

Original Article

Social inequalities associated with the onset of tuberculosis in disease-prone territories in a city from northeastern Brazil

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Abstract

Introduction: Tuberculosis remains a major health problem worldwide, killing thousand adults and children every year mainly in developing countries as Brazil. The disease is socially determined, caused mainly by inequalities as overcrowding, bad conditions of housing, unemployment, and limited access to health care. The aim of this study was to identify the social inequalities associated with the onset of tuberculosis in disease-prone territories in a city from the Northeast.

Methodology: This was an ecological study, which has gathered patients diagnosed with tuberculosis through secondary data source in a city from the northeast of Brazil. The GAMLSS statistical model has been applied considering as response variable the count of Tuberculosis cases and the independent variable, the social conditions. The double Poisson distribution was considered in the analysis. The best model fitted was selected according the Akaike information criterion value. For all tests, the p value < 0.05 was considered as statistically significant.

Results: 460 patients with diagnosis of tuberculosis were identified, which represents an incidence of 36.3 cases/100,000 in males and 20.7 cases/100,000 in females. Regarding social inequality associated with tuberculosis, income (households with per capita income between 1/8 and 3 minimum wages), gender and age (Proportion of males under 15 years of age) were associated with the disease.

Conclusions: The findings evidenced the social determinants associated with tuberculosis, with a greater occurrence of the disease in areas with mostly male children and low-income families, these issues must be managed within and beyond the health sector, which is mandatory for the Tuberculosis elimination.

Key words: Tuberculosis; public health; social determinants of health; social inequality.

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Introduction

Tuberculosis (TB) has been present in humanity for approximately 8,000 years, being considered a serious but curable disease. Regarding the global epidemiological panorama, it is still seen as a serious worldwide public health problem, strongly related to poverty, poor income distribution, lack of social opportunities, civil wars, immigration, austerity policies and the absence of affirmative and social protection policies [1]. Practically one third of the global population is infected and the chance of becoming ill in the contexts highlighted above is considerably high [2].

In the Region of the Americas, TB represents the second greatest cause of death from a single infectious agent [3], with Brazil being one of the main countries responsible for the dimension of the disease on this

continent. Furthermore, it is currently the most lethal infectious disease, and its persistence is due in large part to the serious inequalities and inequities present in the Americas [4].

It should be emphasized that the proportion of people in extreme poverty is increasing in Latin America, with 62 million living in extreme poverty (10.2% of the population), according to data from the Pan American Health Organization (PAHO), report of 2018, which leads to worsening health indicators and persistence of the disease in this scenario [4]. Overcoming TB implies an accurate view of living conditions, the modes of production and social reproduction in the territories, as well as the social determinants.

The epidemiology of tuberculosis is influenced by geographical and social factors. The social and

economic dimensions of a country are based on the health, the level of education and the standard of living of the population in general [5]. Therefore, the Social Determinants of Health (SDH) are understood as socioeconomic, cultural, ethnic-racial, psychological, environmental and behavioral factors that influence the occurrence of health problems and their risk factors in the population. These factors include age, sex, lifestyle, access to information, availability and supply of food and access to essential services, such as health and education, among others [6].

It is from this scenario of inequalities that various policies have been implemented by the World Health Organization (WHO) in order to tackle the problem of TB. In 2014, the WHO, in line with the Sustainable Development Goals, established the End TB strategy, which aims to reduce 95% of mortality and 90% of the incidence of tuberculosis by the year 2035 and end epidemics of the disease by 2050 [6].

Corroborating this strategy, studies show that TB is determined more by the social and cultural context in which people live than by the patient's clinical determinants, with disparities in terms of the distribution of resources increasing the chances of risk of illness and similarly affecting the prognosis. More remote areas tend to concentrate more deficient services in terms of diagnosis and quality of treatment, with there still being great difficulty in developing Directly Observed Treatment (DOT) [7].

