might be due to the MDA program in the area. The majority of those infected with *S. mansoni* in the current study had light intensities, which is similar to the study reported from Chuahit, Dembia district (35), and southern Ethiopia (50).

Factors like poor personal hygiene, family size, poor latrine usage, and source of drinking water as well as the absence of latrine could also contribute to the differences in the prevalence and distribution of these helminths. In the present study, risk factors such as open defecation habits, having untrimmed fingernails during data collection, and eating unwashed vegetables and fruit habits of the study participants were associated with STHs infection. Despite the high coverage of latrines among the studied community; open field defecation was 21.9%. The prevalence of STHs was significantly higher in those who defecate openly than in those who use a latrine. This could be because persons who defecate somewhere other than a latrine are more likely to take up the parasites while touching the ground or soil contaminated with these parasites(57). This was consistent with a study conducted in Bench Maj(37) and Hawassa(38). However, it is different from the study done in Lumame town (43). This difference may be due to the handwashing habit of the individuals after visiting those defecation sites.

This study also showed that individuals with untrimmed fingernails were five times more likely to have STHs infection. This might be due to the dirt under fingernails could harbor different stages of parasites, which can be ingested during nail-biting or thumb-sucking (58,59). This is in line with the finding of research conducted in Lumame town (43). The prevalence of STHs in the study area was also facilitated by the eating of unwashed vegetables and fruit behavior of the study participants. This study found that individuals who did not eat washed vegetables and fruits had a greater prevalence. This could be because unwashed vegetables and fruits can harbor the parasite's infective stage. This was similar to the study done in the Bench Maj (37), Lumame(43), and Tigray(33).

The study participants aged 10-14 years old had a higher proportion of *S. mansoni* infection. This could be because children in this age group appear to be at the greatest risk as a consequence of playing and swimming in water(24). This finding is consistent with a study conducted in Umolante district (41) and Hawassa(38). Swimming in the river was statistically associated with *S. mansoni* infection in the present study. This indicated comparable results with the results from the Ejaji (40) and Hawassa (38) which indicated swimming habit was a risk factor for *S. mansoni* infection.

Snail collection was done to identify *Biomphalaria* species and cercariae shading of Biomphalaria species. Using the morphological identification method, 12/300(4 %) of the snails collected were putatively identified as *B. pfeifferi*, while 288/300(96%) were identified as Physa species. During the study period, no *B. sudanica* was found. This could be due to the restricted geographic distribution of *B. sudanica* in Ethiopia(9). In comparison to the Malacological survey undertaken in Addiremets town, western Tigray, Ethiopia (32), Wolaita zone, Southern Ethiopia(42), and Jimma town(60), only a few *B. pfeifferi* were detected in those surveyed rivers. This variation could be attributable to local environmental and biotic factors that influence freshwater snail occurrence and abundance(9,10).

In the current study, the prevalence of *Schistosoma* infection in *B. pfeifferi* was 0.0%. This absence of infected snails may be linked with snail age, pre-patent phase, water temperature, immune system status, and seasonality of *Schistosoma* species infection (61). This finding is in line with a study conducted in Northwestern Angola 0.0 %(45), Gombe 0.0 %(47), Addiremets town, Ethiopia, 0.0 %(21), and Wolaita Zone, Southern Ethiopia 0.0 %(27).

On the other hand, there are reports of snails shedding cercariae finding from a study conducted in western Tanzania 12.3% (47), Niger River Valley West Africa 3.45% (39), Kisumu City, western Kenya 1.6% (42), Sanja, Northwest Ethiopia, 16.9% and 0.027% during February and April, respectively (29), Omo Gibe River Basin, southwest Ethiopia, 4.6%(44), Hayk town, northeastern Ethiopia, 3.2%(34). The reason for finding infected snails in these study areas in contrast to the current study could be environmental climatic and sociological patterns can contribute to variation in the prevalence of infection of snails(61).

6.1 Limitation

The limitation of this study was that the physicochemical characteristics of the water bodies for the determination of different parameters that determine the distribution of snail intermediate host were not done.

