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Tuberculosis in Brazil: an epidemiological overview from 2018 to 2022

Tuberculose no Brasil: um panorama epidemiológico de 2018 a 2022

Tuberculosis en Brasil: un panorama epidemiológico de 2018 a 2022

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ABSTRACT

Objective: This study aimed to conduct an epidemiological assessment of tuberculosis cases reported in Brazil from 2018 to 2022. **Methods:** Data were collected from the Information System for Notifiable Diseases (SINAN), available on the website of the Department of Health Informatics of the Unified Health System (DATASUS). Tuberculosis data from 2018 to 2022 were analyzed. **Results:** Between 2018 and 2022, 472,781 cases of tuberculosis were reported in Brazil, showing a stable trend in disease notifications over the last 5 years. The Northern region had the highest number of tuberculosis cases per 100,000 inhabitants (66.3 cases). Only 15.63% of patients underwent susceptibility testing before starting treatment. Among these, 12.85% (n = 60,759) were sensitive, and 1.17% exhibited drug resistance. Positively, there was a cure rate of 62.24% among individuals with tuberculosis. Treatment failure occurred in 14.02% of cases due to treatment abandonment. Despite efforts against tuberculosis, 340 deaths were recorded between 2018 and 2022. **Conclusion:** Based on the presented data, several characteristics were identified that could inform the development of public policies focused on tuberculosis.

Keywords: Tuberculosis, Epidemiology, Public health.

RESUMO

Objetivo: Realizar uma avaliação epidemiológica dos casos de tuberculose reportados no Brasil no quinquênio de 2018 a 2022. **Métodos:** Os dados foram coletados do Sistema de Informação de Agravos de Notificação (SINAN), disponibilizados no site do Departamento de Informática do Sistema Único de Saúde (DATASUS). Avaliou-se os dados de Tuberculose disponíveis dos anos de 2018 a 2022. **Resultados:** Entre os anos de 2018 a 2022 foram notificados 472.781 casos de tuberculose no Brasil, sendo possível observar uma estabilidade nas notificações desta doença nos últimos 5 anos. A região Norte apresentou o maior número de casos de Tuberculose a cada 100.000 habitante (66,3 casos). Apenas 15,63% dos pacientes realizaram teste de susceptibilidade a resistência antes de iniciar o tratamento. Destes, 12,85% (n= 60.759) eram sensíveis e 1,17% possuem alguma resistência as drogas em uso. Positivamente houve uma taxa de 62,24% de cura dos indivíduos com tuberculose. O insucesso terapêutico relatado em alguns casos ocorreu devido ao abandono do tratamento, em 14,02% dos casos. Ainda, apesar de todos os esforços contra a tuberculose, entre os anos de 2018 a 2022 foram registrados 340 óbitos. **Conclusão:** Com base nos dados apresentados conseguimos levantar uma série de características que poderão ser utilizadas durante a elaboração de políticas públicas voltadas para a tuberculose.

Palavras-chave: Tuberculose, Epidemiologia, Saúde pública.

RESUMEN

Objetivo: Este estudio tuvo como objetivo realizar una evaluación epidemiológica de los casos de tuberculosis notificados en Brasil entre 2018 y 2022. **Métodos:** Los datos fueron recolectados del Sistema de Información

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de Enfermedades de Declaración Obligatoria (SINAN), disponible en el sitio web del Departamento de Informática en Salud del Sistema Único de Salud (DATASUS). Se analizaron datos de tuberculosis de 2018 a 2022. **Resultados:** Entre 2018 y 2022, se notificaron 472.781 casos de tuberculosis en Brasil, lo que muestra una tendencia estable en las notificaciones de enfermedades en los últimos 5 años. La región Norte tuvo el mayor número de casos de tuberculosis por 100.000 habitantes (66,3 casos). Sólo al 15,63% de los pacientes se les realizaron pruebas de susceptibilidad antes de iniciar el tratamiento. Entre estos, el 12,85% (n = 60.759) eran sensibles y el 1,17% presentaban resistencia a los medicamentos. Positivamente, hubo una tasa de curación del 62,24% entre las personas con tuberculosis. El fracaso del tratamiento se produjo en el 14,02% de los casos por abandono del mismo. A pesar de los esfuerzos contra la tuberculosis, entre 2018 y 2022 se registraron 340 muertes. **Conclusión:** Con base en los datos presentados, se identificaron varias características que podrían informar el desarrollo de políticas públicas enfocadas en la tuberculosis.

