

## Vulnerable populations and tuberculosis treatment outcomes in Brazil

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**Abstract** *This article aims to assess the association between being a prisoner or homeless and treatment failure in cases of tuberculosis diagnosed in Brazil in 2015. We examined cases of tuberculosis in prisoners and the homeless in Brazil in 2015 reported to the national notifiable diseases information system using descriptive analysis and logistic regression. There were 82,056 cases of tuberculosis in 2015. Of these, 7,462 (10.3%) were prisoners and 2,782 (3.9%) were homeless. The rate of treatment success in prisoners was 78.6%, while the rate of failure in the homeless was 63.2%. Being a prisoner was a protective factor against treatment failure (adjusted odds ratio 0.68, 95%CI 0.63-0.73), while being homeless was a risk factor for treatment failure (adjusted odds ratio 2.38, 95%CI 2.17-2.61). Treatment success and failure rates differed between prisoners and the homeless. Our findings reinforce the need for public health policies tailored to the specific needs of these groups implemented in conjunction with social services and public security agencies in order to have a significant impact on TB incidence.*

**Key words** *Tuberculosis, Vulnerable populations, Prisons, The Homeless*

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## Introduction

Tuberculosis (TB) is the leading causes of death from an infectious disease worldwide<sup>1</sup>. It is known that poverty is a cause of TB and that the disease is also a cause of poverty, with this vicious circle being played out at an individual, household and community level<sup>1</sup>.

Studies point to a direct association between socioeconomic factors and the occurrence of the disease, both at the individual and collective level, emphasizing that TB is intimately related to an individual's living conditions and social environment<sup>2</sup>.

Specific groups are especially vulnerable to the disease<sup>3</sup>, with data showing that the risk of falling ill with TB is 28 and 56 times greater among prisoners and the homeless, respectively, than in the general population.

The literature recognizes a number of factors that may influence the outcome of the treatment of tuberculosis, including: sex, age, level of education, form of TB, and associated problems such as AIDS, diabetes, mental illness, alcoholism, smoking, and drug use<sup>4</sup>. However, there is a lack of information on the factors affecting disease outcome among prisoners and the homeless in Brazil.

Given the complexity of the social determinants of TB, pillar 2 of Brazil's Post-2015 Tuberculosis Control Strategy recommends the implementation of social protection policies directed at patients and universal access to healthcare<sup>5</sup>, meaning that it is essential to understand illness behavior in these vulnerable groups.

In view of the above, the objective of this study was to assess the association between being a prisoner or homeless and treatment failure in cases of tuberculosis diagnosed in Brazil in 2015.

## Methods

The study population consisted of cases of tuberculosis diagnosed in Brazil in 2015 reported to Brazil's national notifiable diseases information system (SINAN in Portuguese). Individuals aged under 15 years were excluded because disease behavior differs in the age group.

For the purposes of this study, vulnerable populations were defined as prisoners or homeless persons, based on the information in the item "special situations" on the disease notification form. This item was added to the form in the latest revision at the end of 2014.

Case outcomes were defined based on the categories of the SINAN's tuberculosis follow-up form, as follows: cure, abandonment of treatment (loss to follow-up), death from TB, death from other causes, transfer, multidrug-resistant tuberculosis (MDR-TB), change in scheme, and failure and primary abandonment (primary loss to follow-up). For the regression analysis, these categories were regrouped into treatment success (cure) or failure (all other categories).

Other potential confounding factors were included based on the literature, as follows: sex, age, race/skin color, level of education, region of residence, type of TB case, form of tuberculosis, associated illnesses and problems (AIDS, diabetes mellitus, mental illnesses, alcoholism, smoking, and drug use), examinations (x-ray, sputum smear microscopy and culture), and directly observed therapy. It is important to note that with regard to level of education, the category "not applicable" is used for patients aged under seven years.

The data used in the study were obtained from the SINAN database updated in 2017. The SINAN is a national information system designed to support the collection and processing of data on diseases and public health problems and events, including TB. The database provides valuable inputs to help in planning and disease prevention, assessment and control, and serves as an important epidemiological surveillance tool<sup>6</sup>.

