Tuberculosis cases with post-mortem notification in Brazil, 2014: a descriptive study based on surveillance data*

doi: 10.1590/S1679-49742020000500014

Ursila Manga Aridja¹ – orcid.org/0000-0001-8322-1025
Luciana Guerra Gallo¹ – orcid.org/0000-0001-8344-9951
Ana Flávia de Morais Oliveira¹ – orcid.org/0000-0003-3210-1618
Andressa Wanneska Martins da Silva¹ – orcid.org/0000-0002-3868-9873
Elisabeth Carmen Duarte¹ – orcid.org/0000-0001-9148-5063

¹Universidade de Brasília, Programa de Pós-Graduação em Medicina Tropical, Brasília, DF, Brazil

Abstract

Objective: To characterize tuberculosis cases notified at post-mortem in Brazil in 2014. Methods: This is a descriptive study of tuberculosis cases notified at post-mortem. Data resulted from linkage of the Notifiable Health Conditions Information System-TB (SINAN-TB) and the Mortality Information System (SIM), and were described according to underlying cause of death: tuberculosis, AIDS and other. Results: In the 2,703 tuberculosis cases notified at post-mortem, a higher proportion was found of people of the male sex (73.5%), aged over 39 (80.8%), <8 years of schooling (66.5%), of Black and brown race/skin color (62.8%), with the pulmonary clinical form of tuberculosis (75.2%); there was also a higher proportion of cases notified by the public health service (57.6%) and in municipalities with HDI-M >0.7 (66.6%). Conclusion: The characteristics described of people with post-mortem notification and the magnitude of this outcome suggest weaknesses in tuberculosis care and surveillance services.

Keywords: Tuberculosis; Disease Notification; Epidemiology, Descriptive; Mortality; Information Systems.

*Article derived from the Master’s Degree dissertation entitled ‘Tuberculosis cases with post-mortem notification: characterization and associated factors – Brazil, 2014’, defended by Ursila Manga Aridja at the Tropical Medicine Postgraduate Program (in the area of Epidemiology and Control of Communicable and Parasitic Diseases), University of Brasilia, in March 2020.

Correspondence:
Ursila Manga Aridja – Colina, Bloco K, Apto. 106-A, Asa Norte, Brasilia, DF, Brazil. Postcode: 70910-900
E-mail: ursilamanga@gmail.com
Introduction

Tuberculosis (TB) continues to be the leading cause of death among communicable diseases and one of the ten leading causes of death worldwide. In 2018, there were estimated to have been 10 million cases and 1.4 million deaths directly related to TB.1

When a TB case is notified at post-mortem it can be considered to be a ‘sentinel event’ alerting as to failures in individual care and compromising the effectiveness of the TB control service.

Methods

This is a descriptive study of TB cases notified at post-mortem, found by linking data for the year 2014 held on two Ministry of Health information systems, namely the SINAN-TB system and the Mortality Information System (SIM).

Brazil is a country of continental dimensions, covering an area of 8,510,820.623km2 and with an estimated population of 204.2 million inhab. in 2014.6 There is great social inequality in Brazil, which is particularly unfavorable for the North and Northeast regions, which have the lowest average per capita income and the highest Gini indices among the country’s five regions.7,8 Also in 2014, TB was considered to be one of the most important diseases for Public Health.6 67,966 new cases were recorded that year, with the highest incidence coefficients being found in the states of Amazonas (68.4/100,000 inhab.) and Rio de Janeiro (60.9/100,000 inhab.),10 while nationally the mortality rate was 2.4 deaths per 100,000 inhab.11

It is appropriate to recall that the Brazilian National Health System (SUS) is public, free of charge, offers universal coverage and provides care to the greater part of the population.12 In 2014, jointly the federal, state and municipal public administration networks had some 898,612 health services linked to SUS.13

The study population was comprised of all TB cases notified at post-mortem in Brazil in 2014. The case exclusion criteria were: being under 15 years old, in order to prevent considerable heterogeneity among the study population; and missing information on the sex of the cases.

Notification at post-mortem was defined as notification of a TB case exclusively made at the circumstances of death.

The information on the study population was identified by means of a secondary database, derived from linkage between the SINAN-TB and SIM systems, available only for the year 2014. This study added TB cases found on SINAN-TB input as ‘post-mortem’ cases to TB cases found exclusively on SIM which, for the purposes of this study, were also considered to be ‘post-mortem’ cases. TB should be registered on SIM as the underlying cause of death or a contributing cause of death — recorded on Part I or Part II of Causes of death on the Death Certificate, using codes A15 to A19 of the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10).
The linked database (SIM + SINAN-TB), was provided by the Ministry of Health following a request made via the Electronic Citizens' Information System (e-SIC), on the website http://esic.cgu.gov.br/sistema/site/index.aspx (Protocol No. 25820.004488/2019-30, issued on June 6th 2019).

