WATER-CONTACT PATTERNS AND RISK FACTORS FOR *Schistosoma mansoni* INFECTION IN A RURAL VILLAGE OF NORTHEAST BRAZIL

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SUMMARY

Schistosomiasis mansoni in the Serrano village, municipality of Cururupu, state of Maranhão, Brazil, is a widely spread disease. The PECE (Program for the Control of Schistosomiasis), undertaken since 1979 has reduced the prevalence of *S. mansoni* infection and the hepatosplenic form of the disease. Nevertheless piped water is available in 84% of the households, prevalence remains above 20%. In order to identify other risk factors responsible for the persistence of high prevalence levels, a cross-sectional survey was carried out in a systematic sample of 294 people of varying ages. Socioeconomic, environmental and demographic variables, and water contact patterns were investigated. Fecal samples were collected and analyzed by the Kato-Katz technique. Prevalence of *S. mansoni* infection was 24.1%, higher among males (35.5%) and between 10-19 years of age (36.6%). The risk factors identified in the univariable analysis were water contacts for vegetable extraction (Risk Ratio - RR = 2.92), crossing streams (RR = 2.55), bathing (RR = 2.35), fishing (RR = 2.19), hunting (RR = 2.17), cattle breeding (RR = 2.04), manioc culture (RR = 1.90) and leisure (RR = 1.56). After controlling for confounding variables by proportional hazards model the risks remained higher for males, vegetable extraction, bathing in rivers and water contact in rivers or in periodically inundated parts of riverine woodland (swamplands).

KEYWORDS: Schistosomiasis; Risk factors.

INTRODUCTION

Schistosomiasis mansoni is an endemic disease in many areas of the world [8,11,12]. In Brazil, the highest infection rates are found in the Northeast region of the country and in the state of Minas Gerais [3,7,13,21]. Schistosomiasis mansoni in the western lowland of Maranhão is a widely spread disease, difficult to be controlled by traditional measures. The prevalence of the infection is linked to a subsistence economy performed in an aquatic ecosystem.

Previous studies have shown that risk factors for schistosomiasis may be diverse depending on the frequency and intensity of water contact and on the water linked activities performed in each village. Transmission patterns may be related to domestic, leisure or occupational activities, In Divino (MG), the risk factors for this infection included agricultural activities, fishing and swimming or bathing [18]; in the other villages of the western lowland of Maranhão (Aliança and Coroatá) the risks were higher for those working in vegetable extraction [5], while in Comercinho (MG) [17], Pedro de Toledo (SP) [20] and Ponte do Pasmado (MG) [22], they were closely associated with leisure and domestic activities related to the absence of piped water.

The PECE has been undertaken in Serrano since 1979. The control measures used included stool examinations, mass treatments, health education and improvement of water and sanitation facilities, with emphasis on chemotherapy. Prevalence levels reduced temporarily after treatment to increase later on due to reinfection [5]. Serrano has maintained high prevalence rates (26% in 1979, 21% in 1990 - unpublished data), nevertheless 84% of the households have piped water.

Different water-contact patterns and specific geographical conditions may be the reasons for the little efficacy of the control measures undertaken in Serrano by the PECE and justify further

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studies to identify the risk factors responsible for the persistence of high rates of *Schistosoma mansoni* infection in the western lowland of Maranhão.

The aim of this work is to identify these water-contact patterns and risk factors for infection in order to guide future strategies for the control of schistosomiasis mansoni in this area.

