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Areas of vulnerability to HIV/TB co-infection in Southeastern Brazil

ABSTRACT

OBJECTIVE: To identify areas of vulnerability to new cases of HIV/tuberculosis (TB) co-infection.

METHODS: An ecological descriptive study was conducted by georeferencing new HIV/TB cases reported in the city of Ribeirão Preto, Southeastern Brazil, in 2006. Data were obtained from the São Paulo state information system for TB notification (TB-WEB) database. New cases of HIV/TB co-infection were analyzed according to sociodemographic and clinical characteristics and, subsequently, georeferenced in the city's cartographic basis, based on home addresses. City sectors were categorized into three socioeconomic levels: lower, average and upper levels, based on the analysis of the main components of the 2000 Demographic Census variables (income, level of education and percentage of households with five or more residents). The incidence of HIV/TB co-infection was calculated for each socioeconomic level.

RESULTS: HIV/TB co-infection affected a higher number of economically active adult males and the pulmonary form of TB was the most frequent. Spatial distribution showed that the incidences in areas with average and lower socioeconomic levels (8.3 and 11.5 cases per 100,000 inhabitants, respectively) were higher than that with a higher socioeconomic level (4.8 cases per 100,000 inhabitants).

CONCLUSIONS: The incidence rate of HIV/TB co-infection, analyzed according to socioeconomic levels, showed a non-homogeneous spatial pattern of distribution and higher values in more socially vulnerable areas. The present study identified priority geographical areas to control co-infection and revealed that the geographical information system technology can be used by city managers to plan health actions.

DESCRIPTORS: HIV Infections. Acquired Immunodeficiency Syndrome. Tuberculosis. Comorbidity. Risk Factors. Socioeconomic Factors. Ecological Studies.

INTRODUCTION

Despite the increasing use of the Geographic Information System (GIS) in public health,[23] the incorporation of this technology to analyze the determinants of certain endemic diseases, such as tuberculosis (TB) and AIDS, is still incipient due to the difficulties in or lack of knowledge about system management.[10] GIS use has enabled the integration between different health event indicators and socio-environmental data,[2] providing a broader perspective of the social determinants of the health-disease process.

HIV/TB co-infection has represented a great challenge for public health in recent decades, in view of TB being the main cause of death in individuals with AIDS

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(three deaths per each ten individuals) and practically lethal in HIV-positive individuals.[9] The risk of an individual not infected with HIV developing TB throughout life varies from 5% to 10%, although reaching 50% in AIDS patients.[b] Among HIV-seropositive individuals and those with a latent infection by *Mycobacterium tuberculosis,* the risk increases 20 times, when compared to HIV-seronegative individuals.[16]

Poor housing conditions caused by the lack of a social and housing policy in the urban environment, in addition to unemployment, migration to urban centers and the situation of financial poverty of part of the population, among other social determinants, contribute to the appearance of areas vulnerable to TB development.[13] Individuals' vulnerability to TB results from the marginalization of the population in terms of place of residence, difficulty in access to health services and lack of social representation, and such aspects are worsened by an individual's and the community's poor socioeconomic situation.[a]

Vulnerability to AIDS or TB is a complex concept that involves dimensions (individual, institutional and social ones) that determine individuals' or groups' susceptibility. Following this line of thought, the distribution of risks of one falling ill or dying is considered to occur according to distinct forms of social opportunities or inclusion. These aspects influence the patterns of vulnerability of this population in the health-disease process, associating it with the living conditions of a community and, as a result, with the geo-social space in which they live.[3]

According to certain authors,[11] the understanding of the TB and HIV/AIDS dynamics depends on both epidemiological rates and the understanding of the relationships and living conditions in a socially vulnerable area, enabling better planning and, consequently, the reorganization of health practices and work.

Ribeirão Preto, state of São Paulo, Southeastern Brazil, is socially and economically privileged, when compared to wealthier cities in Brazil, with a Human Development Index (HDI) of 0.855.[b] Nonetheless, it is among the cities with the highest HIV/TB co-infection rates in the state of São Paulo, where Santos and São José dos Campos rank at the top.[17] In 2006, the percentage of HIV cases among those with TB was 30% of the total number of reported cases,[c] posing a challenge to health surveillance, in view of the increased chances of treatment default , recurrence and death in this group of patients. Studies on the aspects that predominate in the transmission chain of this comorbidity and its interaction with the social determinants in the city are essential.