Palabras clave: Tuberculosis, Epidemiología, Salud pública.

INTRODUCTION

Tuberculosis is a serious and highly transmissible infectious disease caused by the bacterium Mycobacterium tuberculosis, which belongs to the Mycobacteriaceae family of bacteria. This disease poses significant public health challenges worldwide due to its ability to spread easily from person to person through the air, primarily affecting the lungs but also capable of affecting other parts of the body, resulting in a spectrum of symptoms and potentially life-threatening complications if left untreated (BASTOS SH, et al., 2019). Since 1993, it has been considered a global epidemic by the World Health Organization (WHO) (CORTEZ AO, et al., 2021).

Furthermore, WHO estimates that approximately one-fourth of the world's population carries Mycobacterium tuberculosis. Of those infected, an estimated 5 to 10% will develop active tuberculosis disease in their lifetime. This highlights the significant global burden of latent tuberculosis infection and underscores the importance of effective tuberculosis control measures to prevent progression to active disease (SILVA DR, et al., 2021). In 2016, a concerning scenario was observed in the context of tuberculosis. Of the deaths attributable to this disease, a significant percentage of 22% occurred in individuals coinfected with HIV, highlighting the complexity and challenges faced in treating these concurrent conditions.

Additionally, approximately 5% of the 10.4 million incident tuberculosis cases recorded that year showed resistance to at least two of the first-line drugs for tuberculosis treatment. This resistance to essential medications underscores the importance of ongoing surveillance, the development of new therapeutic strategies, and the implementation of robust public health policies to effectively combat the spread of drug-resistant tuberculosis (KOCH, A & MIZRAHI V, 2018).

Even in high-income countries, the mortality rates among tuberculosis survivors are significantly elevated, typically ranging from 3 to 6 times higher than those observed in the general population. This disparity underscores the persistent challenges and health risks faced by individuals who have experienced tuberculosis, highlighting the need for continued support and healthcare interventions to improve outcomes for these vulnerable populations (ALLWOOD BW, et al., 2021).

As Brazil ranks among the countries with the highest disease burden globally (MOREIRA ASR, et al., 2020), tuberculosis has garnered significant attention as a public health concern. In response to this, tuberculosis has been designated as a notifiable disease within the country (SANTOS DAS, et al., 2021), emphasizing the importance of surveillance, early detection, and prompt treatment to mitigate its impact on affected populations. Tuberculosis primarily affects the lungs, known as the pulmonary form of the disease. However, it's important to note that tuberculosis can also spread to other organs and systems in the body, leading to what is known as extrapulmonary tuberculosis.

This dissemination can result in a wide range of complications and symptoms depending on the affected organs, highlighting the systemic nature of the disease (SANTOS DAS, et al., 2021). Its primary mode of transmission is through airborne droplets produced by talking, coughing, or sneezing of an individual with

active tuberculosis. It is worth noting that its transmission is now understood to be influenced not only by biological factors, as mentioned, but also by social and environmental factors such as poverty, malnutrition, inadequate housing, poor working conditions, inaccessible health services, and the presence of comorbidities, such as diabetes and HIV infection (TAVARES CM, et al., 2020; OLIVEIRA MSR, et al., 2018; RODRIGUES IC, et al., 2017).

Tuberculosis prevention is not highly specific; however, there is a vaccine known as BCG (Bacillus Calmette-Guérin) that acts as a form of prevention. This vaccine does not prevent infection by Mycobacterium tuberculosis but provides protection against more severe forms of tuberculosis, such as tuberculous meningitis and miliary tuberculosis, mainly in children under 5 years of age (MARTINS VO & MIRANDA CV, 2020). While it's true that 85–95% of individuals infected with M. tuberculosis can effectively control the infection, never progressing to active tuberculosis disease, research indicates that many people struggle to independently generate adequate immune control of M. tuberculosis infection.

This highlights the critical need for the development of an effective tuberculosis vaccine (SCHRAGER LK, et al., 2020). The gold standard for treating tuberculosis involves a combination of Isoniazid, Rifampicin, Pyrazinamide, and Ethambutol. While these medications are highly effective, they can also lead to various side effects. These side effects may include nausea, vomiting, stomach pain, fever, lymphadenopathy, hyperuricemia, optic neuropathy, itching, and mild rash. It's crucial for healthcare providers to monitor patients closely during treatment to manage any adverse reactions and ensure the best possible outcomes (NASCIMENTO DD, et al., 2023).

