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*Original Article*

# Determinants of coinfection tuberculosis and HIV in prisons in Brazil

Nanci Michele Saita[1], Rubia Laine de Paula Andrade[1], Pedro Augusto Bossonario[1], Rafaele Oliveira Bonfim[1], Jordana de Almeida Nogueira[2], Antônio Ruffino Netto[3], Ricardo Alexandre Arcêncio[1], Tereza Cristina Scatena Villa[1], Aline Aparecida Monroe[1]

*[1] Ribeirão Preto College of Nursing, University of São Paulo, Ribeirão Preto, Brazil*
*[2] Department of Nursing, Federal University of Paraíba, João Pessoa, Brazil*
*[3] Ribeirão Preto Medical School, University of São Paulo, Ribeirão Preto, Brazil*

## Abstract

Introduction: Prisons context has the potential for the spread of infectious diseases, like HIV and tuberculosis, which prevalence is higher in the people deprived of liberty compared to the general population.
Objective: to analyze which are the determinants of coinfection tuberculosis and HIV in prisons.
Methodology: Case-control study conducted in the state of São Paulo, Brazil. New cases of tuberculosis in the population deprived of liberty in the period between 2015 and 2017 were considered. Data were obtained through the notification and monitoring system for tuberculosis cases in the state of São Paulo and included sociodemographic and clinical variables and diagnosis and treatment information. The data were analyzed through frequency distribution and bivariate analysis, testing the association of the dependent variable (tuberculosis/HIV coinfection vs. tuberculosis/HIV non-coinfection) with independent variables (sociodemographic, clinical and diagnostics variables) by calculating the odds ratio and p-value.
Results: Among the determinants of tuberculosis/HIV coinfection in prisons, we identified: age between 26-35, 36-55 and 56-84 years, notification in hospitals, negative sputum smear microscopy and culture, X-ray suggestive of another pathology, extrapulmonary and mixed clinical form, and alcoholism. A high percentage of death was also identified among coinfected people.
Conclusions: identifying the determinants of the tuberculosis/HIV coinfected individual can assist in the development and implementation of guidelines aimed at controlling both infections in the prison environment.

**Key words:** Tuberculosis; HIV; AIDS; coinfection; prisons; health profile.

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## Introduction

The increase in the population deprived of liberty (PDL) is a phenomenon observed in developed and developing countries. According to estimates of the Institute for Criminal Policy Research, 10,743,619 people are imprisoned worldwide [1].

The profile of the PDL is characterized by people in situations of social vulnerability, subjected to innumerable risks related to the lack of social and educational coverage and no access to health services and actions [2]. This fact can impact the quality of life of these individuals and lead to the occurrence of infectious diseases, such as tuberculosis (TB) and HIV, thereby causing illness and death [3-4].

These diseases stand out in the prison environment and together, represent serious public health problems given the high number of cases [5,6]. In European countries, HIV prevalence is five to 24 times higher in the PDL compared to the general population, while TB prevalence is 11 to 81 times higher [7]. In addition, people living with HIV are 28 times more likely to contract TB, which is a substantial risk to the health of the PDL [8].

Thus, it is relevant to survey and study the characteristics involved in the TB/HIV coinfection in the prison context[9] in order to understand the sociodemographic and epidemiological characteristics that impact on the prevention and management of both diseases and contribute to plan actions and strategies that increase the responsiveness to coping with the TB/HIV coinfection in prisons.

In this sense, a review of the literature on the profile of people with TB/HIV coinfection in the prison was conducted. A search for publications was performed in the PubMed and Lilacs databases, using free and controlled vocabulary with no search limits and 140

publications were retrieved. After reading the selected materials in full, only one study addressing the theme was included. The study in question [10] was conducted in Mexico and published in 2012. The determinants of TB/HIV coinfection in the prison context was the following: average age of 33.5 years, people with previous hospitalization (96.5%), weight loss (92.0%), extrapulmonary TB (53.6%) and receiving antiretroviral therapy concomitant with anti-TB treatment (82.1%). In this study, there was no comparison group to measure the magnitudes surveyed.

Since there are gaps in the production of knowledge on the subject in question and prison units experience the phenomenon of mass incarceration [11] with potential for the spread of infectious diseases, the aim of this study was to analyze which are the determinants of coinfection tuberculosis and HIV in prisons.

## Methodology

Case-control study conducted in the state of São Paulo, Brazil. This state has the largest prison population in the country [12], with 168 prison units in the year 2018. According to the national survey of penitentiary information, in 2015, the state of São Paulo had 233,067 PDL, of which 219,767 men and 13,300 women [13]. In 2016, there were 240,061 individuals deprived of their liberty, of which 224,957 men and 15,104 women [14] and in 2017, the prison system had 229,031 subjects; 216,511 men and 12,520 women [15].

