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Socioeconomic Studies of Schistosomiasis in Brazil: a Review

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Abstract

This review finds considerable evidence that socioeconomic status has significantly influenced the transmission, spread and treatment of schistosomiasis in Brazil. High infection rates persist among both the rural and urban poor. Rural living, poor housing and water supplies and low educational level were major factors in schistosomiasis occurrence among agricultural populations. In urban areas, prevailing living conditions in shantytowns and labor migrations from and periodic return movements to rural areas were predictive of schistosomiasis. The risk of the establishment of new transmission foci exists in both rural and urban areas, conferred by and affecting poorer people. Associations between schistosomiasis and socioeconomic parameters, persisting inequities in health services accessibility, prevailing health impacts of schistosomiasis, and the ongoing decentralization of health services point to opportunities and strategies for focused interventions aimed at promoting health-enhancing behavior and living conditions and improving access to health care. The authors call for multidisciplinary studies to better examine the complexities of the socioeconomic environment in relation to schistosomiasis and for economic programs to reduce prevailing socioeconomic inequalities.

Keywords

schistosomiasis; socioeconomic conditions and impacts; health services; Brazil

Introduction

The relationship between the socioeconomic position of individuals and populations and their health has been described for hundreds of years (Lynch and Kaplan, 2000) but only during the last three decades have epidemiological studies confirmed the link between socioeconomic inequalities and a wide range of health outcomes, including premature mortality, cardiovascular disease, and self-reported ill health, and have examined potential mechanisms in the relationship between socioeconomic position and poor health (Lawlor and Sterne, 2007). In an attempt to holistically address issues related to the transmission and control of the

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six priority tropical diseases, including schistosomiasis, the World Health Organization developed in 1978 a Socioeconomic Research unit within the Special Programme for Research and Training in Tropical Diseases (Rosenfield, 1990). A strong interest in socioeconomic determinants of schistosomiasis transmission and spread has prevailed in Brazil for more than three decades, starting with the well known study by Barbosa et al. (1971) and continuing until now (Katz, 1998; Soares et al., 2005; Kloetzel, 1989). This is consistent with the usual political perception world-wide that economic and social development can greatly benefit the public, often more than public health interventions (Liese, 1986). Moreover, the high concentration of wealth in the small upper social class relative to other Latin American countries and the many social movements throughout Brazilian history that addressed social inequity (Freire, 1973; Torloni, 1992) appear to have contributed to the focus on socioeconomic aspects of schistosomiasis and other endemic diseases in Brazil. One-third of all Brazilians lived on less than US$1 dollar per day in 2005, even fewer had checking accounts in spite of the country's well developed financial market in retail banking, and microfinance to encourage small business ventures remains ephemeral (de Moura et al., 2005). A large rural population of landless people and share croppers represents one of the poorest segments of the population (Mueller et al., 2006). In 1996, more than 20% of a representative sample of children under age 5 years of age in the poorest quintile but only 2.3% in the most affluent quintile were stunted and infant mortality was 83.2% and 28.6%, respectively (Gwatkin et al., 2000).

The new national health system established in the late 1980s contains provisions for creating universal, integrated and equitable access and utilization of health services for all Brazilians, as mandated by the new federal constitution. However, inequities remain due to disparate living conditions and lack of health services, especially in poor rural areas, mostly in the north and northeast of the country. In a national sample of over 200,000 individuals aged 15–64 years of age, health services utilization rates were found to be inversely related to health care needs and that women used the services significantly more often than men (Barata et al., 2007). Whereas 18.3% of a sample of children in the poorest quintile and 7.4% in the richest quintile were reportedly ill during the previous 2 weeks in 1996, 27.5% of them in the former and 51.8% in the latter were reportedly taken to a health facility when ill, indicating significant more unmet health needs among the poor (Gwatkin et al., 2000). Although the first comparison of the results of the National Household Sample Surveys of 1998 and 2003 revealed increases in health services utilization rates for all income groups and both genders and reduction in the social inequalities in access to care, there is a need to further upgrade the health services (Viacava et al., 2006).

