

Characteristics of tuberculosis in the state of Minas Gerais, Brazil: 2002–2009*

Características da tuberculose no estado de Minas Gerais entre 2002 e 2009

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Abstract

Objective: To analyze the profile of tuberculosis cases reported between 2002 and 2009 in the state of Minas Gerais, Brazil, according to sociodemographic, clinical, and laboratory characteristics, as well as to comorbidities and mortality. **Methods:** This was a descriptive, epidemiological study based on data obtained from the Brazilian Case Registry Database and the Brazilian Mortality Database for the 2002-2009 period. **Results:** There were 47,285 reported cases of tuberculosis, corresponding to a mean incidence of 22.3/100,000 population. The individuals diagnosed with tuberculosis were predominantly in the 20- to 49-year age bracket and male (62.4% and 67.0%, respectively). Individuals with a low level of education accounted for 18.5% of the cases. New cases, cases of recurrence, and cases of retreatment accounted for 83.7%, 5.7%, 5.7%, respectively. The rates of cure and treatment noncompliance were 66.2% and 11.2%, respectively; multidrug-resistant tuberculosis was identified in 0.2% of the cases; and the mortality rate was 12.9%. The directly observed treatment, short-course (DOTS) strategy was applied in 21.8% of the cases. Sputum smear microscopy and culture were performed in only 73.9% and 12.9% of the cases, respectively. Chest X-rays were performed in 90.5% of the cases. Pulmonary tuberculosis was the predominant form (in 83.9%). Comorbidity with alcoholism, HIV infection, and diabetes mellitus were identified in 17.2%, 8.3%, and 3.8%, respectively. **Conclusions:** During the study period, the numbers of new cases, cases of treatment noncompliance, and deaths were high, comorbidities were common, and there was a failure to perform adequately basic tests for the diagnosis of tuberculosis. Multidisciplinary approaches, expanded use of the DOTS strategy, better knowledge of the distribution of tuberculosis, and improvements in the databases are needed in order to achieve better control of the disease in the state of Minas Gerais.

Keywords: Tuberculosis/epidemiology; Tuberculosis/mortality; Information systems.

Resumo

Objetivo: Analisar o perfil de casos de tuberculose no estado de Minas Gerais entre 2002 e 2009, segundo características sociodemográficas, clínicas e laboratoriais, assim como presença de comorbidades e mortalidade. **Métodos:** Estudo epidemiológico descritivo com levantamento de dados dos casos notificados no Sistema de Informação de Agravos de Notificação e Sistema de Informação de Mortalidade entre 2002 e 2009. **Resultados:** Foram notificados 47.285 casos de tuberculose nos anos estudados, com média de incidência 22,3/100.000 habitantes. Os indivíduos com tuberculose eram predominantemente da faixa etária de 20–49 anos (62,4%), do sexo masculino (67,0%) e tinham baixa escolaridade (18,5%). Casos novos, de recidiva e de retratamento representaram, respectivamente, 83,7%, 5,7% e 5,7% do total de casos. As proporções de cura, abandono do tratamento e tuberculose multirresistente foram, respectivamente, 73,1%, 11,2% e 0,2%, enquanto o coeficiente de mortalidade foi 12,9%. O tratamento diretamente observado (TDO) foi administrado em 21,8% dos casos. A baciloscopia e a cultura de escarro somente foram realizadas em 73,9% e 12,9% dos casos, respectivamente. A radiografia de tórax foi realizada em 90,5% dos casos. A forma pulmonar prevaleceu (83,9%). A comorbidade com alcoolismo, infecção pelo HIV e diabetes mellitus foi identificada em 17,2%, 8,3% e 3,8% dos casos, respectivamente. **Conclusões:** No período estudado, o número de casos novos, de abandono e de óbitos foi elevado, as comorbidades foram relevantes, e os exames básicos não foram realizados adequadamente para o diagnóstico da tuberculose. São necessários o trabalho multiprofissional, ampliação da estratégia TDO, maior conhecimento da distribuição da tuberculose em Minas Gerais e melhorias nos bancos de dados para que haja um melhor controle da doença no estado.

