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SOCIOECONOMIC CONTEXT IN BRAZIL AND TUBERCULOSIS RISK FACTORS: WHAT HAS CHANGED?

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Abstract: Introduction: Tuberculosis persists in vulnerable populations, which demonstrates the relationship between the disease and social inequality. Therefore, social and infrastructure investments can change the panorama of tuberculosis in Salvador. The objective was to identify an association between socioeconomic factors, life habits, comorbidities and tuberculosis. **Methodology:** A control case study was carried out in Salvador, Bahia, Brazil, from 2009 to May 2010, with 717 cases and 717 controls, aged 15 to 94, matched by sex and age. The result was pulmonary tuberculosis and the exposures were socioeconomic characteristics, life habits, contact history and comorbidities. The association measure obtained through conditional logistic regression was based on odds ratio and confidence intervals (95% CI) to determine the effect of the risk factors studied. **Results:** a statistically significant association was observed with schooling (OR=1.32; 95%CI: 1.06-1.63), agglomeration ≤1person/housing (OR=1.39; 95%CI:1.08-1 .80); y biennes of consumption ≤ 6 biennes (OR=1.59; 95% CI: 1.28-1.97); prior contact (OR=1.40; 95%CI:1.12-1.75); diabetes mellitus (OR=2.40; 95% CI: 1.35-4.39). A statistically significant negative association was observed between race/color brown and black (OR=0.59; 95% CI: 0.41-0.86) and (OR=0.66; 95% CI: 0.44-0 .97) respectively. **Conclusion:** Despite the social improvements in the country, tuberculosis still persists as a disease related to low life conditions.

Keywords: Tuberculosis, Incidence, Risk Factors.

INTRODUCTION

Tuberculosis (TB) persists in vulnerable populations, confirming its relationship with social inequality (XIMENES, *et al.*, 2009; WHO, 2012; ACOSTA; BASSANESE, 2014). Despite a worldwide decline in the incidence and mortality of tuberculosis, the disease remains a public health problem in the Americas and Brazil, in developed and developing countries (XIMENES, et al., 2009; WHO, 2012). Its social determinants are powerful, and include poverty, to which it is intimately related (5 CAVALCANTI, *et al.,* 2006; XIMENES, et al., 2009; TAHA, *et al.*, 2011; OSLON, *et al.*, 2012).

The large-scale political, social, economic, and demographic transformations that have occurred over the last 40 years have influenced lifestyles, the environment, and the intensity of individual and contextual risks for tuberculosis infection. Most TB studies suggest that risk factors are related to access, abandonment and adherence to treatment, multidrug resistance and HIV and other co-infections (WU; KOUSTUV, 2012; ODONE, *et al.*, 2013). Several studies have found an association between TB and male sex, economically active age, illiteracy, overcrowding, alcoholism, smoking, low income, and HIV and diabetes mellitus comorbidity. New research about tuberculosis risk factors is required, while recent studies have revealed new challenges in identifying the relationship between social change and TB occurrence (XIMENES, et al., 2009; TEIXEIRA; COSTA, 2011; VISWANATHAN, *et al.*, 2012; WU; KOUSTUV, 2012; OREN, *et al.*, 2014).

In 2011, there were 8.7 million new cases worldwide, with 1.1 million associated with HIV. Between 2010 and 2011, the incidence of tuberculosis in Brazil fell by 2.2% (BRASIL, 2013). Comparing 1990 data (5.5/100,000 inhabitants) with 2010 data (2.4/100,000), mortality rates fell by 41%, reaching the WHO's recommended target. This decline represents progress and may be attributed to investment in infrastructure and the successful strategies implemented by global tuberculosis control programmes (WHO, 2009).

The 2012 incidence rate for all forms of tuberculosis in Brazil was 37.3/100,000 inhabitants, with 72,319 cases, while for the pulmonary form this was 21.1/100,000 inhabitants, with 40,922 cases. The regions with the highest rates are the North, Southeast and Northeast; the 2012 incidence was 28.6/100,000, 22.3/100,000 and 20.6/100,000 inhabitants, respectively. In Bahia, in the Northeast, the incidence rate was 21.0/100,000 with 2,981 cases, while in Salvador it was 43.8/100, 00 inhabitants, with 1,189 cases (DATASUS, 2014). The trend is falling, with an average reduction of 1.4% over the 1990 to 2012 period.

Between 2000 and 2010, the Human Development Index (HDI) in Brazil rose from average to high. Recent prioritization of poverty reduction through social investment in infrastructure, education and social programmes, may be associated with these changes (CAVALCANTI, *et al*., 2006; WU; KOUSTUV, 2012; ODONE, *et al*., 2013).The index rose from 0.512 and 0.654 in 2000 to 0.666 and 0.759 in 2010, in Bahia and Salvador respectively, demonstrating the rapid social change in Brazil; this may have contributed to reduced TB incidence in Brazil and Salvador.

