Vc003067

Preliminary study of urinary schistosomiasis in a village in the delta of the Senegal river basin, Senegal

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Abstract

Three years after the first cases of urinary schistosomiasis infection were reported in the village of Mbodiene, Senegal, *Schistosoma haematobium* eggs were found in 87% of the inhabitants of this village; 30% were heavily infected (>50 eggs per 10 mL urine). The prevalence of infection was very high in all age groups, but children showed more intense infections. No difference between sexes was found. In the special situation of a very high prevalence, test strips for proteinuria and haematuria are not very useful for the individual diagnosis of *S. haematobium* infection. Six and 12 weeks after treatment with a single dose of praziquantel (40 mg/kg), *S. haematobium* eggs were found in 25% and 30% of the treated subjects, respectively. *Bulinus globosus* was identified as intermediate host, but other snail vectors may also play a role. *S. mansoni* eggs were found in 1% of the population. Both *S. haematobium* and *S. mansoni* are spreading in the delta of the Senegal river.

Introduction

During the last 2 decades large irrigation projects have been introduced in the Senegal river basin, and 2 dams have been built. At Diama in Senegal, 40 km from the mouth of the river, the first dam became operational in 1986 to prevent salt water intrusion from the sea and a hydro-electric dam which regulates the water flow was built in Manantali, Mali, and became operational in 1989.

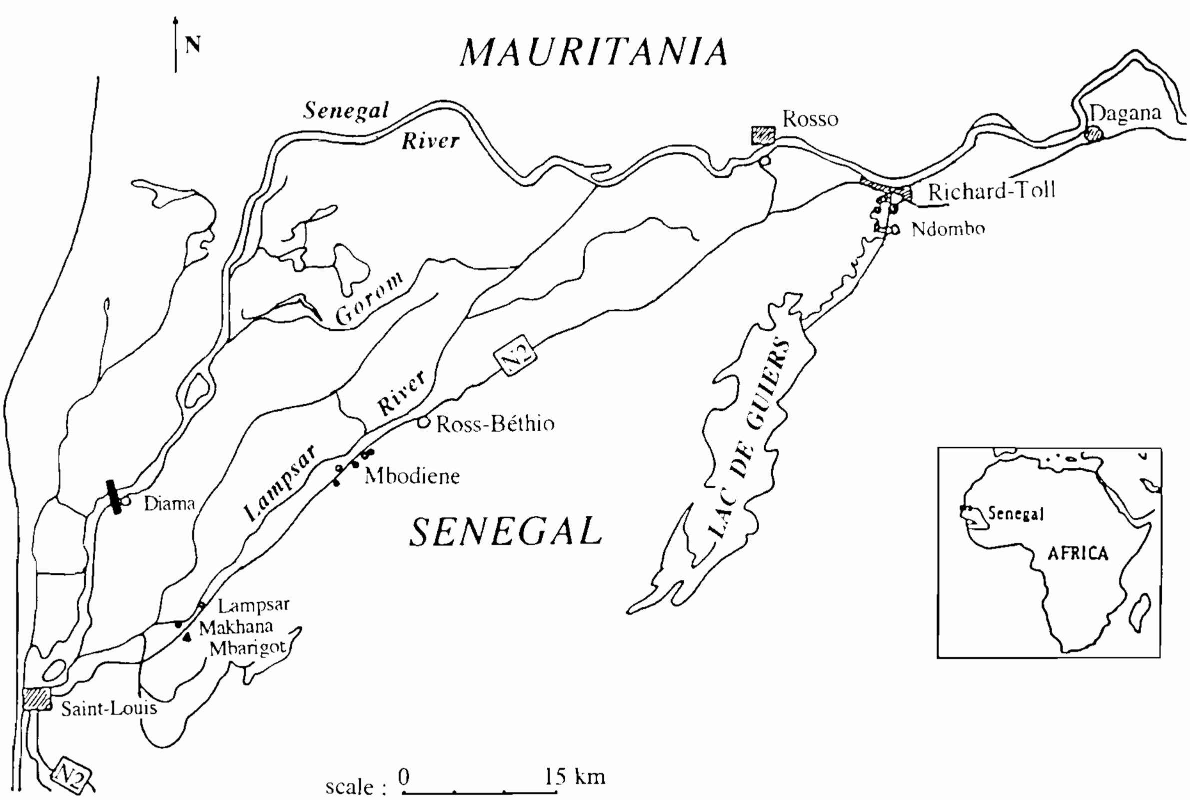

Fig. 1. Map of the Senegal river delta, Senegal.

