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Epidemiological profile of tuberculosis in the prison population of Minas Gerais, Brazil.

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Perfil Epidemiológico de la Tuberculosis en la Población Carcelaria de Minas Gerais, Brasil

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Abstract: Introduction: Tuberculosis is the major cause of health problems among communicable diseases and predominates as an etiology in cases of death from a single infectious agent. In the prison environment, this is even more evident, as overcrowding, poor nutrition, drug consumption and the coexistence of other diseases, associated with the precariousness of the health service, favors the spread of the disease within the walls and to the families of inmates. Currently, it is estimated that the incidence of tuberculosis in the population deprived of liberty corresponds to approximately 11.2% of new cases in the country, and this group represents only 0.3% of the Brazilian population. **Methods:** In this context, the present study aims to carry out an epidemiological analysis of tuberculosis in the prison population of the state of Minas Gerais, Brazil, based on secondary data from the Notifiable Diseases Information System (SINAN), in addition to identifying the main factors related to this type of involvement using measures of dispersion, central tendency and frequency, as well as Student's T tests for independent samples and Mann-Whitney U tests in cases where the assumptions for parametric tests were not met, considering a 95 % confidence interval. **Results:** 1880 cases of tuberculosis were registered, with a monthly average of 22.38 notifications. The proximity of the factors brown ethnicity, male sex, age between 20 and 29 years to the center of case density and between the use of alcohol, other drugs and the abandonment of treatment was notable. **Conclusion:** Thus, the need for new prevention strategies in this context is highlighted due to the high incidence of tuberculosis, often related to negligence and misinformation.

Keywords: Tuberculosis; Prisons; Epidemiology; Public policy.

Resumen: Introducción: La tuberculosis es la principal causa de problemas de salud entre las enfermedades transmisibles y predomina como etiología en los casos de muerte por un solo agente infeccioso. En el ámbito penitenciario esto es aún más evidente, ya que el hacinamiento, la mala alimentación, el consumo de drogas y la coexistencia de otras enfermedades, asociado a la precariedad del servicio de salud, favorece la propagación de la enfermedad al interior de los muros y a las familias de los internos. Actualmente, se estima que la incidencia de tuberculosis en la población privada de libertad corresponde a aproximadamente el 11,2% de los nuevos casos en el país, y ese grupo representa apenas el 0,3% de la población brasileña. **Metodología:** En ese contexto, el presente estudio tiene como objetivo realizar un análisis epidemiológico

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de la tuberculosis en la población penitenciaria del estado de Minas Gerais, Brasil, a partir de datos secundarios del Sistema de Información de Enfermedades de Declaración Obligatoria (SINAN), además de identificar los principales factores relacionados con este tipo de afectación utilizando medidas de dispersión, tendencia central y frecuencia, así como pruebas T de Student para muestras independientes y pruebas U de Mann-Whitney en los casos en que no se cumplieron los supuestos para las pruebas paramétricas, considerando un intervalo de confianza del 95 %.. **Resultados:** Se registraron 1880 casos de tuberculosis, con un promedio mensual de 22,38 notificaciones. Se destacó la proximidad de los factores etnia parda, sexo masculino, edad entre 20 y 29 años al centro de densidad de casos y entre el uso de alcohol, otras drogas y el abandono del tratamiento. **Conclusiones:** Así, se destaca la necesidad de nuevas estrategias de prevención en este contexto debido a la alta incidencia de la tuberculosis, muchas veces relacionada con la negligencia y la desinformación.

Palabras clave: Tuberculosis; prisiones; Epidemiología; Política pública.

1. Introducción

According to the World Health Organization, a quarter of the world population is infected by the Mycobacterium tuberculosis bacillus. Etiological agent of tuberculosis (TB) which is the main cause of health problems among communicable diseases and predominates as an etiology in cases of death by a single infectious agent (WHO, 2020).

The distribution of the number of cases occurs unevenly in the world, concentrating on disadvantaged social groups such as people in poverty, hunger, inadequate hygiene; persons deprived of liberty and ethnic minorities (Santo et al., 2012).

