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The Porto Alegre paradox: social determinants and tuberculosis incidence

O paradoxo de Porto Alegre: os determinantes sociais e a incidência da tuberculose

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ABSTRACT: ***Introduction:*** The incidence of tuberculosis (TB) is strongly associated with social and economic factors. The city of Porto Alegre, in the South of Brazil, has one of the highest Human Development Index and Gross Domestic Product per capita of the country. One would expect that the incidence of tuberculosis in such a place were low. However, the city has very high rates of incidence, the highest among Brazilian capitals. This paradox prompted this work, whose objectives were to analyze the spatial distribution of the incidence rate of bacilliferous pulmonary tuberculosis throughout the neighborhoods of Porto Alegre and its association with socioeconomic indicators. ***Methods:*** Ecological non-concurrent cohort study. The units of analysis were the neighborhoods of the city. The average annual incidence of bacilliferous pulmonary tuberculosis for the period 2000 to 2005 and seven socioeconomic variables were analyzed, with information obtained from the IBGE and the Mortality Information System. Spatial techniques and multivariate analyzes were used to check associations. Inequalities were also measured. ***Results:*** The spatial distribution of the incidence rate of bacilliferous pulmonary tuberculosis is very similar, i.e., associated with the distribution of socioeconomic factors. The Relative Index of Inequality was 7.9, showing the great difference in the incidence rate between neighborhoods. ***Conclusion:*** Porto Alegre presents high incidence rates of bacilliferous pulmonary tuberculosis, which distribution through the neighborhoods of the city is associated with socioeconomic factors. The city's high rate is due to the extremely high incidence rates in its poorest neighborhoods. The authors raise hypotheses and suggest interventions.

Keywords: Tuberculosis. Spatial analysis. Social determinants of health. Epidemiological surveillance. Socioeconomic indicators. Relative Index of Inequality.

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RESUMO: ***Introdução:*** A incidência de tuberculose é fortemente associada a fatores sociais e econômicos, e a cidade de Porto Alegre apresenta um dos mais altos Índices de Desenvolvimento Humano e Produto Interno Bruto per capita do País, no entanto, a apresenta taxas muito altas de incidência da tuberculose, a mais alta entre as capitais brasileiras. Esse paradoxo instigou a realização deste trabalho, cujos objetivos foram: analisar a distribuição espacial da taxa de incidência da tuberculose pulmonar bacilífera pelos bairros de Porto Alegre e verificar sua associação com indicadores socioeconômicos. ***Métodos:*** Coorte ecológica histórica. As unidades de análises foram os bairros da cidade. Verificou-se a incidência média anual de tuberculose pulmonar bacilífera no período de 2000 a 2005 e a situação de sete variáveis socioeconômicas obtidas através do IBGE e do Sistema de Informações de Mortalidade. Foram usadas técnicas de análise espacial e multivariadas para o estudo das associações e também medidas as desigualdades. ***Resultados:*** Identificou-se um padrão espacial de distribuição da taxa de incidência da tuberculose pulmonar bacilífera muito semelhante, isto é, associada à distribuição dos indicadores socioeconômicos. O Índice Relativo de Desigualdade foi de 7,9, mostrando a grande diferença da taxa da incidência entre os bairros. ***Conclusão:*** Porto Alegre apresenta alta taxa da incidência de tuberculose pulmonar bacilífera. A distribuição dessa incidência pelos bairros da cidade mostra-se associada a fatores socioeconômicos. Os autores levantam hipóteses explicativas e sugerem encaminhamentos.

Palavras-chave: Tuberculose. Análise espacial. Determinantes sociais da saúde. Vigilância epidemiológica. Indicadores socioeconômicos. Indice Relativo de Desigualdade.

INTRODUCTION

Tuberculosis is known to be an infectious disease that is highly related to living conditions, poverty and deficiencies in the health system[1]. The city of Porto Alegre, capital of the State of Rio Grande do Sul, in southern Brazil, is in a peculiar situation, for there is a contradiction between the city's level of social and economic development and the incidence rate of tuberculosis.

According to the United Nations Development Programme, the Human Development Index (HDI) of Porto Alegre is of 0.865, which places the city in the high human development category. Porto Alegre has the 9th highest HDI among the 5,507 Brazilian municipalities[2]. However, the high incidence rate of tuberculosis in Porto Alegre is surprising: in 2008, there were 101.73 new cases per 100,000 inhabitants, the highest rate among the 27 Brazilian capitals, including Brasilia. The rate in Porto Alegre was 7.4 times greater than the rate in Brasília, and almost twice the national rate in 2008, which was of 58.91 new cases per 100,000 inhabitants[3].

