Control of Schistosomiasis Mansoni in Ravena (Sabará, State of Minas Gerais, Brazil) through Water Supply and Quadrennial Treatments

Pedro Coura-Filho/[+], Roberto Sena Rocha, Simone da Silva Lamartine, Márcio William C Farah*, Dilermando Fazito de Resende**, José Oswaldo Costa***, Naftale Katz

Laboratório de Esquistossomose, Centro de Pesquisas René Rachou-FIOCRUZ, Av. Augusto de Lima 1715, 30190-002 Belo Horizonte, MG, Brasil *Fundação Mineira de Arte-FUMA, Universidade do Estado de Minas Gerais, Av. Amazonas 6252, 30530-000 Belo Horizonte, MG, Brasil **Fundação Nacional de Saúde, Av. Brasil 2023, 30140-131 Belo Horizonte, MG, Brasil ***Departamento de Medicina Preventiva, Escola de Medicina Veterinaria, UFMG, Belo Horizonte, MG, Brasil

In this study, the results obtained in a control programme of schistosomiasis in Ravena (Sabará, Minas Gerais) between 1980 and 1992 are evaluated. Control measures used in this programme were: specific treatment of the people infected with Schistosoma mansoni *at four year-intervals (1980/84/88) and the supply of tap water to 90% of the residences in 1980. A significant reduction of the prevalence (36.7% to 11.5%, p £ 0.05) and of the intensity of the infection (228.9 eggs per gram of feces (epg), s = 3.7 to 60.3 epg, s = 3.5, p £ 0.05) was observed. No cases of the severe form of the disease were diagnosed in the area. Factors independently associated with the infection were in 1980 daily sand extraction and the lack of tap water in residences and in 1992 daily sand extraction and fishing and weekly swimming. Concluding, the supply of tap water together with quadrennial treatments significantly diminished both the prevalence and intensity of the* S. mansoni *infection, with the additional gain of persistent low indices even after four-year intervals between the treatments.*

Key words: epidemiology of schistosomiasis - control - measures: sanitation and treatments - Brazil

The relation between sanitation and the reduction of the prevalence, egg counts and morbidity of schistosomiasis in Brazil was studied by Barbosa et al. (1971), Lima e Costa et al. (1994) and Coura-Filho (1994). Barbosa et al. (1971) provided the residents of Pontezinha, PE, with cesspools, nine community laundries and health education, for those who were exposed to the infection with *Schistosoma mansoni*, during seven years. At the end of this period they observed a decrease of the prevalence from 30.0 to 3.8%. In three control areas where no control measures were taken the prevalence, egg loads and morbidity rates of the disease showed no significant variation, although two areas seemed to present a tendency to regression as well.

Lima e Costa et al. (1985) recorded that in the nucleus of Comercinho, MG, residences provided with tap water presented the lowest prevalence rates, compared to peripheral areas. In 1994, Lima

e Costa et al., using a method of multiple regression analysis, registered that the lack of supply of water to residences was independently associated with the presence of the hepatosplenic form of the disease.

In a review of studies about the determining factors in the transmission of schistosomiasis obtained from seven endemic areas in Brazil, Coura-Filho (1994) observed the absence of specific treatment to be an indication of the infection with *S. mansoni* in three of the four areas and the lack of water supply to residences in three out of six.

Outside Brazil, Jordan et al. (1982) demonstrated the association between the reduction of the transmission of schistosomiasis and the supply of tap water as a control measure, besides considering water supply to be the most lasting measure for the control of the disease. It was also calculated that this was the most expensive measure: U$ 4.1 per subject per year compared to a single treatment (U$ 1.1).

Hunter et al. (1993) reviewed 16 studies carried out outside Brazil, which indicated a reduction of the transmission of waterborne diseases if water to the residences of the population in an endemic area was supplied.

The influence of specific treatment on the regression of the severe form of the disease is described in literature.

In this study the association between the supply of tap water and quadrennial specific treatment of subjects to *S. mansoni* infection is evaluated as a control measure of schistosomiasis.