The variables of interest to the study were:

a) Individual characteristics
   - Sex (male; female);
   - Age group (years: 15-19; 20-39; 40-59; 60 or over);
   - Schooling (years of study: none; 1-8; more than 8; unknown);
   - Race/skin color (White; Black or brown; indigenous; unknown);
   - Clinical form of tuberculosis (pulmonary; pulmonary + extrapulmonary; extrapulmonary or NOS [without mention of bacteriological or histological confirmation]);
   - Underlying cause of death (TB; AIDS; other);
   - Presence (no; yes) of other diseases mentioned on the Death Certificate – selected chronic diseases (diabetes mellitus [E10-14], hypertension [I10-15], respiratory system diseases [J00-99], among others) and diseases most mentioned on post-mortem notifications.

b) Characteristics of municipality of residence
   - Human development index (HDI-M) (low [below 0.6]; medium [0.6-0.7]; high [over 0.7]);
   - Percentage poverty (low [below 10%]; medium [10-20%]; high [20-45%]; very high [over 45%]). Percentage poverty was defined as the proportion of individuals with household per capita income equal to or less than BRL 140 a month in August 2010;
   - Population size (number of inhabitants: small [under 20,000]; medium [20-100,000]; large [over 100,000]);
   - Brazilian macro-region (North; Northeast; Southeast; South, Midwest);
   - Municipality of residence (we described the ten municipalities with most cases of notification at post-mortem).

c) Characteristics of type of service
   - Medical care for the disease that caused death (no; yes);
   - Type of health service notifying death (public; private; non-profit; not specified);
   - Family Health Strategy (FHS) coverage (low [up to 50%]; medium [50-75%]; high [over 75%]) in the municipality of residence;
   - Primary Care (PC) coverage (low [up to 50%]; medium [50-75%]; high [over 75%]) in the municipality of residence.

The variables relating to the characteristics of the municipality of residence were obtained from the Brazilian Institute of Geography and Statistics (IBGE) and from the United Nations Development Program (UNDP) (2013), while the variables relating to health service characteristics were retrieved from Tabnet (e-Gestor). All the other variables were retrieved from SIM.

The DCCI/MS technical team performed the probabilistic linkage using Reclink III free software, applying a multiple-step routine in which each step used a given blocking key. Probabilistic linkage includes a stage intended to standardize files for later use. The following stage, known as the linkage stage, is comprised of two processes, record blocking and record matching, which assist with optimizing the comparison process, dividing the databases into logic blocks, as well as building scores, according to the blocking strategy used. In this study, the linkage parameters were estimated by applying Expectation-Maximization (EM) algorithms. The final stage, data combination, involves the creation of a new file, based on two other files, whereby pairs considered to be “true” are identified according to the score defined, by matching the full name of the person, their mother’s name and their date of birth. After each blocking stage, the data are reviewed manually. Doubtful records were classified as ‘non-pairs’.

The absolute and relative frequencies of the variables of interest were described with the aid of the Stata version 11.0 and Microsoft Office Excel 2013 computer programs.

The study complied with the ethical principles for conducting research with human beings. As the study only used non-nominal secondary data available for public use, Research Ethics Committee approval was not necessary.

Results

A total of 7,268 deaths mentioning TB in 2014 were identified (Figure 1). 4,447 TB cases were excluded because they had been notified before death on SINAN, as well as 59 cases under 15 years old and 59 cases with no information about sex (Figure 1). The post-mortem notifications (2,703) resulted from adding
together 2,506 (93%) cases recorded exclusively on SIM and 197 (7%) retrieved from SINAN-TB input as ‘post-mortem’. TB as the underlying cause accounted for 64.9% of all deaths, while AIDS as the underlying cause accounted for 19.7%.

The majority of cases notified at post-mortem as having TB as the underlying cause were male (73.5%), over 39 years old (80.8%), with low schooling (8 years or less, 66.5%), of Black or brown race/skin color (62.8%) and with the pulmonary clinical form of infection (75.2%) (Table 1). Differently to the two other underlying causes highlighted by the study, the proportion of people coinfected with AIDS + TB (AIDS as the underlying cause of death) had 68.6% of males, 53.9% of people over 39 years old, 60.8% of people with low schooling and 57.2% of people with the pulmonary clinical form of TB (Table 1).

Deaths notified at post-mortem as having TB as the underlying cause mainly occurred among those living in municipalities with high HDI-M (66.6%), large population size (59.6%), low or medium percentage poverty (72.9%), located in the Southeast (46.4%) and Northeast (32.6%) regions of the country (Table 2).

Among the main contributing diseases, when TB was the underlying cause of death, we identified diseases of the respiratory system (52.7%), mental and behavioral disorders caused by used of psychoactive substances (10.0%), circulatory system diseases (8.9%), malnutrition (6.4%), diseases of the digestive system (5.1%), hypertension (4.4%), diabetes mellitus (4.0%) and diseases of the genitourinary system (3.9%) (Figure 2). Standing out among respiratory diseases were chronic diseases of the upper respiratory tract. When TB appeared as an associated cause, malignant neoplasms were among the most frequent underlying causes of death, although less frequent as associated causes (2.1%) (Figure 2).

For almost all the cases studied (>90%), it was not possible to identify whether the person had had access to medical care for the condition that resulted in death (Table 3). Cases cared for by the public health service accounted for over half the TB notifications at post-mortem, for all three groups of underlying causes of death (TB; AIDS; other). Finally, more than half the cases were notified in municipalities with low FHS coverage (54.2%), although they had medium (42.1%) or high (35.3%) PC coverage (Table 3).

