Acta Scientific Veterinary Sciences (ISSN: 2582-3183)

Volume 7 Issue 4 April 2025

Research Article

Intestinal Schistosomiasis: Prevalence, Infection Intensity (Burden) and Associated Risk Factors, a School-Based Study

Behablom Meharenet[1]*, Solomon Girma[2], Mintesnot Tsegaye[1] and Mersha Alene[3]

[1]Animal Health Institute, Addis Ababa, Ethiopia

[2]Oromia Regional Health Office, Delo Mena District Health Office, Ethiopia

[3]MULU KP Activity Project, Population Services International, Ethiopia

***Corresponding Author:** Behablom Meharenet, Animal Health Institute, Addis Ababa, Ethiopia.

Received: March 11, 2025

Published: March 31, 2025

Abstract

The disease schistosomiasis is commonly caused by two major species, namely, *S haematobium* and *S mansoni* in Ethiopia. The primary objective of the study was to determine the burden of the disease and associated risk factors of intestinal schistosomiasis in and around Delo-Mena district from March to June,2022. The study included an age group of students ranging from 5-14 years with a mean participant age of 9.25 years old. A school-based quantitative cross-sectional study was conducted among two selected primary/elementary schools after completing the interview through a prepared questioner. Parallelly based on the interview, collected stool samples from each individual were processed at the field and facility using single Kato-Katz and Ritchie's concentration techniques for the presence and absence of *S mansoni* eggs as well as infection burden or intensity. A total of n = 250 school children were included during the study with a composition of 37.6% female and 62.4% male. The overall prevalence of *S mansoni* infection was 39.2%, n = 98 (moderate). Among compared determinant risk factors and sociodemographic characteristics, sex, residence, sources of water, and swimming habit had shown a strong statistical association, AOR = 3.11 (1.75,5.51), 0.26 (0.15,0.45), 0.37 (0.21,0.63) and 16.92 (8.11,35.29), respectively p < 0.000. The intensity of *S mansoni* infection was found to be heavier in male students n = 28 (11.2%) when compared to females, p < 0.000. Similarly, students engaged in swimming were more exposed to heavier infection than non-swimmers, n = 31 (13.6%) and n = 3 (1.2%), respectively, with AOR = 16.92(8.11,35.29), p < 0.000. Despite students who had a swimming habit, frequent swimming was also strongly related with heavier *S mansoni* infection with n = 28(11.2%) and n = 3(1.2%), respectively, when students swim always and sometimes. The study concluded with the recommendation of an integrated control strategies due to the resulted burden of infection which was lined to moderate level.

Keywords: Intestinal Schistosomiasis Prevalence; Infection Intensity; Delo-Mena District

Introduction

Schistosomiasis, caused by parasitic flatworms, is a disease of profound medical and veterinary importance, affecting over 240 million people, with over 90% of these in sub-Saharan Africa (SSA) countries [1]. It is endemic in Ethiopia, where more than 37.3 million people are living in endemic areas and about 5 million people are infected [2,3], consequently considered as one of the major causes of outpatient morbidity in the country [4,5].

The disease schistosomiasis is commonly caused by two major species, namely, *S haematobium* and *S mansoni* in Ethiopia, the latter being the most prevalent and widely distributed species. The burden and prevalence of intestinal schistosomiasis are significantly varied from area to area depending on the suitability of snail intermediate hosts and the level of environmental sanitation. Some conducted parasitological studies in the country showed that the prevalence of *S mansoni* is ranged from 10% to 92% [6-10]. Recently in Ethiopia, S *mansoni* infection is reported in almost all administrative regions and is rapidly spreading in connection with water resource development and intensive population movements [11].

People become infected with *S mansoni* when the larval forms or stages of the parasite released from the intermediate host freshwater snails penetrate the skin through contact with infested water [12]. Transmission or life cycle of the disease occurs when people suffering from schistosomiasis contaminate freshwater sources with their excreta containing parasite eggs, then hatch in the water to infect intermediate host fresh water snails [13,14]. In the human body, the larvae or infective cercaria develop into adult schistosomes. Adult worms live in the blood vessels where the females release eggs, and some amounts of eggs are passed out of the body in the faeces or urine to continue the parasite's life cycle. Others become trapped in body tissues, causing immune reactions and progressive damage to organs [13].