Despite the advances in relation to TB, there are still gaps in knowledge about the influence of SDH in hyper-endemic or critical areas, which may present important specificities regarding the determinants of TB. There are few studies with this theme in the Northeast from Brazil, where the TB incidence in 2019 was 86 cases/100,000 people (in the country, the incidence was 36 cases / 100,000 people) and mortality 2.4 deaths / 100,000 people, which reveals the magnitude of the disease and importance for studying TB and its determinants in this scenario [8].

The evidence obtained from the study may impact in TB prevention and treatment, since it contributes to understand the dynamic and impact of the disease in socially vulnerable areas. Therefore, the aim of this study was to identify the social inequalities associated with the onset of tuberculosis in disease-prone territories in a city from northeastern Brazil.

Methodology

Study design and setting

This was an ecological study [9], which, according to authors, is a very useful type of study, especially

considering epidemiology, for identifying vulnerable populations and raising hypotheses about TB [9,10]. It was conducted in the city of Imperatriz, located in the state of Maranhão, in the northeast region of Brazil. The city is considered one of the priority municipalities for tuberculosis control, being one of the eight priority municipalities in Maranhão, justifying the development of studies.

According to data from the Brazilian Institute of Geography and Statistics (IBGE), Imperatriz has an estimated population of 258,016 inhabitants, with a demographic density of 180.79 inhabitants per km² and a territorial area of 1,368.988 km [11].

Regarding socioeconomic indicators, the city has an illiteracy rate of 9.7%, life expectancy at birth of 73.2 years, Human Development Index (HDI) of 0.73, social exclusion index of 0.6, incidence of poverty of 55.28% and Gini Index of 0.46. Considering basic sanitation, 23.0% of the city has a sewage network and 86.0% a supply of drinking water [11].

Regarding to the protocol for diagnosing tuberculosis, this is based on clinical criteria, a bacteriological confirmation, either by microscopy or Xpert MTB/RIF assay and X-Ray (when the clinical form is pulmonary tuberculosis) [12]. In case of a positive diagnosis and if the patients have never been treated previously and are sensitive to the drugs, the medicines most commonly used for treatment include isoniazid, rifampicin, ethambutol and pyrazinamide. The duration of treatment is six months and preferably patients are followed up on an outpatient basis [12].

Study population

The study population consisted of patients diagnosed with TB notified between 2013 and 2018 that were residing in an urban area of the municipality. Exclusion criteria were cases in which the addresses were located in rural areas and cases without addresses or with incomplete addresses.

Source of information and study variables

The Notifiable Disease Information System (SINAN) was used as the data source. The explanatory variables selected for the study, obtained from the Demographic Census, were related to income, housing conditions and number of people living in the household.

Observation unit

The urban census tracts of the municipality of Imperatriz were defined as the unit of analysis. A census tract is the smallest territorial unit, formed by a

continuous area, entirely contained in an urban or rural area [11].

Selection of variables and theoretical framework

Variables were collected to characterize these units considering the SDH theoretical framework. Accordingly, data from the 2010 demographic census, prepared by the IBGE, were used. The explanatory variables selected for this study are presented in Table 1.

Analysis plan

First, the collected cases were geocoded from the residential addresses registered in the case notification form in the SINAN. The respective latitudes and longitudes of these addresses were acquired using the Google Earth® free program. Then, point maps were drawn up to identify which census tract the individual

inhabited at the time of diagnosis. Considering this geographical information, case counts were carried out for the period from 2013 to 2018 per unit of analysis of the study, that is, census tracts, forming the dependent variable of this study.

To analyze the association of SDH with the occurrence of tuberculosis, the Generalized additive models for location, scale and shape (GAMLSS) was used. This is considered a semi-parametric regression model, given the need for a parametric distribution for the response variable, while it can concomitantly assume that the explanatory variables have non-parametric smoothing functions [13].

The analytical flexibility provided in this regression model gains even more breadth due to the wide range of families of probability distributions available and the possibility of up to four different parameters to model

Table 1. Explanatory variables used in the analyses, Imperatriz - MA, Brazil, 2013 – 2018.

