The Burden of Alcohol, Tobacco and Others Drugs Among Prisoners Diagnosed With Tuberculosis: Time Trends and Spatial Determinants in Southern Brazil

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Abstract

Background

Tuberculosis is an infectious disease caused by Mycobacterium tuberculosis and is a public health problem worldwide. It is estimated that 90% of the patients diagnosed with TB live in vulnerable environments with limited health resources, such as individuals living in correctional facilities. This study aimed to identify the consumption of alcohol, tobacco, and other drugs among prisoners diagnosed with tuberculosis and the spatial determinants and time trends of the phenomenon in southern Brazil.

Methods

An ecological study using data from the Brazilian Notifiable Diseases Information System. Tuberculosis cases confirmed from 2014 to 2018 in prisons located in Paraná, Brazil, were selected. The Prais-Winsten procedure was performed to identify time trends by calculating monthly rates and the percentage of monthly variation. The Seasonal-Trend by Loess decomposition method was used to verify the time series and trends. The spatial association was verified with the Getis-Ord Gi* technique, and risk areas were identified using spatial scan statistics.

Results

A total of 1,099 TB cases were found in the studied population. The consumption of tobacco (n = 460; 41.9%), illegal drugs (n = 451; 41.0%), and alcohol (n = 179; 16.3%) stand out. An ascending trend was found for the consumption of alcohol [+ 19.4%/mo. (95%CI: 12.20-23.03)], tobacco [+ 20.2% (95%CI: 12.20-28.82)], and illegal drugs [+ 62.2%/mo. (95%CI: 44.54–81.97)]. Spatial analysis revealed clusters for the use of alcohol, tobacco, and illegal drugs.

Conclusions

This study advances knowledge presenting the burden of drug use and its typology among individuals diagnosed with tuberculosis in the prison system. There is a growing trend among patients to use drugs, especially illegal drugs. The clusters show differences between the places where the prisons are located. Tuberculosis within the prison system is already a complex disease, and it is even more challenging when drugs are consumed. The consumption of drugs increased threefold when tobacco and alcohol were considered.

Background

Tuberculosis (TB) is an infectious disease caused by *Mycobacterium tuberculosis* [1] and is a public health problem worldwide, though developing countries are the most severely affected. Data show that 30 countries account for 87% of the disease burden, and Brazil ranks 19th [2].

Even though the TB burden declined in recent years before the COVID-19 pandemic, it is a disease difficult to control and eliminate due to co-infection with the Human Immunodeficiency Virus (HIV), antimicrobial resistance, multidrug-resistant TB, and increased consumption of alcohol, tobacco, and/or other drugs. In addition, TB is associated with social determinants of health, such as social vulnerability, poverty, and social exclusion to which populations such as immigrants, refugees, the homeless, and Persons Deprived of Liberty (PDL) are exposed [3]. It is estimated that 90% of the patients diagnosed with TB live in vulnerable environments with limited health resources [4], such as individuals living in correctional facilities.

The World Health Organization (WHO) estimates that the prevalence of TB among PDL is 100 times higher than in the population in general [5, 6, 7] the prison environment contributes to TB mortality rates, revealing that the control of the disease is a priority neglected throughout the world [8]. Due to the unhealthy condition to which this population is exposed, Brazilian prisons are considered an important reservoir of TB bacillus and, consequently, a source of transmission among prisoners, prison officers, and their families [9].

A literature review, conducted with the following descriptors “incarcerated,” “drug abuse and tuberculosis,” and “temporal trends and clustering,” revealed that few studies address the use of alcohol, tobacco, and other drugs among PDL diagnosed with TB, showing a need for further research. The development of studies addressing this population is crucial to promote equity and mitigate the effects of the TB burden, especially in a country like Brazil with a large contingent of prisoners. Therefore, this study’s objective is to identify the use of alcohol, tobacco, and other drugs among PDL diagnosed with tuberculosis and the spatial determinants and time trends of the phenomenon in Brazil.

Methods

Study design

Ecological study [10].

Study setting

This study was conducted in the state of Paraná, in southern Brazil, divided into four health macro-regions (east, west, north, and northwest) with 399 cities and an estimated population of 11.34 million inhabitants. The 63 prison facilities distributed in 44 cities were considered in this study [11]. Figure 1 shows the spatial distribution of prisons in the state of Paraná according to the four health macro-regions.

Population and study period

It is estimated that Brazil has 748,009 PDL [11], ranking 3rd among the countries with the largest number of prisoners, with an incidence of 352.6 prisoners per 100,000 inhabitants [12]. Paraná has the 7th largest proportion of PDL in the country, with a population of approximately 29,831 [11].

The TB cases confirmed in the state's prisons from 2014 to 2018 and reported to the Notifiable Diseases Information System (SINAN), Brazilian Ministry of Health, were selected. SINAN collects, reports, and disseminates data concerning reportable diseases according to information provided by the cities' epidemiological surveillance agencies.

Data were collected from the state Health Department using an electronic spreadsheet. The that data are anonymous, and patients cannot identified by name or facility. Inclusion criteria were PDL diagnosed with TB from 2014 and 2018 using alcohol, tobacco, or illegal drugs. The period between 2014 and 2018 was chosen because the reporting form was updated in 2014 and started including information regarding PDL and drug use.