Individuals who have been exposed to fresh or salt water may develop a pruritic rash due to cercarial dermatitis (also called swimmer's itch) [15,16]. Patients with acute schistosomiasis (Katayama fever) present usually 4-8 weeks after contact with infested water. It occurs 2-8 weeks after exposure to *S japonicum* or *S mansoni*. Symptoms of schistosomiasis are caused not by the worms themselves but by the body's reaction to the eggs. Eggs shed by adult worms that do not pass out of the body can become lodged in the intestine or bladder, causing inflammation or scarring. Children who are repeatedly infected can develop anemia, malnutrition, and learning difficulties. After years of infection, the parasite can also damage the liver, intestine, spleen, lungs, and bladder. Without treatment, schistosomiasis can persist for years. Signs and symptoms of chronic schistosomiasis include: abdominal pain, enlarged liver, blood in the stool or blood in the urine, and problems passing urine. Chronic infection can also lead to an increased risk of liver fibrosis or bladder cancer [17].

Therefore, the main objective of the study was to determine the burden of the disease and associated risk factors. Specifically, the objective of the study was intended to determine the prevalence, determine the magnitude of infection intensity (burden) based on EPG count, and assess the associated risk factors.

Methods

Study area and period

Delo-Mena district, Bale Zone, is situated towards South Eastern Ethiopia around 600 kms far from the capital city, Addis Ababa. Its altitude is less than 1,500 meters above sea level. The area is also known for its production of cereals, chickpeas, and haricot beans as important crops, and coffee is the main cash crop in the area [18]. Yadot (urban) and Birbire (rural) primary schools are found in the center and periphery of Delo-Mena town where almost all students are urban and rural residents, respectively [19]. The study was conducted from March to June, 2022.

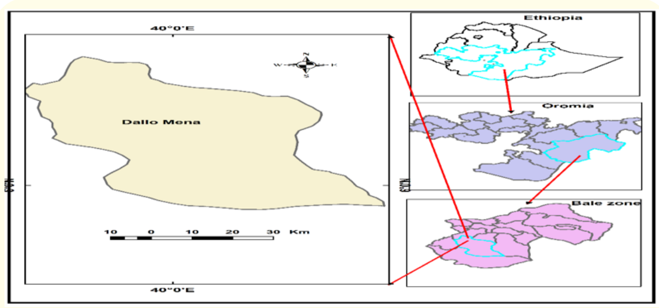

Figure 1: Map of the study area.

Study design

A school-based quantitative cross-sectional study was conducted among two selected primary/elementary schools of Delo-Mena district, Bale Zone, based on their centripetal distance to the main river stream called Yadot. The stool samples were collected, properly, labeled, and processed from all students using a single Kato-Katz and Ritchie's concentration technique parallelly after the questioner used to access the potentially associated risk factors was properly filled by properly trained experts.

Population

Source of population

All school students who were attending in both Yadot (urban) and Birbire (rural) schools were used as a source population.

Study population

Both Yadot (urban) and Birbire (rural) primary/elementary school students who were attending classes were used as the study population.

Inclusion and exclusion criteria

Inclusion criteria

Both Yadot (urban) and Birbire (rural) primary/elementary school students who were attending classes from grades 1-8th and age between 5 to 14 years were included during the study.

Exclusion criteria

All students who were older than 15 years of age and who were not willing to participate in the study are intentionally excluded from the study to control the sampling distribution and bias.

