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Setback of the Schistosomiasis Control Program in the Brazilian state with the highest prevalence of the disease

Retrocesso do Programa de Controle da Esquistossomose no estado de maior prevalência da doença no Brasil

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ABSTRACT

OBJECTIVE: To describe the epidemiological picture of schistosomiasis in the context of the Schistosomiasis Control Program (SCP) in Sergipe State, Brazil. MATERIALS AND METHODS: An ecological time series study was conducted based on secondary data from the Information System of the Schistosomiasis Control Program of the State Secretary of Health of Sergipe, 2008–2017. Data were analyzed using TabWin, Joinpoint Regression, and BioEstat. RESULTS: On average, 36.7 ± 5.6 municipalities participated in the SCP, with 677,841 exams performed, of which 59,996 were positive (annual average of 8.6% ± 1.2%); 4,566 of the positive cases had a high parasitic burden (7.9% ± 2.1%). Of all positive cases, 42,779 were treated (68.7% ± 9.5%). The percentage of cases with a high parasitic load showed a statistically significant increasing trend (5.7% per year). There was a statistically significant downward trend in the number of municipalities joining the SCP (4.0% per year) and the number of tests performed (9.6% per year). Regarding the spatial distribution of schistosomiasis, in 2011, the year with the highest number of municipalities adhering to the SCP, five, 30, and 10 municipalities were considered, respectively, of high, medium, and low endemicity. In 2017, Siriri was considered to be highly endemic, 20 municipalities were of medium endemicity, and five of low endemicity. CONCLUSION: The actions of the SCP decreased in Sergipe, in addition to the apparent underreporting of cases and the increase in cases with a high parasitic burden, compromising the gains obtained in the control of the disease.

Keywords: Schistosomiasis; *Schistosoma mansoni*; Public Health; Epidemiology; Neglected Diseases.

RESUMO

OBJETIVO: Descrever o quadro epidemiológico da esquistossomose no contexto do Programa de Controle da Esquistossomose (PCE) no estado de Sergipe, Brasil. MATERIAIS E MÉTODOS: Foi desenvolvido um estudo ecológico de séries temporais, baseado em dados secundários do Sistema de Informação do Programa de Controle da Esquistossomose da Secretária Estadual de Saúde de Sergipe, de 2008 a 2017. As informações extraídas foram analisadas com os programas TabWin, Joinpoint Regression e BioEstat. RESULTADOS: Em média, 36,7 ± 5,6 municípios participaram do PCE no período, com o total de 677.841 exames realizados, dos quais 59.996 foram positivos (média anual de 8,6% ± 1,2%); 4.566 dos casos positivos apresentaram alta carga parasitária (média de 7,9% ± 2,1%). De todos os casos positivos, 42.779 foram tratados (média de 68,7% ± 9,5%). O percentual de casos com alta carga parasitária apresentou tendência crescente estatisticamente significante (5,7% ao ano). Apresentaram tendência decrescente estatisticamente significante a adesão de municípios ao PCE (4,0% por ano) e o número de exames realizados (9,6% por ano). Em relação à distribuição espacial da esquistossomose, em 2011, ano de maior adesão de municípios ao PCE, cinco, 30 e 10 municípios foram, respectivamente, considerados de alta, média e baixa endemicidade. Em 2017, Siriri foi considerado como de alta endemicidade, 20 municípios foram de média endemicidade e cinco de baixa endemicidade. CONCLUSÃO: As ações do PCE diminuíram em Sergipe, o que somado à aparente subnotificação e ao aumento de casos com alta carga parasitária, compromete os ganhos obtidos no controle da doença.

Palavras-chave: Esquistossomose; *Schistosoma mansoni*; Saúde Pública; Epidemiologia; Doenças Negligenciadas.

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INTRODUCTION

Schistosomiasis is among the most prevalent parasite diseases worldwide[1]. According to reports from the World Health Organization (WHO), this parasitosis belongs to the group of neglected tropical diseases, with almost 240 million people worldwide needing treatment[2]. In 2018, more than 97.2 million people were treated[3].

Schistosomiasis has been reported in 78 countries, including regions in the Americas, Africa and the Eastern Mediterranean. In the Americas, the most affected country is Brazil, with about 1.5 million people infected with *Schistosoma mansoni* and more than 25 million living in places with high risk of infection[3,4,5,6,7]. Autochthonous transmission has been reported in all five Brazilian regions, the endemic states were Alagoas, Bahia, Maranhão, Paraíba, Pernambuco, Rio Grande do Norte, Sergipe, Espírito Santo and Minas Gerais[4]. Currently, schistosomiasis is found in a large extension that goes from Rio Grande do Norte to the north of Minas Gerais, entering Bahia, Minas Gerais and Maranhão. In the states of the North, Midwest and South regions, transmission occurs in restricted areas, being considered focal[8].

