Original Article

Evolution of tuberculosis-related mortality in Fortaleza, Brazil from 1980 to 2001*

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ABSTRACT

Objective: To evaluate the evolution of tuberculosis-related mortality, as well as gender-related and age-related tendencies, in the city of Fortaleza, Brazil. **Methods:** A descriptive study, based on secondary data, was conducted. All deaths from tuberculosis occurring among residents of Fortaleza in the 1980-2001 period and reported to the Ministry of Health via the Mortality Database were included. The evolution of tuberculosis-related mortality was compared with that of overall mortality and with that of mortality from all infectious diseases. The tendencies of the coefficients of overall mortality and of tuberculosis-related mortality, adjusted and unadjusted for age and gender, were calculated for the study period. **Results:** The coefficients of overall mortality and of tuberculosis-related mortality presented decreasing tendencies. The coefficient of tuberculosis-related mortality presented a decreasing tendency in individuals = 19 years of age ($y = -0.0906x + 2.5133$), from 20 to 59 years of age ($y = -0.414x + 12.29$) and 60 years of age ($y = -1.2494x + 40.289$), as well as in males ($y = -0.3175x + 10.971$) and females ($y = -0.1933x + 6.8051$). **Conclusion:** Despite displaying a decreasing tendency, the coefficient of tuberculosis-related mortality remains high.

Keywords: Tuberculosis/mortality; Information systems; Prevalence

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INTRODUCTION

The study of tuberculosis-related demographic tendencies can provide data that facilitate tuberculosis control and prevent the resurgence of the collective fear of the disease,[1] as well as indicating the effectiveness of the control measures. During the 1960s and 1970s, there was great optimism in relation to the prospect that tuberculosis could be controlled. Improvements in sanitary conditions, housing and programs for the control of the disease reduced the risk of infection.[2] However, in 1993, the World Health Organization[3] declared tuberculosis a global emergency, due to the resurgence of the disease in developed countries and to its expansion on the Asiatic and American continents. The World Health Organization related the severity of the situation to social inequality, to the advent of the acquired immunodeficiency syndrome, to the aging of the population and to the great migratory movements.[3] Tuberculosis in Brazil has maintained its endemicity, including during the period in which it was considered under control in industrialized countries.[4]

In areas where the transmission of tuberculosis was reduced, there was a gradual evolution of the occurrence of the disease among older individuals. The annual reduction of the risk of infection was not accompanied by a reduction of re-activation of the disease among the people already infected.[5] Without treatment, 60% to 70% of the patients presenting positive sputum smear microscopy results and negative serology for the human immunodeficiency virus die.[6] The Directly Observed Treatment, Short-course strategy reduced tuberculosis mortality to less than 5%. In patients presenting negative sputum smear microscopy results, without treatment, mortality is approximately 20% without treatment, whereas it is less than 5% with treatment.[6] From 1980 to 1991, there was a 35% reduction in tuberculosis-related mortality in Brazil for all age brackets, except in individuals over the age of 80, whereas from 1991 to 1996, this reduction was minimal for individuals aged 30 or above.[7]

The incidence, prevalence and the number of reported cases of tuberculosis in the city of Fortaleza, located in the state of Ceará, have presented a trend toward a decrease since 1995. Among the possible causes of this decrease are the underdiagnosis and underreporting of the disease, in addition to the actual reduction of the transmission of the infection. The underreporting of cases observed ranged from 3% in 1995 to 18.5% between 2000 and 2002.[8] The increase in the mortality and lethality rates can be indirect indicators of delayed diagnosis. The objective of this study was to evaluate the evolution of tuberculosis-related mortality between 1980 and 2001, as well as to identify gender-related and age-related trends, in Fortaleza.

