Original Article
Faria MGBF, Gomes D, Andrade-Gonçalves RLP, Maurin VP, Bonfim RO, Braga RS, et al. Tuberculosis case profile by sex and context of the Covid-19 pandemic: São Paulo, Brazil. Rev Gaúcha Enferm. 2026;47:e20250225. https://doi.org/10.1590/1983-1447.2026.20250225.en

Tuberculosis case profile by sex and context of the Covid-19 pandemic: São Paulo, Brazil

Perfil de casos de tuberculose segundo sexo e contexto da pandemia da covid-19: São Paulo-Brasil

Perfil de casos de tuberculosis por sexo y contexto de la pandemia de Covid-19: São Paulo, Brasil

Mariana Gaspar Botelho Funari de Faria [a] https://orcid.org/0000-0002-5544-910X
Dulce Gomes [b] https://orcid.org/0000-0001-8085-1945
Rubia Laine de Paula Andrade-Gonçalves [a] https://orcid.org/0000-0001-5843-1733
Venisse Paschoalin Maurin [a] https://orcid.org/0009-0009-7590-5131
Rafaele Oliveira Bonfim [a] https://orcid.org/0000-0001-8157-2323
Rebeca Sousa Braga [a] https://orcid.org/0000-0001-6046-3670
Ricardo Alexandre Arcêncio [a] https://orcid.org/0000-0003-4792-8714
Aline Aparecida Monroe [a] https://orcid.org/0000-0003-4073-2735

[a] Universidade de São Paulo, Escola de Enfermagem de Ribeirão Preto, Departamento Materno Infantil e Saúde Pública, Ribeirão Preto, São Paulo- Brasil
[b] Universidade de Évora, Escola de Ciências e Tecnologia, Évora-Portugal

How to cite this article:
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ABSTRACT

Objective: to analyze the profile of pulmonary tuberculosis cases, considering sex and context of the Covid-19 pandemic.

Method: a cross-sectional study, covering new tuberculosis cases in the state of São Paulo diagnosed between 2014 and 2024. Data were collected from secondary sources and subjected to absolute and relative frequency analysis. No statistical tests were performed as it involved the entire population.

Results: among 147,438 cases, 74% were male. A higher prevalence of diabetes mellitus was observed in females, while in males there was a higher proportion of persons deprived of liberty;

use of psychoactive substances; greater access to exams and diagnostic confirmation. After the pandemic period, there was a reduction in people between 18 and 30 years old and those in deprivation of liberty, and an increase in those between 31 and 40 years old and the performance of molecular rapid tests.
Conclusion: the persistence of vulnerabilities associated with the male gender and a higher prevalence of diabetes mellitus among women were verified, as well as changes in the profile of reported cases and the expansion of molecular rapid testing due to the pandemic, reinforcing the importance of surveillance and care strategies sensitive to gender, age group, and conditions of vulnerability, seeking to improve the response to tuberculosis.
Descriptors: Tuberculosis; Pandemic; Sex.

RESUMO
Objetivo: analisar o perfil de casos de tuberculose pulmonar, considerando o sexo e contexto da pandemia de covid-19.
Método: estudo transversal, abrangendo casos novos de tuberculose no estado de São Paulo diagnosticados entre 2014 e 2024. Dados foram coletados de fontes secundárias e submetidos à análise de frequência absoluta e relativa. Por se tratar de população, não foi realizado teste estatístico.
Resultados: entre 147.438 casos, 74% eram do sexo masculino. Observou-se maior prevalência de diabetes mellitus no sexo feminino, enquanto no masculino houve maior proporção de pessoas privadas de liberdade; uso de substâncias psicoativas; maior acesso a exames e confirmação diagnóstica. Após o período pandêmico, houve redução de pessoas entre 18 e 30 anos e em privação de liberdade e aumento entre 31 e 40 anos e realização do teste rápido molecular.
Conclusão: Verificou-se a persistência de vulnerabilidades associadas ao sexo masculino e maior prevalência de diabetes mellitus entre mulheres, bem como alteração no perfil dos casos notificados e ampliação da realização do teste rápido molecular em função da pandemia, reforçando a importância de estratégias de vigilância e cuidado sensíveis ao sexo, faixa etária e às condições de vulnerabilidade, buscando qualificar o enfrentamento da tuberculose.
Descritores: Tuberculose; Pandemia; Sexo.

RESUMEN
Objetivo: analizar el perfil de los casos de tuberculosis pulmonar, considerando el sexo y contexto de la pandemia de Covid-19.
Método: estudio transversal que abarcó casos nuevos de tuberculosis en el estado de São Paulo diagnosticados entre 2014 y 2024. Los datos se recolectaron de fuentes secundarias y se sometieron a análisis de frecuencia absoluta y relativa. No se realizaron pruebas estadísticas por tratarse de una población total.
Resultados: entre 147.438 casos, el 74% correspondía al sexo masculino. Se observó una mayor prevalencia de diabetes mellitus en el sexo femenino, mientras que en el masculino hubo una mayor proporción de personas privadas de libertad, uso de sustancias psicoactivas, mayor acceso a exámenes y confirmación diagnóstica. Tras el periodo pandémico, hubo una reducción de personas entre 18 y 30 años y en privación de libertad, y un aumento entre los 31 y 40 años, así como en la realización de la prueba rápida molecular.
Conclusión: se verificó la persistencia de vulnerabilidades asociadas al sexo masculino y una mayor prevalencia de diabetes mellitus entre las mujeres, así como una alteración en el perfil de los casos notificados y una ampliación en la realización de la prueba rápida molecular a raíz

de la pandemia. Esto refuerza la importancia de estrategias de vigilancia y cuidado sensibles al sexo, grupo etario y condiciones de vulnerabilidad, con el fin de cualificar el enfrentamiento de la tuberculosis.
Descriptores: Tuberculosis; Pandemia; Sexo.