CHAPTER SEVEN

CONCLUSION AND RECOMMENDATION

7.1. Conclusion

This finding showed 19.4% of STHs and 3.6% of *S. mansoni* infections. Majority of the cases had light intensity. Even though the majority of infection was light, the reported polyparasitism may cause various health problems. This finding also showed untrimmed fingernails, the habit of eating unwashed vegetables and fruits, and open defecation was significantly associated with STHs infection while swimming in the rivers was significantly associated with *S. mansoni* infection.

7.2. Recommendations

Based on the findings of the current study, it is recommended that

- Selective treatment (case-by-case treatment) for STHs and targeted treatment for school-age children twice during primary schooling for *S. mansoni* can manage the consequences of the infection to the level that they are no longer a public health burden.
- Even though STHs and *S. mansoni* infections are not a major public health concern, there is a need to impact the factors associated with the parasite's occurrence to maintain the parasite's low prevalence in the future.
- Increasing community knowledge of latrine usage to prevent open field defecation habits.
- Further studies should be conducted to address factors other than the factors addressed by this study.

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ANNEXES

Annex I: Information Sheet (English version)

Title of the research: Prevalence and risk factors of soil-transmitted helminths and *Schistosoma mansoni* infections among communities along rivers in Gudar town, West Shawa, West Ethiopia.

Name of the organization: Jimma University Institute of Health, Faculty of Health Sciences School of Medical Laboratory Sciences

Principal Investigator: Mulugeta Getachew

Mobile no: 0908324401

Supervisor: Mr. Tariku Belay

Mobile no: 0911663731

Introduction: This information sheet is prepared to explain the research that you are asked to participate in.

Purpose: The purpose of this research is to assess the prevalence, intensity, and risk factors of soil-transmitted helminths and *S.mansoni*. STHs and *S.mansoni* result in significant morbidity and socio-economic burden in Ethiopia. Some epidemiological studies have been conducted in Ethiopia, however, no documented study among individuals living near rivers in the study area. Thus, considering this, we have planned to undertake this research.

Procedure: We kindly invite you to take part in this project which is aimed at determining the magnitude of STHs and *S. mansoni* infections, and associated risk factors. If you are willing to participate in this project, you need to understand and sign the agreement form. For laboratory examination, you will provide a stool sample. If the result of the laboratory examination shows positive, we will link you to the nearest health facility for the management of the case.

Benefits: If you participate in this research, you may get the direct benefit that the test result will be used for the management of your health. Besides, your participation will help us in studying the magnitude of the infection in the area, which is an input for national STHs and *S.mansoni* control activities being carried out.

Confidentiality: The information that we collect from you will be kept confidential except for the health professional and principal investigator. There will be no information that identifies you. The findings of the result will be generalized and not reflect any individual. The questionnaires will be coded and unnamed.

Right to refuse or withdraw: You have full right to participate or not participate. If you decide to participate you have the right to withdraw from the study at any time and this will not label you for any loss of benefits to which you are otherwise entitled. You do not have to answer any question that you do not want to answer.

If you are willing to participate, didn't treat before 2 months for these intestinal parasites, if you are above five years old, and lived there for more than six months you will be requested to give single fresh stool samples of about 2 gm. This information sheet's copy will be given to each participant. Finally, I would like to thank you for taking the time to hear the information given and being willing to participate.

Contact address: If you have any questions regarding the study or procedures, please contact any of the following addresses:

Mulugeta Getachew: Telephone no- 0908324401

Mr. Tariku Belay: Telephone no: 0911663731

Guca odeeffannoo (Afaan oromoo)

Gucni kun kan guutamu warren qo'annaa irratti fedhiin hirmaataniif kan ooluu fi haallii qo'annaa sirritti erga ibsameefii booda kan guutamufi kan mallattaa'udha.

