

TUBERCULOSIS TREND IN INDIGENOUS PEOPLE OF THE LEGAL AMAZON IN THE PERIOD FROM 2001-2022

ABSTRACT

Tuberculosis (TB) remains a significant public health concern among Indigenous peoples in the Legal Amazon. This study aims to describe the epidemiological characteristics and temporal trends of TB indicators within this population from 2001 to 2022. An analysis of data from the Department of Informatics of the Unified Health System (DATASUS) was conducted, including new TB cases among self-reported Indigenous individuals. Indicators were calculated, and temporal trends were analyzed using joinpoint regression. A total of 9,245 cases were registered among Indigenous residents in the Legal Amazon. Males predominated in 2001 (61.2%) and 2022 (56.8%), except in 2019, when females exceeded males (51.6% vs. 48.4%). TB detection significantly decreased between 2001 and 2022 (Average Annual Percent Change – AAPC = -2.7%; 95% Confidence Interval – CI: -3.6 to -1.7). A considerable decline in incidence was observed among Indigenous populations in Rondônia, Acre, Amazonas, and Tocantins with (Annual Percent Change – APC = -7.4%; CI: -1.0 to -4.8) (APC = -3.2%; CI: -5.4 to -0.9) (APC = -4.1%; CI: -4.9 to -3.3%), and (APC = -3.3%; CI: -5.8 to -0.7), respectively. Conversely, a significant increase occurred in Mato Grosso from 2012 to 2015 (APC = 46.6%; CI: -28.4 to 200.0). TB incidence remains high among Indigenous peoples in the Legal Amazon compared to the general population of the region and Brazil, despite declining trends between 2001 and 2022.

KEYWORDS: Public Health, Indigenous Populations' Health, Epidemiology

INTRODUCTION

Tuberculosis (TB) emerges as a critical public health problem, particularly in regions with adverse socioeconomic conditions, such as the Brazilian Amazon. This infectious disease, caused by the bacillus *Mycobacterium tuberculosis*, finds allies in poverty, malnutrition, and limited access to health services for its spread (Ferraz & Valente 2014; Welch & Coimbra Jr. 2011; WHO 2022). Indigenous populations, especially vulnerable due to specific socioeconomic and health conditions, represent a priority group in the context of TB in the Legal Amazon (Levino & Oliveira 2007; Marques et al. 2010).

Recent research highlights the high incidence of TB among Indigenous peoples in the Amazon, shedding light on both the epidemiological dimension of the disease and the challenges related to its diagnosis and treatment in these communities (Rios et al. 2013; Santos et al. 2020). The lack of adequate health infrastructure, difficulty accessing medical services, and discontinuity of treatment emerge as obstacles to TB control in these populations (Levino and Oliveira 2007; Silva et al. 2020).

The epidemiological profile of TB among Indigenous peoples reveals a predominance of the pulmonary form of the disease, with a high mortality rate and transmission mainly among men and productive age groups (Lachi & Nakayama 2015; De Faria 2020). Spatial distribution of cases and identification of high-risk areas are essential for directing intervention strategies and prevention (Ferraz & Valente 2014).

The analysis of social determinants of health, including housing conditions, education, and access to healthcare, is crucial for understanding the dynamics of TB among Indigenous populations. Studies point to a direct relationship between TB incidence and factors such as low income, poverty, and lack of education (Rios et al.,

2013; Ferraz & Valente 2014). The disparities highlighted reinforce the need for specific approaches adapted to the cultural and social realities of these communities. The trend analysis of TB in Indigenous peoples of the Legal Amazon from 2001 to 2022 underlines the importance of observing the temporal and spatial variations of the disease, which are fundamental for the planning and implementation of effective public policies (Dehghani et al., 2018; Marques et al., 2010). The integration of public health strategies that consider the specific cultural, social, and economic aspects of Indigenous populations is vital for the success of the interventions. In this context, this study aims to analyze the trend of tuberculosis in Indigenous peoples of the Legal Amazon during the period of 2001-2022, seeking to understand the epidemiological patterns of the disease in order to provide support for the development of more assertive and culturally adapted public policies for TB control in this region (Pascoal et al., 2022; Costa et al., 2022; Aguiar et al., 2023).

