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RESEARCH ARTICLE

EPIDEMIOLOGICAL STUDY ON *SCHISTOSOMA MANSONI* INFECTION IN DIZA AREA, BENISHANGUL-GUMUZ REGION, NORTHWEST ETHIOPIA

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ABSTRACT

Schistosomiasis is one of the major medical and public health problems in developing countries including Ethiopia. The objective of this study was to assess the establishment of transmission, prevalence and associated risk factors of *S.mansoni* infection among school children of Diza area, Northwest Ethiopia. School based cross sectional study was conducted from March-April 2016. A total of 260 school children were selected using simple random sampling technique and were screened for *S. mansoni* using Kato Katz technique. Data related to potential risk factors were gathered through direct interview by using a pretested structured questionnaire. Malacological survey was also carried out to identify snail intermediate hosts. Data entry and analysis was done using SPSS version 20. Bivariate and multivariate logistic regression analysis was done to examine the association between *S. mansoni* infection and various risk factors (P-value < 0.5).The overall prevalence of *S. mansoni* was 27.3% (71) with mean intensity of infection, 264 eggs per gram of feces. More than half (66.20%) had moderate infection intensity. The collected snails were identified as *Biomphalariapfeifferi*. A significant association was found between *S. mansoni*infection and time taken to cover the distance between home and river, swimming habit, practice of river crossing, knowledge about schistosomiasis and its vector (P<0.05). *Schistosoma mansoni* infection still remains a public health problem in the study area. Therefore, the district health office in collaboration with schools community and other stake holders should work to take measures including mass drug administration, promoting health education and behavioral changes in children towards schistosomiasis.

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INTRODUCTION

Schistosomiasis is a chronic disease caused by parasitic worms that live in certain types of freshwater snails. Intestinal schistosomiasis is an intestinal infection caused by parasitic *Schistosoma mansoni* worms (Hotez and Kamath, 2009). Schistosomiasis is ranking second after malaria as the most devastating parasitic disease in tropical countries. Worldwide, there are more than 230 million people at risk of schistosomiasis infection. The estimated 166 million cases in sub-Saharan Africa represent 90% of the world's cases (The end fund, 2017). *S. mansoni* is widely distributed in Ethiopia (MoH, 2013). Ethiopia is ranking second after Nigeria in terms of the burden caused by schistosomiasis and more than 22 million of the populations are requiring preventive chemotherapy for it (WHO, 2015). Moreover, intense population movements and ecological changes have created suitable habitats for the snails and schistosoms. The endemic foci increased from 8 to 55 according to surveys done between 1960–1980 and 1996–2011. Though there have been no national surveys on schistosomiasis, estimated 4 million people are infected (MoH, 2013). An infection rate of intestinal schistosomiasis as high as 84.6%, was reported among children younger than 14 years of age in certain parts of the country (Alebie *et al*., 2014). To come up with appropriate interventions against this disease, information on transmission, prevalence, distribution and associated risk factors of the disease in different transmission settings is a prerequisite.

However, information on recent magnitude and risk factors of the disease is lacking in the study area. Therefore, the aim of this study was to assess the establishment of transmission, prevalence and associated risk factors of *S. mansoni* infection (SMI) among school children of Diza area, Northwest Ethiopia. Identifying the local risk factors of SMI represents one step towards a better understanding of the transmission patterns. This enables the decision makers and school community to have current information that can be used in improving health status of schoolchildren by designing cost effective intervention measures in the study area and in the

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country in general. The obtained information is also crucial in evaluating the different intervention strategies that will be implemented in the future.

RESEARCH METHOD

Study Area

The study was conducted in Diza area, Benishangul-Gumuz region, Northwest Ethiopia. Dizais found around 640 Kms West of Addis Ababa. The population of Dizause agriculture and gold mining as the major sources of income. The latitude and longitude of Diza area is about 10.25 and 35.16 respectively. The study area is characterized by river basins and streams with significant potential for irrigation agriculture (INBAR, 2010). At the time this study was conducted, no control program was in place against intestinal schistosomiasis.

Study Design and Period

A school based cross-sectional study was conducted from March to April, 2016.

Study Population

The study population were all school children found in Diza and Chesega primary schools of Diza area. School children with age ranged 6 to16 were included in the study if parents/guardians had given written informed consent for them to participate in the study and if assent had been obtained from the children. Teachers were involved to educate parents and children on the importance and risks of participating in the study. Non-volunteers primary school children with a history of taking medication against schistosomiasis three months prior to and during the data collection were excluded from the study.

