Occurrence of tuberculosis in the municipality of Governador Valadares in comparison with national and state-level data from Minas Gerais: an analysis of reported cases from 2001 to 2022 in the Notifiable Diseases Information System

Ocorrência de tuberculose no município de Governador Valadares, no âmbito nacional e do estado de Minas Gerais: uma análise dos casos notificados de 2001 a 2022 no Sistema de Informação de Agravos de Notificação

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Abstract

Tuberculosis represents a worldwide public health problem, particularly severe in Brazil (BR). The objective of this study was to perform an analysis of the epidemiological distribution of reported tuberculosis cases in the municipality of Governador Valadares (GV) and to compare these data with national and Minas Gerais (MG) state data. An observational, retrospective study was conducted using data obtained from the Brazilian Notifiable Diseases Information System (SINAN), with the aim of retrieving information from January 2001 to December 2022. Tuberculosis is a frequent disease, with 1,967,733 reported cases in BR during the evaluated period, of which 101,281 occurred in MG and 2,969 in GV; it predominantly affects males of economically active age, of Mixed-race race/ethnicity (self-reported), with low educational attainment, living in urban areas and in situations of social vulnerability. A considerable number of cases occurred among individuals seropositive for HIV, individuals with diabetes, and those with mental disorders, with the pulmonary form being the most frequent. Most tuberculosis cases had laboratory confirmation, and sputum smear microscopy was the most frequently used technique. Although most cases resulted in cure, treatment abandonment remains a concerning reality, especially considering patients carrying drug-resistant strains, reinforcing the need for public health actions aimed at patient follow-up in order to ensure treatment completion and to prevent the transmission of drug-resistant strains.

Keywords: Tuberculosis; Mycobacterium tuberculosis; Health Information Systems; Brazil.

Resumo

A tuberculose representa um problema de saúde pública mundial, particularmente grave no Brasil (BR). O objetivo deste trabalho foi realizar uma análise da distribuição epidemiológica dos casos notificados de tuberculose no município de Governador Valadares (GV) e comparar com os dados nacionais e do estado de Minas Gerais (MG). Foi realizado um estudo observacional, retrospectivo, a partir de dados obtidos do Sistema de Informação de Agravos de Notificação com o intuito de obter informações do período de janeiro de 2001 a dezembro de 2022. A tuberculose é uma doença frequente, com 1.967.733 casos notificados no BR no período avaliado, sendo 101.281 em MG e 2.969 em GV; afeta uma população, predominantemente, do sexo masculino, em idade economicamente ativa, da raça parda, com baixa escolaridade, residente em regiões urbanas e em situação de vulnerabilidade social. Um número considerável de casos ocorreu entre os indivíduos soropositivos para HIV, diabéticos e naqueles com doenças mentais, sendo a forma exclusivamente pulmonar da doença a mais frequente. A maior parte dos casos de tuberculose apresentou confirmação laboratorial e a baciloscopia do escarro foi a técnica mais usada. Apesar da maioria dos casos ter evoluído para cura, o abandono do tratamento ainda é uma realidade preocupante, em especial considerando-se os portadores de cepas resistentes, reforçando a necessidade e importância de ações de saúde pública que tenham o objetivo de acompanhar os pacientes a fim de garantir a completude do tratamento e evitar a transmissão de cepas resistentes.

Palavras-chave: Tuberculose; *Mycobacterium tuberculosis*; Sistemas de Informação em Saúde; Brasil.

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INTRODUCTION

Tuberculosis represents a worldwide public health problem and is particularly severe in Brazil.[1] It is an infectious and communicable disease that may be caused by bacteria belonging to the *Mycobacterium tuberculosis* complex: *M. tuberculosis, M. bovis, M. africanum, M. canetti, M. microti, M. pinnipedi,* and *M. caprae*.[2] In public health, the most relevant species in Brazil is *Mycobacterium tuberculosis*, an obligate aerobic, slow-growing bacillus transmitted through inhalation of aerosols produced by infected individuals.[3,2] Most cases are associated with poverty, poor living conditions, alcoholism, smoking, and high rates of HIV/AIDS coinfection.[3]

The lungs are the most affected organs; however, the bacillus may invade the bloodstream and the lymphatic circulation, disseminating and affecting other organs and tissues.[4] In the pulmonary form, the most common symptoms are fever, night sweats, hemoptysis, fatigue, and productive cough; in extrapulmonary tuberculosis, symptoms may vary and are related to the affected organ or organs.[5] The diagnosis of tuberculosis includes microbiological culture, molecular tests, sputum microscopy, and chest radiography.[3,5]

In Europe, between the 17th and 19th centuries, the disease accounted for approximately 30% of deaths; in 2022, tuberculosis was the second leading cause of death caused by a single infectious agent worldwide, surpassed only by COVID-19, with an estimated 7.5 million new cases in the same year. According to the World Health Organization (WHO), this number represents individuals who probably developed tuberculosis in previous years but were unable to receive diagnosis or treatment due to the COVID-19 pandemic. According to the WHO, approximately 410 thousand people developed the multidrug-resistant form of the disease, while the number of individuals diagnosed and starting treatment was lower than that observed in 2019, before the aforementioned pandemic.[3]

Brazil is among the 30 countries with the highest tuberculosis burden, which together account for 87% of all cases worldwide.[3] According to the epidemiological bulletin of the Health Surveillance Secretariat of the Ministry of Health[6] (2024), it is estimated that, in 2022, 85,604 new cases were diagnosed and 5,845 deaths were recorded in the country. In Minas Gerais (MG), the incidence of new cases in 2023 was approximately 17.7 cases per 100,000 inhabitants, below the national average for the same year, which was 37 cases per 100,000 inhabitants.[6] In Governador Valadares (GV), in 2019, 37.9 cases per 100,000 inhabitants were recorded.[7]

The objective of this study was to perform a retrospective analysis of the epidemiological distribution of reported tuberculosis cases in the municipality of Governador Valadares using remotely available databases and to compare these data with national data and those from the state of Minas Gerais.

METHODS

An observational, retrospective study was conducted using secondary data obtained from the Brazilian Notifiable Diseases Information System (SINAN), available on the electronic platform of the Department of Informatics of the Unified Health System (DATASUS), which was accessed through the website https://datasus.saude.gov.br/acesso-a-informacao/casos-de-tuberculose-desde-2001-sinan/ between November 2024 and February 2025, with the aim of obtaining information from January 2001 to December 2022. A survey of reported tuberculosis cases was performed in Governador Valadares (GV), in Brazil (BR), and in the state of Minas Gerais (MG), considering age group, race/ethnicity, sex, and educational level.

Percentages were also determined according to area of residence, type of entry in the notification system, institutionalization status, people experiencing homelessness, health profession, and clinical form (pulmonary or extrapulmonary), considering the most affected organs and underlying conditions, such as HIV/AIDS seropositivity, diabetes, alcoholism, and smoking. In addition, the percentages of cases with laboratory confirmation were determined, whether by the first or second sputum smear microscopy and culture test, as well as the percentage of cases that showed sensitivity or resistance to isoniazid, rifampicin, and other first-line antimicrobials, and the outcome status of tuberculosis cases was also determined.

In this study, the research objects consisted of public data obtained through remote consultation of the SINAN–DATASUS platform. There was no contact between researchers and patients, no biological material was requested from patients, and no patient identification was performed.

The results obtained in GV were compared with those found at the other levels, and the analyses of rates for each evaluated variable were performed using an inference test for incidence rates through the BioEstat 5.3 software (Belém, PA, Brazil). Statistical significance was defined as $p \leq 0.05$.