Thus, the present study aimed to identify areas of greater vulnerability to HIV/TB co-infection in 2006.

METHODS

An ecological descriptive study was conducted in the city of Ribeirão Preto, situated in Northeastern São Paulo state, with an estimated population of 559,651 inhabitants in 2006.[d]

Ribeirão Preto is one of the 73 priority cities to control TB which must increase their disease control actions. In 2006, the coefficient of pulmonary TB incidence in this city was 37.82 per 100,000 inhabitants, case detection rate of 40% and percentage of cure of 68.5%.[c]

Health care for TB and HIV/AIDS patients occur in secondary level services, with specialized teams, although not exclusive to the programs, which are comprised of one or two doctors and nursing professionals. Reference outpatient clinics with a Programa de Controle da TB (PCT – TB Control Program) perform supervised TB treatment in approximately 77% of patients. The supervised dose is usually provided in locations of preference of TB and/or co-infected patients, whether at the reference outpatient clinic or in their home.

The Unidade Especial de Tratamento de Doenças Infecciosas (Special Infectious Disease Treatment Unit) do Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo also integrates the health care network for HIV/TB co-infected patients in tertiary care, providing outpatient care and hospitalizations.

TB cases that had been reported as new cases, with a laboratory serological confirmation of HIV and patients who lived in Ribeirão Preto in 2006, were included in this study. New cases are defined as "patients who have never undergone anti-tuberculosis therapy and who were treated for less than 30 days or more than five years".[c]

Data were obtained from the TB-WEB in April 2008. This is an exclusive state-run information system for

[a] World Health Organization. Addressing and poverty in TB control: options for national TB control programmes. Geneva; 2005. (WHO/HTM/TB/2005.352). [cited 2009 Nov 08]. Available from: http://whqlibdoc.who.int/hq/2005/WHO_HTM_TB_2005.352.pdf
[b] Fundação Sistema Estadual de Análise de Dados. Perfil municipal: Adamantina. São Paulo: SEADE; 2010. [cited 2011 Jan 23]. Available from: http://www.seade.gov.br/produtos/perfil/perfil.php
[c] Ministério da Saúde. Secretaria de Atenção à saúde. Departamento de Atenção Básica. Vigilância em Saúde: Dengue, Esquistossomose, Hanseníase, Malária, Tracoma e Tuberculose. 2007: (21): 150. [cited 2009 Sep 4]. Available from: http://www.saude.mt.gov.br/adminpublicacao/arquivo/caderno%20atencao%20basica%20n%2021%202007.pdf
[d] Instituto Brasileiro de Geografia e Estatística. Censos demográficos 2000 [cited 2007 Jul 15]. Available from: http://www.ibge.gov.br/home/estatistica/populacao/censo2000/universo.php?tipo=31o/tabela13_1.shtm&paginaatual=1&uf=35&letra=R

TB notification ,implanted in the state of São Paulo in 2006. The information found in TB notification forms feeds the Sistema de Agravo de Notificação (Sinan – National Information System on Disease Notification) and TB-WEB, where it is stored in a single file on the internet.

The variables selected to characterize cases on an individual level were as follows: sex, date of birth, level of education (years of study), patient's address (TB-WEB), clinical form of TB (pulmonary, extra-pulmonary, pulmonary + extra-pulmonary, and disseminated), type of treatment (supervised or self-administered), and type of treatment outcome (cure, death, treatment default, change of diagnosis and transfer to other health service or city).

The cases selected for this study were geocoded from the patients' addresses (street and number) using the ArcGIS software, version 9.1, in a digital cartographic basis of the city of Ribeirão Preto, obtained from the Companhia de Desenvolvimento Econômico (Company of Economic Development).

Census tracts defined by the 2000 Demographic Census of the Instituto Brasileiro de Geografia e Estatística (IBGE – Brazilian Institute of Geography and Statistics) were used as unit of analysis. Census tracts are continuous and homogeneous areas with an average of 300 homes each.[d] According to the 2000 Demographic Census, the city was divided into 650 census tracts. Of these, 17 were excluded from the analysis because they did not include inhabitants (nine sectors) and eight because they were special-purpose areas, such as hospitals and prisons. A total of 633 sectors were analyzed.

