CHAPTER 1

SCHISTOSOMIASIS MANSONI IN THE STATE OF MARANHÃO, BRAZIL, FROM 2007 TO 2016: TEMPORAL ANALYSIS AND SOCIOECONOMIC FACTORS

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ABSTRACT: Objective: Our aim is to carry out a temporal analysis of the percentage of positivity for schistosomiasis mansoni in the state of Maranhão, Brazil, from 2007 to 2016, highlighting the socioeconomic factors related to the positivity of schistosomiasis in Maranhão. **Methodology**: The indicators of the Control Program on Schistosomiasis were gathered and secondary data on Health Regions and their municipalitieswereanalyzed.The percentage of positivity of the examined population and the coverage of the program were calculated: number of people studied and examined, proportion of endemic/studied municipalities (%) and treatment coverage (%).For the analysis of the positivity trend of schistosomiasis cases over the period, annual percentage change (APC) was calculated. A trend analysis of schistosomiasis correlated with other intestinal parasitic diseases was also carried out.In order to analyze the relationship between the socioeconomic variables of the Health Districts and the positivity rates, the Spearman correlation test was performed. **Results**: In the period, 1,024,413 individuals were surveyed, with 899,672coproscopic exams performed. 34,806 people positive for *S. mansoni* were diagnosed, resulting in a positivity rate of 3.87, which was considered stable over the period.The Health Regions including the municipalities of Baixada Maranhense microregion presented the highest positivity rates. Garbage collection showed a weak correlation with the positivity rate of schistosomiasis. **Conclusions**: Through the data analyses, it was found out that the state showed a tendency towards stability in the positivity rate of schistosomiasis in the period. The microregion known as Baixada Maranhense constitutes an important hostspot of the disease in the state, due to biotic factors associated with precarious environmental conditions and low socioeconomic indicators of the population living in this region, collaborating for this scenario. Therefore, an integrated approach may be necessary for the effective control of the disease in the State.
KEYWORDS: Neglected Tropical Diseases, Epidemiology, Schistosomiasis, Temporal trend.

INTRODUCTION

Schistosomiasis is a helminthiasis transmitted by freshwater snails, whose genera *Biomphalaria* Preston, 1910, *Oncomelania* Gredler, 1881 and *Bulinus* Müller, 1781 are distributed mainly in countries in Africa, Asia and Latin America, including Brazil and affects about 250 million people worldwide[1-3]. Its etiological agent belongs to the genus *Schistosoma* Weinland, 1858, a trematode that, combined with the snail (intermediate host), man (main definitive host) and socio-environmental determinants, establishes a strong epidemiological cycle for the transmission of the parasitosis[4].

It is estimated that the transmission of schistosomiasis in Brazil promotes the infection of 6 million people and that 25 million are exposed to the vulnerability of contracting the disease[5]. The National Survey of Prevalence of Schistosomiasis and Geohelminthiasis, conducted from 2010 to 2014, revealed that the large Southeast and Northeast regions of the country have higher positivity rates, 2.35% and 1.27% respectively. Sergipe (10.7), Pernambuco (3.8), Alagoas (3.4), Minas Gerais (5.8) and Bahia (2.9) showed the highest proportions of positive cases in areas with population of up to 500,000 inhabitants[6].

It is a fact that schistosomiasis is present in Brazil in a more intensified way in the 19 Federated Units, seven of which are located in the Northeast (Pernambuco, Sergipe, Alagoas, Bahia, Paraíba, Maranhão and Rio Grande do Norte). This high prevalence and permanence of the cycle in this region is related to poor basic sanitation, poor access to health centers and delays in diagnosis and treatment[7]. One of the states in the Northeast that has a high occurrence of this parasitosis is Maranhão, where it has been reported since 1920[8]. Of the 217 of its municipalities, it is endemically present in 20 of them and with a focus on 29. The high prevalence is concentrated mainly in the North Coast and Baixada Maranhense region[9].

As it is a disease linked to underdevelopment, the occurrence of schistosomiasis is directly related to its high prevalence in low-income populations, accompanied by factors such as poor sanitation, lack of health education, poor hygiene conditions and the presence of the intermediate host in water collections[10]. With the aim of controlling the spread of the disease in Brazil, the Special Program for the Control of Schistosomiasis (PECE) was created in 1975, replaced in the 1980s by the Program for the Control of Schistosomiasis (PCE), which became a regular initiative of the Ministry of Health (MS)[11]. Currently, disease control occurs through actions carried out at the municipal level, such as demographic delimitation, census coproscopic surveys, treatment of infected people, epidemiological surveillance and annual feed of the PCE Information System (SISPCE)[12].

