Revista da Sociedade Brasileira de Medicina Tropical 47(2):127-129, Mar-Apr, 2014
http://dx.doi.org/10.1590/0037-8682-0080-2014

Editorial

Scientific progress versus ecological influence on *Schistosoma mansoni* transmission

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In this issue of the *Revista da Sociedade Brasileira de Medicina Tropical* / Journal of the Brazilian Society of Tropical Medicine, we are delighted by the broad review and personal experience of Professor José Roberto Lambertucci regarding hepatosplenic schistosomiasis[1]. He is one of the leading clinical experts in schistosomiasis and among those responsible for the high quality of research that has helped explain several clinical aspects of the disease.

In this editorial, I remember the great scientists who were true heroes and who braved winding roads to study schistosomiasis in Brazil, and I also discuss the socioeconomic and ecological aspects that interfere with efforts to control schistosomiasis transmission.

Schistosomiasis is a disease that has accompanied humankind since we began to preferentially inhabit plains, and it has not been quelled by modern progress. In fact, it is among the few parasitic diseases whose worldwide distribution continues to increase. Human efforts have been far more successful than technology-based ones in the struggle to understand and control schistosomiasis. In addition to Professor Lambertucci, several other Brazilian and international scientists have contributed toward our understanding of schistosomiasis. Even in the past, lacking technology and using only their clinical skills, these scientists classified the disease, implemented measures to control its transmission (even managing to eliminate the disease in certain areas), developed simple diagnostic tools that are still being used, tested several drugs while establishing an effective oral treatment for the disease and described a decrease in portal hypertension after a particular *S. mansoni* treatment. In fact, the mass application of this treatment for schistosomiasis sharply reduced the prevalence of severe disease in Brazil. More recently, following new developments in laboratory research methods, several new aspects of the immune response to infection and granuloma formation have been reported.

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Receveid 2 April 2014
Accepted 15 April 2014

However, the environmental changes necessary to combat schistosomiasis transmission have progressed at a slower pace. While modifying the environment to suit our needs, humankind has provided new habitats for snails from the genus *Biomphalaria*, for example, through the construction of dams and irrigation systems using primitive methods. Even the urbanization process creates environments that lack infrastructure or sanitation and are fed by migratory processes of men and snails, leading to an escalation of the disease in an entirely new space[2,3].

Environmental factors significantly influence the onset of schistosomiasis because the completed life cycle of the parasite requires eggs to be released from feces into the environment. In Brazil, especially in poor rural areas, it is still common to encounter conditions that favor infection with *S. mansoni*, as well as co-infections of *S. mansoni* and intestinal nematodes, such as *Ascaris lumbricoides*, *Trichuris trichiura* and hookworm.

The Brazilian program for schistosomiasis control helped to reduce the prevalence of the disease, but because of focal nature of this disease, schistosomiasis infection rates have remained stable in several regions. One example of this phenomenon is in the State of Sergipe. Our group reviewed data from Sergipe's Schistosomiasis Control Program from 2005 to 2008 and analyzed the frequency and geographic distribution of infections by *S. mansoni* and other intestinal parasites[4] These data were exported to the software Spring 5.0.5 to prepare thematic maps of spatial and temporal distribution by year of evaluation. The prevalence in Sergipe remained stable, ranging from 13.61% (14,471/106,287) in 2005 to 10.56% (8,329/78,859) in 2008. Additionally, analysis of the maps revealed a high prevalence of disease in certain municipalities of Sergipe, ranging from 30% to 45%. Furthermore, we found that cities whose prevalence of schistosomiasis was higher than 15% had a lower hygiene index, which is an indicator that measure the percentage of the sewage system in municipalities under the jurisdiction of the Brazilian Department of Water Resources (*Superintendência de Recursos Hídricos* –SRH)[5] ($p=0.05$). We highlight the importance of improving the control of environmental risk factors and education as a means to reduce the prevalence of schistosomiasis.

The recent introduction of the geographic information system (GIS) to epidemiological studies helps to not only map cases but also predict high-risk areas. The GIS provides improved techniques for the storage, query and spatial analysis of data developed from a set of tools for handling spatial information. It is designed to identify variables that reveal the social, economic and environmental factors associated with health risks[4]. GIS information adds a new perspective on the epidemiology and ecology of parasitic diseases on a geographical scale. The application of GIS enhances traditional approaches and allows the surveillance of the distribution of parasitic diseases to direct the efforts of control programs, as it helps to inform which interventions should be targeted and where they should be administered geographically, thus reducing costs and improving efficiency[6].

