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Inequities between migrants and non-migrants with TB: Surveillance evidence from the Brazilian border State of Roraima

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ABSTRACT

Introduction: Until 2014, there was already a significant burden of TB in Roraima, with this State being among the most affected ones in Brazil. Since 2015, though, there has been a progressive increase in cases of TB in the state of Roraima, with a notorious concentration of cases in Venezuelan migrants. Active international migration in border territories should be seen as a warning signal about the need to strengthen health surveillance and One Health actions that encompass all components involved in the risk of active transmission of diseases as tuberculosis in these scenarios.
Objective: This study aims to analyze and compare migrants and non-migrants notified with TB in the State of Roraima in Brazil and identify inequities in terms of diagnosis, access to treatment and outcome of the disease.
Study design: Quantitative, cross-sectional, descriptive study of all confirmed cases of TB notified in the Information System for Notifiable Diseases (SINAN) between 2009 and 2019.
Methods: Data were described through counts, frequencies, prevalence ratios and 95% confidence interval. We used Poisson regression with robust variance to adjust for confounders.
Results: 2111 cases of TB were reported in Roraima between 2009 and 2019 and in this study (mean age 38.2 ± 18.5 years). Cases were more frequently males, brownish race, indigenous people, with high school level education. 10.9% ($n = 181$) of TB cases were migrants, mainly from Venezuela (72.9%). Migrants with TB were more prone to be homeless (PR = 3.7). A higher number of cases of readmission after treatment dropout (3.3%) and AIDS diseases (11.2%) was observed among migrants compared to non-migrants. The proportion of DR-TB was higher among migrants. The percent of cure of TB was lower among migrants and the prevalence of abandonment of treatment, transfers and deaths by other causes was higher compared to non-migrants.
Conclusions: The results of the study have shown considerable differences in the epidemiological profile of TB between migrants and non-migrants living in the State of Roraima, with a tendency for poorer outcomes in the first ones as well as more concentration of vulnerabilities. These results stress out existing inequities between migrants and non-migrants with TB disease and raise questions on the health care network capacity to address these.

1. Introduction

The World Health Organization (WHO) estimated in 10.4 million TB patients and more than 1.3 million deaths from the disease of which approximately 380,000 deaths in HIV infected people, in 2019. In that same year, more than 73,000 cases of TB were reported in Brazil, corresponding to an incidence rate of 35 new cases/100,000 inhabitants, putting the country among the list of the 22 countries with the highest burden of TB [1].

Rio de Janeiro (76 new cases/100,000 inhabitants), Amazonas (76 new cases/100,000 inhabitants), Acre (58 new cases /100,000 inhabitants), Pará (53 new cases/100,000 inhabitants) and Roraima (48 new cases/100,000 inhabitants) are the states of Brazil with the highest incidence of the disease [2].

Between 2000 and 2017, the number of international migrants increased around 49% worldwide [3]. Since 2015 the Brazilian state of Roraima has been dealing with intense migration from Venezuela motivated by the political, economic and social crisis in the country that

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has started in 2013. In the first 45 days of 2018, more than 18,000 persons crossed the border from Venezuela to Roraima [4].

Until 2014, there was already a significant burden of TB in Roraima, with this State being among the most affected ones in Brazil. According to the epidemiological report of the Ministry of Health, in 2014 Roraima presented an incidence of 29.7 cases/100,000 inhab. Ranking among the States of Northern Brazil with the highest incidence of TB [5]. Cases were reported mainly among the native population.

Managing large migratory movements over short periods of time jeopardizes the resilience and the adaptive capacity of the health systems in destination countries [6]. Despite the limitations in accessing health services, between 2015 and 2019, outbreaks of diseases such as measles and hepatitis A, as well as cases of TB, malaria, syphilis and leishmaniasis in groups of Venezuelan migrants were notified in the Information System of Notifiable Diseases (SINAN) of the Brazilian Ministry of Health. The number of cases of these diseases reported among migrants was higher than those reported for the non-migrant population [7].

Since 2015, though, there has been a progressive increase in cases of TB in the state of Roraima, with a notorious concentration of cases in Venezuelan migrants. The last epidemiological report of the Venezuelan Ministry of Health dates to 2016 and already showed a growth of 68% in the number of TB cases, with an incidence rate of 32.4/100,000 inhab, considered the highest in the country in 40 years [8–10].

It is also worth mentioning that, currently, Venezuela has a questionable epidemiological scenario regarding the reporting of official data on possible outbreaks and epidemics of reemerging diseases and, therefore, intense emigration in the country may become an imminent risk factor for the reintroduction and dissemination of diseases already considered controlled in Brazil [11].

