ORIGINAL ARTICLE

Quality, opportunity, and treatment of data of tuberculosis and human immunodeficiency virus co-infection

Qualidade, oportunidade e tratamento de dados de tuberculose e coinfecção com vírus da imunodeficiência humana

Calidad, oportunidad y manejo de los datos de coinfección tuberculosis y virus de la inmunodeficiencia humana

Karllian Kerlen Simonelli Soares[1] ORCID 0000-0002-2296-1190

Wilian Hiroshi Hisatugu[1] ORCID 0000-0001-8333-0539

Fernanda Mattos de Souza[2] ORCID 0000-0002-2296-1190

Ana Paula Rodrigues Costa[1,3] ORCID 0000-0002-2894-448X

Romildo Luiz Monteiro Andrade[1,3] ORCID 0000-0001-6241-475X

Ethel Leonor Noia Maciel[1] ORCID 0000-0003-4826-3355

Thiago Nascimento do Prado[1] ORCID 0000-0001-8132-6288

[1]Laboratório de Epidemiologia. Universidade Federal do Espírito Santo, Vitória, Espírito Santo, Brasil.

[2]Universidade do Estado do Rio de Janeiro (UERJ), Rio de Janeiro, Brasil.

[3] Secretaria de Estado da Saúde do Espírito Santo, Vitória, Espírito Santo, Brasil.

E-mail: enf.karllian@gmail.com

Endereço: Av. Marechal Campos, No. 1468, Maruípe, Vitória, Espírito Santo, Brasil.

ABSTRACT
Background and Objectives: The identification, evaluation, and use of methodological resources for data quality analysis is important to support planning actions of public policies for the control of tuberculosis (TB) and the co-infection TB and human immunodeficiency virus (HIV). The objective was to analyze the quality and timeliness

of notification of TB and TB-HIV co-infection cases from the Notifiable Diseases Information System (SINAN - Sistema de Informação de Agravos de Notificação) in Espírito Santo State, from 2016 to 2018. **Methods:** This is a cross-sectional study of the quality of SINAN data using the Centers for Disease Control and Prevention (CDC) guidelines to analyze the quality and timeliness of SINAN-TB notification, with emphasis on the description of TB-HIV co-infection in Espírito Santo State, from 2016 to 2018. It considered five methodological steps that included quality analysis, standardization of records, duplicity analysis, the completeness of data through linkage with the SINAN-HIV database and anonymization of data. It obtained ethical approval under the number 4022892 on 12/05/2020. **Results:** The study showed that 89% of mandatory variables and 91% of essential variables showed satisfactory completeness. In TB-HIV co-infection 73% of the variables were completed, but essential variables related to TB treatment follow-up showed unsatisfactory completeness. The timeliness of reporting was considered regular. **Conclusion:** Improvements in work processes and the development of a specific methodological process for data treatment are necessary to qualify the information available in SINAN-TB.

Keywords: Epidemiology. Tuberculosis. HIV. Health Information Systems. Co-infection.

RESUMO

Justificativa e Objetivos: A identificação, avaliação e emprego de recursos metodológicos para análise da qualidade dos dados é importante para fundamentar ações de planejamento das políticas públicas no controle da tuberculose (TB) e da coinfecção TB e o vírus da imunodeficiência humana (HIV). O objetivo é analisar a qualidade e a oportunidade de notificação dos casos de TB e coinfecção TB-HIV do Sistema de Informação de Agravos de Notificação (SINAN) no Espírito Santo, de 2016 a 2018. **Métodos:** Trata-se de um estudo transversal da qualidade dos dados do SINAN com uso do Guia do *Centers for Disease Control and Prevention* (CDC) de análise da qualidade e oportunidade de notificação do SINAN-TB, com ênfase na descrição da coinfecção TB-HIV no Espírito Santo, de 2016 a 2018. Considerou-se cinco etapas metodológicas que incluíram análise da qualidade, padronização dos registros, análise de duplicidade, a completitude dos dados por meio de *linkage* com o banco de dados do SINAN-HIV e anonimização dos dados. Obteve aprovação ética sob parecer de nº 4022892 em 12/05/2020. **Resultados:** O estudo mostrou que 89% das variáveis obrigatórias e 91% das variáveis essenciais apresentaram completitude satisfatória. Na coinfecção TB-HIV 73% das variáveis foram preenchidas, porém variáveis essenciais relacionadas ao acompanhamento do tratamento para TB apresentaram completitude insatisfatória. A oportunidade de notificação foi considerada regular. **Conclusão:** Melhorias nos processos de trabalho e elaboração de processo metodológico específico para o tratamento dos dados são necessárias para qualificar as informações disponíveis no SINAN-TB.

