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SEROEPIDEMIOLOGY OF SCHISTOSOMIASIS MANSONI

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In population surveys in which the Schistosoma mansoni *intensity of infection is low, or in localities where the schistosomiasis control program had success, the parasitologic methods lack in sensitivity. Despite of some limitations, the imunological methods are useful to provide valuable information in such field conditions. Thus, the prevalence of schistosomiasis in untreated population can be determined by the detection of IgG or IgM antibodies, as well as the incidence by the IgA antibodies, employing mainly immunoflurescence (IF) and immunoenzymatic (ELISA), and in some extent hemagglutination (HA) or even skin test. The true prevalence and incidence of schistosomiasis can be estimated using a probabilistic model equation, since knowing beforehand the sensitivity and specificity of employed test. The sensitivity and the specificity of serologic test become higher in low aged group, under 14. The geometric mean IF titers also gives a positive correlation with the intensity of infection. Presently, there are need of serologic tests which are economic and practical in seroepidemiologic inquiries, requiring no specilized personnel to collect population blood or serum samples, and also easily interpret the test results. The reagents for such tests are desired to be stable and reproducible. Moreover, it is expected that the tests can distinguish an ative infection.*

Key words: *Schistosoma mansoni* – seroepidemiology

Schistosomiasis mansoni is one of the major public health problems in many parts of developing countries. However, in communities in which the schistosomiasis control program had success, the intensity of infection or reinfection, the prevalence and the morbidity have significantly been reduced (Silveira, 1989; Bonesso et al., 1991).

To date, the parasitologic methods have been sensitive while applied in populations with high or moderate intensity of infection. Nevertheless, these methods have provided underestimate prevalences in populations with low intensity of infection (≤ 100 eggs/g feces), as well as in those living in endemic areas where the schistosomiasis control program is under evaluation (Yogore et al., 1983; Teesdale et al., 1985).

Thus, the immunologic tests are pointed out as helpful tools to be employed in the epidemiologic surveys in areas displaying such referred to features.

An array of immunologic tests was proposed for diagnostic purposes, as immunofluorescence (IF), immunoenzymatic (ELISA), circumoval precipitin (COP) and radioimmunologic (RI) tests, which detect circulating antibodies to *Schistosoma mansoni* (Mott & Dixon, 1982). Adding to these, there is the immediate intradermal (ID) test. Although some antigen-based immunologic tests are available (Ruppel et al., 1990), the currently practised tests are antibody-based for the diagnosis of either patients or populations.

To select an adequate test for seroepidemiologic studies, the following criteria are regarded as relevant: the test should be sensitive and specific but, practical and economic; the test result be easily interpreted; the reagent used in the test be stable and providing reproducible results; and the blood or serum samples be collected by simple procedures from the population.

In general, the immunologic or serologic tests are able to give prevalence estimates for schistosomiasis mansoni in untreated populations by the detection of IgG or IgM antibodies to parasite antigens. The incidence, in turn,

can be determined by the search for IgA antibodies to adult worm gut antigens (Kanamura et al., 1979), or by looking at the seroconversion in the second serum sample collected from those who had negative results in the first assay for IgM or IgG antibodies (Yogore Jr. et al., 1983). Moreover, the prevalence was shown to correlate with the geometric mean IF titers, in the age group under 13 years old (Shiff & Yannakis, 1976).

Our seroepidemiologic studies are conducted in the schistosomiasis mansoni endemic areas where the intensity of infection is low, about 58 eggs/g feces, and the snail vector is *Biomphalaria tenagophila* (Dias et al., 1989). To estimate the prevalence and incidence, blood samples are obtained on filter paper, and the blood eluates assayed in the IF test utilizing paraffin embedded worm sections as antigen (Deelder & Kornelis, 1990).

Thus, the preliminary assessment of incidence done in school-children from Itariri (S. Paulo, Brazil) by means of IgA antibody detection indicated 4.2% (33/645) had acquired the infections in, at least, last 6 months, if considering the IgA lifetime in the acute stage of schistosomiasis.