Mata-duree qo'annaa:-Qorannon kun ilbisoota biyyoo fi bishaan qulqullina hin qabne irraa gara namatti daddarban Lixa Itoopiyaa, Godina Shawaa lixaa, magaalaa Gudariitti hojjatama. **Maqaan qorataa**:-Mulugeetaa Geetaachoo

Lak.bilbilaa:- 0908324401

Too'ataa: Taarikuu Belaay

Lak.bilbilaa : 0911663731

Dhimmi-qo'anichaa:-ilbisoonni biyyoo fi bishaan qulqullina hin qabne irraa gara namatti daddarban dhibeewwan addunyaa guututti tatamsa'aniif miidhaafi du'aatii guddo dhaqqabsiisan keessa isaan tokkoodha. Ilbisoonni kun dhibee garaa , hir'ina dhiigaa fi kkf nama irra qaqqabsa. Qorannoon ilbisoota kana kan gaggeeffamu booliin nama fudhatameeti. **Haala adeemsa qo'annichaa**: - qo'annaa irratti fedhiin hirmaachuu keessan mallattoo keessaniin nuuf ibsitaaniif ragaalee armaan gadii kanneen nuuf kennitan. Gaaffiilee afaaniitiif daqiiqaa muraasaaf waliin turra, Boolii qorannof gahaa ta'e ni fudhanna. Qorannoon laaboraatoorii yuuniversitii Ambootti hojjatama. Wantootni armaan olii Kun qorannoof kan barbaachisan tahu ni ibsina.

Sodaa fi miidhaa qabu:-Qorannoo kana keessatti hirmaachu keessan irran kan ka'e rakkinni kamiiyyuu isin irra hin qaqqabu. Faayida qo'anniichaa fi kafaaltii hirmaataaf godhamu-qorannoo irratti hirmaachuun kafaltii kan hin qabnee fi bu'aa qorannoo irratti hunda'uudhaan namootni haala fayyaa isaanii kan beekaniif ilbisooni eeraman kun boolii isaanii kessatti yoo argaman qorichi bu'uura qajeelfama yaala farra raammoo biyyoolessaa irratti hunda'uun dhaabbilee fayyaa dhiyeenya jiraniin ni kennam.

Iccitii hirmaataa eeguu-wantootni qorannoo irraa argaman hundinuu icciitiin kan eeggamaniifi ragaaleen argaman hundinuu maqaa keessaniin osoo hin tahiin lakkoofsa addaatiin/koodiin kan beekkamaniifi odeeffannoon hundinuu iccitiidhan warra ragaa funaanan biratti kan hafu tahuu isaa isiiniif ibsina.

Mirga fedhaan hirmaachuuf dhiisuu- qorannoo irratti hirmaachuun fedhii kee qofa tahuu isaa beektee, yeroo barbaaddeettii qorannoo keessaa bahuu kan dandeessuu fi yeroo keessaa baatulee rakkoo tokkoo kan sirratti hin fidnee fi tajaajila argachuu qabdu hundumaa argachuu kan dandeessu tahuusaa. Egan yoo hirmaachuuf walii galtan ji’a laman darban keessatti qorichoota farra ilbisoota kanaa yoo hin fudhanne ta’e, umuriin kee waggaa shan olii fi naannoo kana ji’a ja’a oliif yoo jiraatte boolii gaha(giraama lama ta’u) qorannoo laaboraatooriif oolu naaf kennuun hirmaachuu nidandeessu.

Waan hirmaattaniif galatoomaa!!

Annex II: Consent form

I, Mr. /Mrs. ____ being an adult and being the lawful parent/guardian of child's name ___________________Age_____

Do hereby give permission to Mr./Mrs. ________________________________ to include him/her in the intended study as detailed in the protocol that has been explained to me in Afaan Oromoo the language that I understand. I have also understood the implications and benefits of the study. I accept the study to be carried out on my child.

Parent/guardian signature ___________________________ Date__________

Name of the person obtaining the consent____

Unkaa waliigaltee maatii/ guddistoota ijoollee (Afaan Oromoo)

Ani obboo/Adde ________________________ maqaa ijoollee _______________________ umrii ____________

Obboo/ Adde ___________________ haala, sababa, bu’aaf dhibbaan qorannoon kun qabu erga afaan oromootiin naaf ibsameen booda qorannoo kana keessatti mucaa akka hirmaachisan eeyyameera.

