HAWASSA UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCE

SCHOOL OF MEDICAL LABORATORY SCIENCE

PREVALENCE, INTENSITY, AND ASSOCIATED FACTORS OF *SCHISTOSOMA MANSONI* INFECTION AMONG SCHOOL CHILDREN ALONG AN IRRIGATION LINE IN JIMA ARJO DISTRICT, EAST WOLLEGA, WESTERN ETHIOPIA.

BY: KUMSA ASEFA (MSc CANDIDATE)

NOVEMBER, 2023

HAWASSA, ETHIOPIA

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A RESEARCH THESIS SUBMITTED TO THE SCHOOL OF MEDICAL LABORATORY SCIENCE, COLLEGE OF MEDICINE AND HEALTHY SCIENCE, HAWASA UNIVERSITY, IN PARTIAL FULFILLMENT OF THE MASTER OF SCIENCE DEGREE IN MEDICAL PARASITOLOGY.

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ADVISORS' APPROVAL SHEET

This is to declare that the thesis entitled "PREVALENCE, INTENSITY, AND ASSOCIATED FACTORS OF *SCHISTOSOMA MANSONI* INFECTION AMONG SCHOOL CHILDREN ALONG AN IRRIGATION LINE IN JIMMA ARJO DISTRICT, EAST WOLLEGA, WESTERN ETHIOPIA "is submitted in partial fulfillment of the requirements for the degree of masters in Medical Parasitology, the graduate program of the school of medical laboratory science and had been carried out by Kumsa Asefa under our supervision. Therefore, we recommend that the student has fulfilled the requirement and hence here by can submit the thesis to the school.

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EXAMINERS' APPROVAL SHEET

We, the undersigned, members of the Board of Examiners of the final open defense by Kumsa Asefa have read and evaluated his/her thesis entitled "PREVALENCE, INTENSITY, AND ASSOCIATED FACTORS OF *SCHISTOSOMA MANSONI* INFECTION AMONG SCHOOL CHILDREN ALONG AN IRRIGATION LINE IN JIMMA ARJO DISTRICT, EAST WOLLEGA, WESTERN ETHIOPIA "and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the Master's degree in medical parasitology.

Dr. Solomon Asnake (PhD)	________________	____________
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DECLARATION

I hereby declare that this MSc in Medical parasitology thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

Name: Kumsa Asefa Signature: ______________

This MSc in Medical parasitology thesis has been submitted for examination with my approval as thesis advisor.

Dr. Solomon Asnake (PhD) Signature: ________________

Place and Date of Submission: ____________________

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ACRONYMS AND ABBREVIATIONS

AOR	Adjusted Odds Ratio
BCC	Behavioral Change Communication
COR	Crude Odds Ratio
DALYs	Disability-Adjusted Life Years
DRC	Democratic Republic of the Congo
EPG	Eggs Per Gram of Feces
FMoH	Federal Ministry of Health
KK	Kato- Katz
MDA	Mass Drug Administration
NTD	Neglected Tropical Disease
PZQ	Praziquantel
SAC	School-aged Children
SOP	Standard Operating Procedures
WHO	World Health Organization

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ABSTRACT

Background: In Ethiopia, *Schistosoma mansoni* infection is a major public health concern. Schoolchildren typically have the largest parasite burden, and the condition has been associated with anemia, stunting, and cognitive impairments, resulting in poor school performance and greater dropout rates, However, there was insufficient information on the present status of these infections to suggest an intervention in the study area.

Objective: This study aims to assess the prevalence, intensity of infection, and factors associated with *Schistosoma mansoni* infection among schoolchildren along an irrigation line in Jima Arjo district, East Wollega Zone, Western Ethiopia.

Method: A school-based cross-sectional study was carried out between February and May 2023. Stool samples are collected from 523 schoolchildren, who are selected by systematic sampling techniques, and they were be examined for the ova of *S. mansoni* using the three-slide Kato–Katz technique and formal-ether concentration techniques. A pre-structured questionnaire was used to collect socio-demographic characteristics and possible predisposing factors. Data was entered into Epi-info version 3.1 and analyzed by SPSS version 24 software. Variables with $p < 0.25$ in the bivariate analysis (COR) were entered into multivariable analysis (AOR). A p-value <0.05 in the multivariable logistic regression was considered as statistically significant.

Result: The prevalence of *Schistosoma mansoni* infection in the selected primary school was 140 (27.4%). In addition to *Schistosoma mansoni*, *Ascaris lumbricoid* 158 (30.9%), *Hook worm* 41 (8%), *Trichuris trichiura* 24 (4.3%), *Hymenolepis nana* 20 (3.9%), *Giardia lamblia* 18 (3.5%), *Enterobius vermicularis 9 (1.8%)*, and *Tenia species* 7 (1.4%), were other parasites detected in the investigation. The infection intensity of *Schistosoma mansoni* was 99 (75%) light, 27 (20%) moderate, and 7 (5%) heavy. The rate of *Schistosoma mansoni* infections was significantly higher among schoolchildren who were involved in irrigation-related activities (AOR, 4.49; 95% CI 2.43–8.31; p = 0.001), who had swimming habits (AOR, 0.31; 95% CI 0.15-0.61; p = 0.01), bath habits in canal water (AOR, 5.19; 95% CI 1.78–15.09; p = 0.002), bathing in spring water (AOR, 3.37; 95% CI 1.11–10.24; p = 0.032), and crossing water bodies barefoot (AOR, 0.30; 95% CI 0.17–0.54; p = 0.001).

Conclusion: The prevalence of *Schistosoma mansoni* infection was moderate and the infection intensity was light. Therefore, it is crucial to use biannual (twice a year) mass treatment and integrated approaches such as behavioural change, snail control, and environmental intervention to reduce these infections to an insignificant level.

Keywords: *Schistosoma mansoni*, prevalence, infection intensity, associated factors, Jima Arjo district.

CHAPTER ONE: INTRODUCTION

1.1 Background

Human schistosomiasis is a neglected tropical disease (NTD) caused by a blood fluke (trematode worms) of the genus *Schistosoma*, yet it is one of the most important parasitic diseases (Nyangulu *et* al., 2022). Schistosomiasis has been documented in 78 countries globally. The disease is a public health issue in tropical and subtropical regions of Africa, Asia, the Caribbean, and South America(WHO, 2022). According to estimates, at least 236.6 million people required preventive treatment, and 779 million people are at risk of acquiring the infection with 90% of the population living in Africa (Senkwe *et* al., 2022). Schistosomiasis is more severe in Sub-Saharan Africa, where approximately 120 million people have schistosomiasis-related symptoms and 20 million people suffer from chronic schistosomiasis. According to recent disease burden estimates, this disease lost up to 70 million disability-adjusted life years (DALYs) each year over the world (WHO, 2022). Six Schistosoma species are responsible for the occurrence of the two major forms of the disease, depending on where the adult flukes are live. *Schistosoma mansoni*, which causes intestinal schistosomiasis, and *Schistosoma haematobium*, which causes urogenital schistosomiasis, are the two main species that infect people in sub-Saharan Africa, with the former being more prevalent than the latter (Nyangulu *et* al., 2022). *Schistosoma japonicum*, *Schistosoma mekongi*, *Schistosoma guineensis*, and *Schistosoma intercalatum* also cause intestinal schistosomiasis but are less prevalent (Aula *e*t al., 2021).

Schistosomiasis causes severe morbidity due to the accumulation of eggs that become lodged in the tissues of the human host, resulting in a chronic inflammatory response. This leads to abdominal pain, liver fibrosis, diarrhea, bloody stools, anemia and hepatomegaly, as well as brain abnormalities (Rinaldo *et* al., 2021).

Since mass treatment alone is ineffective for achieving long-term control and elimination of schistosomiasis, an integrated strategy combining MDA with improvements in water, sanitation, and hygiene (WASH) and behavioral change communication (BCC) that promote healthy behavior practices is implemented to interrupt transmission and achieve sustained elimination of the disease (Onasanya *et* al., 2021). However, ongoing transmission occurs in endemic areas due to limited access to safe water and a lack of healthy behaviors and habit. In addition to this, the application of these strategies was varied and lacks consistency from locality to locality, which leads to a prolonged stay at various stages to control the disease (Gal *et* al., 2022). Since there were no studies conducted in high-risk areas of our country, especially in Jima Arjo district, there is a need for comprehensive knowledge and understanding of Schistosoma mansoni infection to design and intensify both treatment and prevention measures.

1.2 Statement of problem

The *Schistosomiasis mansoni* infection still causes significant morbidity and mortality, typically in at-risk populations and high-risk areas, despite several efforts to control and eliminate this parasite. This parasite was reported to affect approximately 54 million of those infected, and 400 million more people at risk of infection, primarily in Sub-Saharan Africa (SSA) (WHO, 2022). Sub-Saharan Africa is the most affected region of the world, accounting for more than 90% of the worldwide schistosomiasis burden, resulting in an estimated 0.2 million deaths per year, primarily due to chronic *S. mansoni* infection (Gunda *et* al., 2020). In Ethiopia, approximately 37.3 million people live in places where schistosomiasis is endemic. In the country, the prevalence of *S. mansoni* ranged from 10 to 92%, whereas that of *S. haematobium* ranged from 5 to 58%. In Ethiopia, a high prevalence of *S. mansoni* has been recorded among school-aged children (Hailegebriel *et* al., 2022). In the southern part of Ethiopia, the prevalence of *S. mansoni* infection varied greatly among schoolchildren, ranging from 11.6% to 54.1% (Kabatende *et* al., 2020).

Nowadays, epidemiological studies in Ethiopia revealed that the prevalence of intestinal schistosomiasis caused by *Schistosoma mansoni* varied depending on the nature of the study population, the community's water-contact behavior, the level of environmental sanitation, the study area, and the types of parasitological methods used with approximately 90% reported among school children (Tefera *et* al., 2020). Schoolchildren typically have the largest parasite burden because of their behaviour in engaging in high-risk activities and their susceptibility to the parasite because their immune system is not fully developed. When untreated, the condition has been associated with anemia, stunting growth, and cognitive impairments, resulting in learning difficulties and greater dropout rates. (Worku *et* al., 2014). Schistosomiasis causes serious health, social, and financial problems due to these life-long impacts on infected individuals and households (Rinaldo *et* al., 2021). The widespread distribution of the biomphlaria snail host, migration of population, the reliance of numerous impoverished populations in both rural and urban areas on Schistosoma-infested water sources for their domestic, occupational, and recreational needs, a lack of sanitation, a shortage of potable water, and deficiencies in preventive and curative services are some of the reasons why the disease persists despite extensive control and preventive efforts (Mazigo *et* al., 2010). Even though schistosomiasis is a public health problem in Ethiopia, estimates of its prevalence vary widely, and reports about *S. mansoni* occurrence vary and lack consistency. Thus, there was a need to establish the extent of disease burden and identify contributing factors in high-risk areas along irrigation lines and in at-risk populations, mainly among schoolchildren in Jima Arjo district, East Wollega Zone, Western Ethiopia.