Despite tuberculosis being a disease with mechanisms allowing for prevention, easy diagnosis, and almost universal curability through effective treatment regimens, its incidence remains stubbornly high. This paradox underscores the persistent challenges in combating tuberculosis, highlighting the importance of continued efforts in public health interventions, research, and healthcare infrastructure to reduce its burden globally (BASTOS SH, et al., 2019). Although tuberculosis treatment aims for cure, along with a substantial reduction in disease burden, and its effectiveness is generally over 90%, there remains variability in treatment outcomes depending on the geographical location.

This variation underscores the importance of considering regional factors, such as healthcare infrastructure, access to resources, and socioeconomic conditions, in optimizing tuberculosis control efforts and improving treatment outcomes globally (RABAHI MF, et al., 2017). Thus, there is a need for epidemiological studies to understand the dynamics of the disease in each country, enabling the development of specific and more efficient public policies. Based on this, the present study aimed to conduct an epidemiological assessment of tuberculosis cases reported in Brazil from 2018 to 2022.

METHODOLOGY

A descriptive, quantitative, and retrospective study was conducted using data obtained from the Notifiable Diseases Information System (SINAN), accessible through the Department of Informatics of the Unified Health System (DATASUS) website. The study focused on tuberculosis data spanning from 2018 to 2022, which were retrieved and analyzed from the "Tuberculosis Cases" section on TabNet (https://datasus.saude.gov.br/acesso-a-informacao/casos-de-tuberculose-desde-2001-sinan/). Various variables were examined, including gender, age group, race, education, region, federative unit, sensitivity test results, and outcome.

The analysis employed descriptive statistical methods, with data transferred and organized into Excel® spreadsheets to present absolute frequency (n) and relative (%) values.To standardize the number of cases per 100,000 inhabitants, the total number of cases recorded between 2018 and 2022 was divided by 5, estimating an annual average. The following formula was applied for normalization: Annual number of cases per 100,000 = (Number of cases/year x 100,000) / Population of the region in 2022. Given that the study utilized publicly available secondary data, ethical committee review was deemed unnecessary. The

methodology was established based on previously published epidemiological studies (ANDRADE SM, et al., 2022; BASTOS SH, et al., 2019) to ensure consistency and reliability in data analysis and interpretation.

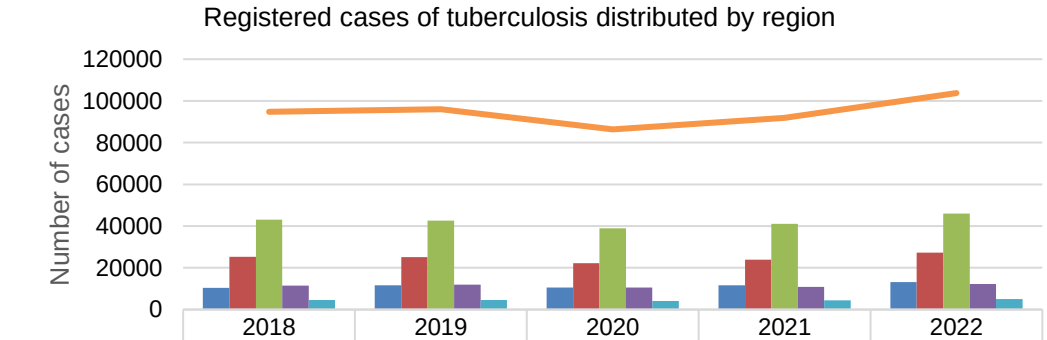
RESULTS AND DISCUSSION

Between 2018 and 2022, Brazil reported a staggering total of 472,781 cases of tuberculosis, reflecting the persistent burden of this infectious disease within the country. Despite efforts to control and treat tuberculosis, the high number of reported cases underscores the ongoing challenges faced in managing this public health issue effectively. Furthermore, it's essential to acknowledge the significant impact that the Corona Virus Disease 2019 (COVID-19) pandemic had on healthcare systems worldwide, including Brazil.

During this period, the attention and resources of healthcare authorities were diverted to addressing the urgent needs arising from the pandemic, potentially leading to disruptions in routine healthcare services and surveillance systems. Consequently, the notification process for other diseases, including tuberculosis, may have been directly affected, potentially resulting in underreporting or delays in reporting. These challenges highlight the importance of robust and adaptable healthcare systems that can effectively respond to emerging public health crises while maintaining essential services for ongoing disease control efforts (CARDOSO LSP, et al., 2023).

