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THE EFFECT OF SCHISTOSOMA MANSONI INFECTION ON CHILD MORBIDITY IN THE STATE OF BAHIA, BRAZIL

I — ANALYSIS AT THE ECOLOGICAL LEVEL (*)

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SUMMARY

This investigation was carried out in 10 small towns of the State of Bahia (Northeastern Brazil). The objective was to study the correlations between the prevalences of liver and spleen enlargment in different areas and the prevalence and intensity of **Schistosoma mansoni** infection in the same areas. Our conclusions are that: a) schistosomiasis mansoni morbidity (prevalences of hepatomegaly and splenomegaly) was directly correlated to the prevalence and intensity of infection; b) the intensity of infection of a community is a good indicator of morbidity and explain the morbidity variation between areas better than the prevalence of infection; c) the prevalence of splenomegaly and the mean size of the liver in the mid-sternal line appear to be good indicators of the **S. mansoni** prevalence and intensity of infection in a community. Our conclusions raised the possibility of construction of definitive regressions equations between indicators of morbidity and indicators of infection, so that the value of one could be used to predict the other.

INTRODUCTION

A strong relationship between intensity of infection with **Schistosoma mansoni** and morbidity has been demonstrated in several populations. This phenomenon is clearest in children in hiperendemic areas [1,4,5,12,14,20,21]. This led to the hypothesis that morbidity would vary between areas with differents prevalences and intensities of infection. This hypothesis has been accepted, but not studied with adequate methodology [9,10].

This investigation was designed to study this question in more detail. It focuses on hepatomegaly and splenomegaly, the most important signs of morbidity from schistosomiasis mansoni infection [5].

POPULATION AND METHODS

This study was carried out in the State of Bahia, in the Northeastern Region of Brazil. This State has an area of 559.921 square kilometers and a population of around 10 million inhabitants [3]. The incidence of malaria has been low in the State in the recent years, and most of the cases were either imported or in isolated focus.

The State has been divided into 26 Homogenous Microregions (MRH) by the National Institute of Geography and Statistics (FIBGE). Each of these MRH include several municipalities.

Previous surveys demonstrated that there was a large variation in the prevalence of **S. mansoni** infection in this State, from hyperendemic

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to parasite-free areas[7,19]; an ideal situation to testing the hypothesis.

Children between 5 and 16 years old were studied in ten differents small towns of the State (Fig. 1). A four-stage random sample scheme was employed. In the first stage 10 MRH were selected; in the second one municipality in each MRH; in the third one town, with a population of 500 to 2000 inhabitants, in each municipality; and at the fourth stage, after a census, 25% of the population between 5 and 16 years old were selected. This resulted in a sample of 978 children with complete data on 840 (86.3%).