The collective level variables obtained from the census tracts selected were as follows: heads of households' mean income, heads of households' mean level of education, female heads of households' mean income, female heads of households' mean level of education, proportion of illiterate individuals, and percentage of households with five or more residents. These variables were selected according to previous studies,[8,22] so they could represent the income, level of education, family density and vulnerable groups (women). Socioeconomic characterization of census tracts was performed using main component analysis, which produces factors not correlated with each other. The factor responsible for the highest proportion of total variation was selected among the factors obtained. The factor was named "socioeconomic factor", since it represents socioeconomic aspects.

A score corresponding to the socioeconomic factor value for each census tract was calculated, where the higher the value, the better the sector's socioeconomic level. Sectors were ordered in a decreasing order and divided into tertiles, resulting in three groups: higher (more favorable socioeconomic conditions), average and lower (less favorable) socioeconomic levels. The incidence of co-infection cases was calculated for each of these areas.

The present study was approved by the Ethics Committee of the Escola de Enfermagem de Ribeirão Preto da Universidade de São Paulo (Protocol 0762/2007).

Table 1. Distribution of new cases of HIV/TB, according to age group, length of time of education, clinical form, type of treatment and treatment outcome . Ribeirão Preto, Southeastern Brazil, 2006.

Variables	n	%
Sex		
Female	33	68.8
Male	15	31.2
Age group (years)		
0 to 10	2	4.2
11 to 19	1	2.1
20 to 39	23	47.9
40 to 59	19	39.5
Inconsistent records[a]	3	6.3
Education (in years)		
None	3	6.3
1 to 3	1	2.1
4 to 7	28	58.3
8 to 11	4	8.3
Information ignored	6	12.5
Data not completed	6	12.5
Clinical form of tb		
Pulmonary	36	75.0
Extra-pulmonary	8	16.7
Pulmonary + extra- pulmonary	3	6.3
Disseminated	1	2.0
Type of treatment		
Supervised treatment	23	48.0
Data not completed	14	29.1
Self-administered	11	22.9
Treatment outcome		
Cure	23	48.0
Death not caused by TB	12	25.0
Change of diagnosis	10	20.8
Default	2	4.2
Transfer to a different health service	1	2.0

[a] Inconsistent records refer to incorrect dates of birth (date of birth is the same as that at the beginning of treatment), as they mention children with an occupation. Source: TB-WEB 2008.

RESULTS

Of all 160 new TB cases reported in the city of Ribeirão Preto, in 2006, 50 (31.2%) were co-infected with HIV/TB. Of all new cases of co-infection, two were excluded from the study due to the address not being found in the city's digital map and to its belonging to a women's penitentiary.

Of all 48 cases selected, 33 (68.8%) were males and 15 (31.2%) were females. Table 1 shows the distribution of new cases of co-infection in Ribeirão Preto, according to age group, level of education, clinical form of TB, type of treatment, and treatment outcome.

Main component analysis produced four factors (Table 2). Among these, the factor responsible for 81.9% of total variation, known as socioeconomic factor, was selected and this resulted in a score, calculated for each census tract using the following expression: 0.84 x (heads of households' mean income) + 0.96 x (heads of households' mean length of time of education) + 0.84 x (female heads of households' mean income) + 0.94 x (female heads of families' mean length of time of education) – 0.84 x (proportion of illiterate individuals) – 0,86 x (proportion of illiterate women) – 0.64 x (percentage of households with five or more residents).

For each census tracts grouped according to higher, average and lower socioeconomic levels, Table 3 shows the numbers of HIV/TB co-infection cases, numbers of inhabitants, incidence rates, areas and demographic density.

HIV/TB incidence rates in lower and average socioeconomic level areas were 140% and 73% higher than that in the area with the best socioeconomic level, respectively. The higher demographic density occurred in the area with average socioeconomic level, rather than that with a lower level, although the latter showed a higher incidence rate of HIV/TB co-infection in the city (Figure).

Table 2. Factors obtained from main component analysis and respective eigenvalues and proportions of explanation. Ribeirão Preto, Southeastern Brazil, 2006.