1.3 Significance of the study

The result of this study was used for mapping since no study was conducted in Jima Arjo district, and provide baseline information for other areas with similar settings. The study findings would contribute to an understanding of the contributing factors for intestinal schistosomiasis in the settlements. That would be very important for public health professionals in the area to design treatment and preventive strategies and raise awareness among the local community, as well as to persuade policymakers to pay more attention to the disease and scale up strategies accordingly.

CHAPTER TWO: LITERATURE REVIEW

The investigation of *Schistosomiasis mansoni* was done by a number of researchers. Despite the fact that the majority of them conducted studies, the potential high-risk areas among schoolchildren remain poorly investigated. As a result, by thoroughly investigating a potential risk area around an irrigation line and optimizing the sensitivity of the Kato Katz technique, which is the gold standard (Lamberton *et* al., 2014 for investigating infection, it was possible to determine the accurate prevalence, intensity, and associated factors of *Schistosoma mansoni* infection and implement the appropriate intervention measures where they are needed.

According to a Brazilian study to increase the detection rate of a parasitological survey, the double Kato Katz technique was applied to diagnose *Schistosoma mansoni*(Massara *et* al., 2004). In this method, two slide preparations from a single stool sample were used on schoolchildren. Among these schoolchildren, 8.6% of eggs tested positive for *Schistosoma mansoni* in stool samples. A multivariable analysis revealed the following factors associated with the infection: water contact (with leisure and professional activities), gender (male), and age (from 10 to 29 years). Even if they used gold standard techniques to detect the infection, increasing the detection rate beyond this is possible by preparing three Kato Katz slides per sample with formol ether concentration technique.

In contrast to this finding, two studies involving communities were conducted in the Democratic Republic of the Congo (DRC) in 2016 and 2017, respectively. In both investigations, a cross-sectional study using Kato-Katz techniques was used. In 2016, each participant's stool sample was examined only once, but in 2017, each participant's stool sample was examined twice. In 2016, 40.1% of participants were infected with *S. mansoni*, whereas 73.1% of participants tested positive for *S. mansoni* in 2017. In both investigations, the intensity of the *Schistosoma mansoni* infection was moderate. The key risk factors that these studies reported as being associated with the infection were swimming and washing in local water bodies, proximity to water bodies, and a lack of latrines in the household. According to the findings of this study, there was a significant variation in the prevalence of infection due to the use of more sophisticated detection techniques in later studies than in earlier ones. In addition to this, the study conducted in 2016 did not resolve the problem since the exact prevalence of the disease was not discovered, and the number of cases arose and increased in 2017. As a result, by increasing the number of slides investigated to three in combination with formol ether concentration, it is possible to determine the exact prevalence of the infection rather than examining a single or double stool sample (Nigo *et* al., 2021).

In comparison to this finding, there was a cross-sectional survey of schoolchildren in two areas in the south-western region of Nigeria to examine the prevalence and intensity of S. mansoni infection. A single Kato-Katz thick smear technique was used to detect *S. mansoni* eggs in feces. Among these schoolchildren, 40% of eggs tested positive for *Schistosoma mansoni* in stool samples (Ojo *et* al., 2021). This investigation revealed that the intensity of the *Schistosoma mansoni* infection was moderate. From this, it is quite possible to address the exact prevalence of the infection by maximizing the use of more than one Kato Katz thick smear technique.

There have been recent findings in Egypt that contradict this result (Ghazy *e*t al., 2022). In this study the cross-sectional study was conducted among children aged 6–15 years on two successive days and examined using the Kato-Katz technique. According to this study, 19.1% of eggs tested positive, and a light intensity of *Schistosoma mansoni* in stool samples was identified. A higher prevalence of human infection was observed among males than females, children aged 11–15 years than their counterparts aged 6–10 years, and mothers with a low level of education. The main identified risk factors were contacting the main body of water-canal for washing clothes, land irrigation, water collection, bathing, and garbage disposal.

On the other hand, a cross-sectional study was conducted to investigate the prevalence and intensity of *Schistosoma mansoni* infection among schoolchildren in western Kenya. Using the single Kato-Katz technique, stool samples were collected and examined for Schistosoma mansoni eggs. The prevalence of *S. mansoni* infection was 60.5%, with a heavy intensity of infection (Odiere *et* al., 2012). From what I have seen, it is quite possible to address the exact prevalence of the infection by optimizing the use of more than one Kato Katz thick smear technique.

Schistosomiasis mansoni is the most prevalent species in Ethiopia, and its prevalence has been recorded in different regions of the country, with rapid distribution associated with water resource development and extensive population movements and approximately 90% of cases reported among schoolchildren (Tefera *et* al., 2020). A cross-sectional survey of schoolchildren was conducted in Northwestern Ethiopia to investigate the prevalence of *S. mansoni* infection. Using the two-slide Kato-Katz technique, stool samples were collected and examined for *Schistosoma mansoni* eggs. The prevalence of *S. mansoni* infection was 12.6% (Tazebew *et* al., 2022). According to this study, the significant predictors of *S. mansoni* infection were schoolchildren in the age categories 5–9 years, 10–14 years, grade levels 5-8, frequent swimming habits in the river, and those who cultivate in irrigation areas, which were significantly associated with a high risk of *S. mansoni* infection. Even if the study used two-slide Kato-Katz techniques, optimization beyond this one results in minimization of the opportunity to miss the parasite.

In contrast to this outcome, there was a cross-sectional investigation among schoolchildren near Lake Tana. Using the single-slide Kato-Katz technique, stool samples were collected and examined for *Schistosoma mansoni* eggs. *Schistosomiasis mansoni* infection was found in 34.9% of schoolchildren, with the majority of cases classified as low infection intensity (Hailegebriel *et* al., 2021). According to this study, the key determining factors identified were being male and bathing habits. Similarly, there was another school-based cross-sectional study in the same part of the country. Stool specimens were collected and examined using the two-slide Kato-Katz method. The prevalence of S. mansoni was 33.5% (Zeleke *et* al., 2020). Thirty-seven, 42, and 21 percent of the study participants' infections were due to light, moderate, and heavy infection intensities, respectively. The age range of 8–11 years old, the 5th–8th-grade level, and using untreated water for domestic supply were found to be risk factors for *S. mansoni* infection. The high prevalence of *S. mansoni* in this study, as well as the relatively higher proportion of moderate infection intensity, suggest that more research is needed to optimize the detection rate of diagnostic techniques for schistosomiasis (Zeleke *et* al., 2020).

According to the Tigray region, there was a cross-sectional parasitological examination conducted among schoolchildren. Stool samples were collected and examined by the one-slide Kato-Katz technique. The prevalence of *S. mansoni* was found in 23.9% of schoolchildren (Assefa *et* al., 2013). This study revealed the association of *S. mansoni* infection with older age groups (10–14 years), time of residence in the study area, water source, previous history of schistosomiasis treatment, frequency of water contact, crossing water bodies, working in an irrigated agricultural field, and distance of home from water bodies. Although the study used one-slide Kato-Katz techniques, optimization beyond this one results in increasing the detection rate of the parasite.

In the same manner, there was a cross-sectional study among fisherman in the southern part of Ethiopia. Stool samples were collected and processed using the single Kato–Katz thick smear technique. The prevalence of *S. mansoni* among the fishermen was 29.21% with a moderate intensity of infection(Menjetta et al., 2019). Similar prevalence of *S. mansoni* were recorded in the age groups 15–19, 20–24, and 25–29 years, and the habit of swimming was the key determinant factor of the infection. From what was seen, it is quite possible to determine the exact prevalence of the infection by optimizing the use of more than one slide of the Kato Katz thick smear technique (Menjetta et al., 2019). On the other hand, there was a cross-sectional parasitological survey among schoolchildren in the Wolaita Zone of the country that revealed an extremely high prevalence of the infection. Stool samples were collected and processed using the one-slide Kato–Katz thick smear technique. The prevalence of *S. mansoni* infection was 58.6% (Alemayehu *e*t al., 2017).

Swimming was the only factor reported to be significantly associated with a *S. mansoni* infection. The fact that the prevalence and severity of *S. mansoni* infections varied among schoolchildren suggests that more research is needed to determine the disease's true burden.

Unlike this result, the most recent cross-sectional survey in this region revealed a lower prevalence among school-aged children (SAC) (Zerdo *et* al., 2022). Stool samples were analyzed using the one-slide Kato–Katz thick smear technique. According to this research, the prevalence of *S. mansoni* was found to be 34.3%. The intensity of *Schistosomiasis mansoni* was light, moderate, and heavy at 15.2%, 10.9%, and 8.2%, respectively. The low socioeconomic status of the household and being male were factors reported to be significantly associated with a *S. mansoni* infection (Zerdo *et* al., 2022).

There were also two cross-sectional studies conducted in the Jima Zone of southwestern Ethiopia that showed significant variation in the burden of schistosomiasis. Both of the studies were conducted among schoolchildren. With single Kato-Katz techniques, the prevalence of *S. mansoni* infection was reported to be 28.7% (Tefera *et* al., 2020), whereas the prevalence of the infection was 42.9% (Bekana *et* al., 2020), with double Kato-Katz techniques. In both studies, the majority of infections were categorized as light intensities with 45%. The former studies identified school distance from rivers, swimming habits in rivers, and crossing rivers on bare feet as independent risk factors for *S. mansoni* infection, whereas the latter one revealed that being male was the key determinant of the infection.

In the western part of Ethiopia, there were reports that indicated the existence of a highly significant *Schistosoma mansoni* infection. To determine the prevalence of *S. mansoni*, a cross-sectional parasitological survey was conducted in Finchaa valley among schoolchildren with two Kato-Katz investigation on two consecutive days. The prevalence of *S. mansoni* was 67.6%. The majority of the infection intensity was moderate 38.7%. The determinant factors identified were using the river water for home use as well as bathing, and river water contact is also statistically significant with the infection (Haile et al., 2012). Similarly, a cross-sectional study was conducted among schoolchildren in Finchaa Sugar Estate, a rural part of West Ethiopia. Stool specimens were collected and examined using the one-slide Kato-Katz technique. The prevalence of *Schistosoma mansoni* infection was 53.2%. Because of the prevalence of *Schistosoma mansoni*, there is a need for investigation, usually at the sub-district level, to determine whether or not hotspots exist (Mekonnen *et* al., 2014). Therefore, the main thing to do is assess the area that has not been researched, and addressing the risk population group is one of the keys to determining the accurate status of the infection and enabling us to respond accordingly.

