Factors Involved in *Schistosoma mansoni* Infection in Rural Areas of Northeast Brazil

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Two contiguous villages in Tracunhaém county (State of Pernambuco), endemic for schistosomiasis, were studied: Itapinassu (138 inhabitants) and São Joaquim (91 inhabitants). Agriculture predominates in the former region while ceramics is the main activity in the latter. Although no statistical difference was found regarding prevalence, severe infection (>400 epg) predominated in Itapinassu, probably related to the kind of occupation. No association was found between parasite burden and severity of disease, in spite of the high infection rates for Schistosoma mansoni *in both communities (approx. 60%). Typical epidemiological features of schistosomiasis such as age-related prevalences and intensities of infection (high in children, low in adults) were also mutual characteristics. Nutritional status determined through anthropometric evaluation was carried out by measuring specific anthropometric indicators. A deficit of energy intake, as well as vitamin A and riboflavin deficiencies were detected. The prevalence of moderate or severe undernutrition in patients under 18 years old was 21.9% in Itapinassu and 24.1% in São Joaquim. In this group an association was found between prevalence of schistosomiasis and chronic undernutrition. Similarly, for patients over 18 year old the prevalence of undernutrition was higher than 20%. However, in this case no association between nutritional status and either prevalence of schistosomiasis or parasite burden could be detected. The two communities had not been treated for eight years.*

Key words: epidemiology - schistosomiasis - risk factors - nutrition

Schistosomiasis is a very widespread disease in the developing world and is one of the most important helminth infections in public health terms. Six hundred million people are thought to be at risk and 200 million are estimated to be infected (Chan et al. 1996). Among the so called major endemic diseases of Brazil, schistosomiasis is the third in the rank as cause of death in rural populations (Amaral & Porto 1994). Patterns of schistosomiasis infection are shaped by two factors: host exposure and host immunity. Both factors demonstrate marked heterogeneity within any given population (Butterworth 1994). The reasons for this heterogeneity are variable and may involve nutritional, genetic and socio-cultural factors. As a behaviour related disease, the risk of infection with schistosomiasis is associated to age, sex, and occupation of individuals (Gryseels 1991). The conditions responsible for the evolution to the severe forms of the disease are not completely clear although the parasite burden seems to be a major determinant (Sleigh et al. 1986). In addition, the contribution of other factors on morbidity in schistosomiasis, including host and parasite genetics, other infections and nutritional status, are still poorly understood (WHO 1992).

The association between the host nutritional status with susceptibility to infection and clinical manifestations of the disease is not completely established (Lima e Costa et al. 1987, Proietti et al. 1992). Thus, further evaluation on this issue is necessary.

In the present communication, the role of different local factors involved in *Schistosoma mansoni* infection (including the nutritional status of the population), in two contiguous endemic villages in northeastern Brazil is discussed.

This research was awarded the "Pirajá da Silva/95" prize at the 5th International Symposium on Schistosomiasis, held in Salvador, BA, Brazil - October 10-13, 1995.
This investigation was supported by FIOCRUZ (PAPES 2 - 95/96) and CNPq.
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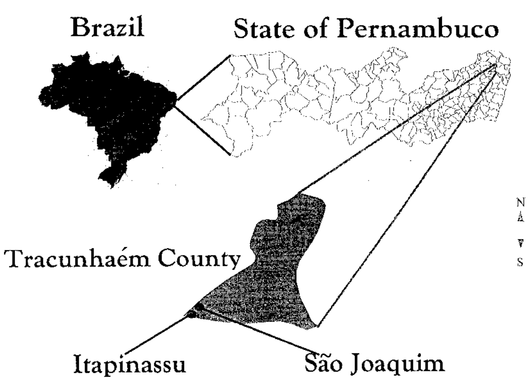
Received 16 April 1997
Accepted 30 June 1997

MATERIALS AND METHODS

Study area - A cross-sectional study was carried out from March 1994 to March 1995 in Tracunhaém county, in the tropical forest zone of the State of Pernambuco, northeastern Brazil. Two contiguous endemic villages were chosen for investigation: Itapinassu and São Joaquim (Fig.). The villages are 50 km away from Recife, capital of the state. In Itapinassu, with 138 inhabitants, agriculture is the predominant activity, while in São Joaquim, a village with 91 inhabitants, ceramics is the main occupation.