Given the few epidemiological studies on schistosomiasis in the state of Maranhão, as well as works that carry out a temporal analysis of the disease and the factors that interfere with it, it is extremely important to carry out a thorough verification of the relationship between environmental, social and economic indicators and the number of positive cases of the disease in the state. Thus, the present study aims to carry out a temporal analysis of the percentage of positivity for schistosomiasis mansoni in the state of Maranhão, Brazil, from 2007 to 2016, highlighting the socioeconomic factors related to the positivity of schistosomiasis in Maranhão.

METHODS

An observational analytical study was carried out, with an ecological design, in which secondary data sources were used.

STUDY AREA

The area considered for this study was the state of Maranhão, which has 217 municipalities, spread over an area of 331,936.949 km², being considered the second largest state in the Northeast region and the eighth largest in Brazil. Its population was 6,574,789 people, according to the census carried out in 2010. The composition of the population was 63.08% urban and 36.92% rural. The state's Human Development Index (HDI) is 0.639. The monthly household income per capita is R$ 597.00[13].

Regarding the basic sanitation service, only 19.3% of households in the state had adequate sewage, that is, they use a septic tank or a sewage collection and treatment network[13].

The state is divided into 19 Health Regions (also called Health Regions). The São Luís Region is made up of the state capital and the four municipalities that make up its Metropolitan Region: Alcântara, Paço do Lumiar, Raposa and São José de Ribamar. The Pinheiro and Zé Doca Health Regions cover the largest number of cities: 17 municipalities each. These two regions, together with the Viana Region, cover the municipalities located in the Baixada Maranhense micro-region. For initial analysis, the 19 Health Regions were considered, which constituted the unit of analysis of this study.

STUDY POPULATION

The population included in the analysis was the "population surveyed", denomination given by the PCE-MA, which consists of the number of people who are considered for the coproscopic survey carried out by the program, that is, those who received the container for collecting the material for examination. This population is reached by the active search carried out by the program. Cases notified by SINAN were also included, which are registered by passive demand, that is, when the infected person seeks the health service for diagnosis and treatment of the disease.

VARIABLES ANALYZED

Dependent variable

Within the scope of the PCE, positivity for schistosomiasis is considered the percentage of positive cases recorded over a period of time. For the analysis of the historical series of positive cases of the disease in the Health Regions of Maranhão, the total number of tests performed and the number of people with eggs (1-4, 5-16, ≥17) in the period from 2007 to 2016 were considered.

For the calculation of positivity it was considered:

$$\frac{\textit{number of people with eggs}}{\textit{total number of exams performed}} \times 100$$

The positivity of each Region corresponds to the ratio of the number of cases to the number of tests carried out in the municipalities belonging to it and which had this data. Municipalities that did not present a positivity rate were excluded from the study.

In addition to positivity, the other operational indicators of the PCE were also considered: population surveyed, population examined (exams performed), municipalities studied and endemic, people to be treated between the years 2007 and 2016.

DATA SOURCE

Data reported by the Schistosomiasis Control Program (PCE-MA) of the State Health Secretariat (SES) were collected, between the years 2007 and 2016, made available through the Schistosomiasis Control Program Information System (SISPCE. http: //tabnet.datasus.gov.br/cgi/deftohtm.exe?sinan/pce/cnv/pcema.def). The data are the results of coproscopic surveys and malacological surveys in endemic areas of the State.

The socioeconomic data related to the municipalities included in the Health Regions considered for this research came from the censuses of the Brazilian Institute of Geography and Statistics (IBGE. https://www.ibge.gov.br/pt/inicio.html), through the following platforms: IBGE Automatic Recovery System – SIDRA, IPEADATA and Atlas of Human Development in Brazil. These banks calculate their variables based on microdata from various IBGE surveys (National Household Sample Survey, Demographic Census).

STATISTICAL ANALYSIS

Initially, the operational indicators of the PCE were surveyed, from which the percentage of positivity of the examined population and the coverage of the program were calculated: number of people studied and examined, proportion of endemic/studied municipalities (%) and treatment coverage (%).

For the analysis of the positivity trend of schistosomiasis cases over the period, annual percentage change (APC) was calculated with a confidence interval (CI) of 95%, using the Joinpoint method for modeling, where positivity was considered as a response variable and years as a regression variable. Models were only obtained from those Regionals that had data for the complete series of years.

A trend analysis of schistosomiasis correlated with other intestinal parasitic diseases was also carried out. For this purpose, the Prais-Winsten regression model was considered. To adjust the model, the percentage of positivity on a logarithmic scale was considered as the dependent variable, and the period of the series as the independent variable.The trend was considered stable when the regression coefficient did not differ from zero ($p > 0.05$).