Descritores: Epidemiologia. Tuberculose. HIV. Sistema de Informação em Saúde. Coinfecção.

RESUMEN

Justificación y Objetivos: La identificación, evaluación y utilización de recursos metodológicos de análisis de la calidad de los datos es importante para apoyar la planificación de políticas públicas de control de la tuberculosis (TB) y la coinfección con el virus de la inmunodeficiencia humana (VIH). El objetivo es analizar la calidad y oportunidad de la notificación de casos de TB y coinfección TB-VIH del *Sistema de Informação de Agravos de Notificação* (SINAN), en el Estado del Espírito Santo, desde

el año 2016 hasta 2018. **Métodos:** Este es un estudio transversal utilizando el análisis de la Guía de los Centros para el Control y Prevención de Enfermedades (CDC) de la calidad y oportunidad de la notificación en SINAN-TB, con énfasis en la descripción de la coinfección TB-VIH, en el Estado del Espírito Santo, desde el año 2016 hasta 2018. Fueran considerados cinco pasos metodológicos que incluyeron análisis de calidad, estandarización de registros, análisis de duplicidad, vinculación con la base de datos SINAN-VIH y anonimización de datos. Obtuvo aprobación ética bajo dictamen n° 4022892 el 12/05/2020. **Resultados:** El 89% de las variables obligatorias y el 91% de las variables esenciales se completaron satisfactoriamente. En la coinfección TB-VIH el 73% de las variables fueron completadas, mientras que las variables esenciales relacionadas con el acompañamiento del tratamiento para la TB presentaron una completitud insatisfactoria. La oportunidad de notificación fue considerada regular. **Conclusión:** Las mejoras en los procesos de trabajo y la elaboración de un proceso metodológico específico para el tratamiento de los datos son necesarias para cualificar la información disponible en el SINAN-TB.

Palabras clave: Epidemiología. Tuberculosis. VIH. Sistemas de Información en Salud. Coinfección.

INTRODUCTION

Tuberculosis (TB) is a respiratory infection caused by *Mycobacterium tuberculosis* (Mtb) which, with timely diagnosis and precise treatment, presents a high chance of cure and, consequently, a break in the chain of transmission [1]. However, it still represents a public health problem, and it is among the main causes of death in the world[2]. Up until the new coronavirus pandemic (COVID-19, abbreviation for coronavirus disease 2019), TB was the main cause of death by a single infectious agent, causing more deaths than the infection by the human immunodeficiency virus (HIV) [1].

In people living with HIV (PLWH), infection with Mtb presents a higher risk of developing active disease and unfavorable outcomes, such as developing multidrug-resistant TB, treatment dropout and death.[2-5]

According to the World Health Organization (WHO), in 2021, approximately 10 million cases of TB occurred in the world, and a total of 1.2 million people died due to the disease, including 208,000 deaths among those with TB-HIV co-infection. Brazil is among the 30 countries with high burden of TB and co-infection TB-HIV.[1] In 2019, 78,428 new cases of TB were notified, from which 8,070 presented TB-HIV co-infection, in other words, 10.3% of the cases.[6,7]

Among the strategies for the elimination of TB, WHO has drawn recommendations to promote the universal health coverage policy and regulatory structures, such as case notification, vital registration, quality and correct use of medicines for the infection control.[1]

TB and HIV case notification is mandatory in Brazil, and it must be done using the Notifiable Diseases Information System (SINAN - *Sistema de Informação de Agravos de Notificação*). However, studies show that the surveillance system presents flaws and case underreporting that can be due to underdiagnosis, typing errors by the responsible professional, and lack of communication among the health services.[8,9] Those inconsistencies might affect the quality of the data and information generated from it, which is deleterious for the planning and conduction of sanitary strategies.[9]

Thus, the identification, evaluation, and use of methodological resources for the analysis of data quality is a useful initiative to base the planning of actions for public policies for the control of TB and the co-infection TB-HIV. Therefore, the present study aimed to analyze the quality and timeliness of notification of TB and TB-HIV co-infection in SINAN (Notifiable Diseases Information System) in Espirito Santo State, from 2016 to 2018.