RESULTS

During the evaluated period, 1,967,733 tuberculosis cases were reported in SINAN throughout BR, of which 101,281 occurred in MG and 2,969 in GV; among these, 6.9%, 5.7%, and 6.1%, respectively, corresponded to relapse after treatment. Male individuals were the most affected at all evaluated levels, corresponding to 67.6% (BR), 68.9% (MG), and 71.1% (GV) of the cases. Among women, in 1.2% of cases in BR and 1% of cases in MG and GV, cases occurred during pregnancy, with a higher number of cases in the second trimester of gestation at all evaluated levels.

The age group from 20 to 29 years was the most affected in BR (23.7%) and in GV (20.8%); in MG, individuals aged 40–49 years showed the highest rate (21.4%). Regarding race/ethnicity, the Mixed-race population presented the highest number of occurrences at all evaluated levels, being affected in 39.3%, 36.9%, and 49.6% of the cases in BR, MG, and GV, respectively, as well as individuals with incomplete middle school (5th–8th grade), who presented rates of 21.4% (BR), 15.3% (MG), and 21.9% (GV) (Table 1).

After analyzing the reported cases according to area of residence, it was observed that residents of urban areas were the most affected at the three evaluated levels (Table 1), with a considerable occurrence of cases among the people experiencing homelessness, illicit drug users, smokers, alcohol users, as well as among incarcerated individuals and institutionalized individuals (Table 2). Health professionals presented infection rates of 0.5%, 0.4%, and 0.3% in BR, MG, and GV, respectively, in relation to the total evaluated population.

Among the comorbidities observed in individuals affected by this infection, a considerable number of cases occurred among HIV/AIDS-seropositive individuals, individuals with diabetes, and those with mental disorders. The exclusively pulmonary form of the disease was the most frequent, with rates of 83.8%, 79.8%, and 81.5% in BR, MG, and GV, respectively. Regarding extrapulmonary tuberculosis, the presence of infection in the pleura and peripheral lymph nodes, among other sites, was observed at all evaluated levels (Table 3).

Most tuberculosis cases had laboratory confirmation in BR (58.4%), MG (58.2%), and GV (54.9%), with sputum smear microscopy being the most frequently used technique. The first smear microscopy showed positive results in 52.5% (BR), 54.4% (MG), and 50.5% (GV) of the cases reported in SINAN; however, in 10.7% (BR), 13.6% (MG), and 14.4% (GV) of the cases, diagnostic confirmation occurred only after a second smear microscopy. Some individuals had laboratory confirmation by culture test, which showed positive results in 14.8% (BR), 12.4% (MG), and 13% (GV) of the reported cases, and antimicrobial susceptibility testing detected some cases of resistance to the antimicrobials most commonly used during treatment (Table 4).

Directly observed treatment (DOT) was not performed in most cases in the country; however, in MG and GV this type of treatment was applied to the majority of individuals. In some cases, positive sputum smear results were observed after the second and sixth months of treatment at all three evaluated levels (Table 5).

Most cases progressed to cure in BR (67.6%), MG (69.7%), and GV (71.3%) [$p \leq 0.05$ in relation to BR]; however, in 2.8% (BR), 3.1% (MG), and 5.9% (GV) [$p \leq 0.05$ in relation to BR and MG] of the cases, the outcome was death attributed to tuberculosis, with a significantly higher rate in GV compared with BR and MG. It is important to note that treatment abandonment rates were 12.4%, 12.7%, and 11.3% in BR, MG, and GV [$p \leq 0.05$ in relation to MG], respectively.

Table 1

Demographic characteristics of individuals with tuberculosis from January 2001 to December 2022 in Brazil, Minas Gerais, and Governador Valadares.

Demographic Data	Brazil	Minas Gerais	Governador Valadares
Total cases by sex	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown	349 (0.01)	1 (0.1)	-
Female	637,757 (32.4)*	31,469 (31.8)*	857 (28.9)
Male	1,329,627 (67.6)*	69,811 (68.9)	2,112 (71.1)
Total cases by age group	**BR n (%)**	**MG n (%)**	**GV n (%)**
<1	8,706 (0.4)	350 (0.3)	9 (0.3)
01-04	15,429 (0.8)*	680 (0.7)	12 (0.4)
05-09	14,072 (0,7)	687 (0.7)	15 (0.5)
10-14	24,821 (1.3)*	988 (0.9)	23 (0.8)
15-19	110,993 (5.6)	4,174 (4.1)*	165 (5.5)
20-29	466,215 (23.7)*	17,968 (17.7)*	619 (20.8)
30-39	428,365 (21.8)	21,495 (21.2)	615 (20.7)
40-49	364,550 (18.5)	21,670 (21.4)*	584 (19.6)
50-59	267,200 (13.6)	15,761 (15.6)*	410 (13.8)
60-69	155,786 (7.9)*	9,620 (9.5)	268 (9)
70-79	78,805 (4)*	5,524 (5.4)	175 (5.9)
80+	31,418 (1.6)*	2,361 (2.3)	74 (2.5)
Total cases according to race/ethnicity	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown	374,052 (19)*	12,652 (12.5)*	480 (16.1)
White	551,142 (28)*	32,003 (31.6)*	578 (19.5)
Black	233,475 (11.9)*	17,986 (17.7)*	414 (13.9)
Asian	16,366 (0.8)	1,022 (1)*	15 (0.5)
Mixed-race	773,776 (39.3)*	37,334 (36.8)*	1,474 (49.6)
Indigenous	18,732 (0.9)*	284 (0.3)	8 (0.2)
Total cases according to educational level	**BR n (%)**	**MG n (%)**	**GV n (%)**
Illiterate	551,822 (28)*	37,526 (37)*	752 (25.3)
1st–4th grade incomplete	116,658 (5.9)*	5,979 (5.9)*	230 (7.7)
1st–4th grade complete	239,669 (12.2)*	14,928 (14.7)	452 (15.2)
5th–8th grade incomplete	76,957 (3.9)	5,105 (5)*	120 (4)
5th–8th grade complete	421,559 (21.4)	15,567 (15.4)*	652 (22)
Middle school complete	78,113 (4)	4,127 (4.8)	128 (4.3)
High school incomplete	230,282 (11.7)*	7,210 (7.1)*	281 (9.5)
High school complete	119,663 (6.1)*	5,694 (5.6)*	223 (7.5)
Higher education incomplete	36,493 (1.8)*	773 (0.7)	31 (1)
Higher education complete	60,526 (3.1)	2,985 (2.9)	75 (2.5)
Not applicable	35,991 (1.8)*	1,387 (1.4)*	25(0.8)
Total cases according to area of residence	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	913,394 (46.4)*	28,899 (28.5)	903 (30.4)
Urban	938,453 (47.7)*	64,540 (63.7)	1,861 (62.7)
Rural	107,477 (5.5)	7,236 (7.1)*	163 (5.5)
Peri-urban	8,409 (0.4)*	606 (0.6)*	42 (1.4)
Total	**1,967,733**	**101,281**	**2,969**

*$P \leq 0.05$ in relation to GV.

Table 2

General characteristics of individuals with tuberculosis from January 2001 to December 2022 in Brazil, Minas Gerais, and Governador Valadares.