CASUISTIC AND METHOD

Study area
The village of Serrano, located in the municipality of Cururupu, western lowland of Maranhão, Brazil, was founded in 1835. Its population of 2,169 inhabitants, composed mainly by slaves'descendants, lives in 504 houses (average 4.17 per household); most of them are made of mud and straw, have piped water (84%), no waste disposal and garbage collection. The locality has many permanent rivers swamplands and prairies which are flooded in rainy season (Jan-Jun) and partially flooded in dry season (July-Dec). The main economic activities accomplished in the lowlands are agriculture (rice, bean and manioc - manioc is placed under shallow water in order to ferment and produce the manioc flour), fishing, cattle breeding, "jaçanã" hunting ("jaçanã" is a kind of wading bird - *Porphygula martinica*) and "juçara" or "buriti" extraction ("juçara" is a kind of cabbage palm - *Euterpe oleracea* and "buriti" is a kind of Brazilian wine palm - *Mauritia flexnosa*). Bathing and swimming in the rivers are common forms of leisure, specially for youth [5-7].

Survey
A cross-sectional survey was carried out in a representative sample of Serrano population. The 2,169 people living in Serrano were identified by means of a census which took note of everyone living in the village for at least three months prior to the study. Systematic sampling was used in order to minimize the cluster effect [11,23]. A minimum sample size of 273 people was calculated (95% confidence for a 30% prevalence rate; 80% power; 90% confidence to detect a difference of 2.2 in risk ratio) and 294 people (95.1% of the selected sample) provided stool samples for examination by the Kato-Katz technique [14] and answered a questionnaire including: demographic and socioeconomic data (gender, age, place of birth, occupation and schooling), environmental information (quality of the house, water supply to the household and sanitation facilities), water contact patterns (type and frequency in the last 6 months) and reasons for these contacts (manioc culture, fishing, hunting, bathing, vegetable extraction, leisure, cattle breeding, crossing streams and domestic activities such as bringing water to the household, washing dishes and clothes). Distance from home to water source and previous treatment for schistosomiasis were also assessed.

When a child aged less than 10 years old was chosen, his/her mother or other relative in charge answered instead. The interviewer had no knowledge of the fecal examination result and the slides were examined always by the same technician.

Data was analyzed by Epi Info [9]. The difference between proportions was checked using chi-square and Fisher exact test.

Risk was assessed by means of risk ratio and its confidence interval. Multivariable analysis was done by Breslow-Cox regression (Cox proportional hazards model using Breslow modification [1,4], assuming constant follow-up duration for all individuals [15]).

Collinearity [16] between places and reasons for water-contact was taken into account and two models were built. In the first one, demographic, environmental, socioeconomic variables and places of water contact were considered and in the second one demographic, environmental, socioeconomic variables and reasons for water contact were placed together. All variables associated with the infection under a significance level below 0.20 in the univariable analysis were included in the models.

The adjusted population attributable risk percent was calculated using Bruzzi's formula, taking into account the proportion of individuals exposed to the risk factor among those infected with *S. mansoni* and the ajusted risk ratio for each variable [2], assuming that each risk factor exerted an independent effect.

RESULTS

Population description
294 people were selected, 139 (47.3%) were females and 155 (52.7%) were males; 75 (25.5%) aged 0 to 9 years old, 82 (27.9%) 10 to 19 and 137 (46.6%) aged 20 years and over. 182 people (61.9%) were born in the village. Schooling was poor, since 86% had up to 4 years of schooling and the illiteracy rate was 27.7%. The majority of households were of the worst type (63.5%); 247 people (84%) had piped water and only 7.5% had a cesspool in the household.

Main occupations were: rural working (55.4%), fishing (44.2%), cattle breeding (37.1%) and vegetable extraction (36.4%) Males preferentially did fishing, hunting, vegetable extracting and agriculture while females were mainly housekeepers or work in public service.

Occupation rate was higher for all age groups above 9 years of age. Especially among those aged 10 to 19 years old, the occupation rate was higher for activities that were of greatest risk of infection, i.e. fishing - 52.4% - and vegetable extraction - 51.2%. It was very common for the same person to work in different economic activities.