Seeking to explain this phenomenon, authors hypothesize that the incidence of tuberculosis is not distributed uniformly in the city, and that it is higher in the districts of Porto Alegre where there is a high concentration of poorer population - so much higher that it would raise the overall incidence in the municipality. The specific objectives of this study are to examine the intraurban distribution of new cases of bacilliferous pulmonary tuberculosis, to identify areas with the highest concentration of cases, to calculate incidence rates of tuberculosis by neighborhoods and measure the inequalities between the city's neighborhoods on these rates, to check the distribution of socioeconomic indicators according to the neighborhoods and to analyze the relationship between the incidence rate and socioeconomic factors.

METHODOLOGY

This is an observational historical ecological cohort study. Ecological, because the information was organized and analyzed using spatial aggregates, the city's neighborhoods. Historical, because secondary data, collected in the past, was used. Cohort, because it is a study of incidence in which the population of Porto Alegre was monitored for a six-year period, 2000 – 2005, for the identification of new cases of tuberculosis.

Porto Alegre has 82 districts, of which 78 are official and 4 are unofficial. The city has two other areas not defined as urban, with little official data and whose populations, a total of 2,206 individuals, were excluded from this study[4]. For the calculation of incidence rates, population data derived from the 2000 Population Census was used, with the total number of 1,360,590 Porto Alegre inhabitants. Of the 82 districts examined, nine had less than 3,000 inhabitants. To avoid the instability of rates which often occurs with very small populations, each of these nine districts was, for analysis purposes, merged with the neighboring district that had greater identity, totaling 73 areas analyzed.

The dependent variable is the incidence rate of bacilliferous pulmonary tuberculosis, resulting from the ratio between the number of new cases of bacilliferous pulmonary tuberculosis georeferenced by neighborhoods and its population[5]. The information about the cases was obtained from the National Notifiable Diseases Surveillance System - Tuberculosis (SINAN-TB) of Porto Alegre.

All new cases of bacilliferous pulmonary tuberculosis diagnosed in the period from 2000 to 2005 were included. Patients who never underwent treatment or who did so for less than 30 days or for more than five years were considered new cases. We included only bacilliferous cases, i.e., with positive sputum smears, because these are the cases that transmit the disease and are especially relevant from the standpoint of public health[6].

Cases of institutionalized population and homeless residents were excluded from the study. The former, for presenting a greater risk of contracting tuberculosis than the general population[7]; the latter, for the unfeasibility of georeferencing. The incidence rates of the districts were adjusted for age and gender using the direct method, with the population of Porto Alegre as the standard population[8].

To assess the influence of socioeconomic conditions on the incidence of tuberculosis, seven independent variables were examined. Five variables were taken from the 2000 demographic census by the Brazilian Institute of Geography and Statistics:

- Schooling: average years of schooling of heads of households in the neighborhood;
- Income: proportion of permanent households whose heads have a monthly income of more than ten times the minimum wage;
- Household density: proportion of permanent households with 6 or more residents;
- Fertility: number of children under one year per 1,000 women in the 15 – 49 years old age group;
- Aging: number of people aged 65 and older for every 100 people under 15 years of age.

Other two independent variables, which also indicate living conditions, were taken from the Mortality Information System:

- Infant mortality: number of deaths of children under 1 year of age per 1,000 live births;
- Violence: rate of mortality from external causes – number of deaths from external causes per 100,000 inhabitants, adjusted for age and gender.

The descriptive analysis shows the characteristics of tuberculosis cases, and, in the spatial description, the points representing each georeferenced case per home address were transformed into a continuous surface, by applying the statistical technique known as Kernel density estimation, using the adaptive radius and quartic function parameters, so that, in the map of Porto Alegre, the color pattern allows the identification of areas with the highest density of estimated cases per square kilometer.

Following the analysis, the incidence rates of tuberculosis and the independent variables were analyzed in an aggregated manner. It was found that the incidence rate of tuberculosis had a distribution with spatial autocorrelation. To that end, the Global Moran's Index was calculated, which ranges from -1 to +1, and in which values near zero indicate lack of spatial autocorrelation and values close to 1 indicate strong spatial autocorrelation[9]. For this calculation, it was necessary to build a neighborhood matrix in which the unweighted contiguity criterion was used, i.e., whether or not there are boundaries between neighborhoods. This matrix was generated by the computer program GeoDa 095i[10] and edited by the authors according to their geographical knowledge of the city. To verify that the Moran's Index differed significantly from zero, the pseudo-significance test was used[10].