Data analysis

The database was checked for consistency, and the cases were grouped according to the following characteristics: 1) total PDL considering all TB confirmed cases; 2) PDL consuming alcohol or reporting to be alcoholic; 3) PDL using tobacco or reporting to be a smoker, and 4) PDL using illegal drugs. Note that the same patient may use more than one drug and be included in more than one group.

Analysis Procedures

Exploratory

Descriptive statistics were performed to present the absolute and relative frequencies of the variables sex, age, race, education; TB/HIV co-infection, diabetes mellitus, mental disorder, information regarding TB clinical profile such as admission, type, and whether the following were performed: radiograph, sputum smear microscopy, histopathology, molecular test; and treatment outcome, using Statistical Package for the Social Sciences (SPSS) version 25.

Time Series

Times series is characterized as a sequential collection of observations indexed over time [13]. Hence, the TB cases reported by the prison system and grouped as mentioned earlier were organized according to the month they were reported to obtain monthly rates.

The Prais-Winsten self-regression method [14] was performed using Software for Statistics and Data Science (STATA) version 14 to classify the event's time trend into ascending, descending, or stationary in the period. The Monthly Percent Change – MPC was calculated whenever a time trend was classified as ascending or descending along with its respective 95% confidence interval (95%CI) [13]. Note that a time trend refers to the ascending, descending, or stationary tendency of a time series in a given period [13, 15].

Then, the robust Seasonal-Trend by Loess (STL by Loess) [15] method was used. This decomposition method is based on a locally weighted regression (Loess) so that it is used to estimate non-linear relationships, separating the components of a time series into trend, seasonality, or noise [15, 16]. Rstudio was used with the forecast package.

Opposed to the Prais-Winsten method in which time trend is globally assessed, and a constant is generated to classify the entire period, the STL method assesses the time trend over the period, verifying its variations over time and whether the trend was always ascending/descending or stationary or there were variations with peaks and/or decreases.

Spatial analysis

The Getis-Ord Gi* statistic, a technique consisting of a local indicator of spatial association, was used to identify the social determinants and cluster formation in each prison in the state, based on a neighborhood matrix. A z-score is generated for the statistically significant cities; the larger the z-score, the more intense the clustering of high values (hot spot). The same logic is used for a negative z-score, i.e., the smaller the z-score, the more intense is the clustering of low values (cold spot).

In addition to the z-score, the p-value and significance level (Gi-Bin) determine whether hot spots and cold spots are statistically significant. For example, values may range between +/- 3 and reflect statistical significance with a 99% confidence level, between +/- 2 with a 95% confidence level, and +/- 1 with a 90% confidence level; zero corresponds to non-statistically significant areas.

Spatial scan statistics was used to identify the TB risk spatial areas for PDL in Paraná, Brazil. First, spatial clusters were identified by finding circles with a variable radius around each center of the cities with prison facilities. Then, the number of observed and expected cases within each circle is calculated, and this procedure is performed until all centers are tested. A cluster is identified when the value observed in the area within the circle is greater or smaller than the expected [17].

In this stage, the following characteristics were considered: Poisson's discrete model, only high-risk clusters, no overlapping geographic clusters, circular clusters, 999 Monte Carlo simulation, while the size of the population exposed was determined by the Gini coefficient in which the number of expected cases in each state is proportional to the size of the population at risk [17, 18]. The relative risk (RR) and confidence interval (95%CI) of each cluster were also calculated; statistical significance was established at $p < 0.05$.

Ethical Aspects

The study was approved by the Research Ethics Committee at the University of São Paulo at Ribeirão Preto College of Nursing under Certificate of Presentation for Ethical Consideration number 24963319.1.0000.5393 and report number 3.836.401, issued on February 13th 2020 in accordance with the Guidelines and Regulatory Standards for Research with Human Subjects, Resolution number 466/2012 of the National Health Council of Brazilian Ministry of Health.

Results

A total of 1,099 TB cases were reported among PDL in Paraná. The use of tobacco was the most frequently reported (n = 460;41.8%), followed by illegal drugs (n = 451;41.0%), and alcohol (n = 179;16.3%). Regarding sociodemographic characteristics, most were Caucasian male individuals, aged between 18 and 29 years old, with a low educational level (< 8 years of schooling) (Table 1).

Table 1
Sociodemographic characteristics of PDL diagnosed with TB according to the type of drug used and total PDL, Paraná, Brazil. (N = 1,099)

Variables	PDL using alcohol	PDL using tobacco	PDL using illegal drugs	Total PDL
	n(%)	n(%)	n(%)	n(%)
Gender				
Male	173(96.6)	447(97.2)	440(97.6)	1064(96.8)
Female	6(3.4)	13(2.8)	11(2.4)	35(3.2)
Race				
Caucasian	112(62.6)	280(60.9)	290(64.3)	722(65.7)
Mixed race	48(26.8)	136(29.6)	122(27.1)	275(25.0)
African descent	19(10.6)	37(8.0)	34(7.5)	83(7.6)
Asian descent	-	3(0.7)	1(0.2)	3(0.3)
Indigenous	-	-	-	2(0.2)
Ignored	-	4(0.8)	2(0.4)	14(1.3)
Age group (years)				
18 to 29	78(43.6)	253(55.0)	269(59.6)	614(55.9)
30 to 39	64(35.8)	142(30.9)	138(30.6)	326(29.7)
> 40	37(20.7)	64(13.9)	40(9.5)	156(14.2)
Education				
Illiterate	9(5.0)	14(3.0)	8(1.8)	22(2.0)
1st to 4th grade	35(19.6)	96(20.9)	78(17.3)	198(18.0)
5th to 8th grade	82(45.8)	222(48.9)	240(53.2)	564(51.3)
> 8 years	32(17.9)	77(16.7)	62(13.7)	297(27.0)

Sources: study's data

TB/HIV co-infection was more prevalent among smokers and those using illegal drugs, whereas TB/diabetes mellitus and mental disorders were more frequent among those consuming alcohol. The TB clinical profile was: new cases, pulmonary TB, no radiograph, positive sputum smear microscopy, histopathology, and molecular test revealing sensitivity to rifampicin among the groups using tobacco and illegal drugs. Regarding TB treatment outcome, cure and DR-TB were predominant among smokers and individuals using illegal drugs, while alcohol consumers tended to abandon the treatment more frequently (Table 2).