Sample Size Determination and Sampling Techniques

The required sample size (n) was estimated using the formula for cross-sectional survey, $n = Z^2\ p\ (1\text{-}p)/d^2$ (Daniel, 1995) and with the following assumptions: prevalence (p) of 20.6 % from a previous study (Essa *et al.*, 2013), 95 % confidence level, 5 % margin of error. Accordingly, the minimum sample size (n) was found to be 251. To minimize errors arising from the likelihood of non-compliance, five percent of the sample size was added to give a final sample size of 264. Two elementary schools found around Diza River were selected as a study schools by purposive sampling method.

The number of school children selected from each school was determined by the probability proportional to size of the school and the class population. To select the school children with age ranged from six to sixteen, the students were stratified according to their educational level (grade 1 to grade 8). First, classes were selected by simple random sampling technique. Then, quota were allocated for each grade with proportional allocation according to the number of students in each grade. Finally, the study participants were selected using systematic random sampling technique by using class rosters as a sample frame (Cochran, 1909).

Methods of Data Collection

Interview with structured questionnaires

Based on the possible risk factors a questionnaire was prepared in English, and re-translated into the local language for interview with schoolchildren to collect the socio-demographic data and risk factors. Finally, to ensure the reliability of the information given during data collection first pilot study was done, the children were interviewed in their mother tongue (Gumuzgna) in the presence of their parents or teachers' using the revised and pretested structured questionnaires.

Stool sample collection and microscopic examination

The collected stool samples were processed for microscopic examination using Kato-Katz method (template delivering 41.7 mg of stool). Two slides per stool specimen (2×41.7 mg of faeces) were prepared and, after 24 hours read by two laboratory technologist (Legesse *et al*., 2010; Ruberanziza *et al*., 2015). Quantitative microscopic examination was done for ova of *S. mansoni* at Diza health center. Averages of egg count on pair of slides per sample was taken and egg count per slide was multiplied by 24 to convert into number of eggs per gram (epg) of stool (Haile *et al*., 2012). Finally, the intensity of infection was performed by quantification of epg of faecesand classified into: light infection (1-99 epg), moderate (100-399 epg) and heavy (greater than 400 epg) (WHO, 2000). For quality assurance, a random sample of 10% of the negative and positive Kato Katz thick smears were re-examined by a third technician and there was no difference in result.

Snail survey and identification

Snails were surveyed from rivers and streams that are nearby to the schools, at human water contact sites by handpicking using forceps and gloves. The collected snails were transported to Aklilu Lemma Institute of Pathobiology for identification and determination of natural trematode infection. For determination of natural trematode infection, the snails were kept in the dark for about 24 hours prior to exposure and then each snail was placed individually in the shedding vials and exposed to electric light for about one hour. Lab-bred mice were exposed to schistosome cercariae shed from the snail for definite identification of schistosome species, based on egg or adult worm morphology. This was done by immersing the tails of the mice in water containing schistosome cercariae. The exposed mice were maintained in the lab for 8 weeks after which they were sacrificed and adult worms were recovered by perfusion (Duval and Dewitt, 1967). During snail collection visual observations were also made on physical characteristics of the habitat such as vegetation abundance, turbidity, the nature of the substrate, on water contact activities and human behavior at selected sites.

Ethical Consideration

The protocol of the study was reviewed and approved by Research and Ethical Committee of Assosa University. Informed assent and consent were obtained from children and teachers/guardian of the children, respectively. The ethical consideration was addressed by treating positive school children with standard drug (Praziquantel) using a single oral dose of 40 mg/kg body weight according to WHO and country guidelines under the supervision of a local nurse (WHO, 2002).

Data Analysis

Data entry and analysis was done using SPSS version 20. Prevalence was calculated using descriptive statistics. First, bivariate analysis was done to examine the association between SMI and various risk factors. Then, potential risk factors with P-value < 0.2 were selected and included in multivariate logistic regression model to measure the strength of association between SMI and potential risk factors (P-value < 0.5). Goodness of fit for multivariate logistic regression model was cheeked using Hosmer and Lemeshow statistic (Hosmer and Lemeshow, 2000).

RESULTS AND DISCUSSION

Snail identification

The collected snails were identified as *Biomphalariapfeifferi*. The natural trematode infection was maintained in lab-bred mice at Aklilu Lemma Institute of Pathobiology. The exposed mice were sacrificed and adult worms were recovered by perfusion. Furthermore, open air defection around the river bank was also very common, ensuring completion of the parasite life cycle.