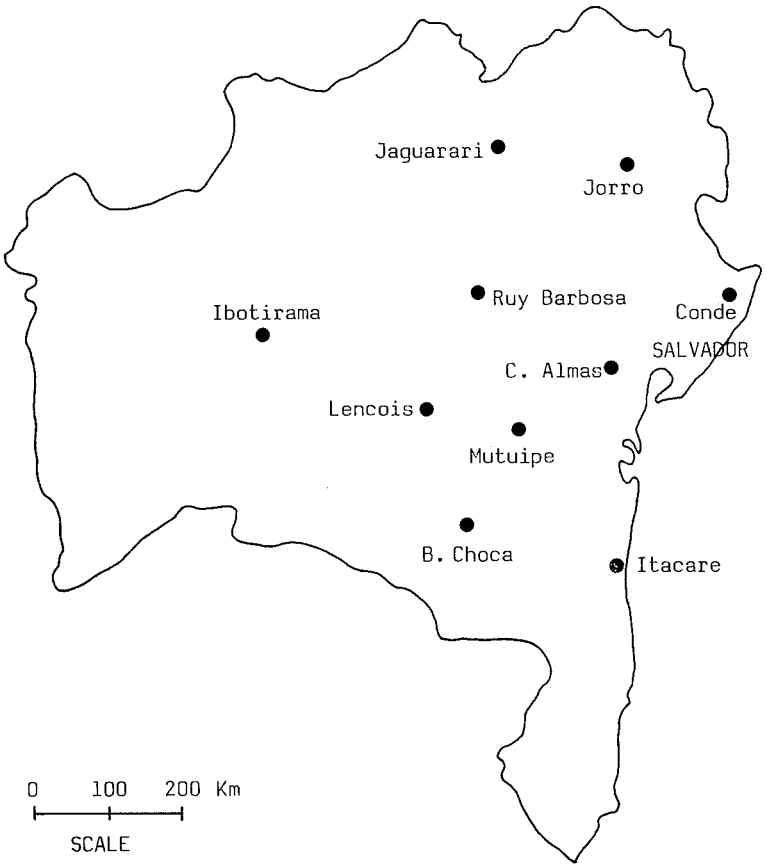

Fig. 1 — Map of the State of Bahia showing the location of 10 sample towns

Stool Examination

Each children was provided with one previously identified cup for colection of a faecal sample. From each sample two thick smears were prepared, using the Kato technique as modified by KATZ et al.[11]. A commercially-available kit was used (Boehringer Mannheim Bioquimica S.A., Rio de Janeiro, Brazil).

Physical Examination

Individuals were examined for liver and spleen enlargment in the supine position. If the liver was palpated, the distance between the liver edge and the right costal margin was measured in the midclavicular line (MCL) and from the xiphoid in the midsternal line (MSL). If the spleen was palpated, the distance from the left costal margin to the spleen edge was measured in the anterior axilary line. The examination were performed without knowledge of the stool results. Hepatomegaly was defined as being present when the liver was palpable more than 2.5 centimeters below the costal margin and splenomegaly was defined as

being present whenever the spleen was palpable.

Variables

For each town were calculated: a) the prevalence of **S. mansoni** infection (X_1); b) the intensity of infection in all children examined (X_2) (the geometric mean of eggs per gram of stool in all children examined was calculated, meanwhile 1.0 was added to each egg count to avoid values zero in the calculation of logarithms); c) the prevalence of hepatomegaly (Y_1); d) the prevalence of splenomegaly (Y_2); e) the mean size of the liver below the right costal margin in the MSL (Y_3); f) the mean size of the liver below the xiphoid in the MCL (Y_4).

Regression equations were computed with X_1 and X_2 as the independent and Y_1, Y_2, Y_3 and Y_4 as the dependent variables. Correlation coeficients (r) and determination coeficients (r^2) were also computed. The **p** values were computed using a one-sided **t** test [17].

RESULTS

The number of children examined in each town and the value of the several variables are presented in Table I. The prevalence of **S. mansoni** ranged from 0 to 81.7%, while the intensity of infection ranged from 0 to 55 eggs per gram of stool. Similarly, all the other variables varied considerably between areas.

Figures 2 and 3 present a summary of the analysis. The intensity of infection (X_2) was significantly associated with all the dependent variables. The correlation between X_1 (prevalence of **S. mansoni** infection) and the outcome variables were statistically significant for Y_2, Y_3 and Y_4, but not quite statistically significant for Y_1 ($r=0.543$, $p=0.052$), although it was in the expected direction and of reasonable magnitude.

For every outcome variable, the association with the intensity of infection was stronger than for prevalence. The prevalence of splenomegaly (Y_2) and the mean size of the liver in the MSL (Y_3) gave the highest correlation coefficients as well as determination coefficients with both independent variables.

The intensity of infection (X_2) in the town of Conde was much higher than in any other (Table I, Fig. 2). If this town's results was excluded from the analysis only the correlation of Y_2 with X_2 remain statistically significant ($Y_2 = 1.73 + 0.25\ X_2$, $r = 0.781$, $r^2 = 0.610$, $t = 3.54$, $p = 0.005$), however the other variables' correlations remained in the same direction and of reasonable magnitude ($r = 0.471$, 0.532, 0.386 respectivelly for Y_1, Y_3 and Y_4).