METHODS

Fortaleza, the capital of the state of Ceará, has a geographical area of 336 km2, all of it considered urban. In the year 2000, its demographic density was 6373.2 inhabitants/km2. According to census records, the population of Fortaleza was 1,307,608 inhabitants in 1980, 1,768,637 inhabitants in 1991, and 2,141,402 inhabitants in the year 2000.[9]

This was a descriptive study based on secondary data. All deaths from tuberculosis occurring among residents of Fortaleza in the 1980-2001 period and reported to the Ministry of Health via the Mortality Database were included. These data are available on the website of the Information Technology Department of the Unified Health Care System.[10] The deaths from tuberculosis recorded between 1996 and 2001 were classified according to the International Statistical Classification of Diseases and Related Health Problems, tenth revision (ICD-10),[11] and the deaths occurring between 1980 and 1995 were classified according to the ICD-9.[12]

The evolution of tuberculosis-related mortality was compared with that of overall mortality. To reduce the bias created by the change in the composition of the population during the period, the overall mortality rates were calculated and adjusted by age bracket through the direct method,[12] using the population of the year 2000 census as the standard population. The year 2000 census was chosen as the reference because it was the most recent in relation to the study period. The population used in the calculation of the mortality rates was the one provided by the Brazilian Institute of Geography and Statistics, available from the Department of Information Technology of the Unified Health Care System.[9] We analyzed age brackets of ten years each: 0 to 19 years of age (children and adolescents); 20 to 59 (adults); and 60 or above (the elderly).

The equations of linear tendency of the mortality rates were calculated using the Excel 7.0 program.[14] The data were processed using Excel 7.013 and Epi-Info 6.04.[15] The variables are presented with their standard deviations and 95% confidence intervals (95% CIs). The chi-square test and odds ratios (ORs) were used for the bivariate analysis.

The study was submitted to and approved by the Ethics in Research Committee of the Federal University of Ceará School of Medicine.

RESULTS

In the period studied, the mean overall mortality rate (deaths/1000 inhabitants) in Fortaleza was 5.7 (standard deviation of 0.8), ranging from 7.7 in 1980 to 4.7 in 1992. In relation to 2001, the overall mortality rate in Fortaleza was higher only in 1981 and 1982 ($p < 0.05$), thereafter remaining stable ($p > 0.05$) (Table 1). The tendency of the adjusted overall mortality rate was toward a decrease in the period ($y = -0.1191x + 7.7158$).

The pulmonary form was responsible for more tuberculosis-related deaths (5.1 cases/100,000 inhabitants) than were the other forms (0.6 cases/100,000 inhabitants). There was a tendency toward a decrease in the rate of mortality caused by pulmonary tuberculosis ($p < 0.001$) and in that cause by other forms of tuberculosis ($p < 0.03$) (Table 1). There was also a tendency toward a decrease in the tuberculosis-related mortality rate adjusted by age bracket ($y = -0.6808x + 20.228$).

During the same period, the tendency was also toward a decrease in the mortality rate for males ($y = -0.3175x + 10.971$) and females ($y = -0.1933x + 6.8051$) (Figure 1). In 1990, there was an accentuated reduction in the tuberculosis-related mortality rate among males. The mean mortality rate per 100,000 inhabitants was 7 among the males and 4.4 among females (OR: 1.59; 95% CI: 1.09-2.32).

The proportion of deaths by age bracket was 61% for individuals between 20 and 59 years of age, 26.7% for those aged 60 or above, and 11.2% for those under 20 years of age (Table 2). Considering the data obtained from the Fortaleza Municipal Secretary of Health for the 1995-2001 period,[16] the proportions of diagnosed cases by age bracket were as follows: 13.2% for those 0 to 19 years of age; 75.4% for those 20 to 59 years of age; and 11.2% for those aged 60 or above. The proportions of deaths were 11.6% (OR: 0.87; 95% CI: 0.68-1.13), 62.2% (OR: 0.83; 95% CI: 0.72-0.94) and 26% (OR: 2.32; 95% CI: 1.93-2.80), respectively (ORs are between each age bracket and the total). The mortality rate presented a tendency toward a decrease among children and adolescents 0 to 19 years of age ($y = -0.0906x + 2.5133$), adults from 20 to 59 years of age ($y = -0.414x + 12.29$) and those aged 60 and above ($y = -1.2494x + 40.289$) (Figure 2). There was a correlation of these tendencies with the mortality rates in these age brackets (0-19: $y = -0.0062x + 0.7873$; 20-59 years of age: y $-0.7026x + 19.838$; those aged 60 and above: $y = -4.172x + 127.94$). Regarding the younger groups, only the age bracket from 15 to 19 years of age presented a tendency toward an increase,

