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Short Communication

Schistosomiasis mansoni in the northeast region of brazil: temporal modeling of positivity, hospitalization, and mortality rates

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Abstract

Introduction: We aimed to analyze trends in Schistosomiasis positivity, mortality, and hospitalization rates in Northeast Brazil. **Methods**: We conducted an ecological study using data from the Brazilian Schistosomiasis Control Program, and Hospital and Mortality Information Systems. A joinpoint regression model was used for temporal analysis. **Results**: The positivity(−4.7%;p<0.001) and hospitalization(−17.7%;p<0.001) rates declined globally, while the mortality remained stationary (−0.8%;p>0.05). However, the hospitalization in Alagoas(27.1%;p<0.001) and Pernambuco (35.1%;p<0.001), and the mortality in Bahia(2.9%;p<0.001) and Sergipe(4.1%;p<0.001), increased. **Conclusions**: Schistosomiasis mansoni represents an important public health problem in Pernambuco, Alagoas, Sergipe, and Bahia.

Keywords: Neglected Diseases. Schistosomiasis mansoni. Time-Series Studies.

Schistosomiasis mansoni (SM) is a neglected tropical disease; it is a parasitic infection with chronic evolution caused by the *Schistosoma mansoni* trematode, whose intermediate hosts are snails from the *Biomphalaria* genus[1,2]. SM currently poses an important public health problem in many developing countries, such as Brazil[1,2].

The presence of SM has been reported in 54 countries, being described mainly in Africa, Eastern Mediterranean, and Americas[1]. In the Americas, Brazil is the country most affected by this disease. Recent data indicate that approximately 1.5 million people are infected with *S. mansoni*and more than 25 million live in areas with a high risk of transmission[1-3]. In 2015 alone, 22,434 cases of SM were recorded, 459 of which resulted in death[1,4].

In Brazil, SM is widely distributed. It has been reported in all five regions(Central-West, North, Northeast, South and Southeast) and is characterized as endemic in seven states in the Northeast Region(Alagoas, Bahia, Maranhão, Paraíba, Pernambuco, Rio Grande do Norte and Sergipe) and two states in the Southeast Region (Espírito Santo and Minas Gerais). In 2015, 78.7% (17,664) of all cases reported in Brazil occurred in the Northeast Region[1,4].

Considering this epidemiological situation and its relevance in Brazil, it is necessary to continuously monitor the disease's epidemiological indicators and subsidize and/or evaluate the strategies implemented. In endemic areas, actions must focus on three elements[3]: i) preventing the occurrence of severe forms, ii) reducing the proportion of positive tests, and iii) containing the endemic spread.

Since the 1970s, when the Brazilian Schistosomiasis Control Program (PCE) was implemented, numerous public

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health actions aimed at controlling the disease have affected its prevalence, with consequent reduction to the endemic level, and resulting hospitalizations and deaths[3]. One such action that stands out was the 2011 implementation of the integrated plan of strategic actions for the elimination of neglected tropical diseases, which included SM. This initiative allocated 1.72 million Brazilian reals to 120 prioritized municipalities so that they could develop actions to contribute to the elimination of this disease within their jurisdiction[5].

Facing the need to monitor SM, this study aimed to analyze trends in its positivity, hospitalization, and mortality rates in the Northeast Region of Brazil. This ecological time-series study analyzed three SM indicators: proportion of positive parasitological tests, hospitalization rate, and mortality rate. Data were obtained from the PCE, Hospital Information System (SIH), and Mortality Information System of the Ministry of Health and DATASUS (Department of Informatics of the Unique System of Brazil). The population data were obtained from the Brazilian Institute of Geography and Statistics.

Two distinct time series were used: i) 1996–2015 for analyzing the proportion of positive parasitological tests and mortality rate, and ii) 2008–2015 for analyzing the hospitalization rate. The joinpoint regression model was used for the trend analysis. This model makes it possible to test whether a multi-segment line is statistically better at describing the evolution of data over time than a straight or less-segmented line[6]. The trends were classified as increasing, decreasing, or stationary. The annual percent change (APC) was also obtained.

The 95% confidence interval was calculated for each trend, and the significance level was set at 5%. The software Joinpoint 4.5.0.1 was used for temporal analysis and the software QGIS 2.14.11 was used to create thematic maps. As the study was conducted using secondary open-access data, approval from the research ethics committee was not required.