The delta of the river in Senegal extends over 120 km inland from the sea, and is up to 50 km wide (Fig.1). In the north it is bordered by the main river, separating Senegal from Mauritania. In the south it is roughly separated from the Dieri, the higher ground, by national road N2. No irrigation is planned in the Dieri, where only traditional agriculture is practised.

Urinary schistosomiasis has been reported several times in the delta (CHAINE & MALEK, 1983; VERCRUYSSE *et al.*, 1985). Reported prevalences were always very low, except in the focus of Lampsar, about 20 km from the sea, where rice irrigation was introduced just after the second world war. It was suggested that the few cases of schistosomiasis found in the rest of the delta were acquired elsewhere (CHAINE & MALEK, 1983). Higher prevalences, around 10%, were found in the Middle Valley and the Dieri (CHAINE & MALEK, 1983; SARR, 1989).

Several studies have warned of a possible extension of schistosomiasis in the Senegal river basin (VERCRUYSSE *et al.*, 1985; MALEK & CHAINE, 1989). *Schistosoma mansoni*

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had never been reported before 1988 (TALLA *et al.*, 1990). Since then, Richard-Toll, a town in the east of the delta, has been facing an epidemic of *S. mansoni* infection. In a period of 3 years, more than 60% of the population has become heavily infected (TALLA *et al.*, 1992; STELMA *et al.*, 1993).

The first signs of a changing distribution of *S. haematobium* infection in the delta were noticed in 1989 and are reported in this paper. The preliminary results from a survey in one village are described.

Study population

Mbodiene is a small village on the national road (N2) between the sea (40 km) and Richard-Toll (65 km). At the beginning of the 1980s an irrigation scheme became operational nearby. The rice fields are separated from the village by the road and by a small irrigation canal (1 m wide) which is used for domestic and recreational purposes. Drinking water is mostly obtained from the Lampsar river, a branch of the Senegal river in which transmission of urinary schistosomiasis takes place in the focus of Lampsar. The distance between Mbodiene and this focus is only about 20 km, but there is little communication between these 2 villages. Nearly 90% of the population of Mbodiene belong to the Ouoloff ethnic group. In January 1989, villagers reported that several children suffered from blood in their urine, a new phenomenon in this village. A quick survey in February 1989 revealed that 53/57 children with a history of haematuria had *S. haematobium* eggs in urine sediment (unpublished data). The villagers have been fully informed of the results of the examinations and the transmission cycle of the disease. Treatment, however, was at that time available only in the private pharmacies in Saint Louis at about US $25 per adult dose of praziquantel.

Methods

Medical observation

Before the study, the whole population was informed about its objectives and methods. A map was drawn and all houses were visited; 434 persons (208 males and 226 females) declared the village as their present permanent address.

The baseline survey took place in July 1992. All villagers were invited to join the study. Each subject was asked to provide at least 2 urine samples on different days and one stool sample. Collection containers were distributed between 10:00 and 14:00. Examinations of urine were carried out on the spot. Urine specimens were thoroughly mixed and examined with a reagent strip (Multistix®, Ames) within one hour of collection. The protein content in the urine was recorded as negative (<10 mg/100 mL of urine), trace (10–30 mg/100 mL), +(30–100 mg/100 mL), ++(100–300 mg/100 mL), +++(300–2000 mg/100 mL) or ++++(>2000 mg/100 mL). Presence of blood or leucocytes in the urine was recorded as trace, +, ++ or +++. After this examination the urine was thoroughly mixed again and 10 mL were filtered with Nytrel® filters (WHO, 1983). The filters were stained with ninhydrin. Eggs were counted the same day; 10% of the slides were chosen at random and recounted within 24 hours (by P. V.) New Nytrel® filters were used for every examination. For each individual, counts were expressed as eggs/10 mL, using the arithmetic mean when 2 urine samples were examined. Mean group egg counts were calculated as geometric means of positive counts only. For 20 subjects the results were based on a single urine specimen.