TABLE 1

Overall mortality rates related to infectious diseases, to tuberculosis in general, to pulmonary tuberculosis, and to other forms of tuberculosis, by year of death, in Fortaleza, Ceará - 1980-2001

Mortality	Overall	Tuberculosis	Pulmonary tuberculosis	Other Forms
1980	7.7	10.6	9.6	1.1
1981	7.6	8.9	7.5	1.4
1982	6.7	9.1	7.6	1.5
1983	6.9	8.2	6.7	1.5
1984	6.8	6.9	6.4	0.4
1985	6.2	9.2	7.9	1.3
1986	5.9	5.8	5.1	0.7
1987	5.5	6.2	4.7	1.5
1988	5.8	6.5	5.6	0.9
1989	5.5	5.3	4.6	0.7
1990	4.9	3.7	3.1	0.6
1991	4.8	5.0	4.4	0.6
1992	4.7	6.3	5.8	0.6
1993	5.4	6.1	5.6	0.5
1994	5.4	4.3	3.6	0.7
1995	5.9	4.3	3.8	0.5
1996	5.7	4.1	3.6	0.5
1997	5.5	4.5	3.9	0.6
1998	5.5	5.7	5.3	0.4
1999	5.5	4.5	4.1	0.4
2000	4.9	3.4	3.0	0.4
2001	5.0	4.4	4.1	0.3
Mean	5.7	5.8	5.1	0.7

Source: Mortality Database

Overall mortality/1000 inhabitants and specific mortality/100,000 inhabitants

whereas all the others presented tendencies toward a decrease (Table 3). Considering the years in which there was a census (1980, 1991, 1996 and 2000), there was a tendency toward a decrease in the tuberculosis-related mortality rate, as well as in most of the age brackets when analyzed separately (Table 2). All the age brackets presented a tendency toward a decrease between 1980 and 1991. A tendency toward an increase was observed in the age brackets from 15 to 19 years of age and from 30 to 39 years of age, when comparing 1991 and 1996. The period between 1996 and 2000 presented a tendency toward an increase in the age brackets from 20 to 29 years of age, 50 to 59 years of age and from 60 to 69 years of age.

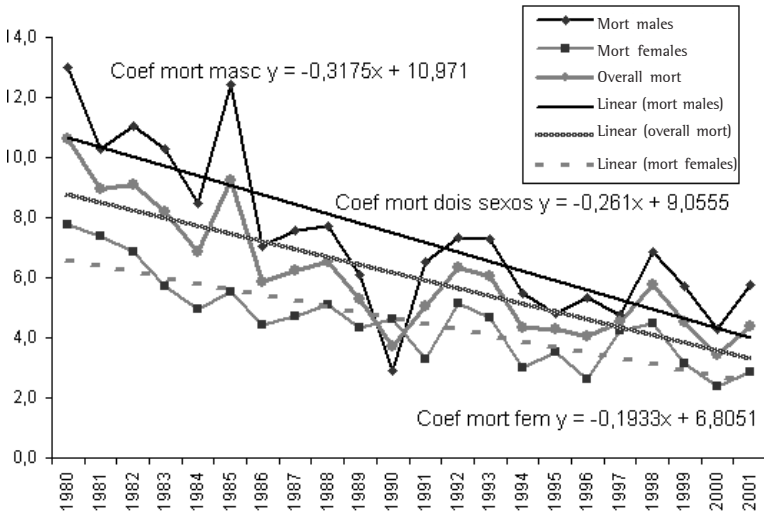

Figure 2 - Tendency and tuberculosis-related mortality rate by gender; overall mortality rate by year, Fortaleza, Ceará, 1980-2001