**Discussion**

The study found a high number of TB cases identified as only being notified at post-mortem. These were recovered mainly from SIM and were therefore not included in the DCCI/MS official statistics. TB cases notified at post-mortem together 2,506 (93%) cases recorded exclusively on SIM and 197 (7%) retrieved from SINAN-TB input as ‘post-mortem’. TB as the underlying cause accounted for 64.9% of all deaths, while AIDS as the underlying cause accounted for 19.7%.

The majority of cases notified at post-mortem as having TB as the underlying cause were male (73.5%), over 39 years old (80.8%), with low schooling (8 years or less, 66.5%), of Black or brown race/skin color (62.8%) and with the pulmonary clinical form of infection (75.2%) (Table 1). Differently to the two other underlying causes highlighted by the study, the proportion of people coinfected with AIDS + TB (AIDS as the underlying cause of death) had 68.6% of males, 53.9% of people over 39 years old, 60.8% of people with low schooling and 57.2% of people with the pulmonary clinical form of TB (Table 1).

Deaths notified at post-mortem as having TB as the underlying cause mainly occurred among those living in municipalities with high HDI-M (66.6%), large population size (59.6%), low or medium percentage poverty (72.9%), located in the Southeast (46.4%) and Northeast (32.6%) regions of the country (Table 2).

Among the main contributing diseases, when TB was the underlying cause of death, we identified diseases of the respiratory system (52.7%), mental and behavioral disorders caused by used of psychoactive substances (10.0%), circulatory system diseases (8.9%), malnutrition (6.4%), diseases of the digestive system (5.1%), hypertension (4.4%), diabetes mellitus (4.0%) and diseases of the genitourinary system (3.9%) (Figure 2). Standing out among respiratory diseases were chronic diseases of the upper respiratory tract. When TB appeared as an associated cause, malignant neoplasms were among the most frequent underlying causes of death, although less frequent as associated causes (2.1%) (Figure 2).

For almost all the cases studied (>90%), it was not possible to identify whether the person had had access to medical care for the condition that resulted in death (Table 3). Cases cared for by the public health service accounted for over half the TB notifications at post-mortem, for all three groups of underlying causes of death (TB; AIDS; other). Finally, more than half the cases were notified in municipalities with low FHS coverage (54.2%), although they had medium (42.1%) or high (35.3%) PC coverage (Table 3).

**Discussion**

The study found a high number of TB cases identified as only being notified at post-mortem. These were recovered mainly from SIM and were therefore not included in the DCCI/MS official statistics. TB cases notified at post-mortem
had TB and AIDS as the main underlying causes of death. Among the notifications of TB at post-mortem, we found higher proportions of people of the male sex, over 39 years old, with eight years schooling or less, of Black or brown race/skin color, with the pulmonary clinical form of TB and notified by the public health service. Moreover, their municipalities of residence had higher HDI-M, low poverty rates, large population size, low Family Health Strategy coverage and high or medium Primary Care coverage.

The proportion of AIDS + TB coinfection, whether as underlying cause or associated cause, corroborates previous studies, according to which AIDS appears as the second leading cause of death among all people with TB.\textsuperscript{1,17} This result is of concern, given that the protocol adopted in Brazil recommends TB testing for all people with HIV and vice versa.\textsuperscript{20}

A higher proportion of males was found among TB cases notified at post-mortem. It is known that men are more affected by TB and die more from this cause, when compared to women, which may be related to the fact of their using health services less, having lower adherence to treatment and having more risk factors, among other reasons.\textsuperscript{1,19} Studies indicated that the male sex is also more subject to case underreporting. Pinheiro et al.\textsuperscript{20} assessed TB underreporting in a municipality in the state of Rio de Janeiro and identified greater underreporting among the male population.

Greater frequency of people who were 60 years old or over was identified among the TB cases notified at post-mortem, when compared to the other age ranges. Many studies demonstrate that there tends to be higher TB incidence among people of productive age, pointing to greater effectiveness of guidelines on detection of cases in this age group.\textsuperscript{4,17,21-23} However, the greater biological vulnerability of the elderly, especially related to the presence of other diseases, increases risk of death from

### Table 1 – Absolute and relative distribution of individual characteristics and clinical form of cases mentioning tuberculosis notified at post-mortem, by underlying cause, Brazil, 2014

