

ORIGINAL ARTICLE**HUMAN INTESTINAL SCHISTOSOMIASIS IN COMMUNITIES LIVING NEAR THREE RIVERS OF JIMMA TOWN, SOUTH WESTERN ETHIOPIA**

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ABSTRACT

BACKGROUND: *Schistosoma mansoni* is one of the parasites with high public and medical importance in Ethiopia. However, information is scarce about *S. mansoni* epidemiology in people living with higher risk of infection in Jimma town. This study was designed to determine point prevalence, intensity and risk factors of *S. mansoni* infection among residents nearby three rivers of Jimma town and assess the rate of *Biomphalaria* species shading cercariae from January to April, 2007.

METHODS: A cross-sectional study was conducted in communities residing nearby three rivers of Jimma town. Structured questionnaires were used to collect data on socio-demographic and behavioral risk factors. After physical examination, stool samples were collected from 517 study participants and processed with Kato-Katz technique for microscopic examination and quantification of egg load. Snails were collected for identification of *Biomphalaria* species and then checked for cercarial shading.

RESULTS: The prevalence of *S. mansoni* was 26.3 % with intensity ranging 24 to 936 eggs per gram of stool. Participants in the age group 10-19 years, OR = 2.19 (95% CI; 1.10 – 4.34), and those living near the Awetu River, OR = 2.67 (95% CI; 1.06 – 6.75), had higher risk of *S. mansoni* infection. Moreover, water contact while crossing a river, OR = 3.77 (95% CI; 1.79 – 7.95), and swimming, OR = 2.59 (95% CI; 1.37 – 4.91), was significantly associated with infection. *Biomphalaria* snails collected from Chore and Awetu Rivers shaded higher rate of cercariae compared with Kito River.

CONCLUSION: A moderate prevalence of *S. mansoni* infection was shown in the study population. Infection rate among the residents correlated with rate of cercarial shading *Biomphalaria* snails. Treatment of targeted groups, appropriate health education and environmental measures (e.g. snail control) are needed to improve the situation.

KEYWORDS: Prevalence, Intensity, *Schistosoma mansoni*, *Biomphalaria* snails

INTRODUCTION

Schistosomiasis (bilharziasis) is a parasitic disease that has a worldwide public health importance. The disease is prevalent in 75 countries (1) and more than 650 million people live in endemic areas (2). Globally, about 200 million people are infected with schistosomiasis; 85% of which are living in sub-

Saharan Africa. Among tropical diseases, the yearly estimated deaths of 200,000 are making schistosomiasis second only to malaria as a cause of mortality (3). Human schistosomiasis is initiated by exposure to water (while planting, fishing, washing, swimming and so on) containing the free living infective stage of the parasite (cercariae) released from the intermediate host (snail) (4).

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In Ethiopia, *Schistosoma mansoni* and *Schistosoma haematobium* have significant medical and public health importance. *S. mansoni* is widespread and its presence has been recorded in all administrative regions and is rapidly spreading in connection with water resource development and intensive population movements (5). Two species of fresh water snails (*Biomphalaria pfeifferi* and *Biomphalaria sudanica*) are responsible for the transmission of *S. mansoni* in the country (6). The former is the most dominant and is found in a variety of habitats like pools, sewages, swamps, lakes, small and medium streams, irrigation canals and rivers (7). *S. haematobium* is restricted to lowland areas and has been so far reported from the Awash and Wabeshebele river basins and from Kurmuk at the Ethiopia/Sudan border. *Bulinus abyssinicus* and *Bulinus africanus* were incriminated as intermediate host of *S. haematobium* in Ethiopia and lower altitudes ranging from 300 to 700 meters were suitable for the establishment of these snails and maintenance of the parasite (6).

The World Health Organization recommends a strategy of controlling morbidity for both schistosomiasis and soil-transmitted helminthiasis so as to reduce consequences to the level that these diseases no longer constitute a public health burden. The strategy bases on the prevalence of infection on a given locality (8).