The Multiple Linear Regression technique was used to assess the relationship between the incidence rate of tuberculosis as a dependent variable and the seven demographic and socioeconomic indicators described above as independent variables. For the selection of the variables that remained in the regression model, the stepwise regression process was used, with probability $F \leq 0.05$ for inclusion and probability $F \geq 0.1$ for exclusion. The assumptions of the regression analysis, such as homoscedasticity, absence of multicollinearity, linear trend and normal distribution of residuals, were checked[11]. Additionally, considering that the possible existence of spatial dependence could invalidate the results of linear regression analyzes, the validity of the analysis was guaranteed by verifying the absence of spatial autocorrelation of the residuals of the linear regression model, according to the decision process proposed by Luc Anselin[12] and the GeoDa 095i computer program, which calculates a Moran's Index for residues of the linear regression model.

To complement the aforementioned analyzes, a stratified analysis was carried out in which 73 districts were grouped into four socioeconomic strata. These strata were numbered 1 to 4 in order of decreasing socioeconomic pattern. Thus, stratum 1 was composed of the districts with the best conditions, stratum 4 comprised the neighborhoods with the worst conditions and strata 2 and 3 consisted of neighborhoods in the intermediate positions. The criteria for classifying neighborhoods in each stratum are presented in another publication[13]. To compare the incidence rates of bacilliferous pulmonary tuberculosis among the strata, relative risks and population attributable risk fraction were calculated, and an analysis of variance (ANOVA) was carried out. In the multiple comparisons for means, Duncan's and the Least Significant Difference (LSD) tests were used.

To measure inequalities in the incidence of bacilliferous pulmonary tuberculosis adjusted for age and gender among the 73 districts, the Slope Index of Inequality (SII) and the Relative Index of Inequality (RII) were calculated. The software used in this calculation, which takes into account the socioeconomic status and population size of each district, was Brechas 1.0[14]. SII and RII indicate The IAD and IRD indicate, through simple linear regression techniques, the absolute and relative differences between the incidence rate in the neighborhood estimated to be in the best socioeconomic position in relation to the neighborhood estimated to be in the worst position. In this type of analysis, the variable that indicates the socioeconomic status of each neighborhood is named RIDIT, ranging from 0 to 1 and indicates the cumulative relative position of each observational unit in relation to a socioeconomic variable[15]. In this analysis, a factor score that summarized a set of seven independent variables was used as a socioeconomic variable. To obtain this score, the Principal Component Analysis was carried out.

In spatial analyzes, computational programs TerraView 3.1.4[16] and GeoDa 0.9.5-1 (Beta) were used[10]. In non-spatial analyzes, in addition to Brechas, SPSS for Windows 13.0 was used

RESULTS

DESCRIPTIVE ANALYSIS

The total number of new cases of bacilliferous pulmonary tuberculosis notified and investigated by SINAN-TB, in the six years of the study, was of 4,602. After individual analysis of each case in relation to the address variable, we excluded 467 (10%) cases. The reasons for exclusion were: institutionalized patients (249 cases), homeless individuals (109 cases), patients who lived in other municipalities (14 cases), duplication in the database (19 cases), patients with insufficient address information for the georeferencing (35 cases) and patients residing in areas not defined as neighborhoods (53 cases). A total of 4,135 cases remained. Considering these cases, the average annual incidence rate of bacilliferous pulmonary tuberculosis in Porto Alegre in the period from 2000 to 2005, was of 50.73 cases per 100,000 inhabitants.

Among cases included in the study, patients were predominantly male (66% of cases). The average age was of 38 years, with a standard deviation of 15 years, a minimum of 10 years and a maximum of 94 years of age. In the schooling variable, 46.5% of patients have had 4 – 7 years of education. Serology for HIV (Human Immunodeficiency Virus) testing was applied to 69.6% of cases, and 30.34% of them had a positive result. All cases underwent pharmacological treatment, and 72% of patients were discharged cured, 13.9% abandoned treatment, and 10.5% died. There are 3.6% of cases of unknown situations in the closing cohort, at nine months of monitoring of each case.

Figure 1 shows the map of Porto Alegre, its neighborhoods and the density of cases of bacilliferous pulmonary tuberculosis per square kilometer. Areas with the highest density of cases are indicated by darker shades. These areas, which do not respect the boundaries of districts, basically correspond to some popular neighborhoods, or slums, such as the *Bom Jesus, Pinto, Morro da Cruz, Maria Degolada, Cruzeiro* and *Safira* neigborhoods. These are densely populated areas, which have the worst socioeconomic indicators.