Characteristics	Brazil	Minas Gerais	Governador Valadares
Total cases among people experiencing homelessness	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	1,170,003 (59.4)*	67,847 (67)	1,925 (64.8)
Yes	31,979 (1.6)*	1,649 (1.6)*	561 (18.9)
No	765,751 (38.9)*	31,785 (31.4)	988 (33.2)
Total cases according to use of illicit drugs	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	1,183,532 (60.1)*	69,361 (68.5)	1,957 (65.9)
Yes	127,219 (6.4)*	5,037 (5)*	233 (7.8)
No	656,982 (34.4)*	26,883 (26.5)	779 (26.2)
Total cases according to smoking status	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	1,180,594 (60)*	69,030 (66.8)*	1,924 (64.8)
Yes	182,875 (9.3)*	9,741 (9.6)*	426 (14.3)
No	604,264 (30.7)*	22,510 (22.2)	619 (20.8)
Total cases according to alcohol use	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	614,663 (31.2)*	34,076 (33.6)	1,036 (34.9)
Yes	275,182 (14)*	21,279 (21)*	541 (18.2)
No	1,077,888 (54.8)*	45,926 (45.3)	1,392 (46.8)
Total cases among incarcerated individuals	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	1,163,757 (59.1)*	67,703 (66.8)	1,926 (64.9)
Yes	92,176 (4.7)	2,360 (2.3)*	152 (5.1)
No	711,800 (36.2)*	31,218 (30.8)	891 (30)
Total cases according to institutionalization status	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	1,378,033 (70)*	64,741 (63.9)	1,883 (63.4)
No	526,689 (26.7)*	33,507 (33)	1,031 (34.7)
Prison	41,601 (2.1)*	1,627 (1.6)	34 (1.1)
Nursing home	1,212 (0)	16 (0)	2 (0.1)
Orphanage	1,231 (0)	85 (0.1)	1 (0)
Other	17,573 (0.9)	1,090 (1.1)*	18 (0.6)
Psychiatric hospital	1,394 (0.1)	70 (0.1)	-
Total	**1,967,733**	**101,281**	**2,969**

*$P \leq 0.05$ in relation to GV.

Table 3

Clinical characteristics of individuals with tuberculosis from January 2001 to December 2022 in Brazil, Minas Gerais, and Governador Valadares.

Characteristics	Brazil	Minas Gerais	Governador Valadares
Total cases according to HIV status	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown	4,518 (0.2)	116 (0.1)	4 (0.1)
Positive	198,669 (10)*	9,182 (9.1)*	156 (5.2)
Negative	1,022,219 (52)*	43,956 (43.4)	1,229 (41.4)
In progress	122,356 (6.2)*	6,236 (6.1)*	68 (2.3)
Not performed	619,971 (31.5)*	41,791 (41.2)*	1,512 (50.9)
Total cases according to diabetes	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	639,894 (32.5)*	37,937 (37.4)	1,085 (36.5)
Yes	112,584 (5.7)	6,039 (6)	166 (5.6)
No	1,215,255 (61.7)*	57,305 (56.6)	1,718 (57.9)
Total cases according to mental disorders	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	649,102 (33)*	38,845 (38.3)*	1,066 (35.9)
Yes	38,457 (1.9)	2,939 (2.9)*	53 (1.8)
No	1,280,174 (65)	59,497 (58.7)*	1,850 (62.3)
Total cases according to clinical form	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	1,961 (0.1)	121 (0.1)	3 (0.1)
Pulmonary	1,649,906 (83.8)	80,839 (79.8)	2,421 (81.5)
Extrapulmonary	252,532 (12.8)*	16,435 (16.2)	464 (15.6)
Pulmonary + extrapulmonary	63,334 (3.2)	3,886 (3.8)*	81 (2.7)
Total cases according to affected organ in extrapulmonary tuberculosis	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	1,654,745 (84.1)	81,054 (80)	2,426 (81.7)
Pleural	122,290 (6.2)*	7,946 (7.8)	253 (8.5)
Peripheral lymph nodes	62,979 (3.2)	3,827 (3.7)*	84 (2.8)
Genitourinary	7,872 (0.4)	959 (0.9)*	14 (0.5)
Bone	14,346 (0.7)	977 (0.9)	30 (1)
Ocular	8,507 (0.4)*	814 (0.8)	32 (1.1)
Miliary	25,161 (1.3)*	1,728 (1.7)	64 (2.1)
Meningoencephalic	17,163 (0.9)*	1,365 (1.3)*	12 (0.4)
Cutaneous	4,310 (0.2)	297 (0.3)	5 (0.2)
Laryngeal	13,341 (0.7)*	173 (0.8)	7 (0.2)
Other	37,017 (1.9)	2,141 (2.1)*	45 (1.5)
Total	**1,967,733**	**101,281**	**2,969**

*$P \leq 0.05$ in relation to GV.

Table 4

Laboratory-confirmed tuberculosis cases from January 2001 to December 2022 in Brazil, Minas Gerais, and Governador Valadares.

Characteristics	Brazil	Minas Gerais	Governador Valadares
Total cases with laboratory confirmation	**BR n (%)**	**MG n (%)**	**GV n (%)**
Yes	1,150,661 (58.5)*	58,970 (58.2)*	1,632 (54.9)
No	817,072 (41.5)*	42,311 (41.7)*	1,337 (45.1)
Total cases according to first sputum smear microscopy	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown	1,933 (0.1)	121 (0.1)	3 (0.1)
Positive	1,034,064 (52.5)	55,019 (54.3)*	1,500 (50.5)
Negative	420,306 (21.3)*	20,312 (20)*	694 (23.4)
Not performed	475,696 (24.2)	24,168 (23.8)	755 (25.4)
Not applicable	35,734 (1.8)*	1,661 (1.6)*	17 (0.6)
Total cases according to second sputum smear microscopy	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown	1,448,277 (73.6)*	63,641 (62.8)	1,875 (63.1)
Positive	210,474 (10.7)*	13,780 (13.6)	426 (14.3)
Negative	111,468 (5.6)*	6,925 (6.8)	222 (7.5)
Not performed	197,514 (10)*	16,935 (16.7)*	446 (15)
Total cases per culture test	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown	5,784 (0.3)	121 (0.1)	3 (0.1)
Positive	292,749 (14.8)*	12,638 (12.5)	387 (13)
Negative	141,653 (7.2)	6,047 (6)*	207 (7)
In progress	96,584 (4.9)*	4,638 (4.6)*	53 (1.8)
Not performed	1,430,963 (72.7)*	77,837 (76.8)	2,319 (78.1)
Total cases by susceptibility to antimicrobials	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	1,503,364 (76.4)*	90,740 (89.6)	2,593 (87.3)
Resistant to isoniazid	3,987 (0.2)	146 (0.1)	9 (0.3)
Resistant to rifampicin	1,636 (0.1)	52 (0)	-
Resistant to isoniazid and rifampicin	2,533 (0.1)	111 (0.1)	4 (0.1)
Resistant to first-line drugs	3,090 (0.1)	172 (0.1)*	23 (0.7)
Susceptible	102,489 (5.2)*	4,637 (4.6)*	238 (8)
In progress	13,288 (0.7)*	344 (0.3)	4 (0.1)
Not performed	337,346 (1.9)*	5,079 (5)*	98 (3.3)
Total	**1,967,733**	**101,281**	**2,969**

*$P \leq 0.05$ in relation to GV.

Table 5

Treatment follow-up of individuals with tuberculosis from January 2001 to December 2022 in Brazil, Minas Gerais, and Governador Valadares.