The serologic prevalences obtained through the detection of IgG antibodies, in the population of Pedro de Toledo (S. Paulo, Brazil) where the epidemiologic features are similar to Itariri, paralled those parasitologic prevalences seen for both younger and adult age groups. Also, the seroepidemiologic evaluation of IF test revealed high specificity of 0.921, in those children under 14 years old, as compared with 0.692 from the older ones, despite of their close values of sensitivity, 0.987 and 0.989. This low specificity seems to derive from cross-reactivities with other non-related infections to which adults had been more exposed in relation to children (Hoshino-Shimizu et al., 1992).

In an attempt to solve the problems concerning the diagnostic features of serologic tests, different *S. mansoni* antigens, purified or not, were assessed but, none of them proved to be superior (Mott & Dixon, 1982). Presently, the bioengineered recombinant or synthetic antigens are under investigation. Probably, to obtain specific and sentive results in serologic tests, a mixture of two or three recombinant antigens will be needed, analogously to that observed for *Trypanosoma cruzi* recombinant antigens to be applied in the serodiagnosis of Chagas' disease (Almeida et al., 1990).

In view of the variation in the sensitivity and specificity of serologic tests, we have calculated the true prevalence (PT) by a probabilistic model (Gart & Buck, 1966). So, the IF prevalence (PIF) was corrected based on the following equation:

$$PT = \frac{(PIF + Spec - 1)}{(Sens + Spec - 1)}$$ or conversely,

$PIF = (P_T)\ (Sens + Spec - 1) + (1 - Spec)$, where Spec is the known specificity, and Sens the known sensitivity of the test.

For example, the younger age group from the population of Pedro de Toledo gave a P_{IF} of 47.7% (492/1,044), and if the equation is applied the corresponding P_T is 43.2%.

This serologic test can be employed in different young aged population but, having in mind that the predictive values of positive results (PV+) and of the negative results (PV–) will change according to the prevalence if low, moderate or high (Galen & Gambino, 1975).

These predictive values of positives and negatives are obtained as follows:

$$PV+ = \frac{(P_T)\ (Sens)}{(P_T)\ (Sens) + (1 - P_T)\ (1 - Spec)}$$ and

$$PV\_ = \frac{(1 - P_T)\ (Spec)}{(1 - P_T)\ (Spec) + (P_T)\ (1 - Sens)}$$

Table I shows, in terms of probability, the P_T with their respective PV+ and PV–, if IF test will be applied for young aged population with different prevalences.

On the other hand, it is possible to estimate the overall rate of false positives (F+) and of false negatives (F–) along with their respective P_T and P_{IF}. The equations which allow to calculate F+ and F– are:

$F+ = (P_{IF}) - (P_T \times Sens)$, and

$F- = (1 - P_{IF}) - (1 - P_T)\ (Spec)$.

TABLE I

Predictive values of positive and negative results according to the schistosomiasis mansoni true prevalence for immunofluorescence (IF) test with sensitivity of 0.987 and specificity of 0.921, in the study of children under 14 years old

True Prevalence (P_t) %	Predictive value	
	Positive	Negative
5	0.397	0.999
10	0.581	0.998
20	0.757	0.996
40	0.893	0.991
50	0.926	0.989
60	0.949	0.979
80	0.980	0.947

Thereby, the values of F+ and F– presented in Table II also allow to calculate P_{IF} and P_T: $P_{IF} = (P_T) + (F+ - (F-)$ and $P_T = (P_{IF}) - (F+) + (F-)$.