MATERIALS AND METHODS

The Legal Amazon, a macro-region established to promote socioeconomic development, covers approximately 5,217,423 km², representing about 61% of Brazil's area. It fully includes the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, and significant parts of Mato Grosso, Tocantins, and Maranhão. In 2022, the total population was estimated at 26.7 million, with an expressive increase of 100.7% in the Indigenous population since 2010 (IBGE 2022).

This region exhibits a complex socio-environmental fabric, with the coexistence of dense urban centers and traditional communities in inaccessible rural zones, reflecting a mosaic of social and economic indicators. This study is an ecological time series

analysis of new tuberculosis cases in Indigenous residents of the Legal Amazon from January 1, 2001, to December 31, 2022, totaling 9,278 cases.

Individuals self-identifying as Indigenous during disease notification were classified as such. Cases not presenting data or categorized as unknown in the race/color variable were not included in the analysis (IBGE 2022).

Data were obtained from the Department of Informatics of the Unified Health System (DATASUS) (Brazil 2024). These data come from compulsory notification forms, which consist of a standardized form filled out by health professionals with sociodemographic, clinical, and treatment information.

Population data were obtained from the Brazilian Institute of Geography and Statistics (IBGE), based on state census data from 2000, 2010, and 2022, and population estimates for the intercensal years (2001-2009 and 2011-2021) (IBGE 2022).

In the descriptive analysis, tuberculosis (TB) incidence coefficients were calculated for three distinct groups: Indigenous, the general population of the Legal Amazon, and the Brazilian population. Incidence coefficients were determined using the formula: number of new TB cases per specific population, multiplied by the constant 100,000. Thus, coefficients for TB incidence among Indigenous peoples in the Legal Amazon and Brazil were established.

The analysis of the Indigenous population's growth rate between the 2000 and 2010 Demographic Censuses adopted the geometric mean annual growth rate of 2.4%. For the subsequent period from 2010 to 2022, the adjusted rate was 3.0%, reflecting adjustments in demographic parameters.

These rates were crucial for estimating changes in the Indigenous population over the specified years, according to data from the Brazilian Institute of Geography and

Statistics (IBGE 2022). To determine the average incidence coefficient of tuberculosis, the arithmetic mean was employed. This was obtained by summing the annual incidence coefficients and subsequently dividing by the number of observations in the period analyzed.

The standard deviation, a measure that expresses the degree of data dispersion around the mean, was obtained through the square root of the variance, which is the average of the squares of the deviations of each observation in relation to the sample mean.

Minimum and maximum values were determined from the data set, representing the extremes of the distribution of observations. These indicators were computed to provide a comprehensive understanding of the central trends and variability of the collected data.

The proportion of tuberculosis cases by gender in the Indigenous population was calculated by dividing the new cases in men or women by the total number of cases, multiplying the result by 100. For the trend analysis of tuberculosis incidence coefficients, the segmented linear regression technique was used in the Joinpoint software version 4.2.0.

The evaluated indicators included incidence coefficients of TB in Brazil, in the Legal Amazon as a whole, in the Indigenous population of the Legal Amazon, as well as for the Indigenous population in the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, Tocantins, and Maranhão.

Additionally, incidence coefficients were calculated by age groups in the categories of 0 to 14 years, 15 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years, and 65 years or more. In the segmented linear regression analysis, the

tuberculosis (TB) incidence coefficients were considered as dependent variables, while the year of occurrence was the independent variable. The Monte Carlo permutation test was used to determine the optimal model fit, prioritizing the one with the highest coefficient of determination (R^2) for the residuals.