In order to analyze the relationship between the socioeconomic variables of the Health Districts and the positivity rates, the Spearman correlation test was performed, since the data distribution was not normal.

The schistosomiasis trend analysis tests were performed using the Joinpoint Regression Program software, Version 4.7.0.0. (National Cancer Institute. https:// surveillance.cancer.gov/joinpoint/). Correlated trend data (Prais-Winsten regression) were analyzed using the STATA program, version 14.0. The other tests were carried out using the Statistical Package for the Social Sciences software (SPSS. International Business Machines - IBM) and plotted in Microsoft Office package Excel (version 2201, Microsoft, USA).

ETHICAL CONSIDERATIONS

The data used in this research were obtained from secondary sources and in the public domain, in which there is no nominal identification of patients, thus respecting the ethical aspects of Resolution No. 466/2012 of the National Health Council.

Indicator	Description
IDHM	Municipal Human Development Index. Geometric mean of the indexes for the dimensions of Income, Education, and Longevity, with equal weights (Source: Human Development Atlas in Brazil).
Percentage of Urban Population	Ratio between the population living in urban areas and the total population, multiplied by 100 (Source: IBGE, 2010 Demographic Census).
Households with Inadequate Water Supply and Sanitation	Ratio between the number of people living in households where the water supply is not from a general network and the sanitation is not done by a sewerage system or septic tank, and the total resident population in permanent private households, multiplied by 100. Only permanent private households are considered (Source: IPEADATA).
Type of Sanitation	Ratio between the population living in permanent private households according to the type of sanitation and the total resident population in permanent private households, multiplied by 100. The following types of sanitation were considered: General network, Septic tank, Rudimentary cesspit, Ditch, river, lake or sea, and No sanitation (Source: IBGE, 2010 Demographic Census).
Water Supply	Ratio between the population living in permanent private households according to the type of water supply and the total resident population in permanent private households, multiplied by 100. The following forms of water supply were considered: General network, Well or spring on the property, River, dam, lake, etc. (Source: IBGE, 2010 Demographic Census).
Garbage Collection	Ratio between the population living in households with garbage collection and the total resident population in permanent private households, multiplied by 100. Situations where garbage collection is done directly by a cleaning service or collected in a service cleaning bin were included (Source: IBGE, 2010 Demographic Census).
Health and Sanitation Expenditures	Average annual expenditure (in BRL) per municipality between the years 2007 and 2011 on the health and sanitation sectors (Source: IPEADATA).

Table 1. Socioeconomic and Health Indicators of Health Regions

RESULTS

Temporal analysis of *Schistosoma mansoni* positivity from 2007 to 2016 in the state of Maranhão

From 2007 to 2016, the PCE-MA listed 1,024,413 individuals as population surveyed. A total of 899,672 coproscopic examinations were carried out during the period (corresponding to 87.82% of this population). 34,806 people positive for *S. mansoni* were diagnosed in the state of Maranhão between 2007 and 2016. Detailed information on operational indicators can be found in a previously published table.[14].Adopting the positivity calculation, a percentage of 3.87 was obtained for the period under analysis. The highest prevalence rate (4.97) was recorded in 2010 and the lowest (2.54) in 2016 (Figure 1).

The state of Maranhão showed a stable trend in the schistosomiasis mansoni positivity rate (APC = 4.11; CI = -8.5 to 0.5; p > 0.05). The State of Maranhão has always been below the positivity in Brazil, except for 2015, when it was observed that the state positivity (3.23) was slightly above the national positivity (3.16) (Figure 1).

