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Schistosoma mansoni Infections and Morbidities Among School Children in Hotspot Areas of Jimma Town, Southwest Ethiopia: A Cross-Sectional Study

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ABSTRACT

BACKGROUND: *Schistosoma mansoni* is endemic in all regions of Ethiopia. School-age children are highly vulnerable to schistosomiasis-related morbidities. This study aimed to determine the prevalence of *S. mansoni* and morbidities among schoolchildren in schistosomiasis hotspot areas of Jimma Town.

METHODS: Cross-sectional study was conducted among schoolchildren in Jimma Town. Stool sample was examined using Kato-Katz for the detection of *S. mansoni*.

RESULTS: A total of 332 schoolchildren were included in the study. The prevalence of *S. mansoni* and STHs was 20.2% and 19.9%, respectively. Males (adjusted odds ratio (AOR) = 4.9; 95% CI: 2.4-10.1; *p* = .001), swimming habits (AOR = 3.0; 95% CI: 1.1-8.3; *p* = .033) and schools attended (AOR = 4.3; 95% CI: 1.4-13.6; *p* = .012, AOR = 3.8; 95% CI: 1.3-10.9; *p* = .014) were associated factors for *S. mansoni* infections. Blood in stool (AOR = 2.0; CI: 1.0-4.1; *p* = .045) and feeling general malaise (AOR = 4.0; CI: 1.4-11.3; *p* = .007) were significantly associated with *S. mansoni* infection-related morbidities. Moreover, prevalence of stunting among schoolchildren 6 to 11 years of age was 29.7% (71/239).

CONCLUSION: The transmission of *S. mansoni* among schoolchildren is moderate. Sex, swimming habits and schools attended were associated with *S. mansoni* infections. Blood in stool and general malaise were clinical characteristics associated with *S. mansoni* infections. Integration of health promotion is needed to achieve control and elimination goals. Attention should also be given to stunted growth of the children.

KEYWORDS: *Schistosoma mansoni*, morbidities, stunting, hotspot areas, Jimma

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Background

Human schistosomiasis/bilharzia is a neglected tropical disease (NTD) of public health importance with an estimated global annual disability-adjusted life years of 1.63 million in 2019. While schistosomiasis exists in 76 countries in the world, more than 90% of the infections occur in sub-Saharan Africa (SSA).[1-4] The disease is highly prevalent in Ethiopia with the 2 species, *Schistosoma haematobium* (*S. haematobium*) and *Schistosoma mansoni* (*S.mansoni*), being responsible for human infections. About 53.3 million people in Ethiopia are estimated to live in *Schistosoma*-endemic areas, and school-age children (SAC) are at higher risk of infections.[5] Intestinal schistosomiasis (caused by *S. mansoni*) is the predominant species and endemic in all regions of the country, while, urogenital schistosomiasis (caused by *S. haematobium*) is more restricted in its distribution.[6,7] The transmission of both *S. mansoni* and *S. haematobium* tends to be focal, even within a district, where appropriate snail species, unhygienic disposal of human excreta, and freshwater bodies coexist.[8,9]

Clinical manifestations of schistosomiasis may start with swimmer's itch immediately after human skin contact with cercaria released from infested freshwater snails. The acute phase (Katayama fever) characterized by fever, headache, gastrointestinal complaints, hepatosplenomegaly, and dermatitis is likely related to immune reaction to the migrating schistosomula and eggs in primary infections, or heavy reinfections.[10] Indeed, acute schistosomiasis mainly occurs in children with no past exposure. Subsequently, chronic schistosomiasis, granuloma formation provoked by *Schistosome* egg aggregation and immune aggregates, happens in different organs based on the infecting species. The chronic stage is the most common form of schistosomiasis in endemic regions.[11,12]

School-age children are highly vulnerable to schistosomiasis.[5] Infection may result in malaise, anemia, intestinal and urogenital bleeding, and portal hypertension.[13-16] Hence, the children may fall ill with possible subsequent cognitive impairment, undernutrition, and growth retardation.[17] Moreover, due to morbidities associated with schistosomiasis, schoolchildren may not pay attention in the class and/or result in school absenteeism.[17,18] Previous studies conducted in different parts of Ethiopia mainly focused on the epidemiology of schistosomiasis though few studies assessed the cognitive and nutritional impacts of the disease, and its clinical aspects.[15,19,20]

