Original Article

Tuberculosis-related mortality in the state of Espírito Santo, Brazil, 1985-2004*

Mortalidade específica por tuberculose no estado do Espírito Santo, no período de 1985 a 2004

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Abstract

Objective: The purpose of this study was to describe tuberculosis-related mortality in Espírito Santo, Brazil, evaluating its tendencies in relation to clinical presentation, gender and age bracket. **Methods:** We conducted a retrospective, descriptive study based on secondary data. For the 1985-2004 period, we investigated all deaths of residents of Espírito Santo in which tuberculosis was given as the underlying cause, as reported in the Brazilian National Mortality Database. **Results:** The adjusted mortality rates for all forms of tuberculosis paralleled the overall mortality rates in the state, decreasing from 5.6/100,000 inhabitants in 1985 to 2.0/100,000 inhabitants in 2004. Pulmonary tuberculosis was the predominant form of the disease (89.7% of tuberculosis-related deaths) throughout the period studied, and the male/female mortality rate ratio ranged from 1.1 in 1998 to 3.19 in 2004. **Conclusions:** We observed a decrease in the mortality rates in all age brackets. Predominance of the pulmonary form, male gender and advanced age was similar to that of overall tuberculosis-related mortality in Brazil.

Keywords: Tuberculosis/epidemiology; Mortality; Information systems.

Resumo

Objetivo: O objetivo deste trabalho é descrever a mortalidade específica por tuberculose no estado do Espírito Santo, e sua tendência em relação às variáveis: forma clínica, sexo e faixas etárias. **Métodos:** Realizou-se um estudo descritivo retrospectivo baseado em dados secundários. Foram incluídos os óbitos registrados no Sistema de Informações sobre Mortalidade que possuíam como causa básica a tuberculose de residentes no estado do Espírito Santo, no período de 1985 a 2004. **Resultados:** A taxa de mortalidade específica ajustada por tuberculose de todas as formas acompanhou a taxa de mortalidade geral do estado apresentando redução de 5,6/100.000 habitantes, em 1985, para 2,0/100.000 habitantes, em 2004. A forma pulmonar foi a mais freqüente em todo o período (89,7% dos óbitos por tuberculose). A razão da taxa de mortalidade no sexo masculino/feminino variou de 1,1 em 1998 a 3,19 no ano de 2004. **Conclusões:** Ocorreu redução da taxa de mortalidade em todas as faixas etárias. A predominância da forma pulmonar, sexo masculino e faixas etárias mais avançadas foram semelhantes à da mortalidade específica por tuberculose no país como um todo.

Descritores: Tuberculose/epidemiologia; Mortalidade; Sistemas de informação.

Introduction

Tuberculosis (TB) is a serious public health problem worldwide. In 2003, the World Health Organization (WHO) registered the occurrence of 8.8 million new cases of TB and 1.7 million deaths worldwide, including patients co-infected with HIV.[1] Eighty percent of the bacterial load is concentrated in 22 countries. The incidence rates of new cases of TB in developing countries are similar to those of industrialized countries in the mid-20th century.[2]

In Brazil, it is estimated that there are 50 million individuals infected with *Mycobacterium tuberculosis,* with

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130,000 new cases and 6,000 deaths reported annually.[3] The principal determiners of the magnitude of TB are social inequality, unplanned accelerated urbanization, migratory processes and the debility/poor management of the health care system, all of which prevent the disease burden from being reduced in pace with the technological development of the country. The situation is further aggravated by the AIDS epidemic and by onset of the drug resistance.[3,4] In fact, interventions from other sectors associated with the health care sector are necessary in order to achieve success in prevention and control.[4]

Without treatment, it is estimated that 60-70% of pulmonary TB patients without HIV co-infection evolve to death. Implementing the strategy of the directly observed therapy, short-course (DOTS) recommended by the WHO could reduce mortality in such cases to 5%.[5]

