

Infection prevalence of *Schistosoma mansoni* and associated risk factors among schoolchildren in suburbs of Mekelle city, Tigray, Northern Ethiopia

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ABSTRACT

Schistosomiasis due to infection with *Schistosoma mansoni* is a public health problem in both tropical and sub tropical countries. Thus, effective control of the disease requires determining its prevalence rate, identifying risk factors of infection and high-risk groups. Therefore, the objective of this study was to establish the prevalence of *S. mansoni* infection and associated risk factors among schoolchildren in suburbs of Mekelle city, Tigray, Northern Ethiopia. For this purpose, a cross-sectional parasitological examination was conducted on 457 schoolchildren from November, 2010 to March, 2011. Stool samples were collected and examined by the Kato-Katz technique. Semi-structured interview questionnaire were administered to the study subjects to identify possible risk factors of infection with *S. mansoni*. Furthermore, malacological survey was conducted to check the presence of snail intermediate hosts of *S. mansoni* in the study area. The overall prevalence of *S. mansoni* in the schoolchildren was 23.9 %. Higher prevalence was detected in male children (30.71%) than in females (14.12 %) ($\chi^2 = 16.642$, $P = 0.000$). On the other hand, the highest (31.2%) prevalence was recorded in children with ages ranging from 10 - 14 years followed by those aged 5 - 9 (11.4 %) and 15 - 19 (9.8 %) years ($\chi^2 = 23.865$, $P = 0.000$), respectively. This study revealed the association of *S. mansoni* infection with older age groups, 10 -14 years (OR = 0.114, $P = 0.001$), time of residence in the study area (OR = 0.462, $P = 0.011$), water source (OR = 0.371, $P = 0.020$), previous history of schistosomiasis treatment (OR = 0.246, $P = 0.000$), frequency of water contact (OR = 26.958, $P = 0.004$), crossing water bodies (OR = 3.049, $P = 0.001$), working in an irrigated agricultural field (OR = 7.363, $P = 0.000$) and distance of home from water bodies (OR = 5.163, $P = 0.000$). Moreover, this study determined the presence of snail intermediate hosts of *S. mansoni* in the study areas. Hence, the study areas are considered important epidemiological foci for the transmission of *S. mansoni*. Therefore, it is necessary to undergo wide scale surveillance and institute proper control and prevention strategies against infection with *Schistosoma mansoni*.

Key words: *S. mansoni*, Schistosomiasis, Risk factors, Risk groups, Prevalence, Mekelle city, Tigray.

1. INTRODUCTION

Intestinal schistosomiasis is a serious public health problem in tropical and subtropical parts of the world (WHO, 1993) caused by *Schistosoma mansoni*. It is ranked next to malaria with respect to its impact on public health and socio-economic development in developing countries including those of Africa (WHO, 1993; Chitsulo et al., 2000).

Factors contributing for the occurrence of *S. mansoni* infection include poor socioeconomic status, change in climate, human water contact behavior and ecological changes related to water resource development projects (Kloos, 1995; WHO, 2004). Poor personal and environmental hygiene coupled with frequent water contact behaviors of school age children are reported to render them more vulnerable to schistosomiasis. Moreover, chronic *S. mansoni* infection causes impaired physical and cognitive developments in children (WHO, 2002; King et al., 2005).

Several studies have been conducted on the prevalence of *S. mansoni* infection among school children in different parts of Ethiopia including Tigray (Tilahun and Amaha, 1996; Leykun, 1998; Brhanu et al., 2001; Birhanu et al., 2009, Tadesse and Beyene, 2009).

However, due to recent construction of micro dams mainly for irrigated agriculture in different parts of Tigray regional state of Ethiopia, there is a suspicion regarding expansion of ecological niches of snail intermediate hosts of *S. mansoni* and occurrence of the disease even in foci which were previously free of schistosomiasis (Alemayehu et al., 1998; Tadesse et al., 2008; Tadesse and Beyene, 2009). However, there is no document with regard to the prevalence of *S. mansoni* infection and its associated risk factors in suburbs of Mekelle city. Therefore, this study was aimed to assess prevalence of *S. mansoni* and its associated risk factors among school children in suburbs of Mekelle city, Tigray, Northern Ethiopia.