Stool examinations consisted of duplicate 25 mg Kato slides (KATZ *et al.*, 1972; POLDERMAN *et al.*, 1985) from a single stool sample. The slides were examined at Richard-Toll, 24 to 48 h after preparation. Stool samples were obtained from 311 subjects. A random 10% sample of the slides was recounted. On the same day, all samples reported to contain *S. mansoni* eggs were also re-examined by one of the authors (F. S.).

All subjects with *S. haematobium* infection were offered treatment with 40 mg/kg of praziquantel, which 245 accepted. Six and 12 weeks after treatment their urine samples were collected and examined as described before.

Snail survey

In September 1991 (at the end of the rainy season) and July 1992 (before the first important rains) snails were collected in the irrigation canal and Lampsar river, at sites where villagers had regular contact with the water. Five observation points were chosen in each habitat.

Results

Prevalence and intensity of infection

Data were obtained from 352 subjects (81%) of the population, 160 male (77% of the male population) and 192 female (85% of the female population). Eighty subjects were absent at the time of the collection of samples and 2 refused to participate. 78% (65/82) of missing subjects were between 5 and 39 years, and 59% were male.

Overall, 87% of the subjects were found to have *S. haematobium* eggs in one or both urine samples and 30% had a mean egg count of more than 50 eggs/10 mL urine. The overall geometric mean was 17 eggs/10 mL in the infected; 35% of the population had more than 50 eggs/10 mL in one or both urine samples. No difference was found between sexes in prevalence or intensity of infection. Prevalence of infection with *S. haematobium* was very high (*c.* 80% or more) in all age groups (Fig. 2A), though slightly lower in the youngest and the oldest age groups (compared to the age group 10–14 years, $P=0.05$ and $P=0.14$, respectively). In children and young adults (under 20 years of age) relatively more heavy infections (over 50 eggs/10 mL urine) were found than in those 20 years or older (35% vs. 23%, $P=0.012$). Of the 8 subjects reported to have been treated, 3 were negative, 3 had light infections and 2 had heavy infections. When the e

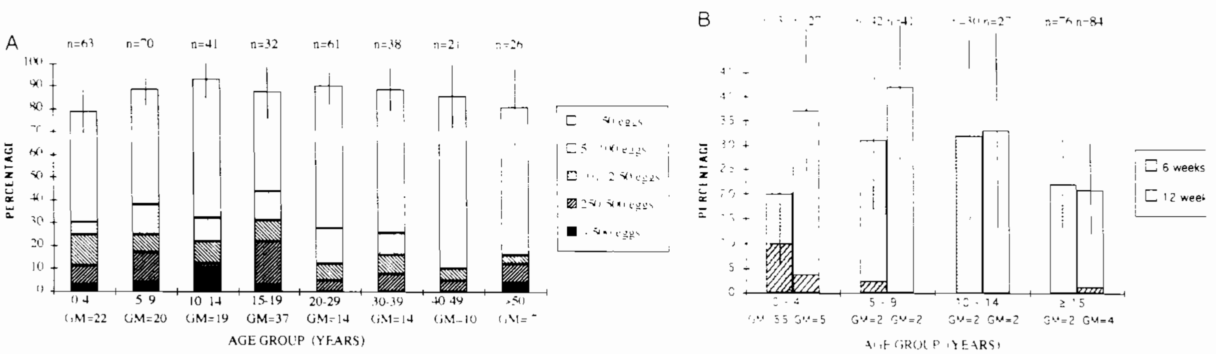

Fig. 2. Prevalence and egg count distribution of *Schistosoma haematobium* in 10 mL urine samples from inhabitants of a recently infected focus (the village of Mbodiene) in the Senegal river basin, (A) before and (B) 6 and 12 weeks after treatment with a single dose of praziquantel (40 mg/kg). Vertical lines indicate 95% confidence limits of prevalence, GM = geometric mean egg count per 10 mL of urine from infected persons; in B, the hatched portion of the blocks indicates the proportion with >50 eggs/10 mL.