Sample size and sampling technique determination

Both schools from Yadot (urban) and Birbire (rural), are selected purposively to obtain a representative sample area, and a stratification was used since the district were homogenous in all aspects as urban and rural therefore, certain homogeneous, or similar subareas, are represented. The sample size was determined using a single population proportion formula with the assumption of marginal error of 5%, 5% confidence level, and from a previously conducted study with a prevalence of schistosomiasis 12.6% [19]. Therefore, the minimum sample size required for the study was The sample size (n) required for the study will be determined using a single population proportion formula

$$n_0 = \frac{Z^2pq}{e^2}$$

= 1.96^2*0.126*0.814/0.0025 = 170, since the population size was less than 10,000 and expected to be 1,500, therefore, the corrected sample size will be determined by = 169.14/ (1+(169.14-1)/1500) = 242 = 168. Finally, the calculated sample size was 170. However, the target population (N) is less than 10,000 (1500), so a correction formula was used. Therefore, the final required sample size is determined as 250.

Data collection procedure

Questionnaire method

After receiving informed consent from research participants, data were collected using a pretested and structured questionnaire by the health workers. The questions were read face-to-face for each participant/child's (the interviewer administered a questionnaire of face-to-face) and the responses were recorded. The questionnaire content has had a sociodemographic question, environmental and behavioral factors, and other associated risk factors.

Stool sample collection and laboratory procedure

After completing the interview and questioner, all selected child were requested to bring about 2 grams of his/her stool sample using labelled sterile plastic stool caps. The collected stool samples are processed using single Kato-Katz and Ritchie's concentration techniques. Kato-Katz stool smear was employed by taking 41.7mg of stool samples [20]. All eggs of *S mansoni* are counted from the template and converted to eggs per gram of feces (EPG) by multiplying with 24. The infection intensities are potentially classified as light, moderate, and heavy based on EPG of 1-99, 100–399, and >400, respectively, according to WHO cut-off values [21]. The remaining stool sample was processed using Ritchie's concentration technique. About 0.5 grams of stool sample was placed in a concentration tube that contained 2.5 ml of formalin. The mixture was shaken very well to make it a uniform suspension followed by the addition of 1mL ether. Then, the test tubes were properly mixed and centrifuged at 1500 rpm for three minutes. After discarding the supernatant, the sediments were examined microscopically for the presence of ova and larvae [22].

Data analysis procedure

The collected data including the questioner are entered into a Microsoft Excel work book. Data analysis was done by using IBM SPSS version 26 to assess the prevalence of *S. mansoni* infection and infection intensity. *S mansoni* infection intensity can be calculated as the geometric mean of eggs per gram of stool and arithmetic mean. A one-way analysis of variance (ANOVA) will be used to compare geometric mean parasite counts where two or more than two groups are compared, respectively. A bivariable correlation analysis, risk estimates of adjusted odds ratio, and Pearson Chi-Square was conducted to estimate an overall statistical association among associated or determinant risk factors. The magnitude of the association was expressed as an odds ratio with a 95% confidence interval and a p-value less than 0.05 was considered as statistically significant.

Operational terms

- **Infection intensity**: The infection intensity is potentially classified as light, moderate, and heavy based on EPG of 1-99, 100–399, and >400, respectively, according to WHO cut-off values [21].
- **Stage of Childhood**: Based on some specific published articles, childhood can be categorized into three stages. In childhood, there is the highest general physical activity from 1 to 13 years of age. We can conventionally split it into three stages: nursery (1-3 years), kindergarten (3-7 years), and elementary school (7-13 years) [23].

Ethical and consent of the participant

Informed consent was obtained from both study participants including the questionnaire and sample contributors. Finally, A code number was used to ensure the confidentiality of the participants' information and the result was given to the researchers.

Results

Sociodemography

Total of n = 250 school children from both Yadot and Birbire elementary schools were the study included and comprising n = 94 (37.6%) female and n = 156 (62.4%) male students within an age group ranging from 5-14 years, with a mean participant age of 9.25 years old. Almost an equivalent proportion of students n = 120 (48%) and n = 130 (52%) from grades 1-4th and 5-8th, respectively, were participated, however, the majority n = 164 (65.6%) of the student age group was between 8-14 years of age. From the total of study participants, about n = 79 (31.6%) of the students used a river water for different purposes of drinking and cooking.