Jimma Town is endemic to *S. mansoni*. Varying magnitude of *S. mansoni* infection was reported among schoolchildren in the Town. A study conducted in 2017 among public elementary schoolchildren in Jimma Town documented the prevalence of *S. mansoni* ranging from 1.8-23.3% between schools.[21] Even more recently, higher prevalence of *S. mansoni* was reported in some public primary schools in the town.[20] Assessing schistosomiasis-related morbidities among schoolchildren in hotspot areas contributes to focus on the actual burden, program limitations, and program integration at the national level. This study aimed to determine the prevalence of *S. mansoni* and soil-transmitted helminths (STHs), and to assess the clinical characteristics and nutritional status of schoolchildren in schistosomiasis hotspot areas of Jimma Town.

Methods

Study design and setting

A cross-sectional study was conducted from April 24 to June 13, 2021, among selected public primary schoolchildren in Jimma Town. The study was conducted among schoolchildren in 5 selected primary schools in the Town. Jimma Town is located 351.7 km southwest of Addis Ababa with an area of 50.52 km^2. Two rivers cross the town, namely Kitto and Awetu. There are also several streams and other small freshwater bodies that likely create favorable environment for the snail intermediate hosts. Seto Yiddo (7°41′31.71″N, 36°50′08.52″E), Hamle19 (7°39′50.74″N, 36°49′41.09″E) and Jimma (7°39′41.10″N, 36°50′18.98″E) primary schools were selected as hotspot areas based on a recent study.[20] The remaining two primary schools, Tulema Keneni (7°40′01.55″N, 36°51′35.01″E) and Abdi Gudina (7°39′20.67″N, 36°50′21.62″), were selected based on their proximity to freshwater bodies (there is a small river in the compound of Tulema Keneni Primary School, and Abdi Gudina Primary School is situated between Awetu and Kito main rivers approximately, at 300 m from both). These 2 schools became operational recently and were not included in the previous studies.

Sample size and sampling technique

The sample size was calculated using single population proportion formula $n = Z\alpha/2^2 * p*(1-p)/d^2$ where, n is the minimum sample size, z is level of confidence according to the standard normal distribution (at 95% CI, $Z\alpha/2^2 = 1.96$), p is the estimated prevalence/proportion, d is the margin of error).[22] Accordingly, taking a prevalence of 28.7% from a previous study[20], 95% confidence level, 5% margin of error and 10% non-response rate, the sample size was estimated to be 346 schoolchildren. The schoolchildren attending 1 to 8 grades were selected using a systematic random sampling technique using class rosters as a sampling frame.

Schistosoma mansoni hotspots were operationally defined as: Primary schools where previous data showed a relatively higher prevalence of *S. mansoni* infections and/or located near/adjacent to rivers/streams.

Data collection

Questionnaire data. The questionnaire, information sheet, and assent forms were first prepared in English and translated to local languages (Afan Oromo and Amharic), and back-translated to English by language experts to maintain the original context. The questionnaire data were collected by four pre-trained laboratory professionals and nurses. The questionnaire data included socio-demographic information (age, sex, family size and residence), clinical characteristics (blood in stool, abdominal pain, colicky pain and malaise), and risk factors of *S. mansoni* infections (swimming, bathing and washing clothes in rivers).

Laboratory data. A single stool sample was collected from each study participant using a clean, labeled and leak-proof stool cup. The school children were instructed to provide sufficient stool sample (approximately 3 g) by marking on the stool cup. They were provided with paper to avoid soil contamination and tissue paper for personal (hygine) use. The collected stool samples were transported to Jimma University NTD Laboratory within 2 hours of collection by maintaining the temperature at 2° to 8°C, and a single Kato-Katz smear[23] of each specimen was examined for possible detection of *S. mansoni* and/or STHs eggs. The Kato-Katz smears were examined after 30 minutes of preparation for the detection of STH eggs and re-examined after 24 hours for *S. mansoni* eggs. Kato-Katz smear preparation, egg detection and count were performed by laboratory experts following standard operating procedures. The intensity of *S. mansoni* eggs was categorized based on World Health Organization (WHO) guidelines as light: 1 to 99, moderate: 100 to 399 and heavy: >400 eggs per gram of stool.[24]