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

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Introduction

Even with the advancement of medicine, tuberculosis remains the infectious disease that causes the greatest number of deaths among adults worldwide. It is estimated that one third of the world population is infected with *Mycobacterium tuberculosis* and that, each year, the bacillus makes approximately 9.4 million people ill, causing 1.7 million deaths. In 2009 in Brazil, there were 71,686 reported new cases and approximately 4,800 reported deaths, which means that Brazil ranks 19th among the 22 countries that are estimated to account for 80% of all cases of tuberculosis worldwide.^(1,2)

In recent years, the Brazilian National Ministry of Health has encouraged tuberculosis control, on the basis of the targets set by the World Health Organization (WHO): diagnose at least 70% of the expected cases; properly treat 100% of the diagnosed cases; cure at least 85% of those cases; and maintain treatment noncompliance at acceptable levels (up to 5%). Among the Brazilian states, Minas Gerais ranks 5th in terms of the number of reported cases.⁽²⁾

Minas Gerais is one of the 27 federative units in Brazil and has a territorial extent of 586,528.29 km². With a population of 19,595,309 people, it is the second most populous state in Brazil, with a population density of 32.73 people/km² and 853 cities. The cities in the state of Minas Gerais account for 51.5% of the cities in southeastern Brazil and for 15.5% of the cities in Brazil. The state is subdivided into 28 Regional Health Management Districts and currently has 25 priority cities for tuberculosis control. In addition, Minas Gerais has 3,553 Family Health Program Teams, who serve 829 cities.^(3,4)

Some diseases can favor the development of tuberculosis. The three chief comorbidities among those related to tuberculosis are HIV infection, alcoholism, and diabetes mellitus (DM). The epidemiological profile of tuberculosis has been changed by HIV over the years. Tuberculosis/HIV co-infection has caused an increase in mortality, changing resistance to antituberculosis drugs and the risk of transmission due to treatment noncompliance.^(5,6)

Studies have shown that DM can favor the development of tuberculosis and account for over 10% of tuberculosis cases due to immunosuppression, and that the risk of developing tuberculosis is approximately three times higher

in patients with DM than in those without.^(7,8) This therefore justifies the need for increasing efforts to identify and treat diabetic patients with latent *M. tuberculosis* infection before the disease becomes active.^(7,9) Alcoholism is also associated with pulmonary tuberculosis, leading to a higher risk of developing the disease and to treatment difficulties.⁽¹⁰⁾

Given this context, knowledge of the characteristics of tuberculosis could contribute to the development of new strategies for the control of this disease in accordance with the targets set by the WHO. Therefore, the objective of the present study was to analyze the profile of tuberculosis between 2002 and 2009 in the state of Minas Gerais according to sociodemographic, clinical, and laboratory characteristics, as well as to comorbidities and mortality.

Methods

This was a descriptive, epidemiological study based on data regarding reported cases of tuberculosis by city of residence obtained from the Brazilian National Ministry of Health *Sistema de Informação de Agravos de Notificação* (SINAN, Brazilian Case Registry Database) for the 2002-2009 period in the state of Minas Gerais. The present study was approved by the Ethics Committee of the Federal University of Minas Gerais (Protocol no. ETIC 216-08).

All cases reported in the period were included, and 341 cases were excluded because of missing or unknown data, such as age, gender, city of residence, and previous treatment.

Incidence, defined on the basis of the tuberculosis cases registered in the SINAN, was calculated by dividing the mean rate of new cases of tuberculosis by the mean population estimate.

We analyzed sociodemographic characteristics (gender, age, and level of education), clinical characteristics (disease form, type of admission, and outcome), and laboratory characteristics (sputum smear microscopy results, sputum culture results, chest X-ray findings, and tuberculin skin test [TST] results), as well as comorbidities (HIV infection, DM, and alcoholism). The reference values used for the analysis of the TST results were as follows: negative, an induration of 0 to 4 mm; weakly positive, an induration of 5 to 9 mm; and strongly positive, an induration \geq 10 mm,⁽¹¹⁾ as described in the SINAN.