The analysis of trends was quantified by the Annual Percent Change (APC) and its 95% confidence interval (CI95%), considering an APC significant with $p < 0.05$ that did not include the value zero. Significant trends were interpreted as increasing (positive APC) or decreasing (negative APC), while non-significant trends were classified as stable (Kim et al. 2000; Clegg et al. 2009). Statistical analysis was conducted using Joinpoint software version 4.3.1. The nature of the secondary data used in the research allowed for exemption from evaluation by a Research Ethics Committee.

RESULTS

Between 2001 and 2022, a total of 1,597,889 new tuberculosis cases were identified among residents throughout Brazil. Specifically, in the Legal Amazon region, the number of new cases recorded in the general population was 239,983, while among the local Indigenous community, the total number of new reported cases was 9,245. According to the results shown in Table 1, the average incidence coefficient of tuberculosis was 102.51 per 100,000 inhabitants among Indigenous peoples of the Legal Amazon, which represents the highest average when compared to the incidence coefficients of the general population of the Legal Amazon and Brazil.

The standard deviation of 22.17 indicated variability in the indicator within this group, with a range from a minimum of 63.2 to a maximum of 152.1 per 100,000 inhabitants over the years evaluated. In comparison, the general population of the Legal

Amazon had a lower average incidence coefficient (42.05 per 100,000 inhabitants) and lower variability, as shown by the standard deviation of 2.92. The general population of Brazil presented the lowest average incidence, with 37.33 per 100,000 inhabitants and a slightly smaller but similar standard deviation to the general population of the Legal Amazon, suggesting a more stable incidence coefficient.

Table 1 – Tuberculosis Incidence Coefficient among Indigenous peoples of the Legal Amazon, the general population of the Legal Amazon, and the general population of Brazil, 2001-2022.

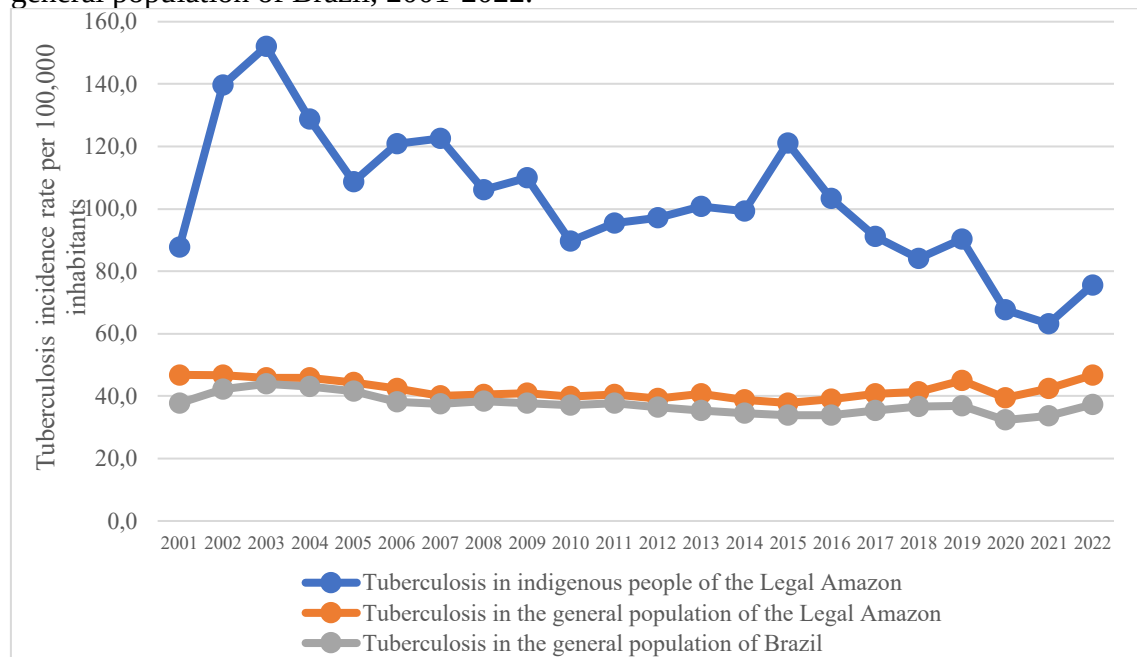
Indicators	Average	Standard Deviation	Minimum	Maximum
Indigenous peoples of the Legal Amazon	102.51	22.17	63.2	152.1
General Population of the Legal Amazon	42.05	2.92	37.8	46.8
General Population of Brazil	37.33	3.09	32.3	43.9

Source: Original creation.