Explanatory variables	Variable type
Private households with per capita household monthly nominal income of up to 1/8 of the minimum wage	Variable related to household income
Private households with per capita household monthly nominal income of between 1/8 and 1/4 of the minimum wage	
Private households with per capita household monthly nominal income of between 1/4 and 1/2 of the minimum wage	
Private households with per capita household monthly nominal income of between 1/2 and 1 minimum wage	
Private households with per capita household monthly nominal income of between 1 and 2 minimum wages	
Private households with per capita household monthly nominal income of between 2 and 3 minimum wages	
Private households with per capita household monthly nominal income of between 3 and 5 minimum wages	
Private households with per capita household monthly nominal income of between 5 and 10 minimum wages	
Private households with per capita household monthly nominal income of more than 10 minimum wages	
Private households with no per capita household monthly nominal income	Variable related to residents' access to urban infrastructure services
Residents in permanent private households with water supply from the general system	
Residents in permanent private households with water supply from a well of spring on the property	
Residents in permanent private households with water supply from rain stored in a cistern	
Residents in permanent private households with a bathroom for the exclusive use of the residents or a toilet and sewage connected to the general sewage or rainwater drainage system	
Residents in permanent private households with a bathroom for the exclusive use of the residents or a toilet and sewage connected to a septic tank	
Residents in permanent private homes with a bathroom for the exclusive use of residents or a toilet and sewage connected to a rudimentary cesspit	
Residents in permanent private households with a bathroom for the exclusive use of the residents or a toilet and sewage connected to a ditch	
Residents in permanent private households with a bathroom for the exclusive use of the residents or a toilet and sewage connected to a river, lake or the sea	
Residents in permanent private households with a bathroom for the exclusive use of the residents or a toilet and sewage connected to another drain	Variable related to the number of residents per household
Permanent private households with 1 resident	
Permanent private households with 2 residents	
Permanent private households with 3 residents	
Permanent private households with 4 residents	
Permanent private households with 5 residents	
Permanent private households with 6 residents	
Permanent private households with 7 residents	
Permanent private households with 8 residents	
Permanent private households with 9 residents	
Permanent private households with 10 or more residents	

the dependent variable, which allows for better fits to different data sets [14].

The dependent variable considered was of the discrete type, that is, the count of TB cases that occurred in each of the 218 urban census tracts in the municipality of Imperatriz during the stipulated period. In order to identify the best probability distribution for the case count, all families for the count available in the GAMLSS were tested, with the final marginal distribution chosen, being the one selected by the lowest Akaike information criterion (AIC) value with penalty $k = 2$ [13].

Therefore, Double Poisson distribution was selected, which is a special case of the double exponential family [15] that comprises two parameters of analysis, μ and σ , both having the log link function. This distribution can model a Poisson with underdispersion (if $\sigma < 1$), overdispersion (if $\sigma > 1$) or a distribution relatively similar to Poisson (if $\sigma = 1$) [15].

After identifying the best probability distribution, two statistical modeling paths were chosen in order to maximize the scope of variables possibly associated with TB. The first consisted of using the explanatory variables, as seen in Table 1, in a multivariate model.

The second approach can be summarized as analyzing the explanatory variables related to income and number of residents per household in a univariate

manner with the mean number of TB cases (parameter μ), in order to identify their relationship coefficient values with this response variable, and from there, grouping these considering the positive or negative effects.

After elaborating these new explanatory variables, another multivariate model was performed. For both options, the stepwise method was used for the selection of variables, considering the AIC values as the best model criterion. The diagnosis of the best model to be used was carried out by verifying the normality of the residuals using the Kolmogorov-Smirnov test, together with the presentation of the residuals (normalized quantile) in the following graphic forms: residuals in relation to the fitted values of μ ; residuals in relation to the index or the values of the dependent variable; estimation of the kernel density of the residuals; and QQ-plot of normality of the residuals. Type I error was set at 0.05 as statistically significant ($p < 0.05$).

The study was approved by the Research Ethics Committee of the College of Nursing of the University of São Paulo at Ribeirão Preto Campus, No. 3.178.950 of 03/01/2019, and followed the ethical recommendations of the National Health Council, according to Resolution 466/12.