METHODS

This is a cross-sectional study of data quality analysis of SINAN-TB according to the quality attributes defined in the methodology proposed by the Centers for Disease Control and Prevention (CDC), United States of America[10,11]

The data quality analysis is performed by checking the attributes of completeness and consistency of data.[10] Data consistency is defined as the percentage of cases with the date of notification higher than the date of diagnosis, using as a threshold greater than or equal to 70%. Yet the analysis of completeness aims at verifying the percentage of filling of variables, in order to identify the frequency of variables "ignored" or "blank". Completeness is considered satisfactory when the result of the analysis gets a value greater than or equal to 70% for essential variables and 100% of the fields for the mandatory variables (Figure 1).[10] Both attributes were categorized as great ($\geq$ 90%), regular (between 70 and 90%) and poor (<70%).[12] Furthermore, the attribute timeliness of notification, from CDC guidelines, was used. It is the proportion of cases from which the time between the date of notification and the date of diagnosis is less than or equal to seven days.[10] All cases of TB and TB-HIV co-infection, notified in SINAN-TB, from 2016 to 2018, of people residing in Espirito Santo State were included in the study. Both databases were made available by the State Health Secretariat (SESA). The time frame used in the study was chosen because of the inclusion of new variables in the version number five of the notification record for TB, such as special populations (persons

deprived of freedom, homeless population, health care professionals and migrants), government benefit claimants, use of antiretroviral therapy (ART) during TB treatment, rapid molecular test for TB (RMT-TB), susceptibility testing, and, if it is a case of "transfer", inclusion of the destination, and the alteration in the variables "if extrapulmonary" (removal of the second option), "sputum-smear bacilloscopy" (withdraw of the second bacilloscopy), "associated diseases and illnesses" (inclusion of illicit drug use and smoking) and "follow-up sputum-smear bacilloscopy" (inclusion after the 6th month).[13]
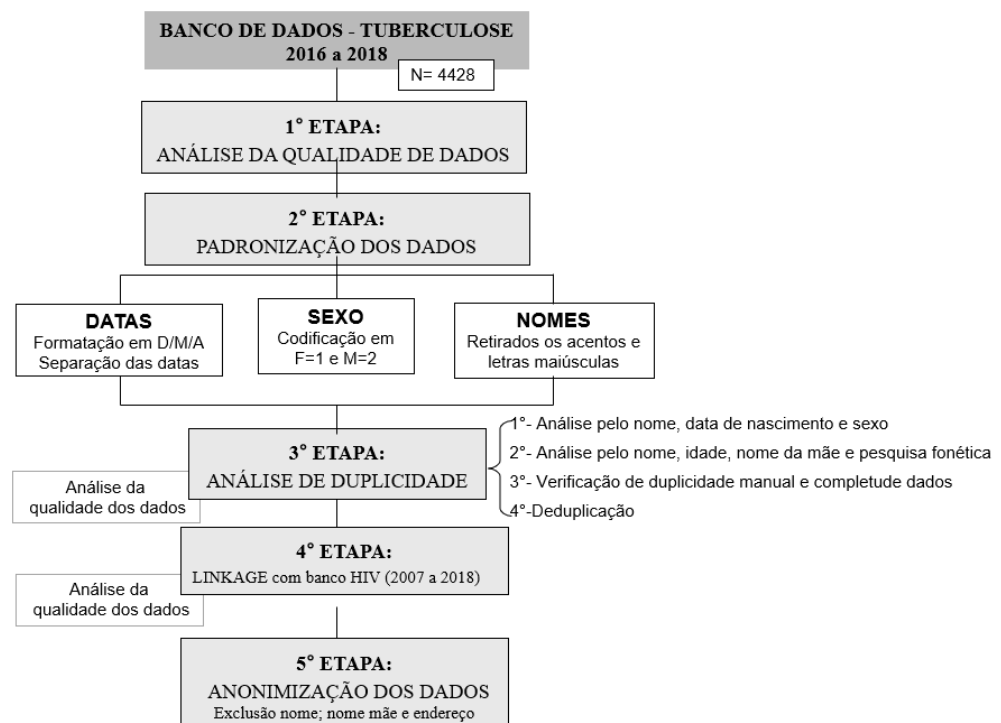
Y – year; D - day; F – female; M – male; M – month; N -number.

Figure 1. Flow chart about the methodology of the process for data quality analysis in SINAN, from 2016 to 2018.

Data analysis was carried out in five steps (figure 1): the first was the data quality analysis; the second was the records standardization; the third step was the duplicity analysis; the fourth step the linkage; and the fifth step was the anonymization of the data.