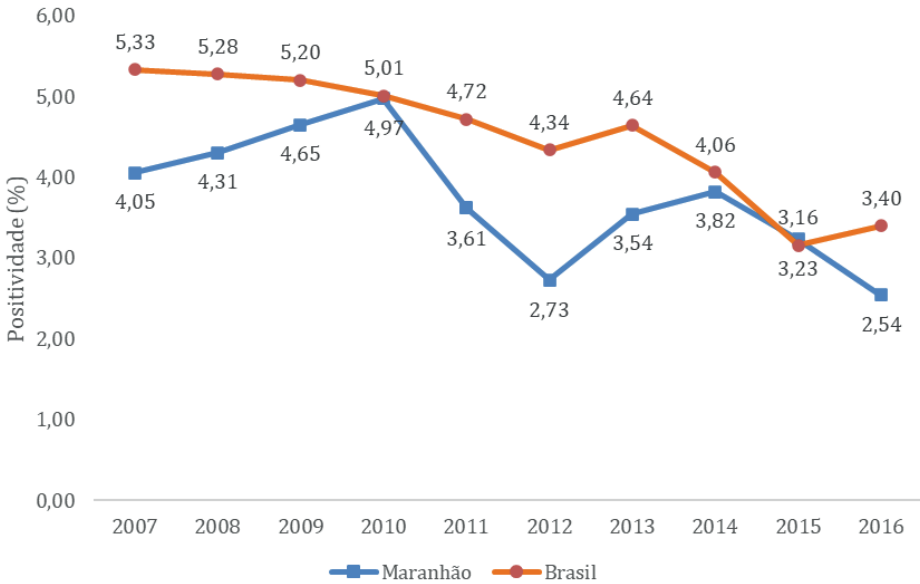


Figure 1. Positivity rates for schistosomiasis in Maranhão and Brazil, 2007-2016

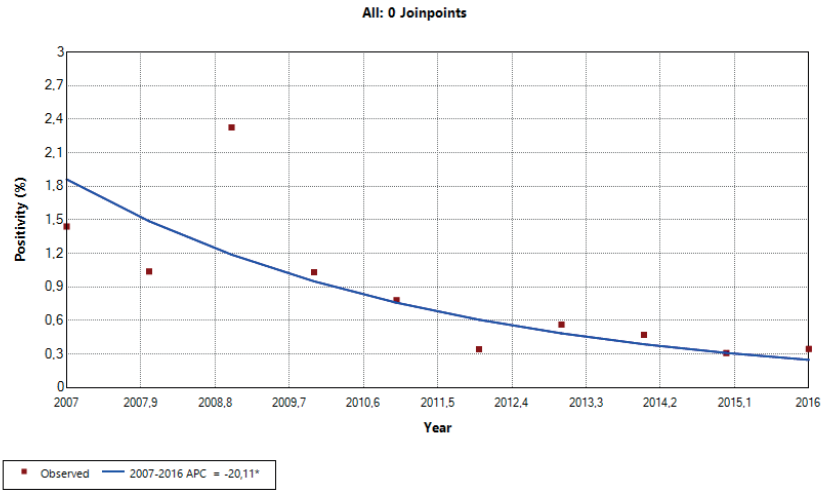
Among the municipalities worked, 87.37% registered positive cases of *S. mansoni* during the period. On average, 77.71% of municipalities recorded positivity rate <5%. The proportion of municipalities that presented positivity ≥5% and <25% was 20.53%. Municipalities with positivity ≥25% and <50% were 1.48%. Only one municipality (Bequimão – HR Pinheiro) had positivity greater than 50% in 2009.

During the period under study, some HR presented significant prevalence rates, as is the case of the Pinheiro Region, followed by the Viana and ZéDoca Regions. The Caxias and Itapecuru Regions had the lowest positivity rates. The Units of Açailândia, Bacabal, Balsas, Codó, Imperatriz, Pedreiras, Presidente Dutra, Santa Inês, and Timon were excluded from the present study due to incomplete or non-computable data.

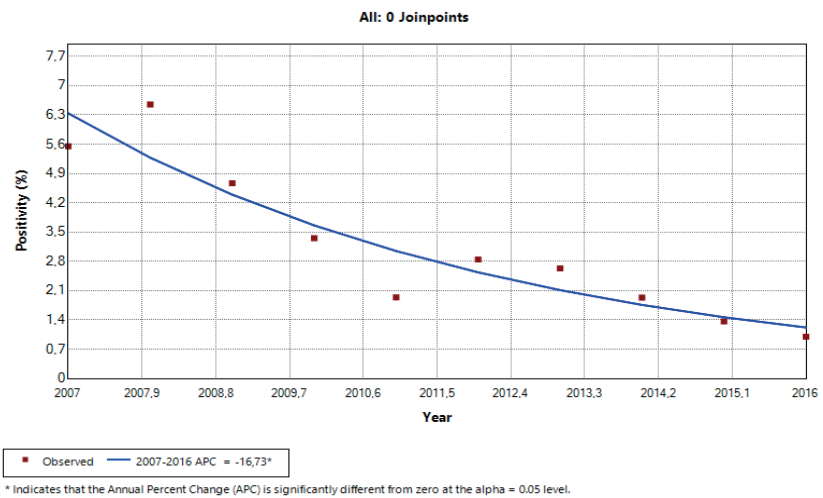
When positivity was analyzed by Health Region, two Regions showed a tendency towards a decrease of cases statistically significant ($p < 0.05$). The São Luís Region demonstrated the greatest downward trend (APC = -20.11; CI= -30.7 to -7.8; $p < 0.05$) (Figure 2a), followed by the ZéDoca Region (APC = -16.72; CI = -22.0 to -11.1; $p < 0.05$) (Figure 2b).