Geographical location of the study area.

Malaria and visceral leishmaniasis are not endemic in the area and the snail vector is *Biomphalaria straminea*. The two communities had not been treated for eight years.

Parasitology - Stool examinations were performed by the methods of Hoffman et al. (1934) and Kato-Katz (Katz et al. 1972), to detect other helminths and estimate the egg intensity of *S. mansoni* infections. The intensity of infection was classified as light (<100 epg), moderate (101-400 epg) and severe (>400 epg).

Clinical examination - All individuals in each village were examined by the same physician, without previous knowledge about the parasitological results.

The patients were inquired about the signs and symptoms they had experienced during the 30 days preceding the clinical examination. Patients were clinically examined and interviewed according to a standard form directed to gastrointestinal manifestations. Liver enlargement was measured in cm in the mid-sternal and mid-clavicular lines, and splenic enlargement in cm in the mid-clavicular and mid-axillary lines. Cases of schistosomiasis were defined as individuals with a positive stool test for *S. mansoni* or hepatosplenomegaly suggestive of schistosomiasis.

A simplified clinical-epidemiological classification of schistosomiasis mansoni (Coutinho & Domingues 1993) was used as follows: type 0 (acute schistosomiasis), type I (intestinal clinical form, including asymptomatic patients), type II (hepato-intestinal form), type III (hepato-splenic form), type IV (other clinical forms).

Clinical examination conducted at the field was complemented with ultrasonographic studies to detect those patients with periportal fibrosis and/ or splenic enlargement not yet palpable.

Ultrasound examination of the liver and spleen was performed by one experienced ultrasound observer, in patients in the supine and both lateral positions. Using a portable ALOKA SSD-500 machine with a convex 3.5 MHz sector probe and power from a portable generator. Measurements included the largest dimension of the spleen and the diameter of the portal vein as it enters the liver. Periportal fibrosis was graded according to the WHO protocol (1991).

The two communities had not been treated for eight years.

All patients positive for *S. mansoni* were treated with oxamniquine in a single dose (15 mg/k for adults and 20 mg/k for patients under 15 years old). A previous therapy against other helminth infections was carried out with mebendazole and/or thiabendazole.

Nutritional status evaluation - The nutritional status of the individuals was studied through anthropometric measurements (weight-age and stature-age indices for children and youths and body mass index for patients over 18 years old). In the first case, the standard values from the National Center for Health Statistics (WHO 1983) were taken for comparison and individuals were classified as follows: normal (P_{10}-P_{90}), needing surveillance for light undernutrition (P_3-P_{10}), needing surveillance for overweight (P_{90}-P_{97}), moderate and severe undernutrition (P<3) and obese ($\geq P_{97}$). The body mass index was determined according to the formula:

$$BMI = \frac{\text{body weight (kg)}}{\text{height}^2}$$

Results were classified as suggested by Garrow (1981): <20 (low weight), 20-24.99 (normal); 25.99 (overweight); ≥30 (obesity).

Weights were obtained using FILIZOLA ID-1500 digital battery/electric operated scales read in 0.1kg increments (Indústria FILIZOLA S/A, São Paulo, Brazil). Heights were measured using a Ross Laboratories (Columbus, OH, USA) stadiometer with an attached headboard. Measurements were taken twice and averaged.

Standardization procedures were conducted prior and throughout the data collection period.

A dietary survey was also carried out among 68 families from the two villages by associating an interview with the householder and direct weighing of the food ingested the previous day (24 hr recall method). Data on food habits and food intake of the population were then obtained (Jelliffe 1968). Food composition tables for Latin America (Leung & Flores 1970) were used for food analysis, energy and nutrient requirements being determined according to the recommendations of the mixed committee FAO/WHO (1985, 1991).