Figure 1 presents the temporal evolution of the tuberculosis incidence coefficient per 100,000 inhabitants from 2001 to 2022. For the Indigenous population in the Legal Amazon, the incidence peaked in 2003 with 152.1 cases per 100,000, followed by a general declining trend reaching its lowest value of 63.2 in 2021, and an increase to 75.5 in 2022, still maintaining a hyperendemic status.

The general population of the Legal Amazon had an incidence of 46.8 cases per 100,000 inhabitants in 2022, indicating a relatively stable variation over the period. For the general population of Brazil, the incidence coefficient showed a relative stability over the years.

Figure 1 – Temporal evolution of the tuberculosis incidence coefficient in the Indigenous population of the Legal Amazon, the general population of the Legal Amazon, and the general population of Brazil, 2001-2022.



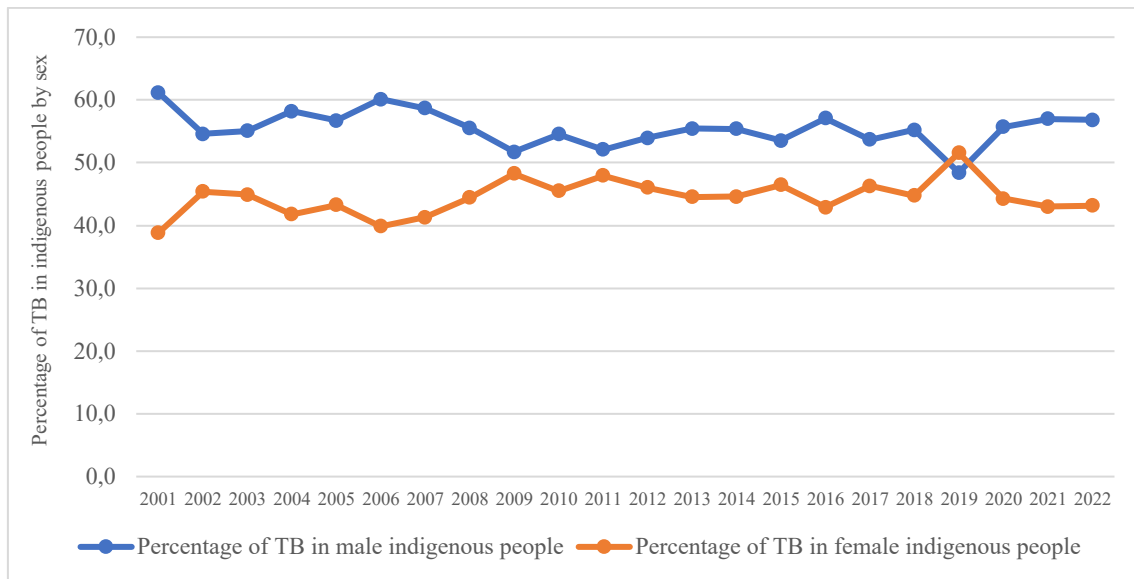
Source: Original creation.

The results presented in Figure 2 show the trend of the proportion of new TB cases among Indigenous males and females. In 2001, the proportion of Indigenous males with TB was 61.2%, compared to 38.8% among females.

Over the years, these percentages varied, with a trend of decrease for Indigenous males until 2009 and a subsequent increase for Indigenous females, culminating in a reversal of this trend in 2019 where females exceeded males in percentage terms, with 51.6% against 48.4%.

The following years show a resumption of male predominance in TB incidence, with the year 2022 registering 56.8% incidence among Indigenous males and 43.2% among females (Figure 2).