2.1 Conceptual Framework

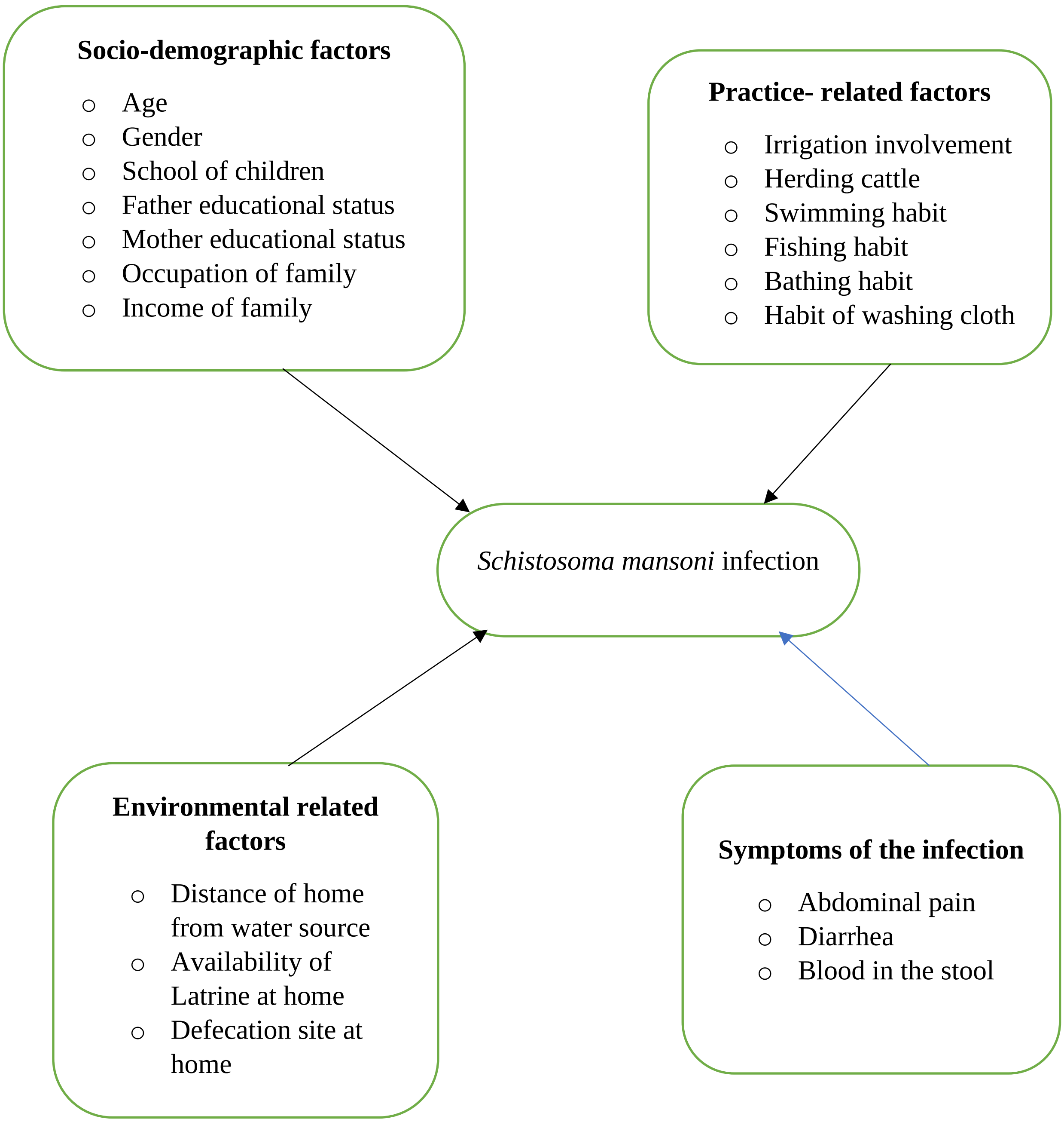

Figure 1:Diagrammatic representation of conceptual framework of *Schistosoma mansoni* infection.

CHAPTER THREE: OBJECTIVES

3.1 General objectives

To assess the prevalence, intensity, and associated factors of *S. mansoni* infection among school children along the irrigation line in Jima Arjo district, East Wollega Zone, Western Ethiopia in 2023.

3.2 Specific objectives

- To determine the prevalence of *Schistosoma mansoni* infection among school children in the study area.
- To evaluate the intensity of *Schistosoma mansoni* infection among school children in the study area.
- To assess associated factors with the prevalence *Schistosoma mansoni* infection among School children in the study area.

CHAPTER FOUR: METHOD AND MATERIALS

4.1 Study area and setting

The research was conducted in Jima Arjo district, East Wollega Zone, at 379km far from Addis Abeba the capital city of Ethiopia. The district is located at a geographical coordinate of latitude 8° 39' 59.99'' N and longitude 36° 39' 59.99'' E. The altitude of the district ranges from 1280 to 2524m above sea level with average annual rain fall from 1200 mm3 to 2200 mm3. The mean annual maximum and minimum temperature of the district range from 36.5 to 16.8°C. The woreda contains four high school and twenty-eight primary schools. The district also has one hospital, four health centers, ten health posts and two private clinics. The total population of the district was 93,547 people, with 47,109 men and 45,438 women. The woreda has 22 kebeles, three of which share an agricultural irrigation system and are located near water bodies particularly Abote, Hara, and Arjo Didesa Kebeles. The main occupation of inhabitants was farming cereals, vegetables, fruits and livestock. The area is now building a number of traditional irrigation systems, including as Nageso, Samsa, and Jaro irrigation, which offer water for agricultural purposes. According to the Jima Arjo primary hospital record, the district's selected area was discovered to be infected with *Schistosoma mansoni* infection.

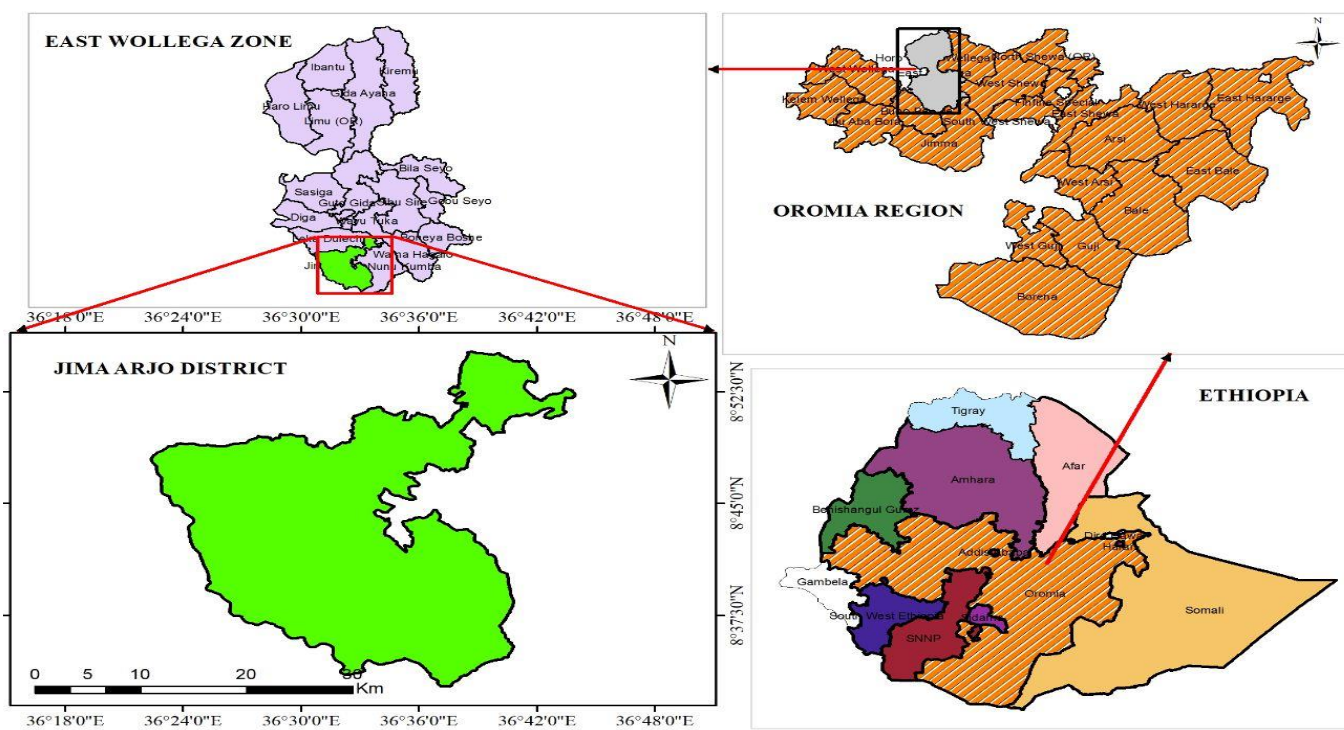

Figure 2:The map of Jima Arjo district

4.2 Study design and period

A school-based cross-sectional study was conducted among school children from February to May, 2023.

4.3 Population

4.3.1 Source population

All primary school children along the irrigation line in Jima Arjo district.

4.3.2 Study population

All school children who have been attending the selected primary schools during the academic year 2022-2023 and fulfill the inclusion criteria.

4.4 Eligibility criteria

4.4.1 Inclusion criteria

All schoolchildren who were willing to participate in the study, attend the selected schools during the study period and those whose parents/care givers given assent was included.

4.4.2 Exclusion criteria

School children those who have a history of taking anthelminthic drugs during the data collection or within the last three months were excluded.

4.5 Sample size and sampling technique

4.5.1 Sample size

Based on research conducted by (Tefera *et* al., 2020) in Jimma town near by rivers, the prevalence of *Schistosoma mansoni* in school children was 28.7% taking this proportion, the sample size for the first objective is calculated using single proportion formula, assuming a 95% confidence interval and a 5% accepted margin of error.

$n=(Z\alpha/2)^2p(1-p)/d^2$

$n=(1.96)^2 0.287(1-0.287)/(0.05)^2$

n=314

But the total study population is 2004; that is less than 10,000; based on this, the correction formula when total population is less than 10,000 is used. Thus, the corrected sample size is calculated as follow,

$$n\ corrected = \frac{n}{1+\frac{n}{N}}$$

$$n\ corrected = \frac{314}{1+\frac{314}{2004}} = 271$$

By multiplying with 1.5 for design or cluster effect between schools, and adding 5% for non- respondent rate the final sample size for this study was 420.

The sample size for the second objective is calculated using the single population proportion formula, assuming a 95% confidence interval and a 5% accepted margin of error. In a previous study in Ethiopia, the proportions of infection intensity for *Schistosoma mansoni* were light (45%)(Tefera et al., 2020), moderate (38.7%)(Haile et al., 2012), and heavy (21%)(Hailegebriel et al., 2021).