When considering the TB database in the first step, the analysis of the mandatory filling variables completeness was used, those variables whose field is considered mandatory to fill 100% of the records in any notification, such as: "Number of notification", "Illness/disease", "Date of current notification", "Municipality of current

notification", "Current health unity", "Date of diagnosis", "Age", "Sex" (male, female), "Pregnant" (mandatory filling if patient is a female), "Current State of residence", and "Current municipality of residence", "Country", "Type of entry", "Form" (pulmonary, extrapulmonary or extrapulmonary plus pulmonary), "Sputum-smear bacilloscopy", "Sputum culture", "Susceptibility testing" (when the culture is positive), "HIV", "Total number of contacts identified".[13]

In addition to the mandatory variables analysis, the completeness of essential variables was evaluated. It was considered those variables with filling in up to 70% of the records, such as: "Special populations" (persons deprived of freedom, homeless population, health care professionals and migrants), "Government benefit claimants", "Associated diseases and illnesses" (aids, alcoholism, diabetes, mental disorder, illicit drug use, smoking, and others), "ART during TB treatment", "RMT-TB", "Date of start of current treatment", "Bacilloscopy from the 1st to the 6th month", "Bacilloscopy after the 6th month", "Directly observed treatment (DOT) performed", "Total number of contacts assessed", "Closure situation", "If transferred", "Federation Unity" (State), "Municipality of residence", and "Date of closure". [13]

We searched to verify the completeness of the following additional variables: "Race/skin color" (yellow/Asian, white, indigenous, mixed, black, and ignored) and "Schooling" (illiterate, 1st to incomplete 4th grade of elementary school, complete 4th grade of elementary school, 5th to incomplete 8th grade of elementary school, complete elementary school, incomplete high school, complete high school, incomplete higher education, complete higher education, does not apply, and ignored).

In the second step, it was carried out the standardization of the variables "Patient name" and "Mother's name", with the removal of the accents and replacing the capital letters by the correspondent small letters. Following, the standardization of "Date of notification", "Date of diagnosis", "Date of birth", "Date of treatment start", "Date of closure" in the format day/month/year; and the codification of the variable "Sex" assigning the value 1 for "F" – female, and 2 for "M" – male (figure 1).

During the third step (figure 1), the duplicity analysis was performed in four stages. In the first stage, records were selected by searching for the name, date of birth and sex; the second stage included searching for the name, age, mother's name, and phonetic search, marking the duplicities; in the third stage, initially we checked the duplicity in the notification dates before carrying out the data linkage, if duplicity was identified, we generated a new record with the notification information and investigation

of the first record, adding the information from the second record, complementing the missing data, and last we performed the deduplication, that is, the exclusion of duplicated records. [13] After the duplicity analysis, data quality analysis was carried out again, with regards to consistency and completeness as well as notification timeliness.

In the fourth stage, we performed the linkage with SINAN-HIV database for cases notified between 2007and 2018, with the purpose of identifying cases notified in SINAN-TB database without the diagnosis of the co-infection with HIV, but that were registered in SINAN-HIV database. After that, the exclusion of TB cases data with a negative diagnosis for HIV was done and solely the records of TB-HIV co-infection cases were kept. After that, analysis of completeness and data consistency of TB-HIV co-infection cases only was performed.

In the last step, we carried out the exclusion of identification data, which is called the data anonymization process, using technical means that are reasonable and available for preventing the possibility of direct or indirect association with the individual (figure 1).

During the methodological process we carried out a descriptive analysis of the data and the results were entered into frequency tables in the software STATA, version 16.

The study was approved by the Research Ethics Committee from the *Centro de Ciências da Saúde da Universidade Federal do Espírito Santo* (CEP/CCS/UFES) under the number CAAE: 05675618.4.0000.5060 and report number 4022892 in 12/05/2020, according to the resolution 466/12 from the Brazilian Nacional Health Council (CNS – *Conselho Nacional de Saúde*).

RESULTS

The analysis of 4,428 records from SINAN-TB database from Espírito Santo State was performed and 375 duplicated records were identified ad removed, resulting in a total of 4,053 cases. At the end of the five-step process of analysis of data treatment, a total of 332 cases presented TB-HIV coinfection, from which three cases were found in the SINAN-HIV database with negative serology for HIV in the SINAN-TB database. We identified that the timeliness of notification was regular, showing that around 25% of the cases were not notified in up to seven days after the confirmation of the disease.