Table 1. Validity of testing for haematuria and proteinuria with dipsticks for the diagnosis of infection with *S. haematobium* in a recently infected focus (the village of Mbodiene) in the Senegal river basin

	Detection of infection			Detection of heavy infection >50 eggs/10 mL urine		
	Threshold of positivity					
	≥trace	≥+	≥++	≥trace	≥+	≥++
Haematuria						
Sensitivity (%)	67	51	40	91	81	73
Specificity (%)	76	85	89	51	68	79
Predictive value of a positive test (%)	95	96	96	44	52	60
Predictive value of a negative test (%)	26	21	18	93	89	87
Proteinuria						
Sensitivity (%)	55	32	17	79	55	35
Specificity (%)	70	87	92	60	82	93
Predictive value of a positive test (%)	92	94	93	46	56	68
Predictive value of a negative test (%)	19	16	15	87	81	77

	Threshold of positivity[a]					
	1	2	3	1	2	3
Haematuria and proteinuria						
Sensitivity (%)	46	30	27	74	55	51
Specificity (%)	85	91	91	71	85	87
Predictive value of a positive test (%)	95	96	95	52	60	62
Predictive value of a negative test (%)	19	17	16	87	82	81
Haematuria or proteinuria						
Sensitivity (%)	76	69	56	96	91	85
Specificity (%)	61	72	80	40	48	63
Predictive value of a positive test (%)	93	94	95	40	43	49
Predictive value of a negative test (%)	28	26	22	96	93	91

[a]Thresholds of positivity are indicated thus: 1, haematuria ≥trace and/or proteinuria ≥trace; 2, haematuria ≥trace and/or proteinuria ≥+; 3, haematuria ≥+ and/or proteinuria ≥+.

treated subjects were excluded from the analysis, distribution of intensity and prevalence of infection did not change.

In 4 subjects (2 males and 2 females), one single schistosome egg with a lateral spine was found in one urine sample, always among many *S. haematobium* eggs. No *S. mansoni* egg was found in the corresponding stool sample.

Sensitivity, specificity and predictive values of positive and negative results of testing with dipsticks for haematuria, proteinuria and combinations of the 2 are given in Table 1. Values for different cut-off levels for each test and combination are calculated for 2 levels of infection with *S. haematobium*. Values for leucocyturia were very similar to those for proteinuria. For all tests or combinations of tests the sensitivity dropped with rising cut-off level, while the specificity rose. When only heavy infections were considered, sensitivity rose while specificity dropped. The predictive value of a positive test result was generally high for the detection of infection, whereas the predictive value of a negative test was low. When only heavy infections were considered, the opposite was true for the predictive values.

S. haematobium eggs were found in stool samples of 46/311 (15%) subjects. Two had no eggs in urine and 21 belonged to the heavily infected group (>50 eggs/10 mL urine). Four stool samples (1%) were found to contain *S. mansoni* eggs. One subject had eggs of both *S. haematobium* and *S. mansoni* in his stool sample.

Follow-up after treatment

Six and 12 weeks after treatment, urine samples were obtained from, respectively, 170 (56%) and 173 (57%) of 306 subjects found to be infected with *S. haematobium* in the initial survey. At 6 weeks *S. haematobium* eggs were found in 43/170 (25%) subjects with a geometric mean of 3 eggs/10 mL in the infected individuals. At 12 weeks *S. haematobium* eggs were found in 52/173 (30%) subjects with a geometric mean egg count of 3/10 mL in the infected individuals. Adults (≥15 years old) were less commonly infected 12 weeks after treatment than children (21% versus 38%, $P=0{\cdot}025$) (Fig. 2B).