Factor	Eigenvalue	Proportion (%)	Accumulated (%)
1	5.129	81.9	81.9
2	0.921	14.7	96.6
3	0.210	3.3	99.9
4	0.006	0.1	100.0

DISCUSSION

The profile of new cases reported in 2006, in Ribeirão Preto, in which a predominance of males with an average level of education and pulmonary clinical form is observed, in addition to a relevant number of extra-pulmonary cases, corroborates results from other studies.[15,17,18]

Poor recording of supervision of the medication dose among the patients studied could indicate a barrier in the flow of communication between health care levels, which usually hinders the continuity if a co-infected patient is required to be transferred from their follow-up location.[24]

The percentage of cure was relatively low, which could imply that it was difficult to treat co-infected patients, who may show more severe forms of TB.[15] Compared to a study conducted in the same city, during a period of four years (from 1998 to 2003),[17] the percentage of cure was approximately 53% among co-infected patients, higher than that of the present study. The number of cases reported as deaths not caused by TB and change of diagnosis in the population studied should be emphasized. Based on the study conducted by Muniz et al[14] (2006), when compared to the present study, a decrease in the percentages of death and treatment default can be observed with the implementation of supervised treatment. This shows that such care "tool" is an important aspect involved in TB treatment.[24]

In many cases of AIDS patients, the result of TB treatment is reported as a "change of diagnosis". The variety of clinical forms of TB among HIV-seropositive patients hinders the diagnosis of the disease in these patients, who usually begin treatment without a confirmed diagnosis. This alternative to control TB does not harm co-infected patients and it is a form to control possible infections among contacts.[15]

The present study found a close relationship between reported cases and areas with higher social vulnerability, because incidence rates are clearly higher in areas

Table 3. New cases of HIV/TB co-infection, number of inhabitants, incidence rates, areas and demographic densities, according to socioeconomic levels of census tracts. Ribeirão Preto, Southeastern Brazil, 2006.

Socioeconomic level	Number of cases (N = 48) n (%)	Number of inhabitants	Rate of incidence (per 100,000 inhabitants)	Area (km²)	Demographic density (inhab./km²)
Higher	7 (14.6)	145,413	4.8	111.8	1,301
Average	16 (33.3)	191,639	8.3	35.9	5,338
Lower	25 (52.1)	217,408	11.5	105.1	2,069