DISCUSSION

Schistosoma mansoni is an important cause of morbidity in infected population and because of this the need for its control has been

T A B L E I

Values of the basic variables in each of the 10 studied towns of the State of Bahia, Brazil

Municipality	No. Examined	X_1	X_2	Y_1	Y_2	Y_3	Y_4
Ibotirama	96	0.0	0.0	21.0	2.5	1.17	0.86
Itacare	82	4.3	1.2	23.7	0.0	1.06	0.78
Barra do Choca	33	10.5	1.5	12.3	1.3	0.59	0.63
Rui Barbosa	75	31.6	4.4	21.1	5.3	1.57	0.93
Cruz das Almas	94	41.8	4.4	34.2	5.1	2.06	0.54
Mutuipe	88	49.0	10.8	10.6	2.2	0.86	0.45
Jaguarari	87	60.0	34.4	30.6	11.8	1.78	0.51
Jorro	62	71.4	26.1	43.5	11.4	2.28	1.55
Conde	92	77.9	55.7	55.2	13.5	3.37	1.99
Lencois	81	81.7	25.0	21.5	3.3	1.46	1.63

X_1 — Prevalence of **S. mansoni** infection (%)
X_2 — Intensity of **S. mansoni** infection (Geom. mean of eggs/g of stool)
Y_1 — Prevalence of hepatomegaly (%)
Y_2 — Prevalence of splenomegaly (%)
Y_3 — Mean size of the liver in MSL (cm.)
Y_4 — Mean size of the liver in MCL (cm.)

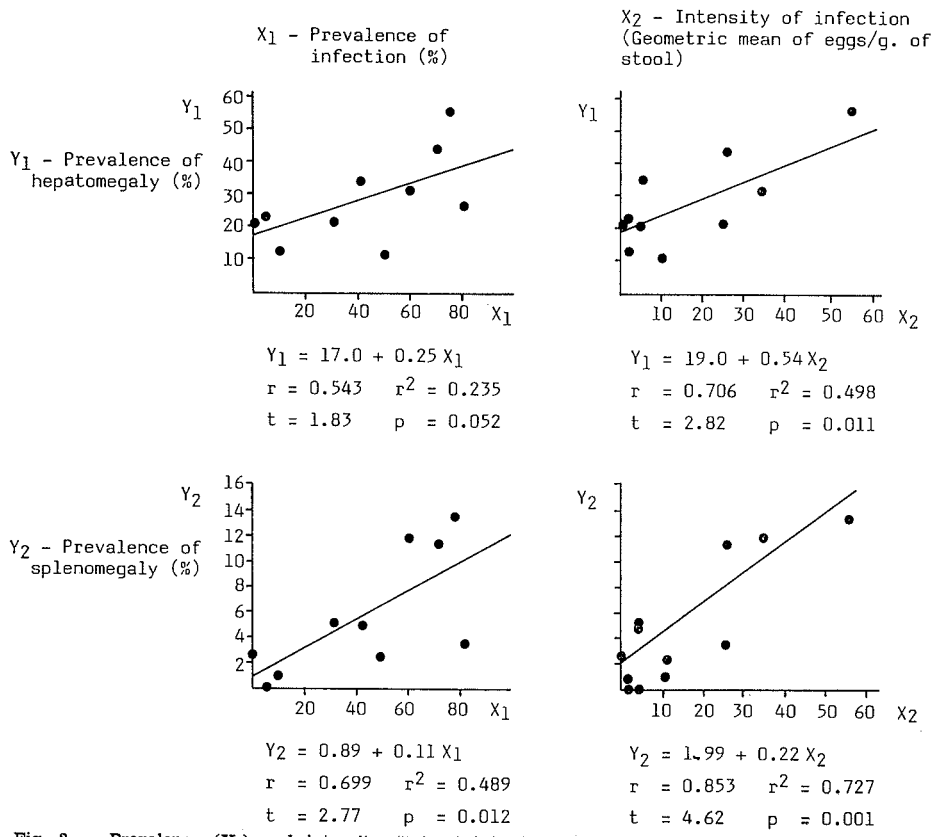

Fig. 2 — Prevalence (X_1) and intensity (X_2) of infection by **S. mansoni** correlated with the prevalence of hepatomegaly (Y_1) and prevalence of hepatomegaly (Y_2) in 10 towns. Bahia, Brazil