DISCUSSION

Some authors[1] observed a tendency toward an increase of the tuberculosis-related mortality rate in Brazil from 1985 to 1997. In Fortaleza, the tendency in the period from 1985 to 1997 (y - 0.106 + 360.62), as well as in the period from 1980 to 2001, was toward a decrease, but with variations throughout the period. This rate peaked in 1985, there was an accentuated reduction in 1990, and it grew until 1992, after which there was a more homogeneous reduction. In 1985 and 1992, the number of deaths attributed to tuberculosis was greater than in previous or subsequent years. In the state of São Paulo, in 1998, the tuberculosis-related mortality rate was 4.6/100,000 inhabitants,[17] whereas in Fortaleza, in this same year, it was 5.7/100,000 inhabitants, which can suggest that the case detection is still delayed or that the compliance with treatment is still heterogeneous. The mortality rate for the pulmonary form of tuberculosis was 8.5 times greater than that for the extrapulmonary form, similar to what is observed in relation to the number of diagnosed cases. However, the extrapulmonary form is more difficult to diagnose and, in general, tends to be more severe. The number and the proportion of deaths were greater among the patients from 20 to 59 years of age. Nevertheless, for those in this bracket who presented the active form of the disease, the chance of dying was approximately 17% lower than that for those in all age brackets combined, whereas it was 2.3 times higher for those aged 60 or above.

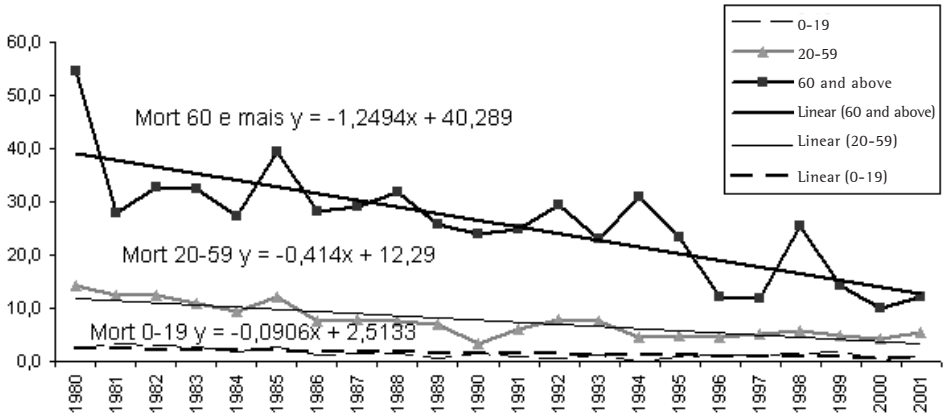

Figure 1 - Tuberculosis-related mortality in children and adolescents, adults and elderly, Fortaleza, Ceará, 1980-2001

TABLE 2

Tuberculosis-related mortality by age bracket and by year of death, Fortaleza, Ceará - 1980-2001

Year	0-4	5-9	10-14	15-19	20-29	30-39	40-49	50-59	60-69	70-79	≥ 80	Total
1980	7.0	0.0	1.3	0.6	6.8	13.9	18.5	34.3	46.1	60.2	91.5	10.6
1981	5.7	2.0	2.5	2.3	5.0	12.8	21.4	23.1	22.7	38.4	28.5	8.9
1982	7.9	1.9	1.8	0.0	2.6	6.4	26.4	38.5	25.8	45.5	39.7	9.1
1983	6.7	0.6	1.8	1.1	4.3	8.3	15.5	31.3	26.5	30.3	74.2	8.2
1984	2.2	0.6	1.2	2.8	5.2	5.3	19.7	16.3	17.5	33.0	69.6	6.9
1985	5.9	1.2	1.7	1.7	5.0	10.2	23.5	22.7	38.8	27.6	76.5	9.2
1986	2.1	1.1	1.1	0.0	4.2	2.0	12.4	25.3	26.5	30.2	31.0	5.8
1987	3.1	0.5	0.0	2.2	4.4	8.0	12.0	13.9	27.1	25.4	49.0	6.2
1988	3.1	1.6	0.5	1.1	3.0	7.3	14.3	14.6	21.2	38.4	74.7	6.5
1989	2.0	0.0	0.0	0.5	3.2	4.8	13.9	14.3	22.0	30.3	35.7	5.3
1990	2.0	1.5	0.5	1.6	0.9	3.0	6.4	7.0	21.2	22.8	42.8	3.7
1991	2.5	1.0	0.0	0.5	2.0	3.3	9.9	20.4	19.0	28.2	49.0	5.0
1992	1.0	0.0	0.5	0.5	2.5	5.1	10.1	30.1	25.8	32.9	38.6	6.3
1993	2.4	0.5	0.0	2.0	4.5	5.5	7.1	23.2	16.8	33.0	31.3	6.1
1994	0.0	0.0	0.0	0.5	2.1	3.9	5.3	13.8	23.4	50.4	23.2	4.3
1995	0.9	1.4	0.5	0.5	3.1	3.5	7.5	10.0	13.6	38.1	38.1	4.3
1996	0.0	0.0	1.4	3.8	1.6	5.0	8.5	5.0	7.9	20.0	12.5	3.6
1997	0.5	1.0	0.5	3.2	3.7	4.2	5.9	10.5	12.9	14.6	0.0	3.9
1998	0.0	0.5	0.4	5.4	2.8	4.7	7.2	15.0	22.8	19.1	53.7	5.3
1999	0.5	0.5	0.4	5.3	2.8	3.7	4.7	13.9	18.6	11.7	0.0	4.1
2000	0.0	0.0	0.0	0.8	2.0	3.8	6.9	6.9	13.6	7.8	0.0	3.0
2001	0.0	0.0	0.0	2.9	2.9	5.5	8.5	7.4	14.4	13.4	0.0	4.1
Mean	4.8	0.8	0.8	2.0	3.4	5.8	11.8	17.5	22.2	28.1	33.0	6.0