This paper reviews the literature of socioeconomic studies of schistosomiasis in Brazil, including assessments of socioeconomic factors in the transmission and spread of schistosomiasis, economic impacts of infection, and equity of health services accessibility and utilization. In addition to PubMed searches using the search terms schistosomiasis, economic aspects, economic impact, epidemiology, and health services topics, we reviewed available conference proceedings and unpublished reports.

Historical aspects and the national schistosomiasis control program

The introduction of schistosomiasis mansoni by African slaves to Brazil and its subsequent spread by their predominantly southward migrations from the sugar cane plantations in the northeastern part of the country constitutes the first impact of socioeconomic inequity on the occurrence of this intestinal parasitosis in Latin America (Machado, 1982). In-depth studies of the relationship between socioeconomic status and schistosomiasis were not carried out until the late 1960s, starting with the classic study by Frederico Barbosa et al. (1971), the methods and findings of which continue to influence schistosomiasis research and control today. Their intervention trial in a small rural village in northeastern Brazil significantly reduced schistosomiasis mansoni prevalence through community organized water supply, environmental sanitation and health education over a five-year period. Barbosa and colleagues concluded that while this decrease in infection rates was mainly due to the water supply, sanitation and health education program, a general improvement of social and economic conditions in the area was a contributing factor. Although health education and sanitation per se were earlier considered to be generally ineffective in controlling schistosomiasis and other intestinal parasitoses, numerous studies have demonstrated in recent years that in conjunction with the provision of accessible, safe and acceptable water and sanitation, when health education, can significantly reduce schistosomiasis infection rates in the medium term in Brazil (Coura, 1995; Katz, 1998) and in other endemic countries (Jordan et al., 1975; Esrey et al., 1991; Noda et al., 1997). Barbosa and colleagues (1996, 1998a) examined the role of occupation and land use, unemployment, malnutrition, and migration in northeastern Brazil and called for the development of a new control model in which schistosomiasis is seen from a social perspective focusing on the population's accumulated knowledge and on shared lay and professional knowledge.

The national schistosomiasis control program, which was implemented in 1975, integrates sanitary engineering (provision of piped water supplies, wells, water tanks, bathrooms, septic tanks, sinks and laundry areas), sanitary education (to reduce high-risk behavior), active and passive case detection, large-scale chemotherapy, and snail control according to the epidemiological and ecological characteristics of different parts of the country (World Health Organization, 1983; 2000). Prevalence of *S. mansoni* infections was reduced nation-wide by 38.5% by treating carriers and more than 50% in hyperendemic municipalities in Paraíba State after the first year of treatment (Amaral et al., 2006). Nation-wide, the number of hospitalized cases fell by 65% between 1988 and 1999 and schistosomiasis specific mortality by 54% between 1979 and 1997 (World Health Organization, 2000). Similarly, mean age of deaths associated with schistosomiasis rose by 32.2% between 1976 and 2003, except in Minas Gerais State, where persisting lower ages at death were attributed to the later start (1983) and lower coverage of the schistosomiasis control program in that State (Amaral et al., 2006). However, reduction in prevalence and intensity of infection have varied among different localities and control has been particularly difficult in localities depending on farming, fishing and other occupational exposures (World Health Organization, 2000), also reported from several municipalities in Alagoas State (Kloetzel, 1989). Barbosa et al.,1992) attributed these and other difficulties encountered by the national schistosomiasis control program to the failure to understand the full extent and depth of the socioeconomic impediments.