INTRODUCTION

Tuberculosis (TB) remains a global concern, becoming even more complex in recent years due to increasing drug resistance, HIV coinfection, and the Covid-19 pandemic[1-2]. The global number of TB cases had shown a slight progressive decline until the onset of the Covid-19 pandemic, reaching approximately 10.1 million, but resumed an upward trend from 2021 onward (10.4 million) during the pandemic period, reaching 10.7 million cases in 2024[3-4]. At the national level, in 2023, Brazil identified 80,012 new TB cases (incidence of 37.0 cases per 100,000 inhabitants), with the state of São Paulo presenting an incidence coefficient of 42.0 cases per 100,000 inhabitants[5].

Despite advanced diagnostic techniques and effective therapeutic regimens, TB contributes significantly to morbidity/mortality among individuals affected by chronic diseases, impacting all age groups[6]. Despite efforts to achieve the Sustainable Development Goals (SDGs), which include health and well-being as a focal point of the third objective, TB mortality increased in 2020 and 2021 (1.40 and 1.42 million, respectively), as a consequence of interruptions in TB diagnosis and treatment during the Covid-19 pandemic[3].

In developing countries, where the impact of TB is more significant due to the high disease burden and, above all, diagnostic delay, TB represents one of the greatest public health challenges amid pandemic-related disruptions[7]. Over the years, a pattern of higher TB notification rates among men has persisted, being approximately 2.7 times higher than among women[8], indicating greater male susceptibility to developing the disease[9-10].

Some studies suggest that women present differences in sputum sample quality, which may result in case underreporting. Regarding HIV coinfection, the global TB burden is higher among women[11-12]. In some low- and middle-income countries, TB diagnosis in women takes longer[10-13].

The prevalence, etiology, and epidemiological situation of TB are directly associated with social determinants and socioeconomic and sociodemographic characteristics, which considerably contribute to disease outcomes[14]. However, a preliminary literature search in the PubMed database in October 2024, using the descriptors Tuberculosis and Sex, revealed a gap in scientific knowledge regarding studies discussing sociodemographic, clinical, and diagnostic

characteristics in relation to sex as a risk factor for TB, especially in studies from Brazil. Appropriating such knowledge makes it possible to improve care and develop strategies to address TB control in the different contexts arising from the Covid-19 pandemic. Although TB manifests in pulmonary and extrapulmonary forms, the pulmonary form has greater epidemiological relevance, as it is the main form responsible for disease transmission[10]. In this context, the objective of this study was to analyze the profile of pulmonary tuberculosis cases, considering sex and the context of the Covid-19 pandemic.

METHOD

Study Design

This is a cross-sectional study, conducted in the state of São Paulo, the most populous state in Brazil, with an estimated population of 45 million inhabitants, divided into 645 municipalities[15].

Population and Study Setting

The study population comprised all new cases of pulmonary TB reported at primary, secondary, and tertiary health care services in the state of São Paulo through the state's exclusive tuberculosis notification system (TB-WEB), used for case notification, monitoring, and control, and diagnosed between January 2014 and June 2024. Cases under 18 years of age and those with a change in diagnosis were excluded.

Data Collection

Data were requested from the São Paulo State Epidemiological Surveillance Center (CVE) “Prof. Alexandre Vranjac” and made available through an Excel® spreadsheet in December 2024. The data provided corresponded to the following variables (SINAN; racaCor; dtnascimento; sexo; escolaridade; tipocupação; ocupação; munresidencia; seqtratamento; dtnotificação; dtinitratamento; tipocaso; encerramento; formaclin1; descoberta; baciloscopia; cultescarro; RX; HIV; testesensibilidade; aids; diabetes; alcoolismo; mental; drogadição; outraimuno; tabagismo; nenhuma; outra; resistência; rifasensivel; isonisensivel; pirazisensivel; etambsensivel; estrepsensivel; etionsensivel; idade; TMRTB). The following filters were subsequently applied upon receipt of this information: age over 18 years; clinical form: pulmonary or miliary; exclusion of cases with a change in diagnosis.

To analyze the profile of pulmonary TB cases by sex and the context of the Covid-19 pandemic, the study variables were grouped into: sociodemographic variables (age group,

race/ethnicity, education, and incarceration status), behavioral and clinical variables (smoking, alcohol and other drug use, diabetes, mental disorder, HIV, and other immune-related conditions), and diagnostic variables (performance of TRM-TB, sputum smear microscopy, sputum culture, sensitivity testing, bacteriological confirmation, and type of case detection).

Data Analysis

Since the database used corresponds to the total number of TB cases reported during the period analyzed, this information was treated as population data, which is not suited to inferential analysis for assessing statistically significant differences. Accordingly, the use of inferential methods, whose purpose is to generalize conclusions from a sample to a population, is not appropriate. Therefore, statistical significance testing was not warranted, since there is no uncertainty associated with population estimation in this context. A descriptive and exploratory analysis was thus chosen, aiming to characterize the profile of TB cases in detail. The previously described variables were analyzed individually, and cross-analyses were also performed among those considered most relevant, in order to deepen the understanding of the patterns and associations present in the study population.

To assess the impact of Covid-19 on the variables analyzed, international technical documents were used, particularly with regard to percentage variations. The total period was divided into three subperiods: pre-pandemic (1/2014 to 2/2020), pandemic (3/2020 to 4/2023), and post-pandemic (5/2023 to 6/2024). Since these subperiods have different lengths (different numbers of months), frequencies had to be standardized to verify proportionality. To this end, the absolute frequencies observed in each subperiod were divided by the corresponding number of months. Relative frequencies were then calculated using these corrected absolute frequencies as the numerator and the total number of months as the denominator, allowing a proportional comparison between the different time intervals.

Ethical Aspects

In accordance with the recommendations set forth in National Health Council (CNS) Resolution No. 466 of December 12, 2012, the study was approved by the Research Ethics Committee of the University of São Paulo at Ribeirão Preto College of Nursing, under opinion No. 6.559.455, dated December 6, 2023.

RESULTS

In the state of São Paulo, 201,281 new TB cases were reported between January 2014 and June 2024, of which 29,363 were excluded for not being pulmonary or miliary TB; 15,330 were excluded due to a change in diagnosis; and 9,150 were excluded for being under 18 years of age. Thus, a total of 147,438 people affected by pulmonary TB were included in the study.