The adjusted overall mortality rate and tuberculosis-related mortality rate presented decreasing tendency curves, although with different angles, suggesting that the factors affecting these curves had a different impact on each of them, or that these curves were affected by different factors. Among the hypotheses that can justify these tendencies, we can think of undercollection of death certificates, resulting in some death certificates not being registered in the Mortality Database, a low rate of suspicion of tuberculosis among the patients who subsequently died, and better control of tuberculosis, allowing fewer cases to become severe and result in death. Among the individuals who developed the active form of tuberculosis, the risk of death was lower for females than for males. The change in the age structure of the population of Fortaleza did not seem to have a pronounced influence on the tuberculosis curve, since both mortality rates, raw and adjusted, presented a similar tendency toward a decrease. In relation to Brazil as a whole,[7] the reduction in the mortality rates in Fortaleza occurred in all the age brackets, between 1980 and 1991, being less accentuated in the age bracket from 15 to 19 years of age, in which the mortality rates increased significantly between 1991 and 1996, resulting in a tendency toward an increase in this period.

Considering that 1% of the global population presents respiratory symptoms, and that 5% of those suffer from smear-positive pulmonary tuberculosis,[18] and, using the population in 2001 with a 5% mortality rate as reference, it was expected that 78 tuberculosis-related deaths would be detected. The detection of 96 deaths corresponds to a 6.2% mortality rate, which is even higher than the upper limit of the expected target with a good control of tuberculosis, even without considering the underreporting of tuberculosis as the cause of death on the death certificates. Based on this estimate, the mortality detected in 1980 would have been 14.8%, and a reduction to 6.2% can be considered expressive for the period.

The limitations of the study of secondary data include the possible missing records of tuberculosis as one of the causes of death, as well as failure in

TABLE 3

Linear tendency equations for mortality rates, Fortaleza, 1980-2001

Age bracket (years)	Mortality rate
0-4	y = -0.3433x + 6.4707
5-9	y = -0.0451x + 1.2314
10-14	y = -0.0781x + 1.634
15-19	y = 0.1118x + 0.5065
20-29	y = -0.1333x + 4.9291
30-39	y = -0.3055x + 9.427
40-49	y = -0.8222x + 21.533
50-59	y = -1.0393x + 30.018
60-69	y = -0.8862x + 32.2
70-79	y = -1.3535x + 45.177
≥ 80	y = -3.0351x + 73.978

the collection of and typographical errors on the death certificates in the Mortality Database, in addition to the possibility that the reductions in the rates and tendencies toward a decrease do not correspond to reality. A detailed evaluation of the correlation between acquired immunodeficiency syndrome and tuberculosis was not carried out, and co-infection can be a factor that influences mortality. We can conclude that the tuberculosis-related mortality rate in Fortaleza remains high, and despite displaying a tendency toward a decrease, the decrease was more pronounced in the 1980s than in the 1990s. This behavior suggests the need to implement strategies for earlier diagnosis and greater treatment compliance.