Recently, our group conducted a cross-sectional study that applied geospatial analysis to study the epidemiology of *Schistosoma mansoni*, intestinal parasites and co-infections in Ilha das Flores, Sergipe, Brazil. We collected individually geo-referenced clinical, socioeconomic, educational, epidemiological and parasitological data from 500 subjects and analyzed the data using conventional statistics and risk maps produced from kernel estimation. We found that the prevalence rate for *S. mansoni* was 24%. We observed associations between *S. mansoni* infection and male gender (65.2% males, p=0.003), the occupation of farmer (p<0.001) or fisherman (p<0.001), low educational level (p<0.001), low income (p=0.0005), contact with water (p<0.001) and drinking untreated water (p<0.001). The kernel estimator maps indicated that the higher risk areas coincided with the poorest regions of the villages and with the parts of the villages with inadequate sewage systems (personal communication, in process for publication). Although these data confirm several past observations, the estimator maps were generated from a scientifically proven process that quantifies these associations and maps the sites where interventions should be prioritized within the municipality.

We also investigated the spatial distribution of the intermediate snail host *Biomphalaria* within the same endemic area as that of schistosomiasis, evaluating the relationship between irrigation and types of natural water sources on the one hand and the influences of location and time of water exposure on the intensity of human infection on the other hand[7]. GIS was used to map the distribution of the intermediate snail hosts in Ilha das Flores, Sergipe, Brazil, in combination with water contact levels and parasitological examinations conducted by the epidemiological survey. We observed a direct correlation between the intensity of human infection with *S. mansoni* and contact with irrigation projects, but the correlation did not persist when we considered human contact with natural water sources. Malacological studies that were conducted to identify the snail species and infection rates indicated that *B. glabrata* is the main species responsible for human schistosomiasis in the municipality but that *B. straminea* is also involved. In addition, the results provide evidence for competitive selection between the two species: at each of the collection points, only one species was found, with a predominance of *B. glabrata* in the irrigation systems and rice fields and a predominance of *B. straminea* in the natural water sources and rice fields[7]. There is currently a predominance of *B. glabrata* over *B.* straminea within the study area. However, Melo and Barbosa, in 1968, and Figueiredo, in 1988, collected snail samples in this region of the backwoods of the São Francisco River valley and showed that *B. straminea* was the exclusive species found at that time[8,9] In 1967, an irrigation system was created in this municipality. Our data showing the predominance of *B. straminea* in natural water sources indicate that this species is the natural snail found inhabiting this type of area and that *B. glabrata* has replaced *B. straminea*. Because *B. glabrata* is less resistant to dry weather conditions than *B. straminea*, the irrigation system, which enriches the soil with food and water, also promotes the survival of this species. It has been shown that *B. straminea* replaces *B. glabrata* both in the natural environment and under laboratory conditions[10]. However, in this area, we demonstrate that under the specific environmental conditions caused by the irrigation system, *B. glabrata* is successfully surviving and is the major species responsible for human *S. mansoni* infection[7]. This knowledge is important for understanding the process of natural selection responsible for the establishment of schistosomiasis in new areas and could potentially lead to future control schemes based on natural, biological control.

In his review, Prof. Lambertucci[1] also called attention to the coinfections and diseases associated with *S. mansoni* infection. In the same study in Ilha das Flores, State of Sergipe, associations among *Trichuris trichiura* (54.8%), *Ascaris lumbricoides* (49.2%), hookworm (17.6%) and *Entamoeba histolytica/dispar* (7%) were observed. Only 59/500 (11.8%) individuals were not infected, whereas 279/500 (55.8%) had three or more parasites. These intestinal parasitic infections were also associated with socioeconomic and educational factors. For example, we found associations of *A. lumbricoides* and hookworm infections with low income (p=0.002 and p=0.01, respectively) and associations of *A. lumbricoides* and *T. trichiura* infections with drinking untreated water (p=0.02 for both) and with open-air sewage systems (p=0.001 and p=0.0005, respectively) (personal communication, in process for publication).

These findings call for an integrated public health approach to effectively control schistosomiasis and other parasitic infections. It is time for Brazilian development to engender a faster social impact. As science progresses, we must make rapid progress in the control of the neglected diseases that affect our country.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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