The number of people affected by TB in the world was estimated at 9.87 million people in 2020 alone, of which 1.4 million had death as an outcome. In Brazil, 96,000 new TB cases were recorded in 2020, which corresponds to an incidence of 45 cases per 100,000 inhabitants. Another study carried out by the Ministry of Health from Brazil considering the Mercosur countries placed Brazil in first place in terms of the number of cases. (WHO, 2020; Ministério da Saúde, 2018)

In addition to being recurrent, this disease also perpetuates poverty, as it compromises the health of individuals and their families, causing important economic and social problems (Ministério da Saúde, 2019). In the prison environment, this is even more evident, as overcrowding, poor nutrition, drug consumption and the coexistence of other diseases, associated with the precariousness of the health service, favors the spread of the disease within the walls and even to the families of inmates (Allgayer et al., 2019).

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Currently, it is estimated that the incidence of tuberculosis in the population deprived of liberty corresponds to approximately 11.2% of new cases in the country, and this same population represents only 0.3% of the Brazilian population. This means that, in general, the risk of becoming ill with tuberculosis for this group is approximately 35 times greater than that observed for the rest of the population (Ministério da Saúde, 2020).

Furthermore, the frequency of resistant forms of the disease in this group is exaggeratedly high, due to irregular treatment, drug use and late detection. It also potentiates the disease and makes it difficult to establish a correct treatment (Oliveira et al., 2015a). Efforts have been made to develop improvements in prison health. In Brazil, tuberculosis control actions aimed at the population deprived of liberty have been regulated for ten years by the National Health Plan in the Penitentiary System. Its main objective is the inclusion of the prison population in the SUS, ensuring that the right to citizenship is effective from the perspective of human rights. The health actions that it establishes are consistent with the principles and guidelines of the SUS, including the prevention of health problems and contagious diseases (Ministério da Saúde, 2010).

The high rates of TB in prisons and the number of people Included in this group in Brazil justify the need for a better understanding of this situation. Thus, the present study aims to carry out an epidemiological analysis of tuberculosis in the prison population in the state of Minas Gerais, Brazil, from 2015 to 2021, in addition to identifying the main factors related to this type of involvement.

2. Methodology

2.1 Approach

Epidemiological observational study, based on secondary data on Tuberculosis in the prison population registered in the state of Minas Gerais, Brazil. The Brazilian prison population comes in fourth in the world and between the countries with the highest incidence of tuberculosis, Brazil occupies the 15th position. The worldwide distribution of the disease makes the relationship with human poverty and misery even clearer, in the prison environment, this relationship becomes more evident, whose average risk of illness is 28 times more prevalent (Ministério da Saúde, Gabinete do Ministro, Secretaria de Vigilância em Saúde, 2015).

These data come from the Notifiable Diseases Information System (SINAN), registered by filling in the Tuberculosis Epidemiological Notification and Investigation Form of the Brazilian Ministry of Health (MS).Los enfoques de curso de vida y de los determinantes sociales de salud han permitido comprender que el envejecimiento individual y el social deben estudiarse de manera

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multidimensional e integral (Dewilde, 2003; Elder, Glen H. & O'Rand, 1995; McMunn, Breeze, Goodman, Nazroo & Oldfield, 2006; Woo et al., 2005).

According to the Brazilian Institute of Geography and Statistics, the state's population is approximately 21 million, with a population density of 33.41 inhab/km2 and a Municipal Human Development Index (HDI) of 0.731 (Instituto Brasileiro de Geografia e Estatística [IBGE], 2010).

2.2   Study population

All records of confirmed cases of tuberculosis, the two types of clinical manifestation: pulmonary and extrapulmonary, in the population deprived of liberty between January 2015 to December 2021 notified in the state of Minas Gerais were included. Cases in which the variables described in the collection procedures were not fulfilled or the diagnostic suspicion was not confirmed were excluded. Informed consent and confidentiality commitment was waived, as it is a study whose aim is to analyze secondary data obtained by the Brazilian government information system.

2.3   Collection techniques

Data collection took place at the beginning of 2022. For this step, the DATASUS File Transfer System, a data public domain platform of Information Technology Department of the Unified Health System in Brazil, was used. Regarding the demographic profile, the following variables were collected: year and month of notification, age in years, sex (male or female) and race/color (white, black, yellow, brown).