There is thus a need to explore the risk factors associated with tuberculosis within this environment, principally the association between socio-economic conditions and tuberculosis. This study aims to identify the association between socio-economic factors, lifestyle habits, comorbidities and tuberculosis, and the impact on the tuberculosis burden.

STUDY POPULATION AND METHODS

A case-control study, matched by sex and age, undertaken in Salvador between 2009 and May 2010. The study population contained 1,434 people aged between 15 and 94 years.

The municipality of Salvador, the capital of Bahia, situated in the Northeast of Brazil, occupies 706.8 km^2 and has a population of 2,718,408. For political and administrative purposes, it is divided into 18 regions, 12 Sanitary Districts and 8 health units that serve patients with a TB diagnosis (DATASUS, 2014).

The study subjects were recruited from the outpatient clinics of three referral hospitals and six primary health units providing the most tuberculosis care in Salvador. The cases and controls were classified following bacilloscopy; cases had confirmed tuberculosis (smear microscopy and culture for *M. tuberculosis)*, while controls attended the same health unit, but had a confirmed absence of tuberculosis.

The study population was composed of 717 cases and 717 controls, providing 95% power, 5%, significance level, Odds Ratio of 2.0, using 1:1 matching.Data collection was from primary sources; a questionnaire containing clinical information, lifestyle habits, history of contact and socio-economic questions to assess sex, age, race/colour, marital status, education level, overcrowding, occupation, family income, consumer goods, housing, number of people per domicile, number of rooms, alcohol abuse, previous contact with TB, and diabetes mellitus comorbidity; and HIV test results if applied. Two nurses trained and supervised a team of five nursing technicians to conduct the fieldwork interview between August 2008 and April 2010. After the interview, samples of sputum were obtained from expectoration. The material was collected in sterile containers, properly stored in refrigerated boxes, and sent to the Central Laboratory of Public Health for smear microscopy and culture.

Alcohol abuse was measured as the sum of CAGE responses (cutting down drinking, annoyance at criticism, feeling guilty, feeling need to steady nerves) and the score was categorized into excessive and sporadic alcohol

consumption. In 1983, Masur and Monteiro validated this questionnaire for Brazil, providing 88% sensitivity and 83% specificity (DADAP, et al., 2001). The questionnaire has been used in other national studies; two or more YES responses indicate excessive alcohol consumption (GUIMARÃES, *et al.*, 2010).

For 'history of contact' the option 'does not apply' was recodified to YES, because a number of people answered that not remember whether they had had previous contact with someone with TB. When we conducted a descriptive analysis by crossing this with other variables specifying form and type of contact, the existence of such contact was recorded.

The socio-economic status, history of contact and comorbidities variables were codified according to dichotomous or polytomous scoring, with a value of (1) attributed to risk and zero (0) to protection or growing degrees of exposure from zero to six along the occupation variable. Univariate analysis of the continuous variables included calculations of the average, median and standard deviation, while simple frequency was measured for categorical variables (ROTHMAN; GREENLAND; LASH, 2008).

Data was presented in absolute and relative frequency tables. To verify thestatistical significance of the association we used Pearson's chi-square test for the dichotomous variables. We conducted univariate descriptive analysis then bivariate analysis using contingency tables and Chi-square test of Pearson to evaluate the statistical significance of the association (ROTHMAN; GREENLAND; LASH, 2008). We selected the variables demonstrating statistically significant difference (p< 10%) for inclusion in conditional logistic regression model. The association between exposure factors and tuberculosis occurrence was expressed through Odds Ratio (OR) and respective 95% confidence intervals (CI 95%). The Stata 10.0 programme was utilized.

Modelling used conditional logistic regression in successive stages keeping the variables where (p<0.05) - the backward elimination method. It was conducted testing model goodness of fit by the Akaike information (AIC) start model value 941.8621 and 961.5652 end model. Therefore, it was observed that the best model is the start, not the end. The Wald, Likelihood Ratio test and model goodness of fit by the Akaike information (AIC) a were used to evaluate the models 1 and 2. The best model is the lowest value. The Population Attributable Fraction (PAF) was calculated for each variable in the final model; this expresses each variable's contribution to tuberculosis occurrence (ROTHMAN; GREENLAND; LASH, 2008).

The project was approved by the Ethics Committee of the Institute of Collective Health at the Federal University of Bahia, Brazil in Salvador (number 012-07)and number 011/2008 of the Centre for Epidemiological Research at the Octávio Mangabeira Hospital (NUPEP). The project was funded by the National Council of Technological and Scientific Development (CNPQ), number 410 498-2006-8.