Figure 2 – Trend of the proportion of new TB cases by gender among Indigenous peoples of the Legal Amazon, 2001-2022.



Source: Original creation.

The linear joinpoint regression results between 2001 and 2022 revealed a significant declining trend in the TB incidence coefficient, with an Annual Percent Change (APC) of -1.0% (95% CI: -1.3 to -0.6). For the general population of the Legal Amazon, two distinct trends were identified. In the first period (2001 to 2015), there was a significant decrease in the TB incidence coefficient, with an APC of -3.6% (95% CI: -4.2 to -3.1). In the subsequent period from 2015 to 2022, the trend was stable, with an APC of -1.0% (95% CI: -2.4 to 0.3). The overall trend for the period from 2001 to 2022 remained significantly decreasing, with an AAPC of -2.8% (95% CI: -3.3 to -2.3). Among the Indigenous population of the Legal Amazon from 2001 to 2022, there was a significant decrease in TB incidence, with an AAPC of -2.7% (95% CI: -3.6 to -1.7) (Table 2).

In the Indigenous population of Rondônia, Acre, Amazonas, and Tocantins, there was a significant decline in the TB incidence coefficient of -7.4% (95% CI: -1.0 to -4.8), -3.2% (95% CI: -5.4 to -0.9), -4.1% (95% CI: -4.9 to -3.3), and -3.3% (95% CI: -5.8 to -0.7), respectively.

In the Indigenous population of Roraima, the TB incidence exhibited two trends: in the first period (2001- 2014), there was a significant decrease of -5.9% (95% CI: -10.1 to -1.6), and in the second period (2014 to 2022), the trend reversed to stability, with an APC of 5.7% (95% CI: -2.8 to 14.9). In Pará and Amapá, between 2001 and 2022, there was stability in the TB incidence coefficient, with an AAPC of 0.9% (95% CI: -0.8 to 2.8) and -2.4% (95% CI: -6.8 to 2.2).

In Maranhão, the TB incidence coefficient among the Indigenous population showed two trends: the first (2001 to 2003) with a non-significant increase (stability) of 69.4% (95% CI: -31.0 to 315.7), and the second (2003 to 2022) with a significant decrease of -5.7% (95% CI: -7.6 to -3.7).

In Mato Grosso, the joinpoint regression trend showed three lines: the first (2001 to 2012) with stability in the TB incidence coefficient (APC: -2.8%; 95% CI: -9.2 to 4.1). The second (2012 to 2015) saw a significant increase in TB incidence (APC: 46.6%; 95% CI: -28.4 to 200.0), and the third (2015 to 2022) with a significant declining trend (APC: -20.2%; 95% CI: -27.4 to -12.3) (Table 2).

Regarding TB trend by age groups for Indigenous individuals under 15 years in the Legal Amazon, there was a significant decrease in TB incidence from 2001 to 2012 with an APC of -6.4%, indicating a declining trend. However, from 2012 to 2015, there was an expressive although not significant increase, with an APC of 22.1%. From 2015 to 2022, the trend returned to a significant decline, with an APC of -14.2%. Over the total period, the average annual percentage change (AAPC) was -5.6%, indicating an overall declining trend in this age group's incidence.

In Indigenous individuals aged 15 to 24 years, there was a brief period of significant increase between 2001 and 2003, followed by a continuous and significant

decline from 2003 to 2022, with an APC of -2.9%. The overall trend (AAPC) for the total period was -0.3%, suggesting stability in TB incidence in this group. For the age groups of 35 to 44 years and 45 to 54 years, the analysis shows a continuous and significant decline in TB incidence throughout the entire period analyzed (2001-2022), with APCs of -1.1% and -1.7%, respectively.

Indigenous individuals aged 55 to 64 years experienced a significant decrease in TB incidence with an APC of -3.4% over the entire period, indicating a continuous and significant declining trend in TB incidence. Among Indigenous individuals aged 65 years or older, there was a trend of decline from 2001 to 2016, followed by a more significant and sharp reduction from 2016 to 2022, with an APC of -11.8%. The overall trend for this group was a significant decrease in incidence, with an AAPC of -4.3% (Table 2).