As for individual living conditions, the possibility of alcoholism, smoking and use of other drugs were evaluated. In addition, the presence of other associated health conditions, HIV/AIDS, diabetes and mental health conditions were considered.

Specifically in relation to tuberculosis, we evaluated the form of involvement, pulmonary, extrapulmonary and occurrences of both forms simultaneously, as well as whether they were new cases, recurrences or re-entries after treatment discontinuation.

2.4   Analysis processing

Data tabulation and processing were performed using Microsoft Excel 2019 and Rstudio software version 1.0.136. Descriptive statistical analyzes were performed, using measures of dispersion, central tendency and frequency, as well as Student's T tests for independent samples and Mann-Whitney U tests in cases where the assumptions for parametric tests were not met, considering a 95 % confidence interval. In a second moment, paired analyzes were performed using chi-square tests for the pre-selection of variables. According to the results of the previous step, a multiple

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correspondence analysis (MCA) was performed and a perceptual map was constructed of data referring to tuberculosis in the prison population of the state of Minas Gerais, Brazil.

Finally, it should be noted that this study does not require the approval of the Research Ethics Committee, since it uses secondary data without the nominal identification of the research subjects, in accordance with the resolution of the National Health Council of Brazil that regulates the guidelines of research involving human subjects.

3. Results

A total of 1880 cases of tuberculosis were recorded in the prison population of Minas Gerais during the period from January 2015 to December 2021, with a monthly average of 22.38 (±1.88) notifications. Table 1 shows the temporal distribution of cases according to month and year of registration.

Table 1

Distribution of Tuberculosis cases in Minas Gerais, from 2015 to 2021, Brazil, according to year and month of occurrence, reported in the Notifiable Diseases Information System (SINAN) for the prison population.
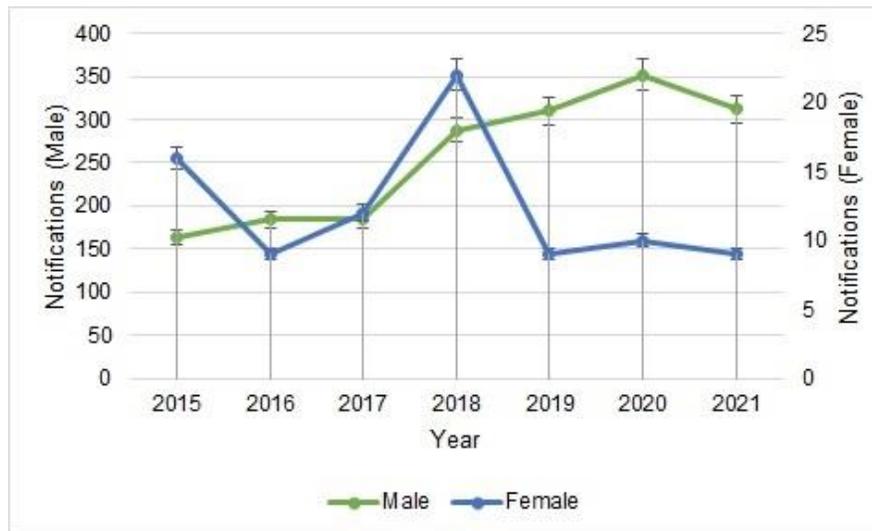
Month	Year of diagnosis							
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**Total**
January	13	19	13	24	18	40	18	145
February	18	13	20	23	16	39	26	155
March	13	12	22	34	29	33	23	166
April	13	20	17	33	21	33	36	173
May	12	12	17	20	25	38	39	163
June	15	21	9	25	22	34	31	157
July	15	18	18	13	33	20	25	142
August	20	19	16	20	41	31	39	186
September	13	18	14	24	36	25	37	167
October	12	18	20	36	24	21	30	161
November	18	13	14	34	32	27	15	153
December	17	10	16	24	22	21	20	130

Source: The authors, 2022.

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Stratification by ethnicity showed a predominance of the brown population (p-value=0.0242) with an annual mean of 117.43 (±26.94) records, followed by the Caucasian population with 75.14 (±14.35) occurrences in absolute numbers. The average annual records of black and yellow individuals were 53.86 (±18.27) and 3.29 (±1.11), respectively. When considering the stratification by sex, there is an annual average of 256.14 (±56.83) cases for males and 12.43 (±3.65) for females. In Figure 1, it is possible to observe the behavior of the occurrences per year, according to the sex indicated in the notification form.