Socio demographic characteristics	Frequency (%)
Gender	250
Male	156(62.4)
Female	94(37.6)
School name	250
Yadot	128(51.2)
Birbire	122(48.8)
Age group	250
5-7 years old	86(34.4)
8-14 years old	164(65.6)
Residence	250
Urban	120(48)
Rural	130(52)
Grade	250
1-4th	120(48)
5-8th	130(52)
Source of water	250
Tap	171(68.4)
River	79(31.6)

Table 1: Study population or socio-demographic characteristics of the study.

Prevalence of intestinal schistosomiasis

The overall prevalence of *S mansoni* infection at the study area was resulted to be 39.2%, n = 98. Among the considered associated risk factors, a comparatively higher prevalence rate of *S mansoni* infection, n = 76(48.7%), n = 70(28%), n = 78(31.2%) and n = 88(35.2%) was respectively observed in male, rural, and non-latrine users and swimmer school children. A bivariable correlation analysis and risk estimate of adjusted odds ratio was performed to estimate an overall statistical association among associated or determinant risk factors. However, strong statistically significant association $p < 0.001$ was observed among different contributing risk factors of sex AOR = 3.11 (1.75,5.50), residence AOR = 0.26 (0.15,0.45) and source of water AOR = 0.36 (0.21,0.63), in addition to latrine usage AOR = 0.37 (0.21,0.67), defecation site AOR = 2.42 (1.43,4.07), swimming habit AOR = 16.92 (8.11,35.29) and swimming frequency. Despite the resulting statistical association of swimming habit and *S mansoni* infection with AOR = 16.92 (8.11,35.29), a comparatively higher prevalence rate was observed among swimmer school children, n = 88(35.2%).

Determinant risk factor/sociodemographic characteristics	Observation	Positive (%)	AOR (CI)
Sex	250	98(39.2%)	
Female	94	22(23.4%)	1
Male	156	76(48.7%)	3.109(1.756,5.506) **
School name	250	98(39.2%)	
Yadot	128	40(31.2%)	1
Birbire	122	58(47.5%)	1.994(1.190,3.339) **
Age group	250	98(39.2%)	
5-7 years old	86	24(27.9%)	1
8-14 years old	164	74(45.1%)	2.124(1.210,3.729) **
Residence	250	98(39.2%)	
Rural	130	70(28%)	1
Urban	120	28(11.2%)	0.261(0.151,0.450) **
Grade	250	98(39.2%)	
1-4th	120	34(14.8%)	1
5-8th	130	61(24.4%)	1.983(1.181,3.330) **
Source of water	250	98(39.2%)	
River	79	44(17.6%)	1
Tap	171	54(21.6%)	0.367(0.212,0.635) **
Latrine usage	250	98(39.2%)	
No	168	78(31.2%)	1
Yes	82	20(8%)	0.372(0.207,0.670) **
Defecation site	250	98(39.2%)	
Around river	140	42(16.8%)	1
Far from river	110	56(22.4%)	2.420(1.439,4.070) **
Swimming habit	250	98(39.2%)	
No	110	10(4.0%)	1
Yes	140	88(35.2%)	16.923(8.115,35.289) **
Swimming river	250	98(39.2%)	
Birbire	122	58(23.2%)	1
Yadot	128	40(16.0%)	0.052(0.299,0.840) **
Swimming frequency	250	98(39.2%)	**
No	110	10(4.0%)	
Sometimes	52	21(8.4%)	
Always	88	67(26.8%)	

Table 2: Prevalence of *S. mansoni* among socio-demographic characteristics and determinant associated risk factors.

** Strong statistical significance.

Infection intensity of S. mansoni

From a total of n = 250 students, n = 41 (41.56 ± 3.56), n = 23 (234.78 ± 16.04), and n = 34 (955.35 ± 518.39) had light, moderate and heavy (Mean ± SE) infections, respectively.

Infection intensity	Count	Mean ± SE	95% CI	Significance
Negative (0)	152	0.00	0.00	-
Light infection (1-99 EPG)	41	41.56 ± 3.56	34.37, 48.75	0.00
Moderate infection (100-399 EPG)	23	234.78 ± 16.04	201.53, 268.04	0.00
Heavy infection (>400 EPG)	34	955.35 ± 518.39	774.48, 1136.23	0.00
Total	250	158.34 ± 23.75	111.56, 205.13	0.60

Table 3: Infection intensity of *S mansoni*.