Currently there is still a deficit of studies about migration public health issues in order to aggregate all the pillars of the “One Health” approach to global health promotion and disease prevention [12]. Active international migration in border territories should be seen as a warning signal for managers and health professionals about the need to strengthen health surveillance actions that encompass all components involved in the risk of active transmission of diseases as tuberculosis that have the human, animals and environment as potential disseminators in these scenarios.

This study aims to analyze cases of TB in migrants and non-migrants in the State of Roraima in Brazil and identify inequities in terms of diagnosis, access to treatment and outcome.

2. Methods

Quantitative, cross-sectional, descriptive study based on the collection of data from the Information System for Notifiable Diseases (SINAN) database of all confirmed cases of TB notified between 2009 and 2019 in the State of Roraima - Brazil. All data from this period was analyzed. The analysis was conducted by the authors (DS and IF). Data were collected in February 2022 and analyzed in the period of April and May 2022 and corresponds to the totality of the records.

We collected secondary data from the TB notification form, namely: sociodemographic (sex, race/color, education, federal unit of residence in Brazil, special populations - deprived of liberty, homeless, health professionals and migrants); clinical (type of entry, clinical form, associated diseases and diseases); diagnosis (sputum smear, chest x-ray, culture, histopathology, rapid molecular test, sensitivity test, HIV test); and follow-up and outcome (follow-up bacilloscopies, antiretroviral therapy, treatment for TB, outcomes). For detailed description see Supplementary file.

To this study, migrants were defined as those individuals not born in Brazil and non-migrants as those who had been born in Brazil. In the database, migrants were identified via the variable Migrant (Y/N) in the case notification form (after 2015) or country of origin (prior to 2015) (Supplementary file).

Until 2014, the migration status in the SINAN database of a non-Brazilian, diagnosed with TB was made signaling the field 30 – Country (if resident outside Brazil) in the TB notification form. In 2015, an error was detected: despite the registration in field 30 as resident outside Brazil, it was being coded as resident in Brazil. In 2016, in the state of Roraima, a strategy was created to identify migrants in SINAN using field 23 – complement of the address (qualitative variable, nominal) that could be filled manually to provide information on the country of origin. Therefore, as of 2015 (data was retrospectively reviewed) information about the country of origin of a TB case was used to identify migrants in this study.

Data was analyzed using counts and frequencies (nominal scale variables) and central tendency and dispersion measures (numerical scale variables) computed in SPSS (Statistical Package for the Social Science), crude prevalence ratios (PR) and corresponding 95% confidence intervals to compare migrants and non-migrants. We used Poisson regression with robust variance to adjust for confounders. The WinPEPI (Whatis) program [13] was used to compute the confidence intervals.

3. Results

Two thousand one hundred and eleven new cases of TB were reported in the state of Roraima between 2009 and 2019. The average age of cases was 38.2 years (sd = 18.5; median = 36.0 years, IQR = 27; min = 0; max = 92). Cases were more frequently males, of brownish race, indigenous people, and with high school level education (Table 1).

Most cases were from the state of Roraima. Nevertheless, there were also cases of TB in individuals from other states of Brazil, namely Amazonas (n = 2111, 2.4%), Maranhão (n = 2111, 0.2%) and Pará (n = 2111, 0.1%).

From total cases, 181 (10.9%) were notified in migrants. These were mainly from Venezuela (n = 132; 72.9%), English Guiana (n = 2), Haiti (n = 2) and Portugal (n = 1) and 44 notifications of immigrants without specific register of origin. Slightly more than one tenth of cases of TB were beneficiaries of some type of social income program offered by the government (n = 119; 10.9%) (Table 1).

Between 2009 and 2014, the State of Roraima presented a total of 511 cases among non-migrants, with the highest number of new cases registered in 2011 (n = 111 cases). In migrants, between 2009 and 2014 no cases of TB were notified. From 2015 to 2019, there was an increase

Table 1
Sociodemographic characteristics of TB cases reported in SINAN, in the State of Roraima, between 2009 and 2019.