Figure 1

Distribution of tuberculosis cases in Minas Gerais, Brazil, from 2015 to 2021, according to sex and year of occurrence, reported in the Notifiable Diseases Information System (SINAN) for the prison population.
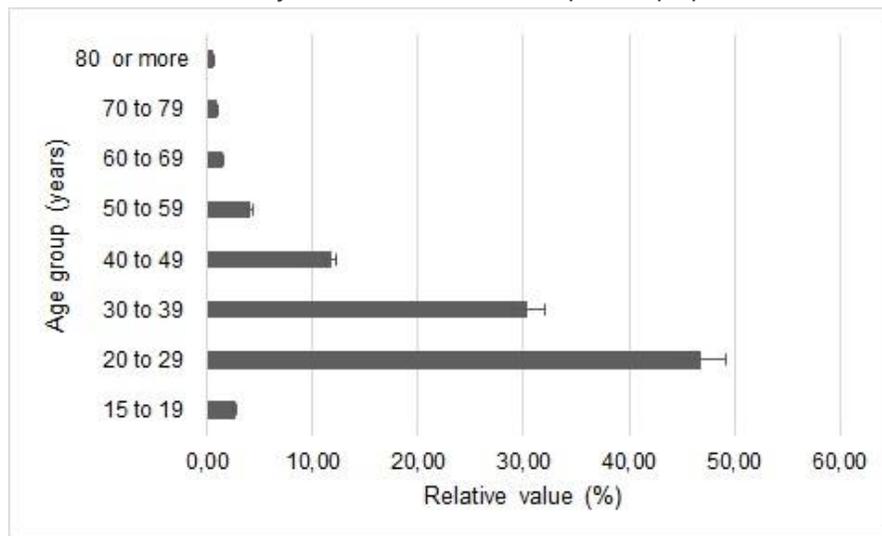

Source: The authors, 2022.

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The records, according to age group, showed a predominance of individuals between 20 and 29 years old (p-value<0.01), with an annual average of 127.29 (±36.13) reported cases in absolute numbers. The age groups 30-39, 40-49 also stood out, with, respectively, 82.72 (±11.90) and 31.86 (±10.71) records on average. Figure 2 shows how the notifications behaved according to age group and year of occurrence.

Figure 2

Distribution of tuberculosis cases in Minas Gerais, Brazil, according to age group and year of occurrence, reported in the Notifiable Diseases Information System (SINAN) for the prison population.
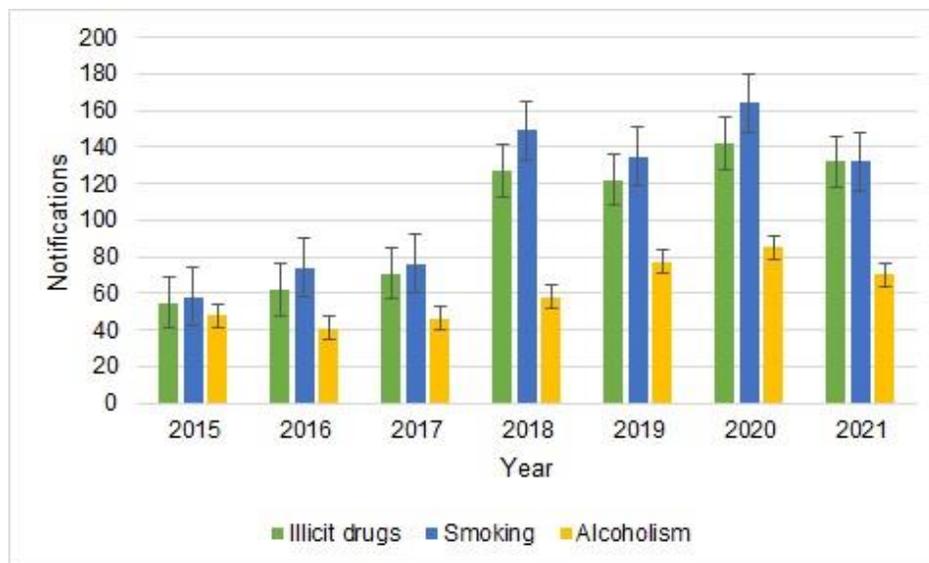

Source: The authors, 2022.