Between 1996 and 2015, 17,340,924 coproscopic examinations were carried out in the Northeast Region and 1,167,296 were positive for *Schistosoma mansoni* (6.7%). Of these examinations, 30.6% (n = 5,301,222) were carried out in Bahia, followed by 20.8% in Alagoas (n = 3,611,969). During the time series, the positivity rate decreased significantly (APC, −4.7%; p<0.001), from 9.9% in 1996 to 3.6% in 2015 **(Figures 1 and 2, and Table 1)**. The states of Alagoas, Sergipe, and Pernambuco showed the highest proportions of positive tests (10.81%, 10.70%, and 7.31%, respectively). In contrast, only 27 cases were recorded in Piauí (0.04% positivity) **(Figure 2)**.

It should be emphasized that in recent years, the number and positivity of the examinations have been high throughout the time series, as shown by the regression model. This indicates that the chain of infection is being maintained and may reflect the existence of operational problems, such as case underreporting[6,7].

Trend analysis of the proportion of total period positivity revealed a significant decline in the states of Maranhão (APC, −3.4%; p<0.001), Sergipe (APC, −27.4%; p<0.001), and Bahia (APC,−25.6%; p<0.001), and an increase in the states of Pernambuco (APC, 35.1%; p<0.001) and Alagoas (APC, 27.1%; p<0.001) **(Table 1)**.

SM was first introduced to Brazil through the cities of Salvador and Recife, initially spreading throughout the states of the Northeast and then into other regions. In Brazil, especially in the Northeast and Southeast, there are favorable socio-environmental conditions for disease dissemination. These conditions include demographic and cultural factors, such as the migratory flow to areas with precarious living conditions, population habits, and biological aspects of both the intermediate host and trematode, including the adult worms longevity (5–8 years) and high egg-laying capacity (approximately 300 eggs per female daily) [3].

The implementation of regular health actions in the last decades and the improvement of the populations' living conditions in the Northeast may explain the SM decline in the region, notwithstanding it continues to represent an important public health problem[3,6]. In Pernambuco, malacological surveys and field expeditions have shown righ infection rates of the population throughout the coastal region of the state, as well as detection of contaminated snails[8-10]. In Alagoas and Sergipe, studies have also indicated that the disease continues spread[7,11].

Studies from Pernambuco have recently shown that the intermediate host (snails of the *Biophalaria* genus) is adapting to the new environmental context, in which puddles and ditches with low to medium levels of water have become important breeding sites for snails[10]. Furthermore, these breeding sites are located in places where large numbers of individuals live and/or transit, thus promoting a close relation between humans and *S. mansoni.*

The second indicator analyzed was the rate of hospitalization. During the 2008–2015 period, 1,142 individuals werehospitalized in theNortheast, resulting in the rate of 0.026/100,000inhabitants. During the times series, the hospitalization rate decreased significantly (APC, −17.7%; p<0.001), from 0.05/100,000 (n = 276 hospitalizations) in 1996 to 0.01/100,000 (n = 83 hospitalizations) in 2015 **(Figure 1 and Table 1)**. The following four states accounted for 84.2% (n = 962) of hospitalizations: Pernambuco (n = 513; rate = 0.07/100,000), Bahia (n = 290; rate = 0.02/100,000), Alagoas (n = 87; rate = 0.03/100,000), and Sergipe (n = 72; rate = 0.04/100,000) **(Figure 2)**.

In the trend analysis of the hospitalization rate, only Rio Grande do Norte and Paraíba exhibited stationary temporal behavior (p>0.05). Hospitalization records in the states of Piauí and Maranhão were unavailable for several years in the series, making it impossible to apply the statistical model. All other states showed significant reduction trends, being the greatest observed in Alagoas (APC, −32.8%; p<0.001) **(Table 1)**.

Cases of hospitalization due to SM indicate the presence of severe forms of the disease, especially the hepatosplenic form, which requires hospital care[12]. The decline in hospitalizations observed in this study may indicate improvements in disease surveillance programs, given that the worsening of the clinical manifestation can be prevented by the early detection and prompt treatment. Thus, carrying out coproscopic surveys, especially in Brazil's endemic areas, represents one of the main SM surveillance actions[13].