The intensity of *S mansoni* infection was found to be heavier in male students n = 28(11.2%) when compared with female n = 6 (2.4%), p < 0.000. Similarly, students engaged in swimming are more exposed to heavier *S mansoni* infection than non-swimmers, n = 31 (13.6%) and n = 3 (1.2%), respectively, with AOR = 16.92(8.11,35.29), p < 0.000, see Table 2. Despite the student swimming habits, frequent swimming is also strongly related with heavier infection with n = 28(11.2%) and n = 3(1.2%), respectively, when students swim always and sometimes p < 0.000.

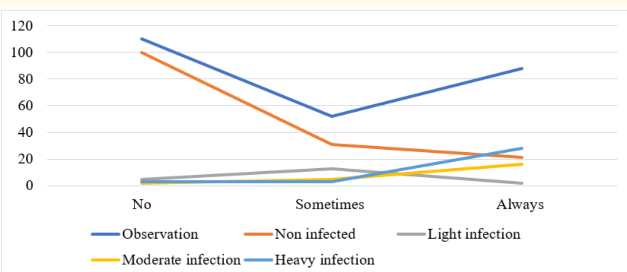

Figure 2: Infection intensity/pattern of *S mansoni* among frequently swimming children of Delo-Mena district from March to June, 2022 study period.

The residence of students also had a significant statistical association with intensity of infection, *S mansoni* was observed among rural n = 31(12.4%) community students than urban n = 3(1.2%), with AOR = 0.261(0.151,0.450) see Table 2, p < 0.000.

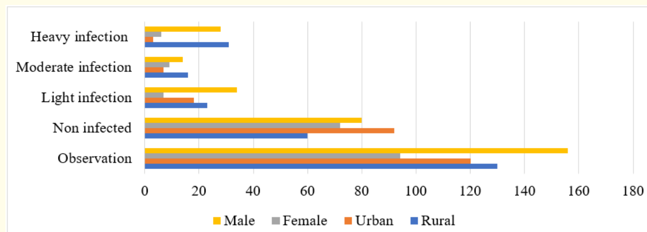

Figure 3: Infection intensity of S mansoni among sex and residence areas of Delo-Mena district.

Moreover, the infection intensity of *S mansoni* was analyzed for all considered determinant risk factors and sociodemographic characteristics of the studied students and their statistical association was found to be significant. Definitely, the intensity of the resulting infection was associated with sex, age group, residence grade, source of drinking water, swimming habit, river, and swimming frequency.

Discussion

The overall prevalence of intestinal schistosomiasis and burden in the study area can be considered as comparable or high in comparison with the findings of other similar studies [6,24-27]. On the other hand, some other related studies have shown that even there was a higher prevalence and infection burden when compared with the current finding [28,29]. However, the overall