Analyzing the TB control policies in Brazil, one author[6] highlighted the impact that the introduction of antituberculosis drugs had on mortality and, consequently, on TB-related mortality, in the 1940s. In 1975, the Tuberculosis Control Program was included in the II Brazilian National Development Plan. The Tuberculosis Control Program was aimed at reducing morbidity and TB-related mortality, as well as at minimizing the socioeconomic problems resulting from this disease. After the declaration of a state of emergency in the control of TB by the WHO in 1993, it became obvious that Brazil needed a control plan. In 2004, the Brazilian National Tuberculosis Control Program, based on relevant epidemiological criteria for the disease, designated 315 cities as priority cities for surveillance, control and prevention of TB.[7]

A study on the tendency of TB-related mortality in the state of Rio de Janeiro, Brazil identified the social improvements which took place in the city of Rio de Janeiro, initially, and the introduction of chemotherapy, in 1945, as causes for its reduction, demonstrating that TB has a strong social context, there being a relationship between the general living conditions of a given population and TB-related mortality .[8]

The global TB control plan organized by the WHO and scheduled for the 2006-2015 period is aimed at reducing the global TB burden (incidence, prevalence and mortality). One of the stipulated goals is the reduction of prevalence and mortality due to the disease by 50% in relation to the rates observed in 1990.[9]

In industrialized countries, death from TB is rare, and mortality is therefore not considered a good epidemiological indicator by which to monitor the disease. In developing countries, the difficulty is due to the unreliability of the data systems.[10] However, the TB mortality rates, together with the incidence rate of TB in all forms, the incidence rate of pulmonary TB and the incidence rate of meningitis due to TB in the age bracket of 0 to 4 years constitute indicators with which to evaluate the result of the control measures in Brazil.[3]

The objective of this study was to analyze TB-related mortality in the state of Espírito Santo between 1985 and 2004 based on secondary data from the *Sistema de Informações sobre Mortalidade* (SIM, Mortality Database).

Table 1 - General and tuberculosis-related mortality[a], adjusted for clinical form, in the state of Espírito Santo (1985-2004).

Year	General MR	Adjusted MR All forms of TB	Adjusted MR Pulmonary TB	Adjusted MR Other forms of TB
1985	8.30	5.60	4.09	0.60
1986	7.97	4.55	3.73	0.28
1987	7.41	5.42	3.90	0.70
1988	7.36	3.68	3.22	0.47
1989	6.62	4.17	3.24	0.30
1990	6.91	3.26	2.48	0.34
1991	6.73	4.67	3.48	0.60
1992	6.58	3.66	2.94	0.45
1993	6.92	4.83	3.99	0.25
1994	6.58	3.95	3.00	0.41
1995	6.28	4.35	3.27	0.43
1996	6.60	3.35	2.76	0.35
1997	6.03	3.39	2.93	0.27
1998	6.50	3.11	2.59	0.30
1999	6.22	2.87	2.44	0.21
2000	5.69	2.26	2.03	0.23
2001	5.50	2.09	1.96	0.16
2002	5.32	1.91	1.88	0.06
2003	5.40	2.06	1.96	0.09
2004	5.30	2.00	1.74	0.25

Source: Brazilian National Mortality Database; data modified by author. MR: mortality rate; TB: tuberculosis. [a]General MR shown per 1,000 inhabitants and TB-related MR shown per 100,000 inhabitants.

Methods

A retrospective descriptive study was carried out based on secondary data. We included deaths of residents in the state of Espírito Santo, registered in the SIM, in which TB was given as the principal cause, obtained from the website of the *Departamento de Informática do Sistema Único de Saúde* (DATASUS, Information Technology Department of the Unified Health Care System) of the Brazilian National Ministry of Health.[11] We excluded deaths in which the age of the deceased was unknown.