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The annual averages of registered cases for alcoholics, smokers or users of other drugs were respective 60.71 (±12.53), 112.57 (±31.22) and 101.57 (±27.54). In Figure 3 it is possible to see in greater detail the temporal variations in the records for these population groups.

Figure 3

Distribution of Tuberculosis cases in Minas Gerais, Brazil, according to vulnerability conditions and year of occurrence, reported in the Notifiable Diseases Information System (SINAN) for the prison population.

Source: The authors, 2022.

As for the form of involvement, there was a predominance of the pulmonary form (p-value<0.01) with an annual average of 238.57 (±51.87) records, representing around 90% of all reported cases each year, extrapulmonary forms had an average of 21.43 (±4.64) and the occurrences of both forms simultaneously presented an average of 8.57 (±2.67) annual records. New cases presented an annual average of 208.29 (±43.77) records, for cases of relapses and re-admissions after abandonment, this value changes to 13.29 (±4.56) and 22.43 (±5. 92), respectively.
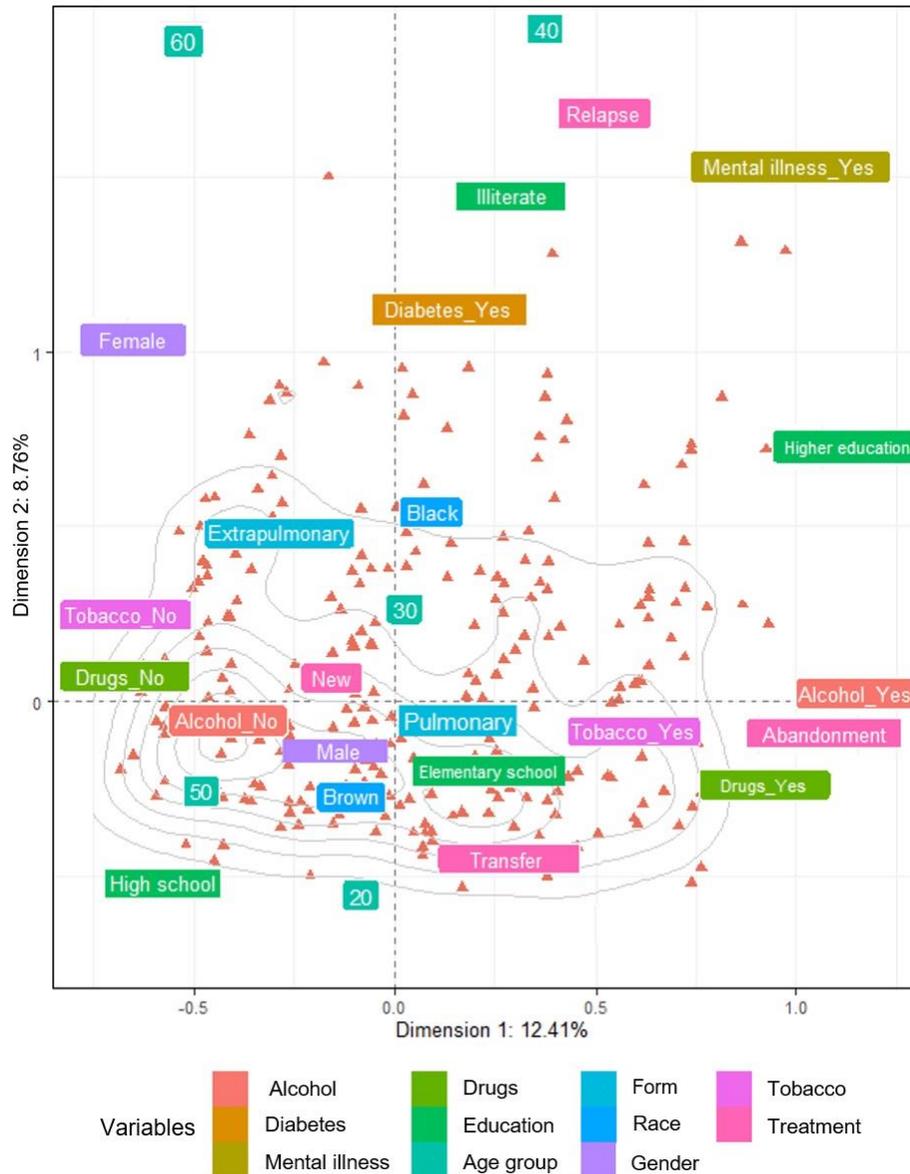
As for the concomitance of other health conditions, the monthly average of records for HIV/AIDS patients was 22.14 (±3.95) cases. For diabetic patients there is 6.29 (±1.75), and for mental health conditions, 11.29 (±4.23).