Characteristics	n (%)
Sex (N = 2111)	
Female	713 (33.8%)
Male	1398 (66.2%)
Race (N = 2111)	
White	204 (9.8%)
Black	86 (4.1%)
Yellow	14 (0.7%)
Brown	1293 (62.0%)
Indigenous	487 (23.4%)
Educational Level (N = 2111)	
Illiterate	239 (14.8%)
1st to 4th grade	344 (21.4%)
5th to 8th grade	369 (22.9%)
High School	474 (29.4%)
University Education	118 (7.3%)
Not applicable	67 (4.2%)
Special Populations (N = 2111) *	
Homeless population	27 (2.3%)
Healthcare professionals	23 (2.0%)
Migrants	181 (10.9%)
Beneficiary of Government Income Transfer Program (N = 2111)	119 (10.9%)

* Categories not mutually exclusive.

in cases in both migrants and non-migrants. The increase of cases in migrants was more stepped from 2017 onwards (Fig. 1).

Migrants were younger (32.5 years; sd = 16.5 years) than non-migrants (38.16 years; sd = 18.8 years) and more frequently women (41.4% vs 32.9%) and indigenous (29.4% vs 24.5%). However, there were no significant differences in the prevalence ratios according to age, sex or race between the two populations.

The prevalence of homeless people was higher in migrants than in non-migrants. On the other hand, the prevalence of beneficiaries of social and financial support from the Government was lower among migrants than in non-migrants (Table 2).

For both migrants and non-migrants, most cases of TB reported referred to new cases with a pulmonary presentation. However, a higher number of cases of readmission after treatment dropout (3.3%), with a higher proportion of pulmonary TB + extrapulmonary TB (mixed clinical form) (7.2%) and AIDS diseases (11.2%) was observed among migrants compared to non-migrants (2.4% reintegration after abandonment, 5.8% of mixed clinical TB, 8.9% of associated AIDS diseases cases) (Table 3).

A higher proportion of positive bacilloscopy was identified among migrants (65.7%) compared to non-migrants (55.6%). Chest x-ray was also more frequent among migrants (85.0% vs 78.3%), as well as histopathology of sputum (4.5% vs 2.4%). Positive cases identified through sputum culture were less frequent in migrants (38.1%) when compared to non-migrants (41.5%).

The rapid molecular test for the diagnosis of TB was performed in 60.8% ($n = 181$) of migrants and 55.5% ($n = 983$) of non-migrants. The results showed that migrants had more frequently TB infection resistant to Rifampicin (2.2% vs 0.8%). Also, the sensitivity test, performed in 90.6% migrants ($n = 85$) and 78.0% of non-migrants ($n = 541$), revealed a higher percentage of cases of TB resistant to Rifampicin (1.2% vs 0.4%) and both Rifampicin and Isoniazid (1.2% vs 0.2%) in migrants but less frequently TB resistant to other first-line drugs (1.2% vs 4.3%).

The HIV test had been performed on 94.5% ($n = 181$) of migrants and 85.7% ($n = 1472$) of non-migrants, with a higher proportion of positive cases among migrants (10.5%) when compared to non-migrants (8.9%) (Table 4).

Regarding the monthly follow-up smears that should be performed during the treatment of TB, migrants tended to present higher values of unperformed smears than non-migrants from the 1st to the 6th month of follow-up.

The percentage of individuals undergoing antiretroviral therapy during TB treatment was higher among migrants (70.0%) when compared to non-migrants (47.4%).

The percentage of cure among TB cases in migrants (45.5%) was lower than in non-migrants (76.2%). Migrants had a higher prevalence of abandonment of treatment (23.6%; PR [95%IC] = 4.3 [3.04;5.89]), compared to non-migrants. There was also a higher prevalence of transfers between migrants (18.5%; PR [95%IC] = 4.44 [3.11;6.33]), when compared to non-migrants (5.2%) and a higher percentage of deaths from TB among migrants (3.4%), when compared to non-migrants (2.9%) and a higher prevalence of migrants deaths by other causes PR [95%IC] = 7.40 [3.59;15.27] (Table 5).