Determination of stunting

The height of the schoolchildren was measured in the leaning position to the nearest 0.1 cm using a standard height measuring device. Height for age (HAZ) and Body Mass Index for age Z-Score (BAZ) were calculated using the WHO AnthroPlus v1.0.4 Anthropometric calculator.[25] School children with Z-score (HAZ < −2SD) were considered as stunted.[26]

Data quality control

Data collectors were trained before data collection on questionnaire contents, sample collection, and the aim of the study. A pre-test was done on 5% of the sample size among Berkuma primary schoolchildren in Jimma Town to check the data collection materials and reagents. All collected data were checked regularly for their completeness. Randomly selected 10% of the total Kato-Katz smears were re-checked by another laboratory expert who was blinded for the previous readings.

Eligibility

Inclusion criteria. Schoolchildren attending Seto Yiddo, Hamle19, Jimma, Tulema Keneni and Abdi Gudina primary schools during the study period were included in the study.

Exclusion criteria. Schoolchildren who received anti-helminthic drugs within two weeks before the data collection date and schoolchildren who were absent after two visits were excluded from the study.

Data management and analysis

The data were cleaned, coded and entered into Microsoft Excel, and exported to a statistical software package STATA-MP_12 (StataCorp., TX, USA) for analysis.[27] Descriptive statistics were calculated to summarize the socio-demographic profile of the study participants. Bivariate and multivariable logistic regressions were utilized to determine the association of the dependent variable with the independent variables. The independent variables included the schoolchildren demographics and *S. mansoni* infection associated factors, which were all categorical (sex, age group, family size, grade attended, latrine ownership, open-field defecation, sources of drinking water, shoe type worn, swimming in rivers, bathing in rivers, washing clothes in rivers and participation in irrigation activities). Moreover, the clinical characteristics assessed were abdominal pain, blood in stool, general malaise and presence of diarrhea in the last two weeks. Association of each independent variable with the dependent variable (*S. mansoni* infection) was analyzed using bivariate logistic regression. Variables with a significant association during the bivariate analysis and those with p-value < .25 were candidates for the multivariable analysis run using the backward elimination method. Odds ratio and the corresponding 95% confidence interval were calculated to show the strength of their association. Moreover, Chi-square test was calculated to assess the association between *S. mansoni* infection and stunting. Statistical significance was set at p-value ≤ .05 during the analysis.

Results

Socio-demographic characteristics

A total of 332 schoolchildren who provided consent and sufficient stool specimen were included in the study. Schoolchildren from Seto Yiddo, Abdi Gudina, Hamle19, Tulema Keneni and Jimma primary schools comprised 31.6%, 18.7%, 18.4%, 15.6%, and 15.6% of the total study participants, respectively. More than half (52.4%) of them were males, and 28.6%, 57.2%, and 14.2% were in the age group of 6 to 8, 9 to 12, and 13 to 16 years of age, respectively. Socio-demographic characteristics of the schoolchildren are summarized in Table 1.

Table 1. Socio-demographic characteristics of schoolchildren in the five selected primary schools in Jimma Town, 2021.

CHARACTERISTICS		FREQUENCY N (%)
Sex	Male	174 (52.4)
	Female	158 (47.6)
Age group (years)	6-8	95 (28.6)
	9-12	190 (57.2)
	13-16	47 (14.2)
Grade	1-4	264 (79.5)
	5-8	68 (20.5)
Family size	3-5	171 (51.5)
	6-13	161 (48.5)
Own latrine	No	5 (1.5)
	Yes	327 (98.5)
Open-field defecation	Sometimes	47 (14.2)
	Never	285 (85.8)
Drinking water source	Protected[a]	282 (84.9)
	Unprotected[b]	50 (15.1)

[a]Protected = pipe water and water sources covered by concrete or other materials to prevent contamination.
[b]Unprotected = water sources with no barriers to protect water from contamination.