Mallattoo maatii/ guddisaa _______________________ Guyyaa ______________

Maqaa nama eeyyamni kennameef ____

Annex III: Assent form (English version)

I, the undersigned, confirm that, as I give consent to participate in the study, it is with a clear understanding of the objectives and conditions of the study and with recognition of my right to withdraw from the study if I change the idea. I have been given the necessary information about the research. I have also been assured that I can withdraw any consent at any time without penalty or loss of benefits. The proposal has been explained to me in the language I understand.

Participant name________________________ signature _________ date _________________

Participant Code _______________________

Name of data collector______________________ signature_________ date________________

Unka walii galtee ijoollee (Afaan oromoo version)

Ani armaan gaditti mallattoo kiyyaan kanan mirkaneessa, odeeffannoo armaan olitti barreeffame dubbisee kaayyoo fi haala qorannichaa hubadheera. yeroo kamittuu yaada Koo yoon jiijjiire adabbii fi tajaajila dhabuu tokko malee qorannicha keessaa bahuu akkan danda'u naaf himameera.

Maqaa hirmaataa________________________mallattoo __________ guyyaa __________________

Koodii hirmaataa__________________________

Maqaa nama ragaa funaanuu_________________________ mallattoo______ guyyaa__________

Annex IV: Data collection tool (English version)

Title: Prevalence and associated risk factors of soil transmitted helminths and *Schistosoma mansoni* among communities along rivers in Gudar town, West Shawa, Ethiopia.

Questioner number_______

Kebele______________

Part I: socio-demographic characteristics

S.n	Questions	Response
1	Sex	1. Male 2. Female
2	Age in years	_____________
3	Education Status	1. Non enrolled 2. Primary 3. Secondary and above
4	Family size	____________
5	What is your main occupation?	1. Daily laborer 2. Unemployed 3. Farmer 4. Housewife 5. Merchant 6. Student
6	Do you work in agricultural activities?	1. Yes 2. no

Part II: Water contact Activities and hygiene

S.n	Questions	Response
1	Is there a latrine in your compound?	1. Yes 2. No
2	If no to Q1, where do you defecate?	1. Open field 2. In bushes
3	Have you ever defecated around the river?	1. Yes 2. No
4	Do you wash your hand after the toilet using soap?	1. Yes 2. no
5	If yes to no 4 how often?	1. Always 2. Sometimes 3. Never

6	Do you use soap when washing your hand before eating?	1. Yes 2. No
7	If yes to no 6 how often?	1. Sometimes 2. Always
8	The habit of fruit washing before eating	1. Yes 2. No
9	Do you trim your finger nail?	1. Yes 2. No
10	Do you use river water for domestic purposes?	1. No 2. Yes
11	If the answer to question 10 is yes do you bring water for cooking and drinking from the river?	1. Yes 2. No
12	Do you swim in the river?	1. Yes 2. No
13	Do you have contact with River while you are crossing it?	1. Yes 2. No
14	Do you wash clothes in River?	1. Yes 2. No
15	Where do you bathe?	1. River 2. home
16	Do you wear shoes when out of the house?	1. Yes, 2. No
17	If yes to no 16 how often?	1. Sometimes 2. always
18	What type of shoes do you wear?	1. Open 2. closed

Annex IV: Data collection tool (Afaan Oromoo)

Mata –duree: Dhibee bilaarhaarziyaa fi raammoolee karaa biyyee tuttuquutiin dhufan dhufan magaala Gudaritti.

