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Original Research Paper

Urogenital Schistosomiasis Transmission and Human Water Contact Patterns in Aponmu-Lona River Basin, Idanre, Ondo State, Nigeria

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A study on urogenital schistosomiasis transmission and human water contact patterns was carried out in Aponmu-Lona River Basin, Idanre, Ondo State, Nigeria for a period of twelve months (May 2016 – April 2017) to corroborate the roles of human water contact patterns with the transmission of urogenital schistosomiasis in the Aponmu-Lona study area. The major water contact activities were fetching, fishing, baptism, bathing and washing clothes, farm tools, and household utensils. Contact patterns varied significantly between males and females (x^2 = 357.75, df =1, p<0.001) and between sites (x^2 = 340.989, df = 36, p<0.001). Out of all the snail species collected and examined for trematode infection, only *Bulinus globosus* snails in site 3 were found to shed cercariae with the prevalence of 4.5% (only 5 shed cercariae out of 112 collected and examined).

Keywords: Urogential schistosomiasis, Human water contact patterns, Bulinus globosus, trematode infection.

INTRODUCTION

Schistosomiasis is a parasitic infection caused by trematode worms of the genus Schistosoma, Weinland (1858). Urogenital schistosomiasis, caused by *S. haematobium* remains an important public health problem globally with approximately 779 million estimated to be at risk (WHO 1985, Ofoezie 1999, Omonijo 2013, Peletu 2016). The transmission cycle of the disease involved freshwater bodies infected with cercariae, intermediate host snails, and humans involving contact infected water bodies (Lutz 1986, Ofoezie *et al* 1997; Peletu 2010). Information on urogenital schistosomiasis transmission and human water contact pattern in Ondo State is scanty despite widespread distribution in some of its neighbouring states. Recent mass media reports however suggest a probable outbreak of the disease in parts of the state, particularly the Aponmu-Lona community in Idanre Local Government Area. This study was therefore carried out as part of an overall investigation to confirm the disease and determine the pattern of transmission in the area, as regards risks and roles being played by human water contact activities.

MATERIALS AND METHODS

Study Area

This study was carried out in Aponmu-Lona River Basin, Idanre Local Government Area, Ondo State, Nigeria, from May 2016-April 2017. The area is located approximately between Latitudes 5°45'N and 5°50'N and Longitudes 4° 34'E and 4°40'E (Map 1). Aponmu-Lona River Basin has a catchment area of approximately 900 km within the southwestern climatic belt of Nigeria. Its major tributaries are rivers Owena and Anu (Map 1). Most water-related activities in the community take place in the river. These activities include palm oil milling, washing clothes, cooking utensil, and cassava tubers, fermentation of cassava tuber, fishing, swimming, and bathing (Adeola, 1991).

Human Water Contact Patterns

Each of the seven sites was observed for water contact activities once every month for twelve months (May 2016-April 2017). Each site was observed for a period of twelve hours 7.00 am - 7.00 pm each day. The seven sampled sites were selected on the premise of their proximity and to the river bodies as well as people's frequency of visits.

All observations were carried out during the last week of every month. During this period, records were taken of individuals entering and leaving the water. Such records include sex, age, types of contact (activities performed), proportion of body immersed (exposure-degree of contact) and time spent (duration of contact which is the difference between time entered and time out of water).

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Snail Sampling

Each of the seven sites was sampled for snails once every month for a period of twelve months (May 2016 – April 2017), using a standard procedure comprising 30 passes of kitchen scoops and a manual search for 30 people per minute (Ofoezie, 1999). The scoop is attached to a metal pipe of about 2.5m long. Sampling in each site was carried out from five designated spots as shown in Map 1.

From each spot, six passes of the scoop were randomly taken across each semi-circular curve and dragged along in the on-shore direction. Each dragged scoop was searched for about ten minutes for snails, and snails collected were kept in pre-labeled containers with perforated lids containing damp and decaying leaves. These were taken to the laboratory for sorting and identification to species or genera according to Brown and Kristensen (1993) and, Brown and Kristensen (1982). The number of each snail species was counted to determine the number of each species or genera per month per site.

