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 enlargement 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 hyperendemic areas. This led to the hypothesis that morbidity would vary between areas with different prevalences and intensities of infection. This hypothesis has been accepted, but not studied with adequate methodology.

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.

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. 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; an ideal situation to testing the hypothesis.

Children between 5 and 16 years old were studied in ten different 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%).

Stool Examination

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

Physical Examination

Individuals were examined for liver and spleen enlargement 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 axillary 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 (X₁); b) the intensity of infection in all children examined (X₂) (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 (Y₁); d) the prevalence of splenomegaly (Y₂); e) the mean size of the liver below the right costal margin in the MSL (Y₃); f) the mean size of the liver below the xiphoid in the MCL (Y₄).

Regression equations were computed with X₁ and X₂ as the independent and Y₁, Y₂, Y₃ and Y₄ as the dependent variables. Correlation coefficients (r) and determination coefficients (r²) 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 (X₂) was significantly associated with all the dependent variables. The correlation between X₁ (prevalence of S. mansoni infection) and the outcome variables were statistically significant for Y₂, Y₃ and Y₄, but not quite statistically significant for Y₁ (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 (Y₂) and the mean size of the liver in the MSL (Y₃) gave the highest correlation coefficients as well as determination coefficients with both independent variables.

The intensity of infection (X₂) 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 Y₂ with X₂ remain statistically significant (Y₂ = 1.73 + 0.25 X₂, r = 0.781, r² = 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 respectively for Y₁, Y₃ and Y₄).

DISCUSSION

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

<table>
<thead>
<tr>
<th>Municipality</th>
<th>No. Examined</th>
<th>X₁</th>
<th>X₂</th>
<th>Y₁</th>
<th>Y₂</th>
<th>Y₃</th>
<th>Y₄</th>
</tr>
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<tbody>
<tr>
<td>Ibotirama</td>
<td>96</td>
<td>0.0</td>
<td>0.0</td>
<td>21.0</td>
<td>2.5</td>
<td>1.17</td>
<td>0.86</td>
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<td>Itacare</td>
<td>82</td>
<td>4.3</td>
<td>1.2</td>
<td>23.7</td>
<td>0.0</td>
<td>1.06</td>
<td>0.78</td>
</tr>
<tr>
<td>Barra do Choca</td>
<td>33</td>
<td>10.5</td>
<td>1.5</td>
<td>12.3</td>
<td>1.3</td>
<td>0.89</td>
<td>0.63</td>
</tr>
<tr>
<td>Rui Barbosa</td>
<td>75</td>
<td>31.6</td>
<td>4.4</td>
<td>21.1</td>
<td>5.3</td>
<td>1.57</td>
<td>0.93</td>
</tr>
<tr>
<td>Cruz das Almas</td>
<td>94</td>
<td>41.8</td>
<td>4.4</td>
<td>34.2</td>
<td>5.1</td>
<td>2.06</td>
<td>0.54</td>
</tr>
<tr>
<td>Mutuipe</td>
<td>88</td>
<td>49.0</td>
<td>10.8</td>
<td>10.6</td>
<td>2.2</td>
<td>0.86</td>
<td>0.45</td>
</tr>
<tr>
<td>Jaguarari</td>
<td>87</td>
<td>60.0</td>
<td>34.4</td>
<td>30.6</td>
<td>11.8</td>
<td>1.78</td>
<td>0.51</td>
</tr>
<tr>
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<td>62</td>
<td>71.4</td>
<td>26.1</td>
<td>43.5</td>
<td>11.4</td>
<td>2.28</td>
<td>1.55</td>
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<td>Conde</td>
<td>92</td>
<td>77.9</td>
<td>55.7</td>
<td>55.2</td>
<td>13.5</td>
<td>3.37</td>
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<tr>
<td>Lençois</td>
<td>81</td>
<td>81.7</td>
<td>25.0</td>
<td>21.5</td>
<td>3.3</td>
<td>1.46</td>
<td>1.63</td>
</tr>
</tbody>
</table>

X₁ — Prevalence of S. mansoni infection (%)
X₂ — Intensity of S. mansoni infection (Geom. mean of eggs/g of stool)
Y₁ — Prevalence of hepatomegaly (%)
Y₂ — Prevalence of splenomegaly (%)
Y₃ — Mean size of the liver in MSL (cm.)
Y₄ — Mean size of the liver in MCL (cm.)
stressed. However, the implementation of effective control measures has proved difficult, especially in large developing countries such as Brazil.

Brazil has large regional and local variations in infection rates. The reasons for these variations are in general related with characteristics of the focus and the frequency of the human contact with the focus. However, the most important factor is the history of the area. In Brazil, it seems to be the vicinity of populations movements in the country's history.

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 irregularities 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 strongly suggestive that the occasional absence of statistically significant correlations, were due the small number of areas studied.

Since KLOTZEL 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.
by the selective treatment of persons with high infection load. However, the definition of a community level of prevalence and intensity of infection represents more than the dynamics of infection in the community, because, as was demonstrated here and elsewhere, they also reflect the general level of morbidity. This enables one to think about 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 beneficial 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 medio-external 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


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