Socioeconomic survey - A standardized questionnaire was applied door to door in the dwellings of the village. The following variables were considered: labor activity (occupation) of the head of the family, occupation and place of birth of the patient and other members of the family, family budget, nature of water contact (recreational, domestic, professional and fording), location of the house in relation to the stream, social and sanitary conditions (level of schooling, occupation, housing quality, source of water and waste disposal).

Ethical considerations - We followed the recommendations of the World Health Organization and of the Declaration of Helsinki (1975) in terms of protecting the rights and well-being of the people studied. At the end of the study, all patients were informed about the results of the examinations performed and received appropriate recommendations, treatment and referrals.

Statistical analysis - Mantel-Haenszel chi-square was used to analyze the significance of the prevalence ratio among groups (Hennekens & Buring 1987) and the chi-square test (with Yate's correction or Fisher's exact) was employed to determine the differences between frequencies; p values less than 0.05 (5%) were considered to be statiscally significant; the software EPIINFO V. 6.03 was used to perform these analyses.

RESULTS

Age distribution of the population in both areas can be seen in Table I. In Tracunhaém, the overall prevalence of schistosomiasis was 58.7%. When the two villages are compared, it is noticed that although no statistical difference was found regarding prevalence rates (Table II), severe infection (>400 epg) predominated in Itapinassu (Table III). Ultrasound data showed severe pathological changes (periportal fibrosis, right liver lobe shrinkage, left lobe and spleen enlargements) mostly among patients from Itapinassu (population involved in agricultural activities). However, no statistical difference was found among patients from both areas (Table IV).

TABLE I

Age distribution of the populations (Tracunhaém, PE, Brazil) 1994

Age groups	Itapinassu		São Joaquim	
	No.	%	No.	%
0 - 4	16	11.6	19	20.9
5 - 9	16	11.6	13	14.3
10 - 14	23	16.7	13	14.3
15 - 19	16	11.6	15	16.5
20 - 34	22	15.9	15	16.5
35 - 49	25	18.1	10	11.0
> 50	19	13.8	6	6.6
Unknown	1	0.7	0	0.0
Total	138	100.0	91	100.0

TABLE II

Prevalence rates of schistosomiasis in the two villages (Tracunhaém, PE, Brazil) 1994

Village	Positive for *Schistosoma mansoni*	Inhabitants	Prevalence (%)
Itapinassu	77	125	61.6
São Joaquim	45	83	54.2
Total	122	208	58.7

Prevalence ratio = 1.13; CI 95% = (0.89;1.44); X^2_{M-H} = 0.97; p = 0.32

TABLE III

Intensity of *Schistosoma mansoni* infection in the two villages (Tracunhaém, PE, Brazil)

Faecal egg output	Itapinassu		São Joaquim	
	No.	%	No.	%
0 - 100	34	44.2	35	77.8
101 - 400	16	20.8	4	8.9
>400	27	35.1	6	13.3
Total	77	100.0	45	100.0

X^2=13.08; p<0.01

TABLE IV

Ultrasound examination

Pathological changes	Itapinassu (104 patients)	São Joaquim (89 patients)	p value
Periportal fibrosis			
Grade 0	51	46	
Grade I	46	43	>0.05[a]
Grade II	6	0	
Grade III	1	0	
Right lobe shrinkage	3	0	>0.05[b]
Left lobe enlargement	46	28	>0.05[a]
Splenomegaly	6	1	>0.05[b]

a: Chi-square test (Yates corrected)
b: Chi-square test (Fisher exact)

Since the prevalence rates of infection and the occurrence of clinical forms of schistosomiasis did not differ between the studied villages, they will be jointly analyzed from now on.

Regarding the prevalence of schistosomiasis, statistically significant association was found with age, sex, local live standing (residing in the target area for more than five years), frequency of water-contact (daily), fishing, laundering, distance from the infected stream (less than 10 m) and lack of sanitation (cesspools). On the other hand, no association was found with origin of the patient (local, from other endemic areas, from non-endemic areas), literacy, domestic watering, fording contacts with infected waters, field activities (agriculture), type of activity (occupation), family budget, type of dwelling, waste disposal and eosinophilia (Table V).