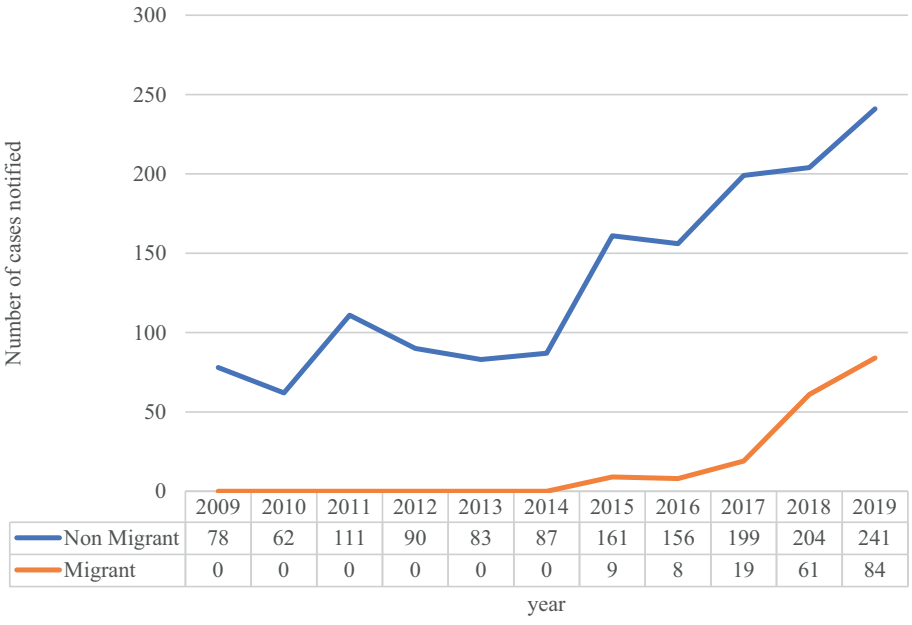
4. Discussion

This study aims to analyze cases of TB in migrants and non-migrants in the State of Roraima in Brazil and identify inequities in terms of diagnosis, access to treatment and outcome.

When comparing migrants to non-migrants, the data show singularities that differ from the general panorama, with a predominance of TB cases in female, indigenous and homeless migrants. The beginning of the intensive dynamics of displacement of international migrants to northern Brazil was led by women, indigenous, predominantly *Warao* ethnic group from the Venezuelan border territory, motivated by the serious political, economic and social instability that plagues Venezuela and that led to the scarcity of water, food, jobs and basic essential services in that territory [14].

According to the International Organization for Migration (IOM), about 48% of the total number of displaced migrants in the world are women [3]. About 42% of women who migrated from Venezuela to Brazil brought with them at least one minor child, a factor that can further aggravate their vulnerability [15]. An earlier study reported that the main reason for *Warao* indigenous people to migrate from Venezuela to Brazil was famine, in addition to the difficulties of accessing public health and education services and the Venezuelan government's disregard for indigenous people [16].

Recent studies indicate that indigenous populations with TB are concentrated in Latin American and the concentration of cases in Brazilian Amazonian indigenous groups is evidenced by incidences of TB



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Non Migrant	78	62	111	90	83	87	161	156	199	204	241
Migrant	0	0	0	0	0	0	9	8	19	61	84

Fig. 1. Distribution of new cases of TB reported in SINAN, in the State of Roraima between 2009 and 2019, according to migration status.

Table 2
Sociodemographic characteristics of TB cases reported in SINAN, in the State of Roraima, between 2009 and 2019, according to migration status.

Characteristics	Non-migrant (%)	Migrant n (%)	PR [95%CI]	aPR [95% CI]* (*N* = 850)
Sex (*N* = 1653)				
Female	485 (32.9%)	75 (41.4%)	1	1
Male	987 (67.1%)	106 (58.6%)	0.72 [0.55;0.96]	0.60 [0.44;0.83]
Race (*N* = 1633)				
White	137 (9.4%)	12 (6.8%)	1	1
Black	57 (3.9%)	10 (5.6%)	1.84 [0.84;4.08]	1.42 [0.57;3.57]
Yellow	9 (0.6%)	0 (0.0%)	–	–
Brown	896 (61.5%)	103 (58.2%)	1.28 [0.72;2.27]	0.94 [0.49;1.78]
Indigenous	357 (24.5%)	52 (29.4%)	0.08 [0.05;0.14]	1.35 [0.65;2.83]
Educational Level (*N* = 1288)				
Illiterate	183 (15.9%)	19 (14.0%)	1	1
1st to 4th grade	240 (20.8%)	23 (16.9%)	1.86 [0.92;3.78]	1.41 [0.72;2.75]
5th to 8th grade	272 (23.6%)	34 (25.0%)	0.93 [0.52;1.66]	1.06 [0.59;1.89]
High School	330 (28.6%)	41 (30.1%)	1.81 [0.69;2.01]	1.60 [0.93;2.76]
University Education	80 (6.9%)	9 (6.6%)	1.17 [0.70;1.97]	1.38 [0.81;2.36]
Not applicable	47 (4.1%)	10 (7.4%)	1.07 [0.51;2.28]	0.98 [0.44;2.20]
Special Populations**				
Homeless population (*N* = 1161)	13 (1,3%)	14 (8.2%)	3.77 [2.55;5.58]	2.88 [1.82;4.57]
Healthcare professionals (*N* = 1162)	21 (2.1%)	2 (1.2%)	0.58 [0.15;2.19]	–
Population deprived of liberty (*N* = 1163)	141 (14.2%)	2 (1.2%)	0.08 [0.02;0.34]	–
Beneficiary of Government Income Transfer Program (*N* = 1078)	116 (12.7%)	1 (0.6%)	0.05 [0.01;0.36]	–

* Adjusted, analysis of complete cases;
** Categories not mutually exclusive.

greater than 1000/100,000 inhabitants or at least 20 times higher than the incidence in the general Brazilian population [17]. The social vulnerabilities related to low education, poor living conditions and health make Brazilian and Venezuelan indigenous people a population more vulnerable to TB illness.

