Temporal trends in tuberculosis-related morbidity and mortality in the state of Santa Catarina, Brazil, between 2002 and 2009*

Tendência temporal da morbidade e mortalidade por tuberculose no estado de Santa Catarina, Brasil, no período entre 2002 e 2009

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Abstract

The objective of this study was to describe temporal trends in tuberculosis morbidity and mortality in the state of Santa Catarina, Brazil, between 2002 and 2009. Data regarding mortality and incidence were obtained from the Brazilian Mortality Database and National Case Registry Database, respectively. Crude rates were calculated and standardized by age using the direct method. We estimated annual variation by joinpoint regression, identifying the points at which there were changes in the trends. There was a significant (3.7%) annual decrease in the mortality rate. In the study period, two distinct temporal trends were identified: one between 2002 and 2007, showing a significant (5.9%) annual decrease in the mortality rate; and one between 2007 and 2009, showing an insignificant (2.0%) annual increase. There was also a significant (0.9%) annual reduction in tuberculosis incidence.

Keywords: Tuberculosis/epidemiology; Tuberculosis/mortality; Brazil.

Resumo

O objetivo deste estudo foi descrever a tendência temporal da morbidade e mortalidade por tuberculose no estado de Santa Catarina no período entre 2002 e 2009. Os dados de mortalidade e incidência foram obtidos, respectivamente, do Sistema de Informação de Mortalidade e do Sistema Nacional de Informação de Agravos de Notificação. As taxas brutas foram calculadas e padronizadas por idade pelo método direto. Estimou-se a variação anual por intermédio de regressão linear segmentada e identificaram-se pontos em que houve modificação da tendência. Observou-se uma redução significativa na taxa de mortalidade de 3,7% ao ano. No período estudado, houve duas tendências distintas: a primeira, entre 2002 e 2007, com redução significativa na taxa de mortalidade de 5,9% ao ano; a segunda, com incremento não significativo dessa taxa de 2,0% ao ano entre 2007 e 2009. Em relação à incidência, observou-se uma redução significativa de 0,9% ao ano.

Descritores: Tuberculose/epidemiologia; Tuberculose/mortalidade; Tuberculose/estatística e dados numéricos.

Tuberculosis remains one of the most significant causes of mortality in developing countries, notably in male patients and in the 45-59 age group, which makes Koch's bacillus the single leading agent of death among infectious diseases.[1] Despite being an ancient disease and having been vulnerable to drug treatment for more than half a century, tuberculosis remains one of the major adverse health events worldwide.[2]

A recently published study[3] reported that the incidence of tuberculosis worldwide, in the Americas, and in Brazil decreased by 11.4%, 50.0%, and 48.8%, respectively, in a 20-year historical time series. whereas the mortality rates decreased by 40.0%, 70.7%, and 70.8%, respectively.

Specifically, in Brazil, the incidence rate of tuberculosis has shown a decline of 26% since 1990, with a mean of 1.4% per year. In 2009, there were 71,700 new cases of the disease and the incidence rate was 37/100,000 population. The highest incidence rates are in the states of Rio de

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Janeiro, Amazonas, and Pará. The lowest rates are reported in the Federal District of Brasília and in the states of Goiás and Tocantins. The mortality rate from tuberculosis in Brazil had a 16.7% reduction between 2002 and 2008, decreasing from 3 to 2.5 deaths/100,000 population.[4]

The objective of the present study was to analyze temporal trends in tuberculosis incidence and mortality in the state of Santa Catarina, Brazil, between 2002 and 2009. Data regarding mortality and incidence were obtained from the Brazilian National Ministry of Health Mortality Database and National Case Registry Database, respectively. All tuberculosis-related deaths and reported tuberculosis cases occurring between 2001 and 2010 in residents of the state of Santa Catarina were selected. For the purpose of smoothing the time series of point-to-point fluctuations caused by the small number of cases in specific strata, the moving average was calculated on the basis of three terms. In this process, the smoothed annual coefficient corresponded to the arithmetic average of the previous, current, and following years' coefficients. This resulted in the data presentation from years 2002 to 2009.

The databases used the tenth revision of the International Classification of Diseases in the recording of occurrences. The census and inter-census estimates of the resident population of the state by age, which are used as denominators to calculate mortality rates, were obtained from the Information Technology Department of the Unified Health Care System of the Brazilian National Ministry of Health.

Initially, crude incidence and mortality rates, which are expressed per 100,000 population, were calculated by the ratio between the number of reported cases or deaths and the estimated population on July 1 of each year in the series. Subsequently, the crude rates were standardized by age using the direct method, with the population of Santa Catarina in 2010 being used as the standard.