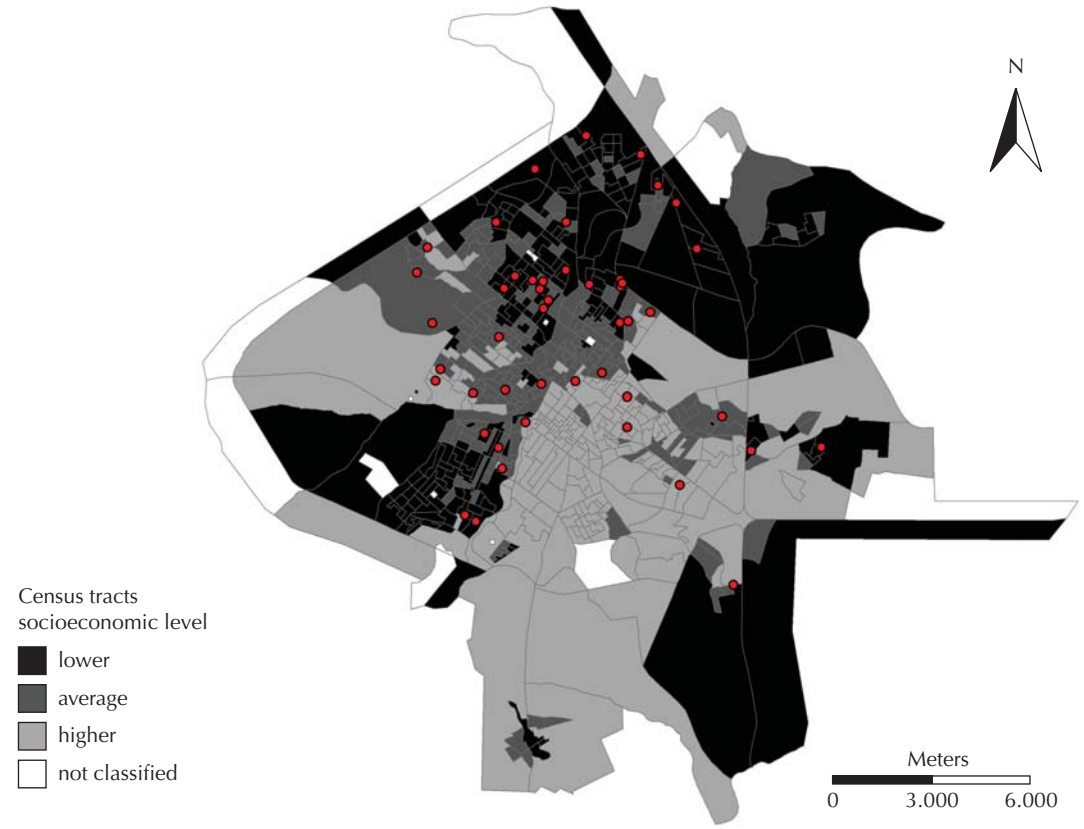

Figure. Location of new cases of HIV/TB co-infection, according to socioeconomic level of census tracts. Ribeirão Preto, Southeastern Brazil, 2006.

with average and lower socioeconomic levels. These results are not in agreement with those of studies which assumed that the distribution of co-infection cases was situated in areas with a higher socioeconomic level and equally distributed among the different social classes.[12] However, this relationship should be investigated with other types of design of epidemiological studies.

The areas identified as vulnerable in the city of Ribeirão Preto have a relevant population density, certain areas can be named "pockets of poverty", including large slums and settlements, in addition to locations with high levels of drug dealing and prostitution. These results agree with a study conducted in Germany,[13] in which TB was concentrated in areas with poor housing conditions and associated with poverty indicators, such as unemployment, low purchase power, lack of social support and low qualification for the labor market. However, the demographic density of the German study does not coincides with that of this study conducted in Ribeirão Preto, once the highest incidence occurred in an area that concentrates the largest part of the population, although not with the highest demographic density (average socioeconomic level area).

Studies on the distribution of TB cases, conducted in the Southeastern and Northeastern regions of Brazil, also found a close relationship between the occurrence of the disease and areas with higher social vulnerability and the lowest quality of life indicators,[21] showing that the social problems of the population directly influence the onset of this disease.

In addition, Rodrigues-Junior et al[17] (2006) did not identify an association between AIDS cases and places of residence, probably because the dynamics of this disease alone greatly differs from that occurring in association with social determinants of TB.

The higher number of co-infection cases among less privileged areas implies and justifies the intensification of activities connected to TB active case finding for early case detection. Knowledge about more vulnerable areas enables health care to be more sensitive to the community's socioeconomic and political context. As an ethical imperative, the city management must meet the health requirements in its area. In addition, to meet those of a social nature, individuals from different social sectors must be integrated, as should knowledge, powers and wills, as a result.[5,20]

The results of the present study showed the social determinism in the health-disease process of a community, i.e., the social and economic structures are present in

the life of individuals, determining their way of being and living and their health conditions.[20]

TB is a social disease that emerges from the inequity in income distribution. The presence of this disease in a community is a reflection of the precariousness of local social development policies and its permanence results in the community's productive capacity running out, as it affects the economically active population more frequently. In a cyclic form, TB appears in poor communities and contributes to their impoverishment, because it has an impact on their economically productive class.[4] The advantage of using geographic spaces as living condition indicators, especially one's place of residence, is the possibility of viewing the complexity of the social organization as a whole.[1]

A similar study on the spatial distribution of TB cases, conducted in Ribeirão Preto for six years, identified a variation in places where the disease occurred in this city. At times, cases were concentrated in a certain area, and at other times, in a different area, although always in areas where social inequalities were more evident and where the level of vulnerability was higher.[10]

In other studies, researchers observed that TB patients were concentrated in areas with a high population density and poor housing and sanitation conditions,[6,19,22] contrasting with the findings of this study, in which the HIV/TB co-infection rate did not show higher values in areas with greater density, although being concentrated in areas with lower socioeconomic levels.

