The impact of AIDS, immigration and housing overcrowding on tuberculosis deaths in São Paulo, Brazil, 1994–1998
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José Leopoldo Ferreira Antunesa,*, Eliseu Alves Waldmanb

a School of Dentistry, University of São Paulo, Av. Prof. Lineu Prestes, 2227 05508-900 São Paulo, SP, Brazil
b School of Public Health, University of São Paulo, Av. Dr. Arnaldo, 715 01246-904 São Paulo, SP, Brazil

Abstract

The objective of this paper was to describe the distribution of tuberculosis (TB) mortality by area in the municipality of São Paulo, Brazil, from 1994 to 1998, and to evaluate its statistical association with several population characteristics. We surveyed TB deaths grouped by residential area, at the district level, and we calculated the rates for these areas standardized by gender and age groups. We applied simultaneous autoregressive — SAR regression analysis (autocorrelated errors model) in order to fit a “stepwise” model correlating TB deaths with the variables of interest. Significant associations were found between TB mortality rates and AIDS mortality rates, overcrowding at the household level, social development (expressed by a socioeconomic index), and rates of foreign immigration and immigration from other Brazilian States. Regression analysis allowed us to estimate the frequency of TB deaths virtually attributable to co-infection with HIV at 22.37% (95% confidence interval: 12.15 – 41.17%). TB death rates and utilization of public health services were not statistically associated, suggesting a reduced effectiveness of programs directed at control of the disease. The correlation between TB death rates and deprivation, measured by the socioeconomic index, indicates higher mortality in underprivileged areas. The significance of the association between housing overcrowding and TB deaths, in contrast to the absence of association with district-level overcrowding, indicates that prolonged contact is needed for disease transmission. Although the influx of foreigners and national migrants to the city diminished after the 1980s, immigration rates have been significantly correlated with TB mortality, suggesting greater vulnerability of these population segments to the disease. © 2001 Elsevier Science Ltd. All rights reserved.

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Introduction

The recrudescence of tuberculosis (TB) morbidity and mortality that has been occurring since the 1980s in various parts of the world has been a source of widespread concern. This process has also affected developed countries in which the eventual elimination of the disease had seemed possible. Different factors seem to have influenced this trend, such as co-infection with the human immunodeficiency virus (HIV) and Mycobacterium tuberculosis, the increased frequency of mycobacterial strains with multiple resistance to the drugs habitually used for the TB treatment, the loss of quality of programs for the control of the disease, and political and economic crises generating migratory processes from regions with elevated prevalence of the disease (Murray, 1997; Kochi, 1994; Raviglione, Surdre, Rieder, Spinaci, & Kochi, 1993).

Dolin, Raviglione and Kochi (1994) stated that the incidence of HIV-attributable TB cases was on the increase worldwide, and estimated the proportions of new cases of TB attributable to the co-infection at 4.2% in 1990, 8.4% in 1995, and 13.8% in 2000. Based upon
1992 Brazilian data, Ruffino-Netto (1995) estimated an even higher value, with 17.7% of the national morbidity of TB involving HIV-attributable cases. In another Brazilian study involving data for patients seen at a reference hospital for infectious diseases in the State of Ceará, Kerr-Pontes, Oliveira and Freire (1997) emphasized the marked presence of extra pulmonary forms of the disease, and the low ratio of patients who managed to recover from TB, as typical characteristics of the disease associated with HIV infection.

Migratory flows from the developing countries with high prevalence of TB have also been a source of concern on the part of health services, especially in countries in the northern hemisphere, which dread the entry of sources of infection from countries in Southeast Asia, Africa and Latin America. Recent studies have pointed out the fact that migrants and refugees, besides proceeding from regions with high TB prevalence, are usually subjected to multiple needs and deprivation, which may increase the risk of transmission of the disease, as well as the risk of infected people developing clinical manifestations of TB (DeRiemer, Chin, Schecter, & Reingold, 1998; Cowie & Sharpe, 1998; Lima, Belluomini, Almeida, & Arantes, 1997).

Furthermore, some studies have indicated increased TB incidence and mortality in urban areas with the worse indicators of socioeconomic deprivation, such as low income, social inequality, restricted access to health services, and marked crowding (Elender, Bentham, & Langford, 1998; Tocque, Doherty, Bellis, Spence, Williams & Davies, 1998; Mangtani, Jolley, Watson, & Langford, 1998).