The established local intermediate host species were measured and examined for Schistosoma infection using the light exposure method. The sizes (i.e. height x width for globose and diameter for discoid) snails were measured using a fine Vanier caliper. Height or length which represents the longest distance between apex and base is measured for globose shells while width is the maximum distance across the shell (globose or discoid).

Statistical Analysis

Snail count per month and frequency of water contact between sites were compared using the Chi-square test from the Contingency Table (Zar, 1972). Duration of water contact between sites and months were determined using the Oneway analysis of variance (Siegel and Castellan, 1988). Water contact patterns and duration were assessed using the correlation coefficient (Siegel and Castellan, 1988).

RESULT

General Patterns of Water Contact in Aponmu-Lona River Basin

A total of 2,494 water contact observations involving nine primary water contact activities were made at the seven sites investigated over a total of 51,895 minutes between May 2016 and April 2017 (Table 1). The primary activities recorded were swimming, fetching, bathing, washing cloth, fishing, washing farm tools, washing household utensils baptism and washing limbs. Mean duration of individual contacts ranged from about 2 minutes of washing limbs to more than 2 hours 30 minutes of fishing. A breakdown of the 51, 895 minutes of total contact duration showed that 10,356 (19.90%) were spent on recreational activities (swimming, playing), 16,098 (31.02%) on domestics activities (washing cloth, fetching, washing household utensils) 3,184 (6.14%) on personal contacts (washing hands, legs and bathing), 10,096 (19.45%) on economic contacts (washing farm tools and farm produce, fishing) and 12,161 (23.43%) on religious contacts (baptism, water worship etc.).

Out of the 2,494 contacts observed, 1,283 (51.4%) involved complete exposure for 25,701 minutes; 324 (13.0%) involved limited exposure for 1,659 minutes while 887 (35.6%) involved partial exposure for 24,535 minutes. Thus, mean duration for the activities were 20.03, 5.1 and 27.7 minutes for complete, limited and partial exposures respectively.

Table 1 presents the distribution of individual contact activities among the seven sites investigated. Site 1 which accounted for 17.0% of total contact activities observed was the most frequently visited site while site 3 where only 13.1% of activities were recorded was the least frequently visited. Swimming was the most important single contact activity (24.7%) while fishing (6.7%) was the least important. Distribution of contact activities generally varied from one site to another depending on the macrophyte cover, nature of the substratum and accessibility. Site 3 was the most suitable site for swimming, site 1 for fetching water, bathing, washing cloth and fishing while site 5 was used for other sundry activities. Statistically, distribution of contact activities by site and by type was significantly ($p<0.001$) different.

