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Challenges and Risk Factors in Directly Observed Treatment of Tuberculosis in Paraíba: An Epidemiological and Correlational Study

Desafios e Fatores de Risco no Tratamento Diretamente Observado da Tuberculose na Paraíba: Um Estudo Epidemiológico e Correlacional

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ABSTRACT

The present study aimed to characterize the clinical-epidemiological profile and risk factors of patients undergoing Directly Observed Treatment (DOT) in the state of Paraíba. This is an epidemiological, quantitative, and descriptive study that used secondary data from the Notifiable Diseases Information System (SINAN). Simple and relative frequencies were calculated, and the Chi-Square Test of Independence, adjusted residuals, and Spearman's bivariate correlation were applied. Between 2019 and 2023, 1,491 patients underwent DOT. The epidemiological profile consisted mainly of men (69.6%), individuals aged 20 to 39 years (39.5%), mixed-race individuals (69.4%), and those with low educational attainment (36.8%). A positive association was found between male patients aged 20 to 59 years and female patients aged 60 years and older (p<0.001). Furthermore, an association was observed between not undergoing DOT and male sex (p=0.030), the presence of HIV (p<0.001) and AIDS (p<0.001), alcoholism (p=0.017), and smoking (p<0.001). Clinically, the pulmonary form was the most prevalent (86.9%). Additionally, the study suggests that a higher number of healthcare facilities is associated with a lower treatment dropout rate (ρ = -0.443, p = 0.009). Given this scenario, it is essential to strengthen public policies that expand access to DOT.

Keywords: Tuberculosis. Risk factors. Directly Observed Treatment. Epidemiological profile. Bivariate correlation.

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RESUMO

O presente estudo teve como objetivo caracterizar perfil clínico-epidemiológico e fatores de risco, em pacientes que fazem uso de TDO no Estado da Paraíba. Trata-se de um estudo epidemiológico, quantitativo e descritivo que utilizou dados secundários do Sistema de Informação de Agravos de Notificação (SINAN). Foram calculadas as frequências simples e relativa e foi aplicado o teste Qui-Quadrado de Independência, os resíduos ajustados e a correlação bivariada de Spearman. Entre os anos de 2019 a 2023, 1.491 pacientes fizeram o uso de TDO. O perfil epidemiológico foi composto, por homens (69,6%), de 20 a 39 anos (39,5%), etnia parda (69,4%) e baixa escolaridade (36,8%). Houve associação positiva entre o sexo masculino entre 20 a 59 anos e o feminino a partir de 60 anos (p<0,001). Ademais, observou-se associação entre o não uso de TDO e o sexo masculino (p=0,030), a presença de HIV (<0,001) e AIDS (<0,001), o alcoolismo (p=0,017) e o tabagismo (p<0,001). Clinicamente, a forma pulmonar foi a mais prevalente (86,9%). Outrossim, sugere-se que quanto maior o número de estabelecimentos de saúde, menor é taxa de abandono (ρ = -0,443, p = 0,009). Diante desse cenário, torna-se essencial fortalecer políticas públicas que ampliem o acesso ao TDO.

Palavras-chave: Tuberculose. Fatores de risco. Tratamento Diretamente Observado. Perfil epidemiológico. Correlação bivariada.

1. INTRODUCTION

Tuberculosis (TB) is an infectious and transmissible bacterial disease caused by the pathogen *Mycobacterium tuberculosis*. This condition primarily affects the lungs, although, in some cases, the bacillus can enter the bloodstream and cause the extrapulmonary form, especially in individuals with Human Immunodeficiency Virus (HIV) (BRAZIL, 2025).

From an epidemiological perspective, TB causes more than one million deaths worldwide each year. In Brazil, specifically, approximately 80,000 new cases and 5,500 deaths are recorded annually (BRAZIL, 2025).

The main symptoms associated with TB include anorexia, cough lasting more than three weeks (with or without sputum production), low-grade fever, pallor, hoarseness, and night sweats (FIOCRUZ, 2025). When a patient presents with these symptoms, laboratory diagnostic tests such as sputum smear microscopy and chest radiography are necessary for confirmation (BRAZIL, 2025).

Once the diagnosis is confirmed, pharmacological treatment consists of multiple drugs, including rifampicin, isoniazid, pyrazinamide, and ethambutol (ANDRADE JÚNIOR et al., 2020). This combination of substances can contribute to treatment discontinuation due to numerous adverse effects, such as gastrointestinal intolerance, skin rashes, nausea, and vomiting (MENDES et al., 2021).