According to the Global Tuberculosis Programme, the estimated incidence of TB ranges from 50 to 100 per 100,000 inhabitants in Brazil (WHO, 1997). Although the same range predominates in Latin America, some nearby countries experience even higher rates, such as Paraguay, Peru and Bolivia, whose TB incidence was estimated by The World Bank (1993) in, respectively, 166, 250 and 335 yearly cases per 100,000 inhabitants, a pattern resembling most African and Southeast Asian rates. Despite having only 35.7% of population, poorer Brazilian regions (the North and Northeast) accounted for more than half the new cases of TB reported in 1997 and 1998 (Brazil, 1998a), and migration involving these areas may spread the disease, jeopardizing the country as a whole. In the State of São Paulo, according to reported cases, the TB incidence was 55.4 per 100,000 inhabitants in 1995, while the city of São Paulo presented a higher figure: 70.2 in 1995. Antunes and Waldman (1999) studied TB trends in São Paulo, and highlighted the recrudescence of the disease in the city, after 1985.

The objective of the present investigation was to report on the distribution of TB mortality by area in the Municipality of São Paulo during the period from 1994 to 1998, to estimate TB mortality attributable to HIV co-infection. The study also aims at identifying the association between TB mortality and different variables of interest such as recent migratory flow, housing overcrowding and deprivation.

This investigation intends to provide information for the improvement of the program of TB control by identifying risk groups and factors possibly involved in the increase in TB mortality observed since 1985 in São Paulo. The city is one of the largest metropolises in the third world, in which great social contrasts exist, with a significant segment of the population living under conditions of deprivation.

**Methods**

**Data sources**

Official mortality data from 1994 to 1998 were obtained from the “Fundação Sistema Estadual de Análise de Dados e Estatística (SEADE)” (Foundation for the State System of Data Analysis and Statistics) of the State of São Paulo, according to basic and associated causes, gender, age, and district of residence of the deceased. The population of the Municipality and of its districts was estimated on the basis of the general demographic censuses performed in 1991 and 1996 by the “Fundação Instituto Brasileiro de Geografia e Estatística (IBGE)” (Foundation for the Brazilian Institute of Geography and Statistics). We also obtained data from the IBGE Foundation concerning the characteristics of the households (mean number of dwellers and mean number of rooms and bedrooms) in each city district, the quantitative characterization of the migratory influx that occurred between 1991 and 1996 according to origin, gender and age of the migrants, as well as the proportion of persons living in rural areas.

Information about the use of basic health services refers to the quotient between the mean number of visits to the health-care public network and the number of inhabitants of the district. These data were obtained from the Municipal Planning Secretariat, which also provided the area of the 96 city districts for the calculation of population density.

The index used to determine the social development of the districts was proposed by Sposati (1996), and was specifically developed to reflect the differentiation of São Paulo’s districts, during the study period. This index ranges, theoretically, from −4 to +4, and consists of the clustering of various factors: measurements of “autonomy” (10 variables evaluating the ability of the citizens to meet their vital, cultural, political and social needs), “quality of life” (17 variables indicating access to social benefits), human development (17 variables related to schooling, longevity, mortality and violence),
and equity (two variables differentiating the discrimination against women).

Inclusion criteria

We included in the study the deaths whose basic or associated cause was TB (010 – 018 and 137 International Classification of Diseases — ICD-9 codes, and A15 – A19 and B90 ICD-10 codes), and AIDS (279.1. ICD-9 code, and B20 to B24 ICD-10 codes).

Geographic scale of analysis

The present study chose the inner city’s districts level as the geographical scale of analysis. Two factors guided this choice: data availability and relevance to local health services. The city of São Paulo has a reliable set of recent mortality and socioeconomic data, discriminated by areas. The present geographic division of areas in the city was established recently (1991), with the main objective of delimiting regions with higher levels of homogeneity, as to the socioeconomic characteristics of the population. Moreover, the study of the TB mortality profile, on this scale, may improve the targeting of resources to areas with greater levels of needs, and inform the health system as to the population characteristics which correlated with TB rates. To the reader interested in the spatial assessment of social phenomena and infectious disease spread, we address the study of Wallace, Huang, Gould & Wallace (1997), which defined different geographic scales, and highlighted patterns of AIDS incidence at a broader US national-level scale.