The definition of cases for the present study included all new cases of TB (incidents) / HIV coinfection in the PDL of prison units in the state of São Paulo. For the selection of controls, new cases of TB without HIV coinfection in the PDL of prison units in the state of São Paulo were considered. Coinfection (yes or no) was identified through the following variables: AIDS, anti-HIV test (collected from the TB-WEB information system) and use of antiretroviral therapy (information provided by the São Paulo State Program for Sexually Transmitted Infection/AIDS Program). The inclusion criterion for both groups (cases and controls) comprised cases of individuals aged 18 years or older reported on the TB-WEB in the period from 2015 to 2017. There was no concern with matching, as all patients (cases and controls) reported on TB-WEB were included, thereby resulting in a matching ratio equal to 22, that is, 22 controls for each case (7,218 controls for 341 cases).

The exposure variables used in the study were collected from the TB Notification and Monitoring System (TB-WEB) and included the following data sets: sociodemographic (sex, age group, race/color, schooling); diagnostic (notification unit, type of discovery, and results of sputum smear, culture and X-ray) and clinical (TB clinical form and comorbidities such as diabetes, alcoholism, mental disorder, drug addiction and smoking). Variables for the follow up of cases (type of indicated treatment and treatment outcome) were also collected.

Data were collected from the same sources and concurrently for cases and controls in order to guarantee the comparability of data.

Data were analyzed using frequency distribution and bivariate analysis through the epitools library of the R/RStudio software, version 1.2.5033. In the bivariate analysis, the risk of occurrence of the dependent variable (coinfection) according to the exposure variables was established by the Odds Ratio (OR) and respective confidence intervals and p values, adopting a significance level of 5%. The follow up variables were subjected to descriptive analysis only, since they could not be constituted as independent variables.

This study was approved by the Research Ethics Committee of the University of São Paulo (Protocol number 1.553.841). The database information was kept confidential.

## Results

In the period from 2015 to 2017, 9,778 TB cases were reported in the prison system in the state of São Paulo. Exclusions represented 2,126 cases due to retreatment, 48 changes in diagnosis, 19 transfers to another state and 26 individuals under 18 years of age, resulting in 7,559 study participants. Of these, 2,276 (2,238 men and 38 women) were diagnosed in 2015; 2,460 (2,420 men and 40 women) in 2016; and 2,823 (2,771 men and 52 women) in 2017. In addition, 341 out of the total study participants were HIV coinfected.

Among coinfected subjects, 94.7% were male and among non-coinfected subjects, 98.4% were male; 39.6% and 44.5% were aged between 26 and 35 years; 46.3% and 46.8% declared themselves as mixed race; and 49.8% and 48.7% had four to seven years of study, respectively (Table 1).

There was evidence that the male sex and schooling between four and 11 years were protective factors for TB/HIV coinfection among the PDL. Regarding age group, age between 26-35, 36-55 and 56-84 years was a risk factor for coinfection compared to age between 18-25 years (Table 1).

Notifications were given predominantly in the prison system both for coinfection cases (71.9%) and non-coinfection cases (76.5%); Primary Health Care

services represented 14.0% of notifications of non-coinfection cases, while hospitals accounted for 12.6% of coinfection cases. The discovery of TB cases was mainly a result of outpatient care search and represented 48.2% of coinfection and 54.6% of non-coinfection cases; in relation to diagnostic tests of coinfection and non-coinfection cases, 45.8% and 55.9% were positive in sputum smear microscopy and 60.4% and 67.7% in sputum culture for coinfection and non-coinfections, respectively. Chest radiography was rarely used as a diagnostic criterion (Table 2).

Cases reported in the hospital with negative result of sputum smear and culture and suspect of another pathology on X-ray are risk factors for TB/HIV coinfection, compared to cases notified in the prison system with positive result of sputum smear and culture and X-ray suggestive of TB. There was less occurrence of notifications in Primary Health Care and in outpatient care search and failure to perform an X-ray among coinfected patients (Table 2).

Most coinfection (85.6%) and non-coinfection (97.5%) cases presented the clinical pulmonary form. Among subjects with comorbidities, 11.1% and 7.2% had alcoholism, 17.6% and 19.5% drug addiction, 23.5% and 24.6% smoking, respectively, in coinfected and non-coinfected cases (Table 3).