Table 2
– Clinical characteristics of PDL diagnosed with TB using alcohol, tobacco, or illegal drugs. Paraná, Brazil (N = 1,099)

Variables	PDL using alcohol	PDL using tobacco	PDL using illegal drugs	Total PDL
	n(%)	n(%)	n(%)	n(%)
AIDS				
Yes	21(11.7)	39(8.5)	39(8.6)	82(7.5)
No	155(86.6)	409(88.9)	394(87.4)	971(88.4)
Diabetes Mellitus				
Yes	7(3.9)	13(2.8)	8(1.8)	21(1.9)
No	170(95.0)	430(93.5)	422(93.6)	1025(93.3)
Mental disorder				
Yes	4(2.2)	9(2.0)	8(1.8)	17(1.5)
No	172(96.1)	435(94.6)	424(94.0)	1029(93.6)
Admission				
New case	136(76.0)	359(78.0)	344(76.3)	880(80.1)
Relapse	11(6.1)	29(6.3)	30(6.7)	70(6.4)
Retreatment after treatment abandonment	20(11.2)	38(8.3)	39(8.6)	66(6.0)
Transference	12(6.7)	34(7.4)	38(8.4)	79(7.2)
Type				
Pulmonary	156(87.2)	410(89.1)	402(89.1)	968(88.1)
Extrapulmonary	21(11.7)	40(8.7)	39(8.6)	105(9.6)
Pulmonary + extrapulmonary	2(1.1)	10(2.2)	10(2.2)	26(2.4)
Radiograph				
Suspected TB	148(82.7)	374(81.3)	360(79.8)	877(79.8)
Normal	3(1.7)	10(2.2)	9(2.0)	32(2.9)
Other pathology	1(0.6)	-	-	3(0.3)
Not taken	26(14.5)	75(16.3)	80(17.7)	182(16.6)
Sputum smear microscopy				
Positive	114(63.7)	288(62.6)	302(67.0)	703(64.0)
Negative	35(19.6)	80(17.4)	65(14.4)	179(16.3)
Not taken	25(14.0)	86(18.7)	78(17.3)	202(18.4)
Histopathology				
Baar Positive	15(8.4)	16(3.5)	22(4.9)	69(6.3)
Suggestive of TB	5(2.8)	21(4.6)	19(4.2)	44(4.0)
Not suggestive of TB	3(1.7)	4(0.9)	4(0.9)	8(o.7)
Not performed	153(85.5)	405(88.0)	396(87.8)	951(86.5)
Molecular test				
Rifampicin sensitivity detected	65(36.3)	227(49.3)	223(49.4)	432(39.3)
Rifampicin resistance detected	3(1.7)	11(2.4)	9(2.0)	21(1.9)
Not detectable	9(5.0)	35(7.6)	29(6.4)	57(5.2)
Not performed	97(54.2)	179(38.9)	182(40.4)	543(49.4)
Outcome				
Cure	116(64.8)	312(67.8)	301(66.7)	743(67.6)
Abandoned	25(14.0)	42(9.1)	40(8.9)	89(8.1)

Variables	PDL using alcohol	PDL using tobacco	PDL using illegal drugs	Total PDL
	n(%)	n(%)	n(%)	n(%)
Death due to TB	2(1.1)	4(0.9)	3(0.7)	18(1.6)
Death due to another cause	5(2.8)	15(3.3)	9(2.0)	31(2.8)
Transferred	18(10.1)	43(9.3)	51(11.3)	119(10.8)
DR-TB	12(6.7)	41(8.9)	43(9.5)	75(6.8)

Source: Study's data.

Table 3
Time trend of TB incidence among PDL according to the consumption of psychoactive substances. Paraná, Brazil. (2014–2018). (N = 1,099)

Variable	Coefficient	(95%CI)*	Time trend	MPC† (95%CI)
Total PDL	-0.30	(-0.19 - -0.40)	Descending	-49.88 (-35.43–60.19)
PDL consuming alcohol	0.07	(0.05–0.09)	Ascending	19.40 (12.20–23.03)
PDL using tobacco	0.08	(0.05–0.11)	Ascending	20.23 (12.20–28.82)
PPL using illegal drugs	0.21	(0.16–0.26)	Ascending	62.18 (44.54–81.97)

Source: Study's data.

*95%CI = 95% Confidence Interval; †MPC = Monthly percentage change

The time trend of TB cases in the total PDL was classified as descending, with a decrease of -49.8% a month (95%CI: -35.43 to -60.19). When analyzing the psychotic substances, an ascending time trend was found for alcohol consumers +19.4%/mo. (95%CI: 12.20 to 23.03); smokers +20.2% (95%CI: 12.20 to 28.82), and drug users +62.2% (95%CI: 44.54 to 81.97), as shown in (Table 3).