A review of literatures on prevalence of *S. mansoni* documented rates that range from less than 1% up to more than 90% in Ethiopia (6). And most of the studies measured the rate of infection in school children; but the epidemiology in the general population has not been adequately described. Jimma town is among the localities where *S. mansoni* and its intermediate host were previously documented (7). However, information is scarce on the epidemiology of infection in the area to plan effective prevention and control measures. This study aimed to determine the prevalence, intensity and risk factors of *S. mansoni* infection among residents of Jimma town and also assess the rate of *Biomphalaria* species shading cercariae.

METHODS AND MATERIALS

A cross sectional study was conducted in Jimma town from January to April, 2007. The town is at mean altitude of 1780 meters above sea level with tropical climate of heavy rainfall and warm climate with a mean annual temperature of 24.9 °C. The total population of Jimma town was estimated to be 159,009 and the average family size was 6.3 (9). Residents living nearby rivers named; Awetu, Kito, and Chore were surveyed. The selection of the rivers was based on their ecological suitability for transmission of *S. mansoni* infection. The rivers Chore and Awetu join together and flow bisecting the town. Further downstream, they come together with Kito River, which passes crossing western part of the town. The flow of these rivers was persistent throughout the year except the part of Chore River, which dries up during a long dry season. An estimated 11, 000 people were living nearby these three rivers and were at higher risk of acquiring *S. mansoni* infection (Information obtained from Jimma Zone Health Office).

Minimum sample size was estimated to be 193 considering 14.8 % prevalence of *S. mansoni* (10), 5% precision and 95% level of confidence. However; in attempt to have better coverage of the study population with available resources, it was decided the maximum sample size to be 5% (550) of the population at risk. Thus, considering family size of 6.3, the number of households would be 87. With emphasis given to households living nearby water contact points along the rivers, 1334 houses were numbered. Then, systematic sampling technique was used to include all members from every 15th houses, which resulted a total of 517 residents to participate in this study. Individuals who had taken treatment for any intestinal parasites during the month prior to the survey and those who lived in the area for less than one year were excluded.

Study subjects were interviewed about demographic and behavioral risk factors using structured questionnaires. Physical examination was carried out by a nurse to assess signs and symptoms of *S. mansoni* infection. Furthermore, stool samples were collected and processed with Kato-Katz technique using template delivering 41.7 mg of stool plug (11). Then, slides were

transferred to the laboratory of Jimma University and read once by the principal investigator. Conversions of egg counts into egg per gram (e.p.g) of stool were done by a factor of 24. Intensity of *S. mansoni* infection was estimated using e.p.g and classified as light (1-99 e.p.g), moderate (100-399 e.p.g) and heavy infections (>399 e.p.g) (8).

Residents were asked to indicate sites in the rivers where people often come in contact with water during washing, swimming, crossing and other activities. A scoop was used to collect snails from rivers at water contact points where at each site 30 minutes was spent to search and gather as many *Biomphalaria* species as possible. Morphological keys were used to identify *Biomphalaria* species as indicated (12); but other snails were not differentiated. *Biomphalaria* snails collected from each river were transferred in to labeled plastic buckets with water and vegetation (salad and cabbage). Then after, each snail were transferred into labeled vial containing aged water, exposed to light for one hour and checked for shading of cercariae. Attempt was not made to detect non-shedding infection; only *Biomphalaria* snails shading one or more cercariae with bifurcated tail were considered to have *Schistosoma* infection. Cercariae were detected using a microscope; however, definite identification of species was not possible due to constraint of resource.

Data was analyzed using SPSS version 13.0 and results were summarized using mean and percentages as appropriate. Differences in proportions and means were evaluated using chi-square and One-Way Anova, respectively. Bivariate and multivariate logistic regression analyses were used to assess the crude and adjusted effect of seemingly significant predictors of the *S. mansoni* infection. Odds ratio with 95% confidence interval was used to measure the strength of association and p-value

of <0.05 was considered to be significant.

The study was approved by the Ethics committee of Medical Faculty, Addis Ababa University as well letter of support was obtained from Jimma Zone Health office. Study subjects were informed about the purpose of the study and oral consent was obtained from each study subject or their parents. Any information obtained from participants during the study was kept confidential. Participants found to be positive for intestinal parasites were treated with anti-parasitic drugs as recommended by the World Health Organization (8). Accordingly, those with *S. mansoni* infection were treated with praziquantel 40 mg/kg body weight, single dose.