Table 2. Sociodemographic and clinical-epidemiological characteristics of the tuberculosis cases and respective rates per 100 thousand inhabitants, Imperatriz - MA, Brazil, 2013 – 2018.

	Variable	n (%)	Rates (100,000 inhabitants)
Sex	Male	260 (62.0)	36.3
	Female	160 (38.0)	20.7
Race	White	95 (22.6)	20.9
	Black	52 (12.3)	43.0
	Yellow	10 (2.3)	53.9
	Mixed	263 (62.6)	29.6
	< 14	17 (4.0)	4.23
Age group (years)	15-59	328 (78.0)	34.1
	> 60	75 (17.8)	61.3
	Tuberculosis form	Pulmonary	368 (87.6)
Extrapulmonary		42 (10.0)	2.82
Pulmonary and extrapulmonary		10 (2.4)	0.67
Entry treatment	New case	374 (89.0)	25.1
	Relapse	23 (5.4)	1.54
	Abandonment re-entry	5 (1.1)	0.33
	Transfer	18 (4.2)	1.21
	Closing situation	Cure	342 (81.4)
Abandonment		7 (1.6)	0.47
Death from tuberculosis		1 (0.2)	0.06
Death from other causes		15 (3.6)	0.87
Transfer		9 (2.1)	0.60
Diagnostic change		8 (2.0)	0.47
Drug-resistant tuberculosis		4 (0.9)	0.26
Primary dropout		1 (0.2)	0.06
Not registered/evaluated		34 (8.0)	2.42

Ethical approval

The study was approved by the Research Ethics Committee of the College of Nursing at Ribeirão Preto - University of São Paulo.

Results

Demographics

The majority of reported cases were male (260; 62.0%), aged 15 to 59 years, (328; 78.0%) and of mixed race (263; 62.6%). Regarding the clinical form of the disease, the majority were pulmonary (368; 87.6%), with new cases (374; 89.0%) that progressed to cure (342; 81.4%) (Table 2). A total of 14 cases out of 434 were disregarded due to incomplete addresses, 8 of which did not include the residence number (2.0%) and six cases with a blank address (1.3%). In total, 420 cases were georeferenced, which corresponds to 97.0% of the cases. From this geocoding, TB case counts were carried out by urban census tracts in the municipality, the variable of interest in the present study.

Explanatory models

Regression model 1 presented the results observed in Table 3; for the parameter related to the mean (μ), only the per capita income between ½ and 1 minimum wage variable remained in the final model, having a direct effect on the TB cases, that is, an increase in the number of households with this income in the urban

census tracts of the municipality resulted in a higher mean number of cases of the disease.

For the variance (σ), of the four variables that remained in the explanatory model, two were associated with TB cases, with the proportion of males under the age of 15 years in the census tracts, which presented a positive ratio coefficient, and the proportion of men between the ages of 15 and 59 years, which showed an inverse or negative relationship with the variance of cases in the census tracts. Accordingly, the variance or dispersion of the data decreased when there was a greater proportion of men between 15 and 59 years old and increased when a greater proportion of young men found in the analysis units of the study (Figure 1).

For the second explanatory model, the variables related to income and the number of residents per household, were analyzed in a univariate way for the parameter μ , that is, through the mean, with the results of the coefficients found presented in Table 3. Those that presented positive coefficients in the sequence of progression of the variable category were added, resulting in a more comprehensive classification of the census tracts of the municipality analyzed. These independent variables were inserted in explanatory model 2, which can be seen in Table 4.

In explanatory model 2, there was an improvement in the AIC value compared to model 1. This probably occurred due to the inclusion of the variable referring to household income between 1/8 and 3 minimum wages.

Table 3. Explanatory model 1 considering the parameters of mean and variance in the number of tuberculosis cases, Imperatriz - MA, 2013-2018.