Socioeconomic determinants of schistosomiasis transmission and spread

Numerous epidemiological studies, most of them carried out at the individual level, revealed numerous types of exposure risks that varied considerably among communities. Some of their results helped to inform and improve the evolving national control program. Our preliminary review of the literature indicated that the great environmental, socioeconomic, cultural and epidemiological heterogenicity of Brazil renders the results of analyses of the relative importance of most individual factors (aside from the well researched water supply, sanitation, and education and parameters) in schistosomiasis distribution too inconclusive to support policy. Nearly all investigators, although using different study designs, sampling procedures (mostly random sampling without cluster sampling) and statistical methods (multivariate regression, with some supplementary parametric and non-parametric tests) but practically all using the Kato-Katz (Katz et al. 1972) parasitological method and studying rural and urban areas in different parts of Brazil, arrived at similar conclusions: Agricultural and fishing activities were significantly correlated with *S. mansoni* prevalence and intensity of infection in most all rural communities (Coura-Filho et al., 1994; Silva et al., 1997; Lima e Costa et al., 1998; Bethony et al., 2004; Disch et al., 2002). In addition, bathing in and domestic contacts with streams (Lima e Costa et al., 1987; Silva et al., 1997; Bethony et al., 2004), poor quality housing (Lima e Costa et al. 1991; Gazzinelli et al., 2006), absence of piped water (Lima e Costa et al., 1987; Coura-Filho et al., 1996; Gazzinelli et al., 2001), latrines and shower, low level of education, and being born in a rural area (Bethony et al., 2001) were all found to be significantly associated with *S. mansoni* prevalence or intensity. In two poor rural communities in Pernambuco and Minas Gerais States, no strong association was found between any of the socioeconomic variables studied and schistosomiasis prevalence in those high-risk communities, which was associated with the dependence of the whole population on infective water sources and their precarious living conditions (Moza et al., 1998; Gazzinelli et al., 2006).

In spite of generally better living conditions in urban than in rural areas, schistosomiasis has a moderately high prevalence in many Brazilian cities because of migration of infected people from endemic rural areas and persistence of transmission sites and even the creation of new snail habitats in the urban environment. In small towns, low socioeconomic status, low quality of housing and lack of safe household water supplies in poor neighborhoods, children swimming and playing in infective water, people who had water contact in rural areas, and migration from and periodic return movements to rural areas were highly predictive of schistosomiasis infection (Lima e Costa et al., 1987; Barreto, 1993; Kloetzel, 1989; Amorim et al., 1997; Barbosa et al., 2000; Ximenes et al., 2001). Schistosomiasis prevalence in Metropolitan Belo Horizonte, a city with more than 3 million inhabitants, has been between 7–10% during much of the last 7 decades, similar to the overall rates for the State of Minas Gerais (Schall et al., 2001). Schistosomiasis risk in this city includes swimming (Firmo et al., 1996), playing and fishing, indicating a lack of safe recreational activities for poorer children and adults. Persistence of high *S. mansoni* infection rates in some rural areas and towns in spite of socioeconomic development has been associated with the spread of intermediate host snails and ineffectiveness of the control program (Katz et al., 1978; Schall et al., 2001) but is also due to uneven rural/urban and regional economic development. For example, most migrants to Belo Horizonte originated in the poorer northern and northeastern parts of the State (Rodrigues, 1995). At the periphery of Belo Horizonte and other cities and towns, snail habitats and transmission sites often persist in open areas that tend to be used by poorer households in shanty towns *(favelas*) who frequent them for domestic and recreational purposes (Soares et al., 1995; Schall et al., 2001; Massara et al., 2004). A new transmission site was recently discovered at the periphery of Rio de Janeiro which was settled during the last few decades by marginalized populations. *S. mansoni* was probably introduced by infected persons from endemic areas due to the continuous flow of migrants into that city, a phenomenon which has also been reported from other Brazilian industrial and commercial centers (Grault et al., 1998).

In recent years migrants have been associated with the establishment of new transmission foci in rural areas where *Biomphalaria* snail hosts already existed. Migration and the spread of schistosomiasis from the northeast to São Paulo and other southeastern States goes back to the 17th century and is largely due to a combination of the greater economic opportunities in the latter, recent mechanization of large agricultural enterprises (and thus less need for manual labor) and additional massive layoffs caused by the 1962 labor statute which raised farm labor wages and other benefits (Machado, 1982; Goza, 1992; Tannen, 1992). In São Paulo State, where the largest numbers of migrants in Brazil have been recorded (between 16.5% and 32.6% of the household heads between 1980 and1993 had come from other States). Fifty-three percent of them had originated in northeastern States (Baeninger, 1996), mostly in poor agricultural areas where schistosomiasis is hyper-endemic (Katz, 1998). In another southern State, Rio Grande do Sul, where *B. glabrata* and other intermediate host snails occur, laborers from endemic areas of Brazil working in local factories are feared to introduce the parasite (Carvalho et al., 1997).