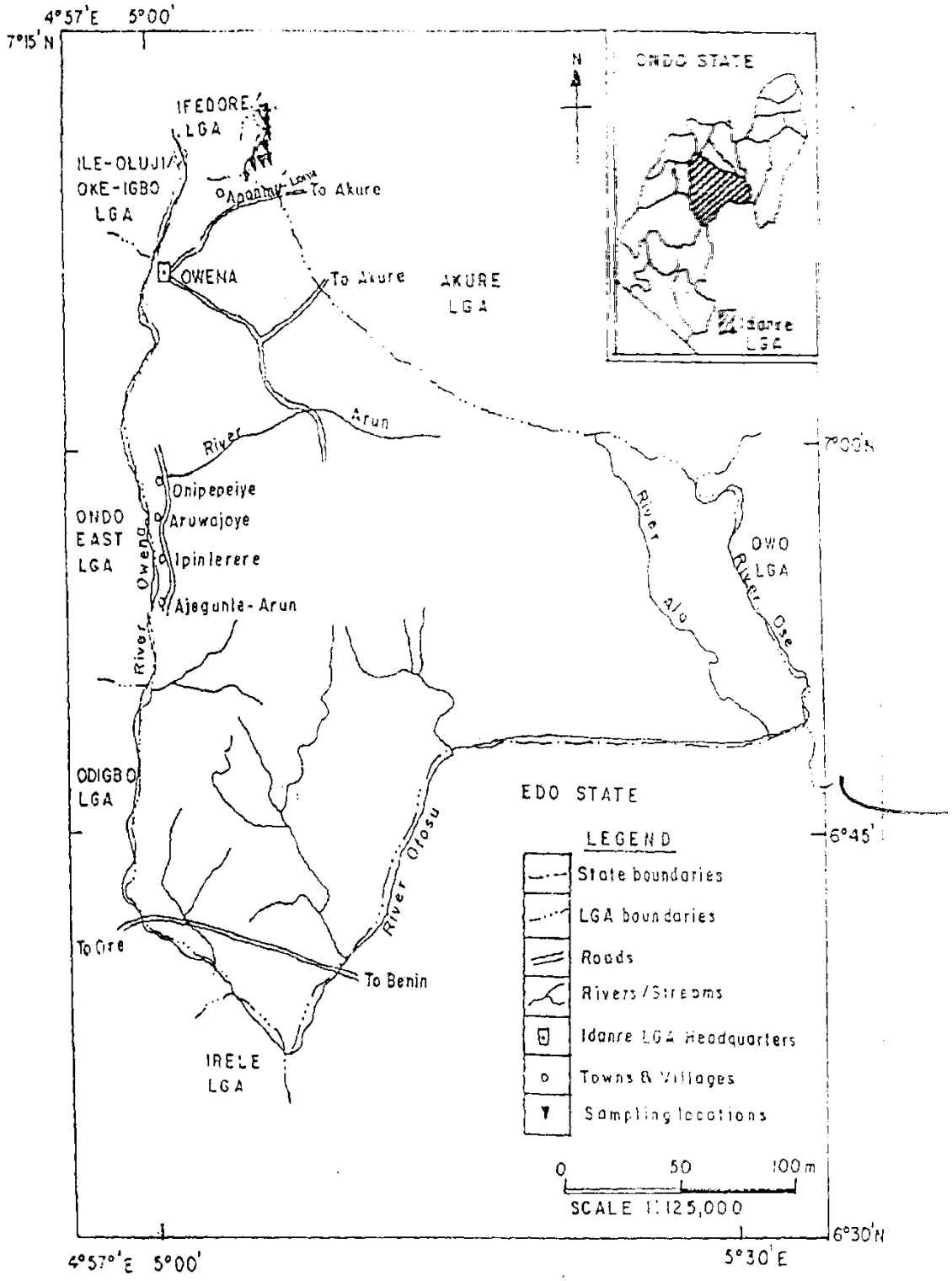
Variation in Water Contact by Age and Sex

Water contact behaviours in the sampling sites were clearly age and sex-related (Table 4.3), although both males and females of all age groups participated in most water contact activities. Generally, males significantly made more contacts (1255) than females (1239) but the females stayed longer in water (26,956 minutes) than the males (24,939). The age-related pattern of water contact also shown that only children in the age group 0-4 years made no contact with water while all other age groups made contacts at varying frequencies and duration. Generally, the frequency of contacts rose from the age group 5-9 years to peak in the 10-14 years among the males and 15-19 years among the females before decreasing sharply to lower levels in older age groups. Duration followed a fairly similar pattern but peak duration was reached in the age group 15-19 years in both the males and females. Statistically, patterns of both frequency and duration of contacts varied significantly ($p<0.001$) for both age and sex.

Daily and Seasonal Patterns of Water Contact

The hourly variation in the number and duration (minutes) of water contact from 7.00am to 7.00pm recorded in all investigated sites combined are presented in Table 3. Both frequency and duration of contacts increased from 7-8am hour to peak at 11-12 and 12-13 hours respectively. Thus, both frequency and duration showed a uni-modal pattern of daily variation. Contacts during the early hours of the day involved activities such as washing cloths, household utensils and fetching while contacts during the afternoon involved swimming, bathing and washing clothes. Fishing activities occur mainly in the mornings and evenings when fishermen return and depart for night fishing respectively.