Considering the expansion of the disease in the country, in 1975 the Special Program for the Control of Schistosomiasis (Programa Especial de Controle da Esquistossomose – PECE) was created, in order to eliminate transmission and reduce the prevalence of infection to less than 4%. Despite the good results, the main objective was not achieved. Subsequently, the PECE was replaced by the Schistosomiasis Control Program (Programa de Controle da Esquistossomose – PCE) in the 1980s[9,10]. In 1993, there was a decentralization of schistosomiasis surveillance and control actions through the creation of the Endemic Disease Control Project (Projeto de Controle de Doenças Endêmicas) in the Northeast, increasing the participation of the municipalities and the coverage of the PCE. Currently, the control of the disease depends on public policies implementation, under the responsibility of the municipal managers and it is inserted among the Primary Care activities[5].

The implementation of measures to control schistosomiasis since 1976 has led to a reduction in hepatosplenic forms and in the number of deaths. After this improvement, the disease reached a new endemic state, with an unsatisfactory response to control actions[5]. In 2010, the National Inquiry on the Prevalence of Schistosomiasis mansoni and Geo-helminths (Inquérito Nacional da Prevalência da Esquistossomose mansoni e Geo-Helmintoses – INPEG) showed a significant drop in positivity rates in all Brazilian states, with the highest prevalence rates in the North and Northeast regions, with the state of Sergipe presenting the higher proportion of positives (8.19%), much higher than that observed for the Northeast Region (1.27%)[11]. Thus, Sergipe has historically had a high prevalence for this parasitosis, with records of prevalence above 50% in municipalities in the east of the state[12,13].

Due to the difficulties in the surveillance and control of schistosomiasis, it is important to understand the dynamics of transmission and the factors associated with it[14]. The transmission of the disease occurs through water transmission in water bodies contaminated with domestic sewage. This mode of infection explains its higher prevalence in the low-income population, in particular the agricultural and fishing communities, being, therefore, associated with low socioeconomic conditions, precarious basic sanitation, poor hygiene, lack of education focused on the health and frequent contact of people with water contaminated by domestic sewage[3,11].

Besides affecting the health of the population, schistosomiasis causes major economic impacts[15]. First, this parasitosis is more disabling than lethal[3,16], reducing the number of the economically active population. In addition, schistosomiasis generates high public health costs, divided between direct costs (diagnosis and treatment of complications), direct costs unrelated to health (transportation and domestic care) and indirect costs (sickness and premature death)[17]. Tourism, in turn, is also affected, as some tourist spots have a potential risk of infection[18].

The scientific contributions about schistosomiasis were very significant. However, there is still a shortage of recent studies that picture the local condition of this disease and analyze the functioning and results of control measures. In this context, and considering that Sergipe is the state with the highest prevalence of this parasitosis in Brazil[11], this study aimed to describe the epidemiological picture of schistosomiasis in the state and to evaluate the activities related to PCE in time series analysis.

MATERIALS AND METHODS

This study analyzed schistosomiasis mansoni data in Sergipe, the smallest Brazilian state in area (21,926.908 km^2), located in the Northeast Region. Its population consists of 2,068,017 inhabitants, and the demographic density is 94.36 inhabitants/km^2. Sergipe is divided into 75 municipalities, the capital, Aracaju, is located on the coast of the state[19].

For the analysis of the epidemiological aspects of schistosomiasis mansoni, an ecological study of time series from 2008 to 2017 was conducted. Secondary data from the Information System of the Schistosomiasis Control Program (Sistema de Informação do Programa de Controle da Esquistossomose – SISPCE) of the Sergipe State Department of Health (SES/SE) and data available at the Informatics Department of the Unified Health System (DATASUS) were used. Only the municipalities considered endemic for this parasitosis (51 municipalities)[20] were part of the data collected by the PCE 20. In the period from 2008 to 2011, the data available in DATASUS[6] were similar to the data from SES/SE. However, as of 2012, DATASUS data have shown to be significantly smaller and incomplete. Therefore, for the years 2012 to 2017, information available in official SES/SE spreadsheets was used.