TABLE II

False positive and negative rates according to schistosomiasis mansoni true prevalences and respective immunofluorescence (IF) prevalences (IF sensitivity = 0.987 and IF specificity = 0.921), in the study of children under 14 years old

True Prevalence %	False Positive %	False Negative %	IF Prevalence %
5	7.5	0.1	12.4
10	7.1	0.2	16.9
20	6.4	0.4	26.0
40	4.8	0.6	44.2
60	3.2	0.8	62.4
80	1.6	1.0	80.6

Also, a positive Spearman's coefficient correlation, $r_s = 0.995$, could be determined as the two prevalences, P_T and P_{IF} were compared, and the regression line equation being: $P_T = 8.475 + 0.863\ P_{IF}$. This equation might be used for correcting the obtained P_{IF} in a population survey, since the data are previously transformed as follows: $x' = \text{arc sin } \sqrt{x}$, in which $x = P_{IF}$.

In Figs 1 and 2 the prevalences provided by IF, ID and parasitologic Kato-Katz (KK) techniques and P_T are presented, according to age groups and to 16 localities of Pedro de Toledo.

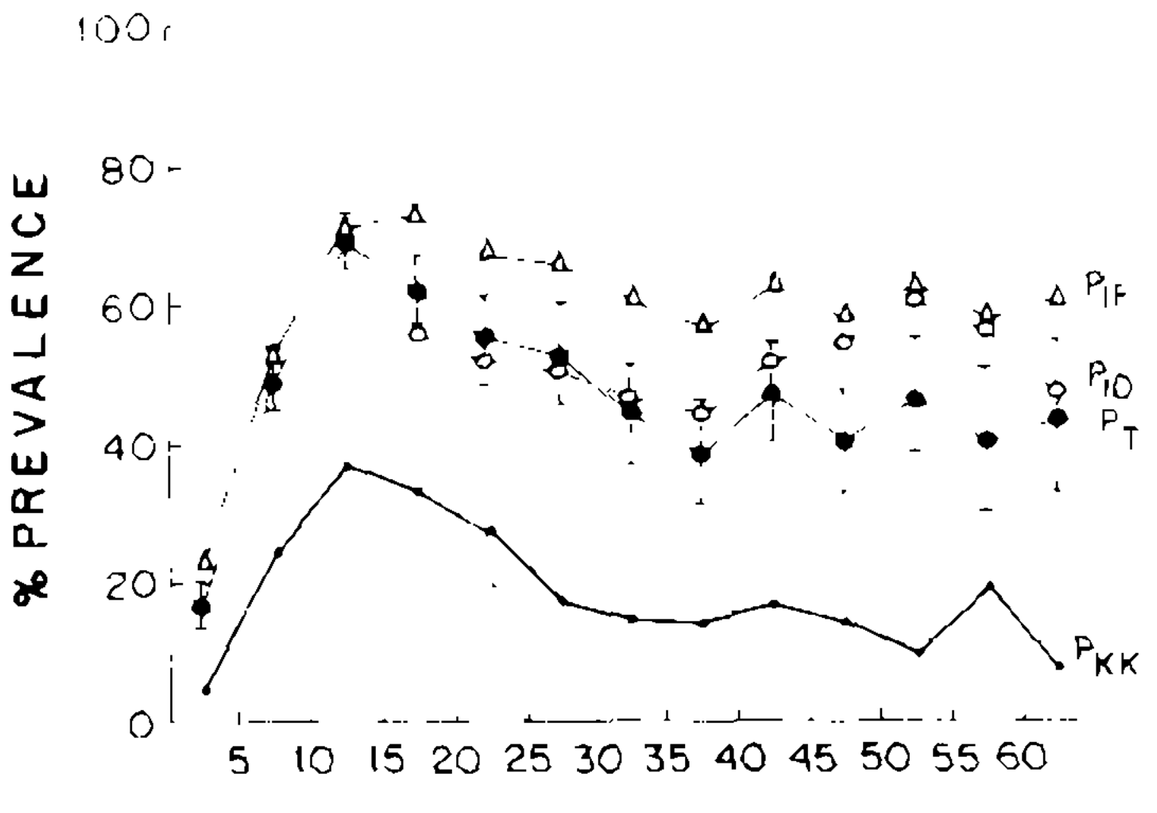

Fig. 1: prevalences provided by immunofluorescence (P_{IF}), intradermal (P_{ID}), Kato-Katz (P_{KK}) tests and true schistosomiasis mansoni prevalence (P_t), according to age-groups (Pedro de Toledo; S. Paulo, Brazil). (P_t with standard deviations).