stressed [23]. However the implementation of effective control measures has proved difficult, especially in large developing countries such as Brazil [18].

Brazil has large regional and local variations in infection rates [7,19]. The reasons for these variations are in general related with characteristics of the focus [1] and the frequency of the human contact with the focus [1,6,8,16]. However, the most important factor — at least in Brazil — seems to be the directions of populations movements in the country's history [2,15].

In the present study we have documented that: a) schistosomiasis mansoni morbidity (prevalences of hepatomegaly and splenomegaly) in children in different areas of Bahia, Brazil, was directly correlated to the prevalence and intensity of infection with the **S. mansoni**; b) the intensity of infection is a good indicator of morbidity and explains the variation in morbidity better than the prevalence of infection; c) the prevalence of splenomegaly and the mean size of the liver in the MSL appear to be good indicators of the **S. mansoni** prevalence and intensity of infection in a community.

Our conclusions raised the possibility of construction of definitive regression equations between indicators of morbidity and indicators of infection, so that the values of one could be used to predict the other. The fact that we study only few areas was possible responsible for some of the irregularites in our analysis, such as the problem of the value of the intensity of infection in the town of Conde. However, the constant high values of the correlation and determination coefficients were stongly sugestive that the occasional absence of statistically signifficant correlations, were due the small number of areas studied.

Since KLOTZEL [12] observed the relationship between the intensity of **S. mansoni** infection and morbidity, it has been possible to consider the control of morbidity at an individual level,