Furthermore, beyond the complexity of the treatment itself, other factors may contribute to therapy abandonment, including socioeconomic issues, low education levels, drug use, alcoholism, and smoking (FERREIRA et al., 2018; RIBEIRO et al., 2023). This highlights the need for strategies to improve medication adherence, reduce treatment dropout rates, and decrease morbidity and mortality, such as Directly Observed Treatment (DOT).

DOT consists of supervising TB patients during medication administration, performed by a healthcare professional or trained individuals under supervision. Ideally, treatment should occur daily on weekdays or, exceptionally, three times a week at a time and location agreed upon by the patient and healthcare service. Additionally, patients must be educated about the disease, treatment (duration, regimen, and medication use), and potential adverse effects (BRAZIL, 2025).

In this context, although epidemiological studies on TB in Paraíba exist (ANDRADE JÚNIOR et al., 2021; FERREIRA et al., 2021; ANDRADE JÚNIOR, 2022), there is a notable

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scarcity of research on the use of DOT in TB patients. Thus, this study aimed to characterize the clinical-epidemiological profile and risk factors in patients undergoing DOT.

2. MATERIALS AND METHODS

This is an epidemiological, quantitative, and descriptive study that utilized secondary data from the Notifiable Diseases Information System (SINAN) (ANDRADE JÚNIOR et al., 2021).

Paraíba is located in the Northeast region of Brazil, with João Pessoa as its capital. The state has an area of 56,467.242 km², an estimated population of 3,974,887 people, and a population density of 70.39 inhabitants/km². The Human Development Index (HDI) was 0.658 in 2021, and the per capita household income was 1,320 reais (IBGE, 2023).

The analyzed variables included year (with data collection from 2019 to 2023), age group, education level, and ethnicity. Additionally, the study investigated the association between the implementation of Directly Observed Treatment (DOT) and immunosuppressive factors such as HIV, AIDS, smoking, and alcoholism. Simple and relative frequencies were calculated.

Furthermore, the Chi-square independence test was performed using the Statistical Package for the Social Sciences (SPSS) software, version 13.0, considering statistical significance at $p < 0.05$. Adjusted residuals (r) were considered positive when equal to or greater than 1.96.

A Spearman bivariate correlation analysis was conducted to examine the relationship between the number of Unified Health System (SUS) services in each municipality of Paraíba and the Municipal Human Development Index (MHDI), with data obtained from the IBGE website (https://cidades.ibge.gov.br/brasil/pb/panorama). These indicators were correlated with the total number of DOT users who discontinued treatment.

Since this study used secondary data from publicly accessible computerized sources, submission to the Research Ethics Committee (CEP) was not required, as stated in CNS Resolution 466/2012.Utilizar fonte arial 12, com espaçamento 1,5. A seção Material e Métodos (ou Metodologia), deverá conter os seguintes itens, apresentados em texto contínuo ou divididos em tópicos:

3. RESULTS AND DISCUSSION

Between 2019 and 2023, a total of 7,796 TB cases were reported in the state of Paraíba; however, only 1,491 patients underwent Directly Observed Treatment (DOT).

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This figure is highly concerning since, due to the prolonged treatment duration and the adverse effects caused by the medications used in therapy, discontinuation or irregular use of these drugs has become a common practice. This underscores the need for strategies such as DOT to reduce morbidity and mortality.

In this context, according to the Brazilian Ministry of Health (2023), in 2019, 35.4% of individuals diagnosed with tuberculosis were enrolled in DOT. However, by 2021, this percentage had dropped to 30.2%, marking the lowest rate since 2008. Given this, the World Health Organization's (WHO) Global Tuberculosis Program introduced new treatment recommendations in 2022, emphasizing the use of digital technologies to support the therapeutic process.

Below, Table 1 presents the number of individuals, by year, who utilized DOT for tuberculosis treatment.

Table 1. Absolute and relative frequencies of individuals affected by tuberculosis in the state of Paraíba who underwent Directly Observed Treatment (DOT) between 2019 and 2023.

Year	N	%
2019	299	20.1
2020	261	17.5
2021	295	19.8
2022	327	21.9
2023	309	20.7
Total	1,491	100

Source: Research data, 2025.

The years 2022 (21.9%) and 2023 (20.7%) saw the highest number of individuals with tuberculosis who are users of DOT in the State of Paraíba. These results are similar to studies conducted in other locations, such as Recife (RODRIGUES et al., 2023), Ceará (MARTINS et al., 2024), and Brazil as a whole (GORGÔNIO et al., 2024).