In the northern frontier State of Rondonia, all 573 cases of schistosomiasis identified between 1994 and 1996 reportedly originated in their home areas in the hyperendemic northeast (Paiva et al., 1997). However, the presence of *B. straminea* in Rondonia (Paraense 2001) makes it likely that some infections were acquired locally. The risk of the spread of schistosomiasis and intermediate snail hosts is increasing also in other areas of the Amazon region being settled by poor farmers, gold miners and extractors of forest products originating in the northeastern states (Bichara et al. 1997; Paraense 2001). In Para State, migration has been associated with the introduction of the parasite into the Amazon Basin (Bichara et al., 1997). Population movements not only resulted in the introduction of *S. mansoni* in destination communities but facilitated maintaining the transmission cycle in sending communities due to the usual return of migrants to their home areas, either for vacation or to settle. Thus they may be missed during chemotherapy programs, reducing the efficiency of control programs (Pieri et al., 1998) and maintaining high infection rates in poor migrant workers. A study in a low endemic community reported that failure to exclude migrants and other persons leaving study areas may result in biased results in project evaluation (Disch et al., 2002).

Exposures related to vacationing, tourism and weekly recreation activities have been identified as an increasingly important schistosomiasis risk factor for more affluent groups in both rural and urban areas (Amorim et al., 1997; Barbosa et al., 2000). This includes visits to rural areas by urban residents of large metropolitan areas who normally are not at risk of infection (Enk et al., 2004). On Itamaracá Island in Pernambuco State, a popular vacation destination, schistosomiasis was found to be highly prevalent among local fishermen and construction workers, and tourists became infected at a number of transmission sites (Barbosa et al., 1998b).

Several studies have focused on the role of the household in generating exposure risk in schistosomiasis in an effort to capture a wider range of determining factors (Watts et al., 1998; Gazzinelli et al., 2001). Such epidemiological studies are also relevant for the implementation of disease prevention and control activities as they can elucidate relevant social relations, mediate risk and examine changes in the physical environment of households to changes in the behavior of household members (Berman et al., 1994; Cairncross et al.; 1996; Watts et al., 1998). The most extensive study of socioeconomic determinants of schistosomiasis carried out in an urban Brazilian community found a significant degree of household aggregation of schistosomiasis cases. Better socioeconomic indicators in the productive process (occupation, economic sector, and household income) and for patterns of consumption (education of the family head, type of housing, household possessions, household water supply, and sanitation, and access to medical care) were all associated with low risk of infection. Similarly, aggregation of all socioeconomic variables at the household level revealed that individuals whose families were more affluent had lower mean egg counts (Ximenes et al., 2003). A similarly structured household study by Gazzinelli et al. (2006a) in a rural community in northern Minas Gerais State, by contrast, failed to identify any socioeconomic variables that were strongly associated with schistosomiasis prevalence, which was attributed to lack of economic differentiation, widespread poverty and uniformly high exposure risk in the population. Both the Ximenes and Gazzinelli studies concluded that improvements in water supply and sanitation in particular are necessary for the control of schistosomiasis in the long term and to facilitate broadly based socioeconomic development. These conclusions are consistent with efforts by the WHO Expert Committee on Schistosomiasis to promote safe, adequate and conveniently located water supplies as an essential measure in schistosomiasis prevention and control (World Health Organization, 1993).

In another rural community studied for determinants of schistosomiasis by the Nursing School of the Federal University of Minas Gerais in Belo Horizonte in collaboration with the Centro de Pesquisas René Rachou, FIOCRUZ, household aggregation of water contact behavior revealed that shared residence accounted for much of the variation in individual water contact. Thus 63% of the variation in all agricultural contacts, 56% of washing limbs, and 41% of bathing contacts were accounted for by shared residence (41%) (Bethony et al., 2004). These studies reveal the critical role of the household in understanding the heterogeneity in water contact frequency among individuals with potentially infective water. They also point out the need for further studies that more comprehensively define the term "household" to determine those aspects of this social unit that most strongly influence water contact behavior and schistosomiasis transmission (Bethony et al., 2002; 2004).