Table 4 presents the monthly distribution of frequency and duration of contacts in Aponmu-Lona River. Frequency rose from its minimum (6.0% of 2494) in September to a peak in February (10.2% of 2,494) and decreases gradually again towards September. The pattern of distribution was not as clearly defined as frequency. Peak monthly duration was attained in June (4,472) and decreased thereafter to a minimum in March (4,106). However, while distribution of frequency varied significantly ($p<0.05$) between the months, duration was comparable. Numbers of contacts were fairly evenly distributed among the months. Generally, more contacts were observed in the rainy season than in the dry season. Frequency and duration of contact varied significantly between the seasons and between months.



Map 1: Map of Aponmu–Lona River Basin showing Sampling Stations

Table 1: The relative importance of different types of water contact recorded at 7 water contact sites in Aponmu-Lona, Idanre, Ondo State, Nigeria (May 2016 – April 2017)

Activity	No. of contact			Duration of contact (minutes)		
Primary	**Male**	**Female**	**Total**	**Minimum**	**Maximum**	**Total**
Swimming	357	259	616	0	131	10356
Fetching	84	240	234	0	123	1659
Bathing	146	78	224	0	66	3184
Washing cloth	27	165	192	0	182	9680
Other washings	309	225	534	0	133	4759
Fishing	150	11	161	3	120	10096
Baptism & Worship	182	261	443	0	136	12161
Total	1255	1239	2494			51895
	X^2= 357.75, df = 6, P = 0.000			P = 0.000		
PURPOSE						
Recreational	357	259	616	0	131	10356
Domestic	420	630	1050	0	182	16098
Personal	146	78	224	0	66	3184
Economic	150	11	161	3	120	10096
Religion	182	261	443	0	136	12161
Total	1255	1239	2494			51895
	X^2= 212.234, df = 4, P = 0.000			P = 0.000		
DEGREE						
Complete	685	598	1283	0	136	25701
Limited	84	240	324	0	123	1659
Partial	486	401	887	0	182	24535
Total	1255	1239	2494			51895
	X^2= 89.057, df = 2, P = 0.000			P = 0.000		

Table 2: Number of water contact activities recorded at 7 sites in Aponmu-Lona River, Idanre, Ondo State, Nigeria (May 2016 – April 2017)

	Number of contacts								
Activity	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**Total**	**% of Overall**
Swimming	82	50	193	61	65	70	95	616	24.7
Fetching	80	41	31	47	39	48	38	324	13.0
Bathing	56	27	11	30	34	31	35	224	9.0
Washing cloth	41	20	18	29	28	30	26	192	7.7
Other washings	83	96	21	88	111	70	65	534	21.4
Fishing	37	21	17	23	17	27	19	161	6.5
Others	45	84	35	71	82	63	63	443	17.8
Total	424	339	326	349	376	339	341	2494	100.0
% Overall contact	17.0	13.6	13.1	14.0	15.1	13.6	13.7	100.0	
	X^2= 340.989, df = 36, P = 0.000								

DISCUSSION

Temporal Variation in Snail Density

The monthly variation in the mean number of the *B. globosus and Biomphalaria pfeifferi* snail species collected is shown in Figs. 1 and 2. The figures reveal a temporal variation which is specific for each snail species. The mean number of *B. globosus*, *M .tuberculata* and *P. freethi* collected in the seven sites increased marginally from May to December 2016 when it rose sharply to a high peak, dropped sharply in January and gradually rose again to low peak by the end of the study in April. However, while peak density of *B. globosus* was attained in July, that of *M tuberculata* occurred in June and *P. freethi* in April. The pattern of variation in the number of the other species encountered was not clearly defined as those of the three species described above. However, peak mean density of *B. pfeiferi* occurred in February and the least in November. For *L. ovum* (the peak mean number was collected in December and the least in May, July, October, and January.

Size Distribution and Infection Patterns Among the Intermediate Host Snail Species

Bulinus globosus collected from all the seven sites ranged from <3-10.5 mm in height (mean height = 6.2±0.18mm) while *Biomphalaria pfeifferi* ranged from <3-9.6 mm in width (mean width = 3.8±0.31mm). About 63.4% of *B. globosus* snails collected were less than 3 mm high while only 5.4% were ≥9 mm high. *B. pfeifferi* snails follow a fairly similar pattern with over 48% measuring <3 mm wide and about 9%≥9 mm wide.