The association among intensity of infection (egg burden) and age, domestic watering, fording contacts, fishing, type of activity and distance from the infected stream was statistically significant and the complete figures of the studied variables are shown in Table VI.

The prevalence of moderate or severe undernutrition in patients under 18 years old was 21.9% in Itapinassu and 24.1% in São Joaquim, much higher than the expected 3%, according to the standard values. In this group, an association was found between prevalence of schistosomiasis (Table VII) and chronic undernutrition, although an association between malnutrition and egg burden could not be detected. Similarly, for patients over 18 years old, the prevalence of undernutrition reached 22.8% in Itapinassu and 26.4% in São Joaquim, again surpassing the value of 20% expected for populations of low income level in northeastern Brazil. In this group, however, no association between nutritional status and either prevalence of schistosomiasis or parasite burden was detected.

The survey on food consumption detected energy deficiency as well as vitamin A and riboflavin deficiencies as the most severe nutritional problems in both communities. Most of the families did not attain food adequacy, mainly at the village of São Joaquim. Energy/lipids index (proportion of energy afforded by dietary lipids) was below the range of 20-30% recommended by FAO/OMS. NDp Cal % (proportion of energy from dietary protein) was surprisingly above the recommendations (6-8% of the dietary energy intake).

No family reached an adequate intake of vitamin A, ingesting less than 50% of the recommended dietary allowances (Table VIII).

DISCUSSION

Although there has been important local sucess in the control of schistosomiasis in countries such as China, Brazil, Penha Island and Tanzania, the infection has increased during the last decade (WHO 1993), partly due to irrigation projects and partly to migration. On the other hand, migration of rural populations into urban areas led schistosomiasis to become an important public health problem in large cities of endemic countries (WHO 1985).

TABLE V

Behaviour of the studied variables concerning prevalence of *Schistosoma mansoni* infection (Tracunhaém, PE, Brazil) 1994

Variables	Analysis	p value
Age	c2 =28.15; df=4	<0.01
Sex (M/F)	Prevalence ratio=1.31 (1.05;1.65)[a]	<0.05
Local live standing	Prevalence ratio=1.77 (1.30;2.42)[a]	<0.01
Frequency of water-contact	Prevalence ratio=1.64 (1.15;2.33)[a]	<0.01
Fishing	Prevalence ratio=1.83 (1.56;2.13)[a]	<0.01
Laundering	Prevalence ratio=1.32 (1.06;1.66)[a]	<0.05
Distance from infected stream	Prevalence ratio=1.35 (1.07;1.70)[a]	<0.05
Lack of sanitation	c2=9.33; df=3	<0.05
Origin of the patient	c2=1.45; df=2	>0.05
Literacy	Prevalence ratio=0.97 (0.79;1.19)[a]	>0.05
Domestic watering	Prevalence ratio=1.23 (0.97;1.57)[a]	>0.05
Fording contacts	Prevalence ratio=1.22 (0.97;1.53)[a]	>0.05
Field activities	Prevalence ratio=1.07 (0.62;1.85)[a]	>0.05
Type of activity	c2=5.1; df=4	>0.05
Family budget	Prevalence ratio=1.24 (0.98;1.58)[a]	>0.05
Type of dwelling	c2=3.29; df=2	>0.05
Waste disposal	c2=2.02; df=2	>0.05
Eosinophilia	Prevalence ratio=1.18 (0.95;1.47)[a]	>0.05

a: 95% confidence intervals

TABLE VI

Behaviour of the studied variables concerning intensity of *Schistosoma mansoni* infection (Tracunhaém, PE, Brazil) 1994