Explanatory model 1	Coefficient	p value
μ coefficients		
Households with per capita household monthly income between ½ and 1 minimum wage	0.005	> 0.010*
σ coefficients		
Households with per capita household monthly income between 5 and 10 minimum wages	-0.025	0.156
Proportion of males under 15 years of age	6.308	0.045*
Proportion of males between 15 and 59 years of age	-16.827	0.025*
Households with per capita household monthly income between 3 and 5 minimum wages	0.027	0.145

AIC value 769.22; *statistical significance ($p < 0.05$).

Table 4. Explanatory model 2 considering the parameters of mean and variance in the number of tuberculosis cases, Imperatriz - MA, 2013-2018.

Explanatory variables	Coefficient	p value
μ coefficients		
Households with per capita household monthly income between 1/8 and 3 minimum wages	0.002	> 0.010*
σ coefficients		
Households with per capita household monthly income between 5 and 10 minimum wages	-0.024	0.182
Proportion of males under 15 years of age	6.490	0.042*
Proportion of males between 15 and 59 years of age	-15.622	0.045*
Households with per capita household monthly income between 3 and 5 minimum wages	-0.030	0.101
Households with sewage connected to river, lake or sea	-0.012	0.086

AIC value 767.75; *statistical significance ($p < 0.05$).

This variable showed a positive relationship with TB cases in the municipality (parameter μ), representing the fact that the increase in the number of inhabitants with this income characteristic in the urban census tracts results in a higher mean number of cases of the disease in the unit of analysis in question. Regarding the variance (parameter σ), model 2 maintained the same variables as model 1, therefore there were no changes in the final result (Figure 2).

The diagnosis of the residuals of models 1 (Figure 1) and 2 (Figure 2) showed a good fit to the dependent variable, not violating the statistical precepts of regression, with little correlation between them, mean close to zero, homoscedasticity and normal distribution.

Discussion

The aim of this study was to identify the social inequalities associated with the onset of tuberculosis in disease-prone territories in a city from northeastern

Figure 1. Summary of randomized residual quartiles: mean = -0.004; variance = 1.039; Kolmogorov-Smirnov test: D = 0.039 ($p = 0.896$).