Mandatory filling variables, that is, those with 100% completeness, in the first data quality analysis (1st step) in SINAN-TB, showed that from a total of 19 variables, 17

presented a completeness percentage of 100%, differently from the variable "Extrapulmonary type" with 17.2% completeness, and the variable "Total number of contacts identified" that presented 98.9% of filling. In the third data quality analysis, with the TB-HIV co-infection cases, the variable "Extrapulmonary type" presented an increase in the frequency of completeness to 33.8% when we considered solely the TB-HIV coinfection cases (table 1).

Table 1. Distribution of the frequency of completeness in mandatory variables performed before and after deduplication and after linkage of SINAN-TB database with SINAN-HIV database in Espirito Santo State, between 2016 and 2018.

Variable	Before deduplication N=4,428		After deduplication N=4,053		After linkage (TB-HIV coinfection only) N=325	
	N	%	N	%	N	%
Number of the notification	4,428	100	4,053	100	325	100
Illness/Disease	4,428	100	4,053	100	325	100
Date of notification	4,428	100	4,053	100	325	100
Municipality of notification	4,428	100	4,053	100	325	100
Health Unity	4,428	100	4,053	100	325	100
Date of diagnosis	4,428	100	4,053	100	325	100
Age	4,428	100	4,053	100	325	100
Sex	4,428	100	4,053	100	325	100
Pregnant	4,428	100	4,053	100	325	100
Federation Unity/State	4,428	100	4,053	100	325	100
Municipality of Residence	4,428	100	4,053	100	325	100
Country	4,428	100	4,053	100	325	100
Type of entry	4,428	100	4,053	100	325	100
Form	4,428	100	4,053	100	325	100
Extrapulmonary type	3,666	17.2	3,329	17.8	215	33.8
Sputum-smear bacilloscopy	4,428	100	4,053	100	325	100
HIV	4,428	100	4,053	100	325	100
Culture	4,428	100	4,053	100	325	100
Total number of contacts identified	4,383	98.9	4,014	99.0	317	97.0

Abbreviations: HIV - human immunodeficiency virus*;* N – number; TB – tuberculosis; SINAN – *sistema de informação de agravos de notificação* (Notifiable Diseases Information System)

As for the completeness analysis of essential variables (with 70% of filling), in the first analysis, from 23 variables analyzed, a total of 21 variables presented a completeness percentage above 70%, except for the variables "Bacilloscopy 6th month", which presented 67.5% of completeness and the variable "Antiretroviral therapy during TB treatment", with 66.5% of filling.

In the second data quality analysis, after the exclusion of the duplicated cases, we observed an increase in the frequency of completeness for the variable "Bacilloscopy 6th

month" to 71.1%. On the other hand, the variable "Antiretroviral therapy during TB treatment" remained presenting a low frequency of completeness after the deduplication (67.7%).

In the third data quality analysis, with the TB-HIV co-infection cases, we observed that the percentage of completeness of the variable "Antiretroviral therapy during TB treatment" reached 91.3% and a decrease in the completeness frequency in the variables of bacilloscopy per month, once it was possible to verify that from the second month the frequency of completeness was below 70% for those variables, as well as for the variable "Total number of contacts assessed", which also presented a reduction to 40.9% (table 2).

Table 2. Distribution of the frequency of completeness in essential variables performed before and after deduplication and after linkage of SINAN-TB database with SINAN-HIV database in Espirito Santo State, between 2016 and 2018.