Annual data were compiled, by the municipality, referring to the following information: a) study population; b) number of tests performed; c) number of positives for *S. mansoni*; d) percentage of positivity for *S. mansoni*; e) number of positives per parasite load; f) number of individuals to be treated for *S. mansoni*; and g) number of individuals treated for *S. mansoni*. The registration of activities of the municipality to the SISPCE, each year, was considered adherence to the PCE.

The data were tabulated in Microsoft Excel 2016®[21] and later calculated, by year: number of exams performed; adherence percentage of the endemic municipalities to the PCE (considering the total of 51 endemic municipalities); percentage of positivity of the evaluated population; percentage of cases with high parasite load (17 or more eggs per slide – equivalent to approximately 400 eggs or more per gram of feces[22]); and percentage of treated people for schistosomiasis mansoni. The method used to perform stool parasitological examinations was Kato-Katz, recommended by the Ministry of Health for PCE[5,11].

The results were analyzed by year and as an average for the entire period, associated with the standard deviation. For the variable's percentage of positivity, percentage of positives with high parasite load and percentage of treated, it was necessary to perform a weighted average calculation, using as weights, respectively, the number of tests performed, the number of positive cases and the number of people to be treated. The calculation performed is described below, where "P" corresponds to the percentage per year and "Pe" to weight:

$$Weighted\ Average = \frac{(P_{2008} * Pe_{2008}) + (P_{2009} * Pe_{2009}) + \cdots + (P_{2017} * Pe_{2017})}{Pe_{2008} + Pe_{2009} + \cdots + Pe_{2017}}$$

Joinpoint Regression v4.7.0.0®[23] was used to construct scatter plots, relating each variable cited (dependent) to the year (independent variable), demonstrating the annual percentage change (APC), considering the 95% confidence interval (CI). Linear regression was determined by Poisson regression and the correlation between variables by Spearman's correlation, expressed by Spearman's correlation coefficient (rs), using the BioEstat v5.3®[24] software.

Finally, the spatial distribution of schistosomiasis in Sergipe was evaluated in relation to the percentage of positivity in the years of greater and lesser adherence by endemic municipalities to the PCE (2011 and 2017, respectively), through the construction of thematic maps, demonstrating the percentage of positivity of schistosomiasis mansoni by the municipality. The maps were made on the software TabWin v4.1.5[6]. The municipalities had their percentages of positivity distributed in five intervals: I) 0 to 9%; II) 10 to 18%; III) 19 to 27%; IV) 28 to 36%; and V) 37 to 45%. Based on the definitions contained in INPEG[11], municipalities with a percentage of positivity below 5% were considered of low endemicity; between 5% and 25%, medium; and above 25%, high endemicity.

RESULTS

Between 2008 and 2017, the average adherence of the endemic municipalities of Sergipe to the PCE was 72% ± 11% (36.7 ± 5.6), with the highest adherence being 88.2% (45) in 2011 and the lowest 51% (26) in 2017. A total of 677,861 exams were performed during the study period, with an annual average of 67,786 ± 23,808. The largest number of tests performed was 100,387 in 2011 and the lowest was 30,494 in 2016 (Table 1).

Table 1 – Historical series with the distribution of tests performed and percentages of municipalities joining PCE, positivity for *S. mansoni*, positive with high parasite load and treatment performed in the state of Sergipe (2008–2017)

Year	Variables				
	Number of tests performed	Percentage of municipalities joining the PCE	Percentage of positivity for *S. mansoni*	Percentage of positives with high parasite load	Percentage of treated for *S. mansoni*
2008	79,858	76.5	10.3	6.7	77.5
2009	92,957	80.4	8.8	5.4	52.3
2010	91,719	82.3	9.6	7.5	64.1
2011	100,387	88.2	8.5	7.9	75.2
2012	71,585	76.5	7.6	6.9	65.0
2013	62,542	64.7	8.1	11.9	78.5
2014	47,058	64.7	6.9	8.0	79.0
2015	61,485	70.6	7.4	8.6	77.0
2016	30,494	64.7	9.9	11.7	58.3
2017	39,776	51.0	7.1	8.8	73.3
Total period average	67,786	72.0	8.6*	7.9*	68.7*