Table 3: Age and Sex-related pattern of human water contact at the seven sites of Aponmu-Lona River, Idanre, Ondo State (May 2006 – April 2007)

AGE GROUP	Total Contact			Total Duration		
	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL
0-4	-	-	-	-	-	-
5-9	264	216	480	4,020	3,091	7,111
10-14	403	393	796	5,516	4,511	10,027
15-19	313	454	767	8,297	12,429	20,726
20-29	169	141	310	5,818	6,428	12,246
30-39	67	24	91	811	462	1,273
40-49	33	8	41	260	24	284
50-59	4	3	7	127	11	138
60+	2	0	2	90	-	90
TOTAL	1,255	1,239	2,494	24,939	26,956	51,895
	X^2= 70.981, DF = 7, P = 0.000			P = 0.000		

Table 4: Variation in the human water contact between 7.00am and 7.00pm

TIME	TOTAL CONTACT	TOTAL DURATION
7-8	98	426
8-9	100	600
9-10	262	3,175
10-11	231	9,974
11-12	242	11,952
12-13	262	13,048
13-14	302	5,825
14-15	291	3,996
15-16	201	2,004
16-17	187	396
17-18	141	303
18-19	26	197
P. value	0.00	0.00
TOTAL	2,494	51,895

Table 5: Monthly variation in water contact pattern at seven sites (May 2016–April 2017)

Months	Total Contacts	Total Duration
May	224	4,384
June	215	4,472
July	187	4,464
August	158	4,450
September	150	4,150
October	191	4,314
November	215	4,236
December	220	4,314
January	225	4,355
February	255	4,304
March	227	4,106
April	227	4,346
TOTAL	2,494	51,895

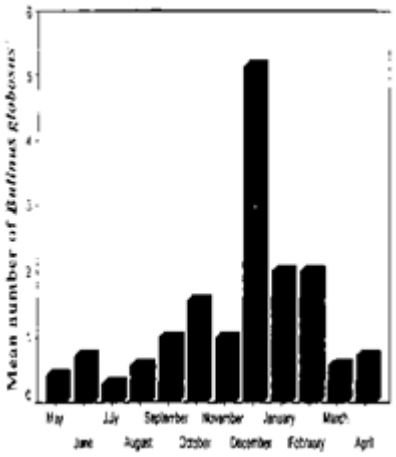


Fig. 1: Pattern of monthly variation in mean number of Bulinus globosus collected from seven sites investigated in Apomu-Lona River, Idanre, Ondo State, Nigeria (2016 – April 2017)

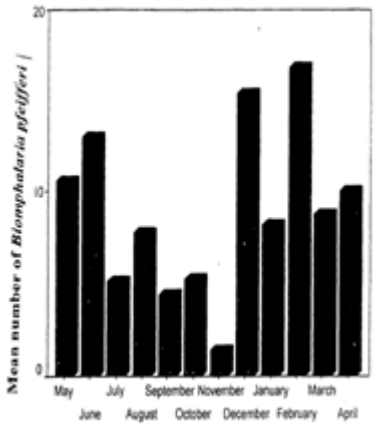


Fig. 2: Pattern of monthly variation in mean number of Biomphalaria pfeifferi collected from seven sites investigated in Apomu-Lona River, Idanre, Ondo State, Nigeria (May 2016 – April 2017)

Table 6: Size classification and infection patterns of *Bulinus globosus* and *Biomphalaria pfeifferi* collected from Aponmu-Lona River, Idanre, Ondo State, Nigeria (May 2016-April 2017)

Species	Size class (mm)	Number collected	Number infected	% of total collection	% infection with trematodes
Bulinus globosus	<3	71	0	63.4	0
	3.0 – 5.9	22	2	19.6	9.1
	6.0 – 8.9	13	2	11.6	15.4
	≥9	6	1	5.4	16.7
	Total	112	5	100	4.5
Biomphalaria pfeifferi	<3	364	0	48.7	0
	3.0 – 5.9	963	0	21.8	0
	6.0 – 8.9	153	0	20.5	0
	≥9	67	0	9.0	0
	Total	747	0		0