The obtained rates were used in the analysis of the temporal trends estimated by regression models. For the purpose of model formation, the standardized rates were considered the dependent variable (y), whereas the years of the study period were considered the independent variable (x).

The Joinpoint Regression Program, version 3.5.1 (Statistical Research and Applications Branch, National Cancer Institute, Rockville, MD, USA), was used to calculate annual change in mortality and in the number of reported cases between 2002 and 2009. This program uses joinpoint regression analysis to estimate annual percent change and to identify the points at which there are changes in the trends. We tested successively adjusted models, in which we assumed a different number of "points" of trend change, ranging from zero (a case in which the trend is represented by a single line segment) to a maximum of two, because of the quantity of observations. The model chosen was the one that had the largest number of points and that maintained statistical significance ($p < 0.05$). On the basis of the estimated slope of each line segment (regression coefficient), we calculated annual percent change and assessed its statistical significance, which was estimated by the generalized linear least squares method, assuming that the rates follow a Poisson distribution and that rate change is not constant over the period. We calculated the upper and lower limits of the 95% CI for the estimated slope of each line segment.

The present study was conducted in accordance with Brazilian National Health Council Resolution 196/96, which outlines the ethical principles for human research in the country. However, all data used were obtained from official public domain health information systems, in which there is no identification of individuals, and therefore there could be no ethical principle violations.

In the study period, there was a significant 3.7% annual decrease in the mortality rate in the state of Santa Catarina (95% CI: −6.6 to −0.7). However, as can be seen in Figure 1 and in Table 1, two distinct temporal trends were identified: one between 2002 and 2007, showing a significant 5.9% annual decrease in the mortality rate (95% CI: −8.9 to −2.8); and one between 2007 and 2009, showing an insignificant 2.0% annual increase (95% CI −12.6 to 19.2). There was also a significant 0.9% annual reduction in tuberculosis incidence (95% CI: −1.5 to −0.3).

The fall in tuberculosis mortality is a global trend. According to the World Health Organization, the absolute number of cases has decreased since 2006 and the incidence of the disease has decreased since 2002. Likewise, there was an 8.6% annual decrease in mortality between 1990 and 2010.[5] This trend has also been reported in Brazil.[6-8] Between 1980 and 2004, there was an irregular decrease in the mortality rate from

Table 1 - Observed and fitted tuberculosis mortality and morbidity/incidence rates per 100,000 population, as well as annual percent change. Santa Catarina, 2002-2009.

Year	Mortality			Morbidity/incidence		
	Observed	Fitted	APC (95% CI)	Observed	Fitted	APC (95% CI)
2002	1.28	1.31	−5.9 (−8.9 to −2.8)	35.34	35.66	−0.9 (−1.5 to −0.3)
2003	1.25	1.24		36.09	35.34	
2004	1.19	1.16		35.31	35.02	
2005	1.13	1.10		34.53	34.71	
2006	1.00	1.03		33.55	34.39	
2007	0.97	0.97		33.75	34.09	
2007	0.97	0.97	2.0 (−12.6 to 19.2)	-	-	
2008	0.97	0.99		33.83	33.78	
2009	1.02	1.01		34.03	33.48	

APC: Annual percent change.