Variable	Initial completeness N= 4,428		Completeness after deduplication N=`4,053		Completeness after linkage, (coinfection only) TB-HIV N=325	
	N	%	N	%	N	%
Special populations - persons deprived of freedom	4,399	99.3	4,026	99.3	320	98.4
Special populations - homeless	4,392	99.1	4,020	99.1	320	98.4
Special populations – healthcare professionals	4,392	99.1	4,019	99.1	320	98.4
Special populations – migrants	4,390	99.1	4,017	99.1	320	98.4
Benefit claimants	4,327	97.7	3,961	97.7	315	96.9
Associated diseases and illnesses – aids	4,370	98.6	4,006	98.8	325	100
Associated diseases and illnesses – Alcoholism	4,392	99.1	4,021	99.2	322	99.0
Associated diseases and illnesses – Diabetes	4,390	99.1	4,025	99.3	322	99.0
Associated diseases and illnesses – Mental Disorder	4,380	98.9	4,016	99.0	322	99.0
Associated diseases and illnesses – Illicit drug use	4,390	99.1	4,025	99.3	324	99.6
Associated diseases and illnesses – Smoking	4,397	99.2	4,028	99.3	322	99.0
Associated diseases and illnesses – Others	3,909	88.2	3,600	88.8	297	91.3
Antiretroviral therapy during TB treatment	2,947	66.5	2,741	67.6	297	91.3
Date of current treatment start	4,310	97.3	3,944	97.3	313	96.3
Bacilloscopy 1st month	3,765	85.0	3,525	86.9	236	72.6
Bacilloscopy 2nd month	3,586	80.9	3,486	86.0	216	66.4
Bacilloscopy 3rd month	3,447	77.8	3,284	81.0	201	61.8
Bacilloscopy 4th month	3,308	74.7	3,170	78.2	189	58.1
Bacilloscopy 5th month	3,185	71.9	3,058	75.4	183	56.3
Bacilloscopy 6th month	2,993	67.5	2,882	71.1	173	53.2
Directly Observed Treatment	3,824	86.3	2,550	87.5	233	71.6
Contacts traced	3,919	88.5	3,644	89.9	133	40.9

| Closure Situation | 4,408 | 99.5 | 4,037 | 99.6 | 323 | 99.3 |

Abbreviations: aids - acquired immunodeficiency syndrome; HIV - human immunodeficiency virus; N – number; TB – tuberculosis; SINAN- *sistema de informação de agravos de notificação* (Notifiable Diseases Information System)

The additional variables "Race/skin color" and "Schooling", included in the study, presented a completeness of more than 70% in all three steps of evaluation (table 3).

Table 3. Distribution of the frequency of completeness in additional variables performed before and after deduplication and after linkage of SINAN-TB database with SINAN-HIV database in Espirito Santo State, between 2016 and 2018.

Variable	Initial Completeness N= 4,428		Completeness after deduplication N= 4,053		Completeness after linkage, TB-HIV coinfection only N=325 `	
	N	%	N	%	N	%
Race/skin color	4,345	98.1	3,986	98.3	321	98.7
Schooling	4,059	91.6	3,744	92.3	313	96.3

Abbreviations: HIV - human immunodeficiency virus; N – number; TB – tuberculosis.

In all the consistency analysis of the notification data, that is, the percentage of cases with the date of notification higher than the date of diagnosis was considered excellent, and most of the dates of notification were higher than the date of diagnosis in all the steps.

As for the analysis of timeliness of notification in SINAN-TB, which correlates the date of notifications with the date of diagnosis, we identified that among the 4,428 records assessed in the first analysis, 2,483 (56.0%) were notified within a minimum interval of one day, 815 (18.4%) up to seven days, totalling 3,298 (74.4%) records with the notification occurring in up to seven days, and records with more than seven days were 1,130 (25.6%).

In a second analysis of timeliness, performed during the step 3, from a total of 4,053 records analyzed, 2,317 (57.0%) were notified within an interval of one day, 755 (18.6%) in up to seven days, totalling 3,072 (75%), and 981 (24.4%) were notified more than seven days later. And in the analysis of opportunity of case notification in SINAN TB-HIV, 176 (54.2%) were identified and notified within an interval of one day, 74 (22.7%) were identified and notified in up to seven days, totalling 250 (76.9%) records with notification in up to seven days from the date of diagnosis, and 75 (23.1%) were notified with more than seven days.

DISCUSSION

Timeliness of notification in SINAN-TB was considered regular in Espirito Santo State, from 2016 to 2018. When considering the methodological process of quality analysis of data from SINAN-TB, it was possible to verify an increase in the percentage of completeness after duplicity analysis and at the end of the steps from the study. When considering solely TB-HIV co-infection data, completeness of the variables related to TB treatment follow up was lower than the recommended. As for the data consistency, we observed that the majority of the notification dates were later than the diagnosis date in all steps.