Evidence was found that the alcoholism and extrapulmonary and pulmonary + extrapulmonary TB are risk factors for TB/HIV coinfection, compared, respectively, to the non-alcoholic people and pulmonary clinical forms (Table 3).

Among groups, 93.3% of the coinfected and 98.1% of the non-coinfected underwent directly observed treatment (DOT). Regarding coinfected subjects, 80.7% evolved to cure of TB, 8.9% died, 8.3% abandoned treatment and 2.2% treatment failure. Among non-coinfected subjects, these percentages were 92.8%, 0.7%, 5.3% and 1.1%, respectively.

## Discussion

The present study portrays the characteristics of cases of TB and TB/HIV coinfection in the PDL of the state of São Paulo from 2015 to 2017. Note the high annual incidence of TB in the São Paulo prison system with 927.5 new cases per 100,000 inmates in 2015; 1,024.7 in 2016; and 1,232.6 in 2017.

The high number of individuals with TB is certainly related to the vulnerability of imprisoned people, since penitentiaries are reservoirs of the disease, caused by overcrowding, poor health conditions, inadequate food and alcohol and drug consumption [16-20]. Despite the high number of diagnoses established in the prison system, some limitations in access to TB diagnosis and treatment stand out. Such limitations result from the inadequate infrastructure in prison units for the diagnosis of cases and difficulties with providing vehicles and police escorts for inmates transportation when a specialized medical evaluation in referral health centers and diagnostic support tests such as X-rays are needed [21,22].

In the state of São Paulo, the percentage of HIV coinfection among new cases of TB in inmates was 4.5%, which is lower than the rate in the general population (17.9%) [23]. The same occurred in a study conducted in the central west of Brazil between 2009 and 2014 [24] and in the city of Porto Alegre in 2014 [25].

**Table 1.** Distribution of coinfection and non-coinfection cases according to sociodemographic variables in prisons in the state of São Paulo, 2015-2017.

| Variable | Response category | Non-coinfection | Coinfection | OR (95%CI) | p |
|---|---|---|---|---|---|
| | | N (%) | N (%) | | |
| Sex | Male | 7,106 (98.4) | 323 (94.7) | 0.28 (0.17-0.47) | **< 0.0001** |
| | Female | 112 (1.6) | 18 (5.3) | 1 | |
| Age group | 18-25 years | 2,771 (38.5) | 60 (17.6) | 1 | |
| | 26-35 years | 3,204 (44.5) | 135 (39.6) | 1.95 (1.43-2.65) | **< 0.0001** |
| | 36-55 years | 1,160 (16.1) | 140 (41.1) | 5.57 (4.09-7.60) | **< 0.0001** |
| | 56-84 years | 67 (0.9) | 6 (1.8) | 4.14 (1.73-9.91) | **0.0056** |
| Race/color | White | 2,753 (42.2) | 130 (43.3) | 1 | |
| | Mixed race | 3,056 (46.8) | 139 (46.3) | 0.96 (0.75-1.23) | 0.8028 |
| | Black | 700 (10.7) | 31 (10.3) | 0.94 (0.63-1.40) | 0.8410 |
| | Asian/Indigenous | 22 (0.3) | - | - | - |
| Schooling | None | 47 (0.9) | 6 (2.9) | 1.60 (0.59-4.40) | 0.3494 |
| | 1-3 years | 368 (6.9) | 17 (8.2) | 0.58 (0.28-1.20) | 0.1690 |
| | 4-7 years | 2,592 (48.7) | 103 (49.8) | 0.50 (0.28-0.89) | **0.0331** |
| | 8-11 years | 2,135 (40.2) | 67 (32.4) | 0.39 (0.22-0.72) | **0.0049** |
| | 12 years or more | 176 (3.3) | 14 (6.8) | 1 | |

**Table 2.** Distribution of coinfection and non-coinfection cases according to diagnostic variables of notification units, type of discovery and tests in prisons of the São Paulo, 2015-2017.