Although socioeconomic determinants of *S. mansoni* transmission tend to cluster at the household, neighborhood and community levels (Bethony et al., 2002; Brooker et al., 2006; Kloos et al., 1998) and the access and utilization of health services by poorer people are particularly impeded by distance constraints (Joseph et al., 1984), few spatial studies have so far been carried out in Brazil. Mapping of schistosomiasis prevalence and prevailing socioeconomic status revealed that these two variables were inversely related and clustered at the neighborhood level in a town in Alagoas State (Kloetzel, 1989) and a town in Bahia (Barreto, 1991). A study quantifying small-scale heterogeneity of schistosomiasis prevalence in another rural community in Minas Gerais using cluster analytic techniques found significant within-household and between-household spatial clustering, although the role of socioeconomic status and associated water supplies and sanitation levels is not known (Brooker et al., 2006). Statistical contour maps and spatial cluster analysis identified high-infection, exposure and IgE antibody clusters at the household level before and after chemotherapy in another rural area in Minas Gerais (Gazzinelli et al., 2006b), which are now being analyzed for possible socioeconomic determinants. Extension of such cluster analyses to include socioeconomic variables will be pursued in this and other study areas in northern Minas Gerais. In a study of more than 4,000 schoolchildren attending 57 primary schools in Ivory Coast, the poorest and most highly infected students lived significantly further away from schools than their wealthier, less infected counterparts (Raso et al., 2005). Several projects, including two studies in Rio de Janeiro State, have started to employ GIS systems in detecting, monitoring and controlling foci of schistosomiasis at the individual to the municipality levels (Moza et al., 2005; Rodrigues et al., 2005).

Socioeconomic issues in health education and community participation

The generally higher schistosomiasis rates among poorer Brazilians, a large proportion of whom, especially older adults, are illiterate has profound implications for schistosomiasis control. In 2005, more than 13% of adults 25 years and older were analphabets, with still higher rates in the northeast (IBGE, 2005). The problem of people not being able to read the health promotion literature which is widely distributed by the Ministry of Health, other government institutions, universities, private biochemical companies, and newspapers and transform this information into preventive behavior has been pointed out by Schall et al. (2001). This failure of health messages to inform, motivate, train and encourage communities and their leaders to play a central role in improving their health has also been reported from other endemic countries and tends to undermine the five specific objectives of health education in schistosomiasis control using the primary health care approach, namely: 1) to prevent and control transmission through changes in water contact behavior, 2) to improve environmental sanitation through he control of fecal and urinary contamination of snails habitats, 3) to comply with chemotherapy, 4) to assist and cooperate with snail control programs, and 5) to promote health-promoting behavior and community motivation to sustain these programs, together with increasing self-reliance in health activities (Mott, 1984; Kloos, 1995). In Brazil, an anthropological/epidemiological study aimed at mobilizing a rural village for health education reported that residents distinguished between minor symptoms, which they attributed to water contact, and major symptoms, allegedly the result of lack of medical treatment. The decrease of heavy infections in the village due to the availability of readily available and free chemotherapy from the Ministry of Health mediated he perception of the severity of schistosomiasis and reduced the need of avoiding contact with transmission sites. As a result, no differences in prevalence of schistosomiasis were noted between the study and control villages (Uchoa et al., 2000).