The cases were presented according to sociodemographic and clinical characteristics and grouped into the following population types: total population (all notified cases), prisoners and nonprisoners, and the homeless and nonhomeless. For each variable, the chi-squared test or Fisher's exact test were used to compare proportions across the populations and control groups.

We used two logistic regression models to separately assess the association between being a prisoner or being homeless and treatment failure. For this purpose, we performed multiple imputation of missing data following the steps suggested by Harrell<sup>7</sup>. First, we examined the pattern of the unregistered data, observing whether the missing data of a given variable were related to the filled in data for another variable in the model – "missing at random" (MAR). For this purpose, we used the "predictive mean matching" (PMM) method, which replaces the missing data for a variable with the actual value from a donor observation (predicted mean)<sup>7</sup>. The following variables were included in the imputation: race/skin color, level of education, type of TB case, form of

TB, associated problems (AIDS, diabetes mellitus, mental illnesses, alcoholism, smoking, and drug use), x-ray examination, sputum smear microscopy and culture, directly observed therapy, and prisoners and the homeless. Ten datasets were generated for the imputation using the variables included in the final models as auxiliary variables.

To obtain an estimation of the association between being a prisoner or homeless and treatment failure we adjusted the logistic regression models including all a priori-selected potential confounders. In the final logistic regression models based on the imputed data, the hypothesis was tested using the Wald test and Wald intervals for 95% confidence intervals (95%CI).

The statistical analyses were performed using the R program 3.4.1 and the Hmisc and rms packages were used for imputation.

The study was approved by the Oswaldo Cruz Foundation's Sérgio Arouca National School of Public Health Research Ethics Committee.

## Results

There were 84,405 reported cases of tuberculosis in Brazil in 2015. A total of 2,349 (2.8%) individuals aged under 15 years were excluded, resulting in a final study sample of 82,056 cases. Of these, 7,462 (10.3%) were prisoners and 2,782 (3.9%) were homeless persons.

The sociodemographic characteristics of prisoners and the homeless were similar, with the majority being male (95.6% and 79.9%, respectively), aged between 15 and 39 years (85.3% and 53.1%, respectively), brown (44.1% and 44.1%, respectively), having between 5 and 8 years of schooling (34.7% and 27.6%, respectively), and living in Brazil's Southeast Region (53.6% and 54.5%, respectively) (Table 1).

The comparison of the clinical characteristics of the populations revealed that prisoners showed more new cases (75.2% vs 56.0%), less reenrollment after loss to follow-up (11.9% vs 33.7%), lower prevalence of AIDS (7.6% vs 23.8%), diabetes (1.4% vs 3.1%), mental illnesses (1.2% vs 6.7%), alcoholism (10.5% vs 52.5%), smoking (21.0% vs 42.2%), and drug use (19.2% vs 53.0%), and higher prevalence of directly observed therapy (42.0% vs 33.2%). With regard to case outcome, the homeless showed a lower frequency of cure (34.7% vs 67.9%) and higher frequency of loss to follow-up (33.7% vs 7.6%), death from TB (5.9% vs 1.0%), and death from other causes (5.7% vs 1.6%) (Table 2).

The data show that the rate of treatment success was slightly higher in prisoners (78.6%) than in the total population (70.4%), while in the homeless the rate of treatment failure (63.2%) was considerably higher than the rate of success (36.8%) (Graph 1).

It is worth highlighting that this study encompassed all types of TB cases. In this regard, a comparison between all types of TB cases and only new cases by population group showed that the rate of cure (treatment success) was slightly higher in new cases across all populations (total population, prisoners and the homeless).

Table 3 shows the results of the final separate models for prisoners and the homeless. The findings show that being a prisoner was a protective factor against treatment failure (adjustedOR 0.68, 95%CI 0.63-0.73), while being homeless was a risk factor for treatment failure (adjustedOR 2.38, 95%CI 2.17-2.61), even after adjustment.

