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The Current Status of *Schistosoma mansoni* Infection among School Children around Hizaty Wedicheber Microdam in Merebmieti, Ethiopia

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Abstract

Background: School age children are at particular risk of morbidity caused by schistosomiasis.

Objective: To determine the prevalence and intensity of infection; and identify associated risk factors for *Schistosoma mansoni* infection.

Methods: A cross sectional study was conducted in Merebmieti elementary school around Hizaty Wedicheber Microdam in Tigray, northern Ethiopia. A total of 469 school children were selected at random. For each selected subject clinical and stool examination was done. Each subject was also interviewed. Stool samples were examined for Schistosoma eggs by Kato-Katz technique. Data was entered and analyzed using SPSS version 16.0 statistical packages software.

Results: The overall prevalence of *S.mansoni* was 42.4% and the mean (GM) intensity of infection was 86.7 eggs per gram (EPG). The prevalence and intensity of infection was higher in males. The highest prevalence was in the 10-14 year age group (49.2%) while intensity reached peak in the 15-19 years of age (107 eggs per gram). Of the 199 positive cases, about 34% harbored moderate (101-399 eggs per gram) and only 2% harbored heavy infection. The strongest predictors for *S.mansoni* infection using multiple regressions were proximity to microdam. Logistic regression analysis confirmed that children 5-9 years old and pipe water use for domestic purpose were protective factors.

Conclusion: On the basis of these results, it can be concluded that *S. mansoni* infection is an important health problem among school children of Merbmieti contributing to the transmission of the disease in the community. Hence, integrated control programme including periodic deworming, improving sanitation, provision of safe water supply are needed to have a lasting impact on transmission of *S.mansoni*.

Keywords: Current status, *S.mansoni*, microdam, Ethiopia

Introduction

Schistosomiasis is one of the most widely spread parasitic infections. It occurs in tropical and subtropical developing countries with an estimated 200 million people infected and over 600 million people at risk of infection worldwide [1,2]. Three species; *Schistosoma haematobium*, *S. japonicum,* and *S. mansoni* cause the bulk of an estimated global burden of 4.5 million disability-adjusted life years, and approximately 85% of them are concentrated in sub-Saharan Africa where the bulk of the at-risk population resides [2-4]. School age children are at particular risk of morbidity caused by *schistosomiasis* because infections during childhood cause growth retardation, anemia, and can lead to cognitive impairment and memory deficits [5].

Ethiopia is one of the endemic countries for *Schistosoma mansoni*. Many studies have shown that *Schistosoma mansoni* is widely distributed and have been recorded in all regions and the disease is spreading, and new transmission foci have been reported [6-9]. The increase in prevalence and spread of the disease in Ethiopia, as in other developing countries, is due to increasing water related projects, population migration and human behavior [1,9-12]. The number of people estimated to be exposed to *S. mansoni* is 18 million (6). The overall prevalence of *S. mansoni* ranges from 15-20% [13]. However, *S. mansoni* infection rates above 60% have been reported from endemic communities in different part of Ethiopia [9,14,15]. The disease is more prevalent and widely distributed in North, North West and Central region of the country [16].

In Tigray region of Ethiopia, *S. mansoni* has been known to be endemic since the late 1960s, and water resource development expanded year to year which resulted in new foci of schistosomiasis. According to the 1992-1993 study report, there were 19 new foci of schistosomiasis identified and cases have been detected in 80% of the areas visited with an overall prevalence of 18.4% [9]. Community based study of schistosomiasis was made in Tigray region in relation to microdams in 1995. The overall prevalence was 39% corresponding to 48% in near dam villages and 30% in distant villages [11] and the prevalence of the study area was 8% [10]. Although an increasing emphasis on construction of dams (water based development) in the

region is important in alleviation of poverty, such development program has the potential adverse effects on health creating a space for the spread of intestinal parasites like *S.mansoni*. Hence, the objective of the study was to assess the current status of *S.mansoni* in Hizaty Wedicheber microdam in Merebmieti.