2. MATERIALS AND METHODS

2.1. Study area

The study was carried out from November 2010 to March 2011 in suburbs of Mekelle city, the capital city of Tigray Regional State, Ethiopia. Mekelle city is located 783 km north of Addis Ababa and it is found between 13° 30.593' N latitude and 039° 28.849' E longitude with altitude of 2200 masl the area covers 53 km², with a population of 215, 546 (CSA, 2007). The major occupations of the inhabitants include civil service, business, daily labor and subsistence agriculture in the sub urban villages. In the city there are 68 governmental and nongovernmental primary schools with a total of 43,792 students. Out of these, seven primary schools are found in suburbs of the city. Water bodies including the Ilala River, Aynalem River, Gereb-Beati dam and My-Bandera River are major sources of irrigation water in suburbs of Mekelle city.

2.2. Study population and design

Schoolchildren infection survey can be used as an index for assessing community infection prevalence (Guyatt et al., 1999). Thus, schoolchildren were selected as study subjects for this study. Among a total of seven primary schools found in suburbs of Mekelle city, only four primary schools namely Ilala, Lachi, Aynalem and Qhiha primary schools were purposely selected. cross-sectional study was conducted on children of the selected schools, who were attending classes during sample collection. The total number of students enrolled in the four schools was 4,765.

2.2.1. Sample Size Estimation

The minimum number of study subjects was estimated by using minimum sample size determination technique (Daniel, 1995),

$$n = \frac{Z^2 P(1-P)}{d^2}.$$

Where “n” is minimum number of sample size, “Z” is standard value, “P” is the prevalence value and “d” is marginal error. At 95% confidence interval Z=1.96 and marginal error is 5%. Since no report was yet recorded for *Schistosoma* infection the P-value was considered to be 50%.

$$n = \frac{(1.96)^2(0.5 \times 0.5)}{(0.05)^2} = 384$$

To minimize sampling error during sample collection, 19% of the estimated value (73 children) was added as contingency for non-response and missing data. Thus a total of 457 children were taken as minimum sample size. Accordingly, 216, 134, 55 and 52, from Ilala, Lachi, Aynalem and Qhiha primary school, respectively were selected by systematic random sampling technique using class roster. Among the selected students, 267 were males and 190 were females, with ages ranging from 5 - 19 years.

2.3. Stool sample collection and microscopic examination

After obtaining ethical clearance and written consent, children who were volunteer to participate in the study were given orientation on how to handle and submit their stool samples. Thereafter, children were given plastic sheet and applicator stick to bring their fresh stool samples. Kato-Katz technique was used to prepare stool smears on slides for microscopic examination (Katz et al., 1972). Forty two grams of stool was taken to determine intensity of the infection in terms of

egg per gram of stool (epg) in each slide. Based on the number of epg, intensity of *S. mansoni* infection classified in to three levels; light infection (1-99 epg), moderate infection (100-399 epg) and heavy infection (≥ 400 epg) (WHO, 1993).

2.4. Survey of risk factors

Semi-structured interview questionnaire were administered to the study subjects to identify risk factors associated with *S. mansoni*. The questionnaire was consisted variables including demographic information, socioeconomic status, previous history of schistosomiasis treatment, sanitary facilities, frequency of water contact and reasons for water contact. The questionnaires were prepared by the mother tongue of the children that is, Tigrigna.

2.5. Malacological surveys

Snail intermediate hosts of *S. mansoni* were surveyed in the human-water contact sites of the study areas; Ilala River, My-Bandera River, Gereb-beati dam and Aynalem River. Snails were collected through hand picking and using forceps. The collected snails were transported to the Biology laboratory, Mekelle University for identification and storage of voucher specimens. In the laboratory the snails were identified to genus level by using keys (Mandahl-Barth, 1962). Collected snail samples were squashed using two slides for checking for cercariae of *S. mansoni*.