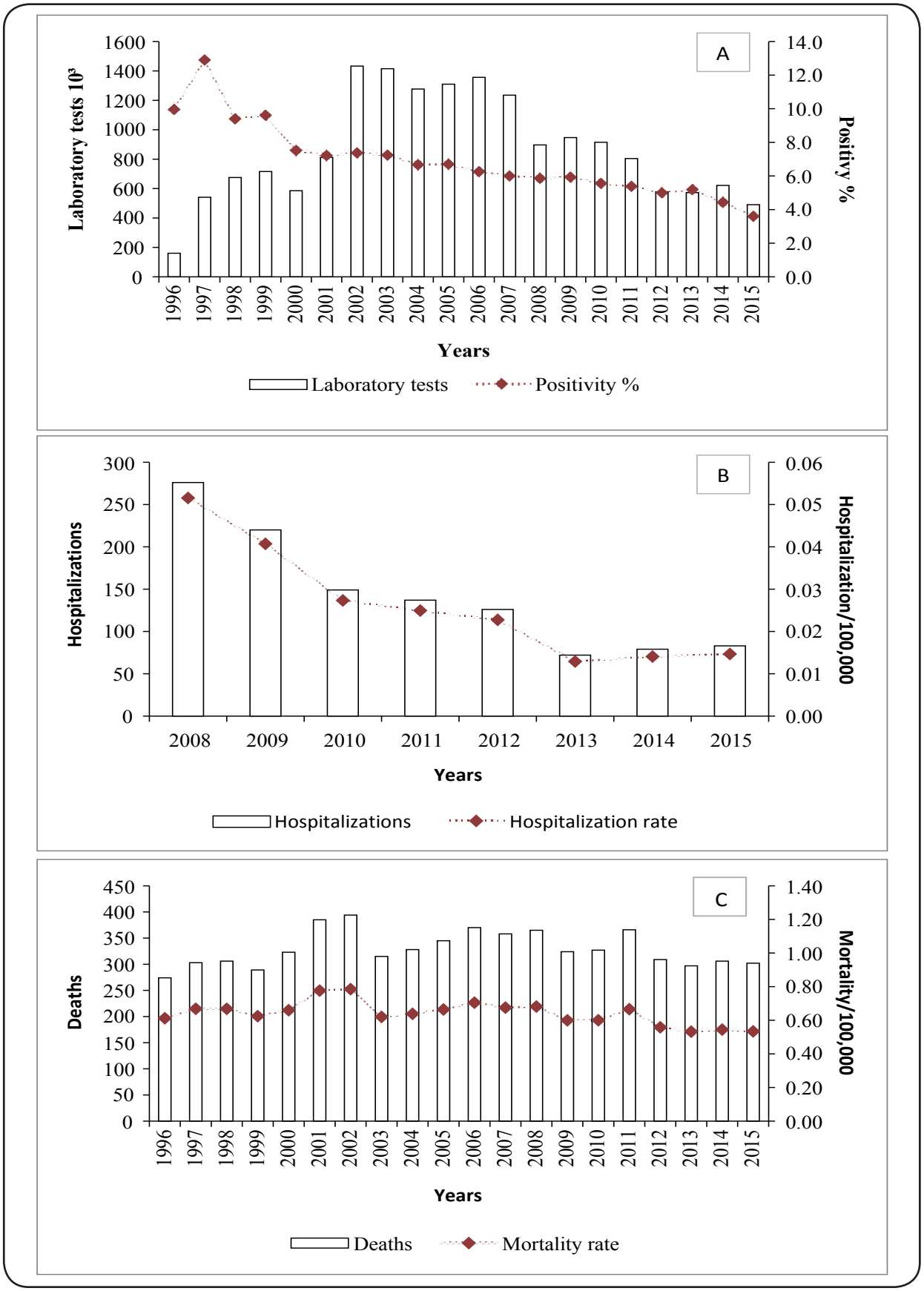

FIGURE 1: Temporal evolution of Schistosomiasis mansoni epidemiological indicators in the Northeast Region of Brazil. **(A).** Laboratory tests and percentage of positivity **(B).** Hospitalization and hospitalization rate **(C).** Deaths and mortality rate.

TABLE 1: Joinpoint regression of positivity, hospitalization, and mortality rates of Schistosomiasis mansoni in the Northeast Region of Brazil.