Materials and Methods

Study area

The study was conducted in Merebmieti Primary school around Hizaty Wedicheber Microdam in Tigray Regional State, northern Ethiopia. Merebmiete Kebele is found in Enderata Wereda of Tigray Region, Northern Ethiopia located 755 km away from Addis Ababa(the capital of Ethiopia) and 25 km South of Mekelle(the capital city of the region). It is located at an altitude of 2271 meters above sea level. Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), this woreda had a total population of 114,297 [17].

Study design and study population

A cross sectional study design was employed from December 2011 to February 2012. The study population included school children attending grade one to eight in Merbmieti elementary school found around Hizaty Wedicheber Microdam.

Sample size was determined by taking the prevalence of the diseases 8% as it was done elsewhere [10] and using the 95% confidence interval with 2.5% marginal error the minimum sample size required for analysis was computed using the formula $n=Z^2\ p\ (1-p)/d^2$, where n=sample size, z=Standardized normal distribution curve for level of confidence (z=1.96 at 95%CI), P=expected prevalence or proportion (0.08), d=degree of marginal error (0.025)2.5%. By considering additional 10% for non-response rate, the sample size was computed to be 473.

Multistage sampling method was used to select the study subjects. Classes were first selected by simple random sampling and then the sampled children were selected using lottery method by using class roster (students list). Class registration list/Roster/of students who were enrolled in Merebmieti elementary school were used as a sample frame and proportional allocation was employed to select students from each selected section. Standardized structured questionnaire was developed for the purpose of data collection on determinants (risk factors) such as: source of water supply, swimming habit, frequency of contact, availability and usage of latrine of the study subjects.

Stool collection and examination

Each student was provided with clean plastic sheet and applicator sticks and instructed to bring his/her own fresh and adequate amount of stool. On delivery of the stool specimen, code, name and age were filled properly on the prepared structured questionnaire. The specimens were processed for microscopic examination using Kato-Katz technique (two slides per stool specimen) employing a template delivering a plug of 41.7 mg of stool and examined by experienced technician. The average of the two slides was taken when eggs were found on the Kato slides.

Clinical examination

The presence or absence of signs and symptoms of *S. mansoni* infection like fever, itching, cough, blood in the stool, bloody diarrhea, abdominal pain, palpable splenomegaly and hepatomegaly were checked by experienced medical officer.

Data analysis

Data were coded, originally entered into computer and cleaned before and during data processing using EPI INFO version 6 and exported to SPSS version16.0 software package for statistical analysis. Different variables were described and characterized by frequency distribution. Prevalence and intensity of *S. mansoni* infection were reported in percent and mean egg count, respectively. The association was statistically tested using univariate and multiviarate regression analysis. The magnitude of association was measured by odds ratio at 95% CI: P-value below 0.05 was considered as statistically significant.

Ethical consideration

The study was conducted after approval by the institutional review board of college of health science, Addis Ababa University. Further permission was also obtained from Tigrai Regional Health bureau and principal of the school. Informed verbal consent of participation was sought before commencing the interview.

All children who tested positive for *S.mansoni* were treated with a single dose of praziquantel at 40 mg/Kg body weight and children were tested positive for *Ascaris lumbrcoides* and *Trichuris trichiura* were treated with standard regiment albenidazol 400 mg tablet.

Result

Of the 473 randomly selected students, 469 students had participated in the study making a response rate of 99.2%. Of the study subjects, 242(51.6%) of them were female participants and 227 (48.4%) were males which resulted in sex ratio of 1.06:1.00. The sex imbalance tends to be higher at the age group of 10-14 years; females were 162 and that of males were 141, respectively. The mean age of school children was found to be 12 years, ranging from 5 to 19 years. Majority (64.4%) of the students belonged to the age group of 10-14 years followed by the age group 5-9 years (20.5%). Regarding the educational status of the students, majority (64%) of them were attending grades 1 to 4 while the rest (36%) were from 5-8 grades. All (100%) of the students were orthodox by religion.

Majority (45.8%) of the study participants mentioned that tap water was the major source of water they use for domestic purposes whereas 3.8% had access to water solely from dam. On the other hand, 39% of them responded that they use tap water, dam and spring, alternatively. Among the 469 respondents, 188 (40%) collected water from the dam for domestic purpose. Of the participants, females (54.5%) were more engaged in collecting water than males (39.5%) (for females, water fetching was the most common activity). On the other hand, majority (86.7 %) of the respondents collected water from the dam at least once per day and a few of them (13.3%) used to collect once per week.