REFERENCES

1. Antunes JLF, Waldman EA. Tuberculosis in the twentieth century: time-series mortality in São Paulo, Brazil, 1900-97. Cad Saúde Pública. 1999;15(3):463-76.
2. Dolin PJ, Raviglione MC, Kochi A. Global tuberculosis incidence and mortality during 1990-2000. Bull World Health Organ. 1994;72(2):213-20.
3. World Health Organization. Global tuberculosis control. WHO report 1998. Geneva: WHO; 1998. (Publication WHO/TB/98-237).
4. Ruffino-Netto A. [Tuberculosis: the negleted calamity] Rev Soc Bras Med Trop. 2002;35(1):51-8. Portuguese.
5. Bates JH, Stead WW. The history of tuberculosis as a global epidemic. Med Clin North Am. 1993;77(6):1205-17.
6. Borgdorff MW, Floyd K, Broekmans JF. Interventions to reduce tuberculosis mortality and transmission in low-and middle-income countries. Bull World Health Organ. 2002;80(3):217-27.
7. Chaimowicz F. Age transition of tuberculosis incidence and mortality in Brazil. Rev Saude Publica. 2001;35(1):81-7.
8. Façanha MC, Guerreiro, MFF, Pinheiro AC, Lima JRC, Vale RLS, Teixeira GFD. Resgate de casos subnotificados de tuberculose em Fortaleza-CE, 2000-2002. Bol Pneumol Sanit. 2003;11(2):13-6.
9. Brasil. Ministério da Saúde. Secretaria Executiva. DATASUS. Informações de saúde: indicadores demográficos e socioeconômicas: População residente [texto na Internet]. Brasília: Ministério da Saúde. [citado 2005 Mar 21]. Disponível em: http://tabnet.datasus.gov.br/cgi/idb2005/matriz.htm#demog
10. Brasil, Ministério da Saúde. Secretaria Executiva: DATASUS. Informações de saúde: indicadores de mortalidade [texto na Internet]. Brasília (DF): Ministério da Saúde. [citado 2005 Mar 21]. Disponível em: http://tabnet.datasus.gov.br/cgi/idb2005/matriz.htm#mort
11. Organização Mundial da Saúde. Centro Brasileiro de Classificação de Doenças. Classificação estatística internacional de doenças e problemas relacionados à saúde: CID-10. Revisão. São Paulo: EDUSP; 1999.
12. Organização Mundial da Saúde. Centro Brasileiro de Classificação de Doenças. Classificação estatística internacional de doenças e problemas relacionados à saúde - CID 9. Revisão. São Paulo: EDUSP; 1980.
13. Gordis L. Measuring the occurence of disease: II. Mortality. In: Gordis L. Epidemiology. 3th ed. Philadelphia: Elsevier Saunders; 2004.
14. Excel [computer program]. Version 2002. versão 7.0. Microsoft Corporation; 2002.
15. Epi-Info [computer program]. Version 6.04b. Atlanta: CDC; 1997. [cited 2005 Dec 12]. Available from:. http://www.cdc.gov/EpiInfo/
16. Fortaleza. Secretaria Municipal da Saúde. Celula de Vigilancia Epidemiológica. Sistema de Agravos de Notificacao- SINAN. Tuberculose. [texto na Internet]. Fortaleza: Secretaria Municipal de Saúde. [citado 2005 Mar 21]. Disponível em: http://www.sms.fortaleza.ce.gov.br/internet/cevepi_index.asp.
17. Santo AH, Pinheiro CE, Jordani MS. Causas múltiplas de morte relacionadas à tuberculose no estado de São Paulo, 1998. Rev Saude Publica 2003;37(6):714-21.
18. Brasil. Ministério da Saúde. Fundação Nacional de Saúde. Tuberculose. Guia de Vigilância Epidemiológica [texto na Internet]. Brasília: Ministério da Saúde; 2002. [citado 2005 Jan 12]. Disponível em: http://portal.saude.gov.br/portal/arquivos/pdf/manual_tuberculose.pdf#search=%22Brasil.