The causes of death were classified according to the International Classification of Diseases (ICD). In the 1985-1995 period, we used the ninth revision (ICD-9), with the following causes: pulmonary TB; other respiratory forms of TB; meningeal TB and TB of the central nervous system; and miliary TB. In the 1996-2004 period, we used the tenth revision (ICD-10), with the following causes: respiratory TB; and other forms of TB. Demographic data necessary for the variables of the study were obtained from the National Ministry of Health DATASUS website.[12]

In order to avoid interference from different age distribution of the population during the period, the population of the census of the year 2000 was used for the calculation of the TB mortality rate, adjusted by the direct method. This adjustment method uses a standard population to eliminate the possibility of differences found being results of the difference in the age distribution of the population. It is used to compare two or more populations with differences in age structures or the same population in different periods.[13]

The causes were grouped as follows: respiratory TB (ICD-10) and pulmonary TB (ICD-9). Other forms of TB (ICD-10) were grouped with the following ICD-9 causes: other respiratory TB, meningitis TB and TB of the central nervous system; and miliary TB. This simplified classification resulted from the observation of the predominance of the respiratory form as cause of death throughout the study period.

Table 2 - Rates of tuberculosis-related mortality/100,000 inhabitants, adjusted for all forms, in the state of Espírito Santo (1985-2004), by age bracket.

Year	Age (years)										
	<5	5-9	10-14	15-19	20-29	30-39	40-49	50-59	60-69	70-79	≥80
1985	1.4	0	0.84	1.03	1.87	5.96	10.43	22.85	15.29	43.94	74.08
1986	1.05	0.36	0	2.03	1.79	5.41	13.4	15.87	15.93	16.51	13.25
1987	1.38	0.35	0	0	2	5.83	10.96	20.35	19.76	46.66	25.82
1988	1.03	0	0.37	0.99	2.47	4.12	5.59	11.16	23.06	36.72	32.52
1989	0.34	0.65	0.72	0	1.32	3.8	9.09	15.43	14.41	27.84	49.5
1990	0.68	0.31	0.35	1.44	2.03	2.12	7.93	6.43	13.56	23.14	27.29
1991	1.35	0.3	0	1.42	1.46	3.9	8.19	20.86	11.4	21.85	82.95
1992	0.36	0.32	0.33	0.88	2.2	5.15	7.66	8.24	12.81	16.94	21.92
1993	0.94	0	0	0.88	1.81	4.51	11.41	18.66	21.34	23.42	23.36
1994	1.51	0.27	0.3	0	1.31	4.07	11.66	13.35	10.33	19.84	30.16
1995	1.17	0	0.29	1.24	1.91	3.1	11.89	11.42	12.23	43.94	21.92
1996	0	0	0	0.71	1.59	3.53	7.78	8.14	11.91	15.37	26.73
1997	0.77	0	0	0	1.32	3.16	9.49	7.22	15.97	17.04	5.19
1998	0.37	0	0	0.66	1.49	2.59	6.14	7.66	12.1	22.84	20.25
1999	0.72	0	0	0	1.03	3.2	5.59	9.31	8.42	18.22	19.76
2000	0.35	0	0	0.6	0.72	1.88	4.02	6.49	9.78	9.12	13.19
2001	0.68	0	0	0.29	0.69	2.01	3.36	5.81	6.08	13.87	12.78
2002	0	0	0	0.28	0.67	1.95	2.51	3.48	9.19	9.81	24.87
2003	0.32	0.31	0	0.27	0.65	1.13	3.41	5.49	7.66	13.13	21.19
2004	0.31	0	0	0.27	0.47	2.2	3.78	5.74	4.97	11.62	14.74
Mean	0.74	0.14	0.16	0.65	1.44	3.48	7.71	11.20	12.81	22.59	28.07

Source: Brazilian National Mortality Database; data modified by the author.

Mortality rates were calculated using the program Excel, version 7.0. The equations of linear tendency and the statistics of model adjustment (value of R^2 and the value of p of the F test to adapt the model) were obtained using the statistical software Statistical Package for the Social Sciences, version 15.0 (SPSS Inc., Chicago, IL, USA). The level of significance adopted was 5%.