## Discussion

Prisoners and the homeless accounted for 10.3% and 3.9%, respectively, of all notified cases of tuberculosis in Brazil in 2015. The sociodemographic characteristics of the prisoners and the homeless in our sample are similar to those of diagnosed cases in these populations reported by previous studies<sup>8,9</sup>, reinforcing the association between falling ill with tuberculosis and individual and socioenvironmental factors<sup>2,10</sup>.

It is worth highlighting that the rate of reenrollment after loss to follow-up was considerably higher in the homeless than in the nonhomeless (33.75% vs 8.5%). Factors such as drinking every day, injecting and non-injecting drug use, and unemployment contribute significantly to this problem<sup>11</sup>. The prevalence of associated problems was also higher in the homeless than in the other populations, highlighting a common characteristic among this group<sup>12,13</sup> that directly influences TB treatment. The prevalence of associated problems in prisoners was similar to that of the total population.

The proportion of cases receiving directly observed therapy (DOT) was higher in prisoners than in nonprisoners (42.6% vs 34.2%). These findings are similar to those reported by a study in the United States that showed that inmates with TB were more likely to receive DOT than noninmates (65.0% vs 41.0%)<sup>14</sup>. Although the proportion of directly observed therapy was

**Table 1.** Sociodemographic characteristics of diagnosed cases of tuberculosis by population type, Brazil, 2015.

Sociodemographic characteristics	Total population n=82,056 (%)	Prisoners n=7,462 (%)	Nonprisoners n=65,230 (%)	Homeless n=2,782 (%)	Nonhomeless n=69,318 (%)
Sex					
Male	56,972 (69.4)	7,133 (95.6)	43,498 (66.7)	2,223 (79.9)	47,930 (69.1)
Female	25,084 (30.6)	329 (4.4)	21,732 (33.3)	559 (20.1)	21,388 (30.9)
Age group					
15 to 39 years	43,013 (52.5)	6,364 (85.3)	32,170 (49.3)	1,477 (53.1)	36,636 (52.8)
40 to 64 years	31,385 (38.2)	1,008 (13.5)	26,539 (40.7)	1,229 (44.2)	26,181 (37.8)
65 years and over	7,658 (9.3)	90 (1.2)	6,521 (10.0)	76 (2.7)	6,501 (9.4)
Race/skin color					
White	25,726 (31.4)	2,360 (31.6)	21,407 (32.8)	739 (26.6)	22,900 (33.0)
Black	10,548 (12.9)	881 (11.8)	8,400 (12.9)	567 (20.4)	8,649 (12.5)
Yellow	570 (0.7)	57 (0.8)	418 (0.6)	12 (0.4)	458 (0.7)
Brown	37,828 (46.0)	3,290 (44.1)	29,687 (45.6)	1,228 (44.1)	31,429 (45.3)
Indigenous	785 (1.0)	31 (0.4)	662 (1.0)	7 (0.3)	680 (1.0)
Missing	6,599 (8.0)	843 (11.3)	4,656 (7.1)	229 (8.2)	5,202 (7.5)
Education level					
Illiterate	3,196 (3.9)	162 (2.2)	2,553 (3.9)	119 (4.3)	2,573 (3.7)
1 to 4 years	14,484 (17.7)	1,154 (15.5)	11,531 (17.7)	575 (20.7)	11,987 (17.3)
5 to 8 years	20,436 (24.9)	2,593 (34.7)	16,070 (24.6)	770 (27.6)	17,732 (25.6)
>8 years	21,487 (26.2)	1,389 (18.6)	18,433 (28.3)	328 (11.8)	19,407 (28.0)
Not applicable	434 (0.5)	32 (0.4)	402 (0.6)	26 (0.9)	408 (0.6)
Missing	22,019 (26.8)	2,132 (28.6)	16,241 (24.9)	964 (34.7)	17,211 (24.8)
Region					
North	8,342 (10.2)	477 (6.4)	6,891 (10.6)	134 (4.8)	7,181 (10.4)
Northeast	21,512 (26.2)	1,458 (19.5)	15,779 (24.2)	444 (16.0)	16,433 (23.7)
Southeast	37,732 (46.0)	3,977 (53.3)	30,479 (46.7)	1,517 (54.5)	32,817 (47.3)
South	10,697 (13.0)	1,116 (15.0)	9,292 (14.2)	568 (20.4)	9,802 (14.1)
Center-West	3,773 (4.6)	434 (5.8)	2,789 (4.3)	119 (4.3)	3,085 (4.5)

Source: Elaborated by the authors.

higher among prisoners than in the other groups, it is important to note that the percentage is substantially lower than the 100% recommended by the Ministry of Health<sup>15</sup>.