RESULTS

The study population was composed of 1 434 individuals, with 717 cases and 717 controls. There were no differences between the cases and controls in relation to the paired variables (p>005). The cases were aged between 15 and 94 years old, with an average of 38.3 years and a SD± 14.5. Controls were aged between 15 and 91 years old, with an average of 38.15 and a SD±14.47 (data not shown). Most cases and controls fell within the 20-40 age range, (48.1%) and (47.3%) respectively, followed by those aged 40-60, (36.4%) cases and (36.5%) controls.

For the socio-economic variables, we observed that most cases had less than eight years of education, experienced overcrowding ≤ 1 person/room and had ≤ 06 consumer goods compared to the controls. A positive, statistically significant, association was found between low education level (OR=1.32; 95% CI=1.28-1.97) overcrowding(OR=1.39; 95% CI=1.08-1.80) have six consumer goods(OR=1.59; 95% CI=1.28-1.97) and tuberculosis.

Less cases than controls were mixed race, 453 (63.2%) compared to 484 (67.5%), and less cases worked in an occupation necessitating higher education (HE occupation) - 9 (1.3%); were retired – 121 (16.8%) or studying – 38 (5.3%).

A negative association was observed between tuberculosis and individuals who had mixed race (OR=0.59; 95% CI: 0.41-0.86) or black (OR=0.66; 95% CI: 0.44-0.97); HE occupation (OR=0.38; 95% CI: 0.17-0.89), retired (OR=0.68; 95% CI: 0.50-0.94) or student (OR=0.50; 95% CI: 0.28-0.89).

History of previous contact was more frequent amongst cases – 288 (40.2%) than controls – 232 (32.4%) (OR=1.40; 95% CI=1.12-1.75). Diabetes mellitus was more frequent amongst cases - 44 (6.2%) than controls – 19 (2.7%) with (OR=2.40; 95% CI=1.35-4.39).

The most robust regression model 1 was schooling < 8 years (OR=1.33; 95% CI =1.05-1.68), overcrowding ≥1 person per room (OR=1.37; 95% CI = 1.04-1.79), diabetes mellitus (OR=2.70; 95% CI = 1.51-4.83), previous contact (OR=1.53; 95% CI = 1.19-1.95), good ≤ 6 goods (OR=1.58; 95% CI = 1.26-1.98) and alcohol abuse (OR=1.64; 95% CI: 1.02-2.62). In this model, being mixed race (OR=0.60; 95% CI=0.41-0.88) or black (OR=0.65; 95% CI=0.43-0.97), in a HE occupation (OR=0.32; 95% CI: 0.14-0.75), retired (OR=0.67; 95% CI:0.49-0.94) or a student (OR=0.51; 95% CI:0.28-0.90) had a negative association.

In the PAF, the schooling variable contributed 12%, overcrowding 7%, diabetes mellitus 3% and alcohol abuse 2% to TB incidence.

DISCUSSION

We identified that schooling, overcrowding, diabetes mellitus, previous contact alcohol abuse, and fewer consumer goods are all associated with TB. The PAF varied from 2% to 12%, indicating the influence of socio-economic conditions, chronic diseases, and lifestyle habits on tuberculosis incidence.

The association between low education level and tuberculosis is similar to that in other national and international studies (CAVALCANTI, *et al.,* 2006; XIMENES, et al., 2009; ODONE, *et al.*, 2013; OREN, *et al.*, 2014). Previous research has found that illiteracy is a risk factor for tuberculosis (CAVALCANTI, *et al.,* 2006; OSLON, *et al.*, 2012; OREN, *et al.*, 2014). Despite reduced illiteracy in Brazil resulting from investment in education over the last decade (GUIMARÃES; JANNUZZI, 2004; IBGE, 2010; PAIM, *et al.*, 2011), the association between less than eight years of schooling and TB continues to be the greatest contributor to TB incidence in Salvador, as measured by the PAF.

Finding that overcrowding is a risk factor for tuberculosis is consistent with the literature. In Brazil, despite the reduction in overcrowding, from six to three people per room, this association is still important in maintaining tuberculosis, even when considering one person per room. Overcrowding reflects increased probability of contact with people with bacillary infections, while individuals living in overcrowded environments have the worst socio-economic conditions (CAVALCANTI, *et al.,* 2006; XIMENES, et al., 2009; IBGE,

2010; ODONE, *et al*., 2013; OREN, *et al*., 2014).