Water contact in different age groups and genders
Water contact rate was very high (78.9%) and frequent (15.6% daily, 33.3% weekly, 17.0% monthly and 12.9% semestral) in this population. The places of contact were the river (67.0%), the swamplands (61.9%), the prairies (50.3%) and the dam (4.8%). Reasons for water contact included: bathing (50.3%), crossing streams (50.0%), vegetable extraction (46.6%), manioc culture (39.1%), fishing (37.1%), leisure (28.2%) and cattle breeding (23.1%). Domestic activities and hunting were rarely mentioned (16.3% and 4.1% respectively). Distance from home to water source was less than 100 meters for

48 individuals (16.3%) and 100 meters and over for the rest of the group (83.7%).

Water contact rate was higher for males (86.5%), than for females (70.5%) for all reasons, except for domestic activities. It was also higher for those aged 10 to 19 years (85.4%) or 20 years and over (81.8%), than for those aged less than 10 years old (66.7%).

Age was the major determinant of the type of water contact. Leisure and bathing were the main reasons for those aged less than 10 years old. Vegetable extraction, bathing, crossing streams, fishing, manioc culture and leisure were more common among those aged 10 to 19 years old and for those aged 20 years and over. Water contact rate was higher among those crossing streams, extracting vegetables, batching, culturing manioc of fishing (Table 1).

TABLE 1

Reasons for water contact according to gender and age (%) in Serrano, Maranhão, Northeast Brazil, 1995.

| Reasons | Gender | | Age | | |
	Male	Female	0 - 9	10 - 19	≥ 20
Bathing	61.9	37.4	48.0	61.0	45.3
Crossing streams	61.9	36.7	22.7	51.2	64.2
Vegetable extraction	55.5	36.7	21.3	64.6	49.6
Manioc culture	49.0	28.1	18.7	47.6	45.3
Fishing	47.1	25.9	16.0	50.0	40.9
Leisure	36.1	19.4	49.3	47.6	5.1
Agriculture	33.5	19.4	8.0	26.8	37.2
Cattle Breeding	36.1	8.6	9.3	32.9	24.8
Domestic activities	11.6	21.6	13.3	18.3	16.8
Hunting	6.5	1.4	1.3	3.7	5.8

Univariable Analysis

Seventy one (24.1%) studied individuals had *S. mansoni* eggs in stools: 61 (86%) excreted less than 500 eggs (total of 5,856 eggs) and 10 (14%) excreted 500 or more eggs per gram of feces (total of 11, 904 eggs). 175 individuals (59.5%) had been treated previously.

Prevalence was higher among males (35.5%) and in the age groups 10 to 14 (35.2%), 15 to 19 (39.3%) and 40 to 49 (35.0%). Prevalence rate was still high among those aged 50 years and over (18.8%). All age groups, excluding those aged 0 to 4 years old, were at risk of infection in the village (Table 2). Housekeepers (RR = 0.53; 95% CI 0.31-0.90) were protected against infection. There was no association between *S. mansoni* infection and place of birth, quality of the house, type of water supply and type of sewage disposal. The risk ratio was higher for those previously treated with schistosomicides (Table 3).

The risks were higher among those who had water contact in rivers, prairies or swamplands, or had daily/weekly contacts.

The activities closely related to infection were vegetable extraction, crossing streams, bathing, fishing, hunting, cattle breeding, manioc culture and leisure. All those differences were statistically significant. The reasons for water contact not associated

TABLE 2

Prevalence of *S. mansoni* infection by age in Serrano, Maranhão, Northeast Brazil, 1995

Age groups (years)	n	%	Total
0-4	1	3.4	29
5-9	11	23.9	46
10-14	19	35.2	54
15-19	11	39.3	28
20-29	7	22.6	31
30-39	6	15.8	38
40-49	7	35.0	20
≥ 50	9	18.8	48
Total	71	24.1	294

TABLE 3

Univariable analysis of *Schistosoma mansoni* infection according to demographic and socioeconomic variables, distance between the house and the water source, and previous treatment with schistosomicides in Serrano, Maranhão, Northeast Brazil, 1995.