Data on the population (per 1,000 people) were obtained from the Brazilian Institute of Geography and Statistics, according to estimates and the 2010 census.⁽³⁾

The analysis of the clinical characteristics involved disease form (pulmonary, extrapulmonary, and disseminated forms), type of (new case, recurrence, readmission after treatment noncompliance, and transfer), and outcomes (cure, treatment noncompliance, transfer, a change in diagnosis, multidrug-resistant (MDR) tuberculosis, and death). Mortality data were obtained from the *Sistema de Informação de Mortalidade* (SIM, Brazilian Mortality Database).

The data obtained were entered into a database with the use of TabWin 3.5, which is made available by the Information Technology Department of the Brazilian National Ministry of Health, and the analyses were performed with the Statistical Package for the Social Sciences, version 16.0 (SPSS Inc., Chicago, IL, USA), and OpenEpi, version 2.3. We performed a descriptive analysis of the information obtained from this database, including a description of the population, frequency distributions, and statistical measures of the selected characteristics. Interval estimation was performed by using confidence intervals for binomial proportions based on the Wilson test score method.⁽¹²⁾

Results

During the study period, there were 47,285 reported cases of tuberculosis. The mean incidence rate was 22.3/100,000 population (Figure 1).

The 20- to 49-year age group had the greatest number of tuberculosis cases, which corresponds to 29,526 cases (62.4%), followed by the over-65-year age group (5,356 cases; 11.3%). Males predominated (31,690 cases; 67.0%; Table 1).

Regarding the level of education, those who had had less than 9 years of schooling had the highest incidence (9,288 cases; 18.5%), followed by those who had had less than 5 years of schooling (8,267 cases; 16.5%; Table 1).

Regarding the type of admission, the distribution was as follows: new case, in 39,581 cases (83.7%); recurrence, in 2,686 cases (5.7%), readmission after treatment noncompliance, in 2,697 cases (5.7%); transfer, in 1,980 cases (4.2%); and no data, in 341 cases (0.7%; Figure 2).

The directly observed treatment, short-course (DOTS) strategy was applied in 10,317 cases (21.8%).

Of the reported cases, 53.8% had a positive first sputum smear and 26.1% did not undergo sputum smear microscopy. Of the patients who underwent culture, 2,743 (66.7%) had positive results. However, 41,227 patients (87.1%) did not undergo the test. Chest X-rays were performed