We also assessed the availability of latrine and usage of the respondents. Accordingly, 344 of the respondents possessed latrine, and 254 (73.3%) of them used properly including all members of the family. In contrast, 125 of the study subjects had no access to latrine facilities and defecated indiscriminately in open field (near and away

from the dam). Even though 254 of the study participants or their family had the access to toilet, 90 (37.7%) of them used to defecate in the open fields. The activity of the study participants in regard to their contact with the dam water was also determined. Consequently, 213(45.4%) of them had swimming habit and among the swimmers, 4% had used to swim always, 53% sometimes and 43% of them swam occasionally in dam water. Males had higher practice of swimming (70.4%). Swimming in dam water was most commonly practiced by the children belonging to the age group of 10-14 years. Besides, majority (58%) of the study subjects reported that they took bath in the dam and 42% of the participants reported they used pipe water for bathing. Of the dam users for bathing, 180(66%) and 92(34%) were males and females, respectively. Seventy six percent of female students used exclusively pipe water for bathing. Children in the age of 10-14 years were more likely to bath in the dam.

Three hundred ninety three of the school children claimed to use dam water for washing clothes while the remaining 76 (16.2%) responded that they used only tap water for laundry purpose. Both sexes were equally involved in washing of clothes with males 195(41.6%) and females 198(42%). Washing clothes was also common among 10-14 years age group. Assessment of knowledge on bilharziasis also showed that about 93% of the participants were not knowledgeable, and only 7% had some information about the disease.

A total of 469 subjects (227 males and 242 females) were examined for *S.mansoni* infection of which 114(50.2%) of the males and 85 (35.1%) of the females were tested positive yielding an overall prevalence of 42.4%. The prevalence was higher in males compared to females thought it was not statistically significant (P>0.05). Besides, the distribution of *S. mansoni* infection by age group and sex was determined. Accordingly, the highest prevalence was seen in the age group 10-14 years with a prevalence of 49.2%. In this study, the prevalence was higher in males with highest peak in those belonging to the age group 15 and above years reaching as high as 63.2% (Table 1).

Age category (in years)	Examined for *S. mansoni*			Positive for *S. mansoni*		
	Male	Female	Total	Male	Female	Total
5-9	48	48	96	9(18.8%)	8(16.7%)	17 (17.7%)
10-14	141	161	303	81(57.4%)	68(42.4%)	149(49.2%)
15-19	38	32	70	24 (63.2%)	9(28.1%)	33 (47.1%)
Total	227	241	469	114 (50.2%)	85(35.1%)	229 (42.4%)

Table 1: Age and sex distribution of *Schistosoma mansoni* infection among school children around Hizaty Wedicheber microdam in Merbmieti, Tigray, Ethiopia

Approximately, 12% of the children with intestinal schistosomiasis lived away from the microdam and 44.2% of the infected children lived proximate to the microdam. Of the participants who were positive for schistosomiasis, 38.6% used tap water, 11.1% used spring water, and 50.3% used dam water for domestic purpose. On the other hand, among those who collected water from the dam, 49.4% were tested positive. Of the 213 swimmers, 111 (52%) were found to be positive for *S. mansoni* infection. Of which, those who reported to have water contact 'always' accounted for 4(4%) and in those sometimes and occasionally recorded 60(54%) and 47(42%) prevalence, respectively. Besides, among the 272 who took bath in the dam, 134(49.2%) tested positive for *S. mansoni*. Among swimming and bathing individuals, the infection rate was higher in males. With regard to laundering, 174(44.3%) infected subjects were observed among those who claimed using dam water for washing clothes and 25(32.9%) among tap water and it was common in 10-14 age group and higher prevalence was recorded in males (60%) compared to females (40%).

The mean intensity of *S. mansoni* infection was 86.7 eggs per gram (epg) of stool (ranging from 24 to768 epg stool). Males had a higher intensity (101.9 epg) compared to females (69.8 epg). The intensity of infection increased with age and peaked at 107 epg stool in the age group of 15 -19 years. Analysis of epg count per gram of stool of the positive cases that were examined by Kato-Katz technique revealed that 63.8% had light infection, (1-100 epg). About 34.1% had moderate (101-399 epg) and only 2% harbored heavy infection i.e above 399 epg. Approximately, 75% of the light infections were in the 10-14 age groups. The percentage of male children was higher than females in moderate infection status; in contrast higher light infection was recorded in females. The percentages of children with light infection decrease as the age of the children increase whereas in moderate infection the percentages increase as the age increase (Table 2).