MATERIALS AND METHODS

Studied area - Ravena is an area in the municipal district of Sabará, MG, in Rio das Velhas basin, a mountainous region characterized by gravelly sedimentation, 30 km north of Belo Horizonte. It has a population of approximately 1,500 inhabitants that live in Ravena (centre) and Lavapés (periphery of the district). It has an annual migratory flux around 5%. The main commercial activity is the growing of bananas, followed by dairy cattle farming and the extraction of granite and sand for building construction. The population of Ravena is provided with a local municipal administration, a Municipal Health Center, two municipal schools, a police station and two catholic churches. Civic services include a telephone post, intermunicipal transport, paved roads, electric light and potable water. 60% of the streets are paved and 40% of the houses are served with a sewerage system. In 1980 a watermain was installed serving 90% of the residences of the district. At that time the prevalence of schistosomiasis was 36.7%; the geometric mean of the number of eggs per gram feces (epg) was 228.9 epg (s = 3.7) and no cases of the hepatosplenic form of schistosomiasis were reported (Coura-Filho et al. 1995).

In 1980, 1984, 1988 and 1992 parasitological stool exams of the residents were performed followed by specific treatment of the infected individuals with a single oral dose of oxamniquine: 20 mg/kg bodyweight for children (younger than 15 years) and 15 mg/kg bodyweight for adults. The drug was administered by a physician of the local health center. From 1989 onward the Municipal Health Center also started to record the results of the parasitological stool exams performed in the population on spontaneous demand outside Ravena.

Analysis of determinants **-** In order to evaluate the clinical-epidemiological evolution of the *S. mansoni* infection in the area the following qualities were considered: prevalence, the intensity of the infection and the clinical forms. To determine the prevalence, the arithmetic mean of the *S. mansoni* egg counts found in two glass slides prepared from one stool sample according to the Kato-Katz method (Katz et al. 1972) was used. The intensity of the infection was based on the geometric mean $(G \pm s)$ of the number of eggs per gram of

feces of positive individuals. For the identification of the clinical forms the classification used by Pessoa and Barros (1953) with slight modifications was applied: intestinal (I), hepatointestinal (HI) and hepatosplenic (HS).

An analysis of the determinants of schistosomiasis was carried out through the multiple regression analysis of the factors (Campos-Filho & Franco 1989) considering the situation before and 12 years after the start of the programme. In a pretested questionnaire the following variables asked for were: biological (sex, age), socio-cultural (place, reason and frequency of contact with water of streams and rivers) and socio-economic variables (profession, education, material condition of the residence and the supply of tap water) according to Coura-Filho (1994). The linear regression of the prevalence per age group of the population during the period was studied.

RESULTS

The prevalence of the *S. mansoni* infection was significantly reduced during the programme, from 36.7 to 11.5% ($p \leq 0.01$), though proved to be not significant in the age group of 0-4 years, both in 1980 and 1992. Subjects in the age group 10-29 years presented the highest prevalences during the period of the programme (Table I). The drop in the prevalence was significant both in the group of children as a whole (0-14 years) and in adults ($\geq$ 15 years) (Table II).

The examination of stool samples performed between 1989 and 1991 by the local health center on spontaneous demand showed that 12 years after the installation of water supply to the residences, around 70% of the examined individuals were subjected to a worm infection, which was 87.4% before the installation. Of the people examined 9.2, 5.4 and 4.2% were excreting eggs of *S. mansoni* in 1989, 1990 and 1991, respectively. The intensity of the infection of *S. mansoni*, being initially 228.9 epg (s = 3.7), was also significantly decreased in all age groups of the population after the first treatment, staying continuously at a level between 21.9 epg (s = 1.7) and 70.3 epg (s = 3.6) without significant variation until 1992 (Table III) both among children and adults living in the nucleus and in the periphery of the district (Table IV).

An increase of the intestinal form (type I) from 81.3% to 97.9% of the total number of infected individuals was observed. The prevalence of the cases of the hepato-intestinal form dropped from 16.8% to 2.1% in 1992. Not a single case of the hepatosplenic form of schistosomiasis was diagnosed in the district.

The intensity of the infection among the subjects with the intestinal form (240.42 epg, s = 4.82)

TABLE I

Prevalence of infection by *Schistosoma mansoni* in Ravena (Sabará, MG), according to age of the population

Age group	Years							
	1980		1984		1988		1992	
	I/E[a]	%	I/E	%	I/E	%	I/E	%
0 - 4	9/110	8.3	0/0	-	0/0	-	3/92	3.3
5 - 9	38/145	26.2	8/54	14.0	0/13	0.0	3/138	2.2
10 - 14	69/146	47.3	23/66	34.8	12/53	22.6	23/170	13.5
15 - 19	87/135	64.4	23/74	31.0	13/51	25.4	38/117	32.5
20 - 29	77/167	46.1	39/114	34.2	25/58	43.1	34/199	17.1
≥ 30	86/295	29.2	32/197	16.2	17/234	7.2	34/453	7.5
Total	366/998	36.7	125/505	24.7	67/1169	16.4	135/1169	11.5

a: infected/examined

Linear regression analysis along the time:

Age group	b	p
0 - 4	-0.39 ± 0.05	0.51
5 - 9	-2.79 ± 1.76	0.26
10 - 14	-2.90 ± 0.49	0.02
15 - 19	-2.58 ± 1.78	0.28
20 - 29	-2.50 ± 0.43	0.03
≥ 30	-1.88 ± 0.44	0.05
Total	-2.18 ± 0.34	0.02

TABLE II

Prevalence of schistosomiasis mansoni in children and adults in Ravena (Sabará, MG)

Years	Ravena (centre)				Lavapés (periphery)			
	Child[a]		Adult		Child		Adult	
	I/E [b]	%	I/E	%	I/E	%	I/E	%
1980	83/344	24.1	207/534	38.8	33/56	58.9	43/63	68.2
1984	17/103	16.5	66/351	18.8	14/17	82.3	28/34	82.3
1988	6/80	7.5	45/283	15.9	6/14	42.8	10/32	31.3
1992	22/343	6.4	11/676	11.8	7/57	12.2	26/93	27.9

a: ≤14 years; *b:* infected/examined

Linear regression analysis along the time:

		b	p
Ravena: (centre)	child (0-14 years)	-0.57 ± 0.12	0.04
	adult (≥ 15 yeras)	-0.39 ± 0.13	0.02
Lavapés	child	-0.14 ± 00.8	0.21
	adult	-0.16 ± 0.08	0.19

was not significantly different from the intensity among subjects with the hepato-intestinal form (196.84 epg, s = 4.73) in 1980. However, 12 years later the latter group showed a significant lower geometric mean of the epg (12.03 epg, s = 0.99) than the group of the intestinal form (54.66 epg, s = 3.51).

Of the houses that initially were served with tap water (90%), 12 years later 81% continued to be connected to the watermains. The number of houses connected to the sewerage system increased from 17.0 to 36.0% during the same period.

The multivariate analysis indicated that in the beginning of the project the daily extraction of sand out of streams and rivers in the region [(OR=3.44 (1.22-8.43)] and the lack of tap water [(OR=2.47 (1.25-6.25)] were independently associated with the infection. Twelve years later the factors independently associated with the infection were: the daily extraction of sand [(OR=2.07 (1.06-4.42)], daily fishing [(OR=2.86 (1.78-7.22)] and weekly swimming [(OR=1.29 (1.40-4.20)] (Table V).

TABLE III

Schistosoma mansoni infection intensity in Ravena (Sabará, MG), according to age group

Age group	Years							
	1980		1984		1988		1992	
	N	G±s[a]	N	G±s	N	G±s	N	G±s
0 - 4	9	102±2.6	-	-	-	-	3	49.7±11.7
5 - 9	38	253±4.2	8	174.8±5.0	-	-	3	21.9±1.7
10 - 14	69	350±3.4	23	125.8±3.6	12	113.0±4.0	23	57.0±3.3
15 - 19	87	295.1±3.3	23	64.1±4.0	13	80.4±3.9	38	70.3±3.6
20 - 29	77	211.3±4.8	39	76.3±3.7	25	67.4±3.7	34	70.0±3.2
≥ 30	86	126.8±3.0	32	28.6±2.2	17	29.7±2.4	34	46.3±3.3
Total	366	228.9±3.7	125	72.7±3.2	67	62.2±3.7	135	60.0±3.5

a: geometric mean ± standard deviation

ANOVA from 1980 to 1992

Age group	p
0 - 4	0.04
5 - 9	0.03
10-14	0.02
15-19	0.02
20-29	0.00
≥ 30	0.03
Total	0.02

TABLE IV

Schistosoma mansoni infection intensity in children and adults in Ravena (Sabará, MG)

	Ravena (core)				Lavapés			
Years	Child[a]		Adult		Child		Adult	
	N	G±s[b]	N	G±s	N	G±s	N	G±s
1980	83	257.0±3.5	207	200.0±3.5	33	365.4±3.9	43	228.1±3.9
1984	17	91.9±2.6	66	56.8±3.4	14	222.0±4.9	28	58.8±4.4
1988	6	79.1±2.1	45	48.3±3.6	6	167.8±6.2	10	94.4±3.1
1992	22	49.1±3.7	80	62.9±3.6	7	56.8±3.8	26	57.3±3.3

a: child 0 - 14 years; *b:* geometric mean ± standard deviation

ANOVA from 1980 to 1992		p
Ravena:	child (0-14 years)	0.04
(centre)	adult (≥ 15 years)	0.03
Lavapés:	child	0.02
	adult	0.04