The perceptual map resulting from the Multiple Correspondence Analysis (MCA) applied to the data collected regarding tuberculosis in the prison population can be seen in Figure 4. Here, it is possible to observe the proximity of the Brown ethnicity factor in relation to the center of density of the registered cases; As well as the male population and age group between 20 and 29 years. In

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addition, the proximity between the use of alcohol, tobacco, other drugs and treatment dropout is remarkable.

Figure 4

Distribution of Tuberculosis cases in Minas Gerais, Brazil, according to vulnerability conditions and year of occurrence, reported in the Notifiable Diseases Information System (SINAN) for the prison population

Source: The authors, 2022.

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4. Discussion

Data from the Brazilian Ministry of Health indicated an incidence rate of 37.4 % for the population affected by tuberculosis in Brazil in 2010. In 2015, this value changed to 33.2 %, showing a reduction for the period (Ministério da Saúde, 2016). However, TB data in 2019 already indicated a trend of increasing incidence rates for the country. A study aimed at analyzing the afore- mentioned involvement in the state of Amazonas showed an increase in diagnosis rates that went from 68.3 % to 72.4 % between 2018 and 2019. In Rio de Janeiro, no changes were observed regarding the diagnosis rates, however, the incidence of the disease be- came 66.3 cases/100 thousand inhab in the year 2019, higher than that observed for the year 2018, of 63.5 cases per 100 thousand inhab. (Ministério da Saúde, 2018; 2019)

In the present study, it was also possible to observe an increase in TB notifications. The monthly averages of notification almost doubled when considering the values for the periods from 2015 to 2017 and 2018 to 2021. In addition to corroborating what is observed in the literature, the data presented here alert to the difficulties that the country will face in the coming years as for the goals established in United Nations General Assembly to end TB. One of Sustainable Development Goals is reduce the incidence of tuberculosis by 90 % and the mortality from the disease by 95% between the years 2015 and 2035 according to Agenda 2030 proposed by the United Nations and supported by countries (WHO, 2015; Ministério da Saúde, 2018; 2019)

In the perceptual map of notifications in prisons, the proximity of the category referring to brown ethnicity with the center of density of registered cases is observed. In addition, the analyzes presented here also pointed to the predominance of brown individuals in terms of annual averages of notifications, this reflects the mass incarceration of this population in Brazil, representing almost 70 % of the population deprived of liberty (Ministério da Justiça e Segurança Pública, 2017).

Thus, the findings of the present study are in agreement with investigations previously carried out in the municipality of Juiz de Fora, Minas Gerais, Brazil (Pereira et al., 2015). In this context, it is important to point out that the Minas Gerais population is predominantly brown according to the Brazilian Institute of Geography and Statistics (IBGE, 2010). In addition, the fact that this group is more influenced by inadequate living conditions and poor access to health services, as well as discrimination, is highlighted. This situation can justify both the predominance of brown individuals in TB notifications in prisons and outside them. (Pinto et al., 2017)

As for gender, both by the perceptual map and by the incidences presented, it is possible to observe the greater participation of the male population in TB cases. Studies carried out considering other population strata also found a male predominance in the context of the disease (San Pedro and

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Oliveira, 2013; de Matos Freitas et al., 2016). Males are at twice the risk of becoming ill with TB (Viana, 2014; Telarolli et al., 2017). This fact may be associated with the tendency of greater negligence regarding their own health observed in this stratum and which is responsible for the beginning of the follow-up of these individuals in more advanced conditions of the disease (Siqueira et al., 2014, Bidinotto et al., 2016).