However, despite a slight reduction in the number of notifications, as shown in Graph 1, there is observable stability in the notifications of this disease over the past 5 years. This could be linked to tuberculosis being a significant comorbidity for patients with COVID-19. As outlined by Silva DR, et al. (2021), the COVID-19 pandemic has had a profound impact on the diagnosis and treatment of tuberculosis, disrupting healthcare systems worldwide. The decrease in the number of tuberculosis diagnoses and treatments during the pandemic is likely to have contributed to fluctuations in mortality rates. This underscores the importance of maintaining tuberculosis control efforts even amidst major public health crises to prevent setbacks in progress towards reducing the burden of this disease (SILVA DR, et al., 2021).

Graph 1- Confirmed cases of tuberculosis per year of diagnosis in the period from 2018 to 2022 in Brazil by region.



	2018	2019	2020	2021	2022
North	10413	11700	10489	11575	13168
Northeast	25230	25122	22260	23860	27257
Southeast	43031	42703	38909	41162	46039
South	11476	11924	10508	10892	12285
Midwest	4585	4638	4188	4350	5017
Total	94735	96087	86354	91839	103766

Source: Rodrigues ISM & Andrade SM, 2024.

The Southeast region recorded the highest number of tuberculosis cases (n=211,844), followed by the Northeast region (n=123,729), North region (n=57,345), and South region (n=57,085). The Central-West

region had the lowest number of cases (n=22,778). These regional differences in tuberculosis burden highlight the need for targeted interventions and resource allocation to address the specific challenges faced by each region in tuberculosis prevention, diagnosis, and treatment. Since presenting these data without taking into account population density may not reflect the severity of the number of cases in each region, we chose to normalize the number of cases based on the population of each region.

For this, we followed the latest IBGE census (2022), which showed that the Southeast region is the most populous, with 41.8% (84.8 million inhabitants) of the total 203 million inhabitants in the country. Next are the Northeast (26.9%; 54.6 million), South (14.7%; 29.9 million), North (8.5%; 17.3 million inhabitants), and Central-West (8%; 16.3 million). Thus, an interesting fact was revealed: the North region actually has the highest number of Tuberculosis cases per 100,000 inhabitants (66.3 cases), followed by the Southeast (49.96 cases), Northeast (45.32 cases), South (38.18 cases), and Central-West (27.95 cases). The differences highlighted between these regions are multifaceted and can be attributed to various factors, including climatic patterns, socioeconomic characteristics, political dynamics, and administrative structures.

Climatic patterns play a significant role in shaping environmental conditions that may influence disease transmission and prevalence. Socioeconomic characteristics such as poverty levels, access to healthcare, and education can impact the ability of communities to prevent, diagnose, and treat diseases effectively. Political dynamics and administrative structures also play a crucial role in shaping healthcare policies, resource allocation, and the overall functioning of healthcare systems, which can vary widely between regions. Understanding and addressing these diverse factors are essential for developing targeted interventions and strategies to improve health outcomes and reduce health disparities across different regions (CORTEZ AO, et al., 2021).

Epidemiological variables related to tuberculosis cases are presented in **Table 1**. It is notable that there has been a significant prevalence of tuberculosis in males, accounting for 70.21% of cases. This gender disparity is likely attributed to various cultural, social, and economic factors, which may influence healthcare-seeking behavior, access to healthcare services, and exposure to risk factors associated with tuberculosis transmission. Understanding these underlying factors is essential for developing targeted interventions to address the gender disparities observed in tuberculosis epidemiology. However, over the past 15 years, there has been increasing discussion regarding more concrete explanations for the disparity in tuberculosis cases between sexes. Interestingly, despite registering fewer cases, females are often found to be more susceptible to complications of the disease.

This discrepancy has spurred research and debate aimed at uncovering the underlying factors contributing to the gender differences in tuberculosis susceptibility and outcomes (BELO MTCT, et al., 2010). Future studies should be conducted to better explain this discussion. Regarding age, the highest number of cases was recorded in individuals aged between 20 and 39 years (46.1%). This is a recurring data point in other epidemiological studies, not only related to tuberculosis but also to other diseases, which can cause damage to the Brazilian economy, as it mainly affects the economically active population – EAP (ANDRADE SM, et al., 2022; OLIVEIRA ABM, et al., 2022; HOLANDA, EC, et al., 2020). In terms of ethnicity, the most affected was the Pardo ethnicity (49.89%), followed by the White ethnicity.