Local	Positivity % (1996–2015)		Hospitalization rate (2008–2015)		Mortality rate (1996–2015)	
	Period	APC (95% CI)	Period	APC (95% CI)	Period	APC (95% CI)
NORTHEAST	1996–2015	-4.7 * (-5.4;-3.9)	1996–2015	-17.7 * (-23.1;-11.9)	1996–2002	2.7 (-1.0;6.5)
					2002–2015	-2.3 * (-3.4;-1.2)
					1996–2015	-0.8 (-2.0;0.5)
Maranhão	1996–2015	-3.4 * (-5.1;-1.7)	-	-	1996–2015	-0.2 (-5.4;5.4)
Piauí	1996–2015	-3.5 (-12.2;6.0)	-	-	-	-
Ceará	1996–1998	26.7 (-27.6;121.5)	1996–2015	-24.0 * (-40.8;-2.4)	1996–2015	-7.2 * (-11.9;-2.3)
	1998–2012	-17.9 * (-20.3;-15.4)				
	2012–2015	71.3 * (29.5;126.5)				
	1996–2015	-3.5 (-9.9;3.4)				
Rio Grande do Norte	1996–2015	-4.0 (-8.6;0.8)	1996–2015	-8.7 (-25.4;11.7)	1996–2015	-0.3 (-3.4;2.9)
Paraíba	1996–2015	-8.9 (-18.6;2.0)	1996–2015	-23.1* (-42.8;-3.6)	1996–2015	1.0 (-2.3;4.3)
Pernambuco	1996–1999	-16.6 (-31.8;2.1)	2008–2013	-20.8 * (-23.0;-18.6)	1996–2001	-3.3 (-9.3;3.0)
	1999–2002	1433.0 * (924.1;2194.9)	2013–2015	9.2 (-3.7;23.7)	2001–2006	7.6 (-1.6;17.7)
	2002–2015	-13.8 * (-15.6;-12.0)	1996–2015	-13.2 * (-15.4;-11.0)	2006–2015	-5.8 * (-8.2;-3.3)
	1996–2015	35.1 * (26.6;44.2)			1996–2015	-1.8 (-4.5;1.0)
Alagoas	1996–1998	2119.7 * (1533.8;2915.8)	1996–2015	-32.8 * (-39.5;-25.2)	1996–2015	-5.1 * (-8.1;-2.1)
	1998–2015	-8.7 * (-9.7;-7.7)				
	1996–2015	27.7 * (23.8;31.7)				
Sergipe	1996–2013	-2.3 * (-3.9;-0.7)	1996–2015	-18.6 * (-28.3;-7.6)	1996–2015	4.1 * (1.0;7.3)
	2013–2015	-94.1 * (-96.3;-90.7)				
	1996–2015	-27.4 * (-30.7;-23.9)				
Bahia	1996–2013	-4.2 * (-7.1;-1.1)	1996–2015	-19.4 * (-25.2;-13.3)	1996–2015	2.9 * (1.4;4.4)
	2013–2015	-91.4 * (-96.5;-78.9)				
	1996–2015	-25.6 * (-32.1;-18.6)				

*Statistical significance (p<0.05); **APC:** Annual Percent Change; **CI:** Confidence Interval.

However, this indicator has some important limitations. One of the main problems is that individuals are often hospitalized due to complications associated with the disease; in these cases SM is not listed as the cause of hospitalization according to the International Classification of Diseases (CID-10) code recorded on the Hospitalization Authorization form. Therefore, the hospitalization rate is underestimated[12]. Another factor influencing the hospitalization rate is related to the availability of hospital care. The lack of beds and even hospital units, especially in small municipalities, results in outpatient treatment of patients who need hospital care. In these cases, there are no records of treatment in the SIH[12].

Regarding mortality, 6,586 deaths due to SM were recorded in the Northeast Region, with an average of 329.3 deaths/year and a rate of 0.64 deaths per 100,000 inhabitants, maintaining a stationary level throughout the series (APC, −0.8%; p>0.05) **(Figure 1 and Table 1)**. The following four states accounted for 91.5% (n = 6,029) of all deaths: Pernambuco (n = 3,295;