Variables	Analysis	p value
Age	c2=11.99; df=4	<0.05
Domestic watering	Prevalence ratio=2.08 (1.45;3.00)[a]	<0.01
Fording contacts	Prevalence ratio=2.17 (1.36;3.45)[a]	<0.01
Fishing	Prevalence ratio=2.31 (1.63;3.27)[a]	<0.01
Type of activity	c2=14.41; df=4	<0.01
Distance from infected stream	Prevalence ratio=2.10 (1.31;3.34)[a]	<0.01
Sex (M/F)	Prevalence ratio=0.81 (0.54;1.21)[a]	>0.05
Local live standing	Prevalence ratio=1.44 (0.80;2.57)[a]	>0.05
Origin of the patient	c2=0.67; df=2	>0.05
Literacy	Prevalence ratio=0.86 (0.56;1.32)[a]	>0.05
Frequency of water-contact	Prevalence ratio=1.61 (0.79;3.27)[a]	>0.05
Laundering	Prevalence ratio=1.13 (0.74;1.73)[a]	>0.05
Field activities	Prevalence ratio=0.92 (0.31;2.74)[a]	>0.05
Family budget	Prevalence ratio=1.45 (0.92;2.29)[a]	>0.05
Waste disposal	Prevalence ratio=1.35 (0.85;2.14)[a]	>0.05
Lack of sanitation	c2=2.31; df=3	>0.05
Eosinophilia	Prevalence ratio=1.02 (0.79;1.31)[a]	>0.05
Clinical form	Prevalence ratio=1.18 (0.73;1.91)[a]	>0.05

a: 95% confidence intervals

TABLE VII

Overall prevalence of *Schistosoma mansoni* infection according to the nutritional status (height/age index), in patients under 18 years old (Tracunhaém, PE, Brazil)

S. mansoni infection	Undernourished	Normal	Total	Prevalence rates of undernutrition (%)
Positive	28	23	51	54.9
Negative	18	35	53	34.0
Total	46	58	104	44.2

Prevalence ratio= 1.62; CI: (95%) (1.03; 2.54); p<0.05

TABLE VIII

Percentage distribution of 68 studied families, according to the adequacy levels of intake for calories and nutrients (Tracunhaém, PE, Brazil) 1994

Calories and nutrients	Recommended dietary allowances									
	<25%		25-50%		50-75%		75-100%		>100%	
	Itap.	SJ	Itap.	SJ	Itap.	SJ	Itap.	SJ	Itap.	SJ
Calories	2.4	-	11.9	15.4	42.8	46.2	31.0	26.9	11.9	11.5
Proteins (g)	2.4	-	-	3.8	14.3	7.7	4.7	7.7	78.6	80.8
Calcium (mg)	4.8	11.5	21.4	30.8	26.2	19.2	14.3	15.4	33.3	23.1
Iron (mg)	2.4	3.9	4.8	19.2	7.1	30.8	23.8	11.5	61.9	34.6
Vit.A-retinol (mcg)	85.7	92.3	14.3	7.7	-	-	-	-	-	-
Vit.B1-thiamine (mg)	2.4	3.8	2.4	30.8	38.0	34.6	28.6	15.4	28.6	15.4
Vit.B2-riboflavin (mg)	11.9	7.7	40.5	57.7	30.9	19.2	11.9	3.9	4.8	11.5
Vit.B6-niacin (mg)	7.1	7.7	16.7	23.1	31.0	26.9	19.0	30.8	26.2	11.5
Vit.C (mg)	16.7	30.7	26.2	15.4	23.8	15.4	4.7	15.4	28.6	23.1

Itap.: Itapinassu; SJ: São Joaquim

It is well known that ecological and socioeconomic factors play a fundamental role in human schistosomiasis (Warren 1973, Jordan & Webbe 1982, Huang & Manderson 1992, WHO 1993). As a behavioural disease, schistosomiasis infection displays complex interactions between human behaviour, social and economic organization, public health provisions and, in some endemic areas, cultural understandings of the nature and cause of the disease (Huang & Manderson 1992).