Prevalence of S. mansoni and other intestinal parasitic infections

The overall prevalence of intestinal parasitic infections was 37.4% (124/332). Six species of intestinal parasites including *S. mansoni*, *A. lumbricoides*, *T. trichiura*, *H. nana*, *E. vermicularis* and *Taenia* species were identified (Figure 1). The predominantly identified parasite species among the children was *S. mansoni* (20.2%), followed by *A. lumbricoides* (11.8%) and *T. trichiura* (10.5%). The prevalence of STHs (*A. lumbricoides* and *T. trichiura* in this study) was 19.9% (66/332). Fifteen students were infected with both *S. mansoni* and STHs. Most of the co-infections were due to *S. mansoni* and *A. lumbricoides* (13 children) followed by *A. lumbricoides* and *T. trichiura* (8 children). Out off the children infected with *S. mansoni*, 32(47.8%), 22(32.8%) and 13(19.4%) had light, moderate and heavy infection intensity, respectively. The oveall geometric mean of egg

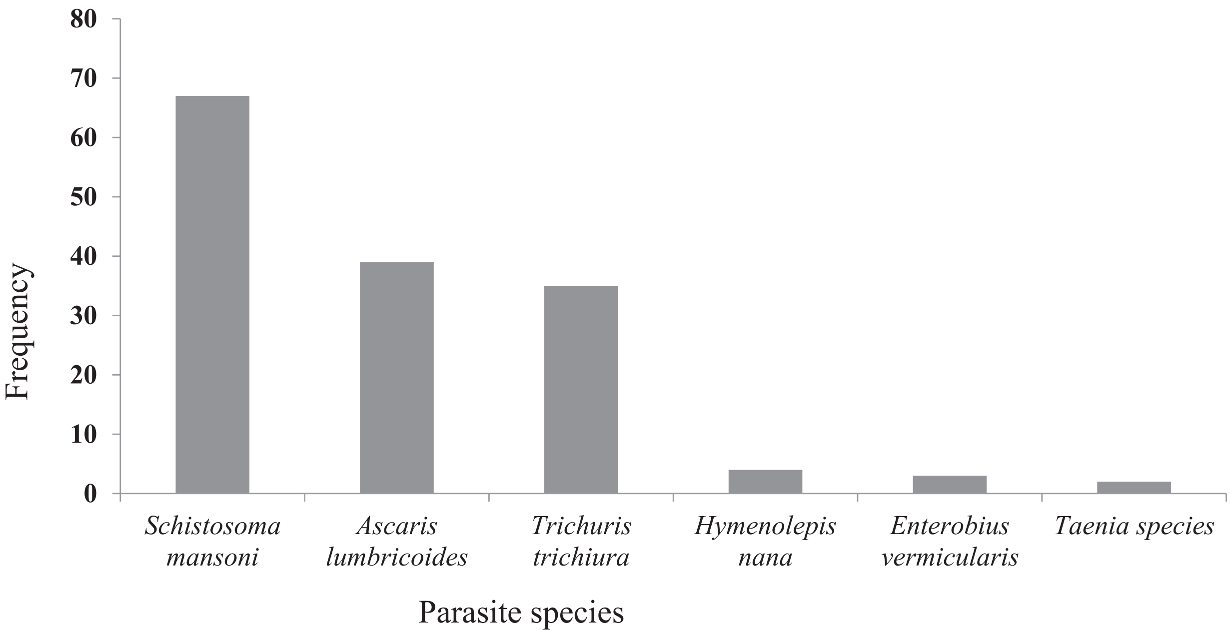

Figure 1. Frequency of intestinal parasitic infections among the study participants (n = 124), Jimma Town, 2021.

count of *S. mansoni* was 120.4 eggs per gram of stool. The geometric mean of egg count of *S. mansoni* in Hamle19, Abdi Gudina, Tulema Keneni, Seto Yido, and Jimma primary schools was 62.8, 85.6, 77.6, 225.3, and 73.4 eggs per gram of stool, respectively.

Factors associated with S. mansoni infections

A total of 50.8% (168/332) schoolchildren claimed freshwater contact habits including swimming, bathing, and/or washing clothes in rivers. The major rivers crossing Jimma Town, Kito and Awetu, were the top contacted rivers by the schoolchildren, 40.5% (68/168) and 31.5% (53/168), respectively. Other small freshwater contact sites (Tulema Keneni, DMC, Chore, Degoye, Zembaba, Sigmo, Haro, Kaba, Adari, Abajifar, Zeydo, Pampi, Derita, Fuafuate and Shenkora) accounted for 28.0% (47/168). The prevalence of *S. mansoni* was 24.5% (13/53), 32% (24/74) and 34.1% (14/41) among schoolchildren who had fresh water contact habits with Awetu, Kito and other rivers, respectively.