When comparing migrants and non-migrants with TB, a higher prevalence of TB cases in homeless migrants was observed. Homeless populations usually consist of heterogeneous groups, in extreme poverty, frail or broken family ties and unconventional housing (precarious, ceded or non-existent) permanent or temporary [18].

The Regional Interagency Coordination Platform for Refugees and Migrants from Venezuela (R4V), led by UNHCR and IOM reported that until 2021, in Roraima, about 6000 Venezuelan migrants were homeless or in unconventional housing/overcrowded spontaneous occupations, without access to basic necessary resources such as drinking water, electricity or food [4]. These groups of migrants were mainly indigenous people, women and children [4].

Previous studies have shown that homeless populations are more likely to contract TB, even in developed countries [19]. Another study that compared outcomes of TB treatments in homeless population and general population in Brazil revealed that the proportion of losses to follow-up (discontinuity in treatment) and death in homeless population was 2.5 and 2.9 times higher, respectively [20].

The results showed that circa 10% of the TB cases reported in Roraima between 2009 and 2019 received some type of social benefit from the government, which is in line with official data [21]. However, among migrants, this percentage was less than 1%. Global strategies to end of TB include social and economic protection strategies for both vulnerable populations and patients undergoing treatment of the disease [22].

In this study, a higher proportion TB-HIV coinfection were detected among migrants. It is recommended that the treatment of TB in people living with TB-HIV be performed in high complexity health services [22], due to the specificities of the clinical follow-up. TB/HIV co-infection in migrants is associated with unfavorable outcomes of the disease [23]. Antiretroviral therapy in cases of TB/HIV co-infection is essential to reduce the risk of severity and unfavorable outcomes associated with these two conditions.

Although higher in migrants, TB-HIV infection was also significant among non-migrants. As such, the capacity of the only specialized health service center in Roraima may suffer a bottleneck related to the progressive increase in the number of cases of coinfection detected in the migrant population since 2015 and may further contribute to the spread of the infection, due to the absence and/or timeliness of adequate

Table 3
Clinical characteristics of TB cases reported in SINAN, in the State of Roraima, between 2009 and 2019, by migration status, type of entry, clinical form and co-existing morbidities.

Characteristics	Non-migrant n (%)	Migrant n (%)	Total n (%)	PR [95%CI]	aPR [95%CI] (*N* = 1083)
Notification entry type (N = 1653)					
New case	1321 (89.7%)	159 (87.8%)	1480 (89.5%)	1	1
Recurrence	32 (2.2%)	2 (1.1%)	34 (2.1%)	0.55 [0.14;2.12]	0.65 [0.18;2.38]
Reintegration after abandonment	35 (2.4%)	6 (3.3%)	41 (2.5%)	1.36 [0.64;2.89]	1.45 [0.70;3.01]
Transfer	70 (4.8%)	14 (7.7%)	84 (5.1%)	1.55 [0.94;2.56]	1.26 [0.74;2.12]
Post-death	14 (1.0%)	0 (0%)	14 (0.8%)	–	–
Clinical form (N = 1653)					
Pulmonary	1193 (81.0%)	150 (82.9%)	1343 (81.2%)	1	1
Extrapulmonary	194 (13.2%)	18 (9.9%)	212 (12.8%)	0.76 [0.48;1.21]	0.63 [0.39;1.02]
Pulmonary + extrapulmonary	85 (5.8%)	13 (7.2%)	98 (5.9%)	1.19 [0.70;2.01]	0.98 [0.55;1.74]
Co-existing morbidities*					
AIDS (*N* = 1535)	122 (8.9%)	19 (11.2%)	141 (9.2%)	1.24 [0.80;1.94]	1.38 [0.87;2.17]
Alcoholism (*N* = 1593)	261 (18.4%)	26 (15.1%)	287 (18.0%)	0.81 [0.54;1.20]	0.95 [0.63;1.46]
Diabetes (*N* = 1602)	150 (10.5%)	4 (2.3%)	154 (9.6%)	0.22 [0.08;0.58]	0.15 [0.05;0.45]
Mental illness (*N* = 1606)	18 (1.3%)	1 (0.6%)	19 (1.2%)	0.48 [0.07;3.27]	–
Illicit drugs use (*N* = 1155)	169 (17.2%)	9 (5.2%)	178 (15.4%)	0.30 [0.16;0.58]	0.25 [0.12;0.52]
Tabagism (*N* = 1153)	220 (22.5%)	31 (17.8%)	251 (21.8%)	0.78 [0.54;1.12]	1.05 [0.70;1.57]