Determinant risk factor/ sociodemographic characteristics	Observation, (%)	Non infected, (%)	Light infection, (%)	Moderate infection, (%)	Heavy infection, (%)	Association, p value
Sex	250 (100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.000
Female	94 (37.6)	72(28.8)	7 (2.8)	9 (3.6)	6 (2.4)	
Male	156 (62.4)	80 (32.0)	34 (13.6)	14 (5.6)	28 (11.2)	
School name	250 (100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.016
Yadot	128 (51.2)	88(35.2)	13(5.2)	9(3.6)	18(7.2)	
Birbire	122(48.8)	64(25.6)	28(11.2)	14(5.6)	16(6.4)	
Age group	250(100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.004
5-7 years old	86	62(24.8)	12(4.8)	9(3.6)	3(1.2)	
8-14 years old	164	90(36.0)	29(11.6)	14(5.6)	31(12.4)	
Residence	250(100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.000
Rural	130	60(24.0)	23(9.2)	16(6.4)	31(12.4)	
Urban	120	92(36.8)	18(7.2)	7(2.8)	3(1.2)	
Grade	250(100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.004
1-4th	120	83(33.2)	20(8.0)	10(4.0)	7(2.8)	
5-8th	130	69(27.6)	21(8.4)	13(5.2)	27(10.8)	
Source of water	250(100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.001
River	79	35(14.0)	20(8.0)	12(4.8)	12(4.8)	
Tap	171	117(46.8)	21(8.4)	11(4.4)	22(8.8)	
Latrine usage	250(100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.003
No	168	90(36.0)	36(14.4)	18(7.2)	24(9.6)	
Yes	82	62(24.8)	5(2.0)	5(2.0)	10(4.0)	
Defecation site	250(100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.008
Around river	140	98(39.2)	17(6.8)	9(3.6)	16(6.4)	
Far from river	110	54(21.6)	24(9.6)	14(5.6)	18(7.2)	
Swimming habit	250(100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.000
No	110	100(40.0)	5(2.0)	2(0.8)	3(1.2)	
Yes	140	52(20.8)	36(14.4)	21(8.4)	31(12.4)	
Swimming river	250(100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.016
Birbire	122	64(25.6)	28(11.2)	14(5.6)	16(6.4)	
Yadot	128	88(35.2)	13(5.2)	9(3.6)	18(7.2)	
Swimming frequency	250(100)	152(60.8)	41(16.4)	23(9.2)	34(13.6)	0.000
No	110	100(40.0)	5(2.0)	2(0.8)	3(1.2)	
Sometimes	52	31(12.4)	13(5.2)	5(2.0)	3(1.2)	
Always	88	21(8.4)	23(9.2)	16(6.4)	28(11.2)	

Table 4: Infection intensity of S mansoni and its determinant factors in and around Delo-Mena district.

prevalence can be specifically classified as a moderate prevalence (between10 to 50% by parasitological methods) according to WHO guidelines for preventive chemotherapy in human helminthiasis [30].

The Ethiopian government launched a mass drug administration (MDA) for school-aged children during 2015, after a year letter of persistent intervention, somewhat comparatively 9.6% of the prevalence rate was reported at the study area before six years ago [31]. The finding of this study was inconsistent with the result of the previous one, 9.6% prevalence, and this might be due to the interruption of MDA at the study area resulting in a gradual rising of a prevalence rate and infection. Furthermore, the lack of sustainability irregularities in the deworming program does not prevent future infection (prophylaxis) as a result of poor environmental sanitation and high-water contact behavior of schoolchildren at the study area. The findings of this particular study are strongly in agreement/ consistent with the recommendation of an integrated strategies such as snail control, proper health education, access to toilet services, and proper environmental sanitation together with the ongoing MDA program [6].

The prevalence and intensity of *S mansoni* infection among different age groups were significantly different in the current study, which is in agreement with studies reported from Tanzania, North-west Ethiopia and Mekelle city [32-34]. In contrast, some studies from Bahir- Dar city and Jimma town show the prevalence and intensity of *S mansoni* infection among different age groups to be similar. This might be due to the age difference and frequent bathing habit of older age children between 8 to 14th years of age when compared with 5to 7th year of age.

Finally, among the considered determinant risk factors including swimming habits, frequency, and use of untreated river water were strongly associated with both higher prevalence and infection burden/intensity of *S mansoni,* similar or consistent with the other studies [6,27,34,35].

Conclusion and Recommendation

A school-based quantitative cross-sectional study was conducted among two selected primary/elementary schools of Delo-Mena district, Bale Zone, based on their centripetal distance to the main river streams called Yadot and Birbire. The results of the study showed that the overall prevalence of *S mansoni* was generally classified as moderate at the study area, which was an indicative for absence of an effective/ persistent control and eradication strategy for the parasite and intermediate host. Finally, the study concluded with the recommendation of an integrated strategies such as snail control, proper health education, access to toilets and other hygienic services, and proper environmental sanitation.

Data Availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Conflict of Interest

The corresponding author declared that there is no conflict of interest.

Author's Contribution

- BM- Correspondence author, Formal analysis, Software, Principal investigator, Manuscript preparation, Writing original draft
- SG- Data collection and Data Edition
- MT- Manuscript edition, Conceptualization
- MA- Methodology, Data curation

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