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Prevalence, behavioural and social factors associated with *Schistosoma intercalatum* and geohelminth infections in São Tomé and Principe

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Abstract. A pilot study was conducted in schoolchildren from three main districts of São Tomé to assess the relationship between the prevalence of infections caused by *Schistosoma intercalatum* or intestinal helminths and individual behaviour and social conditions. Coprological examination revealed an increase of schistosome infections and a persisting high endemicity for ascariasis and trichuriasis. Infection rates were 36.2% for *S. intercalatum* and 70.8%, 68.5% and 4.6% for *Ascaris lumbricoides*, *Trichuris trichiura* and Ancylostomidae, respectively. Out of the 47 children positive for *S. intercalatum*, 35 (74.5%) were co-infected with one or more geohelminths. Logistic regression analysis of data collected through questionnaire demonstrate that behaviour and/or social conditions in the house were positively associated with *S. intercalatum* or *T. trichiura*. Neither sex nor age groups were associated with infections, suggesting that low personal hygiene and sanitation practices were similar for all groups of children. These data are in accordance to those of other studies and highlight the importance of assessing multivariate factors that may contribute to the transmission of these diseases, in order to design integrated control approaches for schistosomiasis and geohelminthiasis which could have more rapid effects on reduction of infections as well as greater cost-effectiveness.

Key words: helminthiasis, schoolchildren, behavioural/social factors.

Transmission of schistosomiasis and geohelminth infections is intrinsically related to environmental contamination with human excreta carrying eggs and infective larvae. Schistosomiasis is a water-related disease and soil plays a key role in the development of geohelminthiasis. *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms are among the most prevalent and widespread soil-transmitted helminths (STH). Estimations indicate that about 2000 million people are affected worldwide with disease associated with schistosomiasis and STH infections of which 300 million suffering from severe life-threatening complications (Savioli *et al.*, 2002; WHO, 2004). Together, these infections represent a high disease burden in tropical and subtropical developing countries, with an estimated DALYs loss at 43.5 million (Chan, 1997; Albonico *et al.*, 1998). The impact of these diseases is particularly important in school age children causing a range of detrimental effects with serious consequences on growth development, physical activities and cognitive functions (Nokes *et al.*, 1992; Savioli *et al.*, 1992; Koroma *et al.*, 1996; Chan, 1997).

Because these infections occur often simultaneously in endemic areas and target similar risk groups, a proposal to control these diseases through an integrated approach based on chemotherapy, improvement of sanitation and health education, was endorsed by the 54th World Health Assembly in 2001 (WHO, 2001). In São Tomé and Príncipe, after human surveys conducted in 1992 for schistosomiasis and intestinal helminths (Almeda *et al.*, 1994; Ripert *et al.*, 1996), no other studies were performed to evaluate the impact of the chemotherapeutic control applied. The aims of this study were (i) to assess the prevalence of *S. intercalatum* and intestinal helminth infections in primary school children aged 5-15 years; and (ii) to identify individual behavioural and social conditions associated with these infections in São Tomé. It is expected that these analyses shall point out indicators to determine the role of factors involved in transmission of the above mentioned parasitoses which will enable the promotion of appropriate intervention measures including the improvement of health education and sanitation for the reduction of these diseases in the communities.

Material and methods

The study was conducted in July 2000 during the dry season in three primary schools in S. Marçal, Guadalupe and Kilombo, small towns of districts of Mézoxi, Lobata and Agua-Grande, respectively, all located in the island of São Tomé. The study sites were selected on the basis of previous reports of high burden of *S. intercalatum* and geohelminth infec-

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tions (Almeda *et ai.*, 1994; Ripert *et ai.*, 1996), the lack of regular therapeutic control for these diseases (personal communication) and the access to facilities for school people. Eighty-two boys and ninety-nine girls aged between 5 and 15 years old (mean 9.751±S.D. 1.873) were randomly selected among the student lists provided by the primary schools' Directors. Childrens presenting clinical signs of illness (e.g., malaria) were not enrolled in the study.