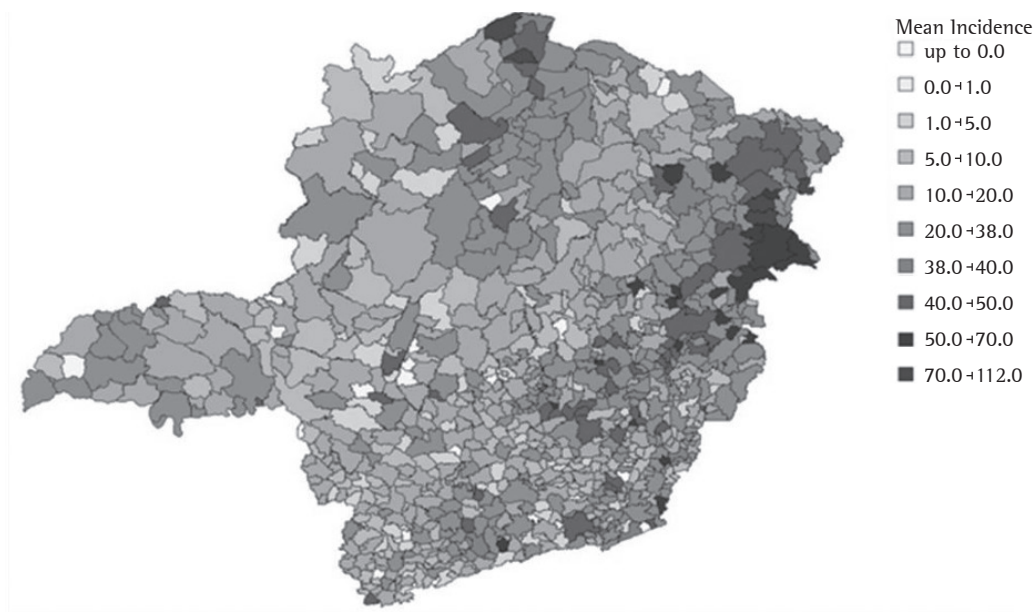


Figure 1 - Spatial distribution of the mean incidence of tuberculosis in the state of Minas Gerais, Brazil, by city, 2002-2009. Source: SINAN-MG (Brazilian Case Registry Database-Minas Gerais).

in 42,343 (89.5%) of the reported cases, and 38,495 (81.4% of the total number of cases) were considered to be cases of suspected tuberculosis.

Table 1 – Frequency of tuberculosis by age bracket, gender, and level of education, Minas Gerais, Brazil, 2002-2009.

Variable	n	%	95% CI
Age bracket, years			
< 1	266	0.6	0.5-0.7
1-4	356	0.7	0.6-0.8
5-9	420	0.9	0.8-1.0
10-14	549	1.2	1.1-1.3
15-19	2,055	4.3	4.2-4.5
20-34	13,757	29.0	28.7-29.5
35-49	15,769	33.4	32.9-33.8
50-64	8,757	18.5	18.2-18.9
65-79	4,286	9.1	8.8-9.3
≥ 80	1,070	2.3	2.1-2.4
Gender			
Male	31,690	67.0	66.6-67.4
Female	15,595	33.0	32.6-33.4
Level of education			
Illiterate	4,097	8.7	8.4-8.9
≤ 9 years of schooling	20,102	42.5	42.1-43.0
High school (incomplete/complete)	5,254	11.1	10.8-11.4
College (incomplete/complete)	1,706	3.6	3.4-3.8
Unknown/no data	16,126	34.1	-

Source: SINAN-MG (Brazilian Case Registry Database-Minas Gerais).

In 37,044 cases (78.3%), TST was not performed. Considering the total number of cases, the TST results were as follows: negative, in 5.4%; weakly positive, in 1.9%; and strongly positive, in 11.6% (Table 2).

The pulmonary, extrapulmonary, and disseminated forms of tuberculosis were found in 39,669 (83.9%), 8,509 (18.0%), and 1,973 (4.2%) of the cases, respectively. Among the patients with pulmonary tuberculosis, 33,505 (80.5%) of the 41,642 results were positive on the first and second smears, confirming the diagnosis of the pulmonary form of the disease, and, for those under 15 years of age, the proportion was 6.9% (479/6,989). Overall, the most common comorbidity was alcoholism, in 8,112 cases (17.2%), followed by HIV infection, in 3,915 (8.3%), and DM, in 1,786 (3.8%). Comorbidity of pulmonary tuberculosis with alcoholism, HIV infection, and DM was identified in 15.0%, 4.5%, and 3.2% of the cases, respectively.

According to the data collected from the SINAN, outcomes were as follows: cure, in 34,611 cases (73.1%); treatment noncompliance, in 5,311 cases (11.2%); transfer, in 2,558, (5.4%); a change in diagnosis, in 1,334 (2.8%); MDR tuberculosis, in 79 (0.2%); and no data/unknown, in 2,715 (5.7%; Figure 3). A total of 677 deaths were reported, and the mortality rate was 3.5% (677/19,220,578).