The age group between 20 and 29 years old was the predominant one in the data presented here, followed by that between 30 and 39 years old. In the literature, the age group between 20 and 39 years old is observed as the predominant one for the disease in the country and 40 and 59 years as the second more predominant (Macêdo et al., 2022). In this way, the influence of prisons on the profile of tuberculosis illness is evident and the way in which they aggravate the classic association of this health condition with poverty, while further reducing the possibility of these individuals to get a job if they manage to leave this environment (San Pedro and Oliveira, 2013).

As for the use of alcohol and other drugs, the prevalence of the disease in users in the context of this study was high. In addition, the proximity between the use of these narcotics and the abandonment of treatment observed in the perceptual map is noteworthy. In the literature it is possible to find mentions to the fact that the use of these substances potentiates the disease and makes it difficult to establish a correct treatment (Araujo et al., 2017). Smoking is an important factor not only for infection but also for tuberculosis mortality. Cigarette smoke is directly related to ciliary airway dysfunction, reduced immune response, failure of macrophage activity and reduced CD4 levels (Rabahi, 2012). In addition, due to its implications on the immune system, the association between alcohol use and TB, which is present in approximately 10 % of all cases, stands out. Regarding the use of illicit drugs, mentions have already been made in the literature of its link with the in- crease in TB cases. While for injecting drug users the risk of infection by M. tuberculosis is 8 %, for the rest of the population there is a value of 0.2 %. (Silva et al., 2018).

The presence of other conditions that compromise health was also notable in the analyzes presented here, establishing itself as an important vulnerability factor. The incidences of co-infection with HIV and tuberculosis stand out, which seems to be relevant in the number of tuberculosis cases, and conditions related to mental health that directly influence the prevention, treatment and management of the disease (Getahun et al., 2010; de Araujo, 2014).

Regarding the management of patients, a higher prevalence of the pulmonary form of the disease was observed, both in the perceptual map and in the analysis of incidences per- formed. The clinical manifestations of this form favor the early diagnosis and treatment of the patient (Sanchez et al., 2005). However, due to specific factors of this population, such as dependence on illicit drugs, smoking, mental health conditions and the prison health service itself, many patients abandon the

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treatment, which can lead to the development of resistance to the treatment for the fungus (Horne et al., 2019).

5. Conclusion

In recent years, there has been a progressive increase in the number of tuberculosis notifications in the Minas Gerais prison system. Although there is a prediction of tuberculosis control centered on the National Tuberculosis Control Plan (PCT), it still proves to be inefficient in prevention in the Brazilian prison scenario, since both program implementation and execution are hampered by problems such as lack of financial investment, difficulty in accessing the health service, and lack of integration between the coordination of justice and health (Oliveira et al., 2015b). However, the growth in the number of cases observed in the state of Minas Gerais may be associated with other factors, such as a possible advance in the compulsory notification system of this disease.

Considering the prison population notified with tuberculosis, it is important to note the discrepancy of involvement by sex, where the highest number of cases is reported in males. This may be a result of the reality of the male prisons in the state, where there is overcrowding and therefore greater agglomeration. In this sense, tuberculosis in the population deprived of liberty follows the same profile described for detainees by the Brazilian Institute of Geography and Statistics, being more prevalent in young people aged between 20 and 29, of brown race and males (IBGE, 2010).

Based on these data, it can be observed that tuberculosis in the population deprived of liberty is an important Brazilian health problem and requires due attention, given its role in the perpetuation of the disease both inside and outside prison walls. Measures for the prevention and identification of tuberculosis in this population should be prioritized, especially in the most vulnerable groups, such as men, smokers, HIV-positive people and people with mental disorders.

The need for coordination between prison health units and extramural basic health units is highlighted to favor the information system and continuity of treatment, especially for those released from the prison system. The registration and notification system are present and seems to work, despite the necessity of capacitation of health professionals in filling out the notification forms, whose seems important to characterization better this population, who are with some data underreported which preventing a deeper understanding of the community affected profile (Ferreira et al., 2015).