Regarding sociodemographic variables, most of the study population was male (74%). Regarding age, 58.1% of males and 56.2% of females were between 18 and 40 years old. Regarding race/ethnicity, 86.5% of males and 86.4% of females self-identified as White or Brown. Regarding education, most had between four and eleven years of schooling, representing 77.7% of males and 79.1% of females. Among cases involving incarceration, 17.6% were male (Table 1).

Table 1 - Distribution of people affected by pulmonary TB by gender and sociodemographic variables, state of São Paulo, Brazil, January 2014 to June 2024.

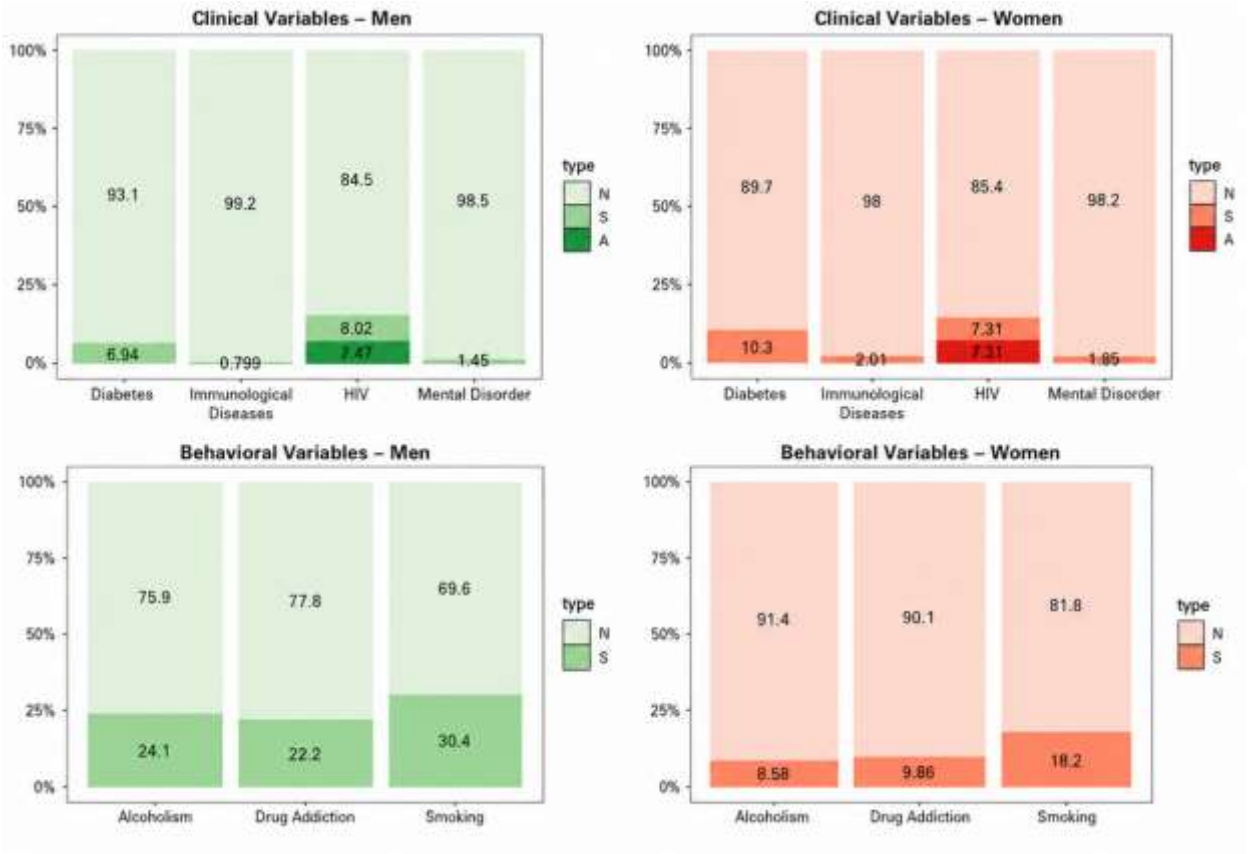
Characteristic		Gender	
		Male n=109,106 (74%)	**Female n=38,332 (26%)**
Age	18-30 years	38,102 (34.9%)	13,419 (35.0%)
	31-40 years	25,304 (23.2%)	8,125 (21.2%)
	41-50 years	18,748 (17.2%)	6,276 (16.4%)
	51-60 years	14,569 (13.3%)	4,981 (13.0%)
	61-70 years	8,275 (7.5%)	3,217 (8.4%)
	71+ years	4,108 (3.8%)	2,314 (6.0%)
Race/Ethnicity*	White	37,712 (43.3%)	14,518 (47.2%)
	Yellow	697 (0.8%)	338 (1.1%)
	Brown	37,657 (43.2%)	12,058 (39.2%)
	Black	10,896 (12.5%)	3,720 (12.1%)
	Indigenous	161 (0.1%)	112 (0.3%)
Education*	None	1,848 (2.3%)	865 (3.0%)
	1-3 years	7,701 (9.7%)	2,486 (8.6%)
	4-7 years	30,072 (37.8%)	8,198 (28.5%)
	8-11 years	31,695 (39.9%)	11,679 (40.6%)
	12-14 years	6,107 (7.7%)	3,794 (13.2%)
	15+ years	2,067 (2.6%)	1,720 (5.9%)
Incarcerated population*	Yes	19,220 (17.6%)	351 (0.9%)
	No	89,886(82.4%)	37,981(99.1%)

*Percentages for the variables Race/Ethnicity, Education, and Incarceration status were not calculated from the total values due to blank entries on the notification form.

Among the variables related to clinical data, it was found that, among males, 24.1% reported alcohol use; 22.2%, illicit drug use; and 30.4% reported smoking. These percentages among females were 8.58%, 9.86%, and 18.2%, respectively. In addition, among males, 0.8% had

another immunodeficiency; 6.9%, diabetes; 8.0% had HIV; and 1.5%, a mental disorder; while among females, these percentages were 2%, 10.3%, 7.3%, and 1.8%, respectively (Figure 1).

