Cogitare Enfermagem

ORIGINAL ARTICLE

COVERAGE OF DIRECTLY OBSERVED TREATMENT ACCORDING TO THE RISK OF TUBERCULOSIS/HIV COINFECTION AND UNFAVORABLE OUTCOMES*

Laura Terenciani Campoy[1], Luiz Henrique Arroyo[2], Antônio Carlos Vieira Ramos[3], Rubia Laine de Paula Andrade[4], Marcos Augusto Moraes Arcoverde[5], Josilene Dália Alves[6], Ricardo Alexandre Arcêncio[7]

ABSTRACT

Objective: To analyze the coverage of directly observed treatment according to the risk of tuberculosis/human immunodeficiency virus coinfection and unfavorable outcomes.
Methods: Ecological study with secondary data related to 10,389 new cases of coinfection notified in the state of São Paulo, Brazil, from 2010 to 2015. They were analyzed by applying local Moran's index, spatial scan statistics, and hierarchical Bayesian models.
Results: The São Paulo metropolitan area and Baixada Santista concentrate the highest incidence of coinfection and treatment default. Low coverage of directly observed treatment was associated with areas at risk for the coinfection and higher withdrawal risk. The city of São Paulo, the coastal region, and the Ribeirão Preto area showed a higher incidence of deaths, which did not show an association with the coverage of directly observed treatment. Conclusion: Low coverage of directly observed treatment was associated with a higher risk of coinfection and treatment default.

DESCRIPTORS: Tuberculosis; Acquired Immunodeficiency Syndrome; Coinfection; Health Services Research; Operations Research.

HOW TO REFERENCE THIS ARTICLE: Campoy LT, Arroyo LH, Ramos ACV, Andrade RL de P, Arcoverde MAM, Alves JD, et al. Coverage of directly observed treatment according to the risk of tuberculosis/HIV coinfection and unfavorable outcomes. Cogitare enferm. [Internet]. 2019 [access "insert day, monh and year"]; 24. Available at: http://dx.doi.org/10.5380/ce.v24i0.66775.

[1]Nurse. Student of the doctoral program in public health nursing. University of São Paulo. Ribeirão Preto, SP, Brazil.
[2]Physical therapist. Student of the doctoral program in nursing. University of São Paulo. Ribeirão Preto, SP, Brazil.
[3]Nurse. Student of the doctoral program in public health nursing. University of São Paulo. Ribeirão Preto, SP, Brazil.
[4]Nurse. Ph.D. in nursing. Laboratory specialist at the Ribeirão Preto College of Nursing at the University of São Paulo. Ribeirão Preto, SP, Brazil.
[5]Nurse. Ph.D. in nursing. Professor at the Western Paraná State University. Foz do Iguaçu, PR, Brazil.
[6]Nurse. Ph.D. in nursing. Professor at the Federal Institute of Mato Grosso. Barra do Garça, MT, Brazil.
[7]Nurse. Ph.D. in nursing. Professor at the Ribeirão Preto College of Nursing at the University of São Paulo. Ribeirão Preto, SP, Brazil.

ARTIGO ORIGINAL / ARTÍCULO ORIGINAL

COBERTURA DE TRATAMENTO DIRETAMENTE OBSERVADO SEGUNDO O RISCO DE COINFECÇÃO TB/HIV E DESFECHOS DESFAVORÁVEIS

RESUMO

Objetivo: analisar a cobertura do tratamento diretamente observado segundo o risco de coinfecção tuberculose/vírus da imunodeficiência humana e desfechos desfavoráveis.
Método: estudo ecológico com dados secundários relacionados aos 10.389 casos novos de coinfecção notificados no estado de São Paulo de 2010 a 2015. Dados analisados pelo Índice Local de Moran, estatística de varredura espacial e Modelos Bayesianos Hierárquicos.
Resultados: região metropolitana de São Paulo e Baixada Santista concentraram maior incidência de coinfecção e abandono ao tratamento. Baixa cobertura de tratamento diretamente observado esteve associada aos territórios em risco para a coinfecção e maior risco de abandono. Município de São Paulo, região litorânea e região de Ribeirão Preto apresentaram maior incidência de óbito, o qual não apresentou relação com a cobertura do tratamento diretamente observado.
Conclusão: baixa cobertura de tratamento diretamente observado apresentou associação com maior risco de coinfecção e abandono do tratamento.

DESCRITORES: Tuberculose; Síndrome de Imunodeficiência Adquirida; Coinfecção; Pesquisa sobre Serviços de Saúde; Pesquisa Operacional.

COBERTURA DE TRATAMIENTO DIRECTAMENTE OBSERVADO SEGÚN RIESGO DE COINFECCIÓN TB/VIH Y DESENLACES DESFAVORABLES

RESUMEN

Objetivo: Analizar la cobertura del tratamiento directamente observado según el riesgo de coinfección tuberculosis/virus de la inmunodeficiencia humana y desenlaces desfavorables.
Método: Estudio ecológico con datos secundarios relacionados con los 10.389 nuevos casos de coinfección informados en el estado de São Paulo de 2010 a 2015. Datos analizados mediante Índice Local de Moran, estadística de muestreo espacial y Modelos Bayesianos Jerárquicos.
Resultados: La región metropolitana de São Paulo y Baixada Santista concentraron mayor incidencia de coinfección y abandono del tratamiento. La baja cobertura de tratamiento directamente observado estuvo asociada a las áreas con riesgo de coinfección y mayor grado de abandono. El Municipio de São Paulo, la región litoral y el área de Ribeirão Preto expresaron mayor incidencia de decesos, no relacionándose ello con la cobertura del tratamiento directamente observado.
Conclusión: La baja cobertura de tratamiento directamente observado mostró asociación con mayor riesgo de coinfección y abandono del tratamiento.