The sample size for light infection intensity is calculated as:

$$n=(Z\alpha/2)^2 p(1-p)/d^2$$

$$n=(1.96)^2 0.45(1-0.45)/(0.05)^2$$

n=380

But the total study population is 2004; that is less than 10,000; based on this, the correction formula when total population is less than 10,000 is used. Thus, the corrected sample size is calculated as follow,

$$n\ corrected = \frac{n}{1+\frac{n}{N}}$$

$$n\ corrected = \frac{380}{1+\frac{380}{2004}} = 319$$

By multiplying 1.5 for design or cluster effect between schools, and adding 5% for non- respondent rate the final sample size for this study was 495.

The sample size for moderate infection intensity is calculated as:

$n=(Z\alpha/2)^2 p(1-p)/d^2$

$n=(1.96)^2 0.387(1-0.387)/(0.05)^2$

n= 365

By using the sample size correction formula when total population is less than 10,000, the corrected sample size is calculated as follow,

$$n\ corrected = \frac{n}{1+\frac{n}{N}}$$

$$n\ corrected = \frac{365}{1+\frac{365}{2004}} = 309$$

By accounting 1.5 for design or cluster effect between schools, and adding 5% for non- respondent rate the final sample size for this study was 479.

The sample size for heavy infection intensity is calculated as:

$n=(Z\alpha/2)^2 p(1-p)/d^2$

$n=(1.96)^2 0.21(1-0.21)/(0.05)^2$

n=255

But the total study population is 2004; that is less than 10,000; based on this, the correction formula when total population is less than 10,000 is used. Thus, the corrected sample size is calculated as follow,

$$n\ corrected = \frac{n}{1+\frac{n}{N}}$$

$$n\ corrected = \frac{255}{1+\frac{255}{2004}} = 226$$

By accounting 1.5 for design or cluster effect between schools, and 5% for non- respondent rate the final sample size for this study was 350.

The sample size for the third objective was determined using (Epi info version 7.2).

Name of variables	%Outcome in exposed	%Outcome in unexposed	Confidence interval	power	Odds ratio	Sample size	reference
Habit of bathing in river	39.9	26.3	95	80	1.86	404	(Hailegebriel et al., 2021)
Irrigation involvement	39	61	95	80	1.68	180	(Tadege and Shimelis, 2017)
Swimming habit in rivers	37.72	21.72	95	80	1.823	280	(Tazebew et al., 2022).
Crossing river on bare foot	43.7	15.82	95	80	4.13	96	(Tefera et al., 2020).

By using sample size correction formula, the corrected sample size is calculated as below.

$$\text{n corrected} = \frac{n}{1+\frac{n}{N}}$$

$$\text{n corrected} = \frac{404}{1+\frac{404}{2004}} = 337$$

The sample size calculated from third objective exceeds the sample size obtained from the first and the second objective so, by accounting 1.5 for design effect between schools and assuming a 5% non-respondent rate, the final sample size for this study was 523

4.5.2 Sampling technique

Schoolchildren along the irrigation line in Jima Arjo district were purposively selected from East wollega Zone as Jima Arjo primary hospital result record revealed that there was the burden of *Schistosoma mansoni* infection in that area. Based on the students' registration list from school as the sampling frame, a systematic sampling technique was used to select the study unit for every four individuals out of 2004 children until all 523 study units are included. Each primary school, Abote, Lugama, and Arjo Didesa, had 702, 788, and 514 students, respectively. To determine the proportion of students to be selected from each of the three schools, the sample size that was determined earlier was allocated proportionally among the three schools. By allocating the sample size of 523 to the schools proportionally, it becomes 183, 206, and 134 participants per school, respectively.

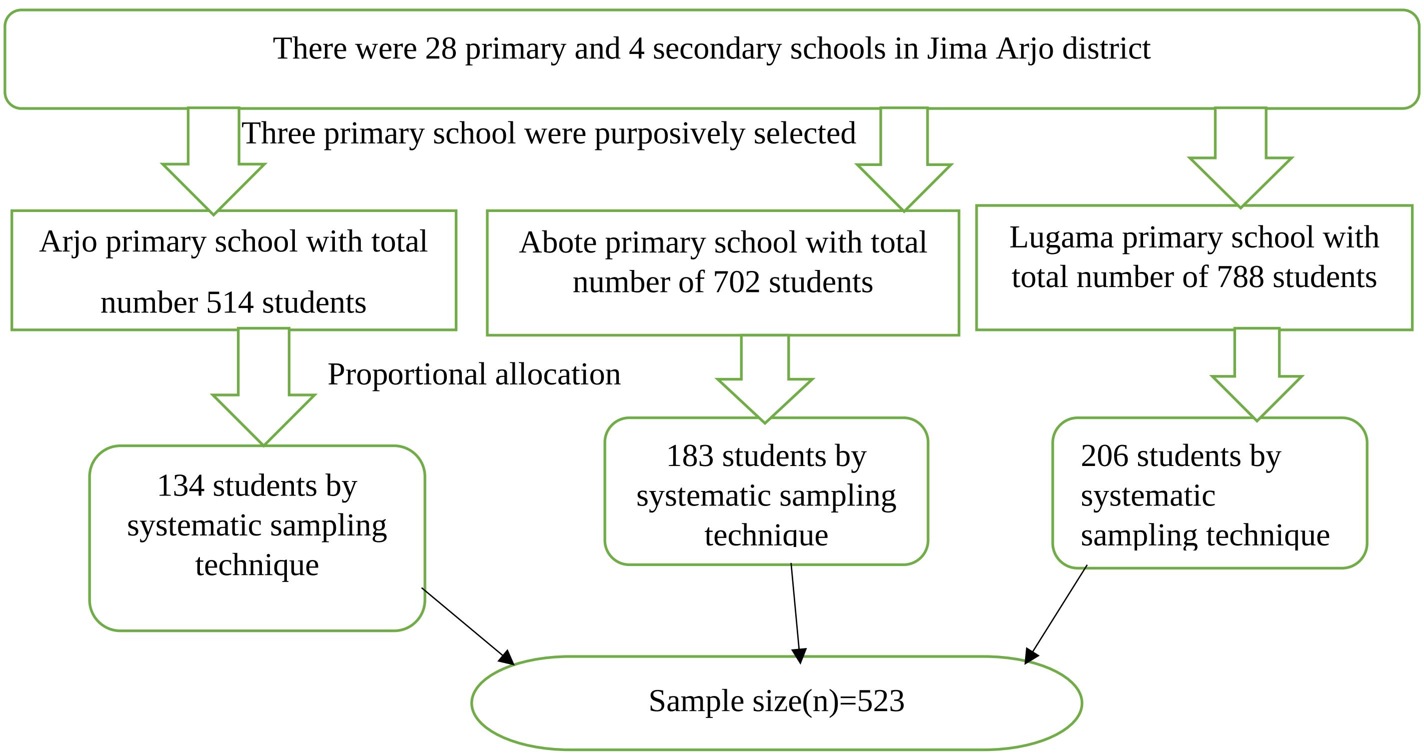

Figure 3:diagrammatic representation of sampling procedure

4.6 Study variables

4.6.1 Dependent variable

The prevalence of *Schistosoma mansoni* infection.

4.6.2 Independent variables

Socio-economic, and socio- demographic characteristics

- Gender
- Age (year)
- Grade level
- School of children
- Father educational status
- Mother educational status
- Occupation of family
- Family income

Practice-related factors

- Herding cattle in the water fields
- Swimming habit
- Fishing habit
- Washing habit
- Bathing habit
- Irrigation involvement

Environmental related factors

- Crossing water sources on bare feet
- Frequency of water contact per week
- Distance of home from water bodies
- Availability of Latrine at home
- Defecation site at home

Symptoms of the infection

- Abdominal pain
- Diarrhea
- Blood in stool

4.7 Data collection procedures

To collect socio-demographic information and potential associated factors for *S. mansoni*, a structured questionnaire was developed in English and translated into Afaan Oromo (the student's local language). To do this, one-day training was given for two Bachelor of science in nurse who speak the local language (Afaan Oromo). The training was focused on describing the purpose of the study, obtaining parental or guardian consent, and how to interview them using a questionnaire. Data collectors was visited students' homes and interview parents or guardians on socio-demographics and associated factors for intestinal schistosomiasis using structured questionnaires. The principal investigator was reviewed the collected data for completeness and make corrections when missing information was obtained.

4.8 Laboratory Investigation by Kato-Katz and Formol ether concentration

Following the interview, the selected children were asked to bring about 4 grams (about two a large teaspoon) of feces in labeled sterile plastic stool caps. A formol ether concentration and triple Kato-Katz slides was prepared from single stool sample collected from each child by taking 41.7 mg of stool samples by three independent laboratory technologists (BSc) with at least three years of work experience. Then, specimens were processed and examined in nearby laboratory of health station. The primary investigator reviewed those samples where results from the three laboratory personnel differed, and those findings would be resolved. All *S. Mansoni* eggs were counted from three Kato Katz microscopic slide and the average of the ova was converted to eggs per gram of feces (EPG) by multiplying by the 24-correction factor. According to WHO cut-off values, the infection intensity will be categorized as light, moderate, or heavy based on EPG values of 1-99, 100-399, and >400, respectively(World Health Organization, 2011). A single slide of formalin ether concentration was prepared per individual as it was recommended by the WHO to be used, typically in areas where the prevalence of Schistosoma mansoni was expected to be low.

4.9 Data quality assurance

The translation of the questionnaire from English to Afaan Oromo was done, and its correctness and completeness was carefully checked. The data collection was supervised daily, and a pretest was conducted on 5% of the sample size (i.e.,26 samples) to ensure that the questions were not ambiguous so as to generate the desired information. Before the actual data collection, the questionnaires were modified based on the findings of the pretest. The children were strongly advised to bring enough stool samples. An experienced laboratory technologist in the field was provide refresher training or orientation for data collectors, laboratory technologists, and technicians regarding Kato-Katz thick smears and

Formol ether concentration techniques. Standard operating procedures (SOP) for pre-analytical, analytical, and post-analytical procedures were implemented and followed during data processing. Furthermore, a fresh working solution of malachite green was employed routinely to maintain the quality of the smear. To guarantee quality control as an internal quality control measure, 10% of the slides examined was chosen at random for reexamination by another microscopist at Jima Arjo Hospital and by another experienced microscopist at Wollega University Referral Hospital as part of an external laboratory evaluation.

4.10 Statistical analysis

All the data from the questionnaires and laboratory results were coded and verified for completeness. After that data was entered into Epi-info version 3.1 and analyzed by SPSS version 24 software. The prevalence of *S. mansoni* was presented as a percentage, the infection intensity of *S. mansoni* was classified as low, moderate, or heavy according to the WHO guidelines, and the mean egg count was reported as a geometric mean. To analyze the possible association of factors with *S. mansoni* and assess the strength of the association, a logistic regression statistical model was utilized. Crude odds ratio (COR) from a bivariate analysis was performed to identify the nominated variables that show a significant association with the dependent variables. To control for cofounding effects, associated factors with a p-value of <0.25 in the bivariate analysis was subjected to multivariable logistic regression analysis. A multivariable logistic regression analysis was carried out to determine the magnitude of the association using the adjusted odds ratio (AOR), taking into account all factors yielding a p-value of <0.25 in bivariate analysis. A p-value of <0.05 will be considered statistically significant.