Prevalence and intensity of SMI

Table 1. Prevalence of SMI according to school and sex among school children (*n*=260) of Diza area, Northwest Ethiopia

School Name	Sex	No. Examined (%)	No. Infected	% Infected
Diza	Male	99 (23.45)	26	26.26
	Female	102 (24.17)	24	23.52
	Sub total	201 (47.63)	50	24.87
	Male	28 (6.63)	10	35.71
Chesega	Female	31 (7.34)	11	35.48
	Sub total	59 (13.98)	21	35.59
	Total Population	260 (100)	71	27.3

A total of 264 schoolchildren were invited to participate and 260 (97.77%) provided proper stool samples and complete information. 201 (77.30%) and 59 (22.69%) students were taken from Diza and Chesegaprimary schools respectively. The overall prevalence of SMI in both sex of the pupils in both schools was 27.3% (71) (Table-1).

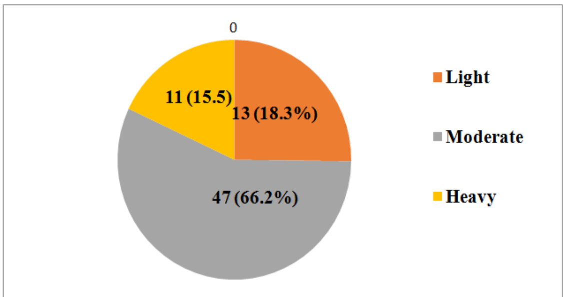

Figure 1. Intensity of SMI among school children of Diza area, Northwest Ethiopia

Majority of the students 47 (66.20%) who were infected with *S. mansoni* had moderate infection (100-399 epg) and followed by light infection (1-99 epg) (13 (18.3%). About 11 (15.5%) of them had heavy infection (greater than 400 epg). The mean number of eggs count per gram was 264 (Fig-1). Of the 260 study subjects, 127 (48.84%) were males and 133 (51.15%) females. The age distribution of the students showed that 74 (28.46%) students were 6-9 years, 118 (45.4%) ranged from 10 to 12 years and 68 students (26.2%) were above 13 years of age. Majority of students were grade 1 to 4, 181 (69.61%). Majority of the students have mother who do not able to read and write 198 (76.15%) and father who do not able to read and write 155 (59.61%). Majority of the students' mother occupation and students' father occupation was house wife 204 (78.46) and farmer 198 (76.15%) respectively (Table 2). In this study, bivariate analysis was done to examine the association between SMI and various risk factors related to socio-demographic risk factors. All the socio-demographic risk factors except fathers' occupation were not statistically associated with SMI (P>0.05). However, the potential socio-demographic risk factors like age, fathers' educational status and area of the school found with P-value < 0.2 were included in multivariate logistic regression model (Table 2). In this study, bivariate analysis was done to examine the association between SMI and various risk factors related to water contact and exposure to running water. Source of water for drinking, time taken to cover the distance between home and river, swimming habit, crossing of stream/river water, knowledge about schistosomiasis vector were statistically associated with SMI (P<0.05). Source of water for bathing and cloth washing and knowledge about schistosomiasis were not statistically associated with SMI (P>0.05). However, they were with P-value < 0.2 and included in multivariate logistic regression model (Table 3). In the final model, potential risk factors with P-value < 0.2 were included and analyzed using multivariate logistic regression model. Overall, variables such as time taken to cover a distance between home and river/stream, swimming habit, practice of river/stream crossing, knowledge about schistosomiasis and its vector were statistically associated with SMI (P<0.05) among the examined participants. The results confirmed that potential risk factors such as shortest time taken to cover the distance between home and river/stream (< 30 minutes), swimming habit, river/stream crossing, no knowledge of about schistosomiasis, and no knowledge about vector of schistosomiasis increased the probability of being infected by SMI in the study participants by2.61, 0.340, 0.294, 3.215 and 4.264 respectively (Table 4).

DISCUSSION

The observed prevalence of SMI of 71 (27.3%) is almost similar with study conducted at Kisantu Health Zone, Congo (Kumbu *et al.*, 2016). They reported *S. mansoni* prevalence of 26.5% among schoolchildren. However, prevalence of SMI in this study was lower compared with reports of other similar studies, 33.3% in Nyamaropa rural area, Zimbabwe (Midzi *et al.*, 2011), 53.7% in Mwea irrigation scheme, central Kenya (Masaku *et al.*, 2015), 42.4% in Merebmieti elementary school, Northern Ethiopia (Desta *et al.*, 2014),77.3% in Demba Girara Primary School, Southern Ethiopia (Alemayehu and Tomass, 2015).This variation can be explained by the fact that environmental factors that influence snail distribution should not be overlooked, despite the fact that these can vary considerably from site to site and area to area, even within short distances. On the other hand, this study has shown higher prevalence rate compared to earlier surveys conducted in students in Sokoto town, Northwest part of Nigeria (2.93%) (Singh *et al.*, 2016), Gorgora Town, Northwest Ethiopia