During the follow-up study after treatment, 13 of 41 subjects in whom *S. haematobium* eggs had not previously been detected were found to be infected, all lightly.

Table 2. Numbers of snails, and numbers infected with furcocercous cercariae, in two water bodies used by the villagers of Mbodiene, Senegal river basin

	Lampsar		Irrigation canal	
	Sept. 1991	July 1992	Sept. 1991	July 1992
Biomphalaria pfeifferi	0	3	0	0
Bulinus forskalii	0	0	15	0
Bulinus globosus	0	2 (1)[a]	0	364 (105)[a]
Bulinus truncatus	0	0	0	78
Bulinus senegalensis	0	0	140	2

[a]Number infected with furcocercous cercariae in parentheses.

Snail survey

The results of the snail survey are shown in Table 2. Known possible intermediate hosts for *S. haematobium* were found in both habitats. Only *Bulinus globosus* was shedding furcocercous cercariae; 106 of 366 (29%) were found to be infected. *B. senegalensis*, *B. truncatus* and *B. forskalii* were also found in the irrigation canal near the village. A few *Biomphalaria pfeifferi*, intermediate host of *S. mansoni*, were found in the Lampsar river.

Discussion

No previous data are available for the village of Mbodiene but it can be assumed that until recently the situation was not different from that in the rest of the delta, i.e. that prevalence of infection with *S. haematobium* was very low. MALEK & CHAINE (1989) suggested that the few cases of schistosomiasis seen were acquired outside the delta, with the exception of the focus in Lampsar. According to villagers, bloody urine was unknown in the village before 1989. If true, then the local community had been exposed to *S. haematobium* for 4 years at the most. Macroscopic haematuria detected by anamnesis has proved satisfactory for community diagnosis of *S. haematobium* (ZIJLMANS *et al.*, 1989; LENGELER *et al.*, 1991). It is therefore most likely that transmission of *S. haematobium* in this village is a new phenomenon. Nevertheless, prevalence of this infection has reached very high levels (87%) and 30% of the subjects can be considered as having a heavy infection (WHO, 1983). The prevalence could even be higher if it were determined by examination of urine samples on more than 2 days (SAVIOLI *et al.*, 1990). Thirty-one percent of subjects in whom *S. haematobium* eggs had not previously been detected were found to be infected during the follow-up study after treatment, all with light infections. They might have been already infected during the initial survey, but missed because of the day to day variability in egg excretion (SAVIOLI *et al.*, 1990).

The very high prevalence in all age groups, even the youngest, is unusual. The equally high prevalence in the older age groups supports the likelihood that infection in this population is recent (HAGAN, 1992).

Haematuria and proteinuria detected by reagent strips are considered to be highly specific and sensitive for *S. haematobium* infection (MOTT *et al.*, 1985; SAVIOLI *et al.*, 1990). However, evaluation of these indirect diagnostic techniques is necessary in any specific situation, because considerable differences have been reported between countries (TANNER *et al.*, 1983; MOTT *et al.*, 1985). In our study the validity of test strips as a diagnostic test for *S. haematobium* infection was disappointing. Indeed, selecting subjects by chance would be likely to be better at detecting infected persons than the use of test strips. However, haematuria testing detected 91% of heavy infections, with a specificity of 76% for the presence of any infection. Detection of proteinuria and leucocyturia was less effective, and combinations of the tests did not result in substantial improvement. In the special situation of very high prevalence, test strips did not prove to be very useful for the diagnosis of individual *S. haematobium* infections.

A single schistosome egg with a lateral spine was found in one urine sample from 4 subjects (2 males and 2 females), always together with many *S. haematobium* eggs. Although no *S. mansoni* egg was found in the corresponding stool sample, these are likely to have been *S. mansoni* eggs. Considering these subjects as positive for *S. mansoni* infection, the prevalence of intestinal schistosomiasis rises from 1·3 to 2·6%. Atypical *S. haematobium* eggs have been observed in stool samples; *S. intercalatum*, however, has never been found in the region but *S. bovis* is highly endemic (VERCRUYSSE *et al.*, 1985).