| Characteristics            | TB, underlying cause of death | TB, contributing cause of death | AIDS, underlying cause of death | Other underlying causes of death | Total |
|----------------------------|-------------------------------|---------------------------------|---------------------------------|----------------------------------|-------|
| Sex                        |                               |                                 |                                 |                                  |       |
| Female                     | 465 (26.5)                    | 167 (31.4)                      | 108 (25.9)                      | 740                              |       |
| Male                       | 1,290 (73.5)                  | 365 (68.6)                      | 308 (74.1)                      | 1,963                            |       |
| Age group (years)          |                               |                                 |                                 |                                  |       |
| 15-20                      | 19 (1.1)                      | 3 (0.6)                         | 6 (1.4)                         | 28                               |       |
| 20-39                      | 317 (18.1)                    | 242 (45.5)                      | 63 (15.2)                       | 622                              |       |
| 40-59                      | 676 (38.5)                    | 250 (47.0)                      | 154 (37.0)                      | 1,080                            |       |
| ≥60                        | 743 (42.3)                    | 37 (6.9)                        | 193 (46.4)                      | 973                              |       |
| Schooling (years of study) |                               |                                 |                                 |                                  |       |
| 00                         | 311 (17.7)                    | 48 (9.1)                        | 59 (14.2)                       | 418                              |       |
| 1-8                        | 857 (48.8)                    | 275 (51.7)                      | 221 (53.1)                      | 1,353                            |       |
| >8                         | 212 (12.1)                    | 101 (18.9)                      | 56 (13.5)                       | 369                              |       |
| Unknown                    | 375 (21.4)                    | 108 (20.3)                      | 80 (19.2)                       | 563                              |       |
| Race/skin color            |                               |                                 |                                 |                                  |       |
| White                      | 567 (32.3)                    | 173 (32.5)                      | 144 (34.6)                      | 884                              |       |
| Black or brown             | 1,101 (62.8)                  | 333 (62.6)                      | 253 (60.8)                      | 1,687                            |       |
| Indigenous                 | 18 (1.0)                      | 2 (0.4)                         | 2 (0.5)                         | 22                               |       |
| Unknown                    | 69 (3.9)                      | 24 (4.5)                        | 17 (4.1)                        | 110                              |       |
| Clinical form of tuberculosis |                             |                                 |                                 |                                  |       |
| Pulmonary                  | 1,320 (75.2)                  | 304 (57.2)                      | 280 (67.3)                      | 1,904                            |       |
| NOSa                       | 259 (14.8)                    | 115 (21.6)                      | 100 (24.1)                      | 474                              |       |
| Extrapulmonary             | 176 (10.0)                    | 113 (21.2)                      | 36 (8.6)                        | 325                              |       |
| Total                      | 1,755 (100.0)                 | 532 (100.0)                     | 416 (100.0)                     | 2,703                            |       |

Legend:
AIDS: Acquired Immunodeficiency Syndrome.
SIM: Mortality Information System.
TB: Tuberculosis.
a) NOS: clinical form of tuberculosis without mention of bacteriological or histological confirmation.
Table 2 – Absolute and relative distribution of characteristics of municipalities of residence of cases mentioning tuberculosis notified at post-mortem, by underlying cause, Brazil, 2014

| Characteristics | TB, underlying cause of death | TB, contributing cause of death | Total |
|-----------------|------------------------------|--------------------------------|-------|
|                 | N (%)                        | N (%)                          | N (%) |
|                 | AIDS, underlying cause of death | Other underlying causes of death |       |
| HDI-M           | N (%)                        | N (%)                          | N (%) |
| Unknown         | 21 (1.2)                     | 6 (1.1)                        | 2 (0.5) | 29 |
| Low (<0.6)      | 192 (10.9)                   | 22 (4.2)                       | 43 (10.3) | 257 |
| Medium (0.6-0.7)| 373 (21.3)                   | 105 (19.7)                     | 70 (16.8) | 548 |
| High (>0.7)     | 1,169 (66.6)                 | 399 (73.0)                     | 301 (72.4) | 1,869 |
| Poverty (%)     | N (%)                        | N (%)                          | N (%) |
| Unknown         | 21 (1.2)                     | 6 (1.1)                        | 2 (0.5) | 29 |
| Low (<10)       | 831 (47.4)                   | 307 (57.7)                     | 216 (51.9) | 1,354 |
| Medium (10-20)  | 448 (25.5)                   | 142 (26.7)                     | 108 (23.9) | 698 |
| High (20-45)    | 271 (15.4)                   | 54 (10.2)                      | 49 (11.8) | 374 |
| Very high (>45) | 184 (10.5)                   | 23 (4.3)                       | 41 (9.9) | 248 |
| Population size (per 1,000 inhab.) | N (%)                        | N (%)                          | N (%) |
| Unknown         | 21 (1.2)                     | 6 (1.1)                        | 2 (0.5) | 29 |
| Small (<20,000) | 268 (15.3)                   | 46 (8.6)                       | 61 (14.7) | 375 |
| Medium (20-100,000) | 420 (23.9)             | 120 (22.6)                     | 98 (23.5) | 638 |
| Large (>100,000)| 1,046 (59.6)                 | 360 (67.7)                     | 255 (61.3) | 1,661 |
| Region of residence | N (%)                        | N (%)                          | N (%) |
| North           | 208 (11.8)                   | 59 (11.1)                      | 40 (9.6) | 307 |
| Northeast       | 572 (32.6)                   | 121 (22.7)                     | 147 (35.4) | 840 |
| Southeast       | 815 (46.4)                   | 244 (45.9)                     | 174 (41.8) | 1,233 |
| South           | 87 (5.0)                     | 78 (14.7)                      | 33 (7.9) | 198 |
| Midwest         | 73 (4.2)                     | 30 (5.6)                       | 22 (5.3) | 125 |
| Municipalities of residence | N (%)                        | N (%)                          | N (%) |
| Rio de Janeiro  | 199 (11.3)                   | 54 (10.2)                      | 41 (9.9) | 294 |
| São Paulo       | 144 (8.2)                    | 31 (5.8)                       | 25 (6.0) | 200 |
| Porto Alegre    | 43 (2.5)                     | 16 (3.0)                       | 15 (3.6) | 74 |
| Recife          | 23 (1.2)                     | 9 (1.7)                        | 1 (0.2) | 34 |
| Salvador        | 27 (1.5)                     | 9 (1.7)                        | 6 (1.4) | 42 |
| Fortaleza        | 43 (2.5)                     | 16 (3.0)                       | 15 (3.6) | 74 |
| Belém           | 26 (1.5)                     | 6 (1.1)                        | 20 (4.8) | 52 |
| Other capitals/municipalities | 47 (2.7)                    | 12 (2.3)                       | 10 (2.4) | 69 |
| Other municipalities | 1,152 (65.6)            | 342 (64.3)                     | 263 (63.2) | 1,757 |
| Total           | 1,755 (100.0)                | 532 (100.0)                    | 416 (100.0) | 2,703 |