2.6. Ethical consideration

The study was approved by the Department of Biology, and ethically cleared by Health Research Ethics Review Committee (HRERC) of Mekelle University, with reference number CHS/1213/R3/16 on December 19, 2010. Children who were positive for *S. mansoni* infection were treated with praziquantel free of charge.

2.7. Data analysis

Data were entered in to Microsoft Excel, and coded appropriately and SPSS version 16 statistics were used to analyze the data. Prevalence and intensity of *S. mansoni* infection were determined in percent and eggs per gram of stool (epg), respectively. Univariate logistic regression analysis was used to assess the association between each risk factor and *S. mansoni* infection using chi square test. To determine the independent risk factors for infection, multiple logistic regression analysis was performed using adjusted odd ratio at 95% Confidence interval. . P-values of less than 0.05 were considered statistically significant.

3. RESULTS

3.1. Prevalence and intensity of *S. mansoni* infection

From a total of 457 schoolchildren participated in the study 109 were found to be positive for *S. mansoni* infection, with an overall prevalence rate of 23.9%. Prevalence of *S. mansoni* infection among the study schools ranged from 7.27% - 31.02%. The highest prevalence of infection was in Ilala (31.02%), while the lowest prevalence was in Aynalem primary school (7.27%) ($\chi^2=26.348$, $P = 0.000$). Infection prevalence of *S. mansoni* with respect to sex shows that higher infection prevalence was in males (30.71%) than in females (14.12%) ($\chi^2=16.642$, $P = 0.000$) (Table 1).

Table 1. Prevalence of *S. mansoni* infection among schoolchildren in suburbs of Mekelle city, North Ethiopia, with respect to sex.

Schools	Number examined			Number (%) infected		
	M	F	T	M	F	T
Ilala	114	102	216	50(43.86)	17 (16.67)	67(31.02)
Lachi	83	51	134	24(28.92)	10 (19.61)	34(25.37)
Aynalem	40	15	55	4(10)	0 (0)	4(7.27)
Qhiha	30	22	52	4(13.33)	0 (0)	4(7.69)
Total	267	190	457	82(30.71)	27 (14.12)	109 (23.9)

Infection prevalence of *S. mansoni* with respect to age group revealed that the highest prevalence (31.2 %) of *S. mansoni* infection was in children with ages ranging from 10 -14 years followed by children with ages ranging from 5 - 9 and 15 - 19 years 11.4% and 9.8%, respectively ($\chi^2=23.865$, $P = 0.000$)(Fig 1).

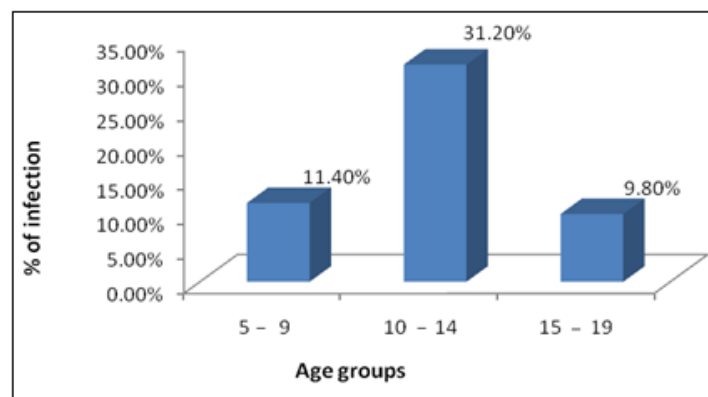


Figure 1. Age specific prevalence of *S. mansoni* in school children in suburbs of Mekelle city, North Ethiopia, 2011.

The intensity of *S. mansoni* infection was expressed in terms of epg and intensity of infection with according to sex showed that higher infection was in females than in males ($\chi^2 = 19.049$, $P = 0.000$) (Fig.2).