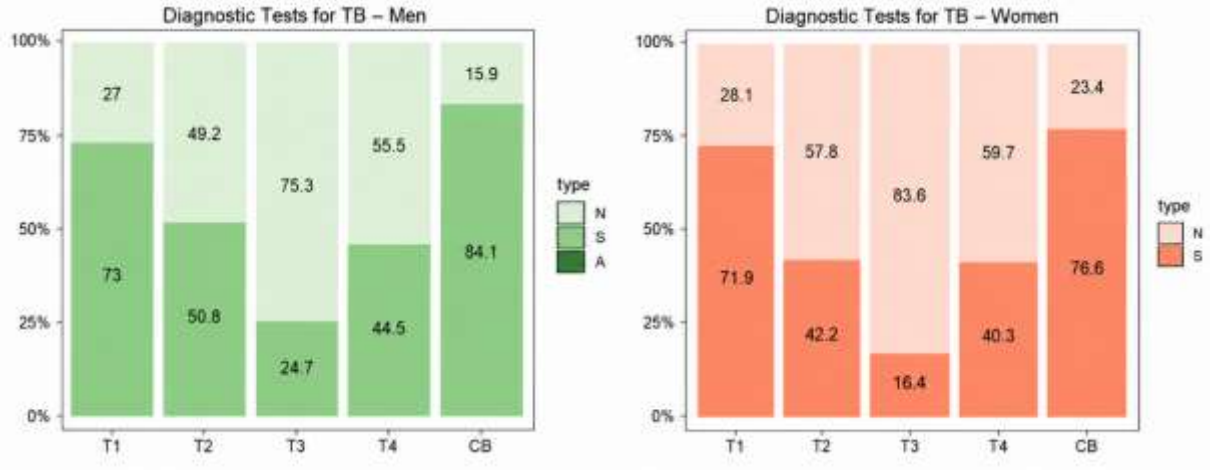
Figure 1 - Distribution of people affected by pulmonary TB by Gender and behavioral and clinical variables, state of São Paulo, Brazil, January 2014 to June 2024.



Legend: N=No; S=Yes; A: In progress

Regarding the TB diagnostic process, 73.0% of males underwent sputum smear microscopy; 50.8%, culture; 24.7%, sensitivity testing; and 44.5% underwent TRM-TB. Among males, the bacteriological confirmation rate was 84.1%. Among females, these percentages were 71.9%, 42.2%, 16.4%, 40.3%, and 76.6%, respectively (Figure 2).

Figure 2 - Distribution of people affected by pulmonary TB by Gender, tests performed, and bacteriological confirmation, state of São Paulo, Brazil, January 2014 to June 2024



Legend: T1=Sputum smear microscopy; T2=Culture; T3: Sensitivity testing; T4=TRM-TB; CB=Bacteriological Confirmation

Regarding diagnostic detection, TB was detected postmortem in 1.3% of males and 1.1% of females, and in 13.5% and 15.6%, respectively, during hospitalization (Table 2).

Table 2 - Distribution of people affected by pulmonary TB by gender and diagnostic detection variables, state of São Paulo, Brazil, January 2014 to June 2024.

Diagnostic detection characteristic		Gender	
		Male n=109,106 (74.0%)	**Female n=38,332 (26.0%)**
Postmortem	Yes	1,365 (1.3%)	414 (1.1%)
	No	104,749 (98.7%)	36,888 (98.9%)
Hospitalization	Yes	14,345 (13.5%)	5,806 (15.6%)
	No	91,769 (86.5%)	31,496 (84.4%)

Considering the pre-pandemic (1/1/2014 to 2/28/2020), pandemic (3/1/2020 to 4/30/2023), and post-pandemic (5/1/2023 to 6/30/2024) periods, as shown in Table 3, there was a slight increase of approximately two percentage points in the proportion of females diagnosed with pulmonary TB in the post-pandemic period.

Regarding age group, the populations aged 18-30 years and 51-60 years showed a reduction in the number of cases over the period analyzed. Regarding race/ethnicity, a slight increase was found in the identification of cases considered Black and Brown in the post-pandemic period; however, a decline was observed in the other categories. Regarding education, a decrease was found in TB incidence among people with one to three years of schooling, four to seven years, and no schooling. On the other hand, among the incarcerated

population, a substantial reduction of approximately 10 percentage points in disease incidence was observed. Regarding diagnostic variables, there was a slight increase in TB confirmation in the post-pandemic period. TRM-TB testing showed an increase of approximately 23 percentage points when comparing the pre- and post-pandemic periods of the study. Finally, regarding the type of detection, a slight increase was found in the identification of postmortem TB cases and a decrease in identification during hospitalization in the post-pandemic period.

Table 3 - Sociodemographic and diagnostic data of pulmonary TB cases according to the pre-pandemic, pandemic, and post-pandemic periods in the state of São Paulo, Brazil, January 2014 to June 2024.