Although follow-up data are limited, a substantial number of subjects was still infected 6 and 12 weeks after treatment. Finding eggs only 6 weeks after treatment cannot be explained by reinfection, but may be due to maturation of previously prepatent infections. The efficacy of praziquantel is lower against immature stages of *S. japonicum* in hamsters (WEBBE & JAMES, 1977) and those of *S. mansoni* in mice (SABAH *et al.*, 1986). Adults were significantly less commonly infected 12 weeks after treatment than children. This could be explained by the hypothesis that praziquantel works better in a mature immune system or by there being a lower rate of reinfection due to either different exposure patterns or immunity to reinfection in adults.

Since 1989 the villagers have been informed about the cause of the haematuria, and nurses responsible for medical care in the area were advised to consider haematuria a sufficient indication for treatment with praziquantel. Since 1991, this drug has been available in the health posts at about US $3 for one adult treatment. Nevertheless, although only one-eighth of the price in private pharmacies, this high cost may have limited the number of treatments. Only 8 treatments (7 children) were given in the first 6 months of 1992.

In 1989, shortly after this new schistosomiasis focus had been identified, a preliminary survey was carried out on some 150 primary schoolchildren from the villages of Ndioungue, Ndiaye, Diagambal and Guomene, surrounding Mbodiene (unpublished data). This survey did not indicate any other new foci of *S. haematobium*, although the situation in those villages was quite similar to that in Mbodiene. There are now indications that urinary schistosomiasis has spread to those villages as well: increasing numbers of cases of haematuria have been reported in routine health statistics from the area. In Makhana and Mbarigot, prevalences of up to 87% were found in children 5 to 14 years old (KONGS, 1993). *S. haematobium* had never been reported in these villages before; however they are located in the immediate surroundings of the village of Lampsar and are probably part of this old focus.

The available data suggest that *Bulinus globosus* is a main intermediate host in Mbodiene and, given the high infection rate, is very effective indeed. The limited data indicate great seasonal variability in snail populations. It is possible that *B. senegalensis* is also an intermediate host as previously found in other foci in the middle valley of the Senegal river basin. *B. jousseaumei* has never been reported in the delta during recent years, although it was said to be as an intermediate host in the focus of Lampsar (CHAINE & MALEK, 1983).

The question arises of why the problem of urinary schistosomiasis appeared in 1989. The small irrigation canal next to the village had existed for 8 years before the problem was identified. At the beginning of the 1980s, a drought period of several years in the Sahel had a major influence on the prevalence of schistosomiasis in general (CHAINE & MALEK, 1983) and reduced the chance of the introduction of snails. Furthermore, irrigation culture has been applied irregularly until now, so the canal is often dry for several months. Also, the water level of the Lampsar river shows significant fluctuations. These are unfavourable conditions for snails, especially for *Biomphalaria* spp. Pesticides and salinity of the water may also limit the snail populations. For example, *Biomphalaria pfeifferi* was found in very high numbers in July 1990 in the Lampsar river at Ross-Bethio (unpublished data) but had disappeared some months later after a drop of the water level and an accidental influx of some salt water from the ocean. Comparable numbers have not been seen there since.

No *B. pfeifferi* was found in Mbodiene during this study. However, it is possible that the subjects with *S. mansoni* eggs were infected in the immediate surroundings of the village. In 1991, 4 of 88 *Biomphalaria pfeifferi* were found to be infected with furcocercariae in the Lampsar river at Ross-Bethio, about 15 km from Mbodiene (DEME, 1993) and in February 1993 (7 months after the study) *Biomphalaria* have been found in the irrigation canal near Mbodiene (J. Vercruysse, personal communication).