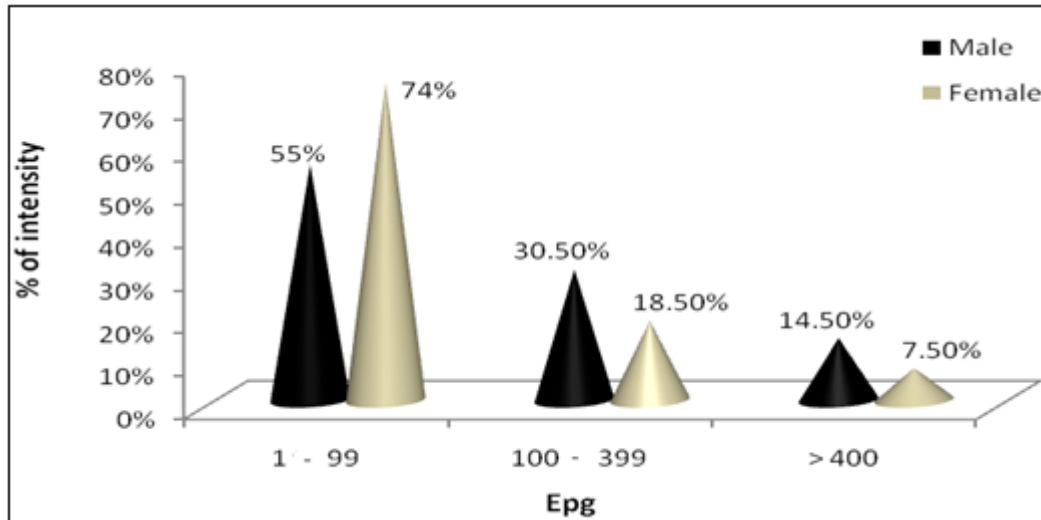


Figure 2. Sex specific intensity of *S. mansoni* infection in schoolchildren in suburbs of Mekelle city, North Ethiopia.

Table 2. Intensity of *S. mansoni* infection in school children in suburbs of Mekelle city, North Ethiopia with respect to age.

Age(year)	<i>N</i> _o examined	<i>N</i> (%) <i>Light</i> <i>infection</i>	<i>N</i> (%) <i>Moderate</i> <i>infection</i>	<i>N</i> (%) <i>heavy</i> <i>infection</i>
5-9	114	8(61.5)	4(30.8)	1(7.7)
10-14	292	55(60.4)	24(26.4)	12(13.2)
15-19	51	2(40)	3 (60)	0(0)
Total	457	65(59.6)	31(28.4)	13(11.9)

The intensity of *S. mansoni* infection according to age group revealed that the highest level of infection was light infection(see Table 2).

3.2. Risk factors associated with *S. mansoni* infection

Gender, age, time of residence in the study area, place of birth, previous history of schistosomiasis treatment, family occupation, water source, frequency of water contact and reasons for water contact like swimming, cross water bodies, working in irrigated agricultural filed, bathing and distance of home from water bodies were significantly associated with *S. mansoni* infection . However, presence of electric power, house hold facilities, sanitary facilities,

washing clothes and recreational fishing were not significantly associated with the infection ($p > 0.05$).

Factors including age, time of residence in the study area, previous history of schistosomiasis treatment, water source, frequency of water contact, crossing water bodies, working in irrigated agricultural fields and distance from water bodies were independently associated with *S.mansoni* infection (Table 3).

Table 3. Multiple logistic regression analysis for risk factors independently associated with *S. mansoni* infection in schoolchildren in suburbs of Mekelle city, Northern Ethiopia, 2011.

Risk factors	Adjusted OR (95% CI)	P-value
Age group		
5 - 9	0.446(0.110-1.798)	2.56
10 - 14	0.114(0.033-0.392)	0.001
15 - 19	-	-
Time of residence study area		
< 3 year	0.462(0.255-0.840)	0.011
Water source		
river	0.371 (0.161- 0.855)	0.020
Pre schistosomiasis treatment		
Non treated	0.246(0.117- 0.518)	0.000
Frequency of water contact		
Daily/weekly	26.958(2.861- 153.99)	0.004
Crossing water bodies		
Yes	3.049(1.584- 5.87)	0.001
Working in agricultural field		
Yes	7.363(3.461-15.665)	0.000
Distance from water bodies		
<1km	5.163 (2.738-9.735)	0.000