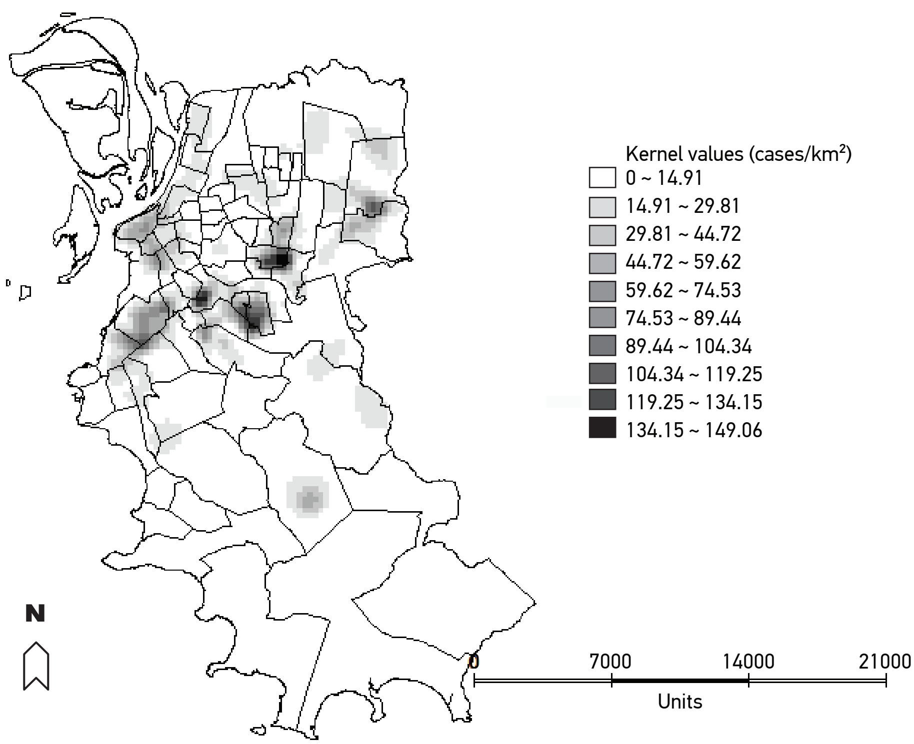

Figure 1. Kernel density estimation of cases of bacilliferous pulmonary tuberculosis (number of cases per square kilometer) in Porto Alegre, between 2000 and 2005.

SPATIAL ANALYSIS BY AREA

The distribution of the average annual incidence rate of bacilliferous pulmonary tuberculosis, adjusted for age and gender, in the municipality's neighborhoods, can be seen in Figure 2. It is clear from this figure that the lowest incidence rates of tuberculosis are in central region of the city, and the highest rates are in the periphery. Except for some neighborhoods in the south region with low rates, other areas present intermediate values.

Two districts presented extreme values, with incidence rates greater than 110 cases per 100,000 inhabitants: *Bom Jesus* and *Mario Quintana*, which have no referral care center for tuberculosis.

The Global Moran's Index, relative to the variable rate of incidence of tuberculosis in all neighborhoods, was of 0.3579, with $p < 0.01$. This result confirms the existence of a pattern of spatial dependence or autocorrelation in the distribution of bacilliferous pulmonary tuberculosis in Porto Alegre. The fact that it is a positive value indicates that the rate of incidence of bacilliferous pulmonary tuberculosis in a neighborhood tends to be more similar to the surrounding neighborhoods than to the more distant neighborhoods.

Figure 3 shows the strata in which the city was divided, according to the socioeconomic variables. Stratum 1 has the best indicators and stratum 4 has the worst levels of the socioeconomic indicators. Comparing it with the map in Figure 2, one can observe that the distribution by socioeconomic strata is similar to the distribution of the incidence of