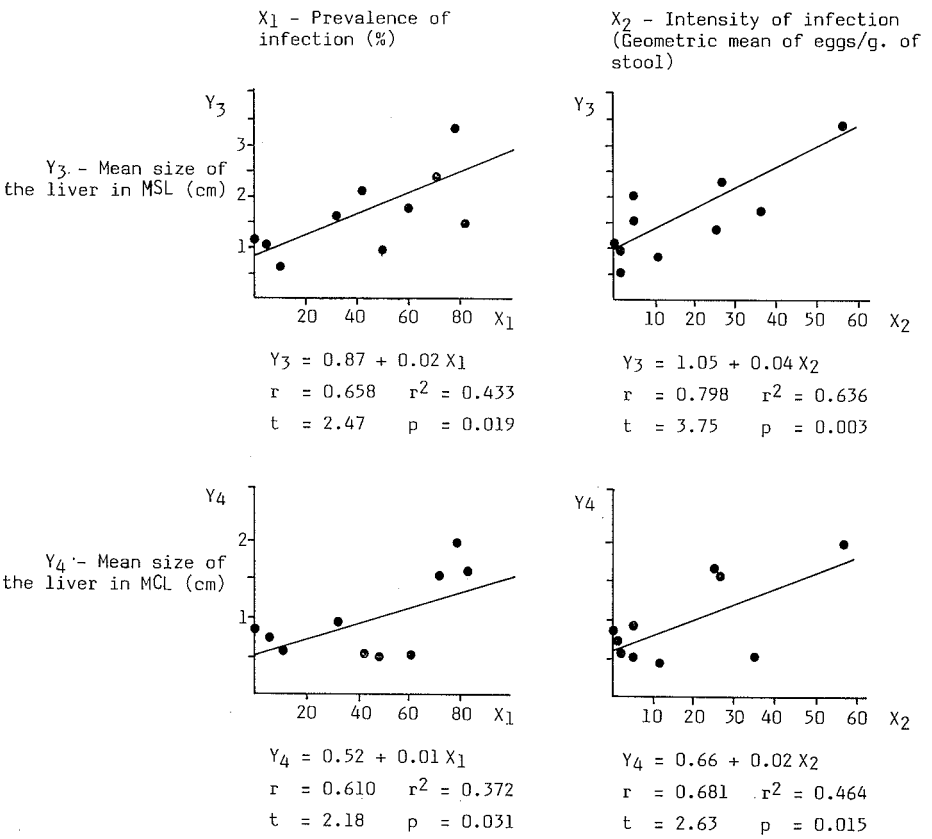

Fig. 3 — Prevalence (X_1) and intensity (X_2) of infection by **S. mansoni** correlated with the mean size of the liver in MSL(Y_3) and in MCL(Y_4) in 10 towns. Bahia, Brazil

by the selective treatment of persons with high infection load [13,22]. However, the definition of a community level of prevalence and intensity of infection represents more than the dinamics of infection in the community, because, as was demonstrated here and elsewhere [4,9,10], they also reflect the general level of morbidity. This enables one to think about of the prevention of the schistosomiasis morbidity and stresses the importance of measures to decrease, in permanent basis, the prevalence and infection when control of transmission is not possible. The results reported here suggest that actions directed towards a reduction in the prevalence and especially in the intensity of infection will be benefical in diminishing morbidity in the population.

RESUMO

O efeito da infecção por Schistosoma mansoni **na morbidade infantil no Estado da Bahia, Brasil. I — Análise do nível ecológico**

Esta investigação foi levada a efeito em 10 pequenas cidades do Estado da Bahia (Nordeste do Brasil), escolhidas através de um processo amostral. O objetivo foi estudar as correlações entre as prevalências de hepatomegalia e esplenomegalia, em diferentes áreas, com a prevalência e a intensidade da infecção pelo **S. mansoni** nas mesmas áreas. Nossas conclusões são: a) a morbidade esquistossomótica (prevalências de hepatomegalia e esplenomegalia) foi diretamente correlacionada com a prevalência e a intensidade da infecção; b) a intensidade da infecção (medida pelo número de ovos nas fezes) mostrou ser um bom indicador do grau de morbidade, explicando a variação da morbidade entre as áreas melhor que a prevalência da infecção; c) a prevalência de esplenomegalia e o tamanho médio do fígado abaixo do rebordo costal na linha mediosternal são bom indicadores da prevalência e da intensidade da infecção pelo **S. mansoni** na comunidade. Nossas conclusões trazem

a possibilidade da construção de equações de regressão definitivas entre indicadores de morbidade e indicadores de infecção, de tal forma que o valor de um possa ser usado para predizer o valor do outro.

REFERENCES

1. BARBOSA, F. S. — Morbidade da Esquistossomose. **Rev. Bras. Malariol. Doenças Trop. (Especial issue)** 3-159, 1966.

2. BARRETO, M. L. — **Esquistossomose Mansônica. Distribuição da Doença e Organização Social do Espaço.** [MSc. Thesis, Federal University of Bahia, Salvador, 1982].

3. BRASIL. SEPLAN. FIBGE. — **Tabulações avançadas do Censo Demográfico. IX Recenseamento Geral do Brasil**, 1980. Vol. 1, Tomo 2, Rio de Janeiro, 1981.

4. CHEEVER, A. W. — A quantitative post morten study of schistosomiasis mansoni in man. **Am. J. Trop. Med. Hyg. 17:** 38-64, 1968.

5. COOK, J. A.; BAKER, S. T.; WARREN, K. S. & JORDAN, P. — A controlled study of morbidity of schistosomiasis mansoni in St. Lucia children, based on quantitative egg excretion. **Am. J. Trop. Med. Hyg. 23:** 625-636, 1974.