Although both prisoners and the homeless are vulnerable groups and TB incidence was greater in these groups than in the general population<sup>15</sup>, our findings show that case outcome differed between these populations.

Data reported to the US national TB surveillance system from 1993 through 2003 showed that inmates with TB were more likely to have at least one TB risk factor compared with noninmates (60.1% vs 42.0%) and less likely to complete treatment (76.8% vs 89.4%)<sup>14</sup>. However, the proportion of inmates who showed a favorable outcome was similar to the rate found for the

prisoners in the present study (78.6%). A study in El Salvador covering the period 2009 to 2013 reported that treatment success rates in prisons were over 95%<sup>16</sup>.

Although we were unable to find other studies in Brazil that showed an association between being a prisoner and favorable case outcomes (protective factor against treatment failure) (OR 0.68, 95%CI 0.63-0.73), we believe that this finding may be associated with the benefits of receiving DOT. A study in Brazil showed that receiving DOT led to a 25% reduction in unfavorable TB treatment outcomes<sup>17</sup>. Our findings show that receiving DOT was associated with treatment success in both prisoners and the homeless.

A number of factors may hamper the continuation of treatment among the homeless, includ-

**Table 2.** Clinical characteristics of diagnosed cases of tuberculosis by population type, Brazil, 2015.

Clinical characteristics	Total population n=82,056 (%)	Prisoners n=7,462 (%)	Nonprisoners n=65,230 (%)	Homeless n=2,782 (%)	Nonhomeless n=69,318 (%)
Type of TB case					
New case	65,998 (80.4)	4,614 (75.2)	53,083 (81.3)	1,559 (56.0)	56,662 (81.7)
Relapse	5,532 (6.7)	763 (10.2)	4,170 (6.4)	196 (7.0)	4,693 (6.8)
Reenrollment after loss to follow-up	7,757 (9.5)	891 (11.9)	5,989 (9.2)	935 (33.7)	5,892 (8.5)
Not known	248 (0.3)	12 (0.2)	139 (0.2)	19 (0.7)	131 (0.2)
Transfer	2,197 (2.7)	176 (2.4)	1,682 (2.6)	65 (2.3)	1,774 (2.6)
Post-death	324 (0.4)	6 (0.1)	167 (0.3)	8 (0.3)	166 (0.2)
Form of TB					
Pulmonary	69,765 (85.0)	7,038 (94.3)	54,487 (83.5)	2,545 (91.5)	58,450 (84.3)
Extrapulmonary	9,746 (11.9)	310 (4.2)	8,578 (13.2)	125 (4.5)	8,720 (12.6)
Pulmonary+Extrapulmonary	2,504 (3.1)	114 (1.5)	2,160 (3.3)	112 (4.0)	2,143 (3.1)
Missing	41 (0)	0 (0)	5 (0)	0 (0)	5 (0)
AIDS					
No	62,967 (76.7)	5,824 (78.1)	51,593 (79.1)	1,876 (67.4)	55,166 (79.6)
Yes	8,771 (10.7)	568 (7.6)	7,367 (11.3)	661 (23.8)	7,235 (10.4)
Missing	10,318 (12.6)	1,070 (14.3)	6,270 (9.6)	245 (8.8)	6,917 (10.0)
Diabetes mellitus					
No	69,397 (84.5)	6,394 (85.7)	56,968 (87.4)	2,471 (88.8)	60,480 (87.2)
Yes	5,888 (7.2)	105 (1.4)	5,116 (7.8)	86 (3.1)	5,102 (7.4)
Missing	6,771 (8.3)	963 (12.9)	3,146 (4.8)	225 (8.1)	3,736 (5.4)
Mental illnesses					
No	73,019 (89.0)	6,402 (85.8)	60,315 (92.5)	2,348 (84.4)	63,939 (92.3)
Yes	1,967 (2.4)	91 (1.2)	1,634 (2.5)	187 (6.7)	1,532 (2.2)
Missing	7,070 (8.6)	969 (13.0)	3,281 (5.0)	247 (8.9)	3,847 (5.5)
Alcoholism					
No	61,029 (74.4)	5,769 (77.3)	49,835 (76.4)	1,163 (41.8)	54,071 (78.0)
Yes	14,626 (17.8)	782 (10.5)	12,393 (19.0)	1,460 (52.5)	11,645 (16.8)
Missing	6,401 (7.8)	911 (12.2)	3,002 (4.6)	159 (5.7)	3,602 (5.2)
Smoking					
No	58,410 (71.2)	4,906 (65.7)	48,665 (74.6)	1,401 (50.4)	51,959 (75.0)
Yes	15,175 (18.5)	1,566 (21.0)	13,063 (20.0)	1,174 (42.2)	13,410 (19.3)
Missing	8,471 (10.3)	990 (13.3)	3,502 (5.4)	207 (7.4)	3,949 (5.7)
Drugs					
No	63,182 (77.0)	4,981 (66.7)	53,289 (81.7)	1,113 (40.0)	56,935 (82.1)
Yes	9,934 (12.1)	1,430 (19.2)	8,117 (12.4)	1,474 (53.0)	8,039 (11.6)
Missing	8,940 (10.9)	1,051 (14.1)	3,824 (5.9)	195 (7.0)	4,344 (6.3)