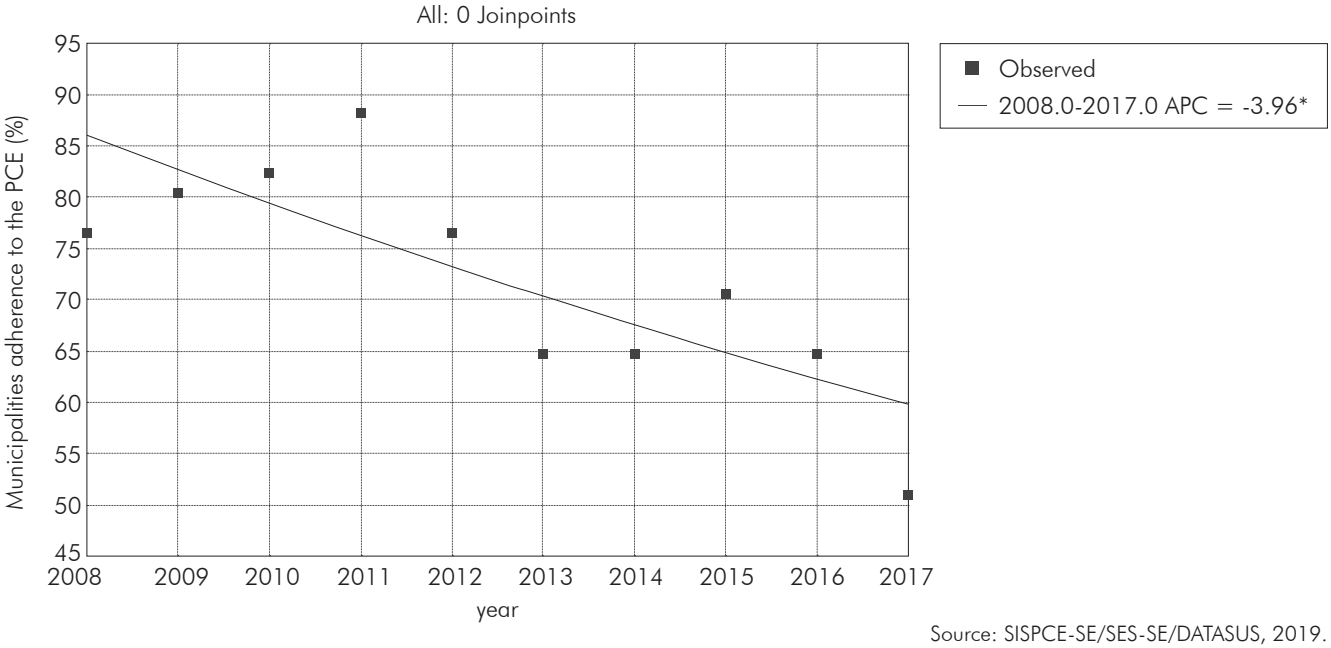
Source: SISPCE-SE/SES-SE/DATASUS, 2019.

* Weighted average, according to the number of tests performed, the number of positive cases and the number of people to be treated each year.

The average positivity for *S. mansoni* in the performed tests was 8.6% ± 1.2% (5,799 ± 2,448 positive tests), the highest percentage being 10.3% (8,258) in 2008, and the lowest 6.9% (3,227) in 2014 (Table 1). The capital, Aracaju, showed an average positivity lower than the averages for the state over the years (2.8% ± 1.2% per year), with 2010 being the year with the highest positivity (4.6%).

Among the total number of positives, there was an average of 7.9% ± 2.1% (457 ± 157) cases with high parasite load per year, reaching a maximum value of 11.9% (604) in 2013 and minimum value of 5.4% (442) in 2009. Regarding treatment coverage, there was an average proportion of 68.7% ± 9.5% (4,278 ± 1,606) patients treated per year, ranging from 58.3% (2,618) in 2016 to 79.0% (2,567) in 2014 (Table 1).