Risk factors such as age group, drinking water sources, maternal education, shoe worn type during the survey and participation in irrigation activities had no statistically significant association with *S. mansoni* infections. Bathing and washing clothes in rivers had significant association with *S. mansoni* infection before adjusting the odds ratio, (COR = 1.9, 95% CI: 1.1-3.3) and (COR = 1.9, 95% CI: 1.1-3.2), respectively. After adjusting for other variables (results of adjusted odds ratio), the following variables were significantly associated with *S. mansoni* infections. The habit of swimming in rivers was a risk factor for *S. mansoni* infections among schoolchildren (AOR = 3.0; 95% CI: 1.1-8.3). Males were 5 times more likely to be infected with *S. mansoni* as compared with females (AOR = 4.9; 95% CI: 2.4-10.1). The prevalence of *S. mansoni* was also significantly higher among schoolchildren who attended Tulema Keneni (AOR = 4.3; 95% CI: 1.4-13.6) and Seto Yido primary schools (AOR = 3.8; 95% CI: 1.3-10.9) compared to children of Hamle19 Primary School. Factors associated with *S. mansoni* infections are summarized in Table 2.

Clinical characteristics

Three students were febrile during the survey (axillary temperature >37.50°C), and none of them were infected with *S. mansoni*. *Schistosoma mansoni* infection was significantly associated with the presence of blood in their stool in the past two weeks (AOR = 2.0; CI: 1.0-4.1) and feeling general malaise during the survey (AOR = 4.0; CI: 1.4-11.3). The association of *S. mansoni* infection and related morbidities is presented in Table 3.

A total of 65.4% (217/332) of schoolchildren experienced at least one of the clinical characteristics (blood in their stool, abdominal pain, colicky pain, general malaise and/or diarrhea in the last 2 weeks before the survey). Out of these, 22.6% (49/217) visited health facilities and 1.4% (3/217) took self-medication. The remaining 76% (165/217) did not take any intervention.

Stunting

The prevalence of stunting among schoolchildren (aged 6-11 years) was 29.7% (71/239). Hence, the AnthroPlus calculator only display results for children 6 to 11 years old. Stunting was 32.6% (42/129) and 26.4% (29/110) among males and females, respectively. A higher prevalence of

Table 2. Riskfactors of *S. mansoni* infections among the schoolchildren from the selected five primary schools in Jimma Town, 2021.

CHARACTERISTICS		POSITIVE N (%)	COR (95% CI)	*P*-VALUE	AOR (95% CI)	*P*-VALUE
Sex	Male	54 (31.0)	5.0 (2.6-9.6)	<.001	4.9(2.4-10.1)	.001*
	Female	13 (8.2)	Ref		Ref	
Age group	6-8	16 (16.8)	Ref			
	9-12	38 (20.0)	1.2 (0.6-2.4)	.522		
	13-16	13 (27.7)	1.9 (0.8-4.4)	.136		
Swim in rivers	Sometimes	37 (31.1)	2.8 (1.6-4.8)	<.001	3.0 (1.1-8.3)	.033*
	Never	30 (14.1)	Ref		Ref	
Bath in rivers	Sometimes	34 (26.8)	1.9 (1.1-3.3)	.020	2.9 (0.8-10.7)	.109
	Never	33 (16.1)	Ref		Ref	
Washing cloth in rivers	Sometimes	33 (26.6)	1.9 (1.1-3.2)	.025	1.8 (0.6-5.1)	.274
	Never	34 (16.4)	Ref		Ref	
Participate in irrigation	No	65 (20.1)	Ref			
	Yes	2 (22.2)	1.1 (0.4-3.1)	.847		
Schools attended	Hamle19	6 (9.8)	Ref		Ref	
	Abdi Gudina	12 (19.4)	2.2 (0.8-6.3)	.142	2.9 (0.9-9.4)	.079
	Tulema Keneni	18 (28.9)	3.7 (1.3-10.5)	.013	4.3 (1.4-13.6)	.012*
	Seto Yido	28 (26.7)	3.3 (1.3-8.6)	.013	3.8 (1.3-10.9)	.014*
	Jimma Primary	6 (11.5)	1.2 (0.4-4.0)	.770	2.2 (0.6-8.5)	.265

Abbreviations: CI, confidence interval; COR, crude odds ratio; AOR, adjusted odds ratio; Ref, reference.
*Significant at $P < .05$.