Age, as expected and as observed in most schistosomiasis surveys, is a major determinant of schistosomiasis infection, older children being at the highest risk of infection (Sama & Ratard 1994). These authors studied a population of an African town in order to quantify the potential risk of schistosome infection from the activities involving water contact, trying also to identify behavioural or socio-cultural factors that increased the risk of infection. Marçal Junior et al. (1993), showed that risk factors for *S. mansoni* infection in a low endemic area were very similar to the factors described in other Brazilian areas.

The association of sex with infection is at times contradictory, and its value in predicting risk of infection is poor. In general, however, occupational, economic and other activities are useful indicators of risk (Huang & Manderson 1992). In the present study male sex was associated with prevalence, but not with intensity of *S. mansoni* infection.

The relationship between socioeconomic situation and the risk of *S. mansoni* infection has been emphasized in the literature. Barbosa (1966), in a study carried out in the State of Pernambuco, observed that *S. mansoni* infection was related to the patient activity, to the quality of housing or to the absence of a cesspool in the dwelling. Barreto (1991) and others also showed that several social, environmental, and behavioural variables are strongly associated with the prevalence and intensity of *S. mansoni* infection. A number of publications indicate the association between occupation and prevalence of *Schistosoma* infection. In the present study, only association with intensity of infection was detected.

A study carried out in Brazil (Lima e Costa et al. 1987) concluded that the rate of infection was significantly higher in people living in houses or dwellings without piped water.

Water contact studies provide the most extensive data on behavioural and social aspects of schistosomiasis infection (Blumenthal 1985) and indicate the complex ways in which such sociological variables as age, gender, occupation, industry, and patterns of settlement constitute risk factors of infection. Studies carried out in Brazil (Lima e Costa et al. 1987, Mota & Sleigh 1987) indicate that the risk of being infected may vary with activity, duration of exposure, extent of body-surface exposed and time of the day. Observations recently published by Fulford et al. (1996) on the relative importance of exposure and resistance to infection in determining the detected age-intensity patterns of schistosomiasis among Kenyan communities, point to the variability of patterns of water contact even between rather culturally similar communities, contact usually peaking in the second decade of life, females (especially young women) spending more time at the water than males.

A spontaneous reduction in prevalence of schistosomiasis mansoni was detected in hyperendemic areas of Brazil, following the provision of adequate water and the construction of toilets and bathrooms (Kloetzel & Schuster 1987).

The epidemiological features of contamination in both villages of the study area were the same, so the predominance of severe infection in Itapinassu (>400 epg) could be explained by differences in occupation resulting in higher exposure for those working in agriculture. It is widely accepted that morbidity related to schistosomiasis appears in only a small proportion of the infected populations, mostly those harbouring heavy worm loads (Arap Siongok et al. 1976). In this study, no association was found between parasite burden and severity of the disease when the two villages were jointly analyzed. It is possible that the population size in our study is limiting the validation of some hypotheses by statistical tests. However, other factors inherent to the population may be interfering on the results, such as nutritional status, genetic background, etc.

There is some indication that persons with high intensities of infection will have some reduction in their work capacities (El Karim 1986). In a study carried out in northeastern Brazil (Barbosa & Costa 1981), sugar cane cutters bearing hepatosplenic form of schistosomiasis were found to have 35.1% less productivity (in terms of earnings) than those with the less severe intestinal clinical form of the disease.

Schistosomiasis is sustained throught the synergy of humans, vector and environment.

Although a relationship has been demonstrated between intensity of infection and morbidity in schistosomiasis due to *S. mansoni,* the contribution of other factors including nutritional status is still poorly understood.

It seems clear, on biological, epidemiological and statistical grounds, that wasting (acute malnutrition) and stunting (chronic malnutrition) represent different processes of malnutrition. Wasting indicates a deficit in tissue and fat mass compared with the amount expected in a child of the same height, and may result either from failure to gain weight or from actual weight loss, infections being a precipitating factor. Stunting signifies slowing in skeletal growth and is frequently associated with chronic or repeated infections, as well as inadequate nutrient intake (WHO 1986).