DESCRIPTORES: Tuberculosis; Síndrome de Inmunodeficiencia Adquirida; Coinfección; Investigación sobre Servicios de Salud; Investigación Operativa.

Laura Terenciani Campoy | Luiz Henrique Arroyo | Antônio Carlos Vieira Ramos | Rubia Laine de Paula Andrade | Marcos Augusto Moraes Arcoverde | Josilene Dália Alves | Ricardo Alexandre Arcêncio

INTRODUCTION

Tuberculosis (TB) remains a serious public health problem, mostly affecting people living in developing countries, which makes its eradication increasingly distant from the target established by the WHO End TB strategy, namely less than one case per 100,000 people[1].

In 2015, 10.4 million TB cases were notified worldwide, of whom 1.1 million (10.6%) were people living with the human immunodeficiency virus (HIV) or the acquired immunodeficiency syndrome (PLHA)[1]. In this scenario, Brazil is ranked twentieth regarding the viral load and nineteenth concerning TB/HIV coinfection[2].

The TB/HIV coinfection is one of the main barriers to control TB[3], given that the presence of both conditions leads to higher chances of unfavorable outcomes, such as treatment default or death[4]. In 2015, the default rate among patients coinfected with TB/HIV was 11.6% and the death rate was 17.8%, numbers significantly higher than the targets advocated by the World Health Organization, which are currently 5% and 1%, respectively[5].

The directly observed treatment (DOT) strategy can be an ally to reach these goals. It is a resource to promote treatment adherence and success[6], since it guarantees that patients will take medications and strengthens the bond between them and health services and professionals[7]. In Brazil, the cure rate is 70.4% approximately, but implementing DOT could increase that number to 90% and allow to reach the established target of 85%[4].

Considering the current challenges to eliminate TB, it is important to carry out investigations that can show the DOT coverage and its impact on treatment outcomes. The present study had the objective of analyzing the DOT coverage in municipalities in the state of São Paulo, Brazil, according to the risk of TB/HIV coinfection and unfavorable outcomes.

METHOD

Ecological study[8] carried out in the 645 municipalities of the Brazilian state of São Paulo, which accounts for around 9.9% (1,963) of the cases of TB/HIV coinfection in the country[9].

The study population met the following inclusion criterion: new cases of TB with coinfection by HIV of people living in the state of São Paulo, between 2010 and 2015. The established exclusion criteria were: people from the prison system and cases whose outcome were failure, change of diagnosis, or transfer to another state. Data were collected in December 2017 from the System for Notification and Monitoring of TB Cases (TBWEB) and public databases of the Brazilian Institute of Geography and Statistics. Treatment of obtained data proceeded after the exclusion of cases according to the mentioned criteria and those whose anti-HIV tests were negative, in progress or lacked information.

Data analysis included the calculation of the annual incidence of TB/HIV coinfection cases by carrying out the direct standardization using the patients' covariables gender and age (≤14 years, 15 to 59 years, and ≥60 years), and considering the total population of the state as the standard population[10].

The proportions of unfavorable outcomes, that is, treatment default or death, in cases of TB/HIV coinfection were calculated by municipality. Deaths caused or not caused by TB were included, given that the latter mostly correspond to deaths by HIV.

An incidence rate and a proportion of unfavorable outcomes were attributed to each municipality, and subsequently choropleth maps were produced using the ArcGIS 10.6 software. In the elaboration of incidence ranges of those maps, the first range was

defined as the absence of registered cases in the municipality, and the other ranges were established by following the approximation method entitled Natural Breaks, developed by Jenks[11].

To identify the areas showing risk for incidence of cases and unfavorable outcomes, the researchers initially used the local Moran's index (local indicators of spatial association or LISA). This is a spatial cluster localization analysis that takes into account both the effect of neighboring municipalities and the average values of all the studied area, in this case the state of São Paulo[12].

The results classify the areas into hot (High-High), cold (Low-Low), and spatial outliers (High-Low and Low-High). Only the High-High and Low-Low regions were considered for the elaboration of subsequent maps and examinations.

These analyses require a spatial relationship parameter (spatial weight), that is, a model of interaction between the studied municipalities, the incidence rate, and the proportion of unfavorable outcomes. Spatial interpolation is fundamental to understand spatial standards[13] and may influence the results significantly[14], so three models were applied to increase the capacity of the present study to detect clusters.

The first one, entitled Inverse Distance Weighting, uses the distance between the examined units as a weighting element of the spatial weight. This way, all the municipalities influence each other, but the neighboring ones have a higher weight in the relationship[15].

The second and third methods determine the level of spatial relationship based on the borders of the analyzed units. They are known as Natural Neighbor or Spatial Contiguity and were developed by Sibson (1981)[16]. The first type of the model was designated Rook, and the second was entitled Queen.