Characteristics	Brazil	Minas Gerais	Governador Valadares
Total cases according to directly observed therapy (DOT)	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	823,371 (41.8)*	38,311 (37.8)*	818 (27.5)
Yes	547,149 (27.8)*	35,305 (34.8)*	1,348 (45.4)
No	597,213 (30.3)*	27,665 (27.3)	803 (27)
Total cases according to sputum smear microscopy after 2 months of treatment	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	571,781 (29)*	23,127 (22.8)*	242 (8.1)
Positive	107,582 (5.4)	8,830 (8.7)*	166 (5.6)
Negative	498,615 (25.3)*	26,060 (25.7)*	1,080 (36.3)
Not performed	706,429 (35.9)*	36,560 (36.1)*	1,311 (44.1)
Not applicable	83,326 (4.2)*	6,704 (6.6)	170 (5.7)
Total cases according to sputum smear microscopy after 6 months of treatment	**BR n (%)**	**MG n (%)**	**GV n (%)**
Unknown/Not reported	763,618 (38.8)*	33,678 (33.2)*	365 (12.3)
Positive	10,167 (0.5)	548 (0.5)	13 (0.4)
Negative	474,582 (24.1)*	27,988 (27.6)*	1,007 (33.9)
Not performed	635,426 (32.3)*	32,365 (31.9)*	1,414 (47.6)
Not applicable	83,940 (4.3)*	6,702 (6.6)	170 (5.7)
Total	**1,967,733**	**101,281**	**2,969**

P ≤ 0.05 in relation to GV.

DISCUSSION

Tuberculosis is one of the oldest diseases affecting humanity, and Brazil is among the countries with the highest burden of this disease.[3,8] In the present study, most affected individuals, at all evaluated levels, were male, with rates similar to the national average reported by the Brazilian Ministry of Health between 2020 and 2022, which reached 70%,[6] and to the results found in previous studies.[8,9] Chidambaram et al.[10] (2021) also observed that male patients tend to present more severe tuberculosis, with more episodes of hemoptysis and greater pulmonary damage, which may be associated with hormonal factors and differential activation of genes linked to the X chromosome.

In BR, 1.2% of women affected by the disease were pregnant, as were 1% in MG and in GV. Tuberculosis during pregnancy is an important cause of maternal and fetal morbidity and mortality, leading to increased rates of unfavorable outcomes for both mother and fetus, including "abortion, preeclampsia, prematurity, low birth weight, anemia, postpartum hemorrhage, sepsis, and even maternal death".[11] In addition, pregnancy affects the diagnosis of tuberculosis by interfering with the performance of imaging tests and with the differentiation between symptoms of the disease and those common to pregnancy, which may lead to delayed diagnosis and consequently increase the risk of adverse effects for both mother and fetus.[12] Treatment is similar to that used for nonpregnant women: two months of isoniazid, rifampicin, pyrazinamide, and ethambutol followed by seven months of isoniazid and rifampicin, in order to avoid the risk of relapse, with hepatotoxicity being the main adverse effect.[13] However, in the study by Beck-Friss et al.[14] (2020), pregnant patients presented hepatic transaminase levels up to five times higher than those of nonpregnant patients during treatment, with normalization after temporary discontinuation of the medications, suggesting that pregnancy increases the

risk of hepatotoxicity during tuberculosis treatment. Even so, the absence of treatment during pregnancy presented a higher risk when compared with a possible occurrence of adverse drug reactions, especially due to the possibility of developing congenital tuberculosis.[12]

The most affected age group in BR and GV was 20–29 years, whereas in MG it was 40–49 years. These results are consistent with those reported by Sousa et al.[15] (2020), Silva et al.[9] (2020), and Dias et al.[16] (2022). This pattern may be explained by the protection provided by the BCG vaccine, which is effective for approximately 15 years and may be associated with greater susceptibility to *M. tuberculosis* infection in adults, since there are no vaccination campaigns targeting this population.[9] Other factors associated with a higher occurrence of this disease in these age groups include greater mobility and social interaction, due to daily work activities and greater involvement in economic activities.[16] In addition, individuals aged 20–29 years constitute a large proportion of individuals with alcohol use, smokers, and illicit drug users, groups considered at risk for infection and associated with higher rates of treatment failure and even treatment abandonment.[17]

The data obtained showed that the race/ethnicity most affected by tuberculosis at the three evaluated levels was Mixed-race individuals, which is corroborated by the study by Silva et al.[18] (2022), who reported that 49% of tuberculosis cases in Brazil between 2017 and 2021 occurred in Mixed-race individuals. According to data from the Brazilian Institute of Geography and Statistics, the population of BR, MG, and GV is predominantly Mixed-race ethnicity, which may explain the higher number of cases in this group. In addition, historically, the Black and Mixed-race population in Brazil has been associated with worse socioeconomic indicators, including health indicators, as a result of social and economic inequalities that determine quality of life;[6,8] therefore, mitigating these disparities is essential in order to reduce disease transmission through initiatives that ensure access to health services and appropriate treatment for these populations.

At all three evaluated levels, most individuals affected by tuberculosis had low educational attainment, which is supported by other studies.[17,19] Low educational attainment reflects social inequalities in the country and is associated with treatment abandonment and unfavorable outcomes, such as death.[17,19] Among individuals affected by tuberculosis, it is important to highlight those in situations of greater social vulnerability, namely the people experiencing homelessness, illicit drug users, and incarcerated individuals, with significantly higher rates in GV compared with those observed in BR and MG. Macedo et al.[20] (2021) reported that, considering reported tuberculosis cases in vulnerable populations in BR, most occurred among incarcerated individuals. According to the Ministry of Health[6] (2023), cases of the disease have increased in these populations, especially among incarcerated individuals, whose main risk factors include precarious living conditions, overcrowding, illicit drug use, and limited access to health services.[21]

Alcohol use is one of the main risk factors for tuberculosis, being associated with higher treatment failure, greater treatment abandonment, and increased mortality, as well as delays in diagnosis and in the initiation of treatment, in addition to important immunological alterations.[22] The proliferation of *M. tuberculosis* is favored by oxidative environments; alcohol induces oxidative stress in pulmonary alveoli through depletion of glutathione (GSH) stores and inhibition of nuclear factor erythroid 2–related factor 2 (Nrf2), which are responsible for activating hundreds of antioxidant genes, impairing the function of innate pulmonary immunity and favoring the replication of *M. tuberculosis*. Thus, patients with alcohol use disorder and tuberculosis present more oxidized alveoli and impaired immune response, allowing greater pathogen proliferation.[23] Alcohol also alters the metabolism of drugs used in tuberculosis treatment, such as isoniazid and rifampicin.[24] Considering that 14% of cases in BR, 21% in MG, and 18.2% in GV were associated with alcohol use, it is important that actions aimed at reducing excessive alcohol consumption among patients be implemented in order to improve treatment outcomes.

Regarding smoking, 9.3% (BR), 9.6% (MG), and 14.3% (GV) of patients were smokers. Nicotine present in cigarettes causes alterations in mucociliary function and impairs innate pulmonary immunity, making the patient more susceptible to infection by *M. tuberculosis*, which also applies to passive smokers.[23] This group is also associated with higher rates of treatment abandonment, delays in diagnosis, longer periods with positive cultures test, treatment abandonment, and unfavorable outcomes.[25] As with alcohol use, smoking prevention and control programs are important to prevent disease spread and to increase the number of favorable treatment outcomes.