Statistical analysis

The data were stored in computer files and analyzed statistically using the SPSS 8.0. software, 1997. INFO-MAP software was used for the analysis of spatial data (Bailey & Gatrell, 1995).

The mortality rates due to TB and AIDS were calculated and standardized by gender and age range according to usual procedures, as described by Daniel (1995). The standardized rates were then used to analyze the spatial correlation of TB mortality with AIDS mortality, and other variables selected for the study: measurements of migratory influx according to regions of origin, rate of utilization of health services, measurements of household crowding and population density, concentration of the population in rural zones, and a socioeconomic index.

The Kolmogorov–Smirnov test (Daniel, 1995) was applied in order to determine whether the distribution of the variables included in the survey could be considered normal. The Kendall–Stuart and Goldfeld–Quandt tests (Johnston, 1991) were applied for the dimensioning of heteroscedasticity in these distributions. To this end, all variables included in the study were submitted to analysis of variance according to their distribution in the proximity matrix. The variables were considered to be heteroscedastic when their mean values in each district, compared to the values assigned to neighboring areas, presented variance of a non-homogeneous pattern.

To correct heteroscedasticity and non-normality of distribution of the variables, factors that prevent the application of regression analysis, we applied the power transformations of Box and Cox, as described by Johnson and Wichern (1998).

To perform the spatial distribution of the data collected we employed the methodology of analysis of data discriminated by area described by Bailey and Gatrell (1995). These authors also provided methodological indications for the construction of the proximity matrix according to the criterion of district neighborhood. The same report was used to instruct the detection of spatial autocorrelation of the variables of interest through the Moran’s I coefficient.

For classification of TB death rates, we used the method of K-means cluster analysis, as described by Johnson and Wichern (1998). For analysis of spatial correlation between variables and for the design of the multivariate model we used the simultaneous autoregressive — SAR regression analysis method (autocorrelated errors model), as described by Bailey and Gatrell (1995).

Results

Two different trends were observed in TB mortality in São Paulo from 1994 to 1998. The increasing rates, from 1994 to 1995, were followed by decline till 1998. The same trends were observed for AIDS deaths in the city, in spite of the more intense decline in the latter period, as shown in Fig. 1.

The standardized mortality rates for TB and AIDS, as well as the remaining socioeconomic variables included in the study, revealed a high pattern of spatial autocorrelation, with the Moran’s I coefficient above the confidence interval limiting the acceptance of the hypothesis of the absence of this effect on its distribution through the districts in the city of São Paulo. To prevent the effect of spatial autocorrelation from affecting the parameters of the regression analysis, a factor that usually causes overestimation of goodness of fit indicators, we used the technique of simultaneous autoregressive — SAR regression analysis (autocorrelated errors model). In order to evaluate the difference in direction, magnitude and significance of coefficients before and after correction for spatial correlation, we also performed ordinary least squares — OLS regression analysis. This model, in comparison with the SAR
regression model, overestimated the contribution of household overcrowding to TB deaths in São Paulo, and underestimated AIDS death rates and both measures of migration. Moreover, as the OLS procedure does not take into account spatial autocorrelation, this model produced overestimated values for the goodness of fit indicators: 0.577 to the adjusted $R^2$ square, and 33.353 to the $F$ statistic.

Table 1 shows the measurements of spatial correlation between TB mortality in the districts and the independent variables under study obtained by this procedure. Table 1 also summarizes the $K$-means cluster analysis for the standardized TB mortality rates, and the descriptive statistics of the population characteristics of areas that were most closely associated with the response variable. The examination of the mean risk ratio by cluster highlights the spatial pattern of higher TB mortality in peripheral areas, as visualized in Fig. 2. Moreover, the display of average values for the independent variables, in each cluster, helps to dimension exploratory associations, at the ecological level, of factors explaining TB mortality in the city. In general, districts with a higher TB mortality profile also registered higher household overcrowding, AIDS death rate, measures of migratory influx, and a lower socioeconomic index.