Results

The specific mortality rate adjusted for TB of all forms was similar to the general mortality rate. For the specific mortality rate, the reduction was from 5.6/100,000 inhabitants in 1985 to 2.0/100,000 inhabitants in 2004, compared with a reduction from 8.3/1,000 inhabitants for 5.3/1,000 inhabitants for the general mortality rate in the same period.

The reduction tendency was similar to that observed in the country as a whole and in the southeastern region. In 2003, the mortality rate observed in the state of Espírito Santo was 2.06/100,000 inhabitants, whereas in Brazil as a whole and in the southeastern region the mortality rates were 2.8 and 2.9/100,000 inhabitants, respectively.[14]

The clinical pulmonary form was responsible for the majority (89.7%) of all TB-related deaths registered in the period, presenting a drop in the mortality rate from 4.09/100,000 to 1.74/100,000, translating to a decrease of 57.5%, a little lower than the decrease seen in the mortality rate for all forms of TB. Mortality due to other clinical forms of TB varied from 0.6/100,000 inhabitants in 1985 to 0.25/100,000 at the end of the study period (Table 1).

A drop in the rate of the mortality specific to all forms of TB was observed in all age brackets (Table 2). Comparing the means of the study period, the age brackets that presented lower values were 5 to 9 years (mean, 0.14/100,000 inhabitants) and 10 to 14 years (mean, 0.16/100,000 inhabitants). Simple linear regression models were created for the mortality rate data adjusted for *age bracket* (y) according to the variable *year* (x). The equations of the models found, the value of R^2 and respective values of p of the F test (Table 3) indicate that the tendencies were toward a decrease and were statistically significant.

A tendency toward a reduction in the TB mortality rate for both genders was observed. In females, the mortality rate decreased from 3.12 to 0.96/100,000 inhabitants, more markedly than in

Table 3 - Linear tendency equations used in order to calculate the mortality rate for death from tuberculosis, of all forms, in the 1985-2004 period, by age bracket.

Age (years)	Model	R^2	p	Tendency
<5	y = −0.049x + 1.256	0.382	0.004	Decreasing
5-9	y = −0.015x + 0.301	0.209	0.043	Decreasing
10-14	y = −0.025x + 0.424	0.336	0.007	Decreasing
15-19	y = −0.048x + 1.159	0.241	0.028	Decreasing
20-29	y = −0.081x + 2.299	0.692	0.000	Decreasing
30-39	y = −0.198x + 5.567	0.701	0.000	Decreasing
40-49	y = −0.409x + 12.01	0.538	0.000	Decreasing
50-59	y = −0.722x + 19.31	0.602	0.000	Decreasing
60-69	y = −0.615x + 19.27	0.573	0.000	Decreasing
70-79	y = −1.326x + 36.51	0.463	0.001	Decreasing
≥80	y = −1.692x + 45.84	0.262	0.021	Decreasing

Table 4 - Rates of tuberculosis-related mortality/100,000 inhabitants, in the state of Espírito Santo (1985-2004), by gender.

Year	Adjusted MR	Adjusted MR for males	Adjusted MR for females	Male/ female MR ratio
1985	5.60	6.19	3.16	1.96
1986	4.55	5.89	1.8	3.27
1987	5.42	5.76	3.26	1.77
1988	3.68	4.83	2.54	1.90
1989	4.17	5.21	1.76	2.96
1990	3.26	3.78	1.81	2.09
1991	4.67	5.78	2.3	2.51
1992	3.66	4.41	2.12	2.08
1993	4.83	4.98	3.48	1.43
1994	3.95	5.19	1.67	3.11
1995	4.35	4.82	2.58	1.87
1996	3.35	4.16	2.06	2.02
1997	3.39	4.44	1.95	2.28
1998	3.11	3.06	2.75	1.11
1999	2.87	3.42	1.83	1.87
2000	2.26	3.52	1.02	3.45
2001	2.09	2.75	1.38	1.99
2002	1.91	2.96	0.93	3.18
2003	2.06	2.98	1.22	2.44
2004	2.00	3.06	0.96	3.19

Source: Brazilian National Mortality Database; data modified by author. MR: mortality rate.

males, for whom it was 6.19 to 3.06/100,000 inhabitants. The ratio for males remained higher than that for females, being 1.11 in 1998 and reaching 3.19 at the end of the study period (Table 4).