Legend:
- AIDS: Acquired Immunodeficiency Syndrome.
- HDI-M: Municipal human development index.
- TB: Tuberculosis.
- a) Other municipalities which are also state capitals.

TB in this age group, conceals symptoms of the disease, reduces awareness of the need for early diagnosis and delays treatment, providing an opportunity for TB underreporting and notification only at post-mortem. 

This study found that people of Black or brown race/skin color accounted for over 60% of all TB notifications at post-mortem. In addition to being the biggest ethnic/racial population group in Brazil, the Black or brown race/skin color variable also has important collinearity with schooling and income in Brazil and, therefore, is associated with the pattern of health service use.6,24,25 People of Black or brown race/skin color are, therefore, more exposed to late diagnosis and treatment, as well as delayed notification of the disease. This result found by the study corroborates this hypotheses and highlights the barriers faced by this population to accessing quality health care in Brazil, one of the world’s most unequal countries.26

The pulmonary clinical form of TB, which is the most frequent form in Brazil,3 accounted for the greater part
Toxoplasmosis (B58)  
Diseases of the blood (D50-89)  
Viral hepatitis (D50-89)  
Malnutrition (E40-46)  
Diabetes (E10-14)  
Diseases of the genitourinary system (N00-99)  
Hypertension (I10-15)  
Mental disordersc  
Diseases of the digestive system (K00-93)  
Malignant neoplasms (C00-D48)  
Diseases of the circulatory system (I00-99)  
Diseases of the respiratory system (J00-99)  
AIDS (B24-24)  
Other b  

a) Chronic diseases with greater frequency of notification at post-mortem were chosen.  
b) Mortality due to: external causes, ill-defined diseases and unknown causes, and non-chronic diseases.  
c) Mental and behavioral disorders due to use of psychoactive substances.  

Legend:  
AIDS: Acquired Immunodeficiency Syndrome.  
TB: Tuberculosis.  

Figure 2 – Distribution (%) of selected underlying and associated causes of death a of cases mentioning tuberculosis notified at post-mortem, Brazil, 2014

Table 3 – Absolute and relative distribution of health care and health service characteristics in the municipalities of residence de tuberculosis cases notified at post-mortem, by underlying cause, Brazil, 2014

| Characteristics                  | TB, underlying cause of death | TB, contributing cause of death | Total |
|----------------------------------|------------------------------|---------------------------------|-------|
|                                  | N (%)                        | N (%)                           | N     |
| Individual level                 |                              |                                 |       |
| Medical care a                    |                              |                                 |       |
| Yes                              | 68 (3.9)                     | 13 (2.4)                        | 5 (1.2)| 86    |
| No                               | 23 (1.3)                     | 3 (0.6)                         | 6 (1.4)| 32    |
| Unknown                          | 1,664 (94.8)                 | 516 (97)                        | 405 (97.4)| 2,585 |
| Type of health service notifying death |                              |                                 |       |
| Public                           | 1,011 (57.6)                 | 364 (68.4)                      | 204 (49.0)| 1,579 |
| Private                          | 85 (4.8)                     | 29 (5.4)                        | 39 (9.4)| 153   |
| Non-profit                       | 261 (14.9)                   | 95 (17.9)                       | 81 (19.5)| 437   |
| Unknown                          | 398 (22.7)                   | 44 (8.3)                        | 92 (22.1)| 534   |
| Municipal level                  |                              |                                 |       |
| FHS coverage b                   |                              |                                 |       |
| Low (<50)                        | 952 (54.2)                   | 321 (60.3)                      | 226 (54.3)| 1,499 |
| Medium (50-75)                   | 324 (18.5)                   | 91 (17.1)                       | 61 (14.7)| 476   |
| High (>75)                       | 479 (27.3)                   | 120 (22.6)                      | 129 (31.0)| 728   |
| PC coverage c                    |                              |                                 |       |
| Low (<50)                        | 397 (22.6)                   | 228 (42.9)                      | 85 (20.4)| 710   |
| Medium (50-75)                   | 739 (42.1)                   | 165 (31.0)                      | 170 (40.9)| 1,074 |
| High (>75)                       | 619 (35.3)                   | 139 (26.1)                      | 161 (38.7)| 919   |
| Total                            | 1,755 (100.0)                | 552 (100.0)                     | 416 (100.0)| 2,703 |

a) Medical care for the disease that led to death, as notified on Death Certificate.  
b) FHS: Family Health Strategy.  
c) PC: Primary Health Care.  
Legend:  
AIDS: Acquired Immunodeficiency Syndrome.  
TB: Tuberculosis.
of cases notified at post-mortem. People with pulmonary TB notified only at post-mortem are a further cause of concern due to their potential for transmitting the disease, even though free accurate diagnostic tests and treatment are available nationwide to provide better prognosis than for other clinical forms.27

On the other hand, extrapulmonary TB cases were more frequent among people coinfected with HIV/AIDS. There is known to be strong association between extrapulmonary TB and HIV infection.5,28 In general, it is harder to diagnose this clinical form of TB, even more so in people with HIV, and this favors underdetection of TB in this population and justifies, in part, the results found.