Table 3. Clinical morbidities and *S. mansoni* infections among the schoolchildren from the selected five primary schools in Jimma Town, 2021.

CHARACTERISTICS		POSITIVE N (%)	COR (95% CI)	*P*-VALUE	AOR (95% CI)	*P*-VALUE
Blood in stool the past 2 wk	Sometimes	18 (31.0)	2.1 (1.1-3.9)	.025	2.0 (1.0-4.1)	.045*
	Never	49 (17.9)	Ref		Ref	
Abdominal pain the past 2 wk	Sometimes	43 (20.7)	1.1 (0.6-1.9)	.772	0.7 (0.4-1.5)	.407
	Never	24 (19.4)	Ref		Ref	
Colicky pain the past 2 wk	No	37 (18.9)	Ref		Ref	
	Yes	30 (22.1)	1.2 (0.7-2.1)	.478	1.2 (0.6-2.3)	.684
Feeling general malaise	No	58 (18.5)	Ref		Ref	Ref
	Yes	9 (50.0)	4.4 (1.7-11.6)	.003	4.0 (1.4-11.3)	.007*
Diarrhea the past 2 wk	No	49 (17.9)	Ref		Ref	
	Yes	18 (31.0)	2.1 (1.1-3.9)	.025	1.9 (0.95-3.7)	.069

Abbreviations: CI, confidence interval; COR, crude odds ratio; AOR, adjusted odds ratio.
*Significant at $P < .05$.

stunting was observed among *S. mansoni*-infected schoolchildren (41.5%) compared to the non-infected (27.3%), however, the difference was not statistically significant (Chi-square = 3.3 and $P = .07$).

Discussion

Ethiopia envisioned interrupting the transmission of certain NTDs including schistosomiasis by 2030.[6] To this end, up-to-date epidemiological information on the NTDs is required.

This study aimed to determine the prevalence of *S. mansoni* and assess its clinical characteristics among primary schoolchildren living in hotspot areas of Jimma Town. Accordingly, the prevalence of *S. mansoni* among the children was 20.2%. Previous studies conducted in Jimma Town also reported prevalence of *S. mansoni* ranging from 5.0-28.7%.[20,21,28] Nationally, more than a third of children are estimated to be infected with *S. mansoni*, with high variability in different areas.[29] Even compared to the local situation, this study was conducted in primary schoolchildren with presumably higher risk of *S. mansoni* infection and re-infection rates due to the availability of freshwater bodies around the schools. Despite repeated praziquantel mass drug administration (MDA) to schoolchildren in the town, the burden of the disease is still unacceptably high. Such high transmission of *S. mansoni* may hinder the planned transmission break, and result in direct health impacts, stunted growth, low school performance, and mental disorder.[17,18]

The transmission of schistosomiasis is often focal, with varying prevalence, even within a specific range of geographical locations.[21,30] This study also showed a significantly higher prevalence of *S. mansoni* among schoolchildren in Tulema Keneni and Seto Yido primary schools compared to Hamle 19 Primary School. This might be due to the presence of freshwater bodies (streams) near the schools' compound. Previous studies also revealed that there was a prevalence variation between schools in Jimma Town.[20,21] The presence of numerous streams, springs, ponds and other small freshwater bodies in Jimma Town and its surroundings may create appropriate habitat for the snail intermediate hosts. Therefore, apart from the MDA, awareness creation to minimize contact with these freshwater bodies, and control directed at the intermediate host is essential.

Human infection with *S. mansoni* occurs through direct skin contact with cercaria-infested freshwater bodies. Direct skin contact with freshwater bodies mainly occurs during bathing, swimming, barefoot crossing, fetching water, irrigation, and laundary activities in rivers.[31-33] In this study, the prevalence of *S. mansoni* was significantly higher among schoolchildren who responded to have habits of swimming. Other studies conducted elsewhere in Ethiopia also reported swimming as a significant riskfactor for *S. mansoni* infection.[20,31] Swimming is a major riskfactor for *Schistosoma* infection due to increased time spent, space covered, and most of body parts being submerged in the water.[34,35] However, in contrast to other study conducted in Ethiopia,[31] irrigation activities were not associated with *S. mansoni* infections. As the study was conducted in urban setting, the number of schoolchildren participated in irrigation activities were too few. Boys tend to swim more often than girls and are likely at higher risk of infection with *S. mansoni*.[32] In this study, the prevalence of *S. mansoni* was significantly higher among male schoolchildren compared to females. Swimming habit was also more common (72.3%) among male schoolchildren than females (20.9%). Previous studies also reported a higher prevalence of *S. mansoni* among male schoolchildren than females.[30,36] This might necessitate gender-specific health promotion to create awareness on possible risk of schistosomiasis during freshwater contacts.