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ing: food insecurity, associated health problems, alcoholism and drug use, low self-esteem, difficulty recognizing symptoms, and the fact that living conditions make it difficult for homeless people to take medications regularly due theft or loss of medicines<sup>18</sup>.

Our findings show that the rate of treatment failure among the homeless was 63.2% and that the adjusted odds ratio for unfavorable outcomes (failure) was 2.38 (95%CI 2.17-2.61). Similar results were found by other studies: a study in São Paulo<sup>9</sup> reported a 57.3% failure rate and an OR

**Table 2.** Clinical characteristics of diagnosed cases of tuberculosis by population type, Brazil, 2015.

Clinical characteristics	Total population n=82,056 (%)	Prisoners n=7,462 (%)	Nonprisoners n=65,230 (%)	Homeless n=2,782 (%)	Nonhomeless n=69,318 (%)
X-ray					
Normal	3,745 (4.6)	144 (1.9)	3,260 (5.0)	73 (2.6)	3,301 (4.8)
Suspect	58,364 (71.1)	3,389 (45.5)	49,135 (75.3)	2,109 (75.9)	50,090 (72.3)
Other pathology	1,202 (1.5)	55 (0.7)	905 (1.4)	18 (0.6)	926 (1.3)
Not performed	15,094 (18.4)	3,375 (45.2)	9,922 (15.2)	491 (17.6)	12,646 (18.2)
Missing	3,651 (4.4)	499 (6.7)	2,008 (3.1)	91 (3.3)	2,355 (3.4)
Sputum smear microscopy					
Negative	15,751 (19.2)	1,545 (20.7)	12,594 (19.3)	500 (18.0)	13,536 (19.5)
Positive	44,390 (54.1)	4,694 (62.9)	34,807 (53.4)	1,680 (60.4)	37,459 (54.1)
Not performed	17,648 (21.5)	1,057 (14.2)	14,014 (21.5)	538 (19.3)	14,422 (20.8)
Not applicable	4,230 (5.2)	166 (2.2)	3,814 (5.8)	64 (2.3)	3,900 (5.6)
Missing	37 (0)	0 (0)	1 (0)	0 (0)	1 (0)
Culture					