Characteristic		Pre-pandemic N=87,113	Pandemic N=44,236	Post-pandemic N= 16,089
Gender	Male	65,043 (74.7%)	32,384 (73.1%)	11,679 (72.6%)
	Female	22,070 (25.3%)	11,852 (26.9%)	4,410 (27.4%)
Age	18-30	31,931 (41.4%)	14,698 (33.2%)	4,892 (30.4%)
	31-40	19,601 (12.5%)	10,091 (22.8%)	3,737 (23.2%)
	41-50	14,279 (18.5%)	7,659 (17.3%)	3,086 (19.2%)
	51-60	11,449 (14.8%)	5,981 (13.5%)	2,120 (13.2%)
	61-70	6,318 (8.2%)	3,747 (8.5%)	1,427 (8.9%)
	71+	3,535 (4.6%)	2,060 (4.7%)	827 (5.1%)
Race/Ethnicity	White	35,216 (45.8%)	15,438 (41.6%)	1,576 (40.5%)
	Yellow	677 (0.9%)	322 (0.9%)	36 (0.9%)
	Brown	31,487 (41.0%)	16,476 (44.4%)	1,752 (45.0%)
	Black	9,267 (12.1%)	4,825 (13.0%)	524 (13.5%)
	Indigenous	219 (0.3%)	49 (0.1%)	05 (0.1%)
Education	None	1,782 (2.7%)	685 (2.2%)	246 (2.2%)
	1-3 years	6,528 (9.9%)	2,720 (8.7%)	939 (8.4%)
	4-7 years	24,146 (36.7%)	10,455 (33.5%)	3,669 (32.7%)
	8-11 years	25,698 (39.9%)	13,017 (41.8%)	4,659 (41.5%)
	12-14 years	5,462 (8.3%)	3,154 (10.1%)	1,285 (11.4%)
	15+ years	2,213 (3.4%)	1,141 (3.7%)	433 (3.9%)
Incarcerated population	Yes	13,631 (15.6%)	4,590 (10.4%)	1,350 (8.4%)
	No	73,482 (84.4%)	39,646 (89.6%)	14,739 (91.6%)
Bacteriological confirmation	Yes	71,216 (81.8%)	36,645 (82.8%)	13,240 (82.3%)
	No	15,897 (18.2%)	7,591 (17.2%)	2,849 (17.7%)
TRM-TB	Yes	30,626 (35.2%)	23,889 (54.0%)	9,472 (58.9%)
	No	56,487 (64.8%)	20,347 (46.0%)	6,617 (41.1%)
Postmortem detection	Yes	1,036 (1.2%)	504 (1.2%)	239 (1.5%)
	No	84,076 (98.8%)	42,349 (98.8%)	15,212 (98.5%)
Hospitalization detection	Yes	11,933 (14.0%)	6,099 (14.2%)	2,119 (13.7%)
	No	73,179 (86.0%)	36,754 (85.8%)	13,332 (86.3%)

DISCUSSION

Through this study, the persistence of vulnerabilities associated with the male gender and a higher prevalence of diabetes mellitus among women were verified, as well as changes in the profile of reported cases and an expansion of rapid molecular testing due to the pandemic, reinforcing the importance of surveillance and care strategies that are sensitive to gender, age group, and conditions of vulnerability, in order to improve the response to TB.

The complexity of the challenges involved in reducing TB morbidity/mortality has driven greater research into the individual determinants most prevalent for disease occurrence, factors such as HIV, smoking, diabetes mellitus, and alcohol and other drug use. The rights of people affected by TB are equal to those of the population without distinction, although conditionalities exist for access to specific rights within the health field[16]. Such factors foster discussion about the differences between men and women from the perspective of vulnerabilities. Regarding social determinants, certain settings are specifically noted for failing to ensure adequate housing conditions, favoring TB transmission, such as contexts marked by overcrowding (e.g., prison units), poor housing conditions, and economic deprivation[17].

Considering these aspects, the results of this study indicated differences between males and females in TB occurrence, differences related to prevalence as well as clinical and behavioral data. In some low- and middle-income countries, TB prevalence was higher among males, who present higher rates of sputum positivity[10-13]. A study also identified differences in disease progression and morbidity/mortality rates between genderes, which may be linked to weaknesses in access to health care and risk behaviors (smoking, alcohol use, associated comorbidities, living and working conditions) among males, leading to a greater propensity for TB illness[18].

In our findings, self-reported White individuals predominated among both males and females, with a slight increase in TB identification among Black and Brown individuals in the post-pandemic period. The population of the state of São Paulo is predominantly White (60.5%), followed by Brown (34.5%) and Black (3.6%) individuals[15]. However, the percentage of TB occurrence in the study population differed from these percentages, being lower among White people and higher among Brown and Black people, showing that these populations remain highly socially vulnerable, since TB is a disease with strong social determination.

Through this study, it is possible to identify percentage differences regarding age groups, particularly between the pre-pandemic, pandemic, and post-pandemic periods, with a

decrease in the number of disease cases among people aged 18 to 30 years and an increase among those aged 31 to 40 years. Although it is difficult to precisely identify the factors that led to this result, it is possible that, because they were not considered a risk group for Covid-19 aggravation and death, younger populations faced challenges in seeking and accessing health services when presenting respiratory symptoms. In addition, the severity of symptoms was likely underestimated by health professionals, which may have contributed to lower suspicion of TB in such cases.

Females were found to have a higher level of education compared with males, which may be related to the early entry of men into the labor market, resulting in school dropout. In addition, more than half of the participants had up to eleven years of schooling (incomplete secondary education), such that lower educational levels tend to be associated with precarious working conditions, low income, food insecurity, and inadequate housing. Such factors increase the likelihood of infection, disease progression, and perpetuation of the TB transmission chain[19].

From the standpoint of education, an increase is observed in participants' level of schooling in the pandemic and post-pandemic periods compared with the pre-pandemic period, which may reflect structural and social changes in the current post-pandemic context. This result may have been facilitated by the increase in distance-learning courses, as well as by the fact that education enables greater autonomy in seeking services, especially in a health crisis scenario.

A reduction in the incarcerated population was also observed, corroborating the findings of a study that revealed a decline in TB incidence among the Brazilian incarcerated population, from 1,006 cases/100,000 inmates between 2015 and 2019 to 852 cases/100,000 inmates in 2021. These results predicted a 7.6% deficit in the number of cases for the year, with a 21.6% drop recorded as early as January 2021[20]. This may result from policies emphasizing the response to TB in the prison setting as one of the strategies to end the disease as a public health problem, as well as from measures used to mitigate Covid-19 in the prison system, which included early release, isolation of suspected cases, mask distribution, and visitation restrictions, among other measures.

Among behavioral factors, this study identified higher rates of drug use, tobacco use, and alcohol consumption among males compared with females. Such behaviors tend to predispose individuals to exposure to situations of social vulnerability, which may compromise the body's ability to control latent TB infection, favoring its progression to the active form, particularly among males.