Health care workers are among the main risk groups for infection by *M. tuberculosis*, especially those in direct contact with patients, namely nurses, nursing technicians, and Community Health Workers (CHW).[26] In the present study, these professionals showed infection rates of 0.5%, 0.4%, and

0.3% in BR, MG, and GV, respectively. These professionals work in the same communities and health services as patients with tuberculosis; in addition, irregular use of N95 masks, as well as lack of their availability in health units, increases exposure to procedures that generate aerosols, therefore requiring preventive educational measures and adequate personal protective equipment (PPE).[26,27] According to the study by Lacerda et al.[27] (2017), which evaluated the prevalence of latent tuberculosis among health care workers in Vitória (ES), 54.1% were infected; a similar result was reported by Prado et al.[26] (2017), in an analysis conducted in five Brazilian cities that found a prevalence of 27% of latent infection among these professionals.

In the present study, a considerable rate of coinfection between tuberculosis and HIV/AIDS was observed, corresponding to 10%, 9.1%, and 5.2% of cases in BR, MG, and GV, respectively, not including those with ongoing diagnosis or cases not reported. In the studies by Júnior et al.[17] (2019), conducted in the state of Alagoas, Nogueira et al.[28] (2021), conducted in the state of Tocantins, and Souza et al.(29) (2020), conducted in the state of Piauí, coinfection rates of 5.6%, 5%, and 6.8% were observed, respectively. In the study by Ferreira et al.[30] (2021), conducted in Belém (PA), the rate of tuberculosis/HIV coinfection was 12.94%. The characteristics of coinfected individuals are similar to those observed in general tuberculosis cases, namely Mixed-race race/ethnicity (self-reported), male sex, economically active age, low educational attainment, and pulmonary form of the disease, in addition to individuals in situations of social vulnerability, such as the people experiencing homelessness, alcohol users, and illicit drug users.[28-33]

Data from the Ministry of Health indicate a reduction in coinfection simultaneously with an increase in HIV testing among tuberculosis cases; however, many states present low testing rates and difficulty in accessing health services, which was intensified by the pandemic.[6] Among the associated factors are social isolation and stigma experienced by individuals with tuberculosis/HIV coinfection, as well as situations of social vulnerability, such as homelessness, which leads to invisibility and neglect of their needs, resulting in high rates of treatment abandonment and, consequently, worse disease outcomes.[34-36]

The role of health care teams is essential to ensure that patients receive adequate treatment and achieve better quality of life. According to Resende et al.[37] (2022), pharmaceutical care, especially when applied to patients coinfected with tuberculosis and HIV/AIDS, was associated with a lower occurrence of drug-related problems. According to the study by Carvalho et al.[34] (2022), the assistance provided by health professionals contributed to improved quality of life among coinfected patients, demonstrating the importance of these professionals in disease management.

Among the evaluated population, 5.7% (BR), 6% (MG), and 5.6% (GV) of patients presented both tuberculosis and diabetes mellitus (DM), similar to the findings of Abreu et al.[38] (2020), who reported a prevalence of 7.2% of these diseases occurring simultaneously in Brazil between 2007 and 2011; in turn, Sousa et al.[39] (2021) reported an average of 11.5% of tuberculosis and diabetes mellitus cases in a city in the state of Maranhão from 2014 to 2018, indicating an increasing trend. Tuberculosis causes metabolic and immunological changes that may lead to insulin resistance and diabetes mellitus, whereas diabetes mellitus impairs the immune system, making the individual more susceptible to infection by *Mycobacterium tuberculosis*.[40] Risk factors for infection by this microorganism in patients with diabetes mellitus include regular alcohol consumption, previous contact with an infected individual, and altered glycemic levels.[41] Therefore, the development of integrated health promotion actions aimed at the treatment of both tuberculosis and diabetes mellitus is important.[38,41]

In the present study, 1.9%, 2.9%, and 1.8% of patients with tuberculosis in BR, MG, and GV, respectively, had mental disorders, which is consistent with the study by Arroyo et al.[42] (2018), who observed that 1.6% of individuals with tuberculosis also had mental disorders in municipalities in the state of São Paulo between 2012 and 2015, especially among those with lower income.

The main form of tuberculosis found in this study was pulmonary, with 83.8% of cases in BR, 79.8% in MG, and 81.5% in GV, similar to that reported by Silva et al.[24] (2018), who found 85% of tuberculosis cases in the pulmonary form in the state of Rio de Janeiro between 2011 and 2014. Regarding extrapulmonary tuberculosis, most cases involved the pleura (6.2% BR, 7.8% MG, and 8.5% GV) and peripheral lymph nodes (3.2% BR, 3.7% MG, and 2.8% GV), which may be explained by the high oxygen availability in these regions, since *M. tuberculosis* is an obligate aerobe.[43,44] Pleural tuberculosis is the most common form of extrapulmonary tuberculosis and may arise from rupture of subpleural pulmonary tuberculous lesions communicating with the pleural space or through lymphatic dissemination.[45] Peripheral lymph node tuberculosis presents with swelling of lymph node groups in a single location, usually painless, firm, and fixed, and the

overlying skin may appear erythematous and edematous.[46]

Resistance to first-line drugs was present in 0.1% of cases in BR and MG, and in 0.7% of cases in GV. These results are consistent with those reported by Oliveira et al.[46] (2021), who found 0.2% of cases of resistance to first-line drugs in BR between 2009 and 2018. However, these values may not represent the actual situation of resistance to tuberculosis treatment, since the main information systems for epidemiological surveillance of the disease, namely the Brazilian Special Tuberculosis Treatment Information System (SITE-TB), used for resistant cases, SINAN, and the Laboratory Environment Manager (GAL), do not have an adequate information flow, with underreporting of resistant cases, which represents an obstacle to disease control, given that unreported cases do not initiate treatment and consequently become sources of transmission of drug-resistant strains.[47]

Used as one of the strategies to promote adherence and follow-up in tuberculosis treatment, directly observed therapy (DOT) consists of "a valuable strategy to link the individual to care and to the health service".[2] In the present study, DOT coverage was 27.8% in BR, 34.8% in MG, and 45.4% in GV. In the study by Meirelles and Palha[48] (2019), it was observed that 34 of the 59 municipalities evaluated in the state of São Paulo showed an increasing trend in DOT coverage, reaching 57.6% of patients from 2006 to 2021. In contrast, the result found for BR in the present study is considerably lower, even when compared with the data reported by Cortez et al.[49] (2021), who found 36.7% coverage in the country between 2006 and 2015. According to the recommendations of the Ministry of Health[2] (2019), DOT is indicated for all patients diagnosed with tuberculosis and creates an opportunity for health professionals to establish a bond with patients and their families, enabling the identification of factors that may lead to nonadherence to treatment.[2] However, Cola et al.[50] (2020) reported in their analysis that less than half of the notified cases underwent DOT between 2014 and 2016; according to the authors, the performance of DOT is conditioned by social and clinical determinants of tuberculosis, such as low educational attainment, alcohol use, reported mental disorders, pulmonary form of the disease, incarceration, and residence in the Southeast, Midwest, and South regions of the country, highlighting inequalities in access to health services.[50]

At the end of the second month of treatment, 5.4%, 8.7%, and 5.6% of patients still had positive sputum smear microscopy in BR, MG, and GV, respectively; these values decreased after the sixth month of treatment to 0.5% in BR and MG and 0.4% in GV. These figures indicate treatment success, suggesting that the interventions carried out by the Family Health Strategy (FHS), including DOT, have been effective in relation to adherence and follow-up of patients during therapy. It is possible for patients to remain smear-positive during treatment without this necessarily indicating treatment failure. However, those who remain positive or become positive again after negativation should be investigated for adherence, treatment failure, and drug resistance.[2]

Cure occurred in most cases, with rates of 67.6% in BR, 69.7% in MG, and 71.3% in GV. Dias et al.[16] (2022) found a similar rate in BR (66.2%) between 2015 and 2019. These results are consistent with data from the Ministry of Health, which indicate that 66.1% of cases resulted in cure in 2023; however, this percentage was 76.2% in 2016, indicating a significant decrease of more than 10%.[6] The rates found in the present study are lower than those reported by Santos et al.[17] (2018), who observed 83% cure in the state of Rio de Janeiro between 2011 and 2014, and by Andrade et al.[19] (2019), who found 79.6% cure in Salvador between 2014 and 2016.