This system contributed for many public health policies, but it can be improved regarding epidemiological issues within the prison units themselves, enabling better data quality for future

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epidemiological studies. These joint actions can increase tuberculosis cure rates and, therefore, reduce the transmission of the disease inside and outside prisons. (Allgayer et al., 2019)

The first step towards the insertion of intervention measures is to recognize the role of public policies, which are essential to guarantee access to health services for all. Therefore, the participation of central public health entities such as the Ministry of Health and the State Departments of Penitentiary Administration is important to implement policies that promote health in the prison system beyond tuberculosis.

Epidemiological analyses, such as those contained in this study, are of public utility, as they outline the general panorama of risk groups and allow new fronts of action. Through them, it was possible to notice the need to develop new strategies focused on the protection of individuals deprived of their liberty, without forgetting the workers of prison units, and also due to the high incidence of TB in this type of environment, often related to the neglect and misinformation.

Epidemiological analyses, such as those contained in this study, are of public utility, as they outline the general panorama of risk groups and allow new fronts of action. Through them, it was possible to notice the need to develop new strategies focused on the protection of individuals deprived of their liberty, without forgetting the workers of prison units, and also due to the high incidence of TB in this type of environment, often related to the neglect and misinformation.In addition, they provide the possibility of subsidizing the elaboration of guidelines for fast and effective care in the state, where the affections are frequent and demand individualized approaches due to the particularities of this population. Finally, it is also mentioned that such studies allow managers to better understand the need to better guide both the prison population and the professionals in these places in order to avoid new occurrences.

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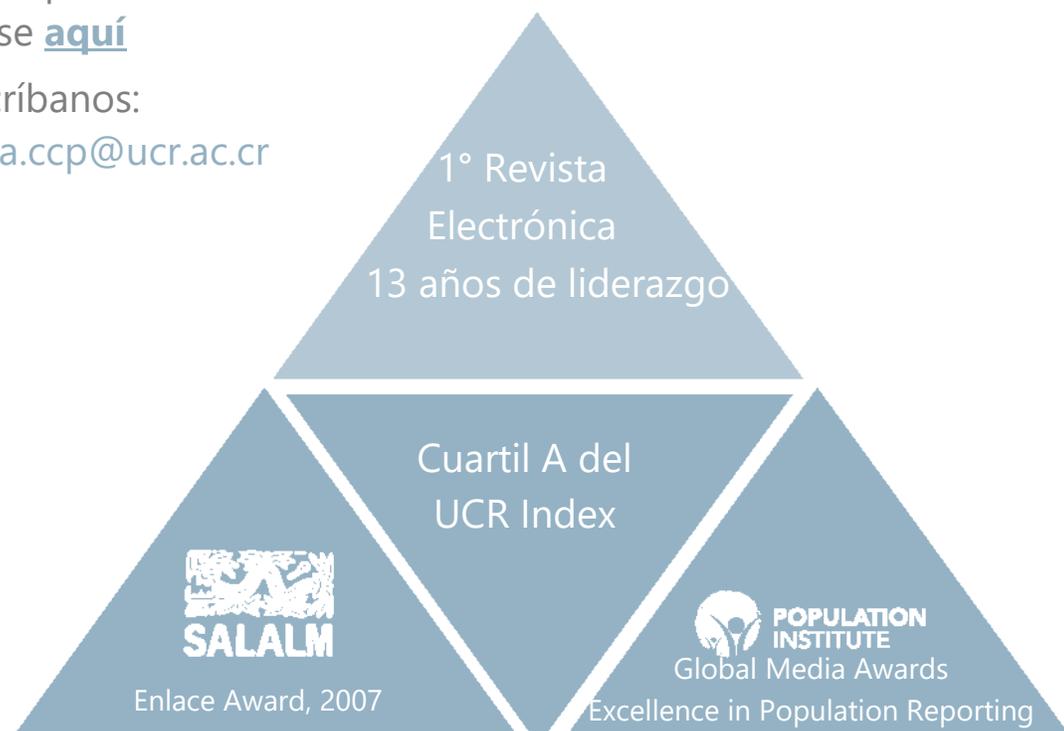World Health Organization. (2020). *World Health Organization Global Tuberculosis Report 2020* (p. 232). Author

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