| Variable | Response category | Non-coinfection | Coinfection | OR (95%CI) | p |
|---|---|---|---|---|---|
| | | N (%) | N (%) | | |
| Notification unit | Prison system | 5,519 (76.5) | 245 (71.9) | 1 | |
| | Primary Health Care | 1,007 (14.0) | 29 (8.5) | 0.65 (0.44-0.96) | **0.0315** |
| | Specialties Clinic | 434 (6.0) | 21 (6.2) | 1.09 (0.69-1.72) | 0.7174 |
| | Hospital | 145 (2.0) | 43 (12.6) | 6.68 (4.64-9.61) | **< 0.0001** |
| | Mixed (PHC+UE) | 95 (1.3) | 3 (0.9) | 0.71 (0.22-2.26) | 0.7995 |
| | Urgency and Emergency | 18 (0.3) | - | - | - |
| Type of discovery | Active case finding in institution | 2,062 (31.2) | 117 (37.4) | 1 | |
| | Outpatient care search | 3,600 (54.6) | 151 (48.2) | 0.74 (0.58-0.95) | **0.0194** |
| | Urgency/Emergency | 357 (5.4) | 22 (7.0) | 1.09 (0.68-1.74) | 0.7130 |
| | Hospitalization | 196 (3.0) | 8 (2.6) | 0.72 (0.35-1.49) | 0.5096 |
| | Active case finding in the community | 35 (0.5) | 1 (0.3) | 0.50 (0.07-3.71) | **< 0.0001** |
| | Contacts tracing | 341 (5.2) | 14 (4.50) | 0.72 (0.41-1.27) | 0.3019 |
| | Discovery after death | 6 (0.1) | - | - | - |
| Results of sputum smear microscopy | Positive | 4,017 (55.9) | 154 (45.8) | 1 | |
| | Negative | 1,445 (20.1) | 116 (34.5) | 2.09 (1.63-2.68) | **< 0.0001** |
| | Not performed | 1,706 (23.7) | 66 (19.6) | 1.01 (0.75-1.35) | 0.9403 |
| | In progress | 20 (0.3) | - | - | - |
| Results of sputum culture | Positive | 4,745 (67.7) | 200 (60.4) | 1 | |
| | Negative | 885 (12.6) | 54 (16.3) | 1.45 (1.06-1.97) | **0.0224** |
| | Not performed | 1,311 (18.7) | 72 (21.8) | 1.30 (0.99-1.72) | 0.0611 |
| | In progress | 69 (1.0) | 5 (1.5) | 1.72 (0.69-4.31) | 0.2284 |
| Results of X-ray | TB suspicion | 1,110 (17.5) | 122 (39.5) | 1 | |
| | Normal | 126 (2.0) | 11 (3.6) | 0.79 (0.42-1.51) | 0.5462 |
| | Other pathology | 27 (0.4) | 8 (2.6) | 2.70 (1.20-6.06) | **0.0213** |
| | Not performed | 5,076 (80.1) | 168 (54.4) | 0.30 (0.24-0.38) | **< 0.0001** |

PHC: Primary Health Care, UE: Urgency and Emergency.

**Table 3.** Distribution of coinfection and non-coinfection cases according to clinical variables in prisons in the state of São Paulo. 2015-2017.

| Variable | Response category | Non-coinfection | Coinfection | OR (95%CI) | p |
|---|---|---|---|---|---|
| | | N (%) | N (%) | | |
| TB clinical form | Pulmonary | 7,037 (97.5) | 292 (85.6) | 1 | |
| | Extrapulmonary | 152 (2.1) | 33 (9.7) | 5.23 (3.53-7.76) | **< 0.0001** |
| | Both pulmonary and extrapulmonary | 29 (0.4) | 16 (4.7) | 13.3 (7.14-24.7) | **< 0.0001** |
| Diabetes | No | 7,162 (99.2) | 340 (99.7) | 1 | |
| | Yes | 56 (0.8) | 1 (0.3) | 0.38 (0.05-2.73) | 0.5199 |
| Alcoholism | No | 6,701 (92.8) | 303 (88.9) | 1 | |
| | Yes | 517 (7.2) | 38 (11.1) | 1.63 (1.15-2.30) | **0.0103** |
| Mental disorder | No | 7,187 (99.6) | 337 (98.8) | 1 | |
| | Yes | 31 (0.4) | 4 (1.2) | 2.75 (0.97-7.84) | 0.0710 |
| Drug addiction | No | 5,811 (80.5) | 281 (82.4) | 1 | |
| | Yes | 1.407 (19.5) | 60 (17.6) | 0.88 (0.66-1.17) | 0.4406 |
| Smoking | No | 5,440 (75.4) | 261 (76.5) | 1 | |
| | Yes | 1,778 (24.6) | 80 (23.5) | 0.94 (0.73-1.21) | 0.6527 |

The hypothesis raised is that the confinement of individuals with HIV favors the clinical-therapeutic follow up of cases, being a predisposing factor for adherence to antiretroviral therapy and a contribution to the improvement of immunological conditions and less development of coinfections, among which the TB/HIV coinfection.