Excessive alcohol and other drug use is associated with significant impairment in the clinical management of TB, including low pulmonary immunity, poor treatment adherence, medication interruptions, and loss to follow-up. In addition, there are direct impacts on physiological mechanisms, such as modulation of the immune response, the integrity of protective barriers, hepatotoxicity, and alterations in the absorption and metabolism of drugs used to treat TB and HIV[21-23]. Tobacco use, recognized as a major risk factor for respiratory diseases, also plays a relevant role in TB epidemiology. It is estimated that by 2050, the number of TB cases attributable to tobacco use will increase significantly, revealing the need for preventive actions aimed at smoking cessation as a TB control strategy[24].

Although males present greater exposure to such risk behaviors, 18% of females reported tobacco use, indicating significant involvement of this group in practices that favor the onset and worsening of TB. This finding points to a possible change in the epidemiological profile of TB over time, with greater exposure of females to risk factors traditionally associated with males, which may impact future disease prevention and control strategies, in conjunction with other health actions and programs.

Among the clinical factors highlighted in this study's findings, males presented higher percentages only for HIV infection. HIV infection is the most important risk factor for the development of TB, being considered the main opportunistic disease associated with the infection[25]. In this regard, males present significant vulnerability to HIV and, consequently, to TB, due to tendencies toward risk behaviors, such as multiple sexual partnerships, inconsistent condom use, and psychoactive substance use, as previously mentioned.

Females, on the other hand, showed a notable association with diabetes mellitus as a comorbidity in the present study. One study showed that among people affected by TB, the prevalence of diabetes mellitus was similar between Genders, but males presented worse treatment outcomes[26]. People with diabetes mellitus have an approximately 2- to 4-fold increased chance of developing TB due to significant alterations in the immune system, such that patients with adequate glycemic control present decreased sputum positivity and a reduced risk of cavitary lesions on radiological examination compared with patients with inadequate glycemic control[27].

Regarding diagnosis, males had greater access to TB tests, resulting in a higher rate of bacteriological confirmation compared with females. This difference points to the influence of social, economic, and cultural determinants, which are interrelated with gender-based inequalities in the health context. The higher occurrence of the disease among males may be explained by greater exposure to *Mycobacterium tuberculosis*, since, due to work-related and

social dynamics, they are more frequently present in public spaces and environments outside the home, which increases the risk of contagion. However, the need for survival acts as a driving force pushing both sexes into precarious and unhealthy living contexts. Females, on the other hand, may face precarious living conditions, aggravated by lower economic autonomy and unequal participation in the labor market. When they do gain access to the formal sector, they generally hold positions requiring lower qualifications and offering low pay, reflecting a historical logic of subordination. These structural factors contribute to restricting women's access to health services, hindering both timely diagnosis and adequate treatment adherence, perpetuating cycles of social and health vulnerability[28].

Over the study period, an increase of approximately 23 percentage points was observed in the performance of TRM-TB when comparing the periods spanning the pandemic. It should be noted that the initial period of the study was during the early implementation phase of the test, which accounts for the lower percentages. Nevertheless, the results show the degree of commitment of managers and technical teams to expanding its use, through the organization and integration of health services and the establishment of care and laboratory workflow agreements, so as to promote and disseminate TRM-TB as the preferred method for TB diagnosis in every suspected case.

Bacteriological confirmation is understood as positivity on TRM-TB, sputum smear microscopy, and culture tests. A slight increase in bacteriological confirmation rates was observed during the pandemic and post-pandemic periods. This increase may be related to the expanded use of TRM-TB, driven by the reorganization of health services and the intensified pursuit of faster and more accurate diagnoses amid the health crisis[29]. On the other hand, the failure to perform diagnostic tests indicates a failure or deficiency of the service in adequately identifying and monitoring people affected by TB, revealing possible programmatic gaps that, in turn, influence the likelihood of unfavorable outcomes[30].

The increase in the identification of TB cases after hospitalization and detection at the time of death, considering the pandemic and post-pandemic periods respectively, even if slight, raises reflections on the impact of the health crisis on TB surveillance. This scenario is partly due to the redirection of human, material, and structural resources toward Covid-19 control, to the detriment of TB prevention and care actions. At the same time, the overlap of respiratory symptoms, frequently attributed to Covid-19, contributed to delays in TB diagnosis, culminating in an increase in the number of unidentified severe cases[31]. Such weaknesses may have led to an increase in postmortem diagnoses, representing an indirect indicator of health system failures in ensuring the sustainability of TB control actions during the health crisis.

As a limitation of this study, due to the use of secondary data, it was not possible to control for all variables of interest or to guarantee the completeness or timeliness of the information. Nevertheless, these data were chosen for their relevance, scope, and availability, which allowed for an initial exploratory analysis of the topic. An analysis by gender was not possible, as this data was not included in the information system.

Finally, the results of this study contribute to advancing scientific knowledge in the health field by deepening the understanding of the different ways in which people experience TB. By identifying the interactions between biological and social factors, the study provides support for the development of clinical management strategies that are more sensitive to the particularities of people affected by the disease, in addition to guiding the formulation of more inclusive public policies aimed at reducing social and health inequalities.

Regarding implications for nursing, the relevance of this study lies in the theoretical and operational knowledge produced, with the potential to support individual and collective intervention strategies, including person-centered care technologies, in order to value the patient as an active partner in the health care process, improve the quality of care provided, emphasizing empathy, respect, and shared decision-making, with a view to ensuring holistic, safe, and personalized care. In addition, considering the broad scope of nursing practice in both care delivery and the management of health services and programs, the results of this study may foster discussions to strengthen the response capacity of the care network, with an emphasis on expanding access to timely diagnosis with etiological confirmation, so as to support the achievement of nationally and internationally agreed targets for addressing TB, including the 2030 Agenda.

CONCLUSION

From the perspective of the profile of people affected by TB, a higher prevalence of diabetes mellitus was observed among females, while males presented a higher proportion of incarceration and psychoactive substance use. Males also had greater access to diagnostic tests and diagnostic confirmation. In light of this, TB control programs should incorporate analysis of the main risk factors that contribute to the disproportionate disease burden between genders, promoting response strategies that consider the particularities of both.