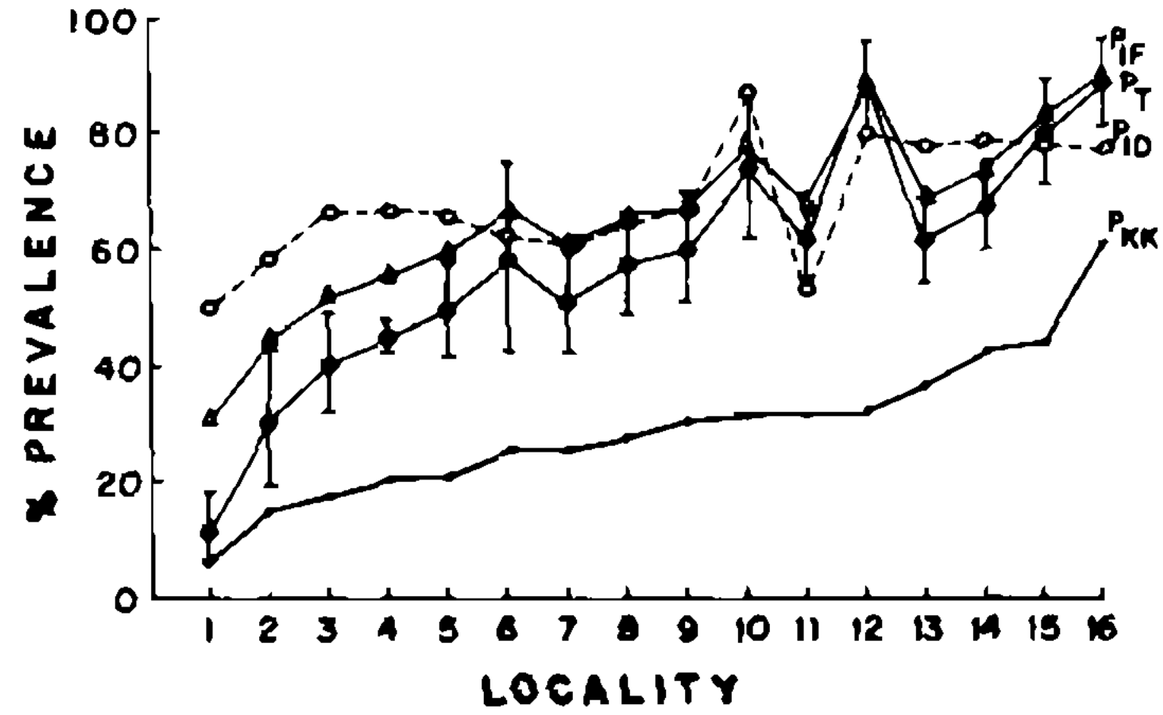

Fig. 2: prevalences provided by immunofluorescence (P_{IF}), intradermal (P_{ID}), Kato-Katz (P_{KK}) tests and true schistosomiasis mansoni prevalence (P_t), according to 16 localities of Pedro de Toledo (S. Paulo, Brazil). (P_t with standard deviations).

No doubt, the serologic tests require to be improved as to their specificity and sensitivity but, other aspects such as discrimination of an active from past infection, and intensity of infection or worm burden will be very helpful for the evaluation of the established schistosomiasis control program, if provided by serology.

Our seroepidemiologic findings, however, seem to be valuable mainly as a framework for further population surveys in schistosomiasis mansoni endemic areas looking like Itariri or Pedro de Toledo.

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