The time series decomposition technique (Figs. 2A, 2B, and 2C) showed an increase in the TB time trend among PDL using alcohol, tobacco, and illegal drugs, whereas Fig. 2D shows a decrease in the time trend of the total population between 2014 and 2018. These findings corroborate data presented in Table 3 concerning the results from the Prais-Winsten analysis.

Figure 3A concerns the total PDL. The Getis-Ord Gi* technique identifies three hot spots: east (metropolitan region of Curitiba), north and west macro-regions. Figure 3B reveals three hot spots, two in the east macro-region (metropolitan region of Curitiba and in Ponta Grossa) and in the north macro-region; the pseudo-significance test presented a z-score of 4.27 confirming the clusters' non-randomness ($p < 0.00$). Figure 3C shows a hot spot in the east macro-region (z-score = 2.41 and $p < 0.01$), and Fig. 4D presents two hot spots in the east and north macro-regions (z-score = 2.13 and $p < 0.03$).

Figure 4A shows a relationship between TB and the total PDL, indicating four spatial risk clustering, namely: 1) one in the city of Pinhais located in the east macro-region (metropolitan region of Curitiba) presenting RR:17.75 (95%CI 15.40-19.65) with 832 PDL and 296 cases; 2) in the city of Paranaguá located in the east macro-region (Paraná coast region) presenting RR:6.75 (95%CI 3.84–11.18) with 56 PDL and five cases; 3) in the north macro-region presenting RR:2.87 (95%CI 2.11–3.66) with 616 PDL and 50 cases; and 4) one in the northwest macro-region presenting RR:2.11 (95%CI 1.76–2.36) with 3,911 PDL and 212 cases.

Figure 4B presents three risk clusters among PDL diagnosed with TB using alcohol: 1) one in the city of Ourizona located in the northwest macro-region presenting RR:20.93 (95%CI 8.86–48.96) with 56 PDL and five cases observed.; 2) one located in the east macro-regional in the metropolitan region of Curitiba presenting RR:9.95 (95%CI 6.99–14.08), with 1,670 PDL and 49 cases; 3) one cluster located in the north macro-region presenting RR:2.05 (95%CI 1.43–2.87) with 7,219 PDL and 52 cases.

Figure 4C presents four spatial risk clusters concerning PDL using tobacco: 1) one in the city of Pinhais in the east macro-region (metropolitan region of Curitiba) RR:30.49 (95%CI 24.56–37.41) with 832 PDL and 142 cases reported; 2) one in Paranaguá, east macro-region (Paraná's coast region) RR:8.57 (95%CI 3.15–6.58) with 56 PDL and five cases observed; 3) north macro-region presenting RR:4.60 (95%CI 2.14–6.37) with 667 PDL and 30 cases; 4) one in Paranavaí in the northwest macro-region presenting RR:3.73 (95%CI 3.64–19.73) with 264 PDL and 9 cases observed.

Figure 4D presents two risk clusters of PDL using drugs: 1) in the city of Pinhais in the east macro-region (metropolitan region of Curitiba) presenting RR:23.81 (95%CI 19.41–28.77) with 832 PDL and 149 cases; and 2) one located in the north macro-region presenting RR:2.06 (95%CI 1.60–2.58) with 3,911 PDL and 87 cases.

Discussion

The use of tobacco and illegal drugs was prevalent among PDL diagnosed with TB, and an ascending trend was verified for alcohol, tobacco, and illegal drugs in prison facilities. The highest RR was found in the prisons located in the east macro-region (metropolitan region of Curitiba), showing that prisons contribute to TB burden and are an environment that favors the disease, considering a large number of alcohol consumers and drug users [5, 7, 9, 19, 20].

Note that the medical center providing care to prisoners is located in the east macro-region, which explains the high number of TB cases in this area. Data suggest that the availability of medical services indicates PDL have access to healthcare services, and the high rates of outpatient care consultations and hospitalizations suggest the quality of these individuals' health conditions [21].

It is worth noting that in 2003 the Ministry of Health, together with the Ministry of Justice, launched the National Health Plan for the Prison System and in 2014 established the National Policy for Integral Health Care for Persons Deprived of Liberty in the Prison System to promote health and prevent diseases in the prison system and ensure PDL access integral and quality health care provided by the Brazilian Unified Health System [22].

However, a high number of TB cases is observed among PDL, mainly pulmonary TB, which is of concern considering that the bacillus is airborne and the prisons' conditions such as overcrowding and poor ventilation favor the dissemination of TB [23]. Therefore, efficient public policies intended to provide health care to PDL.

PDL include socially vulnerable people affected by different diseases,[22] among which dependency on alcohol, tobacco, and illegal drugs stand out. Even though alcohol and tobacco consumption decreased in the population in general, there was a significant increase in the number of smokers and drug users among PDL [19]. Studies report that approximately 80% of the PDL in the United States have a history of illegal drug use [20]. One study was conducted in Norway to investigate drinking habits before imprisonment, reporting that 55% of the prisoners presented alcohol problems of some severity, and 18% were possibly alcohol dependent [24]. Not much data are available in Brazil and research in the field is still incipient considering the difficulty in discussing this phenomenon in public security institutions [25].