4.11 Ethical considerations

Ethical clearance was obtained from the School Research Ethics Review Committee of the School of Medical Laboratory Science and the institutionally reviewed board committee of the College of Medicine and Health Science at Hawassa University. Permission to conduct the study was obtained from East Wollega Zone and Jima Arjo district health and education offices and the directors of selected schools. The study subjects were informed about the study's purpose and objectives, and they were invited to participate voluntarily. A written informed consent was obtained from the guardians or parents of the participant. After permission was obtained, participants were interviewed, and a stool sample was collected. Confidentiality was maintained by using codes instead of names for all participant-related data. All positive cases were linked to the nearest health institution for appropriate treatment as per the national treatment guidelines.

4.12 Plan for dissemination

The result of the study was presented to Hawassa University's Department of Medical Laboratory Science as a fulfillment of a master's degree in medical parasitology. It also disseminated to the Jima Arjo Hospital administrator both in softcopy and hardcopy, and finally, the results will be presented at different workshops and seminars and published in reputable scientific journals.

CHAPTER FIVE: RESULT

5.1 Socio-Demographic Characteristics of the Study Participants

A total of 523 school children were involved into the study, but a complete data was obtained from 511 students. Twelve students were excluded because they were unable to provide a stool sample at the time of data collection. Out of 511 participants 235(46%) of male and 276(54%) female students from three primary school along irrigation line in Jima Arjo woreda were involved in this study. Students from Arjo primary School accounted 130(25.5%), whereas students from Abote and Lugama primary school were 179(35.5%) and 202(39%) respectively. Majority of the students were from age group of 10-14 with the range of age (6-19) and mean of 12.44. Among the study participants 44.6% had latrines at home, yet 59.9% had used open field defecation Table (1).

Table 1:Socio-demographic characteristics of schoolchildren in selected primary schools in Jima Arjo district 2023.

Characteristics	Category	Frequency	Percent
Sex	Male	235	46
	Female	276	54
Age(years)	5-9	87	17
	10-14	309	60.5
	15-19	115	22.5
School of students	Arjo	130	25.5
	Abote	179	35.5
	Lugama	202	39
Grade of students	1-4	303	59.3
	5-8	208	40.7
Occupation of family	Government employ	11	2.3
	Farmer	441	86.3
	Merchant	13	2.3
	Private employ	15	2.9
	Daily laborer	31	6.1
Family income	Low (<1000)	433	84.7
	Middle (1000-3000)	62	12.1
	High (>3000)	16	3.1
Father educational status	No formal education	347	67.9
	Primary	121	23.7
	Secondary	33	6.5
	College and above	10	2
Mother educational	No formal education	407	79.6

status	Primary	79	15.7
	Secondary	18	3.5
	College and above	7	1.2
Latrine at home	Yes	228	44.6
	No	283	55.4
Defecation area at home	Latrine	205	40.1
	Open field	306	59.9

5.2 Prevalence of Schistosoma Mansoni Infection

Microscopic examination of stool specimens by utilizing a triple Kato Katz smear and formol ether concentration techniques revealed that 237 (46.4%) schoolchildren had intestinal parasite infections. The overall prevalence of *Schistosoma mansoni* infection in the selected primary school was 140 (27.4%). In addition to *Schistosoma mansoni*, *Ascaris lumbricoids158* (30.9%), *Hook worm* 41 (8%), *Trichuris Trichiura* 24 (4.3%), *Hymenolepis nana* 20 (3.9%), *Giardia lamblia18* (3.5%), *Enterobius vermicularis* 9 (1.8%) and *Tenia species* 7 (1.4%) were other parasites detected during investigation Figure 4.

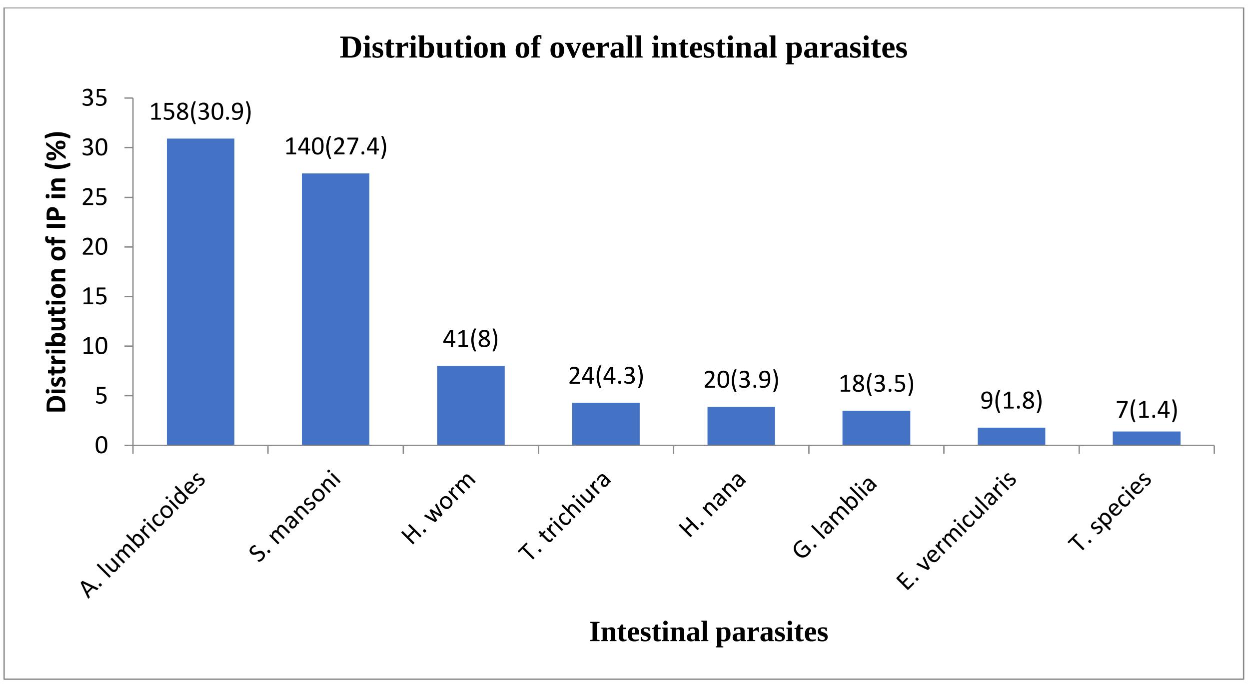

Figure 4: The distribution of overall intestinal parasite among schoolchildren in Jima Arjo district

Table 2: The prevalence of *Schistosoma mansoni* and intestinal parasite among schoolchildren detected using Kato Katz and formal ether concentration techniques.

Parasite detected	Kato-Katz smear n (%)	Formol ether Concentration n (%)	Overall n (%)
Schistosoma mansoni	133(26.0)	109(21.3)	140(27.4)
Ascaris lumbricoides	148(29)	129(25.2)	158(30.9)
Hook worm	23(4.5)	32(6.2)	41(8)
Trichuris trichiura	18(3.5)	13(2.5)	24(4.3)
Hymenolepis nana	17(3.4)	16(3.1)	20(3.9)
Enterobius vermicularis	8(1.6)	6(1.4)	9(1.8)
Taenia species	5(1.1)	3(0.8)	7(1.4)
Giardia lamblia	_	18(3.5)	18(3.5)

The infection prevalence of *Schistosoma mansoni* was 82(34.9%) and 58(21%) between male and female school children respectively. The school children with the age group of 15-19 was more infected. The infection prevalence also varies among the schools from 23.8% to 33.5% with the highest prevalence 33.5% was revealed in Abote primary school. School children with families who work as daily laborers were the most affected, followed by individuals with farming families Table (3).

Table 3:The distribution of *Schistosoma mansoni* by socio-demographic other factors among schoolchildren in Jima Arjo district 2023.

Characteristics	Category	Total%	S. mansoni Pos (%)	S. mansoni neg (%)
Sex	Male	235(46)	82(34.9)	153(65.1)
	Female	276(54)	58(21)	218(79)
Age(years)	5-9	87(17)	10(11.5)	77(88.5)
	10-14	309(60.5)	89(28.8)	220(71.2)
	15-19	115(22.5)	41(64.3)	74(35.7)
School of students	Arjo	130(25.5)	32(24.6)	98 (75.4)
	Abote	179(35.5)	60(33.5)	119(66.5)
	Lugama	202(39)	48(23.8)	154(76.2)
Grade of students	1-4	303(59.3)	69(22.8)	234)(77.2)
	5-8	208(40.7)	71(34.1)	137(65.9)
Occupation of family	Government employ	11(2.3)	2(18.2)	9(81.8)
	Farmer	441(86.3)	124(28.1)	317(71.9)
	Merchant	13(2.3)	1(7.7)	12(92.3)
	Private employ	15(2.9)	4(26.7)	11(73.3)
	Daily laborer	31(6.1)	9(29)	22(71)
Family income	Low (<1000)	433(84.7)	125(28.9)	308(71.1)
	Middle (1000-3000)	62(12.1)	13(21)	49(79)
	High (>3000)	16(3.1)	2(12.5)	14(87.5)
Father educational Status	No formal education	347(67.9)	105(30.3)	242(69.7)
	Primary	121(23.7)	28(23.1)	93(76.9)
	Secondary	33(6.5)	4(12.1)	29(87.9)
	College and above	10(2)	3(30)	7(7)
Mother educational status	No formal education	407(79.6)	117(28.7)	290(71.3)
	Primary	79(15.7)	20(25.3)	59(74.7)
	Secondary	18(3.5)	2(11.1)	16(88.9)
	College and above	7(1.2)	1(14.3)	6(85.7)
Latrine at home	Yes	228(44.6)	74(32.5)	154(67.5)
	No	283(55.4)	66(23.3)	217(76.7)
Defecation area at home	Latrine	205(40.1)	66(32.2)	139(67.7)
	Open field	306(59.9)	74(24.2)	232(75.8)

5.3 Intensity of *Schistosoma Mansoni* Infection

Among 140 *Schistosoma mansoni* infected study participants,133 were positive by Kato- Katz technique which uses standard amount of stool and enables the quantification of ova per gram of stool. The minimum and maximum egg per gram of stool was 24 and 1203 respectively. According to WHO cut off values the ova of *Schistosoma mansoni* 99 (75%), 27 (20%) and 7 (5%) were classified as light, moderate and heavy infection intensity respectively. The majority of infection intensity was classified as light infection intensity with arithmetic and geometric mean of egg count 127.9 and 73.85 respectively figure 5.