| VARIABLES | KATO (+) | | KATO (-) | | RISK RATIO | P |
	N	%	N	%		
GENDER						
Female	16	11.5	123	88.5		
Male	55	35.5	100	64.5	3.08 (1.86-5.12)	0.000
AGE						
0-9	12	16.0	63	84.0		
10-19	30	36.6	52	63.4	2.29 (1.27-4.13)	0.006
≥20	29	21.2	108	78.8	1.32 (0.72-2.44)	0.465
PLACE OF BIRTH						
Other	24	21.4	88	78.6		
In the village	47	25.8	135	74.2	1.21 (0.78-1.86)	0.474
QUALITY OF THE HOUSE						
Best	28	25.5	82	74.5		
Worst	43	23.4	141	76.6	0.92 (0.61-1.39)	0.792
WATER SUPPLY						
Piped	59	23.9	188	76.1		
Well	12	25.5	35	74.5	1.07 (0.62-1.83)	0.955
SEWAGE DISPOSAL						
Cesspool	69	24.5	213	75.5		
Other	2	16.7	10	83.3	0.68 (0.19-2.45)	0.737
DISTANCE BETWEEN THE HOUSE AND THE WATER SOURCE						
≥ 100 meters	59	24.0	187	76.0		
< 100 meters	12	25.0	36	75.0	1.04 (0.61-1.79)	0.972
PREVIOUS TREATMENT *						
No	20	17.5	94	82.5		
Yes	50	28.6	125	71.4	1.63 (1.03-2.58)	0.045

* Five people did not know if they had undergone previous treatment

with *S. mansoni* infection were agriculture other than manioc and domestic activities (Table 4).

TABLE 4

Univariable analysis of *Schistosoma mansoni* infection according to frequency, places and reasons for water contact in Serrano, Maranhão, Northeast Brazil, 1995.

VARIABLES	KATO (+)		KATO (-)		RISK RATIO	P
	n	%	n	%		
WATER CONTACT						
No	3	4.8	59	95.2		
Yes	68	29.3	164	70.7	6.06 (1.97-18.60)	0.000
FREQUENCY OF CONTACT *						
Sporadic	17	19.3	71	80.7		
Daily/Weekly	51	35.4	93	64.6	1.83 (1.13-2.96)	0.014
PLACES OF CONTACT						
RIVER						
No	8	8.2	89	91.6		
Yes	63	32.0	134	68.0	3.88 (1.94-7.76)	0.000
DAM						
No	68	24.3	212	75.7		
Yes	3	21.4	11	78.6	0.88 (0.32-2.46)	0.926
PRAIRIE						
No	23	15.8	123	84.2		
Yes	48	32.4	100	67.6	2.06 (1.32-3.20)	0.000
SWAMPLAND						
No	8	7.1	104	92.9		
Yes	63	34.6	119	65.4	4.85 (2.41-9.73)	0.000
REASONS FOR CONTACT						
AGRICULTURE						
No	46	21.4	169	78.6		
Yes	25	31.6	54	68.4	1.48 (0.98-2.24)	0.095
MANIOC CULTURE						
No	32	17.9	147	82.1		
Yes	39	33.9	76	66.1	1.90 (1.27-2.84)	0.002
FISHING						
No	31	16.8	154	83.2		
Yes	40	36.7	69	63.3	2.19 (1.46-3.28)	0.000
HUNTING						
No	65	23.0	217	77.0		
Yes	6	50.0	6	50.0	2.17 (1.18-3.97)	0.043
DOMESTIC ACTIVITIES						
No	55	22.4	191	77.6		
Yes	16	33.3	32	66.7	1.49 (0.94-2.37)	0.149
BATHING						
No	21	14.4	125	85.6		
Yes	50	33.8	98	66.2	2.35 (1.49-3.70)	0.000
LEISURE						
No	44	20.9	167	79.1		
Yes	27	32.5	56	67.5	1.56 (1.04-2.34)	0.051
VEGETABLE EXTRACTION						
No	20	12.7	137	87.3		
Yes	51	37.2	86	62.8	2.92 (1.84-4.65)	0.000
CATTLE BREEDING						
No	44	19.5	182	80.5		
Yes	27	39.7	41	60.3	2.04 (1.37-3.03)	0.001
CROSSING STREAMS						
No	20	13.6	127	86.4		
Yes	51	34.7	96	65.3	2.55 (1.60-4.05)	0.000