According to data collected from the SIM, there were 2,488 deaths from tuberculosis, of which 2,215 (89.0%) were from pulmonary tuberculosis, 143 (5.8%) were from miliary tuberculosis, 58 (2.3%) were from central nervous

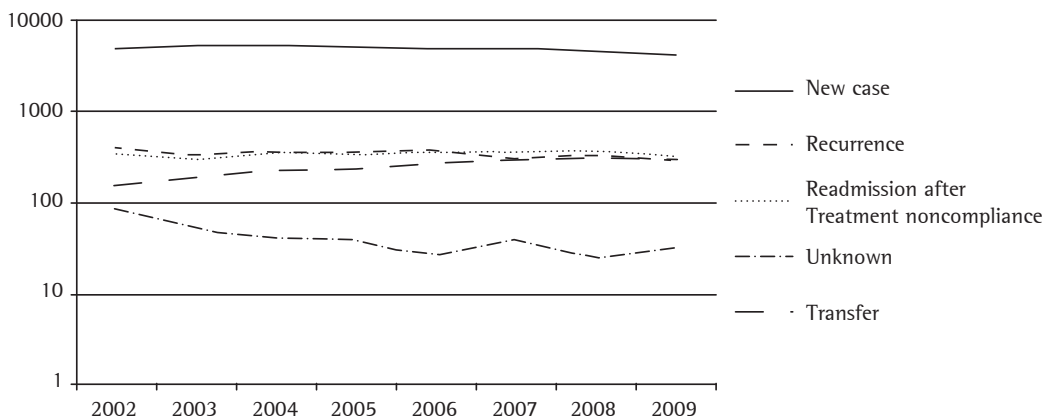


Figure 2 – Profile of tuberculosis by type of admission, Minas Gerais, Brazil, 2002-2009. Source: SINAN-MG (Brazilian Case Registry Database-Minas Gerais). Number of cases on a logarithmic (log₁₀) scale.

Table 2 – Frequency of testing among the cases diagnosed with tuberculosis, Minas Gerais, Brazil, 2002-2009.

Test	n	%	95% CI
1st sputum smear			
Positive	25,461	53.8	53.4-54.3
Negative	9,497	20.1	19.7-20.4
Not performed	12,323	26.1	25.7-26.5
Unknown/no data	4	-	-
2nd sputum smear			
Positive	6,077	27.3	26.7-27.9
Negative	3,236	14.5	14.1-15.0
Not performed	12,943	58.1	57.5-58.8
Unknown/no data	25,029	-	-
Sputum culture			
Positive	2,743	5.8	5.6-6.0
Negative	1,370	2.9	2.7-3.0
In progress	1,941	4.1	3.9-4.3
Not performed	41,227	87.2	86.9-87.5
Unknown/no data	4	-	-
Chest X-ray			
Suspicious	38,495	82.3	81.9-82.6
Normal	3,284	7.0	6.8-7.2
Pathologies other than tuberculosis	564	1.2	1.1-1.3
Not performed	4,453	9.5	9.2-9.8
Unknown/no data	489	-	-
Tuberculin skin test			
Negative	2,551	5.5	5.3-5.7
Weakly positive	904	1.9	1.8-2.1
Strongly positive	5,485	11.9	11.6-12.2
Not performed	37,044	80.6	80.2-80.9
Unknown/no data	1,301	-	-

Source: SINAN-MG (Brazilian Case Registry Database-Minas Gerais).

system tuberculosis, and 72 (2.9%) were from tuberculosis in other organs. The mortality rate was 12.9% (2,488/19,220,578).

Discussion

The mean incidence (defined on the basis of the reported cases alone) in the state of Minas Gerais for the study period was 22.3/100,000 population, which means that Minas Gerais ranks 24th among the Brazilian states⁽¹³⁾ and has met the millennium development goal for tuberculosis incidence, which is to reduce incidence to 25.6 cases per 100,000 population by 2015.⁽¹³⁾ However, an analysis of the distribution of the disease by city reveals a different scenario, since 92 cities had incidence rates equal to or greater than the national average of 38.3/100,000 population. This demonstrates that, in the state of Minas Gerais, prioritization should not be restricted to the metropolitan areas singled out by the tuberculosis control program, given that high incidence rates are found in smaller cities.