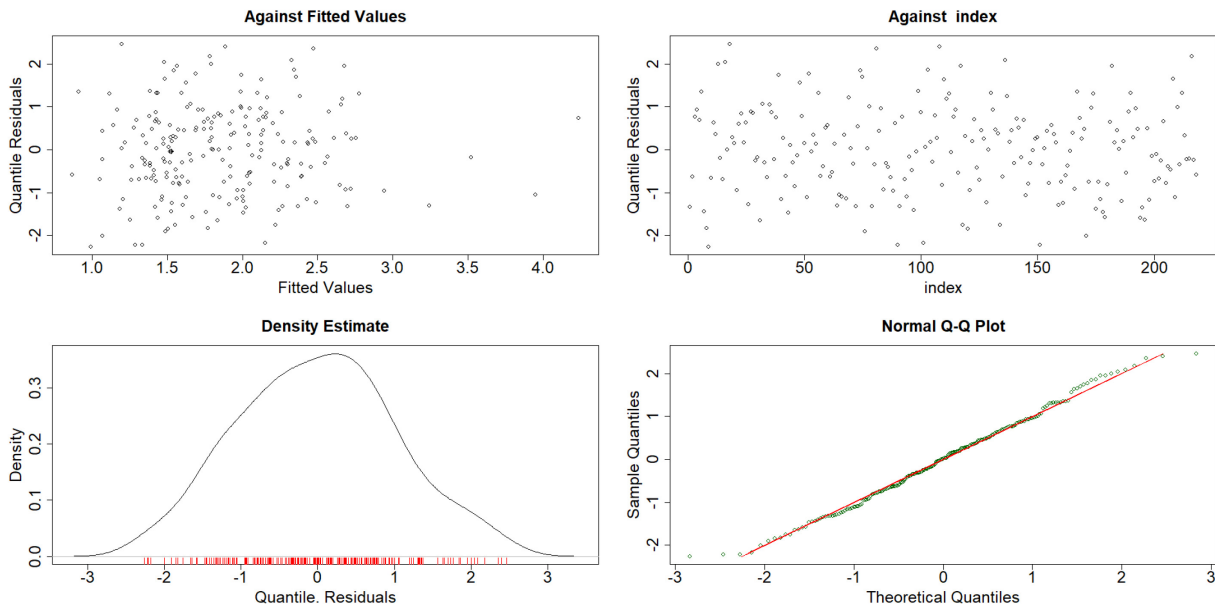
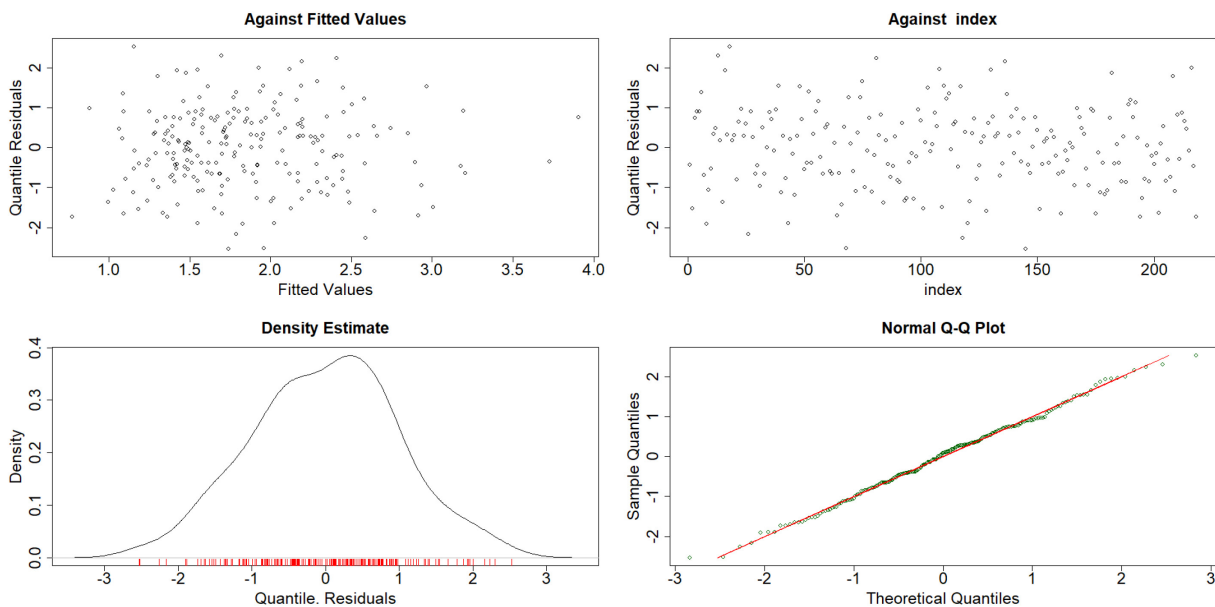


Figure 2. Summary of randomized residual quartiles: mean = -0.002; variance = 0.978; Kolmogorov-Smirnov test: D = 0.039 ($p = 0.888$).



Brazil. In the analysis of the results, it was observed that income was a factor related to the onset of the disease, with great heterogeneity in the distribution of cases. It was observed that the TB situation did not apply uniformly in the different groups and or communities in the study scenario. Therefore, it is understood that studying the inequalities of TB means identifying the value of this dimension for the people that live in situations of vulnerability, with an absence of or weakness in strategic policies or actions related to the social determinants, where it is likely that this scenario will remain unchanged [16].

The variables related to income showed statistical significance for the study, according to the modeling conformed from the results. In addition, the male gender and the age group from 15 to 59 years represented the majority of TB cases in the municipality. Therefore, from the statistical analysis, an intimate relationship between the disease and the socioeconomic conditions of the residents can be perceived. Accordingly, the lower the income, the greater the conditions that generate poverty, therefore, being from less favored social classes equates to a higher probability of developing TB. In this context, different studies show the association between TB infection and belonging to a medium/low social class [6,17].

