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School-based and community-based actions for scaling-up diagnosis and treatment of schistosomiasis toward its elimination in an endemic area of Brazil

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ABSTRACT

This study evaluated a school-based and a community-based scheme for diagnosis, treatment and follow-up of schistosomiasis mansoni among school-aged children in views of resolution CD49.R19 of the Pan American Health Organization toward the elimination of schistosomiasis as a public health problem in the Americas and subsequent commitments endorsed by the Brazilian government. The school-aged population from a representative municipality of the endemic area of Northeastern Brazil was randomly allocated to either school-based or community-based scheme. The two schemes were compared with regard to coverage of diagnosis by the Kato–Katz method (KK) at baseline, treatment of the positives for *Schistosoma mansoni* with praziquantel, treatment of the positives for soil-transmitted helminthes (STH) with mebendazole, as well as follow-up of treatment efficacy and reinfection assessed respectively at four and 12 months after treatment. Nutritional status of the positives for *S. mansoni* was assessed at baseline and re-assessed at 12 months after treatment. Coverage of diagnosis and treatment was satisfactory (>75%) in both schemes. Diagnosis coverage at baseline and at 12 months was significantly higher in the community scheme, whereas treatment coverage did not differ significantly between the two schemes either at baseline or at 12 months. The number of children covered per day was significantly higher in the schools than in the community at baseline but not at follow-up, when daily coverage was higher in the community. With regard to *S. mansoni*, overall treatment efficacy rate at four months was 90.8%, and reinfection rate at 12 months was 21.6%. For STH, overall treatment efficacy was 45.4% and reinfection, 32.8%. The nutritional status of the positives for *S. mansoni* at baseline did not change significantly at 12 months post-treatment. Actions targeted at this particularly vulnerable high-risk group should combine school-based and community-based interventions as well as preventive measures to reduce transmission.

1. Introduction

Schistosomiasis is a highly prevalent helminthiasis among low-income populations, caused by trematodes from the genus *Schistosoma*. By 2008, the World Health Organization (WHO, 2010) estimated that 7.1 million people were infected by *S. mansoni* in the Americas, 95% of which in Brazil. Schistosomiasis mansoni has been regarded as of public health importance in Brazil since the mid-1970s with the implementation of a top-priority Special Program for Schistosomiasis Control (PECE) by the Ministry of Health (MS), based mainly on mass chemotherapy (Machado, 1982). In the following decades, the Program was periodically revised to meet changes in the epidemiological scenario as well as in the public-health policies (Katz, 1998; Amaral et al., 2006) and became known as Schistosomiasis Control Program (PCE). In the first years of the PECE (1977–1979) overall prevalence in the target areas fell from 23% to 9%; however, by 1997, after two decades of control efforts

Abbreviations: AEs, adverse events; BMI, body mass index; CDC, Center of Disease Control; GCP, Good Clinical Practice; CONSORT, Consolidated Standards of Reporting Trials; EPG, eggs per gram of feces; IBGE, Brazilian Institute for Geography and Statistics; IDH-M, Municipal Human Development Index; KK, Kato–Katz; MBZ, mebendazole; MDA, mass drug administration; MDS, Ministry of Social Development; MS, Ministry of Health; PAHO, Pan American Health Organization; PCE, Schistosomiasis Control Program; PECE, Special Program for Schistosomiasis Control; PZQ, praziquantel; RMR, Recife Metropolitan Region; SAEs, serious adverse events; SISPCE, Information System for the Schistosomiasis Control Program; SME, Municipal Secretary of Education; STH, soil-transmitted helminthes; WHA, World Health Assembly; WHO, World Health Organization.

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by the PCE, prevalence in those areas still held around 10% (Coura and Amaral, 2004).

Since the late-1990s, the PCE guidelines for the endemic areas have comprised community-based active search of infected persons. The search is to be conducted through periodic (preferably biennial), community-based stool surveys followed by treatment of the infection carriers at the primary health care level within the country's Unified Health System (SUS) together with auxiliary, preventive measures (Favre et al., 2009). This strategy has contributed to a progressive reduction of prevalence to less than 5% from 2009 onwards according to the Information System for the Schistosomiasis Control Program (SISPCE, 2012). However, active-search surveys remain well below the recommended coverage of 75% of the target populations (Favre et al., 2012).

In October 2009, resolution CD49.R19 of the Pan-American Health Organization (PAHO) urged Member States to eliminate or reduce schistosomiasis and other neglected diseases related to poverty for which tools exist, to levels so that these diseases would no longer be considered public health problems in the Americas by 2015 (PAHO, 2009). Subsequently, in May 2012, the MS adopted Resolution WHA65.21 of the World Health Assembly aimed at intensifying schistosomiasis control toward its elimination. A special Action Plan was then set up (Ministério da Saúde, 2012) for 222 priority municipalities in nine endemic states, based on the estimated prevalence of schistosomiasis according to the SISPCE, as well as the level of extreme poverty of their population in line with the Ministry of Social Development (MDS). The strategy of diagnosis and treatment proposed for the period 2011–2015 can be summarized as follows: (i) mass drug administration (MDA, collective treatment without prior individual diagnosis) to persons over five years of age in localities with egg-positivity above 25%, (ii) treatment of egg-positives and their cohabitants in the localities with egg-positivity between 15% and 25%, and (iii) treatment of egg-positives in localities with egg-positivity below 15% (Ministério da Saúde, 2012).