Hence, the consumption of legal or illegal Psychoactive Substances (PS) within prisons contributes to an increase in the number of diseases, and as this study shows, contributes to the development and maintenance of TB [26, 27]. Furthermore, these substances not only contribute to the development of TB but lead to unfavorable treatment outcomes, considering that PS is associated with higher rates of mental disorders, suicide, mortality, relapse after release [28], and violence within prisons.

The consumption of PS favors the development of diseases among PDL and is associated with higher rates of physical violence and suicide attempts within prisons; suicide attempts in this population are estimated to be three to eight times higher than in the general population. Risk factors include mental disorders, substance use disorders, suicidal ideation, suicide attempt, self-injury behaviors, accommodation in single-occupancy cells, and conviction due to violent crimes [29].

The prisons' social, spatial factors directly contribute to the maintenance of TB and other diseases considering many prisons are overcrowded, present high turnover of PDL, are poorly ventilated, and access to health services is restricted [30].

PDL live in an unhealthy environment with poor hygiene conditions, which often fail to ensure basic human needs to protect one's physical and mental health, directly contributing to disseminating transmissible diseases, violence-related injuries, and mental disorders [31]. These are characteristics observed in the east, north, and northwest macro-regions, which host risk areas for total TB and TB associated with alcohol, tobacco, and illegal drugs. Note that the west macro-region did not present any risk area for TB associated with PS.

The identification of risk prison facilities for the development of TB associated with PS consumption can support the implementation of preventive measures and quality health care, especially in those facilities with a large number of prisoners, that is, facilities exposed to a higher risk. However, there is usually a delay in the TB diagnosis, with a high prevalence of resistant bacteria, inadequate treatment and treatment abandonment, low educational level, malnutrition, mental disorders, previous diseases, TB-HIV co-infection, alcohol, tobacco, and/or illegal drugs consumption/dependency [5, 6, 32].

Therefore, prisons are a reservoir of various diseases, especially infectious-contagious diseases such as TB. The community is also exposed to TB when contacting prison officers, released prisoners, or families visiting prisoners. Hence, the prison environment promotes the incidence and maintenance of TB, and health actions are needed to break the transmission cycle and decrease the number of new cases and deaths [30].

Time trend analysis showed TB increased among PDL consuming alcohol, tobacco, or illegal drugs, which is similar in the general population. The fact that the consumption of these substances has increased worldwide is of concern, considering it is associated with worsened TB treatment outcomes [21, 23].

Therefore, a screening protocol should be implemented in the prison system to identify SP consumption and TB and invest and give priority to early diagnosis and interventions, providing appropriate treatment to avoid interruptions and relapses [30].

Achieving the goals established by the End TB Strategy and eradicating TB by 2050 will only be possible by investing in preventive measures and appropriate TB treatment. Therefore, one of the most difficult challenges is to control the progress of the disease among subpopulations presenting high incidence rates, such as PDL [33]. In this sense, PDL is a social stratum at a higher risk of TB, [7] and strategies are needed to decrease the transmission of the disease and achieve the global goals.

In this sense, the WHO recommends measures be implemented in prisons to prevent new cases, including screening protocols applied in the admission and discharge of inmates, in addition to periodical assessments of PDL or isoniazid preventive therapy [2]. Routinely screening prisoners, isolating confirmed cases, decreasing the number of inmates in a single cell, and avoiding agglomerations are efficient ways to decrease transmissions among prisoners, prison officers, families, and the community [7].

Programs intended to obtain early diagnoses, the report of new cases, and the implementation of proper treatment are vital. However, the access of PDL to health services is restricted, resulting in unfavorable outcomes and high rates of TB.

Conclusions

This study advances with knowledge in the field, as it shows the consumption of alcohol, tobacco, and illegal drugs among PDL diagnosed with TB. Clustering was found in some areas in the state with an ascending trend, highlighting the need to implement policies to control the disease in vulnerable areas and areas hosting prisons. Even though there are studies addressing TB in the prison system, this is one of the first studies investigating spatial differences and determinants using geostatistics.

These techniques are seldom adopted to address these populations, showing the originality and relevance of this investigation. Decreasing disparities and inequalities involves understanding the burden of the disease and its determinants in the prison system so that innovative approaches and studies are also needed.

Abbreviations

CI
Confidence Interval
DR-TB
Drug-resistant Tuberculosis
HIV
Human Immunodeficiency Virus
MPC
Monthly Percent Change
PDL
Persons Deprived of Liberty
PS
Psychoactive Substances
RR
Relative Risk
SINAN
Notifiable Diseases Information System
SPSS
Statistical Package for the Social Sciences
STATA
Software for Statistics and Data Science
STL
Seasonal-Trend by Loess
TB
Tuberculosis
WHO
World Health Organization

Declarations

Ethics approval and consent to participate

The study was approved by the Research Ethics Committee at the University of São Paulo at Ribeirão Preto College of Nursing under Certificate of Presentation for Ethical Consideration number 24963319.1.0000.5393 and report number 3.836.401, issued on February 13th 2020 in accordance with the Guidelines and Regulatory Standards for Research with Human Subjects, Resolution number 466/2012 of the National Health Council of Brazilian Ministry of Health.

Consent for publication

Not applicable.

Availability of data and materials

All the data supporting the study findings are within the manuscript. Additional detailed information and raw data will be shared upon request addressed to the corresponding author.

Competing interests

The authors declare that they have no competing interests.