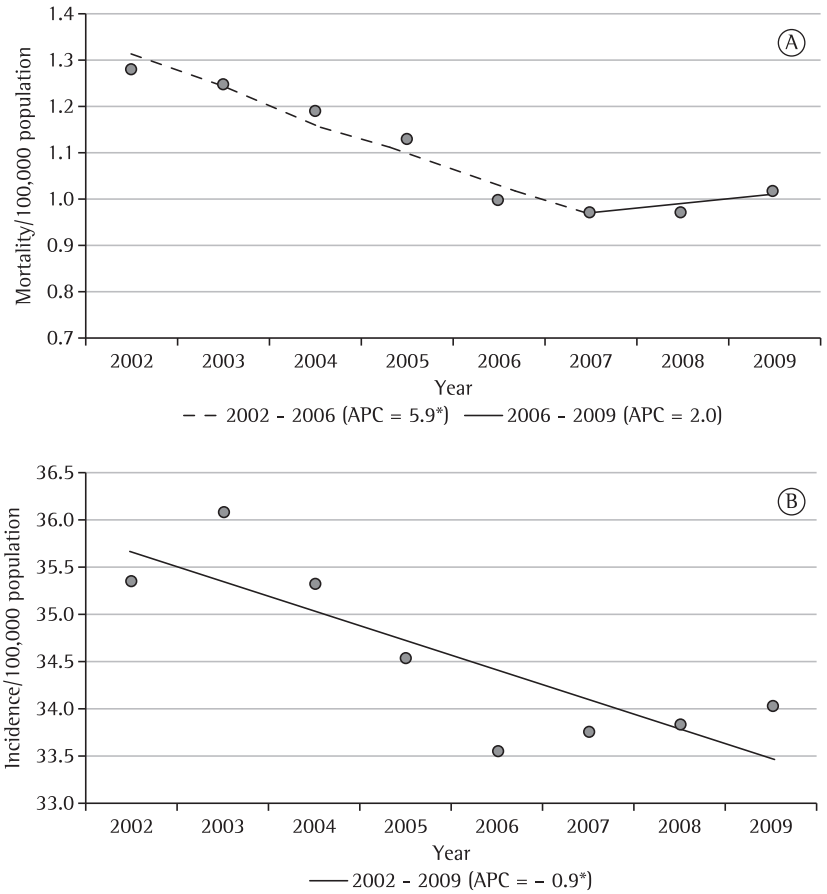

Figure 1 - Trends in tuberculosis mortality (in A) and morbidity/incidence (in B) rates (per 100,000 population). Santa Catarina, 2002-2009. APC: annual percent change. *p < 0.05.

tuberculosis, which ranged from 5.8/100,000 population in 1980 to 2.8/100,000 population in 2004. In 2004, 4,981 deaths where tuberculosis was the underlying cause of death were reported in Brazil. However, this value would increase by 50% if deaths where tuberculosis was an associated

cause of death, as well as deaths where sequelae of tuberculosis were the underlying cause of death, were included. In that same year, the highest standardized rates were found in the states of Pernambuco (5.4/100,000 population) and Rio de Janeiro (5.0/100,000 population), as well as in the capital cities of the states of Pernambuco (namely, Recife; 7.7/100,000 population) and Pará (namely, Belém; 5.8/100,000 population). The AIDS epidemics has an indirect effect on the trends in tuberculosis mortality in Brazil.[8]

One of the factors that might have positively affected incidence and mortality was the implementation of the directly observed treatment strategy in Brazil in 1999, which, by 2007, had resulted in a 32% decline in mortality.[1,9] The directly observed treatment strategy produces a 1% annual increase in the cure rate and drastically reduces treatment dropout, which is directly related to worse disease outcomes.[10,11]

Likewise, investments in health might have had a highly positive effect on the epidemiological situation of infectious diseases. Of the 22 countries with the highest prevalence of tuberculosis, 5 (Brazil, Russia, India, China, and South Africa) collectively invested 2.1 billion dollars in tuberculosis control in 2010, 95% of which was from domestic sources. Tuberculosis indicators were markedly better in the countries with higher expenditures, such as Brazil.[5]

The decline in tuberculosis morbidity and mortality could also be attributed to free, universal access to treatment, as well as to the growth of the network of primary health care facilities. However, resistance to first-line drugs is an emerging problem worldwide, although it still occurs infrequently in Brazil, which might have contributed to the favorable rates reported here.[5,9]

Despite the low prevalence of multidrug-resistant tuberculosis in Brazil, according to global indicators, the results for the 2007-2009 period, which showed a slight, insignificant increase, could be related to the increase in primary isoniazid resistance (from 4.4% to 6.0%) and in primary isoniazid and rifampin resistance (from 1.1% to 1.4%). Given these increases, the Brazilian National Tuberculosis Control Program introduced ethambutol in the intensive treatment phase of the basic regimen in 2009, which can contribute to keeping the rates within the ranges described here.[9,11]

Therefore, factors related to health care facilities, whether in terms of improved access or quality of care, might have had a significant influence on the tuberculosis indicators in the study period. Interventions aimed at early diagnosis and appropriate treatment could have an extremely positive impact on tuberculosis incidence and mortality rates, especially if they are universal in scope and egalitarian in concept, with special attention being given to the lower classes.

It must be emphasized that the results of this descriptive study should be interpreted with caution, because the study design does not allow a cause and effect relationship to be established, but rather describes morbidity and mortality during a limited observation period.

In the light of the findings of the present study, we can conclude that, in the state of Santa Catarina, there was a significant 3.7% annual decrease in the mortality rate from tuberculosis, with two distinct temporal trends being identified. There was also a significant 0.9% annual decrease in the number of reported cases.

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