HIV/TB co-infection is a disease of social complexity and its elimination is not restricted to health, but rather dependent on intersectoral management and investments in housing, transportation and food, among other things. Lack of intersectoral integration poses great challenges to health management, because it does not count on structured instruments and knowledge that can support decision-making. Such problems evidence the reductionist view of the sector-based approach to health and autonomy of an individual.[7] Thus, intersectorality is one of the main measures to tackle social problems in a certain area, such as HIV-TB co-infection, once knowledge integration, mobilization of resources from different sectors and social responsibility of distinct segments of civil society on behalf of the collective well-being are involved in this process.[21]

This approach gains consistency when the needs of population groups, spread over a certain area, cause them to become subjects of this process.[13,21] Thus, an empowered community must be linked to management, who, aware of their rights, participates in local health planning, indicating their actual needs and evaluating the availability and quality of health services. Planning should be conducted according to the socio-epidemiological reality, based on local resources and on the context of its participants.[21]

Public power must enable conditions for local socioeconomic development, through social policies on inclusion, qualification in the job market, improvement in housing conditions and access to health services. Such measures will only be effective if the population participates in decision-making instances.[4]

The association between HIV/TB co-infection and socioeconomic condition, observed in the collective level, does not necessarily exist on the individual level. Thus, other types of study would be required to investigate and identify such association on this level. The GIS was found to be an important technology to understand the social dynamics of HIV/TB co-infection and it contributes to the definition of priority areas for sanitary investment. This technology enables information for immediate decision-making to be provided in a short time.

Despite the limitations pointed out here, the results of the present study allowed for the diagnosis of the HIV/TB co-infection situation in Ribeirão Preto, thus enabling the identification of priority geographic areas to control these diseases. Such results can be considered by managers when planning health actions and defining a local management plan which is closer to the socio-epidemiological reality of the city studied.

REFERENCES

1. Barata RB. Epidemiologia social. *Rev Bras Epidemiol*. 2005;8(1):7-17. DOI:10.1590/S1415-790X2005000100002

2. Barcellos C, Sabroza PC. The place behind the case: leptospirosis risks and associated environmental conditions in a flood- related outbreak in Rio de Janeiro. *Cad Saude Publica*. 2001;17 Suppl:59-67. DOI:10.1590/S0102-311X2001000700014

3. Bates I, Fenton C, Gruber J, Lalloo D, Medina Lara A, Squire SB, et al. Vulnerability to malaria, tuberculosis and HIV/AIDS infection and disease. Part 1: determinants operating at individual and household level. *Lancet Infect Dis*. 2004;4(5):267-77. DOI:10.1016/S1473-3099(04)01002-3

4. Benatar SR, Upshur R. Tuberculosis and poverty: what could (and should) be done? *Int J Tuberc Lung Dis*. 2010;14(10):1215–21.

5. Brunello MEF, Cerqueira DF, Pinto IC, Arcêncio RA, Gonzáles RIC, Villa TCS, et al. Vínculo doente-profissional de saúde na atenção à tuberculose. *Acta Paul Enferm*. 2009;22(2):176-82. DOI:10.1590/S0103-21002009000200010

6. Chan-Yeung M, Yen AGO, Tam CM, Kam KM, Leung CC, Yew WW, et al. Socio-demographic and geographic indicators and distibution of tuberculosis in Hong Kong: a spatial analysis. *Int J Tuberc Lung Dis*. 2005;9(12):1320-6.

7. Gandhi NR, Moll A, Sturm AW, Pawinski R, Govender T, Lalloo U, et al. Extensively drug-resistant tuberculosis as a cause of death in patients co-infected with tuberculosis and HIV in a rural area of South Africa. *Lancet*. 2006;368(9547):1575-80. DOI:10.1016/S0140-6736(06)69573-1

8. Godoy MF, Lucena JM, Miquelin AR, Paiva FF, Oliveira DLQ, Augustin-Junior JL, et al. Mortalidade por doenças cardiovasculares e níveis socioeconômicos na população de São José do Rio Preto, estado de São Paulo, Brasil. *Arq Bras Cardiol*. 2007;88(2):200-6. DOI:10.1590/S0066-782X2007000200011

9. Hino P, Santos CB, Villa TCS, Muniz JN, Monroe AA. Tuberculosis patients submitted to supervised treatment. Ribeirão Preto - São Paulo - Brazil. 1998 and 1999. *Rev Latino-Am Enferm*. 2005;13(1):27-31. DOI:10.1590/S0104-11692005000100005