RESULTS

A total of 517 individuals participated in this study. The majority (49.3%) of them were residents around Chore River; whereas, participants nearby Awetu and Kito Rivers accounted 35.6% and 15.1 %, respectively. The mean age of participants was 22.3 and the male to female ratio was 1:2.1.

The cumulative point prevalence of *S. mansoni* infection in the study population was 136 (26.3%), and it peaked at 10-19 years of age. The intensity of *S. mansoni* infection ranges from 24 to 936 e.p.g. Among those infected subjects, the rates of light, moderate and heavy infections were 69 (50.7%), 54 (40.0%) and 13 (9.6%), respectively. The intensity of infection peaked at 10-19 years of age, which is similar to the prevalence rate. The arithmetic mean e.p.g was found to differ by gender in which males had higher intensity of infection compared to females ($p= 0.03$). However, the observed difference in arithmetic mean e.p.g among age groups was not significant ($p = 0.43$).

Table 1: Sociodemographic characteristics and proportion of *S. mansoni* infection in different categories of the study subjects in Jimma town, 2007.

Characteristics	Total (%)	Number (%) infected with <i>S. mansoni</i>	Chi-square value	P- value
Residence site				
Kito	78 (15.1)	7(9.0)	14.4	0.001
Chore	255(49.3)	77(30.2)		
Awetu	184 (35.6)	52(28.3)		
Age (years)				
< 10	148 (28.6)	26 (17.6)	27.7	0.000
10 – 19	135 (26.1)	57 (42.2)		
20 – 29	76 (14.7)	20 (26.3)		
30– 39	63 (12.2)	10 (15.9)		
40– 49	45 (8.7)	12 (26.7)		
≥ 50	50 (9.7)	11 (22.0)		
Sex				
Female	350 (67.7)	79 (22.6)	7.8	0.005
Male	167 (32.3)	57 (34.1)		
Religion				
Orthodox	248 (48)	58(23.4)	6.4	0.040
Muslim	160 (30.9)	39(24.4)		
Protestant	107 (21.1)	39(35.8)		

As presented in table 1, chi-square analysis shows statistically significant associations of *S. mansoni* infection with age, gender, religion and site of residence ($p < 0.05$). Moreover, contact with river

water while bathing, fetching, swimming, crossing, and washing clothes were all associated with *S. mansoni* infection (Table 2).

Table 2: Infection of *S. mansoni* in relation to river water contact activities in Jimma town, 2007.

Characteristics	Total (%)	Number (%) infected with <i>S. mansoni</i>	Chi-square value	P- value
Bathing in rivers				
No	341(66.0)	65(19.1)	27.1	0.000
Yes	176(34.0)	71(40.3)		
Fetching water from rivers				
No	406(78.5)	93(22.9)	11.7	0.01
Yes	111 (21.5)	43(38.7)		
Swimming habit				
No	418(80.9)	79(18.9)	61.7	0.000
Yes	99(19.1)	57(57.6)		
River water contact while crossing				
No	226 (43.7)	23 (10.2)	53.9	0.000
Yes	291 (56.3)	113(38.8)		
Washing cloths in rivers				
No	300 (58)	56(18.7)	21.5	0.000
Yes	217(42)	80(36.9)		

However, after adjustment for significantly associated variables using multivariate logistic regression analysis, residents nearby Awetu River were found to have higher risk of infection compared to those around Kito River, OR = 2.67 (95% CI; 1.06 – 6.75). The highest risk of *S. mansoni* infection was also shown in the age range 10–19 years compared with those less than 10 years of age, OR = 2.19 (95% CI; 1.10 –

4.34). After adjustment, the role of religion to influence rate of *S. mansoni* infection remained also significant. Similarly, contact with water while swimming, OR = 2.59 (95% CI; 1.37 – 4.91, and crossing rivers, OR = 3.77 (95% CI; 1.79 – 7.95), significantly raised the odds of *S. mansoni* infection compared to those with no habit of swimming and crossing, respectively (Table 3).

Table 3: Multivariate logistic regression analysis on variables found significant predictors of *S. mansoni* infection by chi-square test in Jimma town, 2007.