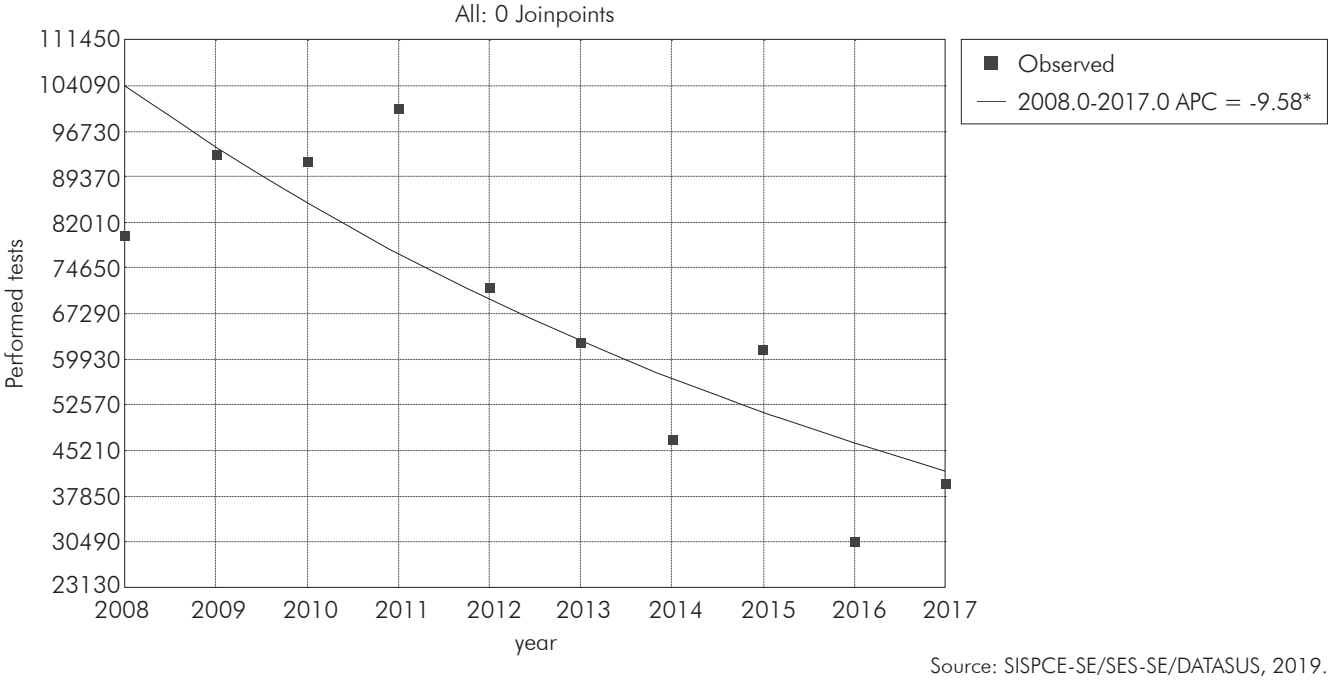
Throughout the time series studied, the percentage of Sergipe municipalities adhering to the PCE showed a statistically significant reduction trend of approximately 4% per year (APC = -3.96; CI = -1.4 to -6.4; p = 0.0007) (Figure 1). The number of exams performed by the Program also suffered a statistically significant reduction of 9.6% per year (APC = -9.58; CI = -14.4 to -4.4; p = 0.0031), which shows a decrease in the population coverage of the PCE coproscopic inquiry (Figure 2).



Source: SISPCE-SE/SES-SE/DATASUS, 2019.

* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level. Final Selected Model: 0 Joinpoints.

Figure 1 – Distribution, per year, of the proportion of municipalities in Sergipe adherence to the PCE (2008–2017)



Source: SISPCE-SE/SES-SE/DATASUS, 2019.

* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level. Final Selected Model: 0 Joinpoints.