Lakkoobsa gaaffii ________

Ganda ______________

Kutaa I: haala hawaas-diinagdee nama qoratamuu

S.n	Questions	Response
1	Saala	1. dhiira 2. dhalaa
2	umurii	_____________
3	Sadarkaa barnootaa	1. Kan hin baratin 2. Sadarkaa 1ffaa 3. Sadarkaa 2ffaa
4	Baay'ina maatii	____________
5	Hojii kee maalidha?	1. D/bulaa 2. Hoji-dhabaa 3. Q/bulaa 4. Haadha manaa 5. daldalaa 6. barataa 7. hojjataa mootumaa
6	Hojii qotiisaa ni hojjettaa?	1. eeyyees 2. lakki

Kutaa II. Haala qulqullinaa fi gochoota bishaanii wajjin wal qabatan

S.n	Gaaffiiwwan	Deebii
1	Mana boolii ni qabduu?	1. eeyyee 2. lakki?
2	Lakki yoo jette, eessa fayyadamta?	1. bakkeerra 2. daggala
3	Naannoo lagaatti nibobbaataa?	1. eeyyee 2. lakki
4	Mana boolii erga fayyadamtee booda harka kee saamunaan ni dhiqattaa?	1. eeyyee 2. lakki

5	Eeyyee yoo jette, yoom yoom dhiqatta?	1. Yeroo hunda 2. al tokko tokko 3. gonkumaa
6	Harkakee dhiqachuuf samunaa ni fayyadamtaa?	1. Eeyyee 2. lakki
7	Eeyyee yoo jette, yoom yoom?	1. al tokko tokko 2. Yeroo hunda
8	Kuduraaf muduraa utuu hin nyaatin niqulqulleesitaa?	1. Eeyyee 2. lakki
9	Qeensa quba keetii niqorqttaa?	1. Eeyyee 2. Lakki
10	Bishaan lagaa tajaajila manaatiif ni fayyadamtuu?	1. Lakki 2. Eeyyee
11	Yoo deebiin gaaffii 12 “a” jette, tajaajila manaaf bishaan lagaa ni fiddaa?	1.eeyyee 2. lakki
12	Bishaan ni daaktaa?	1. Eeyyee 2. Lakki
13	Yommuu laga qaxxaamurtu qaamni kee bishaan ni tuqaa?	1. eeyyee 2. lakki
14	Huccuu kee lagatti ni miiccattaa?	1. eeyyee 2. lakki
15	Dhaqna kee eessatti dhiqatta?	1. laga 2 .mana
16	Yeroo manaa baatu kophee ni godhattaa?	1. eeyyee 2. lakki
17	Eeyye yoo jette, yoom yoom?	1. al tokko tokko 2. Yeroo hunda
18	kophee akkamii godhatta?	1. banaa 2. cufaa

Annex V: Kato -Katz technique (WHO, 2012)

A. Principle and application

In the Kato-Katz technique feces are pressed through a mesh screen to remove large particles a portion of the sieved sample is then transferred to the hole of a template on a slide. After filling the hole, the template is removed and the remaining sample is covered with a piece of cellophane soaked in glycerol (glycerin). The glycerol 'clears' the fecal material found around the eggs. The eggs are then counted and the number calculated per gram of feces. This technique has proved efficient means of diagnosis of intestinal schistosomiasis and soil transmitted helminths.

B. Materials and reagents required

1. Applicator sticks, wooden.
2. Screen, stainless steel, nylon, or plastic 60-105 mesh.
3. Template, stainless steel, plastic, or cardboard. Templates of different sizes have been produced in different countries. A hole of 9 mm on a 1 mm thick template will deliver 50 mg of feces; a hole of 6 mm on a 1.5 mm thick template, 41.7 mg; and a hole of 6.5 mm on a 0.5 mm thick template, 20 mg. The templates should be standardized in the country and the same size of templates should always be used to ensure repeatability and comparability of prevalence and intensity data.
4. Spatula, plastic.
5. Microscope slides (75 x 25 mm).
6. Hydrophilic cellophane, 40-50 mm thick, strips 25 x 30 or 25 x 35 mm in size.
7. Flat-bottom jar with a lid.
8. Forceps
9. Toilet paper or absorbent tissue
10. Newspaper.
11. Glycerol-malachite green or glycerol-methylene blue solution (1 ml of 3% aqueous malachite green or 3% methylene blue is added to 100 ml of glycerol and 100 ml of distilled water and mixed well). This solution is poured onto the cellophane strips in a jar and left for at least 24 h before use.