10. Hino P, Villa TCS, Sassaki CM, Nogueira JA, Santos CB. Geoprocessamento aplicado à área da saúde. *Rev Latino-Am Enferm*. 2006;14(6):939-43. DOI:10.1590/S0104-11692006000600016

11. Kaufmann SHE, Parida SK. Changing funding patterns in tuberculosis. *Nature Med*. 2007;13(3):299-303. DOI:10.1038/nm0307-299

12. Kistemann T, Munzinger A, Dangendorf F. Spatial patterns of tuberculosis incidence in Cologne (Germany). *Soc Sci Med*. 2002;55(1):7-19. DOI:10.1016/S0277-9536(01)00216-7

13. Macq J, Torfoss T, Getahun H. Patient empowerment in tuberculosis control: reflecting on past documented experiences. *Trop Med Int Health*. 2007;12(7):873-85. DOI:10.1111/j.1365-3156.2007.01858.x

14. Muniz JN, Ruffino-Netto A, Villa TCS, Yamamura M, Arcencio R, Cardozo-Gonzales RI, et al. Aspectos epidemiológicos da co-infecção tuberculose e vírus da imunodeficiência humana em Ribeirão Preto (SP), de 1998 a 2003. *J Bras Pneumol*. 2006;32(6):529-34. DOI:10.1590/S1806-37132006000600010

15. Paixão LMM, Gontijo ED. Perfil de casos de tuberculose notificados e fatores associados ao abandono, Belo Horizonte, MG. *Rev Saude Publica*. 2007;41(2):205-13. DOI:10.1590/S0034-89102007000200006

16. Reid A, Scano F, Haileyesus G, Williams B, Dye C, Nunn P, et al. Towards universal access to HIV prevention, treatment, care, and support: the role of tuberculosis/HIV collaboration. *Lancet Infec Dis*. 2006;6(8):483-95. DOI:10.1016/S1473-3099(06)70549-7

17. Rodrigues Jr AL, Ruffino-Netto A, Castilho EA. Distribuição espacial da co-infecção *M tuberculosis*/HIV no Estado de São Paulo, 1991-2001. *Rev Saude Publica*. 2006;40(2):265-70. DOI:10.1590/S0034-89102006000200012

18. Santos MLSG, Ponce MAZ, Vendramini SHF, Villa TCS, Santos NSGM, Wysocki AD, et al. A dimensão epidemiológica da coinfecção TB/HIV. *Rev Latino-Am Enferm*. 2009;17(5):683-8. DOI:10.1590/S0104-11692009000500014

19. Santos SM, Noronha CP. Padrões espaciais de mortalidade e diferenciais sócio-econômicos na cidade do Rio de Janeiro. *Cad Saude Publica*. 2001;17(5):1099-110. DOI:10.1590/S0102-311X2001000500012

20. Scatena LM, Villa TCS, Ruffino-Netto A, Kritski AL, Figueiredo TMRM, Vendramini SHF, et al. Dificuldades de acesso a serviços de saúde para diagnóstico de tuberculose em municípios do Brasil. *Rev Saude Publica*. 2009;43(3):389-97. DOI:10.1590/S0034-89102009005000022

21. Teixeira CF. Promoção e vigilância da saúde no contexto da regionalização da assistência à saúde no SUS. *Cad Saude Publica*. 2002;18 Supl:S153-62. DOI:10.1590/S0102-311X2002000700015

22. Vendramini SHF, Santos MLSG, Gazetta CE, Chiaravallotti-Neto F, Ruffino-Netto A, Villa TCS. Tuberculosis risks and socio-economic level: a case study of a city in the Brazilian south-east, 1998-2004. *Int J Tuberc Lung Dis*. 2006;10(11):1231–5.

23. Vieira RCA, Prado TN, Siqueira MG, Dietze R, Maciel ELN. Distribuição espacial dos casos novos de tuberculose em Vitória, Estado do Espírito Santo, no período de 2000 e 2005. *Rev Soc Bras Med Trop*. 2008;41(1):82-6. DOI:10.1590/S0037-86822008000100017

24. Williams G, Arrascue EA, Jittimanee S, Walusimbi M, Sebek M, Berga E, et al. Guidance for the implementation of best practice for the care of patients with tuberculosis. *Int J Tuberc Lung Dis*. 2008;12(3):236-40.

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