Few studies been carried out since Barbosa's intervention trial in northeastern Brazil (Barbosa et al., 1971) on the role of community self-help and participation. This is in spite the fact that community mobilization programs in schistosomiasis prevention and control have been promoted by the Ministry of Health since the 1980s (Ministry of Health, 1987; Uchoa et al., 2000) and community participation has been identified as a major factor in the promotion of community responsibility and control in maintaining water supplies (World Health Organization, 1993). Kloetzel (1989) attributed the neglect of the study of community-initiated programs to the emphasis given by the national schistosomiasis control program to the heavy reliance of communities on mass chemotherapy administered by the federal Ministry of Health, arguing that this dependency discourages community action and efforts promoting local management of health activities. The decentralization of the health services may only partly overcome this situation, because the Brazilian (like other Latin American) health system is embedded in the informal management and wider political culture which influence the performance of local health systems (Atkinson et al., 2004). Nevertheless, community-based initiatives and participation in water supply and sanitation development and management with municipal rather than federal and state government assistance have been practiced for decades in Brazilian towns and villages. In a poor rural village in the Jequitonhonha Valley, Gazzinelli et al. (2006a) a centralized water supply system was developed entirely through community contributions of labor and materials in the 1980s and remains the only supply today. In another isolated village in northern Minas Gerais, Kloos et al. (1998) found that most households had installed shallow wells and latrines by themselves without outside support and that these households had significantly lower schistosomiasis prevalence and egg counts, as well as significantly lower ascaris and hookworm prevalence in a stepwise linear regression model.

Inequity in health services accessibility and utilization and surveillance issues

Patterns and determinants of the accessibility and utilization of health services by schistosomiasis patients (Danso-Appiah et al. 2004; Kloos et al., 1987) have been relatively neglected by Brazilian researchers. Gazzinelli et al. (1998) briefly described the steps schistosomiasis-infected people took and the constraints they faced in obtaining medical care. They found that this process commonly started in a small village in Brazil either with self-diagnosis and the use of locally grown herbs or, more commonly, a diagnosis by a nearby clinic. This was usually followed by the purchase of anti-schistosomal drugs in local pharmacies. Only in case of serious gastrointestinal signs and symptoms did they seek out the public health services in a town 20km away, since transport difficulties, problems associated with obtaining a medical appointment, and scarcity of drugs were major impediments in obtaining treatment. The same research group carried out a comparative study of the accessibility and utilization of health services by schistosomiasis-infected people in a rural area northern Minas Gerais. They found that few infected persons obtained diagnoses and treatment on their own, largely due to low levels of symptoms and prevailing illness perceptions, lack of resources to visit health facilities outside the study area, and use of home remedies. Females had higher *S. mansoni* infection and utilization rates ($P<0.001$) (Reis et al., 2008). Nation-wide, women are more likely to report poor health and use the outpatient and inpatient health services more often than men, reflecting greater health needs of women (Barata et al., 2007). Poor uneducated women have the least access to the health services, as indicated by Mendoza-Sassi et al. (2003) showing that uneducated lower income women had seen a doctor 62% less often than uneducated wealthier women for various chronic diseases. In a rural area in Minas Gerais, 85% of the infected persons received chemotherapy during the 2002 Fundação Nacional de Saúde-FUNASA Schistosomiasis Control Campaign but only 26% of them obtained treatment on their own between 2002 and 2006 population-based chemotherapy campaigns to cover poorer people (Gazzinelli et al., 2008), arguing for the continuation of these biannual campaigns.

But the use of the biannual mass chemotherapy administered by the Ministry of Health among populations with highly variable egg was earlier criticized as less efficient and more expensive than selective treatment and participation declined in Alagoas State (Kloetzel, 1992; Carmo et al., 1994). A related issue which requires further studies in Brazil (and in other endemic areas) is the relative contribution of socioeconomic development and mass chemotherapy to the decline of schistosomiasis infection rates in Brazil. The argument that differential long-term changes (both decreases and increases) in prevalence in various municipalities in Bahia and Alagoas states are mainly due to new transmission sites and urbanization effects (Kloetzel, 1989; Carmo et al., 1994) does not consider the role of socioeconomic changes, which have been accelerating in the northeastern states during the last three decades.

Efficient and rapid surveillance strategies are warranted now that much of Brazil is entering the low-prevalence stage (WHO 2000). A new approach to screening school children in high-infection households (Enk et al., 2008) may be feasible if primary care workers can adopt this sampling methods in active case finding but would miss some highly infected, poor children who dropped out of elementary school, a problem particularly in hyperendemic northeastern Brazil. By upgrading the State and national disease surveillance and information systems, coverage of severe forms of schistosomiasis, found mostly among poorer segments of the population, may be further increased. A review of the Information System in the Schistosomiasis Control Program (SISPCE) in Bahia, Sergipe, Alagoas, and Pernambuco States revealed a sharp drop in patient recording during the decentralization process, impeding the construction of a surveillance index for serious forms of schistosomiasis (de Farias et al., 2007). That such problems may be overcome is indicated by a recently initiated program of active surveillance of hepatosplenic and neuro-schistosomiasis in Minas Gerais State, which resulted in sharp increases in patient referrals between 2002 and 2005 (Drummond et al., 2006).