In the present study, tuberculosis predominated in the economically active population (i.e., those aged 20-49 years) and in individuals over 65 years of age, especially in males, at a ratio of 2:1, with a low level of education, which is in agreement with the findings of other studies.^(2,13)

Regarding the type of admission, new cases accounted for 83.7%, and, as shown in Figure 2, nearly all types of admission remained stable during the eight-year study period. In addition, it is of note that the calculated incidence is decreasing mainly because of the increase in the

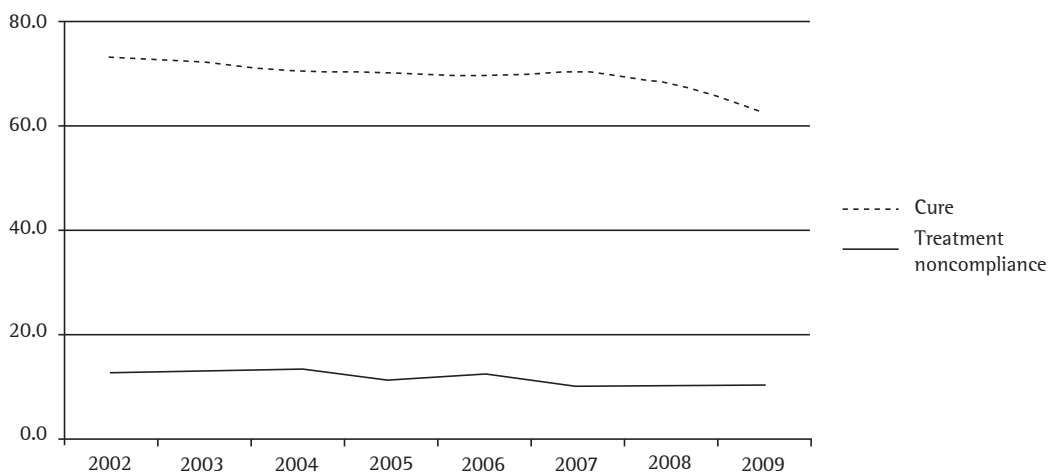


Figure 3 – Profile of tuberculosis by outcome (cure and treatment noncompliance), Minas Gerais, Brazil, 2002-2009. Source: SINAN-MG (Brazilian Case Registry Database-Minas Gerais).

population, given that the absolute number of new cases has not decreased significantly over time. In order to reduce the number of new cases effectively, it is necessary to develop a process that can identify areas with different needs and measures, where the tuberculosis control program will invest in the surveillance of patients with respiratory symptoms and in the identification of the population at risk for latent tuberculosis. When such cases are identified and correctly treated, there will be a true reduction in the number of new cases.

For readmission after treatment noncompliance, the reported rate was only 5.7%; however, the rate of treatment noncompliance during the study period was 11.2%. This shows that the noncompliant patients did not return for another treatment. Active surveillance of these cases should be incorporated into the routine practice of the Family Health Program Teams.

The Brazilian National Tuberculosis Control Program, in accordance with the WHO recommendation, has set a target cure rate of 85% and a target noncompliance rate of up to 5% for pulmonary tuberculosis.⁽²⁾ According to the reported tuberculosis outcomes in the state of Minas Gerais (Figure 3), little has been achieved in terms of cure (66.2%) and noncompliance (11.8%), which underscores the need for the implementation and expanded use of the DOTS strategy, the coverage of which was low.⁽¹³⁾

We found that approximately 30% of the patients did not undergo sputum smear microscopy, which shows that this test is not routinely requested by health care workers. Since sputum smear microscopy is an inexpensive and easy-to-perform test that is needed for screening patients with respiratory symptoms, one realizes the ineffectiveness of the tuberculosis control measures, given that pulmonary tuberculosis was the most common form (in 84%), as shown in other studies.⁽²⁾ Even for the patients who underwent the test, the positivity rate (53.8%) is found to be lower than the 2009 nationwide rate (64%), which underscores the need to implement quality control measures in the laboratories in the state of Minas Gerais.⁽²⁾

The results show that most patients did not undergo sputum culture (87.2%). Although sputum culture is a more complex, more expensive test that takes longer to perform and is less accessible, it is of fundamental importance

to the evaluation of smear-negative cases of pulmonary tuberculosis. Culture allows not only diagnosis but also mycobacterial identification and drug resistance determination, especially for patients with comorbidities, such as alcoholism, HIV infection, and DM. It is of fundamental importance to determine the resistance profile of the strains circulating in the state of Minas Gerais because of the high rate of noncompliance (11.9%), primarily aiming at providing appropriate treatment.^(4,9,10,13) The low incidence of MDR tuberculosis (0.2%) could be underestimated, given that most cases did not undergo sputum culture or susceptibility testing.