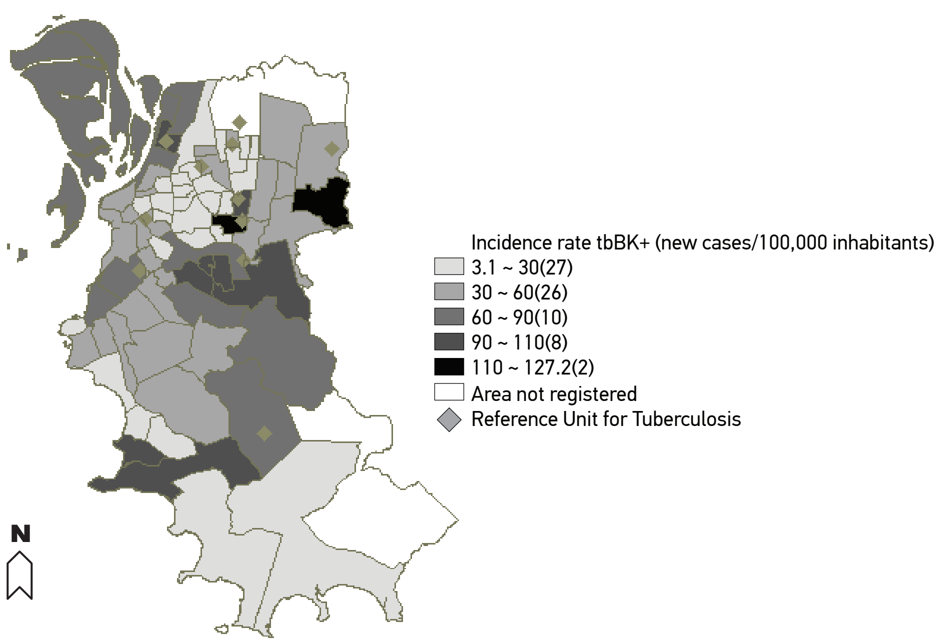

Figure 2. Distribution of average annual incidence rate of pulmonary tuberculosis through the neighborhoods of Porto Alegre, adjusted for age and sex between 2000 and 2005.

bacilliferous pulmonary tuberculosis by neighborhoods in Porto Alegre. The central area of the city, with a lower incidence of cases, belongs to stratum 1, and the most peripheral regions, with high incidence of tuberculosis, belong to stratum 4.

This assessment is corroborated by Figure 4, which shows the increase in the incidence rate of bacilliferous pulmonary tuberculosis in a linear manner from stratum 1 to stratum 4.

Analyzing Figure 4, it is possible to observe a continuous increase in the incidence of bacilliferous pulmonary tuberculosis from stratum 1, which includes the neighborhoods with the best socioeconomic conditions, to stratum 4, which includes the neighborhoods with the worst socioeconomic conditions. The analysis of variance resulted highly significant. A multiple comparison of means through Duncan's and Least Significant Difference tests indicated that all strata differed significantly from each other.

In the multiple linear regression analyzes, where the independent variable is the rate of incidence of bacilliferous pulmonary tuberculosis, and the independent variables are the socioeconomic indicators, the independent or predictive variables that remained in the model were the mortality rate due to external causes, the proportion of households with six or more residents, the rate of aging and the proportion of heads of households with a monthly income of ten minimum wages. The coefficient of determination of this model was $R^2 = 77$, i.e. 77% of the variability in the incidence rate of the disease is explained by the

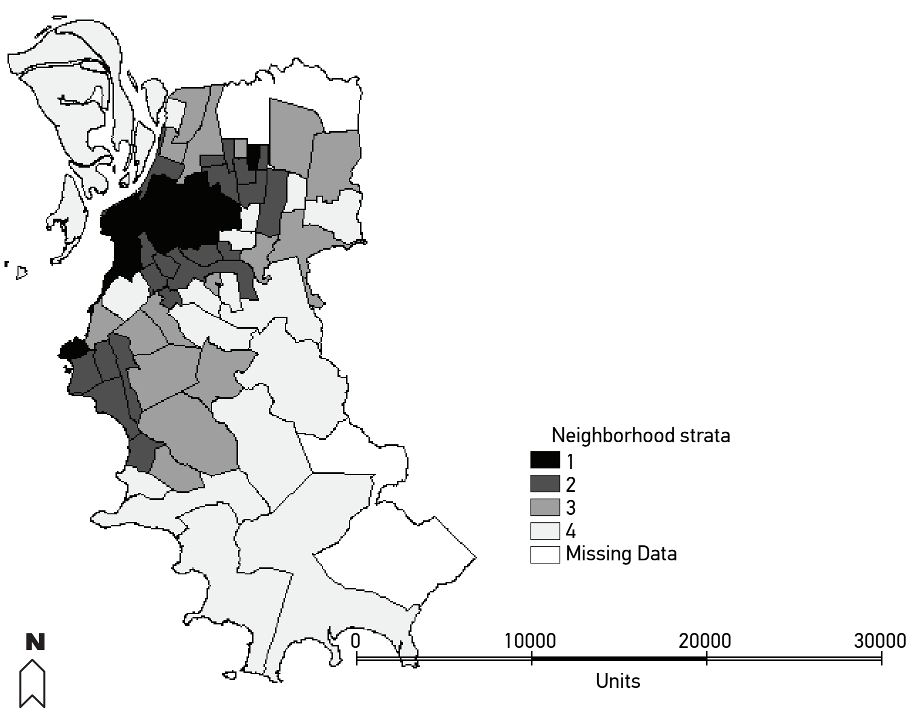

Figure 3. Map of the neighborhoods according to strata of independent variables.