* Those who did not have water contact (62) were excluded.

Multivariable analysis

In the first model, the risk of infection with *S. mansoni* was higher for males and for those having water contact in the swampland. In the second model the risk was also higher for males and for those working in vegetable extraction. It is important to note that water contact in rivers in the first model and bathing in the second, although not associated with the infection, were near the significance level of 0.05. Adjusted population attributable risks were higher for those who had water contact in the swampland (58.5%), water contact in rivers (45.2%), for males (44.8% in the second model) and for those working in vegetable extraction (39.6%) (Table 5).

DISCUSSION AND CONCLUSIONS

Water contact is vital for surviving in this village and therefore occupational activities were the main reasons for water contact, especially for males; females had water contact mainly for domestic purposes. This close relationship between *S. mansoni* infection and agricultural activities were also reported in Peri-Peri (MG) [3], Ilha (MG) [13], and Divino (MG) [18].

In Serrano, the higher prevalence was observed among males. The prevalence rate is higher among males in the majority of the places studied [3, 5, 7, 18, 19] except in Castro Alves (BA) where it is higher among females due to water exposure for domestic purposes[21] and in Aliança and Coroatá, both villages of western lowland of Maranhão, where no difference in prevalence between the genders was reported.[7] Variations in the infection rate with *S. mansoni* according to gender may be explained by differences in the frequency of water contact. These findings point out to the fact that local factors are important for transmission of the disease in each village.

Reasons for water contact differed according to age as a consequence of different kinds of activities associated to gender and age.

TABLE 5

Proportional hazards model estimates of adjusted risk ratio and adjusted population attributable risk percent (PAR%) of *Schistosoma mansoni* infection in Serrano, Maranhão, Northeast Brazil, 1995.

Model I - Demographic, socioeconomic variables and places of water contact.

VARIABLES	RISK RATIO	PAR %
Male Gender	2.16 (1.22-3.83)	41.3%
Water contact in river	2.03 (0.92-4.47)	45.2%
Water contact in swampland	2.94 (1.33-6.49)	58.5%

Model II - Demographic, socioeconomic variables and reasons for water contact

VARIABLES	RISK RATIO	PAR %
Male gender	2.39 (1.34-4.24)	44.8%
Vegetable extraction	2.22 (1.29-3.82)	39.6%
Bathing	1.52 (0.89-2.61)	23.9%

Although water contact rate was higher among those aged 10 to 19 years old, the rates were also very high from 20 to 50 years old (over 50%). The same pattern was observed in Alegre, another village of the western lowland of Maranhão[6]. All age groups, except those under 5 years of age were at risk of infection. In Ponte do Pasmado, infection rate tended to show a greater reduction as age increased [22]. In other studies, the prevalence of infection also predominated among those aged 10 to 19 years old [10, 17, 18, 22]. but there were villages in which the prevalence was higher for those aged 30 years and over [3].

Individuals aged 10 to 19 years probably played a vital role in the transmission of *S. mansoni* infection in this village. They had the highest egg count and their occupation rate was higher, mainly in vegetable extraction.