The positive association between few consumer goods and tuberculosis reinforces the relationship between TB and poverty. Despite increased access to collective goods and services, such as: radios, televisions, DVD players, mobile phones, cookers and fridges, less access to such goods is seen amongst tuberculosis cases. Similar results have been found in other studies in Brazil (XIMENES, *et al.,* 2009; BOCCIA, *et al*., 2011; HARGREAVES, *et al*., 2011). Improvements in socio-economic conditions and reduced social inequality, demonstrated through an HDI of 0.71 in 2010 and a Gini Coefficient of 0.53, have not occurred equitably, and tuberculosis remains associated with poor living conditions (XIMENES, et al., 2009; MEDEIROS, 2012).

The negative association between HE occupation, retired or student may be related to the income from salary, pension or financial support, affording greater access to food, clothes, and consumer goods. These findings are in line with the literature, since occupation is related to higher levels of education, social security protection and more stable socio-economic conditions, providing protection from poverty-related diseases (CAVALCANTI, *et al.,* 2006; ALVES, 2009).

The association between non-white individuals and tuberculosis is contradictory, since it is a protective factor for tuberculosis (LIENHARDT, *et al.,* 2005; OSLON, *et al*., 2012*)*. Any interpretation of this finding should consider that over 50% of the population in Bahia declare themselves as black or mixed race; in Salvador this rises to over 70 (GUIMARÃES, 2004; IBGE, 2010). In our study, race/colour was self-declared, which may be excessively subjective. However, both Brazil and Bahia are considerably racially mixed and an increasing number of people declare themselves as mixed race, while the number of white people has fallen (PAIM, *et al*., 2011).

The association between diabetes and TB was similar to that in national and international studies (FAURHOLT-JEPSEN, *et al*., 2011; VISWANATHAN, et al., 2012; WANG, *et al*, 2012; YOUNG, *et al*., 2012). This association is stronger for people not infected by HIV, while hyperglycemia promotes bacterial growth and increases bacterial virulence (WU; KOUSTUV, 2012; VISWANATHAN, *et al*., 2012). Specially patients with diabetes and TB have greater risk of developing more severe signs and symptoms of tuberculosis and more likely to be adverse to treatment (VISWANATHAN, *et al*., 2012).

The finding regarding previous contact and TB is in line with the literature (CRAMPIN, *et al*., 2008; TAHA, *et al*., 2011; MATHEW, *et al*., 2013; OREN, *et al*., 2014). Evidence exists that risk of TB increases with history of contact and social proximity, potentially increasing disease transmission both inside and outside the home, provided that it is repeatedly frequented by people with bacillary infections and contact occurs for an average of 19 hours (WOOD, *et al*., 2012).

The association between alcohol abuse and tuberculosis has been described. Alcohol is a risk factor for the reactivation of the disease and treatment abandonment, and abuse may lead to macro- and micro-nutrient deficiency, reflected in immunological fragility (GUIMARÃES, *et al.,* 2010; GUPTA, *et al*., 2011).

Education and overcrowding contributed most to TB occurrence, reinforcing the need for investment in education, social programmes, income, and employment generation programmes to interrupt the transmission chain and minimize risks in areas of severe overcrowding (GUIMARÃES, et al., 2012; OREN, et al., 2013).

In terms of study limitations, it may be probable that classification bias occurred because of interviewer error, since the fieldwork team was trained and monitored weekly and used previously validated, standardized instruments, checked by supervisors. There was potential for overmatching since we selected controls and cases from the same health units. This may artificially bias the estimates of both crude and adjusted effect, leading to a reduction in observed effect. Had this occurred, the associations would have been higher than those obtained (ROTHMAN; GREENLAND; LASH, 2008). We believe that these limitations did not compromise the results, which are particularly relevant to understanding the epidemiology of tuberculosis in a country that has experienced recent economic development.

In the research, the use of standards for the selection of the study population, to pairing by gender and age, in addition to controls have been evaluated in relation to the same criteria, and laboratory procedure confirmed the absence of disease and minimized errors. Therefore, contributed to increase the internal validity of the study. As the external validity was noted that the findings confirm similar findings published in national and international literature. The sample was population-based and good representation.

An association was observed between education level, previous contact, overcrowding, alcohol abuse, diabetes mellitus and consumer goods, which are all independent and predictor variables for tuberculosis occurrence. We confirmed that, despite improvements, unfavourable socio-economic conditions remain risk factors for TB. These aspects can hinder the achievement of the desired goals by who, to achieve the elimination of tuberculosis by 2035. In this way, investments are needed to face this situation. Public policy and attitudes providing differentiated treatment for at-risk individuals, without neglecting actions that meet the population's basic and/or essential needs, must therefore be implemented to effectively control tuberculosis. New studies are required to expand knowledge about the complexity of tuberculosis risk factors within different contexts.

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