variability of this set of independent variables. This model has answered all the assumptions of linear regression analyzes. To check whether there was spatial dependence, a spatial analysis of the residues of multiple linear regression was performed[17]. Moran's index of the residues was of 0.01 with p = 0.39. Given these values, it was concluded that there was no spatial dependence in the relationship between the dependent and independent variables, and there was no need to use the spatial regression models.

MEASUREMENT OF INEQUALITIES BETWEEN NEIGHBORHOODS

Comparing the incidence of bacilliferous pulmonary tuberculosis in stratum 4 with stratum 1, both shown in Figure 4, we found a Relative Risk = 6 (95%CI 2.5 – 9.5), i.e., the risk for residents of the neighborhoods that make up the stratum 4 of contracting tuberculosis was six times greater than the risk for residents of stratum 1. The attributable fraction in the population was of 71%, i.e., if the population of the entire city showed the same risk of contracting the disease as the population stratum 1, the rate of incidence of tuberculosis in the entire city would decrease by 71%.

The results of the simple linear regression of the incidence of bacilliferous pulmonary tuberculosis on RIDIT can be observed in Figure 5. The Slope Index of Inequality was of -81.25 cases per 100,000 inhabitants. This index is the absolute difference between the rate estimated for the neighborhood with the best socioeconomic conditions and the rate estimated for the neighborhood with the worst socioeconomic conditions. The negative value indicates that the SII variables vary in opposite directions: the higher the position of RIDIT, the lower the incidence rate.

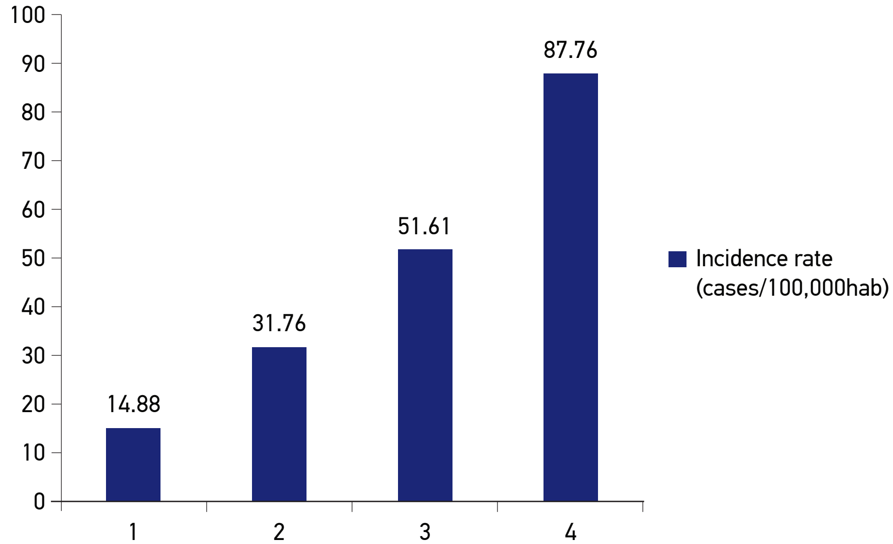

Figure 4. Incidence rate of bacilliferous pulmonary tuberculosis according to socioeconomic strata.