*Adjusted, analysis of complete cases; **Categories not mutually exclusive.

Table 4
Characteristics of TB cases reported in SINAN, in the State of Roraima, between 2009 and 2019 according to migration status, type of diagnosis and exams performed.

Characteristics	Non-migrant n (%)	Migrant n (%)	Total n (%)	PR [95%CI]	aPR [95%CI] (*N* = 1025)*
Sputum bacilloscopy (N = 1653)					
Positive	815 (55.6%)	119 (65.7%)	934 (56.7%)	1	1
Negative	549 (37.5%)	45 (24.9%)	594 (36.1%)	0.59 [0.43;0.82]	0.58 [0.40;0.83]
Not performed	101 (6.9%)	17 (9.4%)	118 (7.2%)	1.13 [0.71;1.81]	1.17 [0.67;2.04]
Chest x-ray (*N* = 1636)					
Suspected	1140 (78.3%)	153 (85.0%)	1293 (79.0%)	1	1
Normal	81 (5.6%)	9 (5.0%)	90 (5.5%)	0.84 [0.45;1.60]	0.80 [0.39;1.64]
Another pathology	4 (0.3%)	0 (0.0%)	4 (0.2%)	–	–
Not performed	231 (15.9%)	18 (10.0%)	249 (15.2%)	0.61 [0.38;1.00]	0.68 [0.42;1.12]
Sputum culture (N = 1653)					
Positive	611 (41.5%)	69 (38.1%)	680 (41.1%)	1	1
Negative	268 (18.2%)	25 (13.8%)	293 (17.7%)	0.84 [0.54;1.30]	1.18 [0.76;1.83]
In progress	144 (9.8%)	38 (21.05%)	182 (11.05)	2.06 [1.43;2.95]	1.66 [1.12;2.44]
Not perfomed	449 (30.5%)	49 (27.1%)	498 (30.1%)	0.97 [0.68;1.37]	1.78 [1.23;2.56]
Histopathology (*N* = 1620)					
Acid-fast bacilli (AFB) positive	34 (2.4%)	8 (4.5%)	42 (2.6%)	1	1
Suggestive of TB	74 (5.1%)	6 (3.4%)	80 (4.9%)	0.40 [0.15;1.06]	0.56 [0.20;1.58]
Not Suggestive of TB	4 (0.3%)	2 (1.1%)	6 (0.4%)	1.75 [0.48;6.37]	1.90 [0.25;14.41]
In progress	51 (3.5%)	6 (3.4%)	57 (3.5%)	0.55 [0.21;1.47]	0.58 [0.19;1.74]
Not performed	1278 (88.7%)	157 (87.7%)	1435 (88.6%)	0.57 [0.30;1.09]	0.60 [0.29;1.23]
Rapid molecular testing (TRM – TB) (*N* = 1164)					
Detectable Sensitive to Rifampicin	452 (46.6%)	88 (48.6%)	540 (46.4%)	1	1
Detectable Resistant to Rifampicin	8 (0.8%)	4 (2.2%)	12 (1.0%)	2.04 [0.90;4.66]	1.25 [0.37;4.19]
Not detectable	79 (8.0%)	17 (9.4%)	96 (8.2%)	1.09 [0.68;1.74]	1.29 [0.78;2.16]
Inconclusive	7 (0.7%)	1 (0.6%)	8 (0.7%)	0.77 [0.12;4.85]	1.15 [0.28;4.78]
Not performed	437 (44.5%)	71 (39.2%)	508 (43.6%)	0.86 [0.64;1.14]	0.77 [0.56;1.05]
Sensibility test (*N* = 626)					
Resistant only to Isoniazid	12 (2.2%)	0 (0.0%)	12 (1.9%)	–	–
Resistant only to Rifampicin	2 (0.4%)	1 (1.2%)	3 (0.5%)	–	–
Resistant to Isoniazid and Rifampicin	1 (0.2%)	1 (1.2%)	2 (0.3%)	–	–
Resistant to other first-line drugs	23 (4.3%)	1 (1.2%)	24 (3.8%)	–	–
Susceptible	365 (67.5%)	71 (83.5%)	436 (69.6%)	–	–
In progress	19 (3.5%)	3 (3.5%)	22 (3.5%0	–	–
Not performed	119 (22.0%)	8 (9.4%)	127 (20.3%)	–	–
HIV test (*N* = 1405)					
Negative	1107 (75.2%)	148 (81.8%)	1255 (75.9%)	1	1
Positive	131 (8.9%)	19 (10.5%)	150 (9.1%)	1.07 [0.69;1.68]]	1.22 [0.78;1.90]