Each child received two labelled plastic containers and was asked to provide one sample of urine and one of stools. Urine and fecal samples were obtained from 181 and 130 children, respectively. Urine samples were processed by sedimentation technique (WHO, 1991), the Kato-Katz (Katz *et ai., 1972)* and Teleman-Lima (WHO, 1991) methods were applied for stool examination. The total number of eggs recovered on each examination (Kato-Katz) was determined by direct microscopic examination and the cut-off points for intensity of infection were according to WHO guidelines (2004). A questionnaire relating individual house sanitation conditions (water supply and excreta disposals) and water contact patterns was administered by the local health team (2 technicians) to all 181 children. Reasons for water contact include: bathing (body hygiene), washing clothes/dishes, collecting water for domestic use, fishing and swimming.

Treatment of children infected with S. *intercalatum* (Praziquantel, 40 mg/kg in a single dose) and/or with intestinal helminths (Mebendazole 100 mg/12 h for 3 days) was provided by a local medical doctor. A malacological survey was performed in 19 different water bodies (rivers, streams and dams) of neighbouring cities and identified by locals as common used sites of water contact..

Statistical methads

All statistical procedures were carried out using statistical package SPSS 11.5 for Windows. Chi-square test (X^2) was used to test prevalence differences between and/or within groups. Phi (cI)» coefficient was used to measure the association of qualitative variables. Non-parametric tests, Mann-Whitney and KruskalI-WalIis, were applied for testing differences in median egg intensity in two or more independent groups, respectively. The coefficient of correlation was calculated as Spearman's r_s. The effects of social (house sanitation conditions) and behaviour (water contact patterns) variables to S. *intercalatum* and/or geohelmintic infections were investigated using logistic regression analysis. For each independent variable (water supply, excreta disposals, types of water contact), the odds ratio (OR), confidence interval (CI 95%) and *P-value* using univariate analysis were estimated. For water contact patterns, a multivariate model was also applied to test the joint effects of each variable on schistosomiasis. A *P-value* <0.05 was considered significant.

Ethical consideratians

This study was approved by the Ministries of Health and Education of the Republic of São Tomé and Príncipe. Teachers and pupils were informed in detail about objectives of the survey. Informed consent for children enrolled in the study was obtained from parents or education representatives.

Results

Urine

All of the urine samples (181) examined was negative for S. *haematabium.*

Staals

Out of the 130 children examined, 89 (86.9%) had helminthic infections. S. *intercalatum, Ascaris lumbricaides, rrichuris trichiura* and hookworms were the four helminth species found in stool samples. The overall prevalence and the parasitic load for each species are presented in Table 1. Moreover, a high frequency (68.4%) of polyparasitism was observed (Fig. 1). Inter-town variation on prevalence and on parasitic load for S. *intercalatum* and intestinal helminths were seen (Table 2). The occurrence of *A.. lumbricaides* and *T. trichiura* was strongly associated (cI>=0.328; *P<O.OO1).* In addition, *T. trichiura* infection intensity was positively correlated with the intensity of infection by S. *intercalatum* *(r_s=0.244, P=0.05)* and *A.. lumbricaides* *(r_s=0.370, P<O.OO1).*

Pattern af helminth infectians amang sex and age graups

The sex infection patterns were quite similar for the helminth species found with higher frequency in

Table 1. Prevalence and intensity of *S. intercalatum* and geohelminth infections in 130 schoolchildren.

Parasite	Total infected N (%)	Light N (%)	Moderate N (%)	Heavy N (%)	Median epga	Range (epg)
S *intercaiatum*[b]	47 (362)	24 (18.5)	17 (13.1)	6 (46)	120	(24-2832)
A *iumbricoides*	93 (715)	24 (185)	66 (50.8)	3 (2.3)	1568	(48-57800)
T trichiura	89 (68.5)	64 (492)	25 (19.2)	–	600	(48-8592)
Hookworms	6 (46)	6 (4.6)	–	–	144	(48-360)

[a] epg : eggs per gram 01 leces.
[b] Cut-off points 01 intensity lar *S. intercalatum* were based on those lor *S mansoni* (WHO, 2004).