It is noteworthy that between 2020 and 2022, there was a progressive increase in the number of cases, which may be associated with the social isolation during the early years of the COVID-19 pandemic, as remaining in closed environments for extended periods contributes to the spread of airborne infectious diseases, such as tuberculosis (BRAZIL, 2025).

Below, in Table 2, an association between gender and age group of individuals affected by TB who are undergoing DOT can be observed.

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Table 2. Association between sex and age group of individuals affected by tuberculosis who are undergoing DOT in the State of Paraíba, between the years of 2019-2023.

Age group	Male gender		Female gender		Total		p
	N	%	N	%	N	%	
Up to 19 years old	62	12.1	55+	6,0	117	7.8	
20 to 59 years old	822+	63.4	287	79,2	1109	74.4	0.001
Above 60 years old	154	24.5	111+	14,8	265	17.8	
Total	1,038	100%	453	100%	2,924	100%	

p = chi-square test of independence; + adjusted residuals ≥1.96. Source: Research data, 2025.

Regarding sex, males were the most affected (69.6%). The most prevalent age group was 20-39 years (39.5%), followed by 40-59 years (34.9%), 60-69 years (10.7%), 70-79 years (5.3%), 15-19 years (4.9%), over 80 years (1.8%), 10-14 years (1%), 1-4 years (0.9%), 5-9 years (0.8%), and under 1 year (0.3%).

Men are typically more affected by tuberculosis due to cultural factors such as alcohol and nicotine consumption, which reduce immunity and impair nutritional status (SILVA et al., 2018).

Regarding age groups, it is notable that individuals between 20 and 59 years are the most economically active, which contributes to increased contact between individuals and raises the probability of encountering the tuberculosis pathogen (ANDRADE JÚNIOR et al., 2019). Elderly individuals are often the second most affected group due to immunosenescence (FERREIRA et al., 2021). As for children and adolescents, they were the least reported in this study, as the BCG vaccine generally provides 10 to 15 years of temporary immunity against *M. tuberculosis*, contributing to their low prevalence (BRAZIL, 2025).

Table 3. Simple and relative frequencies of individuals affected by tuberculosis in the State of Paraíba who used DOT, between the years 2019-2023.

Ethnicity	N	%
Ignored	59	4.0
White	270	18.1
Black	111	7.4
Yellow	12	0.8
Mixed race	1,034	69.4
Indigenous	5	0.3
Total	1,491	100
Education level		
Ignored	565	37.9
No education	100	6.7
Low education	548	36.8
Medium education	200	13.4
High education	54	3.6
Not applicable	24	1.6
Total	1,491	100

Source: Research data, 2025.

Regarding ethnicity, it is evident that the mixed-race group (parda) was the most prevalent. This result is similar to studies conducted in Campina Grande-PB (ANDRADE JÚNIOR et al., 2021), Açailândia-MA (MORAES et al., 2017), and the state of Ceará (MARTINS et al., 2024). This is generally associated with the ethnic composition of the region, where the majority of the population (55.54%) in Paraíba is of mixed-race ethnicity (GOVERNO DA PARAÍBA, 2023). Overall, mixed-race ethnicity is often linked to a higher prevalence of infectious diseases, likely due to socioeconomic, historical disparities and limited access to effective social policies (CONCEIÇÃO et al., 2022).

According to Nascimento et al. (2024), this highlights the historical instability faced by Black populations, who often experience poor socioeconomic conditions, such as inadequate housing, limited access to sanitation, and potable water.

Regarding education, most individuals affected have a low level of schooling (36.8%), which aligns with other studies conducted in the Northeast, in Campina Grande (ANDRADE JÚNIOR et al., 2021) and Juazeiro do Norte-CE (PEREIRA et al., 2022). In this context, it is important to emphasize that few years of schooling contribute to the negative progression of infectious diseases (LAGES et al., 2018), which may be associated with reduced understanding of preventive guidelines and compromised effectiveness of medical treatment (MELO et al., 2018).

Table 4. Association between personal data, clinical factors, and immunodepressant factors in individuals affected by tuberculosis in the state of Paraíba, who used DOT, between 2019-2023.