After carrying out the mentioned procedures, spatial scan statistics[17] was applied to the data. It counts the TB/HIV coinfection cases or the number of people who gave up treatment or died per analysis unit. The identification of risk areas in this type of analysis is performed considering that the data follow a Poisson distribution, with a standardization by the covariables gender and age.

The scan allowed to classify the risk areas based on the relative risk and their respective 95% confidence intervals (CI). The SaTScan version 9.4 software was used, with no overlapping of risk areas, 999 replications for Monte Carlo simulations, and circular risk areas.

The proposal by Han et al. (2016)[18] was used in the definition of the maximum cluster size, which allowed to determine 30% of the population at risk as the maximum population in the circular analysis interval in the three analyzed events.

Subsequently, the 645 municipalities were categorized as belonging or not to one of the risk areas for incidence, treatment default, and death so the hierarchical Bayesian models could be developed. Specifically for LISA, risk areas were considered as those in the High-High category. After defining this as the response variable, logistic regression with binomial distribution was applied, which showed the relationship between the risk areas and the DOT coverage per municipality. They were classified into three categories: high, with ≥80% of DOT coverage; intermediate, 31% to 79% of DOT coverage; and low, with ≤30% of DOT coverage. Indicated and not carried out DOT data were used.

Still regarding this model, the non-completion of this piece of information at TBWEB (missing data) per municipality was considered to remove possible confusing effects in the analysis.

After application of logistic regression, the insertion of the spatial effect was also considered based on the model by Besag, York, and Mollié[19], which takes into account random effects specific to the area by including two components: effects that vary in space

Laura Terenciani Campoy | Luiz Henrique Arroyo | Antônio Carlos Vieira Ramos | Rubia Laine de Paula Andrade | Marcos Augusto Moraes Arcoverde | Josilene Dália Alves | Ricardo Alexandre Arcêncio

in a structured way, that is, correlated clustering or heterogeneity; and effects that vary along the analyzed areas in a nonstructured way, that is, non-correlated heterogeneity. The models with and without the spatial component were compared based on the Watanabe–Akaike information criterion value, and the model with the lowest estimator value was selected.

Statistical models were developed for each response variable, incidence of TB/HIV coinfection cases and people who gave up the treatment or died. Additionally, the odds ratio (OR) and the 95% credibility interval were calculated for each explanatory variable. Noninformative priors were considered for the analyses and the subsequent distributions were obtained by using the integrated nested Laplace approximation, available in the R software in the R-INLA package[20].

The present study was approved by the Research Ethics Committee of the Ribeirão Preto College of Nursing at the University of São Paulo as per report no. 1,617,513.

RESULTS

The search resulted in a total of 10,389 cases of TB/HIV coinfection, among which 7,479 (72%) were men and 2,910 (28%) were women, and 9,980 (96.1%) belonged to the 14 to 59 years age group. The distribution of the cases in the municipalities was: capital of the state (the city of São Paulo) and the São Paulo metropolitan area: 6,290 or 60.5%; interior of the state: 3,113 or 30.0%; and coastal region: 986 or 9.5%. Regarding the outcome, 5,847 (56.3%) patients were cured, 2,396 (23.1%) died, and 2,047 (19.7%) had treatment default.

The spatial distribution of the incidence rates of TB/HIV coinfection cases and the proportion of unfavorable outcomes in the TB treatment can be seen in Figure 1.

A

Incidence rate of the
TB/HIV coinfection
(cases/100.000 people)

- 0.00
- 0.01 - 1.58
- 1.59 - 2.78
- 2.79 - 4.63
- 4.64 - 574.53

B

Treatment default proportion (%)

- 0
- 1 - 13
- 14 - 20
- 21 - 33
- 34 - 100

C

Death proportion (%)