Out of the 112 *Bulinus globosus* snails collected and examined for trematode infection, only 5 (4.5%) were found shedding trematode cercariae (Table 5). All the 5 snails shedding cercaria were >3 mm long and none of the snails <3 mm size range. Thus only *B. globosus* snails greater than 3 mm were found shedding cercariae and no infection was recorded among the *Biomphalaria* snails examined. Three cercarial types recovered from the infected snails were amphistome cercaria cercariaeum cercaria, ornate xiphidio cercaria and brevifurcate apharyngeate distome cercaria.

Water Contact Behaviour

Different trends of water contact have been shown by many studies in areas where schistosomiasis is endemic, reflecting different characteristics available in water bodies (Dalton, 1976, Husting 1983, Chandiwana 1987, Farooq and Mallah 1966). Water contact activities observed in the Aponmu-Lona River included baptism, clothes washing, fetching, farm tools washing and swimming. Although, several of these contacts have been reported from several epidemic settings, this is the first time contact for religious purposes is being reported as a contributory factor in schistosomiasis transmission in an endemic community in Southwest Nigeria.

Generally, water contact patterns have been shown to be affected by sex, age, occupation, religion and culture (Ofoezie et al., 1998). In this study, age and sex-related pattern of water contact were evident, males significantly made more contact than female, however females spent longer times in water than males, this is probably due to the fact that most contacts in the study area were either personal or domestic, and were related to economic reason in which males play more significant roles (Tayo and Jewbury, 1978). Water contact pattern is this study area was site-specific with about 81% of the total contact made at site 3, where human Schistosoma spp. type cercaria was also identified. This has a lot of implications for the transmission and control of schistosomiasis in Aponmu-Lona River Basin.

CONCLUSION

The findings from the twelve-month (May 2016 – April 2017) study established the transmission of urinogenital schistosomiasis in Aponmu-Lona River Basin, Idanre Local Government Area, Ondo State.

The study found that seasonal and focal (both the density and rate) of Schistosoma infection in *Bulinus globosus* were in December. This stands to reason that any control activity may be targeted towards the peak period in December when the water level was relatively low. In site 3 where infected snails were identified focal, molluscicide application as is conventionally recommended would be appropriate. Important water contact activities in Aponmu-Lona River were washing clothes, fetching, washing household utensils, swimming and playing.

RECOMMENDATION

Mass sensitisation (health education) of the members of the community of Aponmu-Lona River is needed to reduce the transmission rate of schistosomiasis in the area. Since humans are the vector of the infection due to their indiscriminate interaction with the infected river, resulting from their ignorance of the pattern of the life cycles of *Schistosoma haemetobium* and the ecology of the local intermediate host snail, *Bulinus globosus*, (a concept previously attested to by WHO 1985) the role of health education is very important. This could be achieved through public enlightenment programmes such as radio gingles, community meetings, periodic seminars and workshops by resource persons. In as much as having contacts with the river cannot be totally prevented the river could be "treated" using conventionally recommended molluscicides.

Those members of the community involved in fishing, washing activities could be advised to always put on protective materials, at least on their legs and hands, each time they want to enter the river. Provision of pipe-borne water, as well as modern toilet facilities, would also go a long way to reduce frequent direct water contact. Infections among the people could be managed through chemotherapy. Chemotherapeutic control is used to reduce morbidity in human populations. Out of all the drugs often recommended on their basis of minimal side effects and efficacy, praziquantel is the most widely used, because it is effective against all the species of schistosomes, easily affordable and well tolerated. In case, the natural ecology of Aponmu-Lona River would be changed by dam construction in the nearest future, the dam should be made less "snail-friendly" through the use of a high water velocity mechanism.

CONFLICT OF INTEREST

The authors guarantee responsibility for everything published in this manuscript, as well as the absence of a conflict of interest and the absence of their financial interest in performing this research and writing this manuscript.

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