Table 2 - Tuberculosis indicators trend, according to joinpoint regression analysis, 2001-2022.

Indicators	Trend 1			Trend 2			Trend 3			Total period	
TB Incidence Coefficient	Period	APC ^b	IC ^c	Período	APC ^b	IC ^c	Period	APC ^b	IC ^c	AAPC ^d	IC ^e
Population of Brazil	2001-2022	-1,0*	-1,3 to -0,6	-	-	-	-	-	-	-1,0*	-1,3 to -0,6
Population of the Legal Amazon	2001-2015	-3,6*	-4,2 to -3,1	2015-2022	-1,0	-2,4 to 0,3	-	-	-	-2,8*	-3,3 to -2,3
Indigenous population of the Legal Amazon	2001-2022	-2,7*	-3,6 to -1,7	-	-	-	-	-	-	-2,7*	-3,6 to -1,7
Indigenous people of Rondônia	2001-2022	-7,4*	-10 to -4,8	-	-	-	-	-	-	-7,4*	-10 to -4,8
Indigenous people of Acre	2001-2022	-3,2*	-5,4 to -0,9	-	-	-	-	-	-	-3,2*	-5,4 to -0,9
Indigenous people of Amazonas	2001-2022	-4,1*	-4,9 to -3,3	-	-	-	-	-	-	-4,1*	-4,9 to -3,3

Indigenous people of Roraima	2001-2014	-5,9*	-10,1 to -1,6	2014-2022	5,7	-2,8 to 14,9	-	-	-	-1,7	-5,5 to 2,3
Indigenous people of Pará	2001-2022	0,9	-0,8 to 2,8	-	-	-	-	-	-	0,9	-0,8 to 2,8
Indigenous people of Amapá	2001-2022	-2,4	-6,8 to 2,2	-	-	-	-	-	-	-2,4	-6,8 a 2,2
Indigenous people of Tocantins	2001-2022	-3,3*	-5,8 to -0,7	-	-	-	-	-	-	-3,3*	-5,8 to -0,7
Indigenous people of Maranhão	2001-2003	69,4	-31,0 to 315,7	2003-2022	-5,7*	-7,6 to -3,7	-	-	-	-0,3	-8,1 to 8,2
Indigenous people of Mato Grosso	2001-2012	-2,8	-9,2 to 4,1	2012-2015	46,6	-28,4 to 200,0	2015-2022	-20,2*	-27,4 to -12,3	-3,5	-12,9 to 7,0
Indigenous <15 years old from the Legal Amazon	2001-2012	-6,4*	-10,6 to -2,1	2012-2015	22,1	-36,2 to 133,7	2015-2022	-14,2*	-20,9 to -7,0	-5,6	-13,8 to 3,4
Indigenous aged 15 to 24 years from the Legal Amazon	2001-2003	28,4	-19,6 to 105,3	2003-2022	-2,9*	-3,9 to -1,9	-	-	-	-0,3	-4,4 to 4,0
Indigenous aged 35 to 44 years from the Legal Amazon	2001-2022	-1,1	-2,3 to 0,2	-	-	-	-	-	-	-1,1	-2,3 to 0,2
Indigenous aged 45 to 54 years from the Legal Amazon	2001-2022	-1,7*	-2,9 to -0,5	-	-	-	-	-	-	-1,7*	-2,9 to -0,5
Indigenous aged 55 to 64 years from the Legal Amazon	2001-2022	-3,4*	-4,9 to -1,9	-	-	-	-	-	-	-3,4*	-4,9 to -1,9
Indigenous aged 65 years or older from the Legal Amazon	2001-2016	-1,2	-3,7 to 1,4	2016 - 2022	-11,8*	-20,2 to -2,5	-	-	-	-4,3*	-7,3 to -1,2

Source: Own elaboration. APC: Annual Percentage Change; AAPC: Average Annual Percentage Change; CI: 95% Confidence Interval.