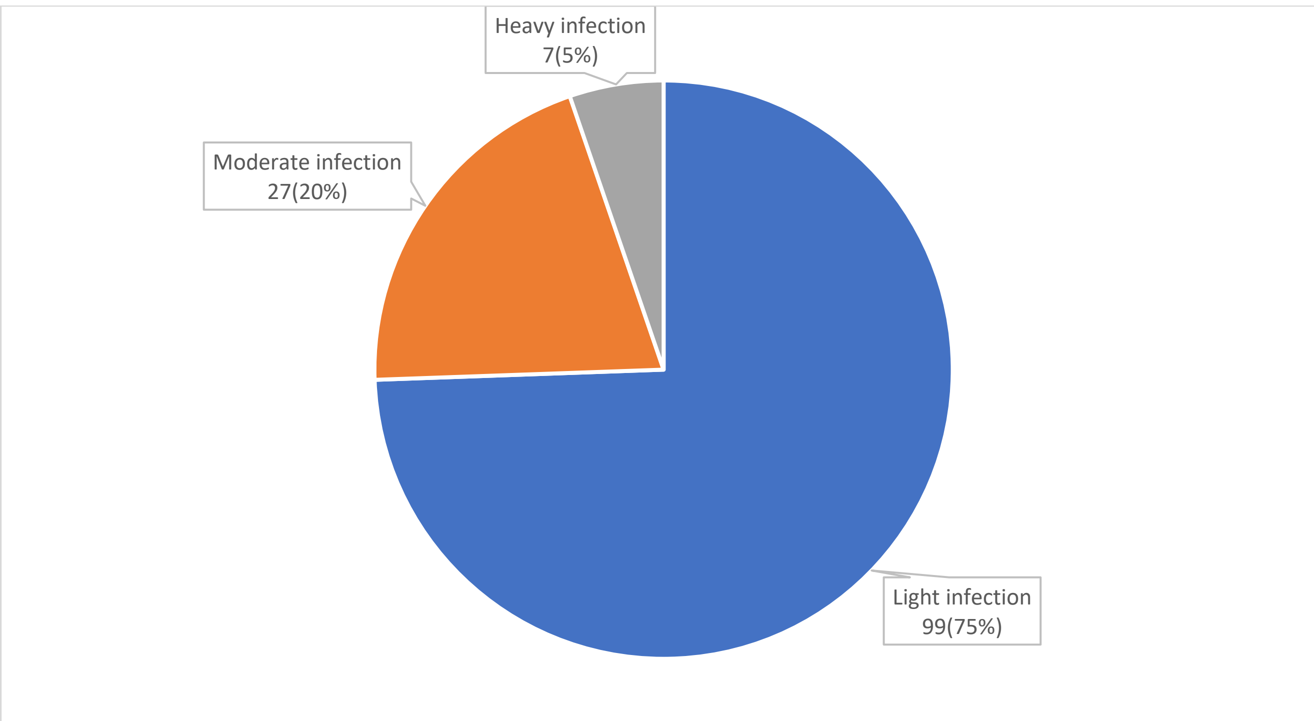

Figure 5: Infection Intensity of *Schistosoma mansoni* among schoolchildren in Jima Arjo district 2023.

5.4 Potential Associated factors with *Schistosoma Mansoni* Infection

The distribution of *Schistosoma mansoni* infection was higher in male (34.9%) than female (21%), yet a high number of female students were involved in the study. In bivariate logistic regression analysis, a variety of activities related to different water bodies, such as washing cloth in canal water, washing cloth in spring water, bathing in canal water, bathing in spring water, herding cattle in the water fields, swimming habits, fishing habits, crossing water bodies on bare foot, and engaging in irrigational-related activities, were candidates with a p-value less than 0.25 to identify an associated factor for *Schistosoma mansoni* infection. In addition to this, socio-demographic and other factors such as gender, age, grade, a father's educational status (primary and secondary school), latrine status, frequency of water contact, and distance of home from water bodies were also candidate predictors of *Schistosoma mansoni* infection. In multivariable logistic regression analysis, irrigation-related activities, swimming habits, habit of bathing in canals and spring water, and crossing rivers on bare feet had p-values less than 0.05 and put schoolchildren at higher odds of contracting Schistosoma mansoni infection Table 4.

Table 4:Bivariate and multivariable analysis of Schistosoma mansoni by socio-demographic and associated factors among schoolchildren in Jima Arjo district.

Variables	*S. mansoni* infection		COR (95% CI)	p-value	AOR (95%CI)	p-value
	Positive%	Negative%				
Gender						
male	82(34.9)	153(65.1)	1		1	
female	58(21)	218(79)	0.496(0.335-0.737)	0.001	1.428(0.773-2.637)	0.255
Age category						
5-9	10(11.5)	77(88.5)	1		1	
10-14	89(28.8)	220(71.2)	3.115(1.542-6.294)	0.002	1.602(0.676-3.797)	0.285
15-19	41(64.3)	74(35.7)	4.266(1.992-9.135)	0.001	1.593(0.514-4.933)	0.420
School of students						
Arjo	32(24.6)	98 (75.4)	1			
Abote	60(33.5)	119(66.5)	0.955(0.571-1.596)	0.859		
Lugama	48(23.8)	154(76.2)	1.544(0.930-2.560)	0.292		
Grade of students						
1-4	63(21.2)	234(78.8)	1		1	
5-8	77(36)	137(64)	1.758(1.187-2.603)	0.005	0.883(0.444-1.753)	0.721
Occupation of family						
Government employ	2(18.2)	9(81.8)	1			
Farmer	124(28.1)	317(71.9)	1.760(0.375-8.262)	0.474		
Merchant	1(7.7)	12(92.3)	0.375(0.029-4.809)	0.451		

Private employ	4(26.7)	11(73.3)	1.636(0.242-11.077)	0.614		
Daily laborer	9(29)	22(71)	1.841(0.331-10.253)	0.486		
Family income						
Low (<1000)	125(28.9)	308(71.1)	1			
Middle (1000-3000)	13(21)	49(79)	2.841(0.636-12.683)	0.274		
High (>3000)	2(12.5)	14(87.5)	1.857(0.374-9.224)	0.449		
Father educational status						
No formal education	98(31.1)	217(68.9)	1		1	
Primary	33(23.1)	110(76.9)	0.694(0.429-1.122)	0.136	0.729(0.402-1.322)	0.298
Secondary	6(14.6)	35(85.4)	0.318(0.109-0.927)	0.036	0.275(0.072-1.055)	0.060
College and above	3(25)	9(75)	0.988(0.251-3.894)	0.986		
Mother educational status						
No formal education	117(28.7)	290(71.3)	1			
primary	20(25.3)	59(74.7)	0.840(0.484-1.457)	0.536		
secondary	2(11.1)	16(88.9)	0.310(0.070-1.369)	0.322		
College and above	1(14.3)	6(85.7)	0.413(0.049-3.469)	0.415		
Latrine at home						
Yes	74(32.5)	154(67.5)	1		1	
No	66(23.3)	217(76.7)	0.633(0.428-0.936)	0.022	0.649(0.389-1.085)	0.099
Defecation area at home						
Latrine	66(32.2)	139(67.7)	1			
Open field	74(24.2)	232(75.8)	0.672(0.454-0.995)	0.470		
Water contact Frequency						
1-3days/ week	40(14.7)	232(85.3)	1		1	
4 and above days Per week	100(41.8)	139(58.2)	1.463(0.982-2.180)	0.062	1.322(0.795-2.196)	0.282
Herding cattle in water field						
Yes	95(33.2)	191(66.8)	1		1	
No	45(20)	180(80)	0.503(0.334-0.757)	0.002	1.019(0.581-1.787)	0.948
Irrigation involvement						
Yes	86(45.7)	102(54.3)	4.432(2.931-6.702)	0.001	4.496(2.431-8.317)	0.001*
No	54(16.7)	269(83.3)	1		1	
Swimming experience						
Yes	51(60.7)	33(39.3)	1		1	

No	89(20.8)	338(79.2)	0.170(0.104-0.280)	0.001	0.310(0.156-0.619)	0.001*
Place of washing						
River	24(17.9)	110(82.1)	1		1	
Canal	59(57.8)	43(42.2)	5.879(3.271-9.358)	0.001	0.831(0.245-2.820)	0.766
Spring	31(37.3)	52(62.7)	2.732(1.460-5.114)	0.002	1.576(0.447-5.559)	0.480
Home	26(13.5)	166(86.5)	0.731(0.399-1.399)	0.310		
Place of bathing						
River	32(14.9)	183(85.1)	1		1	
Canal	66(56.9)	50(43.1)	7.258(4.304-9.766)	0.001	5.190(1.785-15.090	0.002*
Spring	35(36.1)	62(63.9)	3.336(1.903-5.846)	0.001	3.378(1.114-10.247	0.032*
Home	7(8.4)	76(91.6)	0.527(0.223-1.245)	0.144	1.287(0.437-3.791)	0.648
Crossing water on bare-foot						
Yes	90(49.5)	92(50.5)	1		1	
No	50(15.2)	279(84.8)	0.183(0.121-0.278)	0.001	0.306(0.171-0.549)	0.001*
Fishing habit						
Yes	28(65.1)	15(34.9)	1		1	
No	112(23.9)	356(76.1)	0.395(0.195-0.799)	0.010	1.776(0.663-4.755)	0.253
Distance of home from water bodies						
Near(<1Km)	97(43.9)	124(56.1)	1		1	
Far(≥1Km)	4314.8)	247(85.2)	0.530(0.358-0.785)	0.002	0.623(0.382-1.018)	0.069
Abdominal pain						
Yes	98(61.6)	61(38.4)	1			
No	42(11.9)	310(88.1)	0.551(0.362-0.840)	0.276		
Diarrhea						
Yes	43(68.3)	20(31.7)	1			
No	97(27.4)	351(72.6)	1.146(0.578-2.272)	0.696		
Blood in stool						
Yes	25(83.3)	5(16.7)	1			
No	18(54.5)	15(45.5)	0.240(0.074-0.781)	0.318		

CHAPTER SIX: DISCUSSION

This study was intended to assess the prevalence, intensity, and associated factors of *schistosomiasis mansoni* infection among schoolchildren along the irrigated area in Jima Arjo woreda. Accordingly, the prevalence of *Schistosomiasis mansoni* infection was found to be 27.4%. The result of this study indicates that the schoolchildren in the selected study area had a moderate prevalence (≥10%, but<50%) according to WHO guidelines for preventive chemotherapy by parasitological methods of *Schistosoma mansoni* infection and serves as a base line to design strategies for interventions to improve the health of the students(WHO, 2022). The present study also indicates that the majority of the infection intensity was light (75%), followed by moderate (20%) and heavy (5%) infection intensity according to WHO cut-off values based on EPG values of 1-99, 100-399, and >400, respectively (WHO, 2011). The result of the analysis revealed that irrigation-related activities, swimming habits, bathing habits in canals and spring water, and crossing rivers on bare feet put schoolchildren at higher odds of contracting *Schistosoma mansoni*.