Various studies have pointed out the benefits of adopting children of school age as a sentinel or reference group for estimating the situation of schistosomiasis in the communities, planning control strategies and evaluating the impact of control measures in Brazil (Rodrigues et al., 2000; Massara and Schall, 2004; Favre et al., 2006, 2009; Pereira et al., 2010) and elsewhere (WHO, 2011a). However, the issue of school-based vs. community-based intervention for helminth control is still debatable (Oshish et al., 2011; Anderson et al., 2013; Salan et al., 2014). As control efforts move toward the interruption of transmission, maintaining active surveillance for case finding among school-aged children is strongly recommended (WHO, 2009). In Brazil, it has been also recommended that confirmed cases in the surveillance phase should be evaluated for treatment efficacy (cure) through three stool exams at the fourth month after treatment (Ministério da Saúde, 2008).

Considering that the Brazilian schistosomiasis control program, PCE, has been centered in community-based, rather than school-based interventions, the purpose of this research was to evaluate the effectiveness of a school scheme in delivering diagnosis and treatment to school-aged children at the municipal level in a moderate-to-high endemic area of North-East Brazil, as compared with the current, community-based delivery scheme. The primary objective was to assess the coverage (diagnosis and treatment) of school-aged children for schistosomiasis and soil-transmitted helminthes (STH) in each delivery scheme (school or community) by the local health teams according to the PCE guidelines. The secondary objectives were: (i) to assess the infection status of the treated children four months after treatment (treatment efficacy), (ii) to obtain information on reinfection rate at 12 months after treatment and (iii) to assess the potential benefit on nutritional status from deworming within a 12-month period.

2. Materials and methods

2.1. Study area and population

The municipality selected for study was Araçoiaba, in Pernambuco state, occupying an area of 96 km^2 in the Recife Metropolitan Region (RMR), and located 49 km north of the state capital Recife. Its main economic activity is the cash-crop agriculture mostly toward the production of alcohol and sugar. According to the Brazilian Institute for Geography and Statistics (IBGE, 2012), the Municipal Human Development Index (IDH-M) of Araçoiaba is 0.637, the lowest in the RMR; in 2010 the municipality had 18,156 inhabitants, 3710 (20.4%) of which were school-aged children (6–15 years). The enrolment rate in basic education was 95.6% and the dropout rate, 13.6%.

Araçoiaba was chosen for this study because it is representative of the endemic area of schistosomiasis in Brazil, where yearly community-wide surveys had reached only 12% of the population despite moderate-to-high prevalence rates (>25%) being found. According to the SISPCE (2012), 12,635 residents of all ages from nine localities were surveyed in Araçoiaba by the municipal health system between 2005 and 2010; 9722 KK stool exams were performed, of which 2480 (25.5%) were positive for *S. mansoni*, 880 (9.1%) for *Ascaris lumbricoides*, 175 (1.8%) for hookworms and 214 (2.2%) for *Trichuris trichiura*. The local snail host species of *S. mansoni* is *Biomphalaria straminea*.

All children aged 6–15 years who were enrolled in the 10 public schools of Araçoiaba in 2009 were assessed for eligibility, totaling 3190 (86% of the total population in this age-group). The Municipal Secretary of Education (SME) provided a list containing name, school and home address of the enrolled children. The non-enrolled school-aged children were outreached by complementing the SME list with information provided by teachers and students in the school scheme or by households in the community scheme.

2.2. Primary and secondary outcomes

The primary outcomes measured during the study were: (i) diagnosis coverage rate, the proportion of children aged 6–15 years who were diagnosed and (ii) treatment coverage rate, the proportion of those who were treated if egg-positive for schistosomiasis and/or STH by the municipal heath teams within a period of two months. The secondary outcomes were: (i) treatment efficacy rate, the proportion of treated children who became egg-negative at four months after treatment; (ii) reinfection rate, the proportion of egg-negative children at four months who became egg-positive again at 12 months after treatment; (iii) nutritional status, based on anthropometric measurement (weight and height) at baseline and at 12 months.

2.3. Interventions groups and survey design

This was a school-based randomized match-controlled trial in children aged 6–15 years. It was conducted from April 2009 to June 2010.

All public schools of the municipality were paired by area (rural or urban) and ranked according to the number of enrolled children eligible for assessment per school (Table 1) in order to allocate approximate numbers of children in both intervention schemes. Two sets of five matched schools were formed and randomly assigned to either school-based or community based scheme as recommended by Smith and Morrow (1996).

2.4. Sample size

A difference of at least 10% in diagnosis coverage above 75% was assumed to favor one scheme over the other. The minimum sample