Negative	7,993 (9.7)	805 (10.8)	6,592 (10.1)	280 (10.1)	7,019 (10.1)
Positive	17,354 (21.2)	2,790 (37.4)	13,572 (20.8)	981 (35.3)	15,318 (22.1)
Ongoing	2,881 (3.5)	432 (5.8)	2,174 (3.3)	123 (4.4)	2,446 (3.5)
Not performed	53,790 (65.6)	3,435 (46.0)	42,890 (65.8)	1,398 (50.2)	45,533 (64.3)
Missing	38 (0)	0 (0)	2 (0)	0 (0)	2 (0)
Directly observed therapy					
No	25,042 (30.5)	1,377 (18.5)	20,887 (32.0)	780 (28.0)	21,387 (30.9)
Yes	28,045 (34.2)	3,180 (42.6)	22,328 (34.2)	923 (33.2)	24,340 (35.1)
Missing	28,969 (35.3)	2,905 (38.9)	22,015 (33.8)	1,079 (38.8)	23,591 (34.0)
Case outcome					
Cure	53,381 (65)	5,068 (67.9)	42,952 (65.9)	965 (34.7)	46,658 (67.4)
Loss to follow-up	9,106 (11.1)	567 (7.6)	7,515 (11.5)	938 (33.7)	7,112 (10.3)
Death from TB	2,981 (3.6)	72 (1.0)	2,336 (3.6)	164 (5.9)	2,235 (3.2)
Death from other causes	3,588 (4.4)	117 (1.6)	3,029 (4.6)	159 (5.7)	2,971 (4.3)
Transfer	4,818 (5.9)	478 (6.4)	3,548 (5.4)	236 (8.5)	3,749 (5.4)
MDR-TB	893 (1.1)	99 (1.3)	727 (1.1)	33 (1.2)	786 (1.1)
Change in scheme	406 (0.5)	14 (0.2)	371 (0.6)	12 (0.4)	374 (0.5)
Failure	77 (0.1)	0 (0)	66 (0.1)	3 (0.1)	62 (0.1)
Primary loss to follow-up	591 (0.7)	31 (0.4)	507 (0.8)	110 (4.0)	427 (0.6)
Missing	6,215 (7.6)	1,016 (13.6)	4,179 (6.4)	162 (5.8)	4,944 (7.1)

Source: Elaborated by the authors.

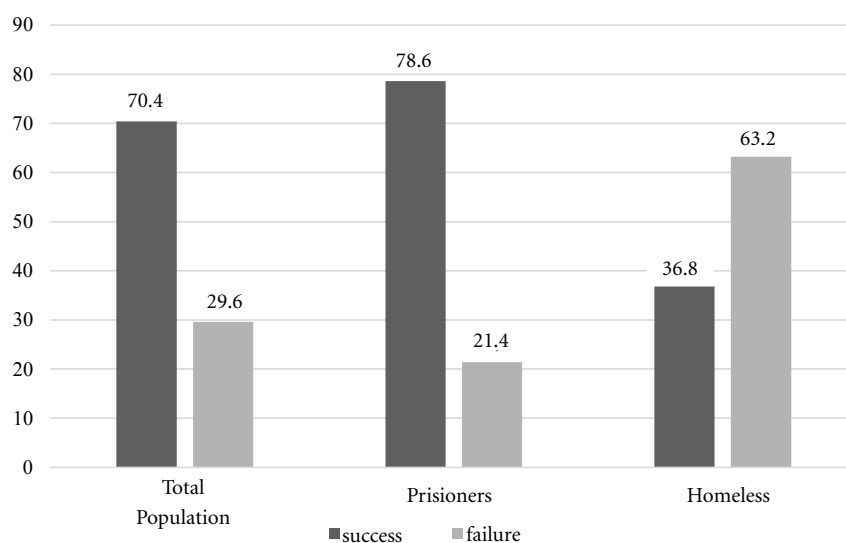
of 4.96 (95%CI 4.27-5.76); in London<sup>19</sup>, homelessness was associated with multidrug resistance (OR 2.1), poor adherence (OR 2.5), and loss to follow-up (OR 3.8); and in Nicaragua<sup>20</sup>, being homeless was associated with loss to follow-up (OR 3.08, 95%CI 1.57-6.49).