The present study revealed that 27.4%(95%CI:24,31%) of schoolchildren in the study areas were infected with *S. mansoni.* This finding is consistent with previous research from Jimma town (28.7%)(Tefera *et* al., 2020), Lake Hawassa (31%)(Tadege and Shimelis, 2017), Sanja town(26.7%)(Worku *et* al., 2014), and Manna district(24%) (Bajiro *et* al., 2016). In contrast to this finding, the prevalence of *Schistosoma mansoni* infection in this study was higher than reports from Wondo district (11.4%)(Ansha *et al*., 2020), Guangua district (12.6%)(Tazebew *et* al., 2022), the suburbs of Mekele city (23.9%)(Assefa *et al.*, 2013), Kafr El-Sheikh in Egypt (19.1%)(Ghazy *et al.*, 2022) and Al-Shmaytin & Al-Mwaset districts-Taiz governorate's-Yemen(14.6%)(Al-Kabab *et al.*, 2023). The observed difference may be due to the number of slide Kato Katz techniques used to diagnose, the sample size, the study period, the environmental factors that suit the snail intermediate host, proximity to water bodies, and the number of parasitological methods used during the investigation.

On the other hand, the prevalence of *Schistosoma mansoni* infection in this study was lower than reports in Lake Tana in northwest Ethiopia (34.9%)(Hailegebriel *et* al., 2021), and, Gomma district (73.8%)(Bekana *et* al., 2022), Damot Woide District of Wolaita Zone (81.3%)(Alemayehu and Tomass, 2015), Fincha valley in Wollega (67.6%)(Haile *et* al., 2012), Democratic Republic of the Congo (40%)(Nigo *et* al., 2021), and Busega district in Tanzania (41.3%)(Ogweno *et* al., 2023). This discrepancy could be attributed to the long-term development of water sources in those areas, the high-frequency water contact behavior of children, changes in climatic conditions, the distance of home from water sources, study period, and the duration of endemicity in that area.

The findings of this study revealed that the majority of *Schistosomiasis mansoni* infection intensity was light (75%), which is consistent with reports from various parts of Ethiopia, such as Jimma town (53.2%)(Tefera et al., 2020), Wondo district (97%) (Ansha et al., 2020), around Lake Tana (61.4%) (Hailegebriel et al., 2021) , and in other parts of Africa, such as Busega district in Northern Tanzania (39.9%) (Ogweno et al., 2023) , and in hotspot areas of Egypt (83.5%) (Ghazy et al., 2022). On the other hand, the result was different with the study in which the infection intensity was moderate, such as the study conducted in Fincha Valley in wollega (38.7%), Northwest (38.7%), Northwest Ethiopia (42%), and in the north-eastern Democratic Republic of the Congo (73.1%), and in which the infection intensity was heavy. This discrepancy could be attributed to differences in exposure to water sources, reinfection rates, the diagnostic techniques employed, and may be the experience of professionals involved in the examination.

A significant association with *Schistosoma mansoni* infection was seen among students who bath in canals and spring water compared to those who bath in river water. The risk of developing the infection was 5.2 and 3.4 times higher when bathing in canal water and spring water than when bathing in river water, respectively. The association between *S. mansoni* infection and the bathing habits of students was documented (Tefera *et al*., 2020), (Hailegebriel *et* al., 2021), and (Ghazy *et* al., 2022). There might be a high chance of being infected with schistosome cercariae-infested water bodies during bathing, in the spring and canal water bodies, as there was more frequent contact and they were more suitable for the survival cercariae because of the stability of the water than river water bodies because of the high-speed flow of water and marine contents, which may harm the snail.

This study found a strong association between students who were active in an irrigation-related farming and students who were not participating in an irrigation-related activities. Those who had irrigational engagement were 4.49 times more likely to be infected than those who had no such irrigational engagement. As also reported by others (Tazebew *et* al., 2022), (Assefa *et* al., 2013), (Tadege and Shimelis, 2017), and (Ghazy *et* al., 2022), the higher infection rate among students involved in irrigation-related activities may be because they relatively had more water contact frequency during bathing, washing, swimming in the canal water, and performing irrigation-related farming activities, which were shown to have more infections compared to those who had no such practices.

An important association was seen among students with crossing water bodies on bare feet. Students who were not crossing water bodies with bare feet were 0.3 times less likely to contract the *S. mansoni* infection than those who crossed water bodies with bare feet. This independent predictors for *Schistosoma mansoni* infection was shown in studies reported from (Tefera *et* al., 2020), (Essa *et* al., 2013), (Worku *et* al., 2014). This association could be due to barefoot crossing of small water bodies such as streams, ponds, and canal waters, which allows cercariae to easily penetrate. Children who had the practice of swimming were shown to have more *Schistosoma mansoni* infections compared to those who had no such practices. The odds of contracting a *Schistosoma mansoni* infection were 0.3 times lower in students who had no swimming habit than students who did. The findings were consistent with those reported by (Ansha *et* al., 2020), (Tazebew *et* al., 2022), (Tefera *et* al., 2020), and (Menjetta *et* al., 2019), indicating that children that have swimming habit were more likely to contract schistosomal infections.

6.1 Conclusions

The prevalence of *Schistosomiasis mansoni* infection was 140 (27.4%) which indicates that the schoolchildren in the selected study area had a moderate prevalence (≥10%, but<50%) according to WHO guidelines for implementing preventive chemotherapy based on the prevalence of the infection. The study also indicates that the majority of the infection intensity was light 99 (75%), followed by moderate 27 (20%) and heavy 7 (5%) infection intensity according to WHO cut-off values based on EPG values of 1-99, 100-399, and >400, respectively (WHO, 2011). Furthermore, as much of the exposure to *Schistosoma mansoni* infections was associated with irrigation-related activities, swimming habits, bathing habits in canals and spring water, and crossing rivers barefoot, those factors should be adequately addressed to sustain the impact of a mass deworming administration program.

6.2 Recommendations

On the basis of WHO, prevalence-based guidelines for treatment Biannual (twice a year) mass drug administration should be implemented in order to reduce the transmission, improve the health outcomes of infected individuals, and prevent the complications of the disease. Moreover, addressing contributing factors is also required through applying modest interventions like environmental interventions like water engineering and focal snail control by using molluscicides, as well as behavioural change interventions through health education, so as to increase awareness of the infection and reduce the burden and transmission of *Schistosoma mansoni* infection.

6.3 Limitation of the study

The investigation has some limitations to be considered typically, as it was impossible to determine the causal-effect relationship, which was the inherent problem of the cross-sectional study design used in the research process. The recall ability and commitment of the children's parents or guardians to offer real data determine the quality of data on associated factors of parasite infection; consequently, a recall and/or information bias may be introduced.

6.4 Strength of the study

The strength of this study was that it used a combination of formol ether concentration and triple Kato Katz techniques to investigate the *Schistosoma mansoni* infection so as not to miss the ova of the parasite. Typically, the sensitivity of the Kato Katz technique was increased through the preparation of a triple slide per individual. A specific population that was living in a high-risk area that was along an irrigation line was researched.

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ANNEX I: SUBJECT INFORMATION SHEET, INFORMED ASSENT AND INFORMED CONSENT

Information Sheet

Introduction

My name is Kumsa Asefa and I am working research from Hawassa university on prevalence, intensity and factors associated with *s. mansoni* infection Among school children along the irrigation line in Jima Arjo woreda, East Wollega, western Ethiopia. Before you decide to participate in this research, it is important for you to understand why the research is being done and what it will involve. For you to be in this study both you and your parent (or guardian) must agree to you being in it. It is your parent (or guardian) job to make sure the benefits and risks of this study are okay for you. But it is still up to you if you want to do it.

The purpose of the study

To determine the prevalence, intensity and factors associated with *Schistosoma mansoni* infection among primary school children along the irrigation line in Jima Arjo woreda. The *Schistosoma mansoni* infection was present in a number of kebele, according to the Jima Arjo clinical information. Thus, you are the main population at risk for this infection. The study will include 523 students. Therefore, you are qualified to take part in this study.

Procedures: - Following your willingness, you are asked to sign assent form and the following procedures will be undertaken.

- A physical examination will be undertaken
- You will provide us 10 minutes interview
- Your child will provide 4 mg of feces, which is about two a large teaspoon.
- There is no risks and discomforts at all.
- The stool sample will be analyzed to determine *S. mansoni* infection.

Benefits: - This study will be of benefit to the entire school children since its success will aid in proper prevalence and school-based mass drug administration treatment of students. There is no direct financial benefit you get by participating in this study but the test result will be delivered timely and appropriate intervention will be pointed.

Confidentiality: - Any information obtained during this study will be kept confidential. This is assured by avoiding use of any identifier and information will be recorded with code number. Should we release the result obtained from the study, it is in the way that avoids any identifier of you and if there is any identifier, there should be signed confirmation of you.

Voluntary participation: - Participation on this study is voluntary and you have the right to refuse from participating at any time. Your decision will not result in any penalty or loss of your benefits to which you entitled. Your decision will not put you at risk any present or future medical care or other benefits to which you otherwise entitled. You may ask questions now and, in the future, if you do not understand something that is being done. For the success of the study, I was asking you to give the correct answer for the respective questions.

Parents/guardian consent form

I have read this informed form or someone has read it to me. If I do not understand something, I ask the nurses or principal investigator to explain it to me. I can always ask the nurses or principal investigator a question about the study if I don’t understand something. I will be given a copy of this form.

- ☐ YES, I let my child to be in this study and I know I can change my mind later.
- ☐ NO, I do not let my child to be in this study

Parents/guardian name: ____________ Signature: __________________ Date: ____________

Whom to Contact: If you have any questions, contact any of the following two individuals and you may ask at any time you want:

1. Dr. Solomon Asnake – Hawassa University, College of Medicine and Health Science, and department of Medical Laboratory Sciences, Hawassa, Ethiopia. Telephone no-0912088346

2. Mr. Mulgeta Mengistu -Hawassa University, College of Medicine and Health Science, Department of Medical Laboratory Science, Hawassa, Ethiopia. Telephone- 0916828543

3. Kumsa Asefa- Principal Investigator. Telephone no-0917838709

ANNEX II: GUCA WALII GALTEE

Yeroo ammaa kana qorannoo dhibee garaa keessa fi ka’umsa dhukkuba kanaa Ijoollee mana barnoota kana keessatti argamaan Dhiha Itiyoophiyaa, Godina Wallagaa bahaa, Aanaa Jimmaa Arjootti geggeessaa waan jirruuf isinis kana hubachuun daa’imni keessan kana keessatti akka qooda fudhatan kabajaan isin gaafanna. Qorannoo gaggeeffamu keessatti daa’ima osoo hin hirmaachisiin dura faayidaa qorannichaa fi ga`ee isin irraa eegamu irratti gaaffii fi yaada qabdan akkassumas dhimmoota isiniif hingalle irratti gaafattanii hubannoo keessan cimsachuu akka dandeessan isiniif mirkaneessuu barbaanna.