According to sociodemographic information, the annual incidence of TB cases in male inmates is higher than the incidence in female inmates (1,028.4 new cases per 100,000 male and 285.7/100,000 in female inmates in 2015; 1,075.8/100,000 in men and 264.8/100,000 in women in 2016; 1,303.9/100,000 in men and 415.3/100,000 in women in 2017). However, the condition of living with HIV has been an important aspect in the development of TB in female inmates, since there was no association between coinfection and the male sex, compared to women.

When analyzing the age group of inmates participating in the study, clearly, the population with TB/HIV coinfection is older than that affected by TB alone. A possible explanation concerns the access to antiretroviral therapy as one of the aspects contributing to the increased life expectancy of people living with HIV [26], including the PDL.

As for education, evidence of no association between coinfected individuals and those with elementary and secondary education was found. This result shows a polarization of HIV infection in individuals with no education or high educational level, and indicates challenges related to preventive/educational actions that consider the differences in the ability to understand and produce meanings of the PDL. Such challenges are intensified when considering the structure of prison units, with a mismatching number of inmates and human resources in prison health teams [27]. On the other hand, other strategies such as peer education are promising in this context [28].

There was an association between the coinfected group and TB notification in the hospital. This is probably a result of the difficulty with the diagnosis of cases due to the paucibacillary condition of coinfected people that generates negative sputum smear and culture and leads to late discovery and worsening of the disease. Sputum smear microscopy is a simple and low-cost diagnostic resource, but has some limitations, such as low sensitivity and specificity, particularly in paucibacillary samples, as those found in people living with HIV [29-30]. Limitations of prison health units are also part of this situation, such as the lack of X-ray machines to help in the diagnosis of coinfection cases.

Still in relation to hospitalization among coinfected individuals, the presence of other clinical forms of TB (in addition to pulmonary) represents an important challenge for the diagnosis and therapeutic management of cases. Regarding clinical variables, evidence of an association between coinfected patients and extrapulmonary and mixed (pulmonary and extrapulmonary) clinical forms was identified in the present study. As a result of hematogenous dissemination of the bacillus in individuals with HIV and other conditions of immunosuppression, extrapulmonary TB is more common among these people [31], which requires other diagnostic techniques performed in specialized and/or hospital services. This may reflect on delayed diagnosis, worsening of clinical conditions and unfavorable outcomes (hospitalizations and deaths) caused by delays in suspecting TB and in the access to specialized health services.

Some lifestyle habits increase the risk of becoming ill with TB, and alcohol consumption is one of them [32]. This information was confirmed in a meta-analysis of molecular epidemiology studies in which alcohol was indicated as a determinant for the development of the disease in high and low income countries [33]. Thus, the possible interaction of another risk factor such as HIV, confers greater vulnerability to the individual in relation to the development of TB.

In this study, a higher percentage of death was identified among coinfected people. A possible explanation is the clinical worsening of cases due to difficulties in the diagnostic process and in the occurrence of adverse events/drug interactions between the therapeutic regimens with antituberculosis and antiretroviral drugs. These aspects make coinfection management even more complex and justify the performance of interventions such as the DOT for the clinical and therapeutic follow up of cases.

Advancing the prevention and management of TB/HIV coinfection involves the need for structuring prison units according to their occupation and epidemiological profile, the respective preparation and awareness of prison health teams, as well as coordination with other facilities of the health care network. In many cases, both health conditions presented need specialized care beyond the scope of health actions and services provided by prison units, which assume care functions compatible with primary health care services.

A possible information bias is a limitation of the study, since it was based on the analysis of data from secondary sources. However, this possible bias does not

invalidate the evidence available about the problem in question.

## Conclusion

Among the determinants of TB/HIV coinfection in prisons, the following were identified: age between 26-35, 36-55 and 56-84 years; notification in hospitals; negative sputum smear microscopy and culture; X-ray suggestive of another pathology; extrapulmonary and mixed clinical form; alcoholism. Among coinfected subjects, less occurrence of notification in Primary Health Care, diagnosis in outpatient care and failure to perform X-ray were observed, as well as a higher percentage of deaths. The distinction of these determinants can assist in the development and implementation of guidelines aimed at controlling both infections in prisons and even outside the prison, since inmates are in constant contact with community people through received visits, exits in case of an open and semi-open penalty enforcement regime, and when leaving prison.

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## Corresponding author

Professor Rubia Laine de Paula Andrade, PhD
Av.: Bandeirantes, 3900
Campus Universitário, Ribeirão Preto, SP, Brazil
CEP – 14026-040
Tel: +55(16)3315-3407
Email: rubia@eerp.usp.br

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