Municipalities with high HDI-M, large population size and low poverty rates, principally those located in the Southeast and Northeast regions, have large populations which explain the greater number of TB cases in all subcategories, including among cases notified at post-mortem.5,29 It should be remembered that despite their high HDI-Ms, these large municipalities also have large social inequalities and a high level of vulnerable populations, contributing in particular to demands that are not met by health services and, consequently, greater possibility of cases being notified only at post-mortem.

In the population studied, when TB was an associated cause, the main underlying causes identified were AIDS, diseases of the respiratory system, circulatory diseases, malignant neoplasms, diseases of the digestive system, mental and behavioral disorders, hypertension and diabetes mellitus, in that order. It is important to note that this list contains diseases that require continuous care and monitoring by health professionals. These findings confirm those of the study conducted by Rocha et al.27 when characterizing multiple causes of death among a cohort of notified cases, these authors found diseases similar to those mentioned above. This result allows one to infer that there are shortcomings in the comprehensiveness of care, as well as lost opportunities of diagnosing and managing TB cases and their contacts.

People cared for in public health services at the time of their death accounted for the largest proportion of post-mortem TB notification (whether or not TB was the underlying cause). This can be explained by the fact of the public service being free of charge and having national coverage, thus reaching the greater part of the population.11 Moreover, people attended to in these services are, on average, more socially vulnerable, which may have contributed to the high proportion of TB cases notified only at post-mortem.

Cases resident in municipalities with low Family Health Strategy coverage and high or medium Primary Care coverage accounted for a high proportion of TB notification at post-mortem. This situation may reflect the population exposed to these coverage levels, given that larger municipalities tend to have lower coverage of this kind of health care, especially FHS. In addition, these results may reveal territories where the entry point to SUS does not effectively occur through Primary Health Care, thus compromising the order of care, as well as adequate TB management and surveillance. Strengthening Primary Care as a strategy for ordering health care will contribute to addressing the problem and, possibly, to reducing TB case underdetection and underreporting in the municipalities. Indeed, according to Rasella et al.30, municipalities with high FHS and PC coverage have better health indicators.

The main limitation of this study relates to the use of secondary data derived from the health surveillance system routine. Incomplete and inaccurate data and lack of standardization when filling in notification forms and Death Certificates, among other shortcomings, may favor information biases/errors. However, Brazil’s SIM is recognized as a robust system, with coverage greater than 95% of estimated deaths.29 Another limitation of the study lies in having considered as notifications at post-mortem all cases notified on SINAN with this classification and those notified exclusively on SIM, based on probabilistic matching. The process of linking the two information systems may have failed to identify all true pairs, resulting in incorrect classification of cases as being cases notified at post-mortem. This could have contributed to cases being overestimated. Finally, the study population may represent (i) individuals with adequate access to TB diagnosis and treatment, but underreported by SINAN, as well as (ii) individuals with no access to TB care. As such, a further limitation would be the difficulty in distinguishing between these different situations and gaining a better understanding of the findings described. However, the vulnerability profile of the people identified leads us to believe that the second situation is more probable.

The study characterized people for whom TB was notified at post-mortem in Brazil in 2014, their sociodemographic and clinical profile, the characteristics of their municipalities of residence and
other selected variables. Our hypothesis is that people notified only at post-mortem are underreported and, probably, underdetected TB cases, whether because of difficulty in diagnosing them, or because of difficulty in accessing health services. Be that as it may, these situations reveal a weakness in the quality of care received. Despite TB being a treatable and avoidable disease, in 2014, 2,703 people were diagnosed at post-mortem and, probably, their contacts were not reached by the surveillance services. This confers epidemiological relevance on the findings. It is possible that these cases reflect an important loss of opportunity on the part of the health system, given that a relevant part of the TB cases notified at post-mortem had at least one chronic condition which should have required continuous monitoring.

In conclusion and based on the results presented, there is a need to enhance TB surveillance in Brazil. It is important to encourage interest in studying risk factors associated with TB diagnosis and notification at post-mortem, with the aim of identifying how these subjects differ from those with regular notification. This type of approach can assist with the formulation of surveillance strategies and policies, with the aim of increasing timely identification of patients with tuberculosis.

Authors’ contributions

Aridja UM and Duarte EC contributed to the study conception and design, analysis and interpretation of the results, drafting and critically reviewing the contents of the manuscript. Oliveira AFM, Silva AWM and Gallo LG contributing to drafting the text, interpreting the results, critically analyzing the intellectual content and reviewing the manuscript. All the authors have approved the final version of the manuscript and are responsible for all aspects thereof, including the guarantee of its accuracy and integrity.