At present, reinfection after treatment is almost inevitable in Mbodiene because no alternative water supply exists. Treatment and health education, water management and weed control of the small irrigation canal are the only immediately available tools for control. These will not eliminate snail hosts of *S. haematobium* but could be sufficient to control *Biomphalaria pfeifferi*. Obviously the whole delta is at risk of schistosomiasis; the dynamics of snail populations will eventually determine the distribution of the 2 endemic species. The increase and ecological changes of the water bodies may also influence other vector borne diseases, such as malaria.

The exact time of the introduction of urinary schistosomiasis in Mbodiene is not known but it appears to have taken place at about the same time as the outbreak of *S. mansoni* in Richard-Toll (TALLA *et al.*, 1990). The parallel explosive evolution of 2 different forms of schistosomiasis in the same region is striking. Transmission in both foci appears to be similarly intense in non-immune populations of the same ethnic groups. Epidemiological and immunological studies in both locations are under way and these new, neighbouring foci provide a unique opportunity to study schistosomiasis in general.

Acknowledgement

We gratefully acknowledge the work of Ngary Sy, Abdoulaye Yague, Sohibou Guindo, Seydou Tine and Mankeur Diop (the technicians). Special thanks go to WARDA (ADRAO), Senegal, which provided excellent working conditions on the spot, and to ORSTOM for logistic support.

This work was supported by the Flemish Community of Belgium and by the Science and Technology for Development programme of the Commission of the European Communities, contracts no. T52-0145NL and T53-CT91-0041 (University of Leiden) and T52M-0079-F and T53-CT91-0030 (Institut Pasteur, Lille) and is associated with the ESPOIR programme for research and control of schistosomiasis in northern Senegal.

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Received 22 September 1993; accepted for publication 21 October 1993

Announcement

PRIZES

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1. Two prizes of £200 may be awarded annually in recognition of outstanding projects which increase knowledge of tropical medicine and hygiene in the broadest sense.
2. Candidates shall be nominated by their head of department, supervisor or Dean, with a supporting statement of up to 500 words.
3. The closing date for receipt of project reports is 31 December. The project should have been done or completed in the previous twelve months.
4. A Committee of three shall choose the prize winners.
5. The announcement of the prize winners will be made at the March meeting of the Society.
6. The prizes will be presented by the President of the Society at the Annual General Meeting in June or July.

Please note that the Society cannot provide funds to cover students' elective travel expenses.

TRANSACTIONS OF THE ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE 1994 88, 406–409

Schistosomiasis in the Republic of São Tomé and Principe: human studies

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Abstract

The only schistosome species found in stool specimens in the local population of the republic of São Tomé is *Schistosoma intercalatum*. An initial survey of schoolchildren showed an overall prevalence of 10·9%, with some schools reaching 29%. No *S. haematobium* egg was found in 782 urine specimens from the local population, although some were seen in the urine of Angolan soldiers stationed near the capital city. One village in the endemic area, San Marçal, had an *S. intercalatum* prevalence of 43%, with 14 persons >40 years of age harbouring severe infections. The transmission area is restricted to the north-east of the main island, where 5 foci apparently account for most of the infections. Seven cases recorded from Principe may be explained by the fact that the children were attending school at São Tomé. Women carrying out domestic activities are more at risk of contracting the infection because of longer periods of water contact than men. The morbidity produced by the infection is restricted to splenomegaly and blood in the stools. High prevalences have been found of *Ascaris lumbricoides* and *Trichuris trichiura*, and hookworm and *Strongyloides stercoralis* were also observed. Praziquantel was well tolerated and appears to be a good tool for control purposes, although reinfection in the transmission area apparently occurs rapidly. Control strategies based on chemotherapy should take into account an older age group as well as the schoolchildren. Focal mollusciciding and the introduction of washing facilities may also have a role to play in control. The possible recent introduction of the infection to the island is discussed.

Introduction

São Tomé and Principe are 2 islands in the Gulf of Guinea, approximately 245 and 217 km from the mainland, with populations of 114 507 and 5637, respectively.