The Regions of Chapadinha, Pinheiro, São João dos Patos and Viana, although showing a reduction in the number of cases, have a stable trend, indicating that these Regions actually have a stationary series. The annual variation rates for these Regions were: Chapadinha (APC = -6.01; CI = -15.9 to 5.0; p > 0.05); Pinheiro (APC= -4.16; CI = -8.6 to 0.5; p > 0.05); São João dos Patos (APC= -4.75; CI= -10.5 to 1.4; p > 0.05); Viana (APC= -2.77; IC= -7.9 to 2.7; p > 0.05) (Figures 2c to 2f). For the other Regions (Barra do Corda, Caxias, Itapecuru-Mirim, Rosário) it was not possible to generate a temporal trend due to insufficient data for the period.

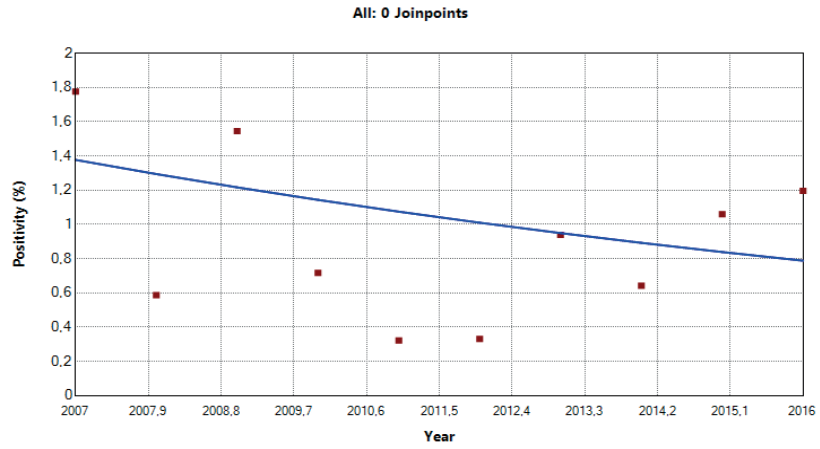
2a) São Luís Regional



2b) Zé Doca Regional

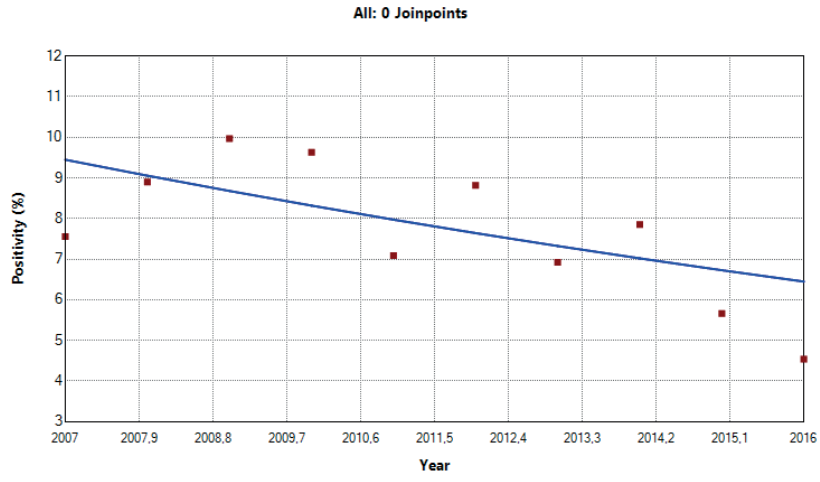


2c) Chapadinha Regional



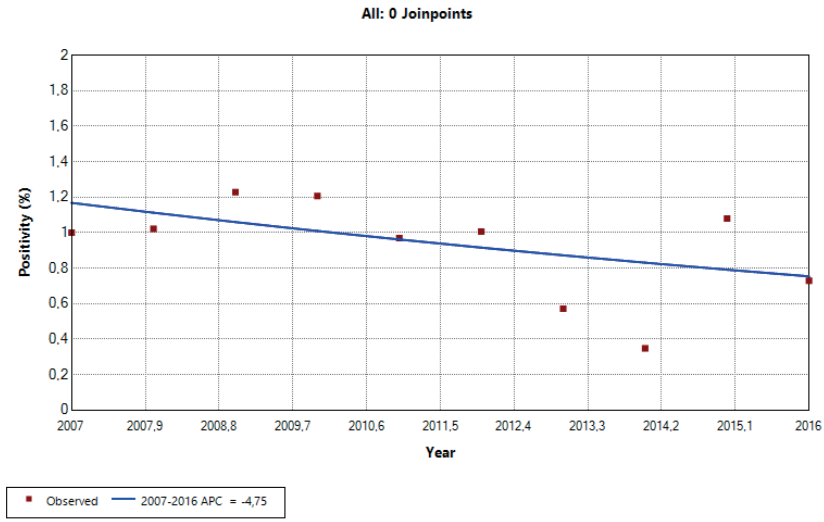
* Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.
Final Selected Model: 0 Joinpoints.