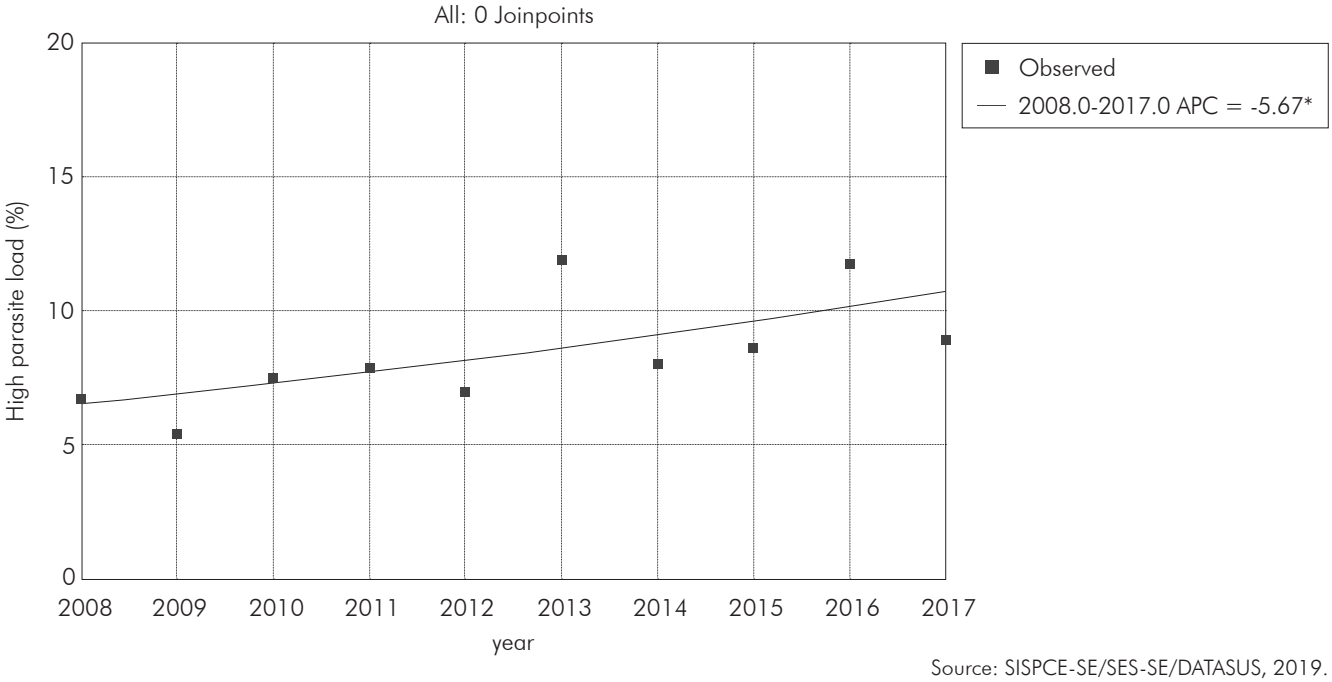
Figure 2 – Number of tests performed for *S. mansoni*, per year, in the state of Sergipe (2008–2017)

The evolution of the percentage of patients with high parasite load to *S. mansoni* showed an increasing trend, with a statistically significant percentage increase of 5.7% per year (APC = 5.67; CI = 0.4 to 11.3; p = 0.038) (Figure 3).

The linear regression analysis for the following variables did not show statistical significance: percentage of positivity for *S. mansoni* (APC = -2.49; CI = -5.6 to 0.7; p = 0.1); and percentage of treated patients (APC = 0.73; CI = -2.8 to 4.4; p = 0.7).

There was a statistically significant negative correlation between the percentage of municipalities adhering to the PCE and the percentage of patients with high parasite load (rs = -0.7139; p = 0.0203) and also between the number of tests performed annually and the percentage of patients with high parasite load (rs = -0.7091; p = 0.0216).

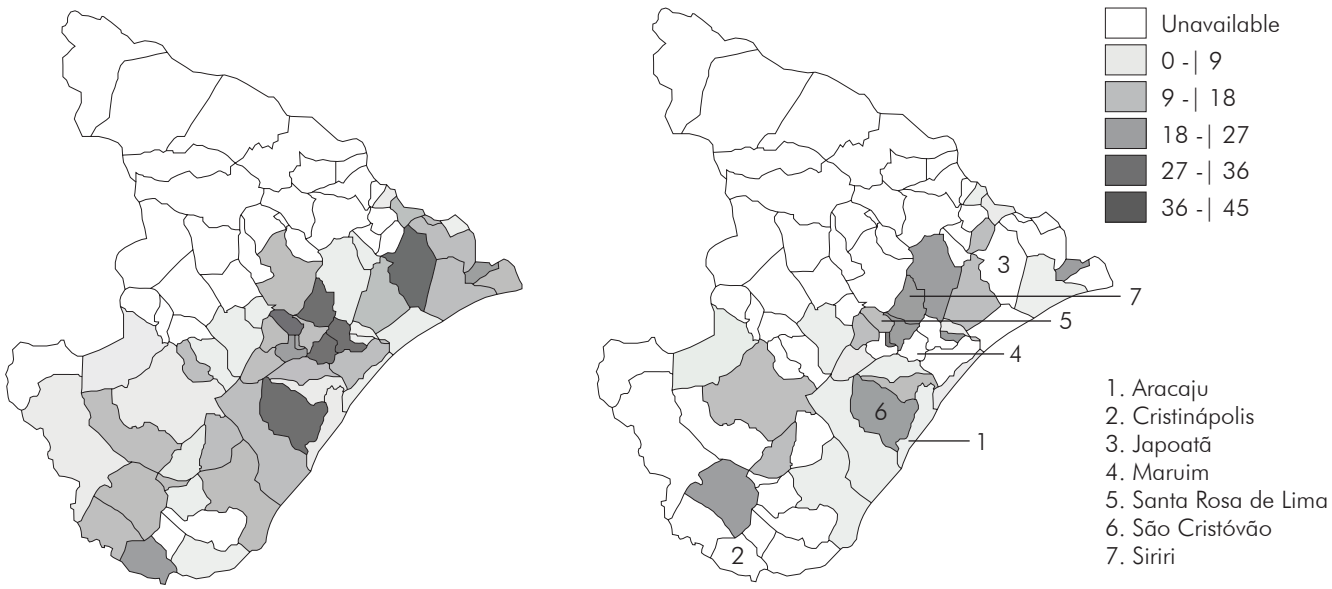
The spatial distribution of schistosomiasis mansoni in Sergipe was observed in terms of percentage of positivity (Figure 4). The years 2011 and 2017 were evaluated, in which there was the highest (45) and lowest adherence (26) of municipalities to the PCE, respectively. In 2011, 100,387 tests were performed and the average positive percentage was 8.5%, of which 75.2% were