During and after the pandemic, there was a reduction in the percentage of people aged 18 to 30 years and of incarcerated people among cases, as well as an increase among those aged 31 to 40 years and those who underwent TRM-TB. This reinforces the need for public policies

that ensure universal access to TRM-TB and timely disease detection, with an emphasis on strengthening health surveillance, especially in contexts of vulnerability and health crises.

REFERENCES

1. Estaji F, Kamali A, Keikha M. Strengthening the global response to Tuberculosis: Insights from the 2024 WHO global TB report. J Clin Tuberc Other Mycobact Dis. 2025;26(39):100522. https://doi.org/10.1016/j.jctube.2025.100522

2. World Health Organization (WHO). Global tuberculosis report 2021[Internet]. Geneva: WHO. 2021[cited 2025 Apr 20]. Available from: https://iris.who.int/bitstream/handle/10665/346387/9789240037021-eng.pdf?sequence=1

3. World Health Organization (WHO). Global tuberculosis report 2024 [Internet]. Geneva: WHO. 2025 [cited 2025 Apr 26]. Available from: https://iris.who.int/bitstream/handle/10665/379339/9789240101531-eng.pdf?sequence=1.

4. World Health Organization (WHO). Global tuberculosis report 2025 [Internet]. Geneva: WHO. 2025 [cited 2026 May 4] Available from: https://iris.who.int/server/api/core/bitstreams/e97dd6f4-b567-4396-8680-717bac6869a9/content.

5. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde e Ambiente. Boletim Epidemiológico: Tuberculose 2024 [Internet]. 2024 [cited 2025 Mar 10]. Available from: Boletim Epidemiológico de Tuberculose - Número Especial - Mar. 2024.pdf

6. Carter DJ, Glaziou P, Lönnroth K, Siroka A, Floyd C, Weil D, et al. The impact of social protection and poverty elimination on global tuberculosis incidence: a statistical modelling analysis of Sustainable Development Goal. Lancet Glob Health. 2018;6(5):e514-e522. https://doi.org/10.1016/S2214-109X(18)30195-5

7. Brubacher LJ, Yellappa V, Lestari BW, Heitkamp P, Vasquez NA, Sassi A, et al. Health and tuberculosis systems resilience, the role of the private sector and pandemic preparedness: insights from a cross-country qualitative study with policy-makers in India, Indonesia and Nigeria. BMJ Glob Health. 2025;10:e016180. https://doi.org/10.1136/bmjgh-2024-016180

8. Schurz H, Salie M, Tromp G, Hoal EG, Kinnear CJ, Möller M. The X chromosome and sex-specific effects in infectious disease susceptibility. Hum Genom. 2019;13(1):2. https://doi.org/10.1186/s40246-018-0185-z

9. Chakaya J, Petersen E, Nantanda R, Mungai BN, Migliori GB, Amanullah F, et al. The WHO Global Tuberculosis 2021 Report: not so good news and turning the tide back to End TB. Int J Infect Dis. 2022;124(1):S26-9. https://doi.org/10.1016/j.ijid.2022.03.011

10. Horton KC, MacPherson P, Houben RMGJ, White RG, Corbett EL. Sex differences in tuberculosis burden and notifications in low- and middle-income countries: a systematic review and meta-analysis. PLoS Med. 2016;13(9):e1002119. https://doi.org/10.1371/journal.pmed.1002119.

11. Ledesma JR, Ma J, Vongpradith A, Maddison ER, Novotney A, Biehl MH. et al. Global, regional, and national sex differences in the global burden of tuberculosis by HIV status, 1990–2019: results from the Global Burden of Disease Study 2019. Lancet Infect Dis. 2022;22(2):222-41. https://doi.org/10.1016/S1473-3099(21)00449-7

12. Li T, Shewade HD, Soe KT, Rainey JJ, Zhang H, Du X, Wang L. Under-reporting of diagnosed tuberculosis to the national surveillance system in China: an inventory study in nine counties in 2015. BMJ Open 2019;9(1):e021529. https://doi.org/10.1136/bmjopen-2018-021529

13. Chidambaram V, Tun NL, Majella MG, Castillo JR, Ayeh SK, 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. Clin Infect Dis. 2021;73(9):1580-8. https://doi.org/10.1093/cid/ciab527

14. Santos BA, Cruz RPDS, Lima SVMA, Santos ADD, Duque AM, Araújo KCGM, et al. Tuberculosis among children and adolescents: an epidemiological and spatial analysis in the state of Sergipe, Brazil, 2001-2017. Cien Saude Colet. 2020;25(8):2939-48. https://doi.org/10.1590/1413-81232020258.25692018

15. Instituto Brasileiro de Geografia e Estatística (IBGE). Censo 2022 [Internet]. 2023[cited 2025 Apr 20]. Available from: https://www.ibge.gov.br/estatisticas/sociais/saude/22827-censo-demografico-2022.html

16. Ferreira MRL, Ballestero JGA, Andrade RLP, Arakawa T, Fronteira I, Monroe AA. Public social protection policies for people affected by tuberculosis: a documentary analysis. Rev Latino-Am Enfermagem. 2025;33:e4503. https://doi.org/10.1590/1518-8345.7526.4504

17. Duarte A, Aguiar M, Pinto I, Furtado S, Tiberi K, Lönnroth GB, et al. Different disease, same challenges: social determinants of tuberculosis and COVID-19. Pulmonology. 2021;27(4):338-44. https://doi.org/10.1016/j.pulmoe.2021.02.002

18. Hertz D, Schneider B. Sex differences in tuberculosis. Semin Immunopathol. 2019;41(2):225-37. https://doi.org/10.1007/s00281-018-0725-6

19. Espinosa-Merino R, Montesano-Villamil M, Ordóñez-Correa R, Cuaya-Coatl M, Lobato S. [Social determinants of health in the epidemiological profile of tuberculosis in Puebla, Mexico, during 2022-2023]. Gac Med Mex. 2024;160(5):565-72. http://doi.org/10.24875/GMM.24000171 Spanish