Personal, Clinical, and Immunodepressive Factors	Uses DOT		Does not use DOT		*P*
	N	%	N	%	
Sex					
Male	1,038	69.6	+1,456	74.2	
Female	453+	30.4	505	25.8	0.03
Total	1,491	100	1,961	100	
Education					
Low/no education	648	71.8	888	69.0	
Medium/High education	254	28.2	399	31.0	0.152
Total	902	100	1,287	100	
Clinical form					
Pulmonary	1,305	87.5	1,705	86.9	
Extrapulmonary	165	11.1	229	11.7	0.854
Pulmonary+Extrapulmonary	21	1.4	27	1.4	
Total	1,491	100	1,961	100	
HIV					
Yes	50	4.7	171+	10,3	
No	1,022+	95.3	1,493	89,7	<0,001
Total	1,072	100	1,664	100	
AIDS					
Yes	36	2,8	154+	8.7	
No	1269+	97,2	1619	91.3	<0.001
Total	1305	100	1773	100	
Alcoholism					
Yes	298	22.1	478+	25.8	
No	1,049+	77.9	1,376	74.2	0.017
Total	1347	100	1,854	100	
Smoking					
Yes	268	24.9	609+	33.7	
No	809+	75.1	1,197	66.3	<0.001
Total	1,077	100	1,806	100	

Source: Research data, 2025.

The search for more adequate pharmacotherapy is essential in the case of tuberculosis; however, sociocultural and immunodepressive factors can contribute to a reduction in treatment adherence (PEREIRA et al., 2022).

In this context, the use of DOT (Directly Observed Treatment) may help to increase the effectiveness of the therapeutic regimen proposed for combating tuberculosis.

Regarding gender, a positive association was observed between females and adherence to DOT, possibly due to the higher frequency with which women seek clinical services (SOUSA et al., 2021) and demonstrate greater commitment to caring for their own health. On the other hand, concerning education, no statistically significant difference was found between the study years and adherence to DOT. However, it is important to highlight that higher levels of education favor a broader understanding of the health-disease process (SOUSA et al., 2021), which can raise awareness of the importance of strategies such as DOT.

Clinically, tuberculosis can present in three forms: pulmonary, extrapulmonary, and mixed. In this study, the pulmonary form was the most prevalent (86.9%) among both DOT users and non-users, which is understandable, as the lungs are the primary site of infection caused by M. tuberculosis (SILVA et al., 2018). Extrapulmonary tuberculosis, which affects up to 15% of patients, spreads to the bloodstream and can involve the Central Nervous System, Genitourinary System, pleura, lymph nodes, among others (RODRIGUEZ-TAKEUCHI; RENJIFO; MEDINA, 2019).

HIV, in turn, is the major risk factor for the development of tuberculosis, especially in individuals with AIDS. In this context, it was observed that patients with HIV and/or AIDS are associated with lower adherence to DOT. This is not surprising, as the treatment of individuals with TB/HIV co-infection is more complex, requiring adherence to two distinct therapeutic regimens: tuberculosis treatment, which must be maintained for at least six months, and HIV treatment, which is continuous. Thus, the large number of medications to be taken daily, along with the increased risk of adverse effects, makes treatment adherence a significant challenge (LEMOS et al., 2016).

It is important to note that, according to Quintino et al. (2024), rifampicin, an antibiotic for TB, can reduce the levels of drugs such as contraceptives, painkillers, and anticoagulants, as well as increase the risk of hepatotoxicity when combined with medications like isoniazid and pyrazinamide. Rifampicin is an inducer of the CYP3A4 enzyme and accelerates the metabolism of antiretrovirals (ARVs), reducing their efficacy. In contrast, ritonavir, used in HIV treatment, inhibits these enzymes, raising the levels of anti-TB drugs and increasing the risk of toxicity. Therefore, careful management of these drug interactions is essential to avoid complications.

In addition to relevant clinical conditions, such as AIDS, unfavorable cultural habits, such as smoking and alcoholism, can reduce adherence to pharmacotherapy.

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Alcohol consumption is directly related to an increased risk of developing tuberculosis (TB). Moreover, it is evident that, in this patient group, there is a higher frequency of treatment failures, accompanied by a resurgence of morbidity and mortality (RAGAN et al., 2020). This reality was directly reflected in the present study, as patients with alcoholism were positively associated with non-use of DOT. These findings are concerning, as the clinical outcome is commonly unfavorable, with a higher likelihood of recurrences and the emergence of microbial resistance phenomena (WIGGER et al., 2022). Smoking, in turn, is directly associated with abandonment of anti-tuberculosis pharmacotherapy (CHIRINOS; MEIRELLES, 2011; SHOLZE et al., 2019). In this context, the present study found that individuals who smoke had a positive association with non-use of DOT.