Characteristics	Crude OR (95% CI)	Adjusted OR (95% CI)	P – value*
Residence site			
Kitto	1	1	
Chore	4.39(1.93-9.97)	2.22(0.88-5.69)	0.090
Awetu	4.00(1.73-9.26)	2.67(1.06-6.75)	0.038
Age (years)			
< 10	1	1	
10 – 19	3.43(1.99-5.91)	2.19(1.10-4.34)	0.025
20 – 29	1.68(0.86-3.25)	1.54(0.69-3.45)	0.293
30– 39	0.89(0.40-1.97)	0.94(0.37-2.37)	0.900
40– 49	1.71(0.78-3.74)	2.07(0.82-5.30)	0.125
≥50	1.32(0.60-2.92)	1.53(0.61-3.85)	0.365
Sex			
Female	1		
Male	1.78(1.18-2.67)	1.66(0.99-2.80)	0.054
Religion			
Orthodox	1	1	
Muslim	1.06(0.66-1.68)	1.57(0.91-2.72)	0.106
Protestant	1.83(1.12-2.98)	1.91(1.09-3.34)	0.025
Swimming habit			
No	1	1	
Yes	5.82(3.65-9.30)	2.59(1.37-4.91)	0.004
River water contact while crossing			
No	1	1	
Yes	5.60(3.43-9.16)	3.77(1.79-7.95)	0.000
Washing cloths in rivers			
No	1	1	
Yes	2.54(1.71-3.80)	0.88(0.45-1.72)	0.707
Bathing in rivers			
No	1	1	
Yes	2.87(1.92-4.30)	0.96(0.55-1.66)	0.873
Fetching water from rivers			
No	1	1	
Yes	2.13(1.36-3.33)	1.12(0.63-2.00)	0.694

* P – value obtained in multivariable logistic regression analysis

Of the total study participants, 333 (66.4%) reported at least one clinical sign and symptoms of intestinal schistosomiasis. *S. mansoni* infection was detected in 90 (27%) of individuals with at least one clinical feature compared with individuals with no any clinical manifestation of schistosomiasis, 46 (25%) ($p = 0.19$). Abdominal pain was the most frequent complaint and

reported in 73 (53.6%) of those with *S. mansoni* infection. On physical examination, splenomegaly or hepatomegaly was detected in 8 (1.5%) of the study participants. However, any of these clinical signs and symptoms was not significantly associated with rate of *S. mansoni* infection ($p > 0.05$).

Table 4: Rate of cercarial shading *Biomphalaria* snails collected from rivers in Jimma town, 2007.

River	Number (%) of collected <i>Biomphalaria</i> snails	Number (%) of cercarial shading <i>Biomphalaria</i> snails	Chi-square	P value
Chore	302 (54.0)	213 (70.5)	84.8	0.000
Awetu	192 (34.3)	106 (55.2)		
Kito	66 (11.8)	6 (9.1)		
Total	560 (100)	325 (58.0)		

The rivers were observed to harbor snails of different genera and with varying degree of snail infestation. Among the rivers, Chore River was the most infested with *Biomphalaria* species. The cumulative rate of *Biomphalaria* species shading cercariae was 325 (58.0%). Rate of cercarial shading was observed to differ among

the three rivers in which the highest rate was observed in snails collected from Chore River (Table 4). Trend in the rate of cercarial shading by *Biomphalaria* species coincides with rate of *S. mansoni* infection among residents nearby the corresponding river from where the snails were collected (figure 1).