* Significantly different from 0 (p < 0.005).

DISCUSSION

This study revealed a significant disparity in the tuberculosis (TB) incidence coefficient between the Indigenous population of the Legal Amazon and the general population of both the region and Brazil from 2001 to 2022. These findings align with previous studies documenting the increased vulnerability of Indigenous populations to tuberculosis, attributed to social and health determinants such as living conditions, access to healthcare, and socioeconomic factors (Smith 2017; Oliveira et al. 2018). Moreover, the observed variability in incidence coefficients among Indigenous people, indicated by

a standard deviation of 22.17, suggests heterogeneity in living conditions and risk factors within this population (Lopez et al. 2019; Martins et al. 2020).

The contrast between the high variability of tuberculosis incidence among Indigenous peoples and the lower variability seen in the general population of the Legal Amazon and Brazil suggests a greater stability in TB control outside Indigenous communities. This phenomenon may be explained by differences in public health efforts, healthcare accessibility and quality, and operational capacity (Garcia et al. 2018; Ferreira et al. 2020). The stability of incidence coefficients in the general population likely reflects the effects of more effective tuberculosis control programs and better public health infrastructure. However, the persistent and high incidence among Indigenous people points to the need for targeted approaches that consider the cultural and social specificities of these communities (Santos et al. 2022; Ferreira et al. 2020), as well as increasing operational capacity in Indigenous health districts by training professionals who make up the Indigenous health teams for safety in diagnosis and case management (Monteiro et al. 2018). Comparing our results with similar studies underscores the importance of culturally adapted public health strategies and strengthening health systems in Indigenous communities (Santos et al. 2022; Vieira et al. 2022).

Previous research has also emphasized the necessity of health interventions that extend beyond medical treatment, including improvements in living conditions and actions addressing the social determinants of health to reduce tuberculosis incidence (Almeida et al. 2020; Silva et al. 2020). Interventions must be designed in collaboration with Indigenous communities to ensure their implementation and acceptance, reinforcing the importance of including traditional knowledge in the fight against tuberculosis (Costa et al. 2021; Pereira et al. 2022).

The trend variation in the proportion of tuberculosis (TB) cases between Indigenous males and females in the Legal Amazon from 2001 to 2022 reflects significant gender-related differences in healthcare access and risk behaviors. The observed decrease in cases among males until 2009, followed by an increase among females, culminating in a reversal in 2019, highlights the need to consider biological, behavioral, and socioeconomic factors in TB epidemiology (Gomes 2017; Pereira et al. 2018; Silva et al. 2019), but also indicates that women are sensitive to seeking health services and caring for their health (Monteiro et al. 2018). This dynamic suggests that public health interventions, changes in health-seeking patterns, and shifts in social determinants can influence TB incidence by gender, underlining the need for adapted control strategies that account for these differences (Almeida et al. 2020; Costa et al. 2021; Oliveira et al. 2022).

The joinpoint regression analysis results for TB incidence from 2001 to 2022 in the Legal Amazon and specifically among Indigenous populations reveal varied trends, indicating an overall decline but with significant regional variations. The general declining trend in TB incidence in the Legal Amazon and among Indigenous populations, with an Average Annual Percent Change (AAPC) of -2.8% and -2.7% respectively, suggests progress in combating TB in these areas. This decrease may reflect the effectiveness of TB control strategies, improvements in healthcare access and quality, as shown in previous studies (Garcia et al. 2017; Lopez et al. 2018). However, the presence of distinct trends, such as the trend reversal to stability in Roraima in the more recent period and the significant increase followed by a decline in Mato Grosso, highlights the complexity of TB control and the influence of specific regional factors, including healthcare accessibility, population mobility, and socioeconomic determinants (Martins et al. 2019; Silva et al. 2020).