Odeeffannoo waliigalaa Qorannichaa

Qorannoon kun dhibee garaa keessa adda baasuuf sakattainsi bobbaa kan gaggeeffamu ta`a. Qorannicha keessatti daa’imman hirmaachuun miidhama qaamaa, hawaasumaafi sammuu kamiyyuu qaqqabsiisuu akka hin dandeenye isiniif mirkaneessuu barbaanna.

Bua`a qorannichaa irraa siniifi daa’imni kallattin fayyadamaa ta’uu baattanis  sagantaawwan ittisaa fi to`annoo dhibee garaa keessa akka biyyaatti hojiirra ooluu jajjabeessuuf fayyadamaa isin taasisa. Qorannicha keessatti daa’imni qooda akka fudhatuun fi ykn dhiisu mirga guutuu qabda.

Odeeffannoo dhunfaadaa’ima qorannicha keessatti hirmaatee qaama biraaf kennuu fi maqaa daa’ima sanaa gabaasa kamuu keessatti hindhiyaatu. Hirmaannaan taasifamu kaffaltii hin qabu. Gaaffii fi yaada yoo qabaattan teessoo fi bilbilli keenya kan armaan gaditi.

1.Dr. Salamon Asnaaqaa   lakk.bilbilaa: 0912088346

2.Kumsaa Asaffaa   Lakk.bilbilaa:0917838709

ANNEX III: ENGLISH QUESTIONARRIES

HAWASSA UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCE

DEPARTMENT OF MEDICAL LABORATORY SCIENCE

A research questionnaire developed to collect all necessary information for the study entitled as prevalence, intensity and associated risk factor among primary school children along the irrigation line in Jima Arjo woreda.

I. Question related to background information

S/N	Questions	Possible answers	Remark
1	Gender	1.male 2.female	
2	How old are you?	________	
3	What is your kebeles?	1.Arjo Didesa 2. Hara 3.Abote	
4	What is your school?	1.Arjo primary school 2.lugama primary school 3.Abote primary school	
5	What is your grade?	1. 2. 3. 4. 5. 6. 7. 8	
6	Grade level	1.1-4 2.5-8	
7	Do you have Healthy education about disease?	1.no health education 2.had health education	
8	occupation family?	1.employed 2.farmer 3.merchant 4.other	
9	Monthly income family?	In birr_____	
10	Fathers' educational status	1.No formal education	

		2.primary 3.secondary 4.college and above	
11	Mothers' educational status	1.No formal education 2.primary 3.secondary 4.college and above	

II. practice related questions

12	Do you involve in an irrigation practice?	1.yes 2.no	
13	Is there any water you used for swimming?	1.yes 2.no	
14	Can you be swimming?	1.yes 2.no	
15	If "yes" What type of body water you used for swimming?	1.river 2.canal 3.both	
16	Where do you bath?	1.river 2.canal 3.home 4.all	
17	Where do you wash your clothes?	1.river 2.canal 3.home 4.other	
18	Where do you Fetch water?	1.river 2.canal 3.both 4.other	

19	Do you have the habit of fishing?	1.yes 2.no	

III. Environmental related Questions

20	Do you cross river on bare foot?	1.yes 2.no	
21	How far is resident area from water source?	1.near 2.far	
22	Water contact frequency days per week	1.1-3 days per week 2.4 and days per week	
23	Do you have latrine at home?	1.yes 2.no	
24	Where do you Defecate?	1.latrine 2.open field	

IV Questions related to symptoms of the infection

25	Do you have Abdominal pain?	1.yes 2.no	
26	Do you have diarrhea?	1.yes 2.no	
27	If “yes”, is it contain blood?	1.yes 2.no	

Laboratory Result

Test parameter	Result category					Remark
		1k-k slide	2k-k slide	3k-k slide	average	
S. mansoni infection detected by Kato Katz Techniques.	Positive negative					
Infection intensity	Light Moderate heavy					
Other parasitic infections detected by Kato Katz techniques	1. 2. 3. 4. 5.					
S. mansoni infection detected by By formol ether concentration techniques.	1.positive 2.negative					
Other parasitic infections detected by formol ether concentration techniques.	1. 2. 3. 4. 5.					

ANNEX IV: AFAAN OROMOO QUESTIONNAIRE

Qorannichaaf ragaa barbaachisaa ta'e hunda kan babal'ina, ciminaa fi sababoota balaa kanaan walqabatan daa'imman mana barumsaa sadarkaa tokkoffaa Abot Didesa irratti walitti qabuuf gaaffiin qorannoo qophaa'eera.

I. Odeeffannoo Waliigalaa

lakk	Gaaffiilee	deebii	yaada
1	Saala	1.dhiira 2.dhalaa	
2	Umurii waggadhaan	________	
3	Maqaa gandaa	1.Arjo Didesa 2. Hara 3.Abote	
4	Maqaa mana barnoota	1.Arjo sadarkaa 1ffaa 2.lugama sadarkaa 1ffaa 3.Abote sadarkaa 1ffaa	
5	Kutaa barataa	1. 2. 3. 4. 5. 6. 7. 8	
6	Rammaddi kutaa barataa	1.1-4 2.5-8	
7	Hubannoo dhukkubichaa qabduu	1.eyyee, qabnaa 2.lakkii, hin qabnu	
8	Hojii maatii	1.miindeefamaa 2.Qonnaan bulaa 3.daldalaa 4.kanneen biroo	
9	Galii maatii	mallaqaan_____	
10	Sadarkaa barnoota abbaa	1.hin barannee 2.sadarkaa 1ffaa 3.sadarkaa 2ffaa 4.sadarkaa olaano	

11	Sadarkaa barnoota haadha	1. hin barannee 2. sadarkaa 1ffaa 3. sadarkaa 2ffaa 4. sadarkaa olaano	

II. gaaffiilee shaakalaan walqabatan

12	Hojii jaalisiiti ni hirmaata	1.eyyee 2.lakkii	
13	Bishaan daakamu dhiyoo jiraa	1.eyyee 2.lakki	
14	Bishaan ni daaktaa	1.eyyee 2.lakkii	
15	Qaamalee bishaan ati daaktu	1.laga 2.bo'oo 3.lachuu	
16	Eessati dhaqna dhiqaattaa	1.laga 2.bo'oo 3.mana	
17	Uffataa eessatii dhiqattaa	1.laga 2.bo'oo 3.manaa	
18	Bishaan eessa warabdaa	1.lagaa 2.bo'oo 3.burqaa 4.kanneen biroo	
19	Qurxummii ni qabdaa?	1.eyyee 2.lakkii	
20	Miilla qullaa bishaan ni seenta	1.eyyee	

		2.lakki	

III. Gaaffiilee naannoon walqabatan

20	Miilla qullaa bishaan ni seenta?	1.eyyee 2.lakkii	
21	Manni keessan qaama bishaanii irraa hamaam fagaata?	1.dhiyoo(<1km) 2.fagoo(>1km)	
22	Torbeeti guyyaaa meeqa qaama bishaani tutuqtaa?	1.1-3 torbeeti 2.4 fi isaa ol	
23	Mana boolii qabdu?	1.eyyee 2.lakkii	
24	Eessatti bobbaata	1.mana booli 2.dirree	

IV gaaffiillee mallattoo dhukkubichaa

25	Garaa dhukkubii qabdaa	1.eyyee 2.lakki	
26	Garaa kaasaa qabdaa	1.eyyee 2.lakkii	
27	Bobaan kee dhiigaa qabaa	1.eyyee 2.lakkii	

Bu'aa qoraannoo laaboratorii

wanta	Firii argamaan	yaada
Dhibbee S. mansoni	qabaa hin qabu	
Cimina dhukkubichaa	salphaa foyya'aa ulfaata	

ANNEX V: LABORATORY PROCEDURE

Kato-Katz technique

Principle

It is based on the clearing of a thick fecal smear with glycerin in the presence of a background stain, usually malachite green. The eggs appear unstained, although miracidia are not visible.

Procedure

1. Mesh a portion of feces, either by pressing the sieve down on feces placed on filter paper or scrap paper or by pushing the sample through the sieve with a spatula, to remove fiber and other coarse debris.
2. Scrape the flat-sided spatula across the upper surface of the mesh screen to collect the sieved feces.
3. Place the template in the center of a clean microscope slide and fill the hole completely with feces from the spatula. Using the side of the spatula, remove excess feces from the edge of the hole.
4. Carefully remove the template and place a presoaked cellophane strip over the cylinder of feces left on the slide.
5. Invert the slide and press on an absorbent surface (e.g., toilet paper) on a bench top to spread the feces under the cellophane strip.
6. Place the slide with the smear on top to facilitate specimen clearing, and leave for 1-24 hours.
7. Examine the smear systematically within 24 hours and count and report the number of *S. mansoni* ova.

- To calculate the total number of eggs per gram of feces, multiply the number of *S. mansoni* eggs in the smear by an appropriate factor. Since the template hole used contains 41.7 mg of stool, it should be multiplied by 24 so as to report the number of eggs per gramme of stool.

Formal-ether concentration technique

Principle

The principle of formal-ether concentration techniques is the sedimentation of the high specific gravity of protozoan cysts and helminth eggs relative to the solution in which it is contained. the denser organisms will settle out of the less dense solution, either by gravity or by centrifugation.

Procedure

1. Mix about half large teaspoon with 10ml of 10% formalin in a 15ml tube.
2. Strain or filter the fecal suspension through gauze placed over a funnel in to a 15ml of conical centrifuge tube.
3. Add 0.85% saline or 10% formalin through the debris on the gauze to bring the volume in the centrifuge tube to 15ml.
4. Centrifuge at 2000rpm for 10 minutes.
5. Decant supernatant, and add 10ml of 10% formalin to the sediment and mix thoroughly with the wooden applicator sticks.
6. Add 4ml of ethyl acetate, stopper the tube, and shake vigorously in an inverted position for 30 seconds.
7. Centrifuge at 1500rpm for 10 minutes.
8. Free the plug of debris from the top of the tube by ringing the slides with an applicator stick. Decant the top layers of supernatant.
9. Use a cotton-tipped applicator to remove debris from sides of the centrifuge tube.
10. Add several drops of 10% formalin to resuspend the concentrated specimen.
11. Mix sediment well and take a drop in to the microscopic slide.
12. Cover with a coverslip and observe first for the presence of parasitic forms under low power (10X) objective, and then high power (40X) objective under the microscope.