Impact of schistosomiasis on production and individual development

The impact of schistosomiasis on economic production has been examined by numerous investigators in different countries. The early studies, which focused on individual work output of adults and and reported variable results, were reviewed by Andreano et al. (1988). More recent studies reviewed by Hotez et al. (2006) reported stronger associations between schistosomiasis infection parameters, as well as soil-transmitted helminth infections, and labor force participation, wages and productivity in endemic areas. In Brazil, Barbosa et al. (1981), after finding no significant earnings differences between infected and non-infected cane cutters in an initial retrospective study, subsequently (in a prospective study) found workers with hepatosplenic schistosomiasis to have 35% less productivity than those with the intestinal form. Extrapolating the results of this study to the State of Pernambuco, the investigators estimated that hepatosplenic disease caused a reduction in productivity of US $16 million tons of sugar cane worth $2 million. In the early 1990s the focus of economic impact studies of schistosomiasis shifted from individual to intra-household effects with the objective of providing more comprehensive assessment that could be addressed through family social networks and supports (Vlassoff, 1992).

In pre-school and school aged children, schistosomiasis and other intestinal parasitoses are increasingly linked with significant malnutrition (anemia and protein/energy deficiency), stunting, cognitive impairment, lower school enrollment, attendance, and grade attainment of school children. These and other impediments to education achievement probably have major long-term economic effects in developing countries, where returns on increased education and physical health are generally high, although the complexity of these studies demands refinement of methodologies in regard to measurement of parameters and evaluation of results (Hotez et al., 2006; King, 2008). In a town in Bahia State in Brazil, Assis et al. (2004), in a logistic regression model, found children heavily infected with *S. mansoni* to have a 2.74 higher risk of stunting than uninfected children and those with inadequate lipid intake a 1.83-fold increased risk of stunting compared to those with adequate diets. The additive effect of coinfections with intestinal parasites on anemia was demonstrated by Brito et al. (2006), who reported an odds ratio of 1.7 for rural children infected with *S. mansoni* and two other parasites, and an odds ratio of 2.4 among those infected with *S. mansoni* and three other parasites. Recent studies in various endemic areas world-wide indicate that the health impact of polyparasitism is probably underreported due to the spatial clustering of multiple infections in individuals and the discovery of hitherto understudied pathological sequelae (Pullan and Brooker, 2008).

Conclusion

This review provides evidence for inequities in schistosomiasis infection status, epidemiologically relevant living conditions, and access to health care in the Brazilian population. These findings point out the need for more equitable schistosomiasis control interventions, which in turn may contribute to poverty alleviation. Considerable progress has been made in research examining the role of socioeconomic factors and the broader socioeconomic environment in the transmission and spread of schistosomiasis in Brazil and points out several additional areas that might benefit from such studies. I addition to cross-sectional studies, there is a need for in-depth socio-epidemiological and medico-anthropological longitudinal research which can identify more comprehensively characteristics, interrelationships and possible modifications of socioeconomic determinants and impacts. The complexities of the social and economic influences on schistosomiasis risk, accessibility to health care, as well as economic impacts of the disease (Joseph et al., 1984; Andreano et al., 1988; Rosenfield, 1990) make a multidisciplinary approach highly desirable. The development of appropriate methodologies may also benefit interventions for other endemic infectious diseases in Brazil due to the interrelated effects of poverty, lack of information, and rural living on their transmission and spread. But overcoming persisting economic inequities underlying much of the vulnerability to schistosomiasis infection also will require further progress in broadly based socioeconomic reform, including land reform towards greater equity of wealth and innovative economic assistance programs such as microcredit for disadvantaged people, including women.

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