Fig. 2 presents a map for the clustering analysis of the standardized TB mortality rates in areas of São Paulo, during the study period. The first cluster, with minimum risk ratio average, i.e. almost half the measure for the city as a whole, occupies the central portion of the city, besides the near south and west regions, the areas that ranked higher on the socioeconomic index. The following three clusters, with increasing risk ratio averages, refer to encircling peripheral areas, which ranked progressively lower on the socioeconomic index. The second cluster measured an average standardized TB mortality rate almost as high as the global rate for the town. The fifth cluster, with the highest risk ratio, ranking to almost seven times the average value for the first cluster, refers to two adjacent districts located in the very heart of the city. These areas also registered the highest values for the average standardized AIDS mortality rate, almost 2.5 times the global AIDS mortality rate for the town. Additionally, this cluster registered the greatest average ratios of immigration in the city, both from abroad and from other Brazilian States (Table 1). These once-prosperous districts are now areas in decay, mainly inhabited by the unemployed and other persons of low income.

Table 2 shows the results of the SAR model of multivariate regression analysis, also displaying its estimates and indicators of goodness of fit. The stepwise method of SAR regression analysis permitted us to select the variables showing the highest goodness of fit indicators to explain the phenomenon under study. The inclusion of four independent variables allowed us to explain 45.0% of all variation in TB mortality within the study period: AIDS death rates, as standardized by sex and age groups, average number of dwellers per bedroom in households, rate of recent immigration (1991–1996) from abroad and from other Brazilian States. The effectiveness of the model could have been improved if supplementary data on other population characteristics, such as homelessness, unemployment, drug use, prostitution, and others, were available at the district level.

Fig. 3 shows scatter plots indicating the point association between TB mortality rates and the independent variables selected by the multivariate regression analysis.
Using this model, it is possible to project an estimate of the percentage of TB deaths attributable to HIV co-infection over the five-year period of the study at 22.37% (95% confidence interval: 12.15 – 41.17%). In addition, it was possible to estimate the percent increase in TB deaths (average for the districts) that would virtually occur over five years as a consequence of the mean increase in one dweller per bedroom in the households, with the remaining conditions of the model remaining unchanged: 14.18% (95% confidence interval: 6.36 – 30.65%).

In order to obtain supplementary data for the analysis of the association between TB and migration, the nationality and age distribution of persons who died of the disease during the study period were examined. These data indicated that, besides the correlation with recent immigration, TB deaths were also associated with former migratory influx. Foreigners and migrants from other Brazilian States are significant segments of São Paulo’s population, respectively, 2.54% and 27.70%, most of them having lived in the city for several years. Despite these numbers, we observed 7.59% of TB deaths among foreigners and 45.27% among people born in other Brazilian States, from 1994 to 1998.

While for people born in the State of São Paulo the mean TB annual rate for the period was 6.42 deaths per 100,000 inhabitants, the rates for foreigners and migrants from other States, standardized to the same gender and age group distribution of population, reached the considerable figures of 13.24 and 53.25 deaths per 100,000 inhabitants, respectively. Age-specific TB death ratios for national migrants and persons born in the State of São Paulo showed similar plateaus, i.e., 43.21 and 44.77%, respectively, among persons older than 60 years, while foreigners of the same age-group presented a much higher ratio: 88.57%.

The high social cost of TB for the national population living in the city of São Paulo can be estimated by the high age-specific TB death ratio — 39.90% — for the age range of 20–49 years.

Discussion

TB mortality in São Paulo has fallen markedly since the middle of the 1940s, after the introduction and widespread utilization of therapeutic resources, and progressive improvements in standards of living. However, this long declining trend was interrupted in 1985, when TB mortality started to increase, coinciding with the expansion of AIDS in the city (Antunes & Waldman, 1999).

In general, since the recrudescence of TB after the 1980s is a global phenomenon, the renewed expansion of TB mortality in São Paulo resembles observations in several other cities. The results of the present study
indicate strong evidence of association between TB and AIDS mortality in recent years. This observation is corroborated by the trends of TB mortality, both for the period of increasing rates till 1995, and the posterior period of decline. These later years were marked by the introduction of new therapeutic resources for AIDS, which increased patient survival. A fact that possibly contributed to the greater impact of the introduction of AIDS therapeutic resources in São Paulo was their distribution free of charge by public health services.