References

1. World Health Organization - WHO. Global tuberculosis report 2019 [Internet]. Geneva: World Health Organization; 2019 [cited 2020 Jan 1]. 283 p. Available from: https://apps.who.int/iris/bitstream/handle/10665/329368/9789241565714-eng.pdf?ua=1
2. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Tuberculose 2020. Bol Epidemiol [Internet]. 2020 mar [cited 2020 abr 2];número especial. Disponível em: https://www.saude.gov.br/images/pdf/2020/marco/24/Boletim-tuberculose-2020-marco--1-.pdf
3. Brasil. Ministério da Saúde. Portaria MS/GM no 204, de 17 de fevereiro de 2016. Define a Lista Nacional de Notificação Compulsória de doenças, agravos e eventos de saúde pública [Internet]. Diário Oficial da União, Brasília (DF), 2016 fev 18 [cited 2020 set 9];Seção I:23. Disponível em: http://bvsms.saude.gov.br/bvs/saudelegis/br/2016/prt204_17_02_2016.html
4. Santos ML, Coeli CM, Batista JAL, Braga MC, Albuquerque FPM. Fatores associados à subnotificação de tuberculose com base no Sinan Aids e Sinan Tuberculose. Rev Bras Epidemiol [Internet]. 2018 [cited 2020 set 7];21:e180019. Disponível em: https://doi.org/10.1590/1980-549720180019
5. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Protocolo para vigilância do óbito com menção de tuberculose nas causas de morte [Internet]. Brasília: Ministério da Saúde; 2017 [cited 2020 jan 10]. Disponível em: http://dive.sc.gov.br/conteudos/publicacoes/Protocolo-para-Vigilância-do-óbito.pdf
6. Instituto Brasileiro de Geografia e Estatística - IBGE. População Censo 2010 [Internet]. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2011 [cited 2019 nov 9]. Disponível em: https://www.ibge.gov.br/en/statistics/social/labor/18391-2010-population-census.html?
7. Ministério da Saúde (BR). Departamento de Informática do SUS - Datasus. Definições [Internet]. Brasília: Ministério da Saúde; 2020 [cited 2020 maio 2]. Disponível em: http://tabnet.datasus.gov.br/cgi/tabegi.exe/tbge/censo/cnv/cnhaf.def
8. Ministério da Saúde (BR). Departamento de Informática do SUS - Datasus. Definições [Internet]. Brasília: Ministério da Saúde; 2020 [cited 2020 maio 2]. Disponível em: http://tabnet.datasus.gov.br/cgi/tbge/censo/cnv/giniuf.def
9. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Vigilância de Doenças não Transmissíveis e Promoção da Saúde. Saúde Brasil 2014: uma análise de situação de saúde e das causas externas [Internet]. Brasília: Ministério da Saúde; 2015 [cited 2020 set 7]. 462 p. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/saude_brasil_2014_analise_situacao.pdf
10. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Vigilância Epidemiológico.
Detectar, tratar e curar: desafios e estratégias brasileiras frente à tuberculose. Bol Epidemiol [Internet], 2015 [citado 2020 set 7];46(9). Disponível em: https://portalarquivos.saude.gov.br/images/pdf/2015/marco/25/boletim-tuberculose-2015.pdf

11. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Vigilância Epidemiológica. Perspectivas brasileiras para o manejo da tuberculose como problema de saúde pública. Bol Epidemiol [Internet]. 2016 [citado 2020 set 7];47(13). Disponível em: http://www.saude.gov.br/images/pdf/2016/marco/24/2016-009-Tuberculose-001.pdf

12. Viana TA, Oliveira RAD, Carvalho CC, Laguardia J, Bellido JG. SUS: oferta, acesso e utilização de serviços de saúde nos últimos 30 anos. Ciência Saúde Coletiva [Internet]. 2018 [citado 2020 jan 10];23(6):1751-62. Disponível em: https://doi.org/10.1590/1413-8123201823.06022018

13. Ministério da Saúde (BR). Departamento de Informática do SUS - Datasus. Definições - CNES estabelecimentos por tipo - Brasil [Internet]. Brasília: Ministério da Saúde; 2020 [citado 2020 maio 2]. Disponível em: http://tabnet.datasus.gov.br/cgi/tabcgi.exe?cnes/cnv/estabbr.def

14. Programa das Nações Unidas para o Desenvolvimento - PNUD. Fundação João Ribeiro. Instituto de Pesquisa Econômica Aplicada. Desenvolvimento humano para além das médias [Internet]. Brasília: PNUD; 2017 [citado 2020 jan 10]. 127 p. Disponível em: https://www.unpd.org/content/dam/brazil/docs/IDH/desenvolvimento-alem-das-medias.pdf

15. Ministério da Saúde (BR). e-Gestor Atenção Básica. Informação e Gestão da Atenção Básica. Cobertura da atenção básica [Internet]. Brasília: Ministério da Saúde; 2020 [citado 2020 jan 10]. Disponível em: https://egestorab.saude.gov.br/paginas/acessoPublico/relatorios/relHistoricoCoberturaAB.xhtml

16. Camargo Júnior KR, Coêlhi CM. Reclink: an application for database linkage implementing the probabilistic record linkage method. Cad Saúde Pública [Internet]. 2012 ago [citado 2020 set 7];28(8): 1559-68. Disponível em: https://doi.org/10.1590/s1980-22142012000800011