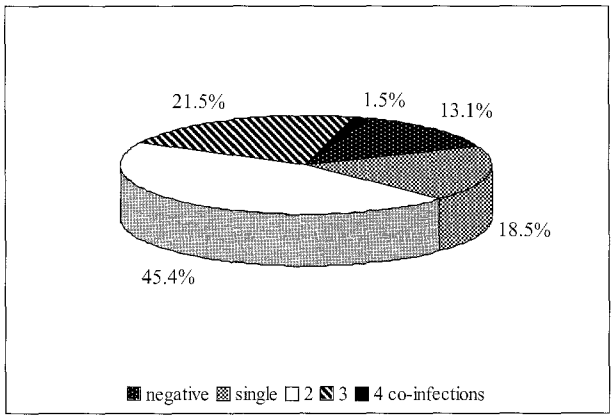

Figure 1. Pattern of helminth infections among schoolchildren.

female and in children under 10 years old but without significant differences in either cases (χ^2, $P>0.05$). For parasitic load also, girls tended to harbour higher worm loads but the difference was not statistically significant (Mann-Whitney test, $P>0.05$).

Individual social conditions in the house

Analysis of house conditions related to water supply and excreta disposals revealed significant differences among towns (χ^2, $P=0.001$ and χ^2, $P<0.001$, respectively). S. Marçal was the town with worst sanitary conditions and most affected by *S. intercalatum* and geohelminths (Table 3).

Association between helminth infections and individual behaviour

There was a significant association between *S. intercalatum* and some river activities, such as bathing and clothes/dishes washing (Table 4). In addition, defecation habits on open field was positively associated with trichuriasis but not with ascariasis (Table 4).

Discussion

Confirming previous observations, *S. intercalatum* seems to be the only schistosome species endemic in São Tomé as no *S. haematobium* eggs were found in the 181 urine samples examined. Results of this study based on stool examination also demonstrated an increase of *S. intercalatum* infections (36.2% prevalence) when compared with those found in previous surveys (11.7%, see Almeda *et al.*, 1994; 25.5%, see Ripert *el al.*, 1996). Overall prevalence rates of geohelminths were in accordance with those of previous studies reported above (Almeda *et al.*, 1994; Ripert *et al.*, 1996) where lower endemicity for ancylostomiasis as well as high infection rates for ascariasis and trichuriasis were observed.

Marked differences were seen among the three towns in terms of prevalence and infection intensity for *S. intercalatum* and geohelminth infections (Table 2), with the highest rates observed in S. Marçal. Approximately 67% of the children living in this town reported lack of house sanitation (piped

Table 2. Inter-town differences on prevalence and infection intensity for *S. intercalatum* and intestinal helminth infections.

Parasite	Towns			Parasitic prevalence P^*	Parasitic load (med epg)[b] P^{**}
	S. Marçal N=47 Pos (%)	Guadalupe N=40 Pos (%)	Kilombo N=43 Pos (%)		
S. intercalatum	22 (46.8)	10 (25.0)	15 (34.9)	>0.05	0.032[a]
A. lumbricoides	34 (72.3)	31 (77.5)	27 (62.8)	>0.05	>0.05
T. trichiura	41 (87.2)	23 (57.5)	25 (58.1)	0.002[a]	0.011[a]
Hookworms	4 (8.5)	2 (5.0)	–	–	–

Pos: positive; [a] Significant differences; [b] median of eggs per gram of stools.
*χ^2 test; ** Kruskal-Wallis test.

Table 3. Individual social conditions in the house (water supply and excreta disposals).