2d) Pinheiro Regional



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

2e) São João dos Patos Regional



2f) Viana Regional

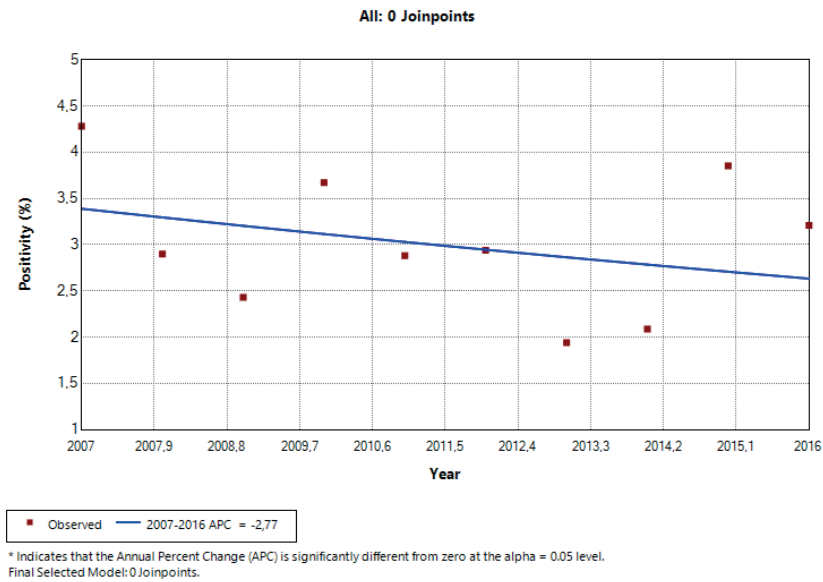


Figure 2. Observed and expected positivity rates by Health Regions of the state of Maranhão, 2007-2016.

When analyzing the trend of schistosomiasis correlated with other parasitic diseases (geohelmintoses) worked on by the PCE in each year of the time series, a change in the disease trend was observed. In this model, an increasing trend was noted in the state of Maranhão (Coef = 0.042; p < 0.001), with an increase rate of 10.27% (Table 2).

The highest rate of positivity growth occurred in the Viana Region, which was 18.61% (Coef = 0.074; p = 0.004), followed by the Regions of São Luís with 14.92% (Coef = 0.603; p = 0.001), Chapadinha, with 14.13% (Coef = 0.057; p < 0.001), Rosário, with 9.47% (Coef = 0.279; p = 0.001), Pinheiro, with 6.18% (Coef = 0.026; p < 0.002) and São João dos Patos, with 4.76% (Coef = 0.129; p < 0.001) (Table 2).

The Regions that showed a stable trend were Caxias (Coef = -0.109; p = 0.084), Itapecuru-mirim (Coef = 0.094; p = 0.077) and Zé Doca (Coef = 0.019; p = 0.673). The only Region that showed a decreasing trend was Barra do Corda, with -6.54% (Coef = -0.029; p < 0.001) (Table 2).

Regionals	Prevalence of schistosomiasis			
	Coefficient	p-valor*	Trend **	Rate of change
São Luís	0.6039	0,001	growing	14,92%
Caxias	-0,1097	0,084	stable	---
Barra do Corda	-0,0293	<0,001	descending	-6,54%
Chapadinha	0,0574	0,041	growing	14,13%
Itapecuru-mirim	0,0941	0,077	stable	---
Pinheiro	0,0260	0,002	growing	6,18%
Rosário	0,2798	0,001	growing	9,47%
Viana	0,0741	0,004	growing	18,61%
São João dos Patos	0,1295	<0,001	growing	4,76%
Zé Doca	0,0191	0,673	stable	---
Maranhão	0,0424	<0,001	growing	10,27%

*Significantly different from zero (p<0.05).**Trends were classified as increasing (p ≤ 0.05 and positive regression coefficient); decreasing (p ≤ 0.05 and negative regression coefficient); and stable (p > 0.05).

Table 2. Prais-Winsten regression model of schistosomiasis prevalence by Health Regions in the state of Maranhão, 2007-2016

Socioeconomic determinants related to the prevalence of schistosomiasis in Maranhão

After correlation analysis, it was found that the indicators water supply, inadequate sanitation and garbage collection showed a weak correlation with the positivity rate of schistosomiasis. The other indicators did not show a significant correlation with the positivity of the disease (Table 3).