Clinical Findings

Clinical data was collected from all participant of this survey. Of the respondents, 243(51.8%) claimed to have one or more symptoms related to *S. mansoni* infection while the remaining, 226(48.2) did not have symptom. No signs related to *S. mansoni* infection were detected. The clinical findings (symptoms) among school children who were positive for *S. mansoni* indicated that abdominal pain 88(18.8%) and blood in stool 85(18.1%) were the most frequent complained symptoms as it is indicated in Figure 1.

Crude Odd Ratio (OR) obtained from univariate logistic regression analysis and adjusted OR obtained from multivariate logistic regression analysis are shown in Table 3. Males showed a higher risk of *S. mansoni* infection than females counterparts, but the difference was not statistically significant (OR, 1.480; 95% CI, 0.932-2.349). Children age 5-9 years were less likely to acquire *S. mansoni* infection; and there was a significant difference between ages (OR, .254; 95% CI.112-.578), whereas children aged 10-14 year age group were 1.154 times likely to have *S. mansoni* infection.

Variables		Intensity of infection		
		Light (1-100 EPG)	Moderate (101-399 EPG)	Heavy (≥400 EPG)
Age group (in years)	5-9 (n=17)	13(76.5%)	4(23.5%)	0(0%)
	10-14 (n=149)	95(63.5%)	52(35.1%)	2(1.4%)
	≥15 (n=33)	19(57.6%)	12(36.4%)	2(6.1%)
	Total	127(63.8%)	68(34.1%)	4(2%)
Sex	Male(n=114)	63(54.9%)	47(41.6%)	4(3.5%)
	Female (n=85)	64(75.3%)	21 (24.7%)	0(0%)

Table 2: The degree of intensity of *S. Mansoni* infection by age and sex among positive school children around Hizaty Wedicheber microdam in Merbmieti, Tigrai, Ethiopia. n:number EPG:eggs per gram

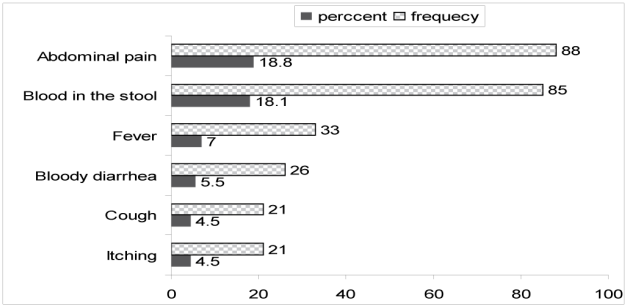

Figure 1: The pattern of clinical manifestation among school children positive for *S.mansoni*, around Hizaty Wedicheber microdam in Merbmieti, Tigray, Ethiopia.

There was a significant difference in the infection rate of *S.mansoni* between children living close to dam and far away from it (P<0.001) with the risk increased to 6.314 times to acquire infection among students living near the microdam. Logistic regression analysis on *S. mansoni* confirmed that using pipe water for domestic purpose was a protective factor and showed a significant association (P<0.05). There was no significant association between grade level of student and infection rate of *S. mansoni* (P>0.05). Furthermore, swimming in the dam was not associated with *S. mansoni* infection, however, infection rate was1.5 times higher in swimmers than non- swimmers (Table 3).

Multivariate analysis of symptoms for *S. mansoni* infection showed that blood in stool was strongly associated with *S. mansoni* infection after adjustments for age, gender (OR 8.4234; 95% CI .602-15.416). On the other hand, there was no significant association between *S. mansoni* infection and abdominal pain and bloody diarrhea (Table 4).