Table 2. Distribution and bivariate logistic regression analysis for association of SMI with socio-demographic factors among school children (*n*=260) of Diza area, Northwest Ethiopia

Risk factors		Intestinal Schistosomiasis		P-value	COR (95%CI)
		No. Examined (%)	No. infected (%)		
Age in years	6-9	74 (28.46)	17 (22.97)	0.151	1.313 (0.905-1.906)
	10-12	118 (45.38)	31 (26.27)		
	>12	68 (26.15)	23 (33.82)		
Sex	Male	127 (48.84)	36 (28.34)	0.713	1.108 (0.642-1.912)
	Female	133 (51.15)	35 (26.31)		
Grade	1-4	181 (69.61)	48 (26.51)	0.666	1.138 (0.633-2.047)
	5-8	79 (30.38)	23 (29.11)		
Mothers' educational Status	Don't read and write	198 (76.15)	54 (27.27)	0.928	0.980 (0.624-1.538)
	Able to read and write	42 (16.15)	12 (28.57)		
	Secondary school and above	20 (7.69)	5 (25)		
Fathers' educational Status	Don't read and write	155 (59.61)	47 (30.32)	0.127	0.719 (0.470-1.098)
	Able to read and write	76 (29.23)	19 (25)		
	Secondary school and above	29 (11.15)	5 (17.24)		
Mothers' occupation	House wife	204 (78.46)	55 (26.96)	0.537	1.178 (0.699-1.985)
	Government employee	47 (18.07)	12 (25.53)		
	Daily laborer	9 (3.46)	4 (44.44)		
Fathers' occupation	Farmer	198 (76.15)	63 (31.81)	0.024	
	Government employee	51 (19.61)	5 (9.80)		0.479 (0.253-0.907)
	Others	11 (4.23)	3 (27.27)		
Area of the school found	Diza	201 (77.30)	50 (24.37)	0.106	1.669 (0.896-3.107)
	Chesega	59 (22.70)	21 (35.59)		
Presence of toilet in home	Yes	199 (76.53)	58 (29.14)	0.232	1.519 (0.766-3.013)
	No	61 (23.46)	13 (21.31)		

Table 3. Distribution and bivariate logistic regression analysis for association of SMI with water contact among school children (*n*=260) of Diza area, Northwest Ethiopia

Risk factors		Intestinal Schistosomiasis		P-value	COR (95%CI)
		No. Examined (%)	No. infected (%)		
	Pond	0	0 (0)	0.029	0.247 (0.071-0.865)
Source of water for drinking	Stream	4 (1.53)	4 (100)		
	River	2 (.76)	0 (0)		
	Pipe	254 (97.69)	67 (26.37)		
Source of water for bathing and cloth washing	Pond	4 (1.53)	2 (50)	0.186	0.545 (0.222-1.340)
	Stream	4 (1.53)	2 (50)		
	River	252 (96.92)	67 (26.58)		
	Pipe	0	0 (0)		
Time taken to cover the distance between home and river	More than 30 minutes	114 (43.84)	45 (39.47)	.000	0.340 (0.193-0.599)
	Less than 30 minutes	146 (56.15)	26 (17.80)		
Swimming habit	No	132 (50.76)	12 (9)	.000	8.55 (4.299-17.008)
	Yes	128 (49.23)	59 (46)		
Crossing of stream/river water	No	141 (54.23)	16 (11.34)	.000	6.714 (3.565-12.64)
	Yes	119 (45.76)	55 (46.21)		
Knowledge about schistosomiasis	No	156 (60)	58 (37.17)	0.186	0.545 (0.222-1.340)
	Yes	104 (40)	13 (12.5)		
Knowledge about schistosomiasis vector	No	188 (72.3)	66 (35.10)	.000	0.189 (0.078-0.460)
	Yes	72 (27.69)	5 (6.9)		