(Note: AOR: adjusted odd ratio; CI: 95 % confidence interval)

Children aged from 10 - 14 years were more infected than the other age groups (AOR 0.114; 95% CI 0.033-0.392, $P = 0.001$). Permanent residents were less infected than the new comers (AOR 0.462; 95% CI 0.255-0.840, $P = 0.011$). Similarly, previously treated children were highly protected than non-treated (AOR 0.246; 95% CI 0.117- 0.518, $P = 0.000$). On the other hand, children who are using river water for other domestic needs were more infected than those using piped water (AOR 0.371; 95% CI 0.161- 0.855, $P = 0.020$). Children with daily/weekly water contact were more infected than those have low water contact frequency (AOR 26.958; 95% CI

2.861- 153.99, $P = 0.004$) and children who cross water bodies were more infected than those who do not cross water bodies (AOR 3.049; 95% CI 1.584- 5.87, $P = 0.001$).

Children who assist their family in irrigated farm works were more infected than those who did not participate in irrigated agricultural activity (AOR 7.363; 95% CI 3.461-15.665, $P = 0.000$) and children who live close to water bodies were more infected than who live far from the water bodies (AOR 5.163; 95% CI 2.738-9.735, $P = 0.000$) (Table 3).

3.3. Malacological survey

Biomphalaria species were detected from four snail collection sites in Ilala and Aynalem Rivers. More number of *Biomphalaria* species was found in Ilala River. There was no snail showed positive for cercariae infection.

4. DISCUSSION

The present study is aimed to assess the prevalence and associated risk factors of *S. mansoni* infection in school children in suburbs of Mekelle city. Overall prevalence of *S. mansoni* infection was 23.9%. This result is similar to the findings of previous studies from different part of Ethiopia (Brhanu and Mengestu, 2004; Brhanu et al., 2009; Tadesse et al., 2009). However, it is lower than the prevalence rate reported by Fekadu et al. (1992) in Metahara, Leykun (2000) in South Gonder zone, Moges et al. (2001) in around Gonder, Brhanu et al. (2002) in Wondo-Genet and Tadesse and Beyene (2009) in Tumuga, South Tigray. The observed infection prevalence variation in this study from other localities might be due the difference in water contact behavior of the schoolchildren, environmental sanitation and socioeconomic status, ecological distribution of snails, local endemicity and sample size. In addition to this, our result is low as compared to previously report in the same study area in school children This could be due to deworming program in Mekelle city carried out by Israeli International Health Agency at school level (WIC, 2011).

The highest prevalence of *S. mansoni* infection was in children with ages ranging from 10 -14 years followed by those with ages ranging from 5 - 9 and 15 - 19 years, respectively. This is in agreement with reports of many investigators in different localities of Ethiopia (Fekadu et al., 1992; Alemayehu et al., 1998; Hailuet al., 1998; Tadesse and Beyene, 2009) and in other countries such as, Handzel et al. (2003) from Kenya and John et al.(2008) from Uganda. In contrast to this, some reports described that the highest infection prevalence of *S. mansoni* to be

in children with ages ranging from 15 - 19 years old and the least prevalence to be in children with ages ranging from 10 - 14 years (Brhanu and Shibru, 1993a; Grum, 2005; Tadesse and Beyene, 2009). This might be due to higher rate of water contact among those children with ages ranging from 10- 14 years and the least infection in the age groups 5 - 9 and 15 -19 years, which might be due to low outdoor water contact activities and the development of age-acquired immunity to re-infection, respectively.

In present study, sex related difference in infection prevalence of *S. mansoni* was observed. Males were more infected than females. This is in agreement with previous reports by Berhanu and Shibru (1993b) from Zeghie, Tilahun and Amaha (1996) from Adwa, Girum (2005) from Babile, Tadesse and Tsehaye (2008) from Hintalo-wajirat, Brhanu et al.(2009) from Southeast of Lake Ziway, Tadesse et al. (2009) from Waja South Tigray and also in other countries such as, Massara et al.(2004) and Enk et al. (2010) from Brazil and John et al.(2008) from Uganda. However, reports from Metahara, Chilga district, Tumuga, and also from Kenya near to Lake Victoria reported that no sex related difference in infection prevalence of *S. mansoni* among schoolchildren (Fekadu et al., 1992; Leykun, 2001; Handzel et al., 2003; Tadesse and Beyene, 2009). The observed sex related variation of infection prevalence of *S. mansoni* in the present study might be due to the high rate of water contact behavior of males than females. Besides, the water contact behavior of females like swimming, crossing water bodies, and working in agricultural area is much lower than males.