Chest X-ray, which is an extremely important tool in the investigation of pulmonary tuberculosis and in the identification of atypical presentations in immunocompromised patients, was the most commonly performed procedure (in 90.5%). Suggestive findings are indispensable in order to request bacteriological examination (sputum smear microscopy and culture),⁽¹³⁾ which was not observed in this study, since sputum smear microscopy and culture were performed in only 73.9% and 12.9% of the cases, respectively. It should also be emphasized that a failure to perform culture precludes the correct identification of the bacterial species, as well as preventing the determination of drug resistance in order to define treatment.

In the study population, TSTs were requested in 80.6% of the cases and seem to have been used as a diagnostic parameter, given that bacteriological examination was not requested.

The high prevalence of comorbidities, such as alcoholism, HIV infection, and DM, shows the need for follow-up by a multidisciplinary team because of the possibility of a worsening of the diseases, as well as for measures, such as the DOTS strategy, at primary health care clinics in order to prevent noncompliance.^(5-7,9,10)

Pulmonary tuberculosis was more common than was extrapulmonary tuberculosis when related to all comorbidities evaluated (alcoholism, HIV, and DM). Of those patients with pulmonary tuberculosis, 80.4% had two positive sputum smears, which shows the good sensitivity of sputum smear microscopy. However, for patients under 15 years of age, the positivity rate of sputum smear microscopy was only 6.8% of the cases of pulmonary tuberculosis, which might be related

to smear-negative lesions and to the difficulty in expectorating.⁽⁸⁾

According to the reported data from the SIM and the SINAN, there was a large difference in terms of mortality (12.9% vs. 3.5%), which shows a large difference between the databases, justifying the need for measures that will enable data availability in a consistent and updated manner on the same platform automatically. Mortality is one of the main assessment measures of the tuberculosis control program, and the target set by the WHO is that mortality should be reduced to less than 5% by 2015. Therefore, strategies should be developed to allow interaction between reporting programs, with cross-referencing of data, allowing improved data reliability.

Currently, epidemiological methods have been used for assessing the distribution of *M. tuberculosis* in a given community. These methods include the molecular biology techniques known as restriction fragment length polymorphism^(14,15) and mycobacterial interspersed repetitive units,^(16,17) which allow the assessment of recent infection (active surveillance) or late infection (surveillance of an at-risk population), as well as spoligotyping, which assesses the distribution of *M. tuberculosis* strains.^(15,16) Therefore, investments can be better targeted at the surveillance of individuals with respiratory symptoms or individuals with comorbidities who require preventive treatment of latent infection.

One of the limitations of this study was the use of secondary data, which might affect the quality of results.⁽¹⁸⁾

In conclusion, during the study period, the numbers of new cases, cases of treatment noncompliance, and deaths from tuberculosis were high, comorbidities were common, and there was a failure to perform basic tests for the adequate diagnosis of tuberculosis in the state of Minas Gerais. Therefore, it is necessary that there be a joint effort involving health care providers and administrators, as well as the civil society and its organized segments, in the fight against tuberculosis. In addition, expanded use of the DOTS strategy; management of tuberculosis/HIV co-infection and MDR tuberculosis; and better knowledge of the distribution of the disease, with the improvement and combination of the data in the SIM and the SINAN; as well as epidemiological studies and studies on the molecular profiles of *M. tuberculosis*, are needed

in order to achieve better control of the disease in the state of Minas Gerais.

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