Source: SISPCE-SE/SES-SE/DATASUS, 2019.

* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level. Final Selected Model: 0 Joinpoints.

Figure 3 – The distribution of the percentage frequency of positivity for *S. mansoni* with high parasite load in the state of Sergipe (2008–2017)



Source: SISPCE-SE/SES-SE/DATASUS, 2019.

A: 2011, year of greatest adherence of municipalities to the PCE; **B:** 2017, year of lowest adherence of municipalities to the PCE.

Figure 4 – Map of the percentage of positivity for *S. mansoni* in the state of Sergipe, in 2011 and 2017

treated. In that year, the following municipalities showed high endemicity: Cristinápolis (25.2%), Japoatã (27.1%), Maruim (28.8%), Santa Rosa de Lima (30.5%) and São Cristóvão (32.8%). In addition to these five, 30 municipalities showed medium endemicity and 10 municipalities were considered low endemicity, among which is the state's capital, Aracaju (4.4%). In 2017, 39,776 tests were performed, and the average positivity percentage was 7.1%, of which 73.3% were treated. In that year, Siriri had a prevalence of 25.5%, being the only municipality with high endemicity. Twenty municipalities showed medium endemicity and five, low endemicity, including Aracaju (1.4%).

DISCUSSION

Sergipe was identified as the Brazilian state with the highest prevalence of schistosomiasis in the last inquiry conducted in Brazil[11]. However, despite this finding, the results of the present analysis showed a reduction in attention to schistosomiasis. The number of municipalities carrying out the PCE activities, from 2008 to 2017, showed a decreasing trend and an approximate reduction of 4% per year, so that, in 2017, only 26 municipalities registered activities, excluding, even, municipalities considered highly endemic in previous periods, such as Japoatã, Maruim and Cristinápolis. This drop-in adherence to the Program has serious consequences for the state since the Health Surveillance Secretariat (SVS) provides inputs and technical and financial support based on statistical reports and analyses of the PCE from the state and municipal health secretariats[25]. A relevant fact is that this reduction in adherence to the PCE coincides with the emergence – or worsening – of other epidemics in the state, such as dengue, chikungunya, zika, among others, suggesting a possible diversion of attention from public health agencies[26,27,28,29,30,31].

As a result of the smaller number of endemic municipalities carrying out the Program's activities, the number of tests performed decreased, showing a downward trend of approximately 9.6% per year, which indicates a probable underreporting of cases. Other authors have also reported this reduction in the number of tests performed in periods similar to the one studied in this article[26,32], in parallel with the decrease in municipalities' adherence to the PCE[25]. These phenomena occurred shortly after the decentralization of endemic control actions and can generate erroneous data about the distribution of the disease in the state, as well as misinterpretations about the real scenario of the disease[25]. Added to this, the disagreement of information, as of 2012, between DATASUS and the data from SES/SE which, in addition to contributing to such errors of interpretation, point out flaws in the flow of registration of notifications between municipalities, states and the Union.

The proportion of positive tests for schistosomiasis fluctuated during the study period, with an average of 8.6%. In 2011, the year of greatest adherence by the municipalities, positivity was 8.5%, a percentage similar to the 10-year average and higher than the northeastern average in the same year[33], as well as that of other states with a high prevalence of the disease, such as Alagoas[34]. Although positivity does not express the prevalence of the disease since coproscopic inquiries are not carried out for this purpose and are not based on a representative population sample, the average found is also similar to the prevalence obtained in the national inquiry (8.19%) carried out between 2010 and 2015[11]. In fact, Sergipe is a historically endemic state, with favorable conditions for establishing this parasitosis[25,35,36,37]. In 2010, the state had a deficit in basic sanitation, with nearly the double of the percentage of people living in households with inadequate water supply and sewage services (11%) in relation to the country (6%)[38].