20. Nascimento DR, Serpa SF, Santos MB, Carmo RF, Brito RJVC, Gomes, OV, et al. The impact of the COVID-19 pandemic on TB diagnosis in the Brazilian prison population, 2020–2021. Int J Tuberc Lung Dis. 2023;27(9):688-93. https://doi.org/10.5588/ijtld.22.0666

21. Mohammed A, Aboagye RG, Duodu PA, Adnani QES, Wongnaah FG, Seidu AA, et al. Sex-related absolute inequalities in tuberculosis incidence in 47 countries in Africa. BMC Medicine. 2025;23:324. https://doi.org/10.1186/s12916-025-04098-8

22. Miller AC, Gelmanova IY, Keshavjee S, Atwood S, Yanova G, Mishustin S, et al. Alcohol use and the management of multidrug-resistant tuberculosis in Tomsk, Russian Federation. Int J Tuberc Lung Dis. 2012;16(7):891-6. https://doi.org/10.5588/ijtld.11.0795

23. Williams EC, Hahn JA, Saitz R, Bryant K, Lira MC, Samet JH. Alcohol use and human immunodeficiency virus (HIV) infection: current knowledge, implications, and future directions. Alcohol Clin Exp Res. 2016;40(10):2056-72. https://doi.org/10.1111/acer.13204

24. Oliveira RL, Azevedo LS, Macêdo ES, Aguiar MLP, Abreu AS, Privado LB, et al. [Reports of tobacco, alcohol and illicit drug use among patients undergoing treatment for tuberculosis]. Braz J Health Rev. 2020;3(5):14866-77. https://doi.org/10.34119/bjhrv3n5-278 Portuguese

25. Rabahi MF, Silva Jr JLR, Ferreira ACG, Silva DGST, Conde MB. Tuberculosis treatment. J Bras Pneumol. 2017;43(5):472-86. https://doi.org/10.1590/s1806-37562016000000388

26. James SL, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018;392(10159):1789-858. https://doi.org/10.1016/S0140-6736(18)32279-7

27. Zhao L, Gao F, Zheng C, Sun X. The impact of optimal glycemic control on tuberculosis treatment outcomes in patients with diabetes mellitus: systematic review and meta-analysis. JMIR Public Health Surveill. 2024;10:e53948. https://doi.org/10.2196/53948

28. Chikovore J, Hart G, Kumwenda M, Chipungu GA, Desmond N, Corbett L. Control, struggle, and emergent masculinities: a qualitative study of men's care-seeking determinants for chronic cough and tuberculosis symptoms in Blantyre, Malawi. BMC Public Health. 2014;14(1):1053. https://doi.org/10.1186/1471-2458-14-1053

29. Ministério da Saúde (BR). Tuberculose 2025 [Internet]. Brasília: Ministério da Saúde, 2025 [cited 2025 Apr 10]. Available from: https://www.gov.br/aids/pt-br/central-de-conteudo/boletins-epidemiologicos/2025/boletim-epidemiologico-tuberculose-2025/@@download/file

30. Almeida FA, Gonçalves MJF. Factors associated with unsuccessful tuberculosis treatment in Manaus, Amazonas, from 2011 to 2021. Rev Esc Enferm USP. 2024;58:e20240431. https://doi.org/10.1590/1980-220X-REEUSP-2023-0431en

31. Han E, Nabity SA, Dasgupta-Tsinikas S, Guevara RE, Moore M, Kadakia A, et al. Tuberculosis diagnostic delays and treatment outcomes among patients with COVID-19, California, USA, 2020. Emerg Infect Dis. 2024;30(1):136-40. https://doi.org/10.3201/eid3001.230924

Data and Material Availability

Access to the dataset may be granted upon request to the corresponding author

Acknowledgments

This study was supported by the São Paulo Research Foundation (FAPESP), grant 2023/06383-0, and by thematic research project 2022/08510-7.

Authorship contribution

Conceptualization- Mariana Gaspar Botelho Funari de Faria; Dulce Gomes; Rubia Laine de Paula Andrade-Gonçalves.

Data curation- Mariana Gaspar Botelho Funari de Faria; Dulce Gomes; Rubia Laine de Paula Andrade-Gonçalves; Aline Aparecida Monroe.

Formal analysis- Mariana Gaspar Botelho Funari de Faria; Dulce Gomes; Rubia Laine de Paula Andrade-Gonçalves; Venisse Paschoalin Maurin; Rafaele Oliveira Bonfim; Rebeca Sousa Braga; Ricardo Alexandre Arcêncio; Aline Aparecida Monroe.

Funding acquisition- Mariana Gaspar Botelho Funari de Faria.

Methodology- Mariana Gaspar Botelho Funari de Faria; Dulce Gomes; Rubia Laine de Paula Andrade-Gonçalves.

Supervision- Dulce Gomes; Aline Aparecida Monroe.

Validation-Mariana Gaspar Botelho Funari de Faria; Dulce Gomes; Rubia Laine de Paula Andrade-Gonçalves; Venisse Paschoalin Maurin; Rafaele Oliveira Bonfim; Rebeca Sousa Braga; Ricardo Alexandre Arcêncio; Aline Aparecida Monroe

Writing – original draft- Mariana Gaspar Botelho Funari de Faria; Rebeca Sousa Braga.

Writing – review & editing- Mariana Gaspar Botelho Funari de Faria; Dulce Gomes; Rubia Laine de Paula Andrade-Gonçalves; Venisse Paschoalin Maurin; Rafaele Oliveira Bonfim; Rebeca Sousa Braga; Ricardo Alexandre Arcêncio; Aline Aparecida Monroe.

The authors declare that there is no conflict of interest.

Corresponding author:
Mariana Gaspar Botelho Funari de Faria
rimagod@usp.br

Received: 08.05.2025
Approved: 05.28.2026

Associate editor:
Dagmar Elaine Kaiser

Editor-in-chief:
João Lucas Campos de Oliveira