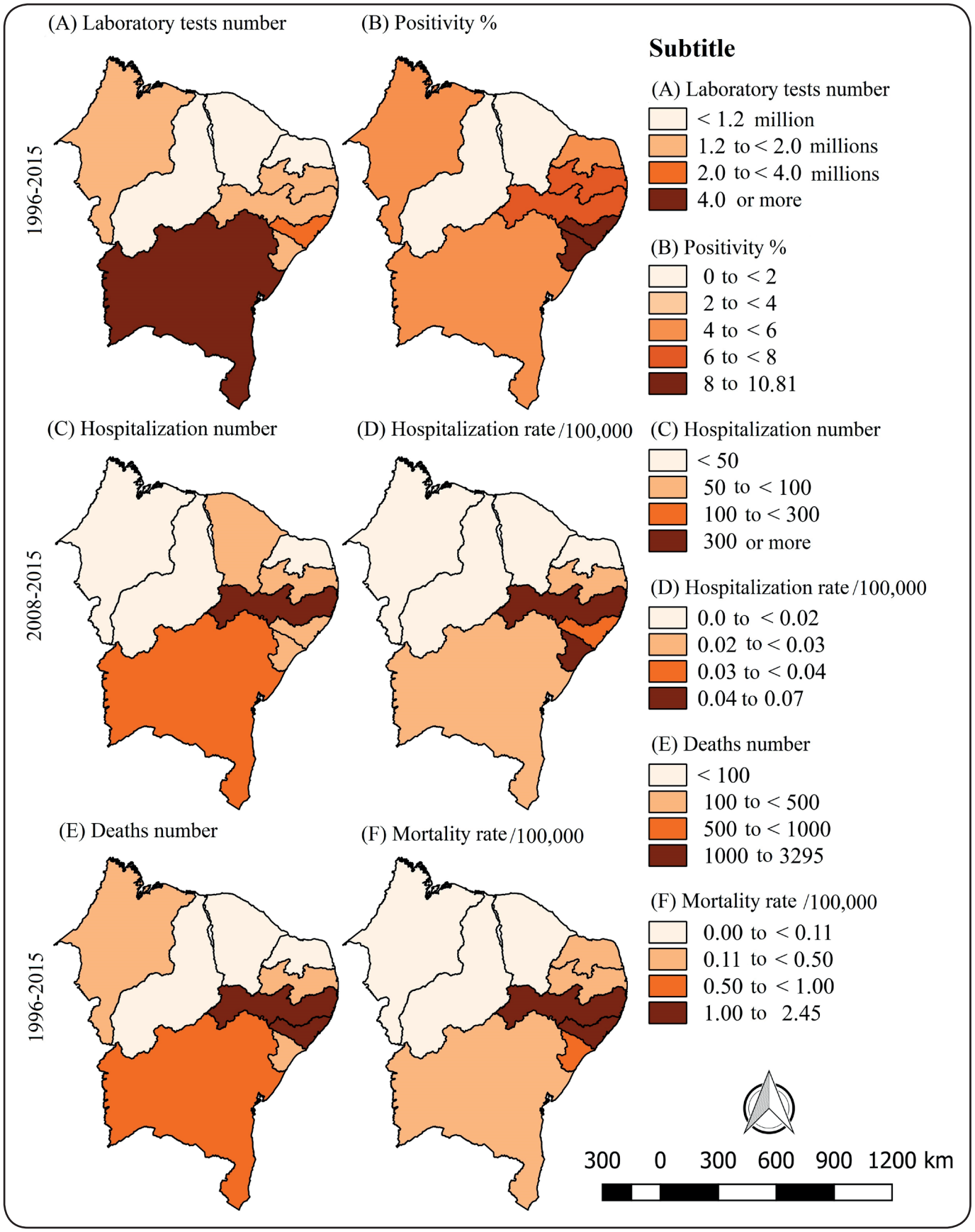

FIGURE 2: Spatial distribution of the epidemiological indicators of Schistosomiasis mansoni in the Northeast Region of Brazil. **(A).** Laboratory tests **(B).** Percentage of positivity **(C).** Hospitalization **(D).** Hospitalization rate **(E).** Deaths **(F).** Mortality rate.

rate=1.94/100,000), Alagoas (n=1,463; rate=2.45/100,000), Sergipe (n=277; rate=0.69/100,000), and Bahia (n=994; rate=0.35/100,000) **(Figure 2)**. The regression model showed a reduction in Alagoas (APC, −5.1%; p<0.001) and Ceará (APC, −7.2%; p<0.001), and an increase in Sergipe (APC, 4.1%; p<0.001) and Bahia (APC, 2.9%; p<0.001) **(Table 1)**.

The mortality decline in the Northeast region follows the national pattern observed in the last decades, being the direct result of control measures implemented in the country, such as coproscopic surveys, chemotherapy, environmental control actions, and general socio-sanitary improvements[14]. However, the higher mortality rates in Pernambuco, Alagoas, Sergipe, and Bahia, in addition to the proven increasing trends in the latter two states, indicate pitfalls in the disease control programs.

We argue that the mortality rate is one of the most sensitive indicators regarding the implementation of public health measures that aim to control SM in a region, given that these deaths are potentially avoidable[3]. Their occurrence, thus, indicates the chain of transmission persistence, late diagnosis, and failure to provide healthcare to patients.

One study carried out in Pernambuco[15] that evaluated the implementation of SM control actions in three municipalities in the Mata Sul region highlighted problems in the management of control programs, deficiencies in epidemiological and environmental disease surveillance, weaknesses in laboratory support, and absence of actions in health education.

It can be concluded from our data analysis that SM continues to represent an important healthcare problem in the Northeast region of Brazil. This reaffirms the need for policies to strengthen disease control programs in a broader perspective of intervention, approaching social and environmental determinants involved in the SM transmission dynamic, as well as for patient care measures.

Conflict of Interest: The authors declare that there is no conflict of interest.

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