Regarding the municipal prevalence in the most recent period evaluated (2017), Ilha das Flores, Itabaianinha, São Cristóvão and Siriri stand out, which registered a positivity rate higher than 20%. These municipalities had Municipal Human Development Indexes (MHDI) considered medium in 2010 (0.562; 0.556; 0.662; and 0.609, respectively) and notably lower than the national MHDI (0.727)[39]. The capital of Sergipe, with a high MHDI (0.770)[38], however, showed a 4.6% positivity in the same year. This comparison may indicate a relationship between the degree of human development and the prevalence of schistosomiasis, as long as the links in the transmission chain are present[40]. In addition to the low socioeconomic conditions and the deficit in infrastructure being determinants of the high prevalence of schistosomiasis[26], the heterogeneity and irregularity in the execution of control programs[41] should also be recognized as contributing to the inequality of positivity between the municipalities. In 2017, for example, several municipalities considered highly endemic did not register actions of the PCE (Figure 4).

Another important fact is the change in the dynamics of disease transmission in response to environmental changes caused by man. It is known that, with urbanization, large areas of the soil are waterproof, which makes it difficult to drain rainwater and enables the formation of swamps that are often contaminated with domestic effluents. Therefore, the transmission of schistosomiasis has become not only associated with ponds and other reservoirs in rural areas, but also with peridomicile puddles in urban areas, with an increase in autochthonous cases[42,43,44,45]. This transmission mechanism can be avoided after implementing measures for adequate rainwater drainage and sewage treatment[46].

Concerning the severity of the infection, this study exposed an increase in the parasite load, going from 5.4% (2009) to 11.9% (2013), with values remaining above 8% since 2013, in contrast with the historical reduction observed in other Brazilian states after the adoption of control programs[34,47]. The increased parasite load was correlated with the reduction of the activities of the program and the number of tests performed. This combination may be the result of the weakening of actions for early diagnosis, although the possibility of bias

regarding the non-adherence of municipalities that could have lower percentages of high parasite load should be considered. However, municipalities of medium and high endemicity are also failing to conduct the activities of the PCE (Figure 4). The observation of increased parasite load is very relevant, since the intensity of the infection has been having a direct relationship with the severity of the disease, with serious consequences for the patient and an increase in the cost for health services[48]. In addition, treatment coverage presented an average of 68.7% ± 9.5%, a percentage lower than the 80.0% treatment target defined by PCE[5]. This deficit may reflect flaws in the planning of actions, such as the active search for patients at times incompatible with their routine, or the difficulty of the patient's access to Primary Care health services[32].

In 2012, the Ministry of Health released the "Integrated plan for strategic actions to eliminate leprosy, filariasis, schistosomiasis and onchocerciasis as a public health problem, trachoma as a cause of blindness and control of geo-helminthiasis" in which, among its objectives, it aimed to eliminate schistosomiasis as a public health problem in endemic municipalities by 2015. One of the objectives of this plan was to cover 100% of the treatment of positive cases[16]. As this analysis demonstrates, in addition to not reaching the programmed goals, there was a setback in the state of Sergipe, a situation that was also reproduced in other Brazilian states[34].

This study presents as a limitation the use of secondary data, generated from the execution and registration of PCE data, which may have been different in each municipality, such as the scope and frequency of inquiries and insertion in primary care. However, it is useful in terms of recognizing the scenario of possible loss of PCE priority in Sergipe. Only with the resumption of the implementation of the control program and the execution of new measures along with the implementation of the National Basic Sanitation Plan[49], Brazil can approach the goal of eliminating schistosomiasis as a public health problem by 2025, defined by WHO[3].

CONCLUSION

According to data analysis, there was a decrease in the activities of the PCE in the cities of Sergipe during the period from 2008 to 2017. In addition, there was a tendency to increase cases with high parasite load and, probably, severe cases with a consequent increase in public health costs for the state. In no year was the target of 80% treatment coverage set by the Program reached. These observations reveal the difficulties in controlling schistosomiasis in the most prevalent state in Brazil.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHORS' CONTRIBUTION

All authors contributed to the idealization of the text, analysis and interpretation of the data, participating in the writing and proofreading of the manuscript and in the approval of the final published version. The authors declare themselves responsible for the full content of the article, guaranteeing its accuracy and integrity.

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