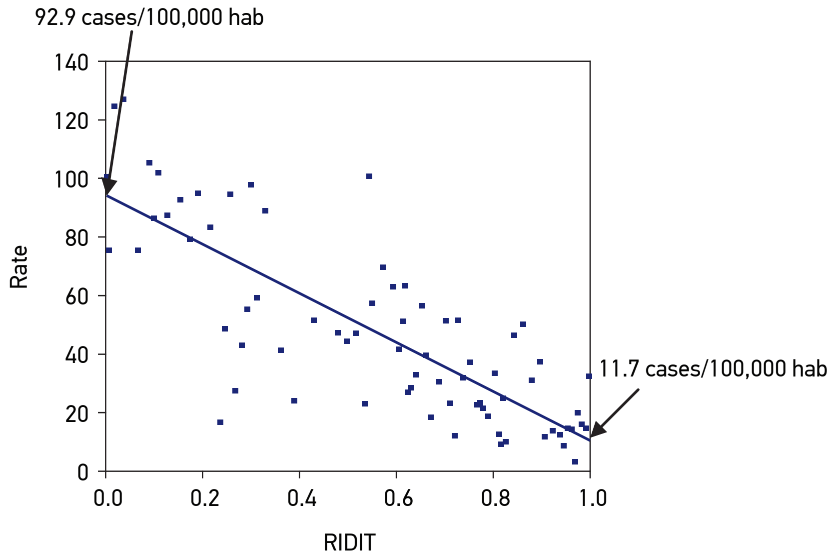

Figure 5. Scatter diagram and linear regression line of the Incidence Rate of Tuberculosis.

The Relative Index of Inequality was of 7.9, i.e., the incidence rate estimated for the neighborhood in the worse socioeconomic position of Porto Alegre is about eight times higher than the rate estimated for the neighborhood in the best position.

DISCUSSION

This study was carried out using various analytical approaches, and the results were quite consistent. Initially, it was shown that, from the spatial point of view, the average annual incidence rate of bacilliferous pulmonary tuberculosis does not present a homogeneous or random distribution throughout the city's territory. This can be observed in the Kernel density estimation, in the Global and Local Moran's Indices and in cartograms showing the distribution of the incidence of tuberculosis in the city's neighborhoods. In all cases, it was observed that the places of highest incidence were also the locations of the city's popular neighborhoods or slums, and that the places with the lowest incidences were the neighborhoods with the best socioeconomic conditions.

Non-spatial analyzes also showed the close relationship between the incidence of tuberculosis and socioeconomic status. These results were observed in the multiple linear regression, in the inequality measurements (SII and RII), in the comparison between the socioeconomic groups in which the city is divided, in the analysis of variance and in the multiple comparison of means. All these analyzes confirm that the incidence rate of tuberculosis is strongly correlated with socioeconomic conditions, to the point of about 77% of its variability, according to multiple linear regression analysis, being explained by variations in a set of independent variables that are indicative of social vulnerability. These variables include mortality from external causes, and studies show that 40% of these deaths are homicides, and that most victims come from the underprivileged strata of the population[18,19], which leads to its association with the incidence of tuberculosis. Another important variable in explaining the variability in the incidence rate of tuberculosis was the proportion of households with more than six residents, i.e. the household density. Several studies have shown that the higher the household density, the higher the tuberculosis transmission rate[20,21].

This relationship between tuberculosis and poverty can also be detected in the Relative Index of Inequality, which resulted in 7.9. That is, the incidence rate of bacilliferous pulmonary tuberculosis in the most deprived area is almost eight times higher than the incidence rate in the most privileged neighborhood. This inequality is greater than that found in other studies that measured social inequalities in tuberculosis in Brazil[22,23]. Similar results were obtained with the stratified analysis, which divided the city into four socioeconomic strata. In strata 2 and 3, the risk for tuberculosis was 2.1 and 3.5 times higher than in stratum 1, with the best socioeconomic conditions. Stratum 4 presented a 6 times higher risk than that observed in the reference stratum, thus showing the effect of living in areas with high concentrations of slums, which is the case in stratum 4. The incidence rate in stratum 4, 87 cases per 100,000 inhabitants, is similar in countries like India, Pakistan and Bangladesh[24]. In relation to the attributable risk fraction in the population, if the entire population of Porto Alegre presented the same risks of stratum 1, that is, if the entire population had had the same opportunities and living conditions of the population residing in stratum 1, the incidence of bacilliferous pulmonary tuberculosis in Porto Alegre cases would drop from 50.13 to 14.71 cases per 100,000 inhabitants, reaching incidence rates compatible with those in eastern European countries such as Croatia, Hungary and Bulgaria[25].

The data shows that Porto Alegre is a city with intense socioeconomic inequalities, as well as inequalities in the distribution of the incidence of bacilliferous pulmonary tuberculosis. It also shows that these inequalities have a spatial expression, which indicates how much the city is socially and spatially segregated.

CONCLUSION

We can conclude that the paradox of Porto Alegre can be explained by the extremely high incidence rates in poorer areas of the city, raising the city's average to higher values than expected, considering the level of socioeconomic development of the city. The question is: why is the incidence among residents of the poorest neighborhoods in the city of Porto Alegre so high? What can differentiate Porto Alegre from other Brazilian cities of similar size?