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Author's contributions

The conception of the work, design of the work, acquisition of data, analysis, and interpretation of data was done by ARS, JDA, TZB, FLS, MJQG and RAA. Data curation, drafting the article, revising it critically for intellectual content, validation and final approval of the version to be published was done by ARS, RAA, TZB, ACVR, GLF, FMP, MAMA, SCP, AAM, IF and DG. All authors read and approved the final version of the manuscript.

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Figures

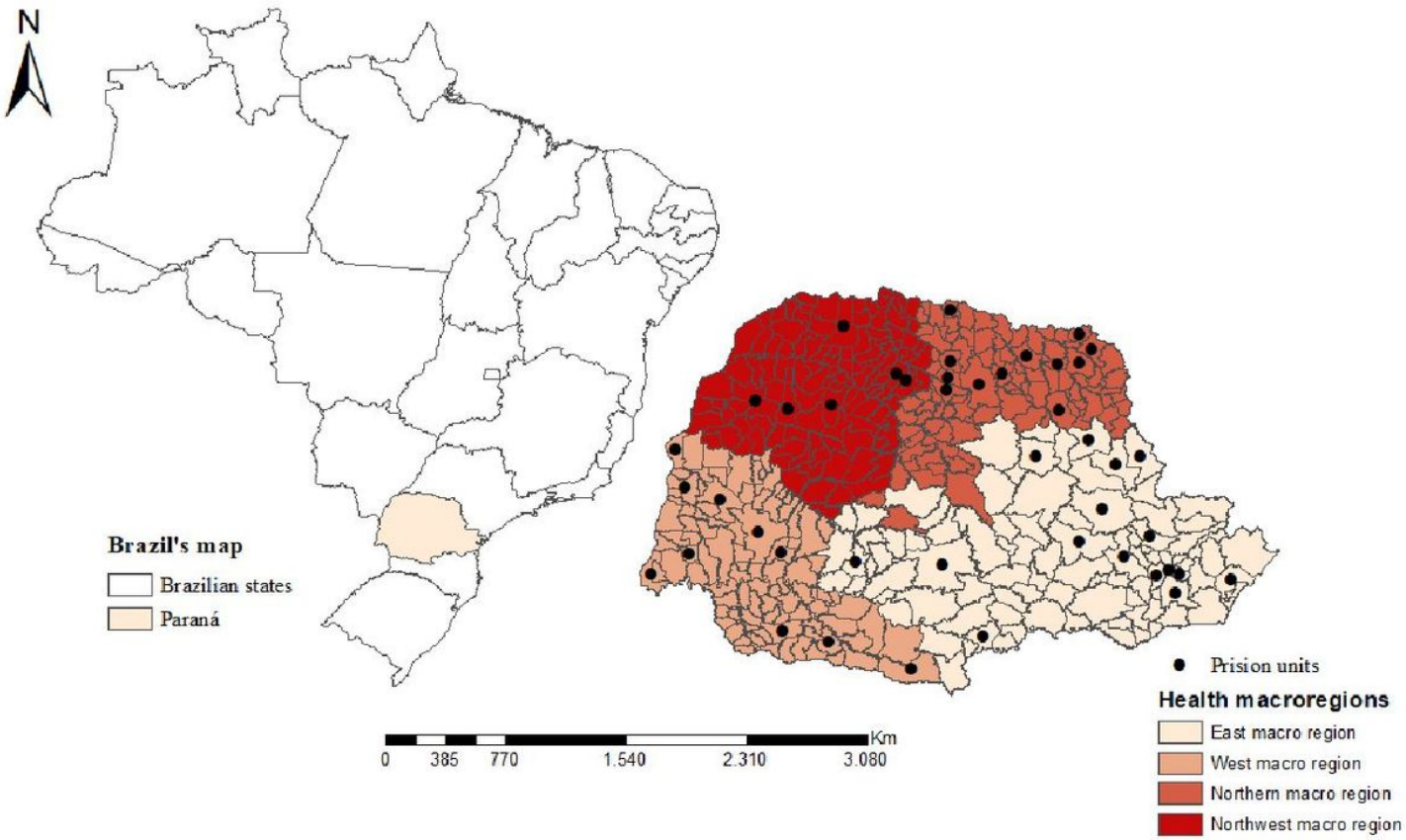

Figure 1

Distribution of macro-regions and prisons in the cities located in Paraná, Brazil 2021.

