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Temporal trend of Tuberculosis incidence in northeastern Brazilian municipalities according to Social Vulnerability Index parameters: An ecological study

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TO THE EDITOR,

Tuberculosis (TB) is an infectious and contagious disease of chronic evolution caused by the intracellular bacillus *Mycobacterium tuberculosis*, which is transmitted primarily through the airways by the dispersion of aerosols expelled by individuals with active disease.[1,2] It is estimated that one-third of the world's population is infected with this bacillus and that nearly 10 million new cases are registered every year. In addition, TB is currently the second leading infectious disease in the world in terms of mortality, with approximately 1.3 million deaths annually.[1-3]

Aside from the biological component, the occurrence of TB is associated with precarious living conditions, such as poverty, poor nutrition, and the existence of crowded households. These living circumstances to which people are exposed are known as social determinants of health.[4,5] These determinants, although dynamic, can be measured using indicators that express the degree of human development and pragmatic social vulnerability of the population.[6]

Considering the need to monitor the temporal evolution of the disease and provide knowledge on the TB elimination process in the country, the aim of the present study was to analyze the temporal trend of TB incidence in northeastern Brazilian municipalities, according to Social Vulnerability Index (SVI) parameters, from 2001 to 2017.

This ecological study was carried out in the Brazilian Northeast, a region which comprises nine states and 1,793 municipalities. Here, we analyzed the following epidemiological indicators: annual and average TB incidence rate per 100,000 inhabitants from 2001 to 2017. Data regarding new cases of TB were obtained from the National System of Notifiable Diseases (SINAN).

The SVI was created to indicate the access to or insufficiency of social assets, whose possession or deprivation determines the welfare conditions of the populations in areas of the Brazilian territory.[6] It comprises 16 variables grouped into the following three dimensions: i) urban infrastructure, ii) human capital, and iii) income and work. The SVI varies from 0 to 1, where 0 corresponds to the ideal (desirable) social situation and 1, the worst. Municipalities are classified as follows: very low social vulnerability (0 to 0.200), low (0.200 to 0.300), medium (0.300 to 0.400), high (0.400 to 0.500), and very high (greater than 0.500).[10] The social vulnerability indicators were obtained from the Atlas of Social Vulnerability of the Institute for Applied Economic Research (IPEA - http://ivs.ipea.gov.br).

Trend analysis was carried out with the use of a joinpoint regression model. This model evaluates whether a line with multiple segments is statistically better to describe the temporal evolution of a dataset than a straight line or a line with fewer segments. The annual percent change (APC) was calculated, considering a confidence interval of 95% and 5% significance.[7] Trend analysis was performed using the Joinpoint Regression software, version 4.5.0.1 (National Cancer Institute, Bethesda, MD, USA). The study did not require ethics committee approval since it used secondary data from the public domain.

Regarding the SVI-human capital, municipalities with low (n = 6; 0.3%; 40.69/100,000) and medium SVI (n = 67; 3.7%; 38.28/100,000) had higher TB incidence rates than those with high (n = 443; 24.7%; 25.50/100,000) and very high SVI (n = 1277; 71.2%; 23.86/100,000). Three strata showed decreasing trends (low, medium, and high), with the largest annual percentage decline observed in the high SVI stratum (AAPC: -2.7; 95% CI: -4.0 to -1.5) (Table 1).

Regarding the SVI-income and work, municipalities with low SVI (n = 8; 0.4%; 41.95/100,000) showed a higher TB incidence rate when compared to municipalities with very high SVI (n = 1320; 73.6%; 23.72/100,000). Only the medium, high, and very high strata showed decreasing trends over the studied period (2001 - 2017) (Table 1).

The SVI-urban infrastructure dimension showed an inverse behavior compared to the others. Municipalities with high (n = 221; 12.3%; 28.79/100,000) and very high SVI (n = 208; 11.6%; 25.14/100,000) showed the highest TB incidence rates. Three strata showed decreasing trends (high, low, and very low). However, the trends were stationary in the medium (AAPC = -1.9; 95% CI: -4.0 to 0.2) and very high (AAPC: -2.1; 95% CI: -4.3 to 0.1) strata, with a greater percentage reduction in the very low stratum (AAPC: -3.1; 95% CI: -5.9 to -0.2) (Table 1).

Notably, the relationship between TB and living conditions is not static. This is because, in endemic areas, better

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Table 1. Trends in TB incidence rates in northeastern municipalities according to the dimensions of the Social Vulnerability Index (SVI), Brazil, 2001-2017.