Risk Factors	*Schistosoma mansoni*		Crude OR (CI) (P-value)	Adjusted OR (CI) (P-value)
	Number of positives	Number of negatives		
Sex Male Female	114 85	113 157	1.863(1.286-2.699)* 1.00	1.480(.932-2.349) 1.00
Age group in years 5-9 10-14 15-19	17 149 33	79 154 37	.241(.199-.488)** 1.085(.645-1.826) 1.00	.254(.112-.578)** 1.154(.633-2.101) 1.00
Address Merb-mieti§ Elkin¥	196 3	247 23	6.070(1.798-20.493)* 1.00	6.314(1.768-22.542)** 1.00
Grade 1-4 5-8	122 77	178 92	0.891(.560-1.198) 1.00	.849(.524-1.357) 1.00
Water source	77	139	0.554(.374-.821)*	.639(.417-.980)*

Tap water Spring water Dam, tap+dam, spring+dam	22 100	31 100	0.710(.385-1.310)	.646(.333-1.253) 1.00
Swimming in dam Yes No	111 88	102 168	2.077(1.431-3.015)** 1.00	1.467(.924-2.330) 1.00
Bathing Dam Tap water	134 65	138 12	1.972(1.348-2.884)** 1.00	1.251(.705-2.222) 1.00
Washing clothes in dam Yes No	174 25	219 51	1.621(.965-2.721) 1.00	1.374(.840-2.249) 1.00

Table 3: Univariate and multivariate logistic regression analysis of factors associated *S. mansoni* infection among school children around Hizaty Wedicheber microdam in Merbmieti, Tigray, Ethiopia. OR: odd ratio, CI: 95% confidence interval, * p<0.05, **p<0.001 §: an area found around the dam, ¥: an area found far away from the dam

Risk Factors	*S.mansoni*		Crude OR (CI) (P-value)	Adjusted OR (CI) (P-value)
	Total No	Total +ve		
Sex Male Female	227 243	114 85	1.863(1.286-2.699)* 1.00	1.721(1.121-2.641)* 1.00
Age group (yrs) 5-9 10-14 15 -19	96 303 70	17 149 33	.241(.199-.488)** 1.085(.645-1.826) 1.00	.334(.151-.741)* 1.385(.756-2.539) 1.00
Fever Yes No	50	33 17	2.958(1.596-5.483)* 1.00	1.677(.818-3.440) 1.00
Blood in stool Yes No	103	85 18	10.438(5.995-18.173)** 1.00	8.423(4.602-15.416)** 1.00
Bloodydiarrhea Yes No	38	26 12	3.230(1.587-6.575)* 1.00	1.744(.760-4.001) 1.00
Abdominal pain Yes No	152	88 64	2.552(1.711-3.792)** 1.00	1.213(.733-2.007) 1.00

Table 4: Univariate and multivariate logistic regression analysis for factors potentially associated with Schistosoma mansoni infection among school children around Hizaty Wedicheber microdam in Merbmieti, Tigray, Ethiopia. OR: odd ratio, CI: 95% confidence interval, *p<0.05, **p<0.001, No:number, +ve: positive

Discussion

Among human parasitic diseases, schistosomiasis ranks second to malaria in terms of socio-economic and public health importance in tropical and subtropical areas [18]. The disease is widely prevalent in the northern and northwestern administrative regions of the country [19].

Majority of the villages with schistosomiasis cases lie between 1000-2200 meters [16]. The altitude of our study area is 2271 meters which is higher than the upper limit boundary of *S.mansoni* infection

in Ethiopia with moderate prevalence of infection. In agreement with our study, 33% infection rate was documented in a village near Mai-Shelaluk microdam at 2317 meters in a study conducted in Tigrai [10]. This may be due to the microclimatic change in the microdam vicinity favoring survival of parasite or intermediate host. In the present study, the overall prevalence of *S. mansoni* was 42.4% and the mean intensity of infection was 86.7 eggs per gram (epg) of stool. This prevalence was higher than a study which was reported from some part of Tigrai which showed the prevalence of *S. mansoni* to be 8% [10]. This discrepancy reflects soci-demographic differences in the survey populations in that this survey studied only school children, a group known to be at high risk of infection.