(20.6%) (Essa *et al*., 2013) and primary schools in Manna District, Southwest Ethiopia (24.0 %) (Bajiro *et al*., 2016). This difference might be due to the focal distribution of *S. mansoni* (Singh *et al*., 2016), and close proximity of the schools to Diza River and nearby streams. Moreover, the present study participants had the practice of river/stream crossing when they went to school. Generally, the contradictory report on the prevalence of SMI could be due to variation in awareness regarding transmission SMI and socio-economic factors of parents' study subjects between study participants in this study and previous studies. We also suggest that this could be attributed to frequent visit to the water bodies which might be infested with *S. mansoni* parasites, hence more exposure to infection. Moreover, as the collection period was short, potential seasonal fluctuations might have affected the actual prevalence. The infection intensity in our study indicated a moderate infection level, which is comparable with findings from (Erko *et al*., 2012) and (Haile *et al*., 2012) in Ethiopia. However, light infection intensities were reported from Timuga and Waja from Tigray (Dejenie *et al*., 2010) and Mekelle City (Assefa *et al.,* 2013) in Northern Ethiopia. The difference may be explained by the frequency of students' contact with contaminated water-bodies and the burden of the adult worms hosted (Bajiro *et al*., 2016). Water contact habits of the study subjects confirmed that swimming and river/stream crossing with bare foot are the risk factors for SMI.

Similarly, students who had the practice of river/stream crossing had slightly higher odds for the infection as compared to their counterparts. This is in agreement with the report of (Masaku *et al*., 2015) and (Alemayehu and Tomass, 2015). They showed children who come into contact with borehole, canal or stream/river were all significantly at risk of SMI as compared to those who use piped water ($p < 0.001$). This could be attributed to the preference shown by snail hosts for slow flowing rivers, or stagnant bodies of water. Because these snails harbor schistosome parasites and contributing to high infection rate among the people coming in contact with such water bodies (Singh *et al*., 2016). Knowledge about schistosomiasis and its vectors were significantly associated with SMI. Among 260 students interviewed, 60% and 72.3 % of them were without knowledge of schistosomiasis and its

Table 4. Multivariate logistic regression analysis for potential risk factors associated with SMI among school children (n=260) of Diza area, Northwest Ethiopia

Risk factors for SMI		P-value	AOR (95% CI)
Age in Years	6-9	0.220	0.555 (0.217-1.421)
	10-12	0.606	0.798 (0.339-1.878)
	13-16	1.00	1.00
Fathers educational Status	Don't read and write	0.082	3.424 (0.856-13.685)
	Able to read and write	0.527	1.546 (0.401-5.957)
	Secondary school & above	1.00	1.00
Fathers' occupation	Farmer	1.00	1.00
	Government employee	0.671	0.676 (0.111-4.120)
	Others	0.199	0.273 (0.038-1.975)
Time taken to cover a distance between home and river/stream	Less than 30 minutes	0.010	2.61 (1.253-5.438)
	More than 30 minutes	1.00	1.00
Swimming habit	Yes	0.045	0.340 (0.118-0.976)
	No	1.00	1.00
Practice of river/ stream crossing	Yes	0.022	0.294 (0.103-0.838)
	No	1.00	1.00
Knowledge about schistosomiasis	Yes	1.00	1.00
	No	0.010	3.215 (1.318-7.840)
Knowledge about schistosomiasis vector	Yes	1.00	1.00
	No	0.020	4.264 (1.261-14.420)
Source of water for drinking	Stream	0.999	.000
	River	0.999	.000
	Pipe	1.00	1.00
Source of water for bathing and cloth washing	Stream	.999	.000
	River	0.399	4.343 (0.143-131.509)
	Pipe	1.00	1.00
Area of the school found	Diza	0.499	1.334 (0.578-3.077)
	Chesega	1.00	1.00

AOR= Adjusted odd ratio; CI, Confidence interval

vectors involved in transmission respectively. Students who had no awareness about knowledge of schistosomiasis and schistosomiasis vectors were 3.215 times (95% CI: 1.318-7.840) and 4.264 times (95% CI: 1.261-14.420) more likely to be infected with *S. mansoni* respectively. The reason might be that the students were not conscious about the epidemiology of this disease either informally or formally through their school curriculum. This in turn may cause not only increased infection but also decreased interest of people from seeking medical treatment. Similar studies showed that low awareness about schistosomiasis increases the risk of infection (Essa *et al*., 2013).

Conclusion

The findings of the present study showed SMI was prevalent health problem and causing moderate risk of the morbidity among school children of Diza area. Water contact and exposure to running water when they went to school, swimming habit, and crossing of stream / river were the potential risk factors associated with acquiring of SMI among schoolchildren of Diza area. The present study also revealed poor knowledge about schistosomiasis and its modes of transmission and preventive measures; particularly about the role of snails in the transmission of schistosomiasis. Health education and the treatment of infected persons are suggested as first line of measure, and hence a biannual mass drug administration with Praziquantelis required. Long term integrated control measures and improving safe water access to the community; as well as elimination of intermediate host is imperative. As such there are urgent needs for the state government authority, local governments as well as nongovernmental organizations to formalize and establish feasible control programmes in the area.

The health extension program and school-parent forums should also emphasize on school-health.

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