17. Rocha MS, Oliveira GP, Aguiar FP, Saraceni V, Pinheiro RS. Do que morrem os pacientes com tuberculose: causas múltiplas de morte de uma coorte de casos notificados e uma proposta de investigação de causas presumíveis. Cad Saúde Pública [Internet]. 2015 abr [citado 2020 set 7];31(4):709-21. Disponível em: https://doi.org/10.1590/0102-311X20150101214

18. Ministério da Saúde (BR). Secretaria Executiva.

Recomendação para o manejo da coinfecção TB-HIV em serviços de atenção especializada à pessoas viver com HIV/AIDS [Internet]. Brasília: Ministério da Saúde; 2013 [citado 2020 abr 20]. 28 p. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/recomendaoes_manejo_coinfeccao_tb_hiv.pdf

19. Teixeira DBS, Cruz SPL. Atenção à saúde do homem: análise da sua resistência na procura dos serviços de saúde. Rev Cuba Enferm [Internet]. 2016 [citado 2020 mar 26];32(4). Disponível em: http://www.renfermeria.sld.cu/index.php/enf/article/view/985/209

20. Pinheiro RS, Andrade VL, Oliveira GP. Subnotificação da tuberculose no Sistema de Informação de Agravos de Notificação (SINAN): abandono primário de bacilíferos e captação de casos em outras fontes de informação usando linkage probabilístico. Cad Saúde Pública [Internet]. 2012 ago [citado 2020 set 7];28(8): 1559-68. Disponível em: http://dx.doi.org/10.1590/s0100-311x2012000800011

21. Lacerda TC, Souza FM, Prado TN, Locatelli RL, Fregoni G, Lima RCD, et al. Infecção por tuberculose entre profissionais de saúde da atenção básica. J Bras Pneumol [Internet]. 2017 dez [citado 2020 set 7];43(6):416-23. Disponível em: https://doi.org/10.1590/s1806-3756201600000211

22. Reis-Santos B, Shete P, Bertolde A, Sales CM, Sanchez MN, Arakaki-Sanchez D, et al. Tuberculosis in Brazil and cash transfer programs: A longitudinal database study of the effect of cash transfer on cure rates. PLoS One [Internet]. 2019 Feb [citado 2019 Nov 10];14(2):e0212617. Available from: http://dx.plos.org/10.1371/journal.pone.0212617

23. Freire ILS, Santos FR, Menezes LCC, Medeiros AB, Lima RF, Silva BCO. Adesão dos idosos às formas de administração do tratamento da tuberculose. J Res Fundam Care Online [Internet]. 2017 [citado 2020 set 7];32(4). Disponible en: http://www.revenfermeria.sld.cu/index.php/enf/article/view/985/209

24. Oliveira JF, Ferrari AP, Tonete VLP, Parada CMGL. Perinatal results and first-year of life according to maternal skin color: a cohort study. Rev Esc Enferm USP [Internet]. 2019 Jul [citado 2020 set 7];53:e03480. Available from: https://doi.org/10.1590/s1980-220x2018003903480

25. Berguó E. Demografia e desigualdade: algumas considerações sobre negros no Brasil. In: Anais do VI Encontro Nacional de Estudos Populacionais [Internet]; 1988 out 16-20; Olinda, PE. [S.l]: Associação Brasileira de Estudos Populacionais;1988 [citado 2020 jan 10]. p. 89-110. Disponível em: http://www.abepp.org.br/publicacoes/index.php/anais/article/viewFile/479/463
26. The World Bank. GINI index (World Bank estimate) [Internet]. [S.I.]: The World Bank Group; 2019 [cited 2020 Jan 10]. Available from: https://data.worldbank.org/indicator/SI.POV.GINI?view=map&year=2016

27. Ferreira SRS, Glasenapp R, Flores R. Tuberculose na atenção primária à saúde [Internet]. Brasília: Ministério da Saúde; 2011 [citado 2020 abr 13]. 130 p. Disponível em: http://www.mobilizadores.org.br/wpcontent/uploads/2014/05/livro_tuberculose11.pdf

28. Bates M, Mudenda V, Shibemba A, Kaluwayi J, Tembo J, Kabwe M, et al. Burden of tuberculosis at post mortem in inpatients at a tertiary referral centre in sub-Saharan Africa: a prospective descriptive autopsy study. Lancet Infect Dis [Internet]. 2015 May [cited 2020 Sep 7];15(5):544-51. Available from: http://dx.doi.org/10.1016/S1473-3099(15)70058-7

29. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Vigilância Epidemiológica. Vigilância em saúde no Brasil 2003 [2019. Bol Epidemiol [Internet]. 2019 set [citado 2020 set 7]. número especial. Disponível em: https://portalarquivos.saude.gov.br/images/pdf/2019/setembro/25/boletim-especial-21ago19-web.pdf

30. Rasella D, Harhay MO, Pamponet ML, Aquino R, Barreto ML. Impact of primary health care on mortality from heart and cerebrovascular diseases in Brazil: A nationwide analysis of longitudinal data. BMJ [Internet]. 2014 Jul [citado 2020 Sep 7];349:g4014. Available from: http://dx.doi.org/10.1136/bmj.g4014

Received on 04/04/2020
Approved on 18/08/2020

Associate editor: Bárbara Reis-Santos - orcid.org/0000-0001-6952-0352