The tuberculosis mortality rate in GV (5.9%) was significantly higher than in BR (2.8%) and MG (3.1%), and higher than that reported by Andrade et al.[19] (2019) in Salvador (2.3%). Factors such as more than 9 years of schooling, marital union, household density of two or fewer persons per bedroom, and the presence of governmental or nongovernmental income-transfer benefits during treatment were associated with lower occurrence of unfavorable outcomes and greater chances of cure.[19]

Although the previously presented results demonstrate that most infected individuals progressed to cure, treatment abandonment remains a concerning reality and, in the present study, showed rates of 12.4%, 12.7%, and 11.3% in BR, MG, and GV, respectively. Soeiro et al.[51] (2022) analyzed the distribution of treatment abandonment rates in the country between 2012 and 2018, obtaining an average of 10% for BR, states, and municipalities, similar to Cortez et al.[49] (2021), who reported a treatment abandonment rate of 11.4% in Brazil as a whole between 2006 and 2015. In the study by Lima et al.[52] (2023), a rate of 18.23% was observed, with the highest percentage in the South region of the country (22.94%). The main factors associated with treatment abandonment were male sex, low educational attainment, use of alcohol and/or illicit drugs, adverse drug effects, non-White ethnicity, and difficulty in accessing treatment.[53-56]

This study has some limitations, such as the use of secondary notification data. It was also observed that the tuberculosis notification system still has deficiencies, with

many missing or incomplete data, highlighting the need for improvements in the training of health professionals for proper completion of notification forms. In addition, between 2020 and 2022, there was a marked reduction in the number of reported tuberculosis cases, as well as a decrease in DOT and cure rates, with a consequent increase in reentry after treatment abandonment. This fact reflects the reorganization of health services to meet the demands of the COVID-19 pandemic, generating a negative impact on the notification of new cases.[6,18,57]

FINAL CONSIDERATIONS

In this study, it was possible to observe, at all evaluated levels, that tuberculosis is a frequent disease and predominantly affects males of economically active age, of Mixed-race individuals, with low educational attainment, living in urban areas and in situations of social vulnerability. A considerable number of cases occurred among individuals seropositive for HIV/AIDS, individuals with diabetes, and those with mental disorders, with the exclusively pulmonary form of the disease being the most frequent. Most tuberculosis cases had laboratory confirmation, and sputum smear microscopy was the most frequently used technique.

Although most cases resulted in cure, treatment abandonment remains a concerning reality, especially considering patients carrying drug-resistant strains, reinforcing the need for public health actions aimed at ensuring treatment adherence, such as directly observed therapy (DOT), in order to prevent the transmission of drug-resistant strains.

It is important to emphasize the need for policies aimed at reducing social inequalities and improving protection for vulnerable populations in order to achieve better outcomes in tuberculosis treatment. It is also necessary to highlight the importance of actions directed at preventing transmission and promoting health among high-risk groups, as well as the need for professional training focused on the proper and complete completion of SINAN notification forms, with the objective of reducing underreporting and the high number of missing or incomplete data.

REFERENCES

1. Hino P, Yamamoto TT, Bastos SH, Beraldo AA, Figueiredo TMRMD, Bertolozzi MR. Tuberculosis in the street population: a systematic review. Rev Esc Enferm USP. 2021;55:e03688. doi: https://doi.org/10.1590/S1980-220X2019039603688
2. Brasil. Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. Manual de Recomendações para o Controle da Tuberculose no Brasil. 2ª ed. Brasília, DF: Ministério da Saúde. 2019. 364p.
3. Organização Mundial da Saúde. Global tuberculosis report 2023. Available from: https://iris.who.int/. Accessed: Apr 6, 2024.
4. Petrone L, Petruccioli E, Vanini V, Cuzzi G, Gualano G, Vittozzi P, et al. Coinfection of tuberculosis and COVID-19 limits the ability to in vitro respond to SARS-CoV-2. International Journal of Infectious Diseases. 2021 Dez;113:S82-7. doi: https://doi.org/10.1016/j.ijid.2021.02.090.
5. Suárez I, Fünger SM, Kröger S, Rademacher J, Fätkenheuer G, Rybniker J. The Diagnosis and Treatment of Tuberculosis. Deutsches Arzteblatt International. 2019 Out;116(43):729-735. doi: https://doi.org/10.3238/arztebl.2019.0729.
6. Brasil. Ministério da Saúde. Secretaria de Vigilância em Saúde. Secretaria de Vigilância em Saúde e Ambiente. Departamento de HIV/Aids, Tuberculose, Hepatites Virais e Infecções Sexualmente Transmissíveis. Boletim Epidemiológico: Tuberculose 2023. Brasília, DF: Ministério da Saúde. 2023. 64p.
7. Prefeitura Municipal de Governador Valadares. Secretaria Municipal de Saúde. Departamento de Vigilância em Saúde, Gerência de Epidemiologia. Boletim Epidemiológico: Tuberculose 2021. Governador Valadares, MG: Secretaria Municipal de Saúde. 2021. 11p. Available from: https://www.valadares.mg.gov.br/abrir_arquivo.aspx/Boletim_Tuberculose?cdLocal=2&arquivo=%7BB3BDD7E7-E6EE-CEB0-21176CD2EAD1845A%7D.pdf. Accessed: Apr 6, 2024.
8. Martins TR, Carmo OFBD, Vilhaba JJ. Casos de tuberculose no Brasil. RSD. 2023 Nov; 12(11):e124121143863. doi: http://dx.doi.org/10.33448/rsd-v12i11.43863.
9. Silva FT. Número de casos confirmados de tuberculose no Brasil entre 2007 e 2016. Revista Científica Multidisciplinar Núcleo do Conhecimento. 2020 Apr; 04(04):94–104. doi: 10.32749/nucleodoconhecimento.com.br/saude/casos-confirmados-de-tuberculose.
10. Chidambaram V, Tun NL, Majella MG, Ruelas Castillo J, Ayeh SK, Kumar A, et al. Male Sex Is Associated with Worse Microbiological and Clinical Outcomes Following Tuberculosis Treatment: A Retrospective Cohort Study, a Systematic Review of the Literature, and Meta-analysis. Clinical Infectious Diseases. 2021 Nov;73(9):1580-8. doi: 10.1093/cid/ciab527.
11. Pessoa JDS, Buck ECDS, Alves SRP, Barrêto AJR, Ferreira MDGN, Trigueiro DRS. Tuberculose e gravidez: implicações e ações durante o tratamento. Acervo Saúde. 2023 Mai;23(2):01-15. doi: https://doi.org/10.25248/reas.e12530.2023.
12. Miele K, Bamrah Morris S, Tepper NK. Tuberculosis in Pregnancy. Obstetrics & Gynecology. 2020 Jun;135(6):1444-53. doi: 10.1097/AOG.0000000000003890.
13. Annamraju H, Mackillop L. Respiratory disease in pregnancy. Obstetrics, Gynaecology & Reproductive Medicine. 2017 Abr;27(4):105-11. doi: 10.1016/j.ogrm.2017.01.011
14. Beck-Friis J, Studahl M, Yilmaz A, Andersson R, Lönnermark E. Increased risk of hepatotoxicity and temporary drug withdrawal during treatment of active tuberculosis in pregnant women. International Journal of Infectious Diseases. 2020 Set;98:138-43. doi: 10.1016/j.ijid.2020.06.069.
15. Sousa FDCA, Soares HVA, Lemos LEAS, Reis DM, Silva WCD, Rodrigues LADS. Perfil epidemiológico de doenças negligenciadas de notificação compulsória no Brasil com análise dos investimentos governamentais nessa área. RSD. 2020 Jan;9(1):e62911610. doi: 10.22533/at.ed.29819091216.
16. Dias CAGDM, Araújo MHMD, Silva AWC, Oliveira ED, Dendasck CV, Fecury AA. Casos confirmados de tuberculose no Brasil entre 2015 e 2019. Revista Científica Multidisciplinar Núcleo do Conhecimento. 2022 Nov;11(1):153-60. doi:10.32749/nucleodoconhecimento.com.br/saude/casos-confirmados.