The existence of an association between nutritional status and schistosomiasis is still not clear. Several studies have tried to correlate the nutritional status of the host with prevalence/intensity of infection (Coutinho 1976, 1980, Stephenson 1986, Coutinho et al. 1992, Ferreira et al. 1993) or severity of clinical manisfestations in schistosomiasis (De Witt et al. 1964, Coutinho et al. 1972, Akpon & Warren 1975, Akpom 1982, Stephenson 1993, Sturrock et al. 1996). Conflicting results may be due to differences in local epidemiological features and in part, to different methodologies (Costa et al. 1988, Proietti et al. 1992). The prevalence of moderate or severe undernutrition in patients under 18 years old was 21.9% in Itapinassu and 24.1% in São Joaquim, much higher than the expected 3% (WHO 1983). In this group an association was found between prevalence of schistosomiasis and chronic undernutrition.

The determination of the Body Mass Index in epidemiological studies has been recommended for anthropological measurement in adults (Smalley et al. 1990). By using this index it was found that, for patients over 18 years old, the prevalence of undernutrition was higher than the expected 20% rate found in northeastern Brazil, by the way, the highest prevalence in the country (INAN 1991). However, in this case no association between nutritional status and either prevalence of schistosomiasis or parasite burden (fecal egg output) could be detected.

Dietary intake of the populations and "food safety" (available food for a healthy life of all family members) in the worked localities was low. Energy, vitamin A and riboflavin intakes were the main deficiencies detected in both communities and most of the families did not reach the recommended dietary allowances. The lowest values for food intake were found in São Joaquim. The values obtained for lipid energy rates were low and according to the low intake of free lipids. NDp Cal % (percentage of calories from utilized protein) was adequate or even high in most families, suggesting that the ingested protein probably is not being conveniently utilized to replace the body stores, being rather used to supply energy expenditure, since energetic deficiency was detected in families of the two communities. Again, regarding micronutrients, almost all of them were below the recommended dietary allowances (WHO 1991). Vitamin A, for example, had very low intakes in both localities and no family reached even 50% of its recommended allowance.

A cross-sectional study on the nutritional status of schoolchildren with schistosomiasis and geohelminth infection carried out in Salvador (State of Bahia, northeastern Brazil) by Parraga et al. (1996) detected chronic malnutrition with linear stunting in 21% of the children as a whole and concluded that light or moderate intensity infection with *S. mansoni* may contribute to growth deficits.

In patients under 18 years old the prevalence of schistosomiasis was higher in the undernourished. The reasons why we could not demonstrate a similar association concerning intensity of infection and/or for the group of over 18 years old, was likely ascribed to the small population dealt with. In the present study, the nutritional status could have been affected by schistosomiasis infection or even act as one of the risk factors for the infected population.

Anyway, as all known control measures so far used have not proven to be able to erradicate but rather temporarily reduce prevalence and morbidity rates of schistosomiasis in Brazil, improvement of the nutritional status of infected populations could be a valuable complementary measure to improve health of communities in endemic areas, enabling them to overcome not only the effects of *S. mansoni* but also of concomitant geohelminth infections usually prevalent in regions of low socioeconomic level.

Currently, after treatment for schistosomiasis, prospective studies are in progress in an effort to identify the relative role of each factor involved in the eventual infection, leading to a proposal of an integrated model for local control of the disease.

ACKNOWLEDGEMENTS

To Dr Ubiracy Guida, head of Schistosomiasis Control Program of the National Health Foundation, for technical support of the project; to the staff of our field station at São Lourenço da Mata (State of Pernambuco) for technical support during the field activities; to Rosilda Oliveira and Leopoldina Siqueira (Dept. of Nutrition-Health Sciences Center, Federal University of Pernambuco) for help in conducting the dietary survey; to Sheila de Oliveira, Giselle Camponzana and Kirte Teixeira, for technical assistance during the work; and to Simone Santos for secretarial assistance. To Prof. Frederico Simões Barbosa for critical review of the manuscript and valuable suggestions.

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