- 0
- 1 - 20
- 21 - 30
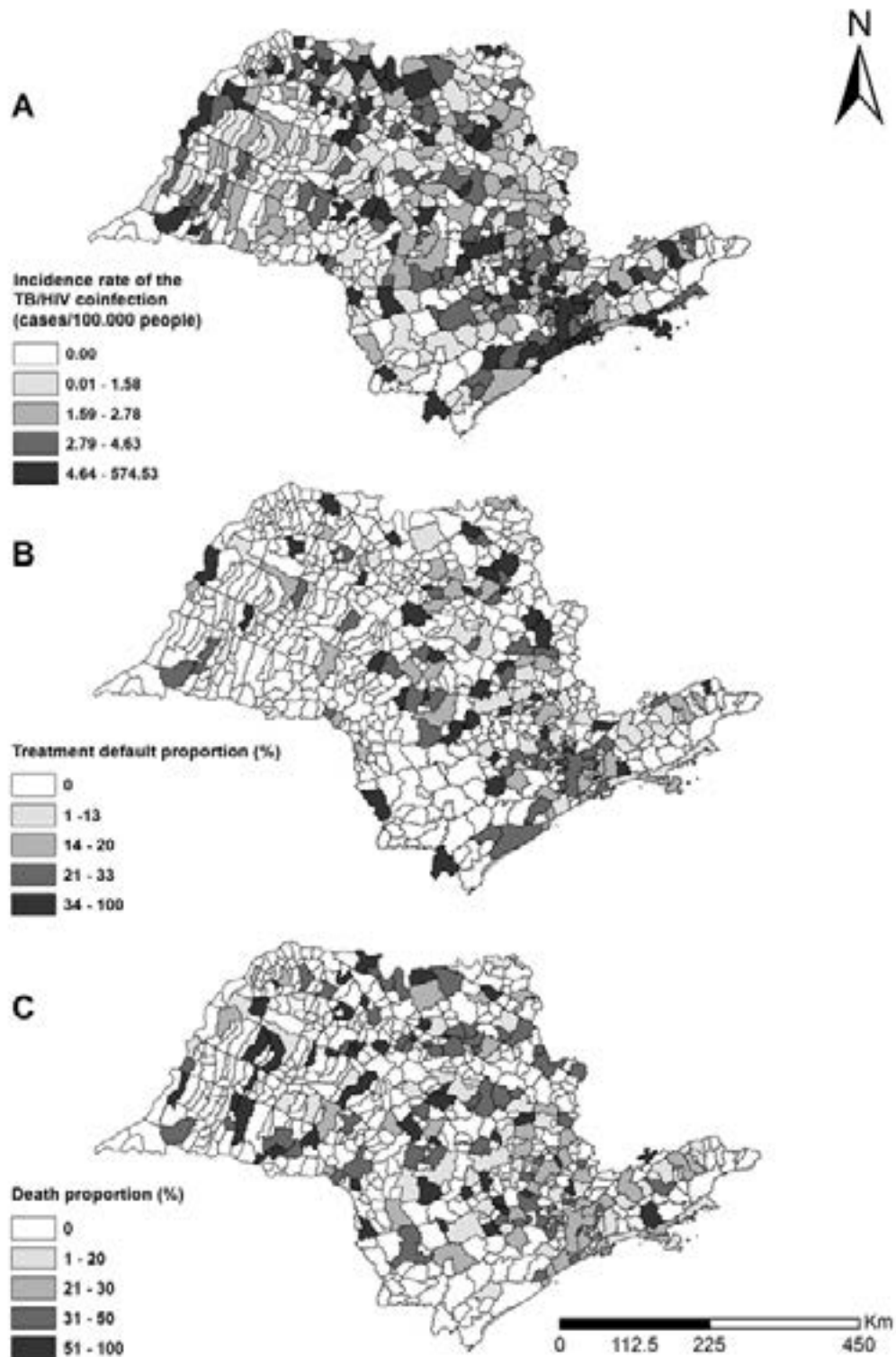- 31 - 50
- 51 - 100

N

Km
0   112.5   225   450

Figure 1 – Spatial pattern of the TB/HIV coinfection and unfavorable outcomes in the state of São Paulo, Brazil (2010-2015). Ribeirão Preto, SP, Brazil, 2019
Caption: A – Incidence of the TB/HIV coinfection (cases/100,000 people). B – Proportion of cases of TB/HIV coinfection that had TB treatment default (%). C – Proportion of cases of TB/HIV coinfection that died (%).

The highest incidence rates were concentrated in the São Paulo metropolitan area and Baixada Santista, but it was found that some municipalities in the interior of the state had equally high incidence rates without being necessarily surrounded by municipalities in the same situation. It is important to mention that 13 (2%) municipalities showed incidence rates higher than 20 per 100,000 people.

Laura Terenciani Campoy | Luiz Henrique Arroyo | Antônio Carlos Vieira Ramos | Rubia Laine de Paula Andrade | Marcos Augusto Moraes Arcoverde | Josilene Dália Alves | Ricardo Alexandre Arcêncio

Regarding the unfavorable outcomes in people with the TB/HIV coinfection, the observed treatment default pattern was similar to that found for case incidence, that is, municipalities nearer the São Paulo metropolitan area showed a higher default frequency. In contrast, the distribution of patients who died in the state seems to have a random pattern, given that some municipalities located in the interior of the state had a high proportion of patients who died without having neighboring municipalities in the same situation. However, it is relevant to point out that the São Paulo metropolitan area showed a certain concentration of this event.