IBGE data (2022) indicate that Brazil is mainly composed of White individuals (42.8%) and Pardo individuals (45.3%), explaining the percentage of cases found in this study. Another important point that deserves attention in the epidemiological interpretation of tuberculosis in Brazil is education. However, 31.02% of the registered cases do not have information on education, which complicates the extrapolation of results. Additionally, without knowing the target audience, it is difficult to raise awareness with informative campaigns (ROLIM HM, et al., 2021). The available data indicates that individuals attending the 5th to 8th grade of incomplete elementary education (18.12%) were the most affected by tuberculosis.

This observation suggests a correlation between lower education levels and tuberculosis incidence, which can be attributed to factors such as income, social conditions, and limited knowledge about tuberculosis (RODRIGUES MW & MELLO AGNC, 2018). Furthermore, low education levels have been identified as a

determining factor in treatment abandonment, highlighting the need for targeted educational interventions and social support programs to improve tuberculosis control efforts among vulnerable populations (SILVA PF, et al., 2014).

Table 1- Distribution of epidemiological variables referring to Tuberculosis cases in Brazil, 2018-2022.

Variables	N	%
Gender		
Male	331,957	70.21
Female	140,774	29.78
Ignored	50	0.01
Age range		
< 1 year	2,268	0.48
1-9	5,780	1.22
10-14	4,948	1.05
15-19	23,899	5.05
20-39	217,929	46.1
40-59	147,413	31.18
60-69	42,374	8.96
70-79	19,945	4.22
From 80 years old	7,973	1.69
Ignored	246	0.05
Ethnicity/Race		
Ignored	35,974	7.61
White	129,886	27.47
Black	62,504	13.22
Yellow	4,231	0.9
Brown	235,867	49.89
Indigenous	4,319	0.91
Education		
Ignored	146,632	31.02
Illiterate	15,801	3.34
1st to 4th incomplete series of ES	45,557	9.64
Complete 4th grade of ES	19,936	4.22
Incomplete 5th to 8th gradeof ES	85,663	18.12
Complete primaryeducation	26,445	5.59
Incomplete high school	59,136	12.51
Complete high school	46,442	9.82
Incomplete higher education	13,104	2.77
Complete higher education	14,065	2.97

Source: Rodrigues ISM & Andrade SM, 2024. ES - Elementary School.

As seen in **Table 2**, five Brazilian states hold more than half of the tuberculosis registration numbers, namely São Paulo, Rio de Janeiro, Rio Grande do Sul, Pernambuco, and Bahia. São Paulo leads with 106,926 cases. Similar data regarding the prevalence of tuberculosis among males and the higher susceptibility of females to complications of the disease is also highlighted by Campoy LT, et al. (2019). Their study, which assessed the quality and management of care for tuberculosis and HIV coinfection in the State of São Paulo, provides further evidence of the gender disparities observed in tuberculosis epidemiology and outcomes.

This research underscores the importance of addressing gender-specific factors in tuberculosis control efforts to ensure equitable access to care and improve treatment outcomes for all affected individuals. One of the reasons widely addressed to justify the high number of cases in SP is the higher susceptibility of the homeless population, as these individuals are exposed to greater food insecurity, unavailability of drinking water, and sleep deprivation, exposing them to various diseases, harms, and situations of vulnerability (SILVA DR, et al., 2021; YAMAMURA M, et al., 2014).

Table 2- Federative Units (FUs) with the highest number of registered cases of Tuberculosis in Brazil, 2018-2022.

FU	N	%
São Paulo	106,926	22.62
Rio de Janeiro	74,714	15.80
Rio Grande do Sul	32,706	6.92
Pernambuco	30,798	6.51
Bahia	26,624	5.63
Demais estados	201,013	42.52
Total	472,781	100

Source: Rodrigues ISM & Andrade SM, 2024.

Since the 1940s, resistance to antituberculosis agents has been a subject of study and has been reported in the literature (KESHAVJEE S & FARMER PE, 2012). As a result, the performance of sensitivity tests has become crucial in tuberculosis management to prevent treatment failures and relapses (GINSBURG AS, et al., 2003). These tests help identify drug-resistant strains of Mycobacterium tuberculosis, allowing healthcare providers to tailor treatment regimens accordingly and improve patient outcomes.

Therefore, the data presented here raise significant concerns about the lack of information on sensitivity tests in 48.15% (n=227,667) of patients and the non-performance in 36.22% (n=171,265) of cases (Table 3). This means that only 15.63% of patients had susceptibility analysis to resistance before starting treatment. Of these, 12.85% (n=60,759) were sensitive, and 1.17% had some drug resistance. Brazil stands out for its Unified Health System (SUS), which provides free access to four essential drugs for the treatment of tuberculosis cases in the basic regimen: rifampicin, isoniazid, pyrazinamide, and ethambutol.