Discussion

The WHO estimated that in the region of the Americas (central and south) a reduction in the specific incidence by age and mortality would occur, albeit slow, due to the expected increase in the prevalence of HIV infection.[15] The DOTS strategy has been effective in interrupting TB transmission, in the prevention of the development of resistance of the bacillus to the tuberculostatic drugs and in the reduction of mortality.[16] This strategy has gained strength in Espírito Santo, in a gradual form, in eight cities considered priorities for the control of the disease.

Data obtained from the SIM demonstrate that the specific mortality rate fell by approximately 52.4% in the 1980-2003 period. In that period, the pulmonary form was predominant, accounting for approximately 90% of all TB-related deaths.[14] In the state of Espírito Santo, this decrease was more pronounced (64.3%), the pulmonary form also being predominant (89.7%). In the city of Fortaleza, Brazil,[17] this behavior was similar, the reduction of the rate of mortality due to all forms of TB and to pulmonary TB being slightly lower than that found in this study.

Mortality among individuals 19 years of age or younger was always presented less significant than in the other age brackets; the age bracket over 70 years of age presented values 6 to 7 times above the statewide mean. Infections that occurred at a younger age and suffer reactivation in elderly people, the characteristic co-morbidity and immunodeficiency, as well as the aging of the population of the country might explain the evolution to active TB and death in the elderly population.[14,18] The decreasing incidence in the study period can be attributed to the improvement of the strategies of control implemented in Espírito Santo, principally related to initiation of treatment and chemoprophylaxis for patients under the age of 15. Nevertheless, the TB program needs to develop strategies of control that benefit individuals over 59 years of age, creating opportunities for appropriate treatment and avoiding the evolution to death.[14,18,19]

The mortality rate in males, always higher than in females, follows the incidence pattern of the disease. Morbidity is higher among men, as a consequence of the combination of biological and social facts, as well as of the possible differences in exposure factors and prevalence of the infection with evolution to disease, together with factors related to access to health care services,[2,14] indicating the need for further studies that would identify such differences in our state.

In Rio de Janeiro, Brazil, in the 1999-2001 period, mortality due to multiple causes related to TB was higher among men (13, 10.3 and 11.2 per 100,000 men) than among women (3.5, 3.4 and 3.3 per 100,000 women).[20] A study carried out in Fortaleza identified mean mortality rates 7 per 100,000 men deaths in males and 4.4 per 100,000 women, with an odds ratio of 1.59 (95% CI: 1.09-2.32).[17] Another study identified, among 4,680 reported cases of death due to TB, a male/female ratio of 2.5:1. In the cases of TB/AIDS comorbidity, this ratio was higher (3.8:1) and remained stable between 1993 and 1996 and between 1997 and 2000.[21] Among the explanations given for these findings are the higher index of alcoholism and higher index of TB treatment abandonment found among men.

One of the limitations of the present study was the search for the number of deaths in which TB was given as the principal cause, not computing the cases in which the TB was present as a comorbid condition, such as in the deaths in which TB figures as an AIDS-related morbidity. A study comparing the SIM database with the Brazilian Case Registry Database would improve the quality of the data regarding the diagnostic confirmation of the pulmonary cases and the existence of comorbidities that could influence the risk of death due to TB. The cases diagnosed at the time of death show delay in the diagnosis and presence of reservoir cases of the disease, maintaining its transmission.[22]

The deaths registered in the SIM in which TB was given as the principal or associated cause should be investigated by the technicians of the Tuberculosis Control Program as an integrating action for the identification of the magnitude of the disease and for surveillance in its control.

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