A cohort study conducted in the United States during the period 1994 to 2010 showed that the homeless were twice as likely to not complete treatment<sup>21</sup>. Most of the homeless TB patients

were young male adults and the sample showed a high prevalence of excessive alcohol use, drug use and HIV infection<sup>21</sup>, as observed in the present study.

It is important to emphasize that issues related to difficulty of access to health facilities such as lack of flexibility of opening hours aggravate this problem<sup>18</sup>.

This study has some limitations. First, the "special situations" item on the SINAN notifica-



**Graph 1.** Tuberculosis treatment outcomes (% success and failure) by population type. Brazil, 2015.

Source: Elaborated by the authors.

tion form was only introduced in 2014, meaning that the number of homeless persons in 2015 may be underestimated as health professionals were getting used to the new form during the study period. In addition, both the homeless and prisoners are socially stigmatized groups, which means that these persons may have been ashamed to admit that they belong to these groups at the time of notification.

Although the National Tuberculosis Program uses tools designed to control the quality of SINAN data, there was a large amount of incomplete data for certain variables, meaning it was necessary to use multiple imputation. In this regard, the comparisons of the analyses using the imputed data and the analysis using complete data showed similar values. It is important to note that the SINAN is a well-structured national information system and the advantages of using this system include the low cost of data collection and broad coverage of data<sup>6</sup>.

Considering the need for a social inclusion policy that addresses the promotion of the human rights of prisoners, in 2003, the ministries of health and justice introduced the National Penitentiary System Health Plan (PNSSP in Portuguese), which reoriented health care for this pop-

ulation. A decade later, the Plan was reviewed and updated, resulting in the introduction of the National Policy for Comprehensive Health Care for Prisoners in the Prison System (PNAISP in Portuguese) in January 2014. The primary objective of the PNAISP is to guarantee prisoners access to comprehensive health care under Brazil's public health system, the *Sistema Único de Saúde* (SUS) or Unified Health System. The PNAISP provides that prison system health services should be part of the SUS's Health Care Network, confirming primary care within the prison system as the front door of the system and organizer of health actions and services throughout the network<sup>22,23</sup>. These policies have contributed significantly to the improvement of health care in the prison system and to the diagnosis, treatment and control of tuberculosis among prisoners.

It is important to highlight that the main factors related to tuberculosis in prisoners and the homeless are social and institutional, resulting from social inequality and barriers to access to health services. Actions that address only biological aspects of the disease are therefore insufficient for infection control.

Cash transfer programs have made an effective contribution to reducing TB incidence<sup>24</sup> and

**Table 3.** Association between being a prisoner or homeless and treatment failure adjusted for variables in the logistic regression model. Brazil, 2015.

Characteristics	Prisoners ORa	95%CI	Homeless ORa	95%CI
Vulnerable population				
No	reference		reference	
Yes	0.68	0.63-0.73	2.38	2.17-2.61
<b>Adjusted for</b>				
Sex				
Male	reference		reference	
Female	0.84	0.80-0.87	0.87	0.83-0.90
Age group				
15 to 39 years	reference		reference	
40 to 64 years	0.98	0.94-1.02	1.01	0.97-1.05
65 years and over	1.49	1.39-1.60	1.57	1.46-1.68
Race/skin color				
White	reference		reference	
Black	1.22	1.15-1.29	1.20	1.14-1.28
Yellow	1.10	0.89-1.35	1.09	0.88-1.33
Brown	1.21	1.15-1.27	1.20	1.15-1.26
Indigenous	1.17	0.96-1.41	1.21	0.94-1.45
Education level				
Illiterate	reference		reference	
1 to 4 years	0.80	0.73-0.89	0.81	0.73-0.89
5 to 8 years	0.77	0.69-0.85	0.78	0.70-0.86
>8 years	0.57	0.51-0.63	0.59	0.53-0.65
Not applicable	0.75	0.60-0.94	0.76	0.60-0.95
Region				
North	reference		reference	
Northeast	1.19	1.11-1.28	1.18	1.10-1.26
Southeast	1.12	1.04-1.20	1.09	1.01-1.17
South	1.40	1.28-1.53	1.37	1.23-1.48
Center-West	1.30	1.17-1.44	1.26	1.13-1.40
Type of TB case				
New case	reference		reference	
Relapse	1.24	1.15-1.32	1.21	1.13-1.30
Reenrollment after loss to follow-up	3.32	3.13-3.51	3.16	2.98-3.35
Not known	2.68	1.97-3.63	2.54	1.86-3.45
Transfer	2.11	1.91-2.32	2.08	1.88-2.29
Post-death	1313.87	7.36e-09-2.34e+14	1337.84	7.36e-09-2.34e+14