* Adjusted, analysis of complete cases.

diagnosis and treatment.

Early diagnosis of TB is considered essential to stop active cycles of disease transmission. Despite the institution of clinical diagnosis (based on signs and symptoms) especially in children and adolescents, laboratory diagnosis - depending on availability - is strongly recommended [[22,24,25]].

The results showed a higher proportion of positive baciloscopy among migrants when compared to non-migrants. The creation of shelters for refugees with international organizations that offer health services may have contributed to increase the collection of sputum smears in refugee migrants. However, it should be noted that depending on overcrowding in shelters, there is a greater risk of spreading TB in these environments [26].

Migration associated with social vulnerabilities such as unemployment, precarious housing or absence of fixed housing and illegal/undocumented status can favor the dissemination of resistant forms of TB [26], since individuals affected by these conditions are more prone to poor adherence and failure of primary TB treatment.

In this study, the proportion of DR-TB was higher in migrants which might also be associated with abandonment of treatment while migrants were still in Venezuela or as a consequence of the migration process [27]. Interruption of treatment is considered one of the most serious problems for TB control as it results in persistence of the active source of infection, increased rates of recurrence and increased risk of developing resistant bacilli strains [24]. In our study, migrants were almost four-fold more prone to interrupt their treatment.

Clinical follow-up of TB treatment, over six months or more, is essential for monitoring adherence and clinical evolution of the patient until reaching favorable outcomes [28]. Strategies such as Directly Observed Treatment (DOT) can contribute to increase the positive outcomes of the treatment of TB and to reduce treatment dropout, and should be widely used by health professionals as a disease control strategy [24].

The outcomes measured in this study showed a lower percentage of cure than recommended by the World Health Organization - WHO - (at least 85% of patients cured) [22] and a percentage of dropout higher than the goal established by the WHO (at most 5% of treatment dropouts) [22] in both migrants and non-migrants. A previous study conducted in the northern region of Brazil showed similar results for the general population [29] as well as one conducted in the Southeast region in migrants and non-migrants with TB [30]. All these results seem to point to operational failures in the provision of intervention and services aimed at the clinical management of TB in different contexts of the country.

Being a migrant is often associated with hindered access to social assistance and health services, especially for those undocumented [31]. This situation can aggravate even more scenarios of food insecurity and poverty already experienced by migrants, with consequent unfavorable outcomes for those affected by TB.

A previous study showed that TB is one of the leading causes of death among migrants in Europe [32]. TB deaths are more frequent in individuals diagnosed in more advanced stages and/or with resistant strains of the disease, which were common characteristics in migrants diagnosed with TB in this study, where the outcome death was more

Table 5
Characteristics of TB cases reported in SINAN, in the State of Roraima, between 2009 and 2019 according to migration status, clinical follow-up during treatment and outcome.