Concerning the local Moran's index and the case incidence (Figure 2), the São Paulo metropolitan area showed a High-High cluster in the three used spatial interpolation methods. The Low-Low cluster proved to have a higher number of municipalities and concentrated in the northwestern region of the state.
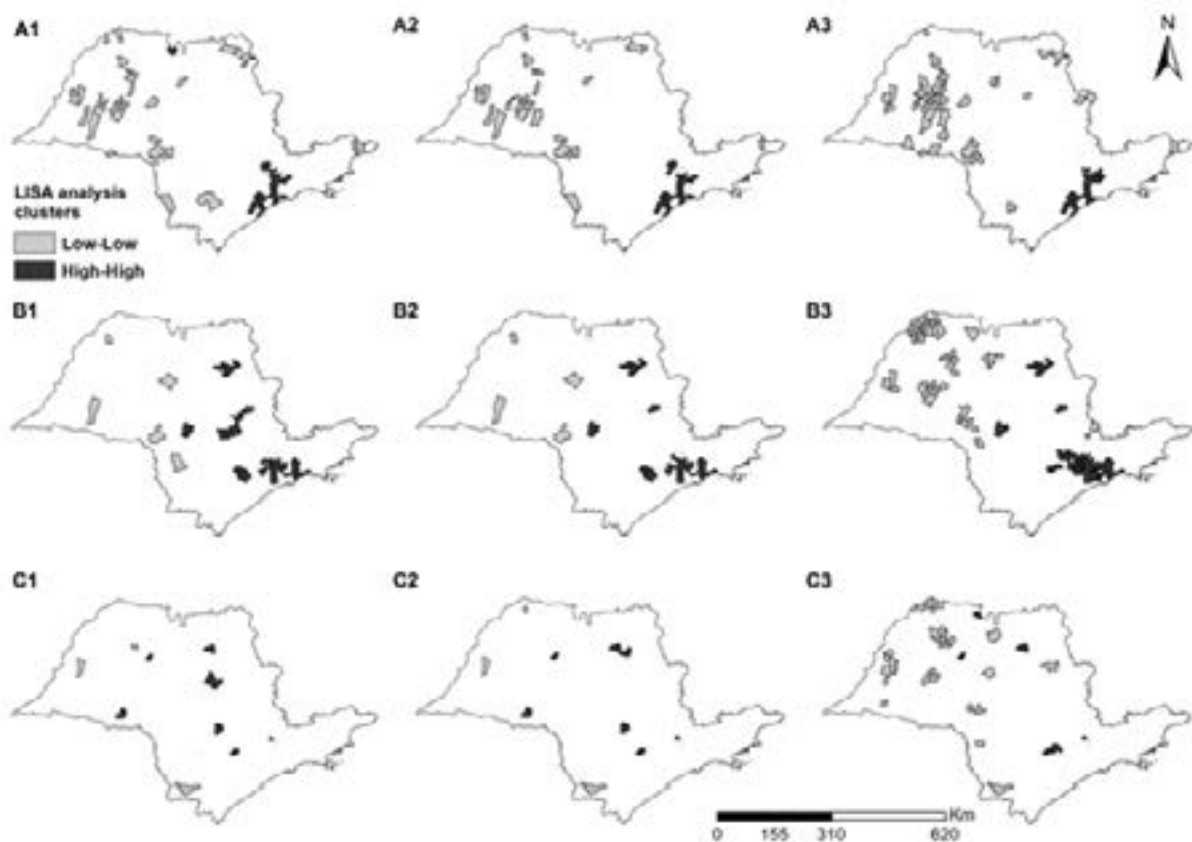

Figure 2 – Spatial distribution of incidence rates of TB/HIV coinfection and proportions of unfavorable outcomes in the state of São Paulo, Brazil (2010-2015). Ribeirão Preto, SP, Brazil, 2019
Caption: A – Incidence rate of TB/HIV coinfection (cases/100,000 people). B – Proportion of cases of TB/HIV coinfection that gave up the TB treatment (%). C – Proportion of cases of TB/HIV coinfection that died (%). A1, B1, C1 - Contiguity edges corners; A2, B2, C2 - Contiguity edges only; A3, B3, C3 - Inverse distance.

Local indicators of spatial association analysis showed a High-High cluster in the São Paulo metropolitan area, the Ribeirão Preto region, and the municipalities of Lençóis Paulista and Leme. The municipalities of Rio Claro and Piracicaba were considered as being part of the High-High cluster. The Low-Low cluster was more frequent in the northwestern region and the border with the state of Minas Gerais.

In the analysis of death occurrences in cases of TB/HIV coinfection, a few municipalities

that contributed to the High-High cluster significantly were identified. For the Low-Low cluster, the northwestern region was more prominent.

Spatial scan analysis of the cases identified four risk areas, shown in Figure 3. Risk area 1 was located in the capital of the state, and risk area 2 was in the coastal region. The interior of the state accounted for two risk areas, the first one including Ribeirão Preto, Cravinhos, and Dummont (risk area 3) and the second one being the city of São José do Rio Preto (risk area 4).

Figure 3 – Critical areas for TB/HIV coinfection, TB treatment default, and death among cases of coinfection in the state of São Paulo, Brazil (2010-2015). Ribeirão Preto, SP, Brazil, 2019
Caption: A – Risk areas for the incidence of TB/HIV coinfection. B – Risk areas for TB default treatment in cases of TB/HIV coinfection (%). C – Risk areas for death in cases of TB/HIV coinfection (%).

Laura Terenciani Campoy | Luiz Henrique Arroyo | Antônio Carlos Vieira Ramos | Rubia Laine de Paula Andrade | Marcos Augusto Moraes Arcoverde | Josilene Dália Alves | Ricardo Alexandre Arcêncio

Regarding treatment default, the scan identified two risk areas: the city of São Paulo and Santos. Three risk areas were identified for deaths associated with the coinfection: the city of São Paulo, the coastal region of the state, and the Ribeirão Preto region.

Subsequently, the three proposed models were verified by applying Bayesian analyses (Table 1), with the response variables being the risk areas for incidence, treatment default, and death. In all analyses, the model designed with the spatial component was the one that showed the best Watanabe–Akaike information criterion estimator.

Table 1 – Results of the regression associating risk areas for incidence and unfavorable outcomes of TB/HIV cases and directly observed treatment. Ribeirão Preto, SP, Brazil, 2019

Explanatory variable	Odds Ratio (95% credibility interval)		
	Risk areas for incidence*	Risk areas for treatment default†	Risk areas for death‡
Coverage of directly observed treatment			
≥ 80%	1	1	1
31% – 79%	1.10 (0.31- 4.10)	3.39(1.03-12.15)	2.92(0.94-9.04)
≤ 30%	0.18(0.03-0.76)	0.13(0.02-0.57)	0.01(0.01-9.30)
Lack of completion of the notification form regarding treatment type (continuous variable)	3.81(0.30-35.61)	1.33(0.09-14.62)	0.78(0.02-18.49)

*Watanabe-Akaike Information Criterion with spatial component = 133.73; without spatial component = 187.98. Special structure explained 36% of data variability.
†Watanabe-Akaike Information Criterion with spatial component = 145.89; without spatial component = 250.93. Special structure explained 30% of data variability.
‡Watanabe-Akaike Information Criterion with spatial component = 253.14; without spatial component = 263.71. Special structure explained 97% of data variability.