Thus, it is evident that the investigated immunodepressive factors are associated with non-adherence to DOT, which contributes to increased morbidity and mortality rates (SILVA et al., 2018) and raises the need for more specific public health policies for TB patients who have other comorbidities and cultural habits that contribute to the worsening of their clinical condition.

In this sense, after understanding that cultural factors and the presence of HIV/AIDS can influence DOT use, a bivariate correlation was performed between the Human Development Index (IDHM), SUS healthcare services, and DOT users who abandoned (n=112) pharmacotherapy (Figure 1A and 1B).

Figure 1. Simple scatter plot between the abandonment rate and the Human Development Index (IDHM) (A) and the number of healthcare facilities linked to the SUS (Unified Health System) (B).
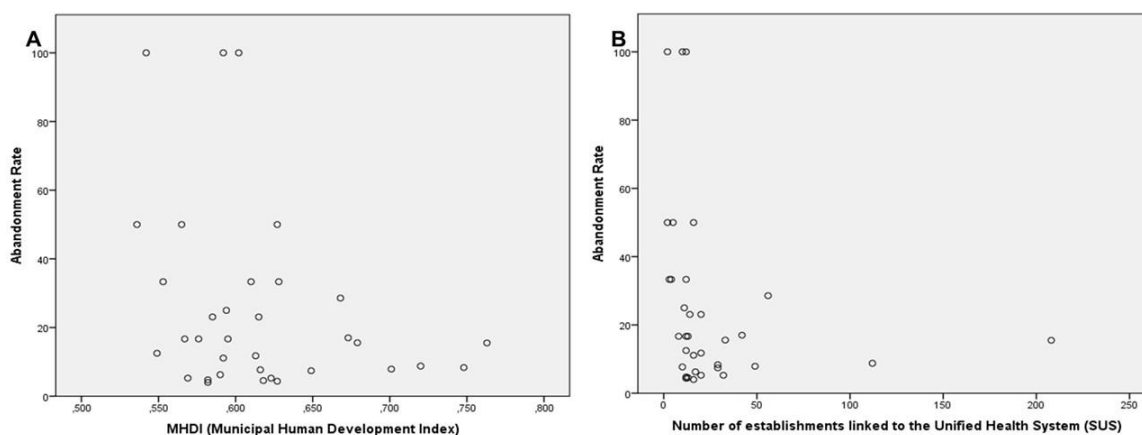

Figure 1. Simple scatter plot between the abandonment rate and the Human Development Index (IDHM) (A) and the number of healthcare facilities linked to the SUS (Unified Health System) (B).

Source: Research data, 2025.

In this context, it was observed that as the IDHM increases, the dropout rate tends to decrease. However, this correlation is weak and not statistically significant (ρ = -0.238, p = 0.175). Nonetheless, it is suggested that the higher the number of healthcare facilities, the lower the dropout rate. This correlation is stronger than that of the IDHM, indicating a more pronounced relationship between the two variables, in addition to being statistically significant (ρ = -0.443, p = 0.009).

Thus, it is evident that the presence of active healthcare services is essential for the continuity of anti-tuberculosis pharmacotherapy. Furthermore, the decentralization of healthcare facilities contributes to improving care and reaching a larger number of different populations in various Brazilian locations (SOUZA et al., 2015), emphasizing the importance of an active SUS in health promotion and protection.

5. FINAL CONSIDERATIONS

The results highlight the low adherence to DOT among tuberculosis patients in Paraíba, which may compromise treatment effectiveness and contribute to the persistence of the disease. Additionally, factors such as low education levels, socioeconomic vulnerability, and racial disparities can influence treatment adherence, reinforcing the need for intersectoral approaches in the fight against tuberculosis.

The predominance of cases among men and individuals of economically active age, as well as the presence of HIV, AIDS, smoking, and alcoholism as factors that reduce adherence to DOT, emphasize the importance of targeted strategies for these groups, considering their diversity and cultural aspects. Furthermore, healthcare services linked to the SUS contribute to strengthening the continuity of tuberculosis pharmacotherapy, enhancing the system and its decentralized approach to care delivery.

Given this scenario, it is essential to strengthen public policies that expand access to DOT, promote health education, and reduce social and structural barriers that hinder treatment. Only through integrated actions will it be possible to improve epidemiological indicators and advance tuberculosis control in Paraíba.

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