Towns	Total questioned	Type of water supply: Piped water N (%)	Type of water supply: Collected from river/streams N (%)	Excreta disposals: Latrines N (%)	Excreta disposals: Field N (%)
S. Marçal	47	11 (23.4)	36 (76.6)	10 (21.3)	37 (78.7)
Guadalupe	40	3 (7.5)	37 (92.5)	14 (35.0)	26 (65.0)
Kilombo	43	18 (41.9)	25 (58.1)	34 (79.1)	9 (20.9)

Table 4. Behavioural and social factors associated with *S. intercalatum* and geohelminth infections

Variables	Odds ratio	95% confidence interval	*P* value (2-sided)
For *S. intercalatum*§			
Bathing (body hygiene)*			
Yes	2.53	1.20-5.32	0.014[a]
Washing clothes/dishes*			
Yes	2.52	1.07-5.90	0.034[a]
Collecting water for domestic use*			
Yes	2.46	0.97-6.24	0.057[b]
Fishing*			
Yes	0.24	0.52-1.11	0.068[b]
For *T. trichiura*§§			
Excreta on open field*			
Yes	3.61	1.66-7.87	0.001[a]
For *A. lumbricoides*§§			
Excreta on open field			
Yes	0.63	0.29-1.35	0.239[b]

*No-reference category; § Multivariate logistic regression analysis; §§ Univariate analysis.
[a] Significant differences; [b] Not significant.

water and latrines) and thus had higher contact with infective water bodies for body hygiene and domestic activities as well as with contaminated soil. In general, infections were more frequent in girls and in children under 10 years, however neither sex nor age appeared to be associated with prevalence or intensity of infection, suggesting that deficient hygienic and low sanitation practices were not restricted to a particular group of children.

The logistic regression analysis suggested two main possible risk factors for schistosome infection in these children: river water contacts for individual hygiene and domestic activities. There was evidence that those who used to bath for personal hygiene and to wash clothes/dishes were at significantly higher risk of schistosomiasis. This association of these two variables remained statistically significant after adjustment in the multivariate model (Table 4). Data from various epidemiological studies demonstrate a significant association between fishing practice and schistosome infection (Ximenes *et al.*, 2001; Handzel *et al.*, 2003). In our study only 15 (11.5%) of the children referred to fish in rivers or streams which could explain the lack of association of this activity with schistosomiasis. Malacological studies confirmed the presence of *Bulinus forskalii* snails in these water bodies infected with *S. intercalatum* cercariae (Rompão, 2000). Lack of latrines and consequently, defecation practices on open field, were associated with *T. trichiura* infection (OR=3.61, 95% CI: 1.66-7.87, *P*=0.001) and although no direct association was found with ascariasis (Table 4), their influence on the infection pattern should not be ruled out.

Socio-environment and behaviour conditions have been recognised as dominant factors contributing to schistosome and geohelminthic infections (Al-Shammari *et al.*, 2001; Ximenes *et al.*, 2001). Overlapping of both schistosome and geohelminth infections is a common feature in many endemic areas and a highly cost-effective control approach could be achieved by combining anti-schistosome and anti-geohelminth drugs (Bundy *et al.*, 1991; WHO, 2001), by improving water supply and appropriate sanitation as well as health education programs (Albonico *et al.*, 2002; Asaolu and Ofoezie, 2003; WHO, 2004). During the last eight years no control programmes have been applied against *S. intercalatum* and geohelminth infections in communities of São Tomé and Príncipe where these are endemic. Even considering the small sample of this study, the epidemiological situation of these helminth infections reveals an increase of schistosomiasis prevalence and continuous high infection rates of *A. lumbricoides* and *T. trichiura* on school-age children. The majority of infected children (68.4%) presented mixed infections by two or more helminth species (Fig. 1).

In conclusion, our data as to their distribution indicate that both types of infections overlap sufficiently at the three main areas to require a combined control strategy which could be highly effective for reducing morbidity and transmission due to these parasitic diseases, particularly in the most vulnerable groups of the population.

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