The activity closest related to infection was vegetable extraction (RR = 2.22). Exposure to this risk factor was high (46.6%) and the population attributable risk was 39.3%. This activity is performed in the swamplands and water contact in swamplands had the highest risk ratio (2.93) and also the highest population attributable risk (58.6%). Thus, the control program must also include this issue as a target point to consider. Health education must discuss this close relationship between vegetable extraction and the risk of *S. mansoni* infection. Other studies had just mentioned that vegetable extraction is an important risk factor for *S. mansoni* infection in some villages of western lowland of Maranhão [5].

Domestic activities were not related to infection probably because 84% of the people had piped water in the household. Despite the provision of domestic water supply, bathing remained associated with an increasing risk of infection. Maybe bathing is vital to social contact [12] and is one of the few options of leisure in this village. The provision of a domestic water supply probably decreased the infection rate among housekeepers and infants in

Serrano. Water contact rate among those working in water linked activities has not decreased.

It has been shown that the intensity of water contact is as much important as the frequency of water contact for this infection. Recreational activities, such as bathing and swimming, lead to more prolonged water contact than domestic ones [12]. The intensity of infection was not taken into acount in the present study, thus bathing may be associated to a greater risk than reported. Bathing, although not associated with the infection in a strict significance level of 0.05 in the multivariable analysis, must still play an important role in transmission despite the provision of domestic water supply. The provision of piped water to the households tended to reduce but did not eliminate the risk of infection due to domestic and recreational purposes, since the river is an important place in which social contacts occur in this village. Similar results had been shown in Peri-Peri (MG) [3]. ETARD had also mentioned that the provision of water supply had little impact in the prevalence rate among males [12].

The gender/age patterns of infection in Serrano were highly dependent on the social activities performed and on cultural norms regarding male/female and infant/youth/adult roles. Therefore, it is necessary, to achieve a better control of infection in endemic areas, to conduct anthropological studies in order to explore the social and cultural relationships regarding water contact[8].

The recommended control measures for this village are: health education with emphasis on local risk factors for infection, creation of other leisure options and continuing periodical stool examinations and mass treatments. As pointed out by ETARD, changing water contact behavior seems to be an unrealistic means of preventing transmission [12], since exposure to risk factors is not a question of option for this population but a need imposed by work and leisure [3]. Health education activities directed towards avoiding water contact would be suitable only if alternatives to traditional water contacts were available [11].

RESUMO

Padrões de contato com água e fatores de risco para a infecção por *Schistosoma mansoni* em localidade rural do nordeste brasileiro.

A esquistossomose mansônica na localidade de Serrano, município de Cururupu, Estado do Maranhão, Brasil, é uma endemia de difícil controle. Desde 1979, o PECE tem logrado reduzir a prevalência de infecção pelo *S. mansoni* e das formas graves da doença. Na tentativa de identificar os fatores de risco responsáveis pela persistência da infecção, realizou-se, em novembro de 1995, um censo na localidade e, através de amostragem sistemática, aplicou-se questionário domiciliar a 294 pessoas de todas as idades. Neste inquérito domiciliar do tipo seccional, estudou-se dados socioeconômicos, demográficos, variáveis ambientais e de saneamento e indagou-se sobre os padrões de contato com a água. Realizou-se exame de fezes pelo método de Kato-Katz. A prevalência da infecção foi de 24,1%,

maior no sexo masculino (35,5%) e na 2ª década de vida (36,6%). A prevalência da infecção esteve associada com extração de juçara e/ou buriti (Razão de Prevalências - RP = 2,92), deslocamento (RP = 2, 55), banho (RP = 2, 35), pesca (RP = 2,19), caça (RP = 2,17), criação de animais (RP = 2,04), atividade de colocar mandioca n'água (RP = 1,90) e lazer (RP = 1,56). Após o ajuste para fatores de confusão através da regressão de Cox modificada por Breslow, sexo masculino, contato com água de rio ou igapó, realizar atividades de extração de juçara e banho de rio foram os fatores que restaram associados com a infecção, sendo prioritários no estabelecimento das medidas de controle.

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