6. DALTON, P. — A socio-ecological approach to the control of **Schistosoma mansoni** in St. Lucia. **Bull. Wld. Hlth. Org. 54:** 587-595, 1976.

7. FREITAS, C. A. — Situação atual da esquistossomose no Brasil. **Rev. Bras. Malariol. Doenças Trop. 24:** 3-63, 1972.

8. HUSTING, E. L. — Sociologicial patterns and their influence on the transmission of bilharziasis. **Centr. Afr. J. Med. 16:** 5-10, 1970.

9. JORDAN, P. — **Schistosomiasis and Disease.** In: MILLER, M. J. (ed.). **Proceedings of a Symposium on the Future of Schistosomiasis Control.** New Orleans, Tulane University, 1972, pp. 17-23.

10. JORDAN, P. & WEBBE, G. — **Epidemiology.** In: JORDAN, P. & WEBBE, G. (eds.). **Schistosomiasis. Epidemiology, Treatment and Control.** London, Heineman, 1982, pp. 227-292.

11. KATZ, N.; CHAVES, A. & PELLEGRINO, J. — A simple device for quantitative determination of **S. mansoni** eggs in faeces examined by the thick-smear technique. **Rev. Inst. Med. trop. São Paulo 14:** 397-400, 1972.

12. KLOTZEL, K. — Splenomegaly in schistosomiasis mansoni. **Am. J. Trop. Med. Hyg. 11:** 472-476, 1962.

13. KLOTZEL, K. — "Selective" chemotherapy for schistosomiasis mansoni. **Trans. R. Soc. Trop. Med. Hyg. 69:** 344, 1974.

14. LEHMAN, J. S.; MOTT, K. E.; MORROW, R. H.; MUNIZ, T. M. & BOYER, M. H. — The intensity and effects of infection with **Schistosoma mansoni** in a rural community in Northeast Brazil. **Am. J. Trop. Med. Hyg. 25:** 285-294, 1976.

15. LIMA, E. C. — Expansão da esquistossomose mansônica nos Estados de São Paulo e Paraná, face aos movimentos migratórios. **An. Fac. Med. Univ. Fed. Paraná 9/10:** 93-112, 1966-1967.

16. LOUREIRO, S. — **Schistosomiasis mansoni in children — an epidemiological study of patterns of water exposure using path analysis.** [PhD Thesis, University of Texas, Huston, 1978].

17. MUELLER, J. H.; SCHUESSLER, K. F. & COSTNER, H. L. — **Statistics Reasoning in Sociology.** Boston, Houghton Mifflin, 1970.

18. PAULLINI, E.; FREITAS, C. A. & AQUIRRE, G. H. — Control of schistosomiasis in Brazil. In: MILLER, M. J. (ed.). **Proceedings of a Symposium on the Future of Schistosomiasis Control.** New Orleans, Tulane University, 1972, pp. 104-110.

19. PELLON, A. B. & TEIXEIRA, I. — **Distribuição da Esquistossomose Mansônica no Brasil.** Rio de Janeiro, Divisão de Organização Sanitária, 1950.

20. PRATA, A. & BINA, J. C. — Development of the hepatosplenic form of schistosomiasis. **Gaz. Med. Bahia 68:** 49-60, 1968.

21. SIONGOK, T. K. A.; MAHMOUD, A. A. F.; OUMA, J. H.; WARREN, K. S.; MULLER, A. S.; HANDA, A. K. & HOUSER, H. B. — Morbidity of schistosomiasis mansoni in relation to intensity of infection: study of a community in Machakos. Kenya. **Am. J. Trop. Med. Hyg. 25:** 273-284, 1976.

22. WARREN, K. S. & MAHMOUD, A. A. F. — Targeted mass treatment: a new approach to the control of schistosomiasis. **Trans. Ass. Amer. Phys. 89:** 195-202, 1976.

23. WORLD HEALTH ORGANIZATION — Schistosomiasis control. **Tech. Rep. Series,** Number 515, Geneva, 1973.

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