Concerning incidence, assuming a DOT coverage equal to or higher than 80% of the coinfection cases as a reference value, data indicated a relationship between risk areas and low DOT coverage (OR = 0.18; 95% credibility interval = 0.03-0.76). Regarding treatment default, there was an association of risk areas for this outcome with and intermediate (OR = 3.39; 95% credibility interval = 1.03-12.15) and low DOT coverage (OR = 0.13; 95% credibility interval = 0.02-0.57), with a DOT coverage equal to or higher than 80% of the coinfection cases being used again as a reference value. No evidence of association of risk areas for death with DOT coverage was found.

DISCUSSION

The regions that showed risk areas in cluster analyses have the marked characteristics of being populous, with considerable socioeconomic inequalities, and intense human flow[21]. Large urban centers usually show a higher number of notifications of TB cases, a fact that matches the higher rate of occurrence of risk factors for the development of TB and its unfavorable outcomes, such as intravenous drug abuse, migration and lack of habitation, and social inequality.

Additionally, these are tourist and port regions, because of both including the capital

of the state and the largest economic center in the country and being coastal areas, which may impair control actions for the coinfection. These results are compatible with those of a study carried out in Portugal[22], which identified that the main urban areas belonging to tourist regions showed the highest default rates in TB cases.

The different spatial analyses performed in the present study allowed to achieve a more comprehensive screening in risk areas for the incidence of TB/HIV coinfection and unfavorable outcomes. This approach increases the understanding of the coinfection distribution in the São Paulo state and shows possible critical areas that demand intervention actions. The largest risk areas in the state were observed for incidence and treatment default, which may indicate that characteristics inherent in these regions are relevant for the spatial distribution of the cases and treatment default.

Analysis of the association of risk areas with the DOT coverage identified an important relationship. It is known that DOT is more effective than the self-administered modality for treatment success[23]. Despite all the challenges faced to operationalize DOT, involving, for instance, the organization of health services and of the geopolitical and management context and the need for healthcare professionals and local governments to adapt to it, there were improvements in TB control indicators after the implementation of this policy, especially in vulnerable populations[24].

The Brazilian Ministry of Health considers as DOT the effectuation of at least 24 medication administrations watched by a professional of the health team during the loading dose phase and 48 medication administrations watched by a professional of the health team during the maintenance phase. The procedure can be carried out both at the patients' homes and health units[4].

Actions oriented toward preventing TB treatment default are necessary, given that it increases the chances of antibiotic resistance, transmission of diseases, morbidity, and mortality[25]. The targets of these actions must be the populations more likely to give up the TB treatment, such as PLHA, street dwellers, drug users, and persons deprived of freedom, among others[26].

The main reasons that lead patients with TB/HIV coinfection to give up the TB treatment relate to the fact that they feel healed after the improvement of the symptoms; the intolerance to the medications' adverse effects; their unfavorable socioeconomic condition; the impossibility to be absent at work, which limits the attendance to the health service to have medical appointments and get the medications; and the use of alcohol and ilicit drugs, which reduce the patients' perception of the importance to adhere to the treatment. Deficiencies in health services, including inadequate physical structure, reduced human resources, and limited access to health actions and services also contribute to nonadherence[27].

The proposed classification for the DOT coverage in the municipalities in the state of São Paulo was essential to explain the possible relationship between DOT and occurrence of risk areas. Municipalities that have a DOT coverage lower than 30% possibly are those with a lower incidence of coinfection cases, which makes the DOT strategy not to be effectively implemented by health services because priority is given to regions with a higher incidence of cases.

However, municipalities with a DOT coverage between 31% and 79% were those with the highest probability of turning into risk areas for treatment default, which may indicate that, although these places are more endemic for the disease, the coverage is not high enough to reach all the patients, leading to a higher rate of the outcome. Comparatively, municipalities that have a DOT coverage higher than 80% reduce their probability to become risk areas for default and show a greater capacity of access of patients with the coinfection to DOT.

Regarding the death outcome, analyses did not point to a relationship with the DOT coverage. It is important to emphasize that there are many factors that may be related to

Laura Terenciani Campoy | Luiz Henrique Arroyo | Antônio Carlos Vieira Ramos | Rubia Laine de Paula Andrade | Marcos Augusto Moraes Arcoverde | Josilene Dália Alves | Ricardo Alexandre Arcêncio

the death of people with TB/HIV coinfection, including the potential of the medications, the implementation of programs, and clinical characteristics, which are specific to each case. These factors may explain both the non-association with the DOT coverage and the heterogeneity in the spatial distribution found in spatial analyses. However, health actions to reduce mortality in TB/HIV coinfection cases must be oriented toward this specific population, given that these people's condition is related to a higher probability of evolving into death in comparison with PLHA who do not have TB[3].