The indicator inadequate water supply and sanitation showed a positive correlation with the positivity rate of schistosomiasis in the Regions ($r = 0.3941$; $p < 0.01$). The indicator garbage collection showed a negative correlation with positivity ($r = -0.3092$; $p < 0.05$).

Indicators	r	p-valor
Inadequate water supply and sanitation	0.3941	0.0081
Garbage collection	-0.3092	0.0411

*Indicators that showed a significant correlation.

Tabela 3. Spearman correlation coefficient between the positivity rate and socioeconomic indicators* in Maranhão

DISCUSSION

In a study similar to this, Mendes et al (2022)[14], analyzing the spatial distribution in the state of Maranhão in the same period, reported that the average positivity of schistosomiasis for the state of Maranhão (3.87) remained below the Brazilian average (4.77), only matching this in the years 2010 and 2015. The temporal analysis also showed that although there was a tendency to reduce positivity in Maranhão, this is not significant, concluding that there is a stable trend in the schistosomiasis rate in the state.In fact, another study that analyzed the temporal trends and spatial and spatiotemporal distribution of schistosomiasis mansoni in northeast Brazil between 2005 and 2016 found out that the tendency of the disease in Maranhão was descending, although with a significant difference, indicating that the reduction was real[15].

Between the years of 1947 and 1952, Pellon and Teixeira carried out the first inquiry on schistosomiasis, which comprised nine states of Northeast Region, besides the states of Espírito Santo and Minas Gerais and revealed a prevalence of 10%. Two other inquiries followed this one. The second one (1975-1979), carried out in the context of the implementation of the Special Program for the Control of Schistosomiasis - PECE, examined 447,786 students, from which 30,068 tested positive, reaching a prevalence of 6,7%. The most current Schistosomiasis and Geohelminth Prevalence Survey, which covered all states of the Federation, has surveyed 197,564 schoolchildren aged 7 to 17 years old. The results showed that Northeastern and Southeastern regions of the country had the highest rates of positivity, 1.27% and 2.35%, respectively. The data brought by these surveys reveal that there is a trend of reduction in the rate of positivity of the disease in the country. However, the Northeastern and Southeastern regions still remain important areas for the spread of the endemic disease[16].

When we analyze the international context of the disease, the prevalence of schistosomiasis has also decreased over the years, mainly in South American and Asian

countries. Morocco and some countries in the Caribbean islands have made significant progress in controlling and managing the disease. Brazil, China and Egypt are taking measures to eliminate the endemic disease, such as implementing their own surveillance and control programs, chemotherapy treatment and water distribution through the general network (plumbing). Most sub-Saharan countries, however, still agonize under the weight of the disease[17].

Schistosomiasis is the second most common neglected tropical disease in sub-Saharan Africa. This region is home to 93% (192 million) of the world's 207 million cases of schistosomiasis. The highest prevalence of this infection is seen in Nigeria (29 million), closely followed by the United Republic of Tanzania (19 million), Ghana and the Democratic Republic of Congo (15 million), which make up the top five countries in Africa that record infection. by *S. mansoni*. The main factors responsible for the persistence of schistosomiasis transmission in the region include climate change and global warming, proximity to water bodies, irrigation and dam construction, as well as socioeconomic factors, such as occupational activities and poverty[17].

This scenario with its biotic, social and economic factors is similar to some regions of Brazil, such as the Northeast region, and consequently, the state of Maranhão. The Maranhão Epidemiological Situation Report for 2011 showed that schistosomiasis was considered endemic in 20 municipalities and focal in 29 of the 217 existing municipalities. The North Coast and Baixada Maranhense regions, according to the report, concentrated the oldest epidemics and the highest prevalence rates when compared to others.

Mendes et al (2022)[14] brings similar results, showing that schistosomiasis has two main endemic nuclei in Maranhão, highlighting the epidemiological importance of the Baixada Maranhense, an area considered endemic and comprising the Pinheiro, Viana, and Ze Doca Regions (partially), with positivity rates of 7.69, 3.07, and 3.18 respectively. With more than 500 thousand inhabitants, Baixada Maranhense is a geographic micro-region located on the banks of the GolfãoMaranhense and has a predominantly rural population. The region's economy is largely made up of agriculture, especially family and subsistence agriculture, such as babassu vegetable extraction, artisanal fishing and small family farming. Rice cultivation, for example, has great socioeconomic importance for the region, as families take advantage of the flooded region to grow this crop[18].

The environmental characteristics of the area, added to the economic activities performed there, create a favorable scenario for the spread of several diseases. For example, schistosomiasis was recorded in the area because of the presence of snails *B. glabrata* and *B. straminea*, which are epidemiologically important species of the disease. The presence of floodplains for long periods of the year contributes to the reproduction of those molluscs, which later transmit the disease to humans. Ramos et al. (1970)[19] concluded that floods can promote the spread of schistosomiasis, creating conditions for new outbreaks.