The stability and variations in TB incidence trends in states like Pará, Amapá, and the distinct phases in Roraima and Mato Grosso underscore the importance of locally adapted control strategies and the need for continuous surveillance. These findings align with literature pointing to the heterogeneity of TB epidemiology among Indigenous populations and the need for integrated approaches that consider cultural, social, and public health factors (Costa et al. 2021; Pereira et al. 2022). The reversal to stability in Roraima and the temporary increase pattern in Mato Grosso draw attention to the challenges in sustaining progress in TB control and the importance of investigating and addressing the underlying causes of these variations, including specific risk factors such as genetics and susceptibility, the coverage and effects of public health interventions, and changes in the socioeconomic context (Oliveira et al. 2021; Santos et al. 2022).

The disparity in TB incidence is particularly evident when considering different age groups. The declining trends of TB in Indigenous individuals under 15 years of age in the Legal Amazon across different time segments can be attributed to increased access to culturally adapted Indigenous health teams, expanded BCG vaccination, active TB screening in high-risk communities, and prophylaxis for exposed Indigenous individuals, thereby contributing to the reduction in TB incidence in this group (Newton et al. 2008; Graham 2011; Gava et al. 2013). However, the stability of incidence found over the total period reports that vigilance is needed as TB diagnosis in children presents significant challenges due to the nonspecific nature of symptoms and difficulties in obtaining bacteriological confirmation, especially in children under ten years where sputum collection and false-negative results are common (Perez & Marais 2012). In response, the Ministry of Health adopts a diagnostic system based on scoring, considering clinical and epidemiological aspects, which has shown validity and accuracy. Epidemiological

analyses indicate marked discrepancies in TB incidence among children and adolescents, especially in specific regions of Brazil, with alarmingly high rates among the Indigenous population, reflecting social inequalities and difficulties in accessing diagnosis and treatment (Gava et al. 2013). The lack of conclusive diagnostic data and inadequacy in complementary examinations highlight barriers to healthcare access. Additionally, the improper implementation of management strategies such as directly observed treatment may exacerbate risks of abandonment and death during treatment, underscoring the urgent need to strengthen TB control and management measures in primary care settings and among vulnerable populations (Viana et. 2019).

Indigenous youth, particularly in the 15 to 24 years and 35 to 54 years age groups, face increased vulnerability to TB, reflecting socioeconomic factors and limited access to effective healthcare services (Viana et al. 2021). However, in this study, these groups demonstrated an overall trend of stability in TB incidence, possibly due to targeted health interventions and the reduction of barriers to diagnosis compared to the group of children under 15 years.

Among older Indigenous individuals, in age groups between 55 to 64 years and those aged 65 years or more, the significant decrease in TB incidence might reflect a combination of factors including possibly greater acquired immunity over a lifetime and the long-term accrued benefit of health interventions (Basta et al. 2004; Levino & Oliveira 2007). This age group may also benefit from greater disease knowledge and health practices that protect against TB compared to younger generations.

One of the primary limitations of this study lies in the use of secondary data for analyzing tuberculosis (TB) incidence among the Indigenous population of the Legal Amazon. While these data provide a comprehensive overview of trends over time, they

may be subject to underreporting or variations in recording quality, which could affect the accuracy of results. Additionally, the lack of detailed information on individual risk factors, socioeconomic conditions, and access to health services limits the ability to fully understand the underlying causes of the observed trends. Future research should focus on collecting primary data, conducting qualitative assessments of health determinants, and exploring specific genetic and susceptibility factors among Indigenous populations to provide deeper insights into prevention and control strategies.

CONCLUSIONS

This study underscores a significant decrease in tuberculosis incidence among the Indigenous population of the Legal Amazon from 2001 to 2022, highlighting advancements in disease control. However, the persistent disparity in TB incidence between Indigenous peoples and the general population, along with observed regional variability, emphasizes the need for more targeted and culturally sensitive public health approaches. Future strategies should focus on improving healthcare access, integrating traditional practices into TB management, and adapting interventions to the specificities of each community. This study reinforces the importance of continuing efforts to reduce the TB incidence coefficient among Indigenous populations through an integrated approach addressing both social determinants of health and specific population risk factors.

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