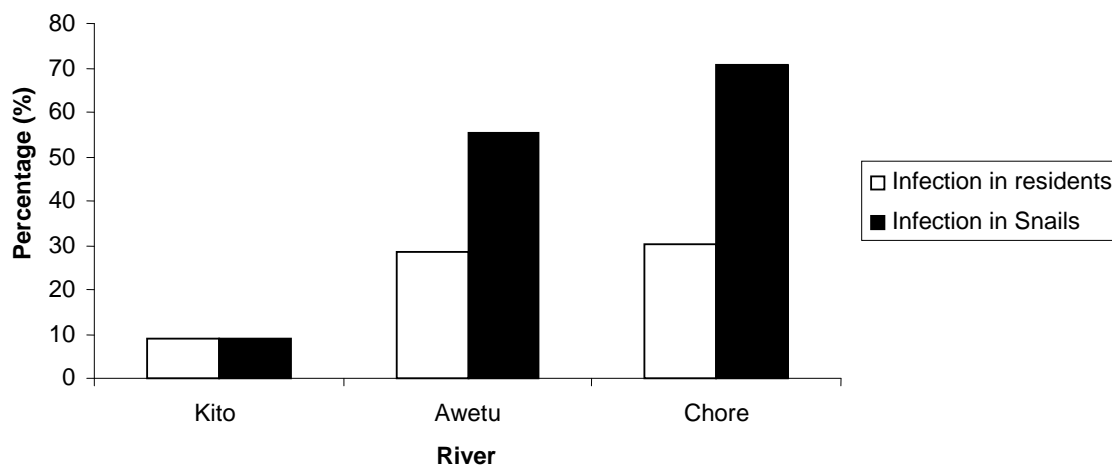


Figure 1: Rates of cercarial shading *Biomphalaria* snails and *S. mansoni* infection in residents nearby respective rivers in Jimma town, 2007.

DISCUSSION

The point prevalence, intensity and risk factors of *S. mansoni* infection were determined in people dwelling around the three rivers (Chore, Kito and

Awetu) in Jimma town. And also an attempt was made to assess the rate of cercarial shading status in *Biomphalaria* snails collected from the three rivers. The cumulative point prevalence of *S. mansoni* was 26.3 %, with intensity of

infection ranging 24 to 936 e.p.g. In comparison, lower rate of infection (14.8%) was reported previously in the general population of Jimma town (10). This difference in prevalence rate may be because the study subjects were at relatively higher risk as households included had close contact with potentially infective rivers. Moreover, the effect of time and different laboratory methods used may have attributed for the observed disparity.

The prevalence and intensity of *S. mansoni* infection peaked among participants in the age range 10-19 years, and a similar finding was also reported in Kenya (13). On the other hand, a bimodal pattern in peak prevalence and intensity of *S. mansoni* infection was reported elsewhere (14). *S. mansoni* infection occurred irrespective of gender; in contrast to several results revealing the preponderance of infection among men (15-17). The shared water contact activities among both sex categories may justify the similar rate of infection in the current study. However, our result indicating the significance of religion to influence rate of *S. mansoni* infection deserves further investigation as similar observation is uncommon.

Snail collection has been proposed for identifying water bodies that are transmission sites for schistosomiasis. It was observed that rivers of Chore and Awetu were more infested with *Biomphalaria* snails in comparison with Kito River. This may be due to the fact that the former two rivers were containing adequate vegetation which favor the intermediate host to flourish as compared with Kito River, which is swampy and hence, unfavorable for snails.

As to the rate of infected intermediate host (*Biomphalaria* species), the majority (58.0%) of the snails collected from rivers were shading cercariae. A previous report from Jimma town showed a 50% rate of infection in the intermediate host (7). In contrast to this study, however, lower infection rate was shown in a study conducted on Lake Zway (0.5% - 6%) (18). This difference may be due to efficiency of parasite transfer from vertebrate to snail host, which is determined by factors including seasonal variation, snail density, prevalence and intensity of *Schistosoma* species and deposition rate of *Schistosoma* eggs in water bodies. It has been

also noted that the rate of cercarial shading snails coincides with *S. mansoni* infection among residents living nearby corresponding rivers. However, *Biomphalaria* species was known to shade human and animal schistosomes and morphologic differentiation of *S. mansoni* from other cercariae is practically impossible. Thus, the possibility of shaded cercariae other than *S. mansoni* species could not be ruled out and this limitation should be taken in to account when interpreting the result of this study.

Overall, as classified by the World Health Organization (8), a moderate (10-50%) prevalence of *S. mansoni* infection was revealed among communities living nearby the three rivers of Jimma town and the rate of snails shading cercariae coincides with the rate of *S. mansoni* infection among residents. This preliminary data highlights swimming and walking through the rivers are significant risk factors for acquiring *S. mansoni* infection. Therefore, a multi-faceted control approach is direly needed to reduce the burden of *S. mansoni* in Jimma town. Interventions leading to reduction of water contact (swimming and crossing the rivers), improved environmental sanitation in the rivers' catchments, construction and appropriate use of latrine, safe water supply, snail control, health education and targeted chemotherapy of the affected communities should be systematically planned to make control efforts achievable.

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