Our results present a higher percentage of TB deaths attributable to HIV co-infection than the estimates reported in the literature for international patterns (Dolin et al., 1994) and for Brazil as a whole, in 1992 (Ruffino-Netto, 1995). This difference may be explained by the use of different analytical methods, but also reflects the incorporation of more recent data on mortality due to the two diseases. Moreover, the observation of a higher prevalence of co-infection ties in with the yearly register, from 1993 to 1997, varying from 17.3 to 23.5% of notified TB patients as also infected by the HIV (Galesi, 1999). The concern with the magnitude of these values is still more intense, when we consider the increasing number of homeless and drug-addicted persons in the city.

Our estimate of a higher ratio of TB deaths attributable to HIV co-infection is also consistent with the high scores for the AIDS and TB incidences, as measured for the city of São Paulo, in 1996: 57.6 and 34.6 per 100,000 inhabitants, respectively, according to public health records (Waldvogel & Morais, 1998).
Moreover, individuals suffering both the *Mycobacterium tuberculosis* and HIV infections have a greater probability of developing TB, and have shorter average life time (Dolin et al., 1994). The co-infection also accelerates the progression of AIDS, by increasing HIV replication in patients, possibly as a consequence of the latent HIV activation by complex mechanisms (Goletti et al., 1998).

In our results, the access to basic health services was not correlated with TB mortality, a factor that leads us to raise the hypothesis of the low effectiveness of these services. In spite of this observation, we should draw attention to some critical considerations in the interpretation of these results. The number of patient visits is not directly associated with the quality of care provided, and this variable did not include the visits to the private health network, which is responsible for part of the attendance services provided in some districts, especially those with a higher socioeconomic profile. Nor does this variable take into account the multiple and complex effects of patients traveling between intra-urban areas looking for health services.

Despite these limitations, it should be pointed out that the hypothesis of low effectiveness of health services with respect to the control of TB is compatible with recent data reported in the Brazilian literature. Waldman, Silva and Monteiro (1995), while summarizing a survey of the performance of the program for TB control in the State of São Paulo, observed an 18.4% ratio of abandonment of treatment among 13,414 patients in 1992 and considered as low the proportion of cure after seven months of treatment. The poor profile of TB programs in the city may have been stimulated by the reduced incorporation of the TB DOTS (directly observed short-course treatment) strategy, and the interruption of home visits to notified cases of the disease, which instructed patients and communicants as to the needed control actions, and sought to identify new cases of the disease, as well as infected persons (Galesi, 1999; Rosemberg, 1999).

Another aspect to be emphasized is the absence of a spatial correlation between TB mortality and some indicators of population concentrations, such as the mean number of residents per dwelling, a statistic that does not take into consideration the size of the dwelling, and the population density per district area, which does not take into consideration the daily flow of inhabitants between districts. Nor was a correlation found between TB mortality and the percentage of persons residing in the rural area, although the reduced ratio (4.55%) from the city’s rural population should be considered: 77 districts reported only urban population, nine districts reported less than 10% of a rural population, and only 10 districts reported a slightly higher percentage of rural dwellers.

Table 1 indicates the potential impact of each variable analyzed on the differential mortality rate due to TB in the districts of São Paulo during the study period. The negative correlation observed between TB mortality and social development, as expressed by the socioeconomic index, supports the hypothesis that the disease affects the underprivileged segments of population more strongly. In spite of the importance of this variable, it was excluded from the selected model by the stepwise multivariate regression analysis, due to collinearity with other variables that better fitted the model (Table 2).

Remaining variables that correlated significantly with TB mortality, in addition to AIDS mortality, were the mean number of dwellers per bedroom in the households, an index of population density that takes into account the dimensions of the household, and the indicators of recent immigration of persons from other Brazilian States and from abroad. Furthermore, the mean number of rooms per household, which may be considered to be an inverse indicator of population concentration, was negatively correlated with TB mortality. In other words, the smaller the mean size of the household, the higher the mortality due to TB in the city districts. This observation suggests the association