it continues

curing the disease<sup>25</sup>. Research has also shown the benefits of DOT, suggesting that that this strategy should be expanded, especially among the homeless. In 2011, the National Primary Care Policy (PNAB in Portuguese) introduced the *Consultório na Rua* or Street Clinics, aimed at improving access to health services for the homeless by providing timely comprehensive care to

this group. Street Clinics have multiprofessional teams that provide mobile care in partnership with conventional primary care teams<sup>18</sup>, playing an important role in promoting DOT among the homeless.

Given the complexity of the context of tuberculosis in prisoners and the homeless revealed by this study, public health policies need to be tai-



**Table 3.** Association between being a prisoner or homeless and treatment failure adjusted for variables in the logistic regression model. Brazil, 2015.

Characteristics	Prisoners ORa	95%CI	Homeless ORa	95%CI
Form of TB				
Pulmonary	reference		reference	
Extrapulmonary	0.83	0.77-0.88	0.85	0.79-0.91
Pulmonary+Extrapulmonary	1.19	1.07-1.31	1.21	1.09-1.33
AIDS				
No	reference		reference	
Yes	2.93	2.77-3.10	2.92	2.76-3.08
Diabetes mellitus				
No	reference		reference	
Yes	1.00	0.93-1.06	1.02	0.95-1.08
Mental illnesses				
No	reference		reference	
Yes	1.16	1.04-1.29	1.13	1.01-1.25
Alcoholism				
No	reference		reference	
Yes	1.39	1.32-1.45	1.38	1.31-1.44
Smoking				
No	reference		reference	
Yes	1.08	1.03-1.14	1.08	1.02-1.13
Drug use				
No	reference		reference	
Yes	1.68	1.59-1.79	1.54	1.44-1.63
X-ray				
Normal	reference		reference	
Suspect	1.08	0.99-1.19	1.10	1.00-1.20
Other pathology	1.51	1.29-1.77	1.51	1.29-1.77
Not performed	1.12	1.01-1.24	1.07	0.97-1.18
Sputum smear microscopy				
Negative	reference		reference	
Positive	0.93	0.88-0.97	0.94	0.89-0.99
Not performed	1.17	1.11-1.24	1.19	1.12-1.25
Not applicable	1.00	0.91-1.11	1.03	0.93-1.13
Culture				
Negative	reference		reference	
Positive	1.52	1.41-1.63	1.48	1.38-1.59
Ongoing	3.90	3.48-4.37	3.80	3.39-4.25
Not performed	1.64	1.53-1.75	1.65	1.55-1.76
Directly observed therapy				
No	reference		reference	
Yes	0.47	0.45-0.48	0.46	0.44-0.48

ORa - adjusted odds ratio.

Source: Elaborated by the authors.

lored to the specific needs of these groups and implemented in conjunction with social services

and public security agencies in order to have a significant impact on TB incidence.

### **Collaborations**

LR Macedo worked on the conception, writing of the article and critical review. ELN Macedo and CJ Struchiner worked on the conception, critical review and approval of the version to be published.

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Article submitted 12/05/2020

Approved 13/08/2020

Final version submitted 15/08/2020

Chief editors: Romeu Gomes, Antônio Augusto Moura da Silva