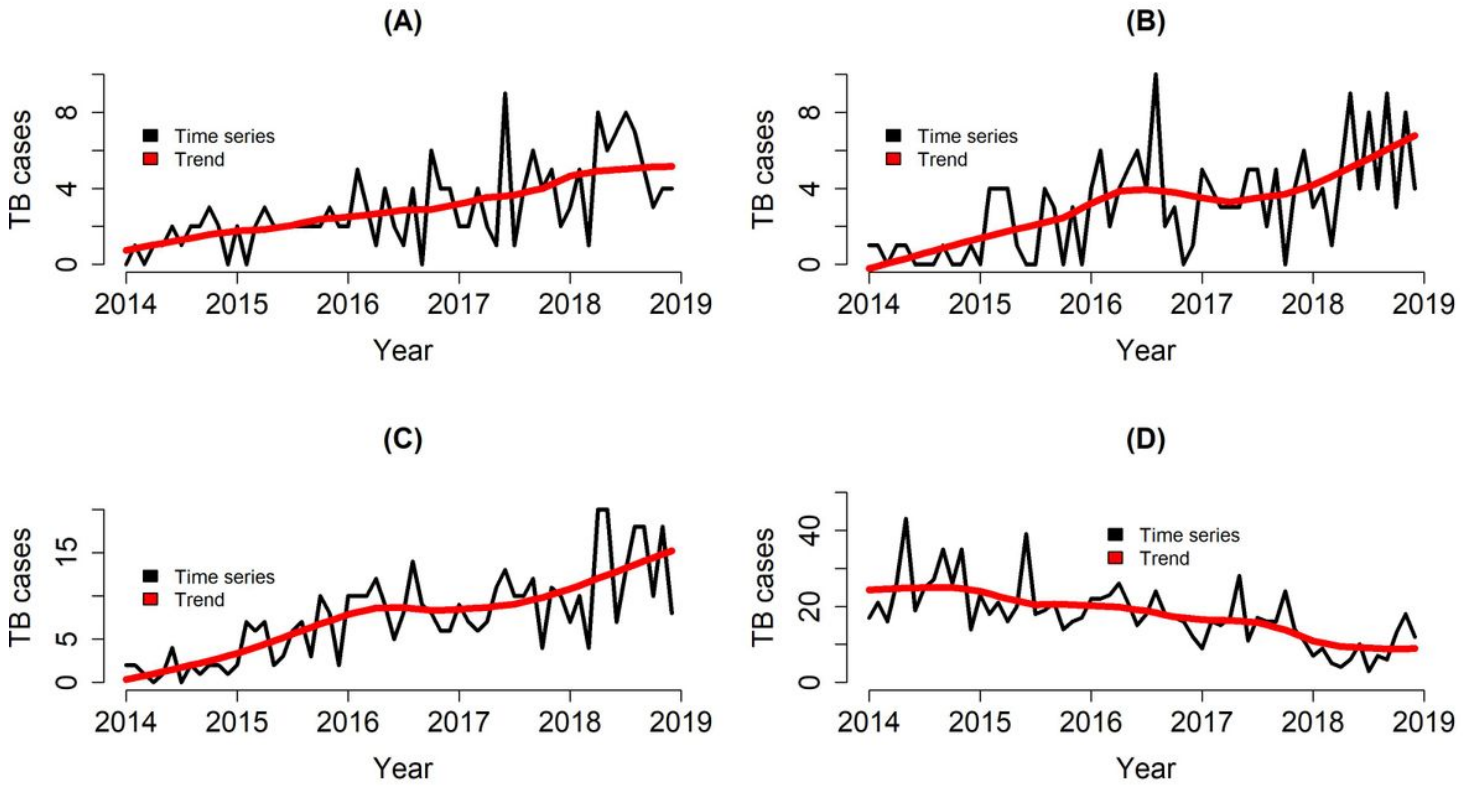

Figure 2

TB time series concerning PDL in prisons located in Paraná, Brazil (2014-2019) (N=1,099).