Although the mortality rate in TB/HIV coinfection cases is high, the Brazilian Unified Health System has strategies that favor the improvement of this indicator and which go beyond offering DOT. These strategies include freely dispensing tuberculostatic and antiretroviral medications, continuously updating clinical protocols and therapeutic guidelines, and preventing HIV transmission by offering condoms and intimate lubricants indiscriminately[28,29].

To reach the goals proposed by the End TB strategy, it is necessary to improve the access to TB diagnosis and the handling of multidrug-resistant TB and act on the conditions for TB/HIV coinfection[6,30]. Consequently, it is necessary to develop operational studies, which play a relevant role in this process, because they can point the challenges to implement public policies and provide evidence from the patients' and health system's perspective[30].

One of the main challenges to control TB/HIV coinfection is the coordination of the programs of both diseases[2]. The diagnosis and treatment of these patients are carried out sometimes through the TB Control Program, sometimes through the Sexually Transmitted Diseases/AIDS program. Therefore, treatment success may be related to the management of the programs and their capacity to coordinate TB- and HIV-related actions.

The present study has limitations regarding the use of secondary data, which may have inconsistencies and missing data, causing information bias.

CONCLUSION

The São Paulo metropolitan area and Baixada Santista showed a higher risk for TB/HIV coinfection, as well as for TB treatment default and deaths. The present study brought progress to the use of statistical methods when analyzed whether these factors were associated with DOT coverage and identified that a lower DOT coverage was associated with the emergence of risk areas for the incidence of TB/HIV coinfection and TB treatment default. The findings may help managers apply public policies oriented toward these regions to achieve a more comprehensive and effective implementation of DOT and reach out populations more vulnerable to the coinfection.

ACKNOWLEDGMENTS

REFERENCES

1. World Health Organization (WHO). Global tuberculosis report 2017. Geneva: WHO; 2017 [access 25 mar 2019]. Available at: https://www.aidsdatahub.org/sites/default/files/publication/WHO_Global_

Tuberculosis_Report_2017.pdf.

2. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. Brasil livre da tuberculose: plano nacional pelo fim da tuberculose como problema de saúde pública [Internet]. Brasília: Ministério da Saúde; 2017 [access 26 mar 2019]. Available at: http://bvsms.saude.gov.br/bvs/publicacoes/brasil_livre_tuberculose_plano_nacional.pdf.

3. World Health Organization, UNAIDS. Global report: UNAIDS report on the global AIDS epidemic 2013 [Internet]. Unaids. 2013. 198 p. [access 26 mar 2019]. Available at: https://www.unaids.org/sites/default/files/media_asset/UNAIDS_Global_Report_2013_en_1.pdf.

4. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. Manual de Recomendações para o Controle da Tuberculose no Brasil. Brasília (DF): Ministério da Saúde; 2018 [access 16 fev 2019]. Available at: http://bvsms.saude.gov.br/bvs/publicacoes/manual_recomendacoes_controle_tuberculose_brasil_2_ed.pdf.

5. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Bol. Epidemiol. [Internet]. 2016 [access 07 abr 2019]; 47(13). Available at: http://portalsaude.saude.gov.br/images/pdf/2016/marco/24/2016-009-Tuberculose-001.pdf.

6. Unis G, Ribeiro AW, Esteves LS, Spies FS, Picon PD, Costa ERD, et al. Tuberculosis recurrence in a high incidence setting for HIV and tuberculosis in Brazil. BMC Infect Dis [Internet]. 2014 [access 16 fev 2019]; 14. Available at: https://doi.org/10.1186/s12879-014-0548-6.

7. Matteelli A, Rendon A, Tiberi S, Al-Abri S, Voniatis C, Carvalho ACC, et al. Tuberculosis elimination: Where are we now? Eur Respir Rev [Internet]. 2018 [access 23 jan 2019]; 27(148):1–15. Available at: http://dx.doi.org/10.1183/16000617.0035-2018.

8. Rothman K, Greenland S, Lash T. Epidemiologia Moderna. 3 ed. Artmed. 2011.

9. Ministério da Saúde (BR). Departamento de Informática do SUS (BR). Informações de saúde: epidemiológicas e morbidade – 2015 [Internet]. Brasília (DF): Ministério da Saúde; 2016 [access 07 mar 2019]. Available at: http://www2.datasus.gov.br/DATASUS/index.php?area=0203.

10. Gordis L. Epidemiology. 5 ed. Systematic biology; 2013. 416 p.

11. Jenks G. The data model concept in statistical mapping. Int Yearb Cartogr.; 1967.

12. Anselin L. Local Indicators of Spatial Association—LISA. Geogr Anal.; 1995.

13. Tobler W. A Computer Movie Simulating Urban Growth in the Detroit Region. Econ Geogr. [Internet]. 1970 [access 26 mar 2019]. Available at: http://doi.org/10.2307/143141.

14. Arslan H. Spatial and temporal mapping of groundwater salinity using ordinary kriging and indicator kriging: The case of Bafra Plain, Turkey. Agric Water Manag. [Internet]. 2012 [access 23 jan 2019]; 113:57-63. Available at: https://doi.org/10.1016/j.agwat.2012.06.015.