C. Procedure

1. Place a small amount of fecal material on newspaper or scrap paper and press the small screen on top so that, some of the feces are sieved through the screen and accumulate on top.

2. Scrape the flat-sided spatula across the upper surface of the screen to collect the sieved feces. 3. Place the template with a hole on the center of a microscope slide and add feces from the spatula so that the hole is filled. Using the side of the spatula pass over the template to remove excess feces from the edge of the hole (the spatula and screen may be discarded or, if carefully washed, may be reused).

4. Remove the template carefully so that the cylinder of feces is left on the slide.

5. Cover the fecal material with the pre-soaked cellophane strip. The strip must be very wet if the feces are dry and less so if the feces are soft (if excess glycerol solution is present on the upper surface of cellophane wipe with toilet paper). In dry climates, excess glycerol will retard but not prevent drying.

6. Invert the microscope slide and firmly press the fecal sample against the hydrophilic cellophane strip on another microscope slide or a smooth hard surface such as a piece of tile or a flat stone. The fecal material will be spread evenly between the microscope slide and the cellophane strip. It should be possible to read newspaper print through the smear after clarification.

7. Carefully remove the slide by gently sliding it sideways to avoid separating the cellophane strip or lifting it off. Place the slide on the bench with the cellophane upwards. Water evaporates while glycerol clears the feces.

8. For all except *Hookworm* eggs, keep slide for one or more hours at ambient temperature to clear the fecal material before examination under the microscope. To speed up clearing and examination, the slide can be placed in a 40°C incubator or kept in direct sunlight for several minutes.

9. *Ascaris* and *Trichuris* eggs will remain visible and recognizable for many months in these preparations. *Hookworm* eggs clear rapidly and will no longer be visible after 30-60 minutes. Schistosome eggs may be recognizable for up to several months but it is preferable in a schistosomiasis endemic area to examine the slide preparations within 24 hours.