SVI Overall	Number of Municipalities	Incidence/ 100,000	Period	APC/ AAPC	(95% CI)	Trend
Very low	0	-				
Low	32	30.19	2001-2017	-3.5	-3.9; -3.0	Decreasing
Medium	315	26.66	2001-2017	-3.6	-4.1; -3.0	Decreasing
High	859	24.70	2001-2005	2.2	-1.2; 5.7	Increasing
			2005-2012	-3.5	-5.1; -1.8	Stationary
			2012-2015	-7.4	-18.3; 5.0	Decreasing
			2015-2017	4.0	-8.5; 18.1	Stationary
			2001-2017	-1.9	-4.3; 0.5	Stationary
Very high	587	23.84	2001-2006	2.6	0.5; 4.8	Increasing
			2006-2015	-5.7	-6.6; -4.9	Decreasing
			2015-2017	1.4	-14.2; 19.9	Stationary
			2001-2017	-2.3	-4.2; -0.4	Decreasing
SVI Urban Infrastructure	**Number of Municipalities**	**Incidence/ 100,000**	**Period**	**APC/ AAPC**	**(95% CI)**	**Trend**
Very low	435	24.57	2001-2006	0.5	-2.4; 3.5	Stationary
			2006-2012	-5.0	-7.7; -2.2	Decreasing
			2012-2015	-9.3	-21.8; 5.3	Stationary
			2015-2017	3.9	-10.6; 20.7	Stationary
			2001-2017	-3.1	-5.9; -0.2	Decreasing
Low	504	24.34	2001-2004	0.8	-4.7; 6.5	Stationary
			2004-2012	-3.4	-4.8; -2.1	Decreasing
			2012-2015	-6.7	-17.0; 5.0	Stationary
			2015-2017	4.0	-7.6; 17.1	Stationary
			2001-2017	-2.4	-4.6; -0.1	Decreasing
Medium	425	23.60	2001-2006	2.7	0.8; 4.6	Increasing
			2006-2012	-4.4	-6.1; -2.6	Decreasing
			2012-2015	-7.4	-17.0; 3.3	Stationary
			2015-2017	3.1	-8.0; 15.5	Stationary
			2001-2017	-1.9	-4.0; 0.2	Stationary
High	221	28.79	2001-2017	-1.5	-1.9; -1.1	Decreasing
Very high	208	25.14	2001-2005	7.0	3.0; 11.2	Increasing
			2005-2015	-6.7	-7.6; -5.8	Decreasing
			2015-2017	3.8	-13.6; 24.7	Stationary
			2001-2017	-2.1	-4.3; 0.1	Stationary
SVI Human Capital	**Number of Municipalities**	**Incidence/ 100,000**	**Period**	**APC/ AAPC**	**(95% CI)**	**Trend**
Very low	0	-				
Low	6	40.69	2001-2009	-4.4	-6.1; -2.6	Decreasing
			2009-2017	-0.6	-2.4; 1.2	Stationary
			2001-2017	-2.5	-3.6; -1.4	Decreasing
Medium	67	38.28	2001-2004	4.0	-6.1; 15.1	Stationary
			2004-2017	-3.9	-4.7; -3.1	Decreasing
			2001-2017	-2.5	-4.2; -0.7	Decreasing
High	443	25.50	2001-2005	1.8	-3.3; 7.2	Stationary
			2005-2017	-4.2	-5.1; -3.4	Decreasing
			2001-2017	-2.7	-4.0; -1.5	Decreasing
Very high	1277	23.86	2001-2005	2.2	-0.6; 5.1	Stationary
			2005-2012	-3.8	-5.1; -2.5	Decreasing
			2012-2015	-7.7	-17.6; 3.5	Stationary
			2015-2017	3.8	-8.0; 17.1	Stationary
			2001-2017	-2.2	-4.3; 0.1	Stationary
SVI Income and Work	**Number of Municipalities**	**Incidence/ 100,000**	**Period**	**APC/ AAPC**	**(95% CI)**	**Trend**
Very low	0	-				
Low	8	41.95	2001-2003	25.4	-2.7; 61.6	Stationary
			2003-2017	-4.0	-4.8; -3.2	Decreasing
			2001-2017	-0.8	-3.6; 2.2	Stationary

Continue...▶

Table 1. Trends in TB incidence rates in northeastern municipalities according to the dimensions of the Social Vulnerability Index (SVI), Brazil, 2001-2017. (Continued...)

SVI Income and Work	Number of Municipalities	Incidence/ 100,000	Period	APC/ AAPC	(95% CI)	Trend
Medium	71	33.89	2001-2017	-2.2	-2.5; -1.8	Decreasing
High	394	26.70	2001-2003	7.7	-6.3; 23.9	Stationary
			2003-2017	-3.1	-3.5; -2.7	Decreasing
			2001-2017	-1.8	-3.4; -0.2	Decreasing
Very high	1320	23.72	2001-2006	2.0	-0.8; 4.8	Stationary
			2006-2015	-5.7	-6.8; -4.5	Decreasing
			2015-2017	1.2	-13.8; 18.7	Stationary
			2001-2017	-2.5	-4.4; -0.5	Decreasing

APC: Annual Percent Change; AAPC: Average Annual Percent Change. 95% CI: 95% Confidence Interval; SVI: Social Vulnerability Index.

living conditions may result in greater diagnoses and, consequently, higher incidence rates, at least in a first moment. On the other hand, vulnerability, while contributing to the maintenance of the disease, leaves sick subjects invisible to the health system, while good living conditions have the opposite effect.[8]

Low education and exposure to poverty, for example, are factors that hamper access to services for the diagnosis and treatment of the disease. If, on the one hand, exposure to social vulnerability keeps the chain of transmission active in the community, on the other hand, it can prevent sick individuals from being diagnosed, as many are disregarded by the health system, thus fostering the underreporting of disease data.[9,10]

Another important issue concerns the lower capacity to reduce the incidence in municipalities with very high SVI (Human Capital and Urban Infrastructure). However, it is already known that in order to eliminate this disease, it is necessary to have treatment coverage of at least 90% of the latent form, with contact testing and the use of rapid tests in the same proportion.[2,5] This condition can only be achieved by improving these social indicators, which reflect the population's living situation.

Therefore, the results obtained in this study indicate the urgent need to strengthen local actions against TB, especially in more vulnerable areas.

AUTHOR CONTRIBUTIONS

JPSP, ABB, MB, RFC, and CDFS: study conception and design. JPSP: data collection and writing of the Introduction section. JPSP, MB, and CDFS: data collection, writing of the Methods and Results sections, and statistical analysis. JPSP, ABB, RFC, and CDFS: writing of the Discussion section. All authors contributed to the initial draft and reviewed and approved the final version of the manuscript.

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