The *Atlas of the Global Distribution of Schistosomiasis* (DOUMENGE *et al.*, 1987) states that about 30% of the children in São Tomé were infected with *Schistosoma haematobium*, but GRACIO (1988) found snails of the *Bulinus forskalii* group and suggested that schistosomiasis could be caused by *S. haematobium*, *S. intercalatum* and a hybrid. However, a detailed survey of 1637 island children (ROMERO *et al.*, 1989) showed the presence of schistosome eggs in stool samples only; they were identified as *S. intercalatum*. CORACHAN *et al.* (1988) described the first clinical case *S. intercalatum* infection in an immigrant from São Tomé.

In order to clarify the situation, a programme was designed to provide information on the epidemiology and biology of schistosomiasis and to assess prospects for its future control in São Tomé. The present paper refers primarily to the clinical and epidemiological aspects of the study.

Human infections with *S. intercalatum* were described comprehensively by FISHER (1934) in Zaire. *S. intercalatum* is present in 5 countries, according to a World Health Organization survey (IAROTSKI & DAVIS, 1981)—Chad, Central African Republic, Gabon, Cameroon and Zaire—and subsequently reports reflecting a wider distribution have appeared. Clinical infections in immigrants from Equatorial Guinea were described by MAS *et al.* (1985) and CORACHAN *et al.* (1987a), and a survey in that country revealed a focus of the infection in a district of Bata, the capital city (SIMARRO *et al.*, 1989). Infections in Spanish tourists from Mali were described from a travellers' clinic (CORACHAN *et al.*, 1987b, 1992). The infection has also been reported from Nigeria (ARENE *et al.*, 1989).

The objectives of the study in humans were to determine the prevalence of schistosomiasis in children of school age, to assess the morbidity and therapeutic response of the infection, to establish the pattern of water contact in the endemic areas, and to monitor the distribution of infection in the whole population of a village in an endemic area.

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Materials and Methods

A survey was conducted in 1991 of 2930 schoolchildren (aged 5–15 years) from 26 schools in São Tomé for intestinal helminths and faecal and urinary schistosomiasis. In addition, 100 pupils from the 2 main schools of the island of Principe (Pagué district) were examined by the Kato-Katz technique (KATZ *et al.*, 1970); 3 slides were prepared from each stool sample. Seven hundred and eighty-two urine samples were examined by filtration as described by PETERS (1976); they were checked for gross haematuria and examined for haematuria and proteinuria with chemical reagent strips (Hemastix® and Albustix®, AMES laboratories). Urine samples from 332 schoolchildren infected with *S. intercalatum* were examined similarly in 1992.

An earlier indication of an *S. intercalatum* prevalence of 11% (ROMERO *et al.*, 1989) led us to choose a sample size of 3030 pupils from a total of 20 000 schoolchildren based on the local census. Cluster sampling was used first stratifying by districts and then by schools, proportionally to the number of children per school.

A questionnaire relating to morbidity, water contact patterns and personal data was administered by 2 physicians and 2 field workers. All questions concerning symptoms related to their presence in the last month. The physicians physically examined all children. The questionnaire had been previously validated by repeated testing with local personnel. All infected persons found during the first survey (1991) were treated and re-examined at intervals of 3 and 12 months. In every survey, infected persons were treated with 40 mg/kg praziquantel in a single dose. Mebendazole (100 mg/12 h for 3 d) was given to treat other intestinal helminths. A new stool survey of 2856 children, which did not include the cases found in 1991, was conducted in 1992.

A survey for *S. intercalatum* was made in 1991–1992 of all 752 inhabitants (470 females and 282 males) of the village of San Marçal in São Tomé. Urine samples from these 752 persons were also examined by filtration.

In addition, a small sample of Angolan soldiers based at the airport were examined for schistosomiasis infection.

Results

Parasitology

School survey. The only *Schistosoma* species found was *S. intercalatum*; 332 children (10·9%) in the first survey, and 333 (11·7%) in the second were infected, comprising