15. Isaaks EH, Srivastava R. Applied Geostatistics. Press OU. New York: Oxford University Press; 1989. 561 p.

16. Sibson R. A brief description of natural neighbor interpolation. In: Interpreting Multivariate Data; 1981.

17. Kulldorff M, Nagarwalla N. Spatial disease clusters: Detection and inference. Stat Med. [Internet]. 1995 [access 26 mar 2019]; 14(8):799-810. Available at: https://doi.org/10.1002/sim.4780140809.

18. Han J, Zhu L, Kulldorff M, Hostovich S, Stinchcomb DG, Tatalovich Z, et al. Using Gini coefficient to determining optimal cluster reporting sizes for spatial scan statistics. Int J Health Geogr [Internet]. 2016 [access 16 fev 2019]; 15(1). Available at: https://doi.org/10.1186/s12942-016-0056-6.

19. Besag J, York J, Mollié A. Bayesian image restoration, with two applications in spatial statistics.

Laura Terenciani Campoy | Luiz Henrique Arroyo | Antônio Carlos Vieira Ramos | Rubia Laine de Paula Andrade | Marcos Augusto Moraes Arcoverde | Josilene Dália Alves | Ricardo Alexandre Arcêncio

Ann I Stat Math. [Internet]. 1991 [access 16 fev 2019]; 43(1):1-20. Available at: https://doi.org/10.1007/BF00116466.

20. Rue H, Martino S, Lindgren F, Simpson D, Riebler A, Krainski E. INLA: Functions Which Allow to Perform Full Bayesian Analysis of Latent Gaussian Models Using Integrated Nested Laplace Approximaxion. R package version 0.0-1389624686. 2014.

21. Oliveira RNF. As Políticas Públicas de Educação e Saúde como integrantes dos índices de vulnerabilidade social e condicionantes da prosperidade social [dissertação]. NOVA Information Management School: Universidade Nova Lisboa; 2018. Available at: http://hdl.handle.net/10362/31398.

22. Nunes C, Duarte R, Veiga AM, Taylor B. Who are the patients that default tuberculosis treatment? – space matters! Epidemiol Infect [Internet]. 2017 [access 07 mar 2019]; 145(6):1130–4. Available at: https://doi.org/10.1017/S0950268816003307.

23. Tian JH, Lu ZX, Bachmann MO, Song F. Effectiveness of directly observed treatment of tuberculosis: A systematic review of controlled studies. Int J Tuberc Lung Dis [Internet]. 2014 [access 07 mar 2019]; 18(9):1092-8. Available at: https://doi.org/10.5588/ijtld.13.0867.

24. Ibanês AS, Carneiro Junior N. Panorama internacional e nacional da estratégia do tratamento diretamente supervisionado (DOTS) nas políticas de controle da tuberculose. ABCS Health Sci [Internet]. 2013 [access 17 fev 2019]; 38(1):25-32. Available at: https://doi.org/10.7322/abcshs.v38i1.5.

25. Grzybowski S, Enarson DA. The fate of cases of pulmonary tuberculosis under various treatment programmes. Bull Int Union Tuberc. [Internet]. 1978 [access 23 jan 2019]; 53(2):70-5. Available at: https://www.cabdirect.org/cabdirect/abstract/19782902484.

26. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. Saúde Brasil 2013 : uma análise da situação de saúde e das doenças transmissíveis relacionadas à pobreza. [Internet]. Brasília: Ministério da Saúde; 2014 [access 26 abr 2019]. Available at: http://bvsms.saude.gov.br/bvs/publicacoes/saude_brasil_2013_analise_situacao_saude.pdf.

27. Rodrigues ILA, Monteiro LL, Pacheco RHB, Silva SÉD da. Abandonment of tuberculosis treatment among patients co-infected with TB/HIV. Rev Esc Enferm USP [Internet]. 2010 [access 12 abr 2019]; 44(2):383-7. Available at: http://dx.doi.org/10.1590/S0080-62342010000200020.

28. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de DST/Aids. Boletim Epidemiológico: Aids e DST. 2014; 4 (3):1–84.

29. Trajman A, Pinto M, Souza R, Freitas M, Torrens A, Lima J, et al. Market assessment of tuberculosis diagnostics in Brazil in 2012. PLoS One [Internet]. 2014 [access 14 mar 2019]; 9(8):e104105. Available at: https://doi.org/10.1371/journal.pone.0104105.

30. Lienhardt C, Lönnroth K, Menzies D, Balasegaram H, Chakaya J, Cobelens F, et al. Translational research for tuberculosis elimination: priorities, challenges, and actions. PLOS Med [Internet]. 2016 [access 23 mar 2019]; 13(3):e1001965. Available at: https://doi.org/10.1371/journal.pmed.1001965

Corresponding author:
Laura Terenciani Campoy
Universidade de São Paulo
Av. dos Bandeirantes, 3900 - 14040-902 - Ribeirão Preto, SP, Brasil
E-mail: lauratcampoy@hotmail.com

Role of Authors:

Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work - LTC, LHA, MAMA

Drafting the work or revising it critically for important intellectual content - LTC, LHA, ACVR, RLPA

Final approval of the version to be published - LTC, LHA, ACVR, RLPA, MAMA, JDA, RAA

Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved - LTC, LHA, ACVR, RLPA, MAMA, JDA, RAA

Laura Terenciani Campoy | Luiz Henrique Arroyo | Antônio Carlos Vieira Ramos | Rubia Laine de Paula Andrade | Marcos Augusto Moraes Arcoverde | Josilene Dália Alves | Ricardo Alexandre Arcêncio