The discussion of this aspect provokes the reflection on the need to guarantee access of these populations to social protection policies, since it can be identified that certain social groups, with less purchasing power, have less power to confront inequalities related to finance, housing, work, basic sanitation and also few resources to face social stress, aspects that contribute to increase the risks of illness due to tuberculosis [18,19].

Studies report that low socioeconomic status, as well as a lack of social support, can directly influence the occurrence of new TB cases or, once infected, can interfere with the quality of life of these patients, as well as the success or failure of the treatment [19]. The scientific literature shows that areas with great deprivation of socioeconomic conditions concentrate a greater number of people with lower quality of life, that are more susceptible to depression, drug abuse and violence [20]. In view of this, authors recommend that where there are disadvantaged social contexts, particularly in areas of precarious housing, high unemployment and low income, public policies aimed at encouraging sports, recreation and other mechanisms to alleviate social stress should be promoted, as well as actions aimed at improving the social and health

conditions of the territories. From the perspective of health surveillance, the search for respiratory symptoms is also recommended for the early diagnosis of tuberculosis, as the worsening of social and economic conditions results in significant degradation of living conditions, increasing the possibility of individual vulnerability and, consequently, the risk of becoming ill due to the disease [21,22].

A study carried out in China, showed that in economically developed areas there was a reduction in the incidence of new TB cases and in the success of the treatment, when compared to economically underdeveloped areas [23].

Considering the clinical-individual aspects, people living in areas with social underdevelopment are more likely to contract tuberculosis, especially when infected with HIV or sick with AIDS, using drugs and alcohol or having mental illnesses [23]. Corroborating this discussion, researchers have found that there is a reduction in the incidence of tuberculosis when associated with higher per capita income, improved basic sanitation, and increased early detection of new TB cases [24].

Accordingly, the social determinants of health should not be neglected when discussing processes of illness due to TB, as they promote or reinforce inequalities, inequities and social exclusion in the different social strata present in society [25].

Inequality in the context of illness due to tuberculosis is, therefore, determined by the unequal distribution of income, education, good nutrition, adequate housing, satisfactory environmental conditions, access to employment and cultural barriers to health care, among other aspects. Studies reinforce, therefore, that unequal social conditions facilitate the transmission of TB in the community [6,16,24].

The greater occurrence of TB in people in situations of social vulnerability, especially individuals with low income, has also been identified in other studies [24-27]. It is, therefore, important to know the areas with the highest number of tuberculosis cases and the social and economic surroundings involved, considering that this information can be used by public managers in planning actions and strategies for prevention, early diagnosis or better monitoring of the treatment of the disease, as well as for improving the socio-sanitary and economic conditions of these populations.

These results are important, since they may guide public managers in the implementation or inclusion of these people or families in social protection programs, such as the *Bolsa Família* Program. Social protection programs can effectively contribute to reduce or

eliminate TB [16] and some recent data have revealed positive impacts, direct or indirect, on improving cases and treatment outcomes for these people, especially among the poorest individuals [28-30].

The *Bolsa Família* Program was implemented in the country in 2004 and currently assists approximately 21% of the Brazilian population, through direct income transfer to poor and extremely poor families, according to the fulfillment of certain health and education conditions [31].

In another study, it was demonstrated that the program can effectively contribute to the achievement of the goals of eliminating tuberculosis, with a view to improving the indicators of cure, abandonment and deaths associated with the disease [28].

The positive effects of reducing tuberculosis cases are added to expanding access to education, reducing unemployment, long-term economic growth and expanding access to health services [29]. A study revealed that sectorally the actions may not be effective, as despite identifying a reduction in tuberculosis cases since the implementation of the Stop TB strategy (2006), the reduction of TB is still incipient, as the disease is related to the presence of poverty, inequity and social exclusion, in addition to disorderly and increasing urbanization. These aspects generate living conditions and circumstances favorable for the transmission of TB, regardless of the disease control measures implemented [32].