This comprehensive approach to tuberculosis treatment, facilitated by the SUS, has significantly contributed to successful cure rates and the rapid reduction of disease transmission within the country. By ensuring access to these vital medications, Brazil has been able to effectively combat tuberculosis and improve health outcomes for affected individuals, demonstrating the importance of equitable healthcare systems in disease control efforts (RABAHI MF, et al., 2017).

Table 3- Sensitivity test - Tuberculosis in Brazil, 2018-2022.

Sensitivity test	N	%
Ignored	227,667	48.15
Isoniazid Resistance	2,020	0.43
Rifampicin Resistance	1,001	0.21
Isoniazid and Rifampicin Resistance	1,016	0.22
First-line drug resistance	1,456	0.31
Sensitive	60,759	12.85
In progress	7,597	1.61
Unrealized	171,265	36.22
Total	472,781	100

Source: Rodrigues ISM & Andrade SM, 2024.

Finally, one of the most crucial aspects of conducting an epidemiological study is analyzing the outcomes of reported cases. This step is essential for understanding the impact of the disease on affected populations, identifying risk factors associated with adverse outcomes, evaluating the effectiveness of interventions, and informing public health policies and strategies. By carefully examining the outcomes of reported cases, researchers and public health professionals can gain valuable insights into the trajectory of the disease, its burden on healthcare systems, and opportunities for prevention and control measures.

This analysis is integral to the broader goal of epidemiological research, which is to improve health outcomes and promote well-being in communities worldwide. This allows us to verify if the measures taken for

the cure and control of tuberculosis are having the expected effect. As observed in table 4, there was a positive cure rate of 62.24% for individuals with tuberculosis. The current regimen based on isoniazid, rifampicin, pyrazinamide, and ethambutol emerged due to therapeutic failures observed from the 1960s onwards, primarily resulting from bacterial resistance. This issue remains a significant topic of attention in tuberculosis treatment today.

The development of drug-resistant strains of Mycobacterium tuberculosis poses a considerable challenge to tuberculosis control efforts globally, requiring ongoing research, surveillance, and the development of innovative treatment strategies to combat this persistent threat (MASSABNI AC & BONINI EH, 2019). It is also possible to observe that part of the therapeutic failure occurs due to treatment abandonment in 14.02% of cases, leading to low treatment effectiveness. It is worth noting that other factors are also related to low effectiveness, such as incorrect and/or irregular use of medications (RABAHI MF, et al., 2017).

However, it's important to note that these last two factors are typically not captured or accounted for during the information deposition in the notification system. In conclusion, despite all efforts against tuberculosis, 340 deaths were recorded between 2018 and 2022. However, it's concerning that 28,863 cases were classified as unknown/white, which may result in the omission of important statistics and hinder our understanding of the full extent of the tuberculosis burden. This underscores the importance of improving data collection methods and addressing gaps in reporting to ensure comprehensive surveillance and effective tuberculosis control strategies.

Table 4- Evolution of Tuberculosis cases in Brazil, 2018-2022.

Evolution	N	%
Ignored	28,863	6.11
Cure	294,282	62.24
Abandonment	66,286	14.02
Death from tuberculosis	18,416	3.89
Death from other causes	19,980	4.23
Transfer	31,394	6.64
DR-TB	5,056	1.07
Schema Change	3,823	0.81
Bankruptcy	340	0.07
Primary Abandonment	4,341	0.92
Total	472,781	100

Source: Rodrigues ISM & Andrade SM, 2024. DR-TB: Drug-resistant tuberculosis.

CONCLUSION

Based on the presented data, we have identified several key characteristics that can inform the development of public policies related to tuberculosis. Foremost among these is the recognition of the need for a multidisciplinary approach to tuberculosis management, involving healthcare professionals from various disciplines to ensure the best possible treatment outcomes for patients. Central to this approach is the importance of raising awareness among patients about the critical role of adherence to the therapeutic regimen. Treatment abandonment is a significant contributing factor to treatment failure, and efforts to improve adherence can lead to increased cure rates, reduced transmission rates, and a lower incidence of cases with resistance to treatment. By prioritizing comprehensive care and patient education, we aim to enhance tuberculosis control efforts and ultimately improve health outcomes for affected individuals and communities.

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