Analysis on the intensity of *S. mansoni* infection in relation to sex showed that higher moderate and heavy infections were in males than females. This is similar to finding from previous studies by Hailu et al. (1993) from Finchaa River valley, Brhanu and Shibru (1993b) from Zaghie and Tadesse et al. (2009) from Waja. This might be due to repeated engagement of males in water related activities compared to females who have low water contact activities which might be the cause for light infection in females.

The intensity of *S. mansoni* infection according to age groups showed that the peak light infection was observed in children aged 5 - 9 years and followed by 10 -14 years. This is similar to a study conducted by Fekadu et al. (1992). In contrast to this, other investigators described that light infection was in age group of 15 -19 years old children (Tadesse et al., 2009).The highest light infection in the 5 - 9 age group children might be the high susceptibility of this

group to *S.mansoni* infection whereas in the age group 10 -14 years might be due to frequent water contact.

In this study, the peak for moderate infection was in children aged 15 - 19 years old. However, other investigators reported that the peak for moderate infection were in age groups 10 - 14 years old (Brhanu et al., 1991; Tadesse and Beyene, 2009). This could be due to these age group may have frequent water contact during their occupational activities like working in agricultural area. Time of residence in the study area was identified as a risk factor of *S. mansoni* infection. New comer children were more infected than those permanent residents. This was supported by Steinmann et al. (2006). This is due to the fact that permanent residents in an endemic area might contribute the development of immunity against *S. mansoni* infection, while new comers may not. Thus, new comers are vulnerable to the infection.

Previous history of intestinal schistosomiasis treatment was associated with *S .mansoni* infection. Children who were not treated before were at higher risk of infection than those who were treated. This is similar to finding from previous studies by Hailu et al.(1999) and Tadesse et al. (2010). This might be due to treatment by effective drugs can reduce the output of eggs in the infected individuals and reduce transmission at community level.

Frequency of water contact was identified as risk factor for *S.mansoni* infection in which children with frequent water contact were more infected than those who have less frequent water contact. Similarly, children who use river water source for household use were more infected than those who use piped water. This agrees with other studies (Matthyset al., 2007; Enket al., 2010). This could be due to children who have frequent water contact activities may have high rate of vulnerability to *S.mansoni* infection.

Crossing water bodies and working in an irrigated agricultural field were significantly associated with *S. mansoni* infection. This is in agreement with other findings (Brhanu and Shibu, 1993a; Massaraet al., 2004; Brhanuet al., 2009; Enk et al., 2010; Tadesse and Tsehaye, 2010). This could be due to the agricultural based economy of the community, which makes them to stay in contact with water bodies that contain *S. mansoni* cercariae.

Distance from the water bodies was also associated with the infection. Children who live near to the water bodies were more infected with *S. mansoni* than those who live far. This is similar to the previous findings of Fekadu et al. (1992) from Metehra and Matthys et al. (2007) from Cote d'Ivoire.

This might be associated with repeated outdoor water contact activities of children close to their home.

5. CONCLUSION

Infection of *S.mansoni* is an important health problem inschoolchildren in suburbs of Mekelle city. It is associated with risk factors such as age, time of residence in the study area, using river water for household consumption, previous history of treatment, frequency of water contact, crossing water bodies, work in irrigated agricultural fields and proximity of home to water bodies. The infection of *S.mansoni* is more common among those individuals who have frequent water contact for different purposes. There is a need to give school based orientation to the school children and emphasize the reduction of water contact activities of school children and an intervention strategy should be designed and be implemented to reduce schistosomiasis prevalence.

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