In endemic areas, infected individuals may not show the acute clinical manifestations of *S. mansoni* due to previous exposure to the disease.[11,37,38] The clinical manifestations are often chronic forms in endemic regions which may include diarrhea, blood in stool, colicky pain, general malaise, anemia, stunting, hepatosplenic pathogenesis, portal hypertension, and other complications.[11,12,16] The majority of the schoolchildren who participated in this study had reported at least one of these symptoms during the survey. In this study, *S. mansoni* infection was significantly associated with blood in stool in the last two weeks and a feeling of general malaise during the survey. Studies conducted elsewhere also reported a positive association between *S. mansoni* infections and blood in stool.[16,19] Blood loss with stool may lead the infected children to iron deficiency anemia. The schoolchildren feeling general malaise may also experience school absenteeism, low school performance, and concomitant cognitive impairment.[14,17,18] It should be noted that these clinical manifestations are not specific to *S. mansoni* infection. On the other hand, infected individuals may also be asymptomatic, especially in endemic areas,[39] as it was observed in 9% of *S. mansoni* infected children in this study.

The overall prevalence of stunting among school children aged 6 to 11 years in this study was 29.7%. A higher prevalence of stunting was observed among *S. mansoni* infected children, however, it was not statistically significant. A similar finding was also reported elsewhere in Ethiopia.[40] The prevalence of stunting among schoolchildren was higher compared to a previous study conducted in Jimma Town,[41] but lower than the stunting prevalence reported in Gondar Town.[42] Hence, it is important to notice the increasing prevalence of stunting in Jimma Town and to consider the initiation of school-feeding programs in the town. School feeding programs showed improved nutritional status among school children in Addis Ababa.[43]

The study has insights into both the epidemiology of *S. mansoni* and the clinical features experienced by the school children. This will help to understand the burden of the disease and enhance strengthening interventions. It should be noted that the study has the following limitations; (i) Single Kato-Katz smear was used for the detection of *S. mansoni* and other STHs. To increase the sensitivity, we examined the Kato-Katz slides after 24 hours by experienced personnels with strict quality control. (i) Clinical examination of schoolchildren was restricted to physical examination and clinical history. (i) Only stunting (height-for-age) was determined and other nutritional indices were not measured.

Conclusion

The transmission of *S. mansoni* among schoolchildren is moderate. Male schoolchildren, habits of swimming and schools attended were significantly associated with *S. mansoni* infections. Blood in stool and general malaise were clinical characteristics associated with *S. mansoni* infections. In addition to mass chemo-therapy, integration of health promotions about transmission and clinical characteristics of *S. mansoni* and STHs are necessarily needed for the control and elimination goals. Attention should also be given to stunting among school children.

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Author's Contribution

AT conceived the study. AT, EZ, BA, HG, ED, BS and MA were involved in the designing of the research and data collection acquisition. AT and EZ involved in data analysis and drafted the manuscript. ZM critically reviewed the manuscript. All authors read and approved the final version of the manuscript.

Ethical Approval and Consent to Participate

Ethical approval was obtained from the ethical review board of Institute of Health, Jimma University (Ref No: IHRPGD/105/21, Date: 07/05/2021). Support letter was written to each primary school from Research and Innovation Directorate, Institute of Health, Jimma University. Permission was sought from school directors of Seto Yiddo, Hamle19, Jimma, Tulema Keneni and Abdi Gudina primary schools. Before data collection, oral assent was obtained from the selected schoolchildren on the first day of contact, and the signed written consent form was obtained from the respective parents/guardians. Data collection commenced on the second day. Confidentiality of individual information was maintained in all steps of the research. School children infected with *S. mansoni* and other intestinal parasites were treated based on the national guidelines in collaboration with health centers in the areas.

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