The frequency of data completeness for most of the variables was higher than 70%, for both mandatory filling and the essential variables in the three steps evaluated. This can be considered a progress in the quality analysis process of health information systems since previous studies presented low completeness in the filling of mandatory and essential variables. [14,15,16] Low completeness of data can be deleterious to the surveillance system because it directly impacts the interventions and elaboration of public health policies for disease control.[9]

The variable "antiretroviral therapy" (ART) presented a completeness percentage lower than 70% among the cases of TB, but the percentage increased when we analyzed only TB-HIV co-infection cases. The early identification of the use of ART, during the diagnosis of TB, reduces the risk of complications related to the treatment, and the adherence difficulties due to personal matters or issues related to the health service. A study carried out in Brazil, from 2006 to 2016, found that early start of ART reduces in up to 94% the risk of dying of aids during the first six months.[10,17]

A filling percentage lower than 70% was also observed for variables related to the treatment follow-up among the TB-HIV co-infection cases. The low frequency of variables related to the treatment follow-up in people with TB and the co-infection TB-HIV is suggestive of a poor treatment follow-up and can compromise the surveillance of the cases following the guidelines of the Ministry of Health (MoH) as an effective strategy for the control of the disease's chain of transmission, with the performance of a monthly bacilloscopy as from the second month of treatment. Furthermore, contact tracing allows the early detection of a case, and consequently, minimizes the chance of evolving to a severe form of the disease and drug resistance, in addition to create an opportunity to

screen for latent infection with Mtb (LTBI) and the prescription of the TB preventive treatment.[16, 19]

A retrospective cross-sectional study, including 354 individuals, carried out in Ethiopia during 2016 and 2017, highlighted the importance of case follow-up for the treatment success and the consequent reduction in the mortality rate among TB-HIV coinfection cases[19]. Besides the reduction of the unfavorable outcome "death", with a proper follow-up it is possible to minimize the treatment dropout and the recurrence of the disease. And that is because the risk of unfavorable outcomes is three times more likely to occur in people with TB-HIV co-infection when compared to patients without the co-infection.[15,21]

The notification flow occurs by case recording in the notification record by the healthcare professional using the laboratory and clinical-epidemiologic criteria, filling the record with precise identification information from the user, from the service, and clinical and epidemiological data. This data can be collected by direct interview with the user, from TB record books and case follow-up or via medical record, or else, using other systems such as the Mortality Information System (SIM - *Sistema de Informações sobre Mortalidade*), the Hospital Information System (SIH - *Sistema de Informação Hospitalar*) or the Laboratory Environment Manager (GAL - *Gerenciador de Ambiente Laboratorial*). [13,19]

After the notification process, the municipality epidemiologic surveillance division generates a monthly report called the "Follow-up Report" (*Boletim de acompanhamento*), in which the cases notified with closure date blank and under treatment for 30 days after the date of diagnosis are listed by health unity. The report is forwarded to the health services for the updating of the data and return for the feedback of the information in the system. Then, the municipality epidemiologic surveillance division consolidates the data and forwards to the State epidemiologic surveillance division, that after its evaluation, will forward it to the federal level, which will then be made available in SINAN.[13,19]

The health surveillance is responsible for the investigation of cases suspected of having TB, the notification of confirmed cases and assuring the generation of treatment and follow-up data of confirmed cases up until their outcome, so as to plan and implement the actions needed for the control of TB and HIV/aids. The data quality assurance is also dependent on the correct typing, analysis, case follow-up and data evaluation by the

surveillance professionals in the municipality, with the aim of reaching the targets established in the State and federal levels.[9,8,15]

For achieving that, it is needed training, qualification and to sensitize the healthcare professionals involved in the process of notification, in addition to the correct filling of the forms, the improvement of the surveillance and the data evaluation, once the information generated is essential for the planning and monitoring of the actions and services related to the control of TB.[16, 21,22, 23]

The timeliness of TB data notification was considered satisfactory according to the CDC[10] guidelines, once more than 70% of the notifications occurred in up until seven days after the diagnosis. It differs from the findings of other studies carried out in the country, in which the timeliness of notification was classified as regular and poor for cases of TB and HIV co-infection. [24,12,15]

The study presents a few limitations, such as not considering separately for analysis the cases that had multiple notifications. As well as using guidelines for the evaluation of general health information systems, not a specific one for TB, and that are outdated (from 2001). In addition to the indiscriminate use of different analysis attributes of the database, without taking into consideration the importance of the data preparation or treatment process for the evaluation. In many circumstances, the easiness of use of the attribute limits the interpretation and comparability of the results.

Despite those limitations, the data quality analysis from TB-HIV coi-nfection cases registered in SINAN may guide the strategies for the improvement in the notification process and TB-HIV case follow-up and favor the interruption of the chain of transmission. The present study showed that the methodological process used was effective to improve the quality and timeliness of the data.