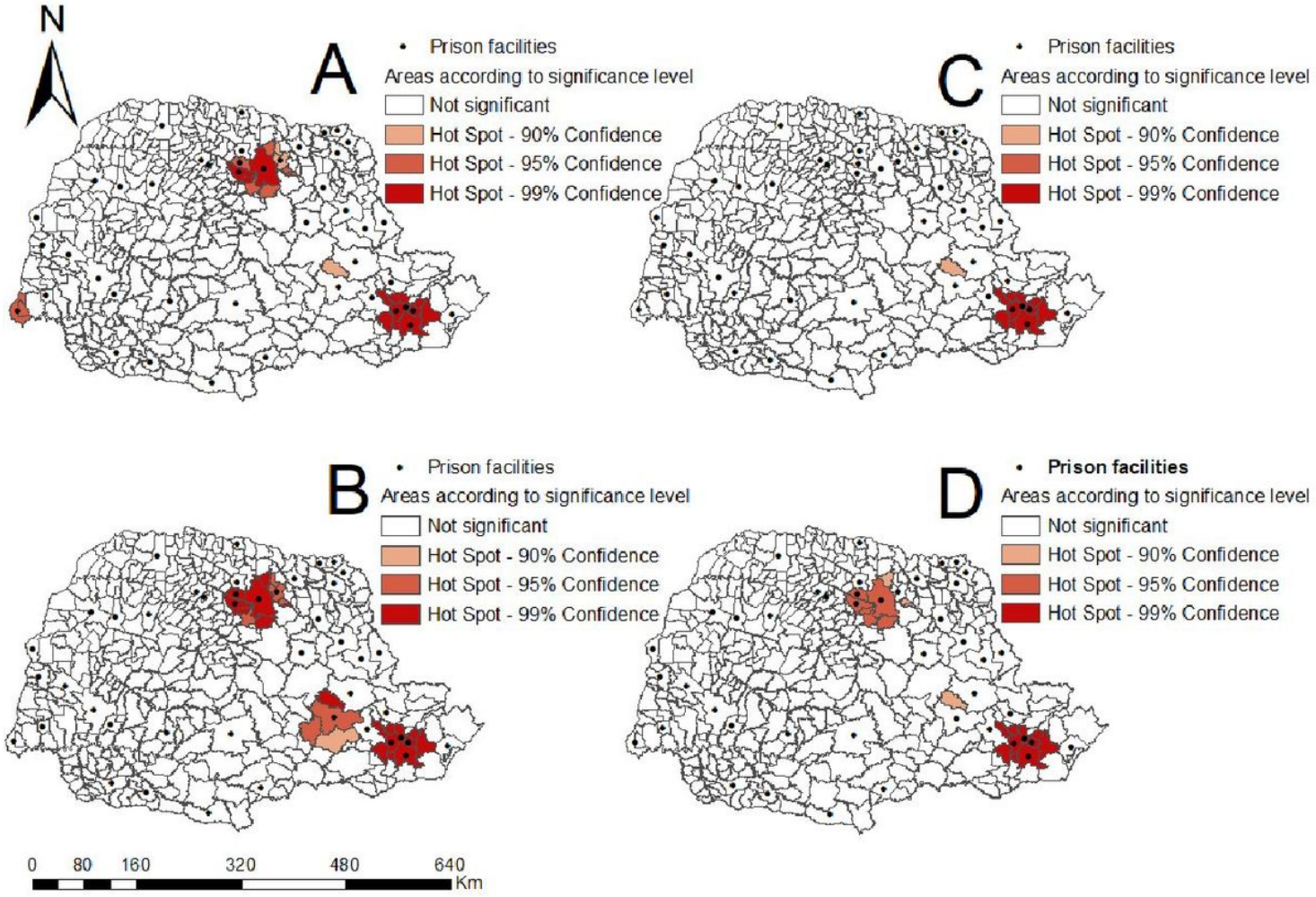

Figure 3

TB High-clusters e Low-clusters for the prison facilities. Paraná, Brazil, 2014-2018.

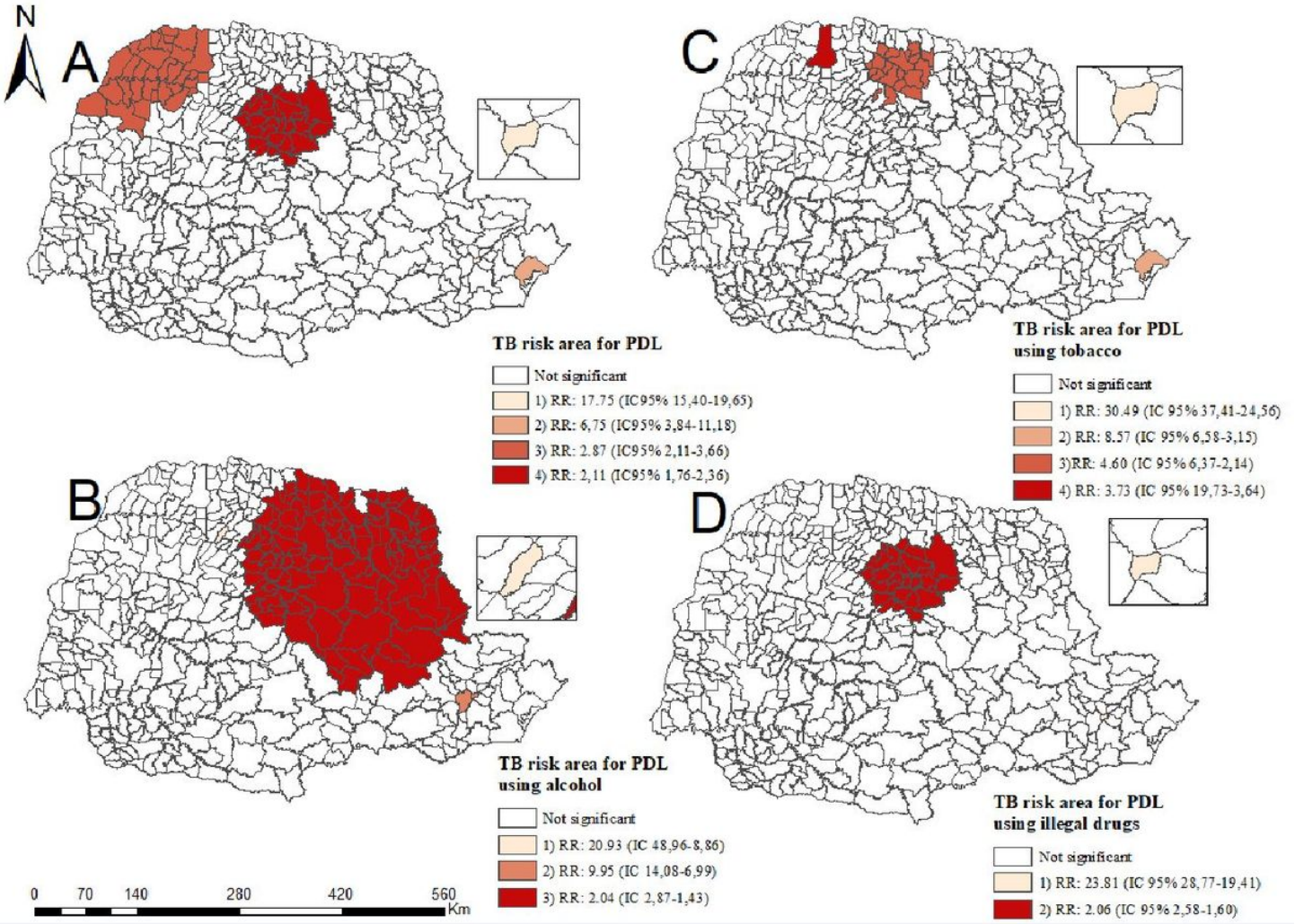

Figure 4

Areas of spatial risk for tuberculosis among PPL users of alcohol, tobacco and other drugs. Paraná, Brazil 2014-2018.