TABLE V

Schistosoma mansoni infection determinants in Ravena (Sabará, MG) in 1980 and 1992

Risk factors	1980		1992	
	OR [a]	p	OR	p
Professional (daily sand extration)	3.44 (1.22 - 8.43)	0.01	2.07 (1.06 - 4.42)	0.05
Daily fishing	NS[b]		2.86 (1.78 - 7.22)	0.02
Weekly swimming	NS		1.29 (1.40 - 4.20)	0.04
Residences without potable water	2.47 (1.25 - 6.23)	0.00	NS	

a: Odds Ratios; *b*: NS = non-significant to p ≤ 0.05

DISCUSSION

Evaluating the measures taken for the control of helminthoses difficulties rise to define the ideal method of control. One of the difficulties is the impossibility to compare the data of distinct populations after intervention, even when socio-economic and cultural conditions and used methods are similar. Also in this study, designed to compare clinical-epidemiological data before and after the implementation of measures of control of schistosomiasis in Ravena, MG, the possible changes in the way of life of the exposed population were not taken into consideration.

During the period of study a significant reduction of the prevalence, egg loads and morbidity rates was observed, but unknown is to what extent each of the two measures, the intradomiciliary supply of potable water and the specific treatment, is responsible for this reduction.

In 1992 water supply to the residences was not independently associated with the infection. At that time the determinants for the transmission of schistosomiasis in the area were the habits of swimming and fishing, mostly done in natural pools and/or recreation clubs located close to the district. These clubs were also visited by residents of neighbouring settlements, mainly from the periphery of Belo Horizonte, not submitted to any programme of control of schistosomiasis.

In areas where control programmes are undertaken a remainder of the individuals continues to excrete eggs of *S. mansoni*. Responsible for the continuation of the transmission in the area is probably a group formed by subjects with contraindications to treatment, non-examined or non-diagnosed individuals, reinfected or non-cured patients and migrants. Responsible for the maintenance of the highest rates of prevalence among the residents of Lavapés seems to be the absence of a sewerage system and the proximity of the residences to the streams that are receiving excrements. The multivariate analysis demonstrated that living in mentioned place was independently associated with the transmission in the district in the beginning of the programme.

Similar outcomes were described for the correlation of the supply of tap water and the reduction of the infection in Santa Lucia. In the latter area the initial control measure consisted of specific treatment followed in a later stage by the provision of tap water, which reduced the prevalence, egg loads and morbidity rates of schistosomiasis even more. Still, 10% of the population continued to have water contact in transmission sites, mainly because of swimming and fishing.

When analysing the determinants for the transmission of schistosomiasis in seven endemic areas in Brazil Coura-Filho (1994) also observed continuing water contact even after the supply of tap water, resulting from leisure activities in urban areas and from occupational (agricultural and domestic) activities in rural areas.

Barbosa et al. (1971) and Lima e Costa et al. (1987) noticed in Brazil a reduction of water contact of individuals when supplied with tap water; Hunter et al. (1993) estimated this specific contribution to the reduction of water contact to be at least 20%, whereas Jordan et al. (1982) registered a reduction up to 50% in the localities they studied.

The costs of the installation of tap water are generally considered to be high, but the resulting impact on the control of schistosomiasis is longer lasting and in Ravena the users willingly participated financially in the operational costs of the installation and distribution of tap water, like in Santa Lucia. This mutual participation of local government and residents gave way to the supply of tap water to 90% of the residences in 1980, but fails in different, recently urbanized areas in the peripheral zones of the big cities, where the flux of settlement of new migrants exceeds the governmental capacity to create an urban infra-structure (not only tap water, but also sewerage system, light, public transport and schooling).

In a settlement in Minas Gerais where yearly specific treatment was combined with three-monthly applications of molluscicides a significant drop of the prevalence was recorded, but after interruption of the measures it tended to revert to initial levels. The initial prevalence in the endemic area of 43.5% decreased to 4.4% after the implementation of control measures during 13 years, but reverted to a prevalence of 19.6% three years after the interruption of the programme Coura-Filho et al. (1994).

In conclusion, this study verifies that three quadrennial specific treatments and the supply of tap water reduced the prevalence and intensity of the infection with *S. mansoni* permanently, both in the urban nucleus and in the periphery of the district, consequently pointing out an efficient model of control of schistosomiasis and its implementation should therefore be stimulated in other endemic areas in Brazil.

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