17. Santos Júnior CJD, Rocha TJM, Soares VDL. Análise temporal dos casos de coinfecção Tuberculose-HIV na população de um estado do Nordeste do Brasil. Rev Epidemiol Control Infect. 2019 Set;9(3). doi: http://dx.doi.org/10.17058/reci.v9i3.13108.
18. Silva LM, Silva GD, Silva ABO, Oliveira MDS, Dos Santos GS, Gomes MBDS, et al. O cenário da Tuberculose no Brasil: impactos da pandemia da COVID-19 na subnotificação e descontinuidade do tratamento: The Tuberculosis scenario in Brazil: impacts of the COVID-19 pandemic onunreporting and discontinuity of treatment. Braz J Hea Rev. 2022 Out;5(5):21067–81. doi: :10.34119/bjhrv5n5-260.
19. Andrade KVFD, Nery JS, Araújo GSD, Barreto ML, Pereira SM. Associação entre desfecho do tratamento, características sociodemográficas e benefícios sociais recebidos por indivíduos com tuberculose em Salvador, Bahia, 2014-2016*. Epidemiologia e Serviços de Saúde. 2019 Jul;28(2): e2018220. doi: 10.5123/S1679-49742019000200004.
20. Macedo LR, Maciel ELN, Struchiner CJ. Populações vulneráveis e o desfecho dos casos de tuberculose no Brasil. Ciênc saúde coletiva. 2021 Out; 26(10):4749-59. doi:10.1590/1413-812320212610.24132020.
21. Carmo IAD, Maia JC, Novaes JVCD, Almeida LDS, Pereira NADC, Costa GVRD, et al. Os desafios para o controle da tuberculose no Brasil/The challenges for tuberculosis control in Brazil. Em: Ciências da saúde teorias e práticas. 1 ed Brazilian Journals Editora. 2022 Nov/Dec;5(6):23969-23978. doi:10.34119/bjhrv5n6-168.
22. Chaulk CP, Moonan PK. Over the limit: tuberculosis and excessive alcohol use. Int J Tuberc Lung Dis. 2020 Jan; 24(1):3-4. doi: doi:10.5588/ijtld.19.0325.
23. Wigger GW, Bouton TC, Jacobson KR, Auld SC, Yeligar SM, Staitieh BS. The Impact of Alcohol Use Disorder on Tuberculosis: A Review of the Epidemiology and Potential Immunologic Mechanisms. Front Immunol. 2022 Mar;13. doi: https://doi.org/10.3389/fimmu.2022.864817.
24. Silva DR, Muñoz-Torrico M, Duarte R, Galvão T, Bonini EH, Arbex FF, et al. Risk factors for tuberculosis: diabetes, smoking, alcohol use, and the use of other drugs. J bras pneumol. 2018 Abr;44(2):145-52. doi: http://dx.doi.org/10.1590/S1806-37562017000000443.
25. Feldman C, Theron AJ, Cholo MC, Anderson R. Cigarette Smoking as a Risk Factor for Tuberculosis in Adults: Epidemiology and Aspects of Disease Pathogenesis. Pathogens. 2024 Fev;13(2):151. doi: https://doi.org/10.3390/pathogens13020151.
26. Prado TND, Riley LW, Sanchez M, Fregona G, Nóbrega RLP, Possuelo LG, et al. Prevalence and risk factors for latent tuberculosis infection among primary health care workers in Brazil. Cad Saúde Pública. 2017 Dez; 33(12):e00154916. doi:10.1590/0102-311X00154916.
27. Lacerda TC, Souza FMD, Prado TND, Locatelli RL, Fregona G, Lima RDCD, et al. Tuberculosis infection among primary health care workers. J bras pneumol. 2017 Dez;43(6):416–23. doi: http://dx.doi.org/10.1590/S1806-37562016000000211.
28. Nogueira MH, Silva CL, Souza SHS, Soares LF, Monteiro LD. Prevalência e aspectos epidemiológicos da coinfecção da tuberculose e HIV no Estado do Tocantins, 2001-2020. RSD. 2021 Nov;10(14):e278101422279. http://dx.doi.org/10.33448/rsd-v10i14.22279.
29. Souza ACSV, D'Albuquerque ACC, Araújo RAD, Oliveira SFD, Carvalho CGND. Características clínico-epidemiológicas da coinfecção por tuberculose e HIV no Estado do Piauí, Brasil. RSD. 2020 Ago; 9(9):e512997415. doi: http://dx.doi.org/10.33448/rsd-v9i9.7415.
30. Ferreira WS, Avelar GG, De Melo FX, Neto MCSM, Krischer TS, Da Silva AL, et al. Perfil clínico epidemiológico dos casos de tuberculose com coinfecção HIV no município de Belém. Acervo Saúde. 2021 Fev;13(2):e5970.doi: https://doi.org/10.25248/REAS.e5970.2021.
31. Bastos SH, Taminato M, Tancredi MV, Luppi CG, Nichiata LYI, Hino P. Coinfecção tuberculose/HIV: perfil sociodemográfico e saúde de usuários de um centro especializado. Acta Paulista de Enfermagem. 2020 Out; 33:eAPE20190051. doi: http://dx.doi.org/10.37689/acta ape/2020AO00515.
32. Magnabosco GT, Andrade RLDP, Arakawa T, Monroe AA, Villa TCS. Desfecho dos Casos de Tuberculose em Pessoas com HIV: Subsídios para Intervenção. Acta paul enferm. 2019 Out;32(5):554-63. doi: http://dx.doi.org/10.1590/1982 0194201900077.
33. Nunes CC, Sousa RJDA, Costa AGDS, Filgueiras LA, Almeida YS. Aspectos socioeconômicos e a coinfecção Tuberculose/HIV no Brasil: uma revisão da literatura. Edu, Ciência e Saúde. 2020 Jul/Dez;7(2):162-179. doi: http://dx.doi.org/10.20438/ecs.v7i2.294.
34. Carvalho MVDF, Silva ARDS, Taminato M, Bertolozzi MR, Fernandes H, Sakabe S, et al. A coinfecção tuberculose/HIV com enfoque no cuidado e na qualidade de vida. Acta Paulista de Enfermagem. 2022 Fev;35:eAPE02811. doi: http://dx.doi.org/10.37689/acta-ape/2022AO02811.
35. Orfão NH, Da Silva KM, Ferreira MRL, Brunello MEF. População em situação de rua: perfil dos casos de coinfecção tuberculose e HIV. Rev Enf Contemp. 2021 Mar;10(1):94-102. doi: http:// dx.doi.org/10.17267/2317-3378rec.v10i1.3565.
36. Rossetto M, Maffacciolli R, Rocha CMF, Oliveira DLLCD, Serrant L. Coinfecção tuberculose/HIV/aids em Porto Alegre, RS - invisibilidade e silenciamento dos grupos mais afetados. Rev Gaúcha Enferm. 2019;40:e20180033. doi: https://doi.org/10.1590/1983-1447.2019.20180033.
37. Resende NHD, Lopes DJM, Martins UCDM, Reis AMM, Miranda SSD, Carvalho WDS. Problemas relacionados ao uso de medicamentos no acompanhamento farmacoterapêutico de pacientes com tuberculose, HIV/AIDS e na coinfecção: revisão integrativa. RSD. 2022 Mar;11(4):e1211427424. http://dx.doi.org/10.33448/rsd-v11i4.27424.
38. Abreu RGD, Rolim LS, Sousa AIAD, Oliveira MRFD. Tuberculose e diabetes: associação com características sociodemográficas e de diagnóstico e tratamento. Brasil, 2007-2011. Rev Bras Epidemiol. 2020;23:e200009. 10.1590/1980-549720200009.
39. Sousa GGDSD, Pascoal LM, Costa ACPDJ, Santos FS, Santos LHD, Arcêncio RA, et al. Trend and factors associated with Tuberculosis-Diabetes Mellitus comorbidity in a Northeastern Brazilian municipality. Rev Bras Enferm. 2021; 74(3):e20201238. doi: https://doi.org/10.1590/0034-7167-2020-1238.
40. Bisht MK, Dahiya P, Ghosh S, Mukhopadhyay S. The cause–effect relation of tuberculosis on incidence of diabetes mellitus. Front Cell Infect Microbiol. 2023 Jun;13:1134036. doi: 10.3389/fcimb.2023.1134036
41. Leal ML, Maciel ELN, Cade NV. Fatores associados à tuberculose em população de diabéticos: um estudo caso-controle. Ciênc Saúde Coletiva. 2019 Set;24(9):3247-56. doi:10.1590/1413-81232018249.30392017.
42. Arroyo LAH, Arcoverde MAM, Alves JD, Fuentealba-Torres M, Cartagena-Ramos D, Scholze AR, et al. Spatial analysis of cases of Tuberculosis with Mental Disorders in São Paulo. Rev Bras Enferm. 2019 Jun;72(3):654-62.
43. Barros PGD, Pinto ML, Silva TCD, Silva EL, Figueiredo TMRMD. Perfil Epidemiológico dos casos de Tuberculose Extrapulmonar em um município do estado da Paraíba, 2001-2010. Cad saúde colet. 2014 Dez;22(4):343-50.
44. Natali D, Cloatre G, Brosset C, Verdalle P, Fauvy A, Massart JP, et al. What pulmonologists need to know about extrapulmonary tuberculosis. Breathe. 2020 Dez;16(4):200216. doi: http://dx.doi.org/10.1590/0034-7167-2017-0949.
45. Pattamapaspong N, Kanthawang T, Peh WCG, Hammami N, Bouaziz MC, Ladeb MF. Imaging of thoracic tuberculosis: pulmonary and extrapulmonary. BJR|Open. 2023 Dez;6(1):tzae031. doi: https://doi.org/10.1093/bjro/tzae031.
46. Oliveira CCD, Cruz EM, Magalhães GD, Suzart MV, Prince MA, Gonçalves CT, et al. Tuberculose Resistente e Multirresistente no Brasil. RUC. 2021 Nov; 23(2):01-15. doi: 10.46551/ruc.v23n2a09.
47. Bartholomay P, Pinheiro RS, Johansen FDC, Oliveira SBD, Rocha MS, Pelissari DM, et al. Lacunas na vigilância da tuberculose drogarresistente: relacionando sistemas de informação do Brasil. Cad Saúde Pública. 2020; 36(5):e00082219. doi: 10.1590/0102-311X00082219.