In Maranhão, studies show that the species *B. glabrata* and *B. straminea* cohabit different regions of the state. Cantanhede et al. (2014)[20], in a study on freshwater gastropods in the endemic area of Baixada Maranhense, found the presence of *B. glabrata* specimens in five municipalities, and *B. straminea* in nine. These species were observed in synanthropy in two biotopes in Pinheiro and four biotopes in São Bento. On the east coast of Maranhão, in the municipality of Tutóia, snails of the species *B. glabrata* were found, of which 8.3% were infected by *S. mansoni*[21]. In the city of São Luís, studies identified the two species of gastropods in two neighborhoods on the outskirts of the capital, however, only *B. glabrata* snails were infected[22-24]. Em um estudo sobre a análise epidemiológica da esquistossomose em áreas de risco em São Luís, Nascimento (2011)[25] encontrou que os bairros que apresentaram prevalência mais alta para a doença reuniam as mesmas condições ambientais de cidades do interior do estado.

In addition to environmental factors, socioeconomic characteristics of the municipalities that belong to these Regions also help to explain the maintenance of schistosomiasis in the state. According to Cantanhede et al. (2011)[26] "low socioeconomic development and the absence of health education and sanitation actions are important characteristics in the context of factors that act as determinants for the transmission and establishment of this parasitic disease".

In China, the morbidity and prevalence of helminthiasis has decreased significantly in the last 50 years, being considered one of the most successful countries in controlling these diseases, especially schistosomiasis, which is already in the pre-elimination stage. In addition to routine activities such as chemotherapy, molluscicide treatment in snail habitats and health education, other important interventions including mechanization of livestock farming, prohibition of pastures along rivers, improvement of sanitary conditions through the provision of drinking water, construction of toilets and latrines, construction of gas tanks and the provision of fecal matter containers for fishing boats were integrated into the control of schistosomiasis[27].

The years included in this study correspond to the stage subsequent to the decentralization of the PCE, in which municipalities took over schistosomiasis control actions, starting in 1999. It can be noted that the PCE-MA underwent a broad reduction in its activities throughout the analyzed period. There was a significant reduction in the total number of people worked, exams carried out and the number of people treated.

As measures to prevent and control schistosomiasis, the Control Programs have two main combat fronts: the identification of *S. mansoni* carriers, through biannual coproscopic surveys and the demand for health services and the treatment of carriers to reduce the parasitic load and prevent emergence of severe forms of the disease. In addition to this, other measures must be taken, such as environmental sanitation, which is also listed as one of the main measures in preventing schistosomiasis, as it creates conditions that reduce the proliferation and contamination of intermediate hosts, with a consequent reduction in human contact with transmitting agents (infected snails)[28].

Some special programs have been developed to tackle neglected diseases, as a complement to regular control programs. In the state of Pernambuco, the Sanar Program, established in 2013, aims to reduce or eliminate some neglected communicable diseases as a public health problem. The Program selected 40 municipalities located in endemic areas of Pernambuco, in which actions to control schistosomiasis and geohelminthiasis were intensified. These cities were selected because they had an annual average positivity rate greater than 10%, between 2006 and 2010. A logical model was then used to control the disease, developed within five main components: management, epidemiological surveillance, laboratory support, patient care and health education and communication. The great differential attribute of the program was that, in addition to providing assistance to municipalities, it was also the executor of actions with the development of interventionist activities[29].

In Maranhão, in 2015 the "Mais IDH" Program was launched, which is the current government's main program to combat extreme poverty and social inequalities in the 30 municipalities with the lowest HDI in Maranhão. In the area of health, in addition to other actions, the program proposes to carry out health stations and active search for patients at risk and/or symptomatic for neglected endemic diseases[30].

Based on all these perspectives, investing in the quality of the Schistosomiasis Control Program is essential if managers aim to control the disease in their municipality, district, region or state, following the example of other countries that have already achieved success by applying the necessary efforts to such.

CONCLUSION

It is possible to conclude that the Maranhão State presented a tendency towards stability in the positivity rate of schistosomiasis between 2007 to 2016**.** The Health Regions including the municipalities of Baixada Maranhense presented the highest positivity rates. This fact can be explained by the presence of biotic factors associated with precarious environmental conditions and low socioeconomic indicators of the population living in this region. An integrated approach may be necessary for the effective control of the disease in the state, which can include preventive actions such as sanitation and information, suitable treatment of infected people and strengthening health programs.

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DECLARATIONS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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