Table 2

<table>
<thead>
<tr>
<th>Estimates</th>
<th>B</th>
<th>Std. error</th>
<th>Beta</th>
<th>T</th>
<th>Significance P</th>
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</thead>
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<tr>
<td>Constant</td>
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<td>1.790E-02</td>
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<td>1.353</td>
<td>0.179</td>
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<tr>
<td>AIDS mortality rate</td>
<td>7.288E-01</td>
<td>1.232E-01</td>
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<td>5.914</td>
<td>&lt;0.001</td>
</tr>
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<td>Mean number of dwellers per bedroom in the household</td>
<td>2.689</td>
<td>6.266E-01</td>
<td>0.483</td>
<td>4.297</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Rate of immigration from other countries</td>
<td>2.899E-01</td>
<td>7.441E-02</td>
<td>0.419</td>
<td>3.897</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Rate of immigration from other Brazilian States</td>
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<tr>
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<td>—</td>
<td>—</td>
<td>—</td>
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</tr>
<tr>
<td>F</td>
<td>20.470</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Standard error</td>
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<td>—</td>
<td>—</td>
<td>—</td>
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</tr>
<tr>
<td>Degrees of freedom</td>
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<td>—</td>
<td>—</td>
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</tbody>
</table>
between living in smaller housing units and TB mortality, which is consistent with the respiratory transmission of the disease, and its correlation with underprivileged segments of population. The inclusion in the regression model of the variable concerning the mean number of dwellers per bedroom in households reinforces concerns reported in the literature about the association of the disease with crowding. The significant correlation between TB mortality and this indicator of population concentration at the household level, in contrast to the lack of a significant correlation between TB mortality and population density per district area, is suggestive of the fact that the transmission of the disease requires prolonged contact. This register agrees with a similar observation reported by Elender, Bentham and Langford (1998) in a study on TB mortality in England and Wales between 1982 and 1992. Hawker, Bakhshi, Ali and Farrington (1999) also pointed out the strong relationship between TB and household overcrowding, in white people, while performing an ecological analysis of the incidence rate of the disease in 39 electoral wards of Birmingham, UK.

As to the indicators of recent immigration, the specialized literature also views this phenomenon as one of the most important factors associated with higher rates of TB (Heath, Roberts, Winks & Capon, 1998; Zuber, McKenna, Binkin, Onorato & Castro, 1997). In this respect, in addition to representing new sources of transmission for the disease, recent foreign as well as national immigrants from other Brazilian States are thought to expand the section of the population with multiple deprivations, among them a higher risk to TB. Although the participation of migrants that arrived between 1991 and 1996 in the composition of the population in the city is low, the model designed indicates that their distribution in the districts is significantly correlated with TB mortality. The multivariate regression model enabled us to estimate the percentage of TB deaths associated with the recent arrival of foreign immigrants: 2.12% (95% confidence interval: 1.61–2.79%) and due to the recent arrival of migrants from other Brazilian States: 5.36% (95% confidence interval: 3.68–7.79%). Although these values do not seem high, their significance can be better appreciated when they are compared to the even more greatly reduced percentage of foreigners and of migrants from other Brazilian States that have recently arrived in the city: only 0.15 and 3.75%, respectively, of the total population of 9,839,066 inhabitants in 1996. When issuing their recommendations for the prevention and control of TB among foreigners in the United States, the Centers for Disease Control and Prevention (1998) pointed out the complexity of the migratory phenomenon and reiterated the need to conduct complementary studies for the epidemiological characterization of the disease in these population segments for a better programming of control actions. Throughout virtually the entire century, the city of São Paulo has been the destination of different and intense migratory flows; however, it should be pointed out that these population movements had decreased considerably after the early 1980s, even before the recrudescence of TB in our midst. In addition, despite the reduced immigration from 1991 to 1996, there was a very high (45.27%) proportion of total deaths due to TB among persons from other Brazilian States, many of them having reached the city during earlier periods.

In Brazil, recent data have identified the North and Northeast regions as those where TB prevalence is highest (Brazil, 1998b). With respect to the recent migratory movement, the 1996 demographic census reported that among Brazilians from other States of the Federation residing in São Paulo, 73.96% were from the Northeast and 3.57% from the North regions. These migrants, corresponding to almost 80% of the total number of recent migrants from other Brazilian States, in addition to coming from areas with a high incidence of TB, are known to have experienced multiple deficits and deprivations both in their place of origin and from the viewpoint of their living and working conditions in São Paulo.

The only indicator of national immigration that was not correlated with TB corresponded to persons from other towns in the State of São Paulo who had recently settled in the Capital, suggesting that this migratory movement may not have been responsible for considerable variations in the mortality due to the disease, as observed in the districts. This observation agrees with the register, by Galesi (1999), that the incidence of the disease in Municipalities in the interior of the State are, in general, inferior to the data registered for the Capital.