Prevalence of *S.mansoni* in our study site was similar with studies conducted in Uganda (42.4%) [20]. However, it was lower than studies conducted in different parts of the country such as Adwa, Zarema, Gorgora and Dek which showed prevalence rate of 66%, 85%, 67%, 69% , respectively [14,21]. On the other hand, the present prevalence was found to be higher than those conducted in Tigrai (5.95%) [22] in the North, Gorgora (29%) [23] and Dembia plains (35%) [24] in the Northwest, Wondo Genet (34.6%) [25] and Langano (21.2%) [26] in the southern part of the country.

Moreover, the finding of the current study showed that the infection rate (prevalence) was higher among male students than that of their female counter parts, as it has been previously demonstrated in other parts of Ethiopia [27]. The higher infection rate in males can be explained by the fact that male children stay most of the time outdoors, playing with peers and more frequently swim and take baths in cercaria-infected water body and more likely vulnerable to acquire infection. However, this is not always the case as studies conducted among primary schools students near Lake Victoria of Kenya [28] and Bati town of Ethiopia [16] have shown to be slightly higher in females. In Kenya, the prevalence of *S. mansoni* is higher in men than in women, yet detailed water contact studies indicate that women have longer and more frequent contact with infected water bodies during the collection of water and the washing of clothes [29].

In this study, moderate prevalence and light intensity of infection was observed. Considering age, highest prevalence (49.2%) was observed in 10-14 year age group and agrees with previous studies in Tigrai and Wollo [15] and Bahirdar [33]. The intensity of *S.mansoni* infection in terms of geometric mean egg count per gram of feaces reached 83.52 for prevalence of 49.2% in the 10-14 year age group and 107 epg for prevalence of 47.1% in 15 and above years old students. The mean egg count was found to be 86.7. This figure is by far lower than those parasitological studies done elsewhere in Ethiopia. For instance, in Adwa town the intensity was 597 and 591 epg for prevalence of 68% and 64% in the 10-14 and 15 and above age group, respectively [14]. In Bahirdar town, intensity of infection was 245 epg for a prevalence of 56% for the same age group [30]. Among school children aged 7-16 years in Chuait (Gondar Region) intensity of infection was 259 epg [31].

In different endemic countries, the prevalence and intensity of infection are directly correlated [32] unlike the present study which indicated the prevalence to increase until the age of 10-14 years and then decline whereas intensity of infection increases as age increases and close to 75% of light infection were in the 10-14 age groups. This implies that it is children in their 10-14 years age who harbor most of the schistosomiasis infection and also contribute to the most of the contamination of the environment. The prevalence decreased in 15-19 years old and this is probably due to low water contact and acquired immunity or resistance to reinfection. Furthermore, marked variation in the prevalence of infection has been observed in those who lived closer to the dam. This goes in agreement with a study conducted in Machakos district of Keneya which showed children living closer to the river which provides the habitats for intermediate hosts had higher chance of infection than children living far away from the river [33]. This is further supported by a study conducted in Ethiopia, Metehara Sugar Estates, that proximity to irrigation canals was observed the most important factor influencing transmission of schistosomiasis [34]. This might be due to the reason that individuals living on or near the water body are more likely to undertake risky water contact behavior, increasing their exposure to infection.

Use of water from pipe source was significantly associated with being not infected by *S.mansoni*, those who were using pipe water had less chance of being infected with *S.mansoni* than those who did use unprotected spring and dam as their water source. A study in Egypt showed that the presence of house piped water supply lowered infection rates ($P<0.001$) [35]. Another study conducted in Brazil revealed that majority of dwellings had a piped water supply and no association was observed between water supply and infection [36]. The findings of this study also indicated that there was no significant association between swimming, bathing, washing clothes in or near the dam and prevalence of *S. mansoni* infection. In contrast, a study from Kenya showed that these factors to be associated with high risk of infection [28].

Blood in stool was the only symptom that was found to be significantly associated with *S. mansoni* infection. Such an association has consistently been reported in community and school based studies [28,35,37,38].

Conclusion and Recommendations

S. mansoni infection is becoming main health problem among school children and contributing to *S. mansoni* transmission in the community. Children living closer to the microdam were at high risk of infection than those were living far away from it. Hence, high prevalence of intestinal schistosomiasis in the study area shows the need of integrated control programme including periodic deworming, improving sanitation, provision of safe water supply and latrines to reduce human-water contact, appropriate health education and other environmental measures to have a lasting impact on transmission of *S.mansoni*.

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