Porto Alegre has a huge housing deficit, indicated by the proportion of people living in slums (10.5% of the population)[26]. This deficit is related to the increase in household density and poor quality of housing, which are smaller and often have ventilation problems and lack of solar incidence, factors that favor the transmission of tuberculosis[27] Data from the Brazilian Institute of Geography and Statistics, however, indicate that the household density in Porto Alegre is not higher than in other large Brazilian cities[28], and should not be used as the explanation for the paradox.

Something that differentiates Porto Alegre is the incidence of AIDS. In 2010, this incidence was of 99.8 new cases per 100,000 inhabitants, and was the highest among all Brazilian cities with over 50,000 inhabitants, and 42% higher than the second Brazilian capital with the highest rate, Florianópolis[29]. As HIV infection is an important risk factor for the development of tuberculosis[30] and its recurrence, and the poorer populations are more vulnerable to HIV infection[31], this high incidence rate of AIDS may be contributing to the determination of the high incidence rates of tuberculosis in the slums of Porto Alegre. In this study, the prevalence of HIV infection in tuberculosis patients was of 30.3%, and, in a sample of blood donors in the city, the prevalence was of 1.7%[32]. Unfortunately, because information relating to HIV infection are not available for people who do not have tuberculosis, it was not possible to use them in the regression analyzes as a possible factor to explain the paradox of Porto Alegre. Regarding the incidence of AIDS by neighborhoods, the information only became available in 2002, which also prevented its use in this study.

It is also possible that the deficiencies, both in quantity and quality of services that treat patients with tuberculosis, are contributing to the high incidence rates in the city. Even if there are no validated and available indicators of quality of health services, these deficiencies are evidenced, for example, by the lack of services to treat patients with tuberculosis in the neighborhood Mario Quintana, the one with the highest incidence. The fact that none of the services that treat patients with tuberculosis in the city have deployed the control action recommended by the International Plan for Tuberculosis Control[33], which is the strategy known as Directly Observed Treatment Short-course (DOTS), may be a factor, so as the low coverage by the Family Health Program (FHP) in Porto Alegre, which should favor the delay in diagnosis and the spread of tuberculosis. In the years when the study data were collected (2000 – 2005), Porto Alegre had 7.9% of its population covered by the FHP, one of the lowest coverage rates among Brazilian capitals, only higher than the rates in Brasilia and Rio de Janeiro[34].

There is also the issue of the Central Prison of Porto Alegre, which is in an emergency situation in relation to tuberculosis. The prison, located in the middle of the city's slums, is currently housing approximately 5,000 inmates, despite having a capacity of no more than 1,600. Recent study showed that the incidence of pulmonary tuberculosis in prison in 2009 was of 5,200 new cases per 100,000 inmates, while the incidence in Porto Alegre in the same year was of 113 new cases per 100,000 inhabitants, i.e., the risk of developing tuberculosis in the Central Prison of Porto Alegre is 46 times higher than in the general population[35]. As most inmates come from and return to poor communities, they end up being a source to the spread of the disease.

Another characteristic that may help explain the paradox is the prevalence of smoking among adults in the city, which was, in 2003, of 25.2%, the highest among Brazilian capitals, reaching 33.1% in the population with less years of schooling[36]. According to Rufino[37], smoking can be considered a risk factor for tuberculosis. The habit of smoking was associated with tuberculosis through its association with the habit of drinking. One study[38] showed that men who smoke and are of lower social class are more likely to have alcohol-related problems. Thus, there is evidence that the poorest population has higher rates of smoking and possibly alcoholism, which combine to increase the risk of illness

So it is possible that the combination of AIDS, deficiencies in health services and the prison system, smoking and other yet unidentified factors are especially affecting the poorest populations of Porto Alegre, which would explain the paradox of the city with incidence rates of tuberculosis, which are incompatible with its overall level of development.

To achieve the Millennium Development Goals set out in the UN General Assembly[39], in particular the sixth goal, which refers to the reduction of morbidity and mortality from infectious diseases, intersectoral intervention actions on set of causes and its determinants need to be planned. These actions could then include the expansion of public policies aimed at reducing poverty and also fight the poor quality and the housing deficit, in order to reduce transmission of the disease, being careful, however, not to further increase urban segregation. It would also be necessary to promote the early diagnosis of tuberculosis through the investigation of respiratory symptoms and contacts of patients with tuberculosis, through the expansion of family health units, increasing its coverage, especially to the most vulnerable population.

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