Characteristics	Non-migrant n (%)	Migrant n (%)	Total n (%)	PR [95%CI]	A PR [95%]*
Follow-up smears					
1st month (*N* = 1501)					
Positive	127 (10.4%)	8 (6.1%)	135 (10.0%)	1	–
Negative	568 (46.7%)	66 (50.4%)	634 (47.1%)	1.76 [0.86;3.57]	–
Not performed	521 (42.8%)	57 (43.5%)	578 (42.9%)	1.66 [0.81;3.04]	–
2nd month (*N* = 1466)					
Positive	33 (2.5%)	3 (2.1%)	36 (2.5%)	1	–
Negative	649 (49.1%)	60 (41.4%)	709 (48.4%)	1.02 [0.33;3.10]	–
Unrealized	503 (38.1%)	64 (44.1%)	567 (38.7%)	1.35 [0.45;4.10]	–
3rd month (*N* = 1434)					
Positive	11 (0.9%)	1 (0.7%)	12 (0.8%)	1	–
Negative	589 (45.6%)	57 (40.4%)	646 (45.0%)	1.06 [0.16;7.03]	–
Unrealized	557 (43.1%)	65 (46.1%)	622 (43.3%)	1.25 [0.19;8.31]	–
4th month (*N* = 1394)					
Positive	5 (0.4%)	1 (0.7%)	6 (0.4%)	1	–
Negative	540 (42.9%)	51 (38.1%)	591 (42.4%)	0.52 [0.85;3.16]	–
Unrealized	579 (46.0%)	64 (47.8%)	643 (46.1%)	0.60 [0.10;3.63]	
5th month (*N* = 1326)					
Positive	4 (0.3%)	1 (0.8%)	5 (0.4%)	1	
Negative	525 (43.5%)	40 (33.3%)	565 (42.6%)	0.35 [0.06;2.10]	
Unrealized	541 (44.9%)	61 (50.8%)	602 (45.4%)	0.51 [0.09;2.97]	
6th month (*N* = 1246)					
Positive	6 (0.5%)	0 (0.0%)	6 (0.5%)	–	
Negative	518 (45.4%)	33 (30.6%)	551 (44.2%)	–	
Unrealized	478 (42.0%)	57 (52.8%)	535 (42.9%)	–	
After 6 months (*N* = 478)					
Positive	1 (0.2%)	0 (0.0%)	1 (0.1%)	–	
Negative	155 (36.3%)	5 (9.3%)	160 (9.7%)	–	
Unrealized	124 (29.2%)	31 (57.4%)	155 (9.4%)	–	
Antiretroviral therapy during treatment for TB (*N* = 157)	65 (47.4%)	14 (70.0%)	79 (50.3%)	2.30 [0.93;5.69]	
Outcomes (*N* = 1645)					
Cure	1118 (76.2%)	81 (45.5%)	1199 (72.9%)	1	
Abandonment of treatment	105 (7.2%)	42 (23.6%)	147 (8.9%)	4.3 [3.04;5.89]	
Primary Abandonment DR-TB	4 (0.3%)	4 (2.2%)	8 (0.5%)	1.85 [0.85;4.03]	
	22 (1.5%)		26 (1.6%)	0.92 [0.39;2.22]	
Transfer	77 (5.2%)	33 (18.5%)	110 (6.7%)	4.44 [3.11;6.33]	
Change of diagnosis	24 (1.6%)	3 (1.7%)	27 (1.6%)	1.64 [0.55;4.88]	
TB related death	42 (2.9%)	6 (3.4%)	48 (2.9%)	2.28 [0.90;5.75]	
Death by other causes	75 (5.1%)	5 (2.8%)	80 (4.9%)	7.40 [3.59;15.27]	

* It was not possible to make the adjusted model because it only had 46 complete observations.

frequent in migrants.

The main limitation of this study is related to the quality of the secondary data used. Although TB is a notifiable disease, its notification is dependent on the degree of sensitivity and responsibility of the notifiers. An expressive number of variables not filled or filled with inconsistent information was found over the period under analysis. Changes in the notification form led to the discontinuity of information over time.

Underreporting or omission of important information may have implications for the results obtained. This may result from the fact that the process of notification is still manually done, not all information is mandatory and not all notifiers receive adequate training to fulfill the notification form.

Nevertheless, this study as it includes all observations during the study period has high external validity in terms of its findings.

5. Conclusions

There are considerable differences in the epidemiological profile of TB cases in migrants and non-migrants. In this study it was observed that, in the State of Roraima, the cases of tuberculosis reported in the migrant population are concentrated women, indigenous people and homeless people mostly from Venezuela. There was also a higher proportion of cases of resistant TB and a higher proportion of co-infection TB/HIV, when compared to non-migrants and a higher prevalence of unfavorable outcomes among migrants when compared to non-migrants.

The recent migratory flow from Venezuela to Brazil, due to the economic and social instability of the first, mainly through the border of the state of Roraima, stresses out the need to provide dedicated services to migrants, including health services in general and for infectious diseases. These results prompt questions about the resolution of the existing health care services network in the state of Roraima and on the strategic actions planned and implemented to prevent and control TB for both the general population and the migrant population.

Given the relevance of the theme, this study can be used as a model for reproduction in other migratory contexts of international borders of Brazil, collaborating for the epidemiological design of tuberculosis the implementation of strategies to reduce disease transmission in these scenarios.

Author statement

I Débora de Almeida Soares, the corresponding author of this manuscript, certify that the contributors' included in this paper are correct and have been approved by all co-authors. All authors have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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