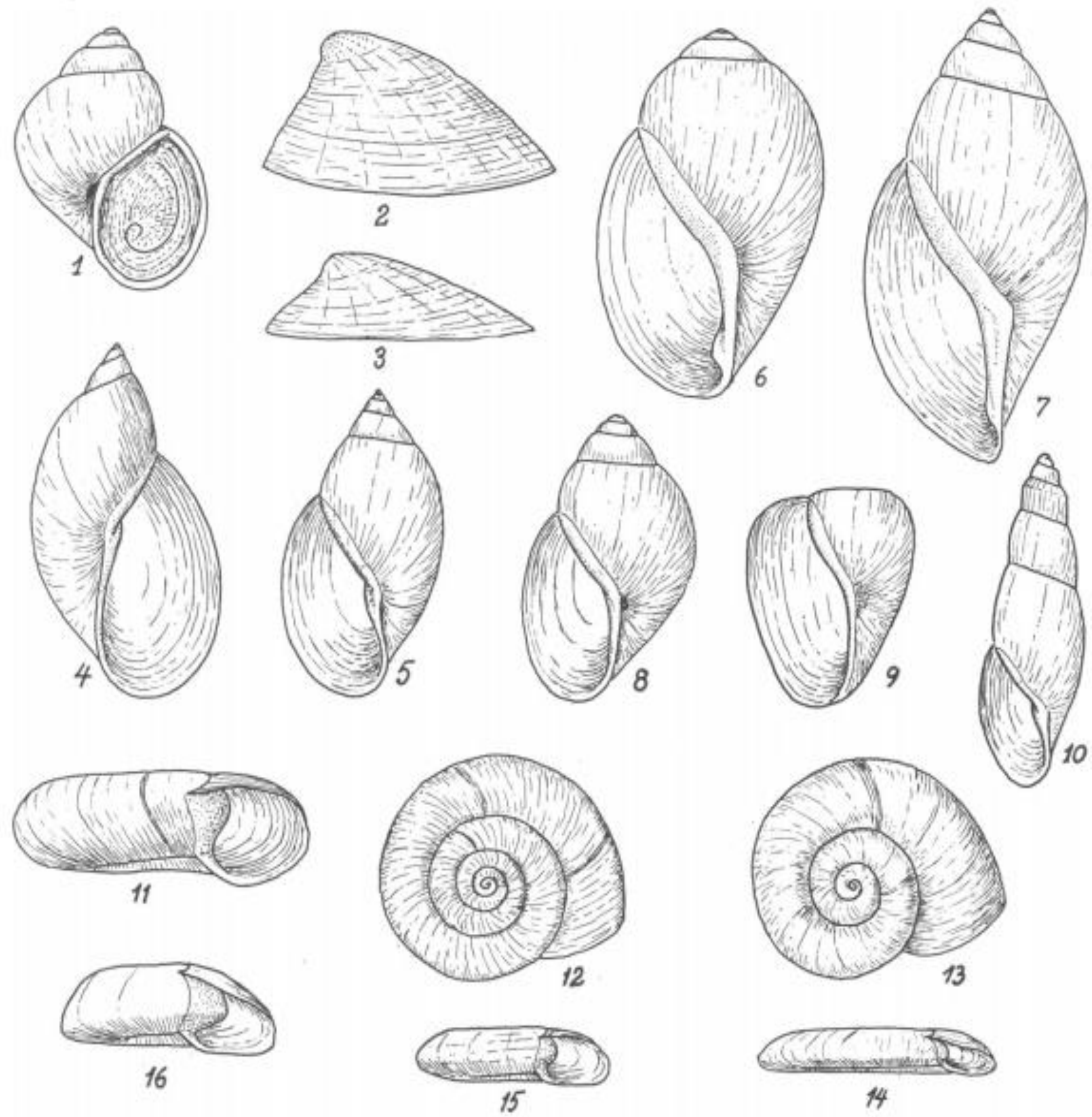
10. The smear should be examined systematically and the number of eggs of each species reported. Later multiply by the appropriate number to give the number of eggs per gram of feces (by 20 if using a 50 mg template; by 50 for a 20 mg template; and by 24 for a 41.7 mg template.

Annex VI: Identification of Snails (Brown and Christensen, 1993)

1. Collect the snail by scoop or handpicking using forceps and gloves.

2. Examine the morphology of the species based on the figure below.

FIG. 1-16
SHELLS OF FRESHWATER SNAILS



1. Prosobranch (*Gabbia*) with operculum. 5 mm high.
2. *Burnupia* sp. 5 mm long.
3. *Ferrissia* sp. 3 mm long.
4. *Lymnaea natalensis*. 15 mm high.
5. *Physa borbonica*. 12 mm high.
6. *Bulinus (Physopsis) globosus*. 16 mm high.
7. *Bulinus (Ph.) nasutus*. 18 mm high.
8. *Bulinus (Bulinus) tropicus*. 12 mm high.
9. *Bulinus (B.) truncatus trigonus*. 9 mm high.
10. *Bulinus (B.) forskalii*. 14 mm high.
11. *Biomphalaria pfeifferi*. 14 mm wide.
12. *Biomphalaria sudanica*. 15 mm wide.
13. *Biomphalaria pfeifferi*. 15 mm wide.
14. *Anisus* sp. 5 mm wide.
15. *Gyraulus* sp. 4.5 mm wide.
16. *Lentorbis* sp. 5 mm wide.

Annex VII: DECLARATION SHEET

I, the undersigned, MSc student declare that this thesis is my original work in partial fulfillment of the requirement for the degree of Master of Medical Parasitology.

Name: ____

Signature _________________Date___________________

Name of the institution: Jimma University

ADVISOR

This paper has been submitted with my approval as a university advisor.

Name: **Mr. Tariku Belay**

Name of institution: Jimma University

Signature ____________________________ Date ________________

Exrenal examiner	**Signature**	**Date**
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Internal examiner	**Signature**	**Date**
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External examiner	**Signature**	**Date**
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