It was also observed that the predominance of TB cases was in men and in the economically active age group. These findings corroborate studies that revealed this association [21] both in Brazil [17,29,33-35] and worldwide [16,35]. Likewise, the study is in line with the literature, which reveals that the pulmonary clinical form is the most prevalent [16,33,34].

The findings of the present study reinforce the evidence that the population most affected by the disease is formed by people with difficulties in accessing health services and, therefore, with less access to rights [36]. The issue of care and TB has already been widely covered in the literature, including from which perspective the diagnosis, treatment, follow-up should be conducted. Models of care production that place the person at the center of the care should be taken as the reference, moving away from the medical-individual approach, which places the territory and its needs as the *locus* of practice and intervention.

Therefore, studies that investigate the comprehension of this territory, contribute significantly to the construction and adoption of more extensive affirmative policies and actions, for the correction of

injustices and the production of equity [37]. Accordingly, when the care is based on the individual, the chance of new episodes is higher, however, when it transcends to the collective, its impact is much greater, because on this scale, it has the strength to subsidize policies and modify contexts. It is relevant to mention that the concept of territory is not restricted to the geographical and physical aspects, but is overall a changing process, with operational and relational strength, so the community that comprises it has great strength to reconstruct it based on their wishes and projects [38].

Therefore, studies with this focus contribute significantly to this process of construction and reconstruction. The methodological resources applied in this study proved to be efficient for comprehending the modes of production and social reproduction in these territories, translated through income, education, occupation and material conditions.

The findings have confirmed the determinants of the onset of tuberculosis in disease-prone territories, however it is important also to discuss regarding the available technologies and action for TB control in these areas. Diagnosing cases early mainly through active case finding and screening of symptomatic respiratory (cough more than two weeks) are the main strategy to face the disease and interrupt the transmission cycle in the vulnerable communities. Beyond that, the identification TB latent, either Tuberculin Skin Test or quantiferon-TB Gold test, among the vulnerable groups are really important mainly those who are contact in an index case [12].

The isoniazid preventive therapy for nine months has been recommended in case of TB latent, currently in people living with HIV, cohabiting newborn or children under five years old of bacilliferous index case, however the patients 'compliance to the regime prescribed are a great challenge in Brazil [12].

Bacillus Calmette–Guérin (BCG) vaccine is also other important strategy to protect against the serious forms of TB, specifically during the babyhood - first year of life [12]. However, this vaccine has no lasting effectiveness and does not prevent the illness from tuberculosis in the adulthood, reason why some actions addressed to the promotion of health and disease prevention must be emphasized mainly in vulnerable areas [12]. In the northeast the coverage of BCG is lower than 90% [39]. The programs of the education in health might be mobilized was well campaign to raise awareness of the communities on the issue of TB, which is a disease that has diagnosis and treatment, being

therefore a curable disease and where exactly to seek the care.

With regard to the limitations of the study, aspects related to the characteristic bias of ecological studies should be mentioned, in which the findings of this investigation cannot be inferred casuistically for the individual level, being only representative for the populations. In addition, the acquisition of information through secondary data can lead to errors inherent in the notification or input of the data and possible bias in the investigation, such as, for example, underreporting.

The findings of this study showed the problem of TB in the hyper-endemic municipality, which until then, had not used statistical resources as a tool to identify factors related to the occurrence of the disease.

Conclusions

Through the analyses used, it was possible to establish the relationship between the SDH and the occurrence of TB in the municipality in question. The results evidence the need to do more than is currently being done to control tuberculosis, aiming for the elimination of social inequalities, without compromising the continuous efforts directed towards the proximal determinants, especially those that influence access to quality healthcare. These TB prevention and control initiatives must target the fundamental causes of the disease, that is, its social determinants.

It is considered that well-founded social policies, centered on equity in health, aimed at the most disadvantaged and vulnerable groups, combined with actions of a more interdisciplinary nature with widespread innovation, could have a favorable impact on TB control, not only at the local level, but also at the national and global levels.

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Authors' contributions

All authors have seen and approved the content of the manuscript and have contributed significantly to the work.

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