48. Meirelles RJDA, Palha PF. Directly observed treatment for tuberculosis in the State of São Paulo. Rev Bras Enferm 2019 Out;72(5):1167–72. doi: http://dx.doi.org/10.1590/0034-7167-2017-0279.
49. Cortez AO, Melo AC, Neves LO, Resende KA, Camargos P. Tuberculosis in Brazil: one country, multiple realities. J Bras Pneumol. 2021 Abr;e20200119. https://dx.doi.org/10.36416/1806-3756/e20200119.
50. Cola JP, Prado TND, Sales CMM, Maciel ELN. Estratégia Saúde da Família e determinantes para o tratamento diretamente observado da tuberculose no Brasil: estudo transversal com dados do sistema de vigilância, 2014-2016. Epidemiol Serv Saúde. 2020;29(5):e2020284. doi: 10.1590/S1679-49742020000500010.
51. Soeiro VMDS, Caldas ADJM, Ferreira TF. Abandono do tratamento da tuberculose no Brasil, 2012-2018: tendência e distribuição espaço-temporal. Ciênc Saúde Coletiva. 2022 Mar;27(3):825-36. doi: 10.1590/1413-81232022273.45132020;
52. Lima LV, Pavinati G, Palmieri IGS, Vieira JP, Blasque JC, Higarashi IH, et al. Fatores associados à perda de seguimento do tratamento para tuberculose no Brasil: coorte retrospectiva. Rev Gaúcha Enferm. 2023;44:e20230077. doi: https://doi.org/10.1590/1983-1447.2023.20230077.pt.
53. Costa PV, Machado MTC, Oliveira LGD. Adesão ao tratamento para Tuberculose Multidroga Resistente (TBMDR): estudo de caso em ambulatório de referência, Niterói (RJ), Brasil. Cad Saúde Colet. 2019 Mar;27(1):108-15. doi: 10.1590/1414-462X201900010292.
54. Couto DSD, Carvalho RN, Azevedo EBD, Moraes MND, Pinheiro PGOD, Faustino EB. Fatores determinantes para o abandono do tratamento da tuberculose: representações dos usuários de um hospital público. Saúde em Debate. 2014 Jul/Set;38(102):572-581. doi: 10.5935/0103-1104.20140053.
55. Santos DADS, Marques ALA, Goulart LS, Mattos MD, Olinda RAD. Fatores Associados ao Abandono do Tratamento da Tuberculose Pulmonar. Cogit Enferm. 2021 Abr;26:e72794. dx.doi.org/10.5380/ce.v26i0.72794.
56. Viana PVDS, Redner P, Ramos JP. Fatores associados ao abandono e ao óbito de casos de tuberculose drogarresistente (TBDR) atendidos em um centro de referência no Rio de Janeiro, Brasil. Cad Saúde Pública. 2018 Mai;34(5): e00048217. doi: 10.1590/0102-311X00048217.
57. Hentringer IMB, Ribeiro AMJ, Barreto IJB, Silva APSC. Efeito da pandemia da COVID-19 sobre os casos novos de tuberculose no Brasil: uma análise temporal e espacial. Mundo Saúde. 2023 Jan;47:e13912022. doi: 10.15343/0104-7809.202347e13912022P.