With respect to entering the variable “recent foreign immigration in the city of São Paulo” into the regression model, it is also necessary to compare this result with new data. According to the 1991 demographic census, it may be said that the city practically did not experience relevant international migratory processes in recent years. Among the total number of foreigners residing in São Paulo at the time, 92.85% had arrived in the city before 1981, demonstrating that this population group had been forming over time and that the entry of new immigrant contingents is relatively low. However, recent studies suggested that imported Mycobacterium tuberculosis infection (active or latent) is responsible for most TB cases among foreign-born persons proceeding from high prevalence regions. Zuber et al. (1997) showed that TB incidence in long-term US resident immigrants ranked high, even several years after their arrival. Relying on this observation, one should state that the indicators of TB spread in their places of origin predetermine migrants’ future risk of developing the disease, over remaining life span. This observation agrees with
our findings in which the rate of TB among foreigners is more than twice the rate among persons born at the State of São Paulo. For immigrants from other Brazilian States the TB rate is more than eight times the rate among persons born in the State of São Paulo.

Indeed, the study of the nationality of foreigners, including both recent and long-term residents, indicates that most of them came from countries where the risk for TB is considered high. The main regions of origin of foreigners who settled in the city of São Paulo (Portugal: 33.11%; Asian countries: 21.29%; Latin America: 10.29%) had TB incidence rates, in 1995, estimated by the Global Tuberculosis Programme (WHO, 1997) within the two highest categories, i.e., more than 100 cases, and 50 – 100 cases, per 100,000 inhabitants. As reported in the literature for countries in the northern hemisphere, these data raise concern about the possible importation of new sources of TB transmission to the city through the international migratory flow.

Although the proportional participation of recent foreign immigrants is small in relation to the high-population contingent of the city, concern with the fact that this group has become associated with TB mortality can be better understood in the light of its age distribution. While the population in the 50 year age range or older, with a recognized higher risk for the disease, measured 16.18% for the city as a whole and a surprisingly high 68.12% ratio among all early foreign immigrants who had arrived before 1981, it was only 8.65% among recent foreign immigrants. In contrast, younger individuals (20–50 years of age), a more easily mobilized contingent for international migratory movements, represented a significantly higher percentage of recent foreign immigrants, i.e., 59.21% as opposed to 47.94% for the inhabitants of the city as a whole. This differential age range distribution of foreign immigrants may be interpreted as an additional indication that the correlation between this population segment and TB mortality in the city may be associated with the entry of new sources of infection.

New reasons for concern arise from this hypothesis when we consider immigration-specific TB death ratios in the city of São Paulo from 1994 to 1998. Of the total number of deaths due to the disease, 7.59% involved foreigners, regardless of their time of arrival in the city. This information, taken together with the high proportion of deaths within the group “foreigners over 60”, leads us to raise the hypothesis of a reactivation of the infection, in addition to suggesting the vulnerability of the foreign population segment, mostly consisting of elderly persons, to the sources of transmission existing in the city.

Final comments

The observed correlation between recent migratory influx and TB mortality reflects the adverse standards of living of these population segments in the city, and deserves special attention from health services. Although more than 30% of São Paulo’s inhabitants proceed from abroad or from other Brazilian States, most of them arrived several years ago. Foreigners, who arrived mainly in the years following the Second World War, make up a predominantly aged group. Despite their better socioeconomic status, they also present increased risk of developing TB, as a consequence of the high prevalence of the disease in their countries of origin in the middle of the century. As to national immigrants, an important segment of the city’s population, they also came from cities with high TB prevalence. Moreover, they congregate in areas with worse urban services and a greater incidence of AIDS, their level of education is low, they live in smaller houses, and they suffer higher levels of unemployment, alcoholism, drug-addiction and under nutritional status. Even those who arrived several years ago may be thought of as remaining at increased risk of TB.

The excess of mortality due to TB in São Paulo, from 1985 on, may largely be attributed to HIV infection and inadequate performance of health services. Both these factors seem to have more intensely affected the immigrants in the city. TB control relies strongly on political decision of governmental authorities and community involvement with the matter. Among measures to be considered, the prophylactic treatment of PPD positive persons deserves more detailed evaluation, in particular as to the ability of health services to achieve patients’ compliance with the measure and adherence to treatment. The efforts directed toward AIDS control in the city may be taken as a guide to the TB program, because of their success in achieving a marked reduction in mortality, after 1995.

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