It is noteworthy that most of the information systems already perform some methodological procedures, but some inconsistencies are not identified in those processes.[16]. For that, an improved elaboration of methodological paths for the data evaluation is necessary, databases integration, in addition to publicize the results of this yearly analysis of the performance indicators from the information systems, as well as expanding the partnership with the academia, aiming to generate improvements and facilitate the analysis process.[16]

We recommend broadening the dialogue among managers, the health services[25] and the academia for the revision of technical documents, classification of mandatory variables in SINAN, professional qualification, and the implementation of strategies in

the methodological processes of qualified information production, searching to minimize unfavorable outcomes with the aim of contributing to the control and elimination of TB.

ACKNOWLEDGEMENTS

REFERENCES

1. World Health Organization (Who). Geneva: World Health Organization. Global Tuberculosis Report. 2022. https://www.who.int/publications/i/item/9789240037021.

2. United Nations. High-Level Meeting On The Fight Against Tuberculosis. Political Declaration of The Un General Assembly High-Level Meeting 2018. Resolution A/Res/73/3 Adopted By The United Nations General Assembly on 10 October 2018 Following Approval By The High-Level Meeting of The General Assembly on The Fight Against Tuberculosis on 26 September 2018. https://cdn.who.int/media/docs/default-source/documents/tuberculosis/political-declaration-un-general-assembly-tb-tuberculosis77cd7a27-7e8d-4fbb-9729-a5dbd505798f.pdf?sfvrsn=4f4090dc_1&download=true.

3. Soares VM, Almeida IN, Figueredo LJA, et al. Fatores Associados à Tuberculose e à Tuberculose Multirresistente em Pacientes Atendidos em um Hospital de Referência Terciária em Minas Gerais, Brasil. J Bras Pneumol. 2020; 46(2): e20180386. http://www.jornaldepneumologia.com.br/details/3112.

4. Wong K, Nguyen J, Blair L, et al. Pathogenesis of Human Immunodeficiency Virus-Mycobacterium Tuberculosis Co-Infection. J Clin Med. 2020; 9(11): 3575. https://doi.org/10.3390/jcm9113575

5. Getaneh T, Negesse A, Dessie G, et al. The Impact of Tuberculosis Co-Infection On Virological Failure Among Adults Living With HIV In Ethiopia: A Systematic Review And Meta-Analysis. Journal of Clinical Tuberculosis and Other Mycobacterial Diseases. 2022; 27. https://doi.org/10.1016/j.jctube.2022.100310.

6. Ministério da Saúde (BR). Secretaria de Vigilância Em Saúde. Boletim Epidemiológico da Tuberculose. Brasil, 2022. Número Esp. 2022. https://www.gov.br/aids/pt-br/centrais-de-conteudo/publicacoes/2022/boletim-epidemiologico-de-tuberculose-2013-2022/view

7. Ministério da Saúde (BR). Secretaria de Vigilância Em Saúde. Panorama Epidemiológico da Coinfecção TB-HIV no Brasil 2020. V. 50. 2021. http://antigo.aids.gov.br/pt-br/pub/2021/panorama-epidemiologico-da-coinfeccao-tb-hiv-no-brasil-2020

8. Zhou D, Pender M, Jiang W, et al. Under-reporting of TB cases and associated factors: a case study in China. BMC Public Health. 2019; *19*, 1664. https://doi.org/10.1186/s12889-019-8009-1

9. Marques CC, Medeiros ER, Sousa MES, et al. Casos de Tuberculose Coinfectados por HIV em um Estado do Nordeste Brasileiro. Enfermería Actual de Costa Rica. 2019; 36. https://www.mendeley.com/catalogue/edefce0b-b183-3758-b544-f97331c441a1/.

10. German RR, Lee L, Horan J, et al. Updated Guidelines For Evaluating Public Health Surveillance Systems. In: Updated Guidelines For Evaluating Public Health Surveillance Systems. 2001. 50. City: Center For Disease Control And Prevention (Cdc); 2001; 1–35. https://pubmed.ncbi.nlm.nih.gov/18634202/

11. Silva AA, Teixeira AMS, Domingues CMAS, et al. Avaliação do Sistema de Vigilância do Programa Nacional de Imunizações - Módulo Registro do Vacinado, Brasil, 2017. Epidemiol Serv Saúde. 2021; 30(1): e2019596. http://scielo.iec.gov.br/scielo.php?script=sci_arttext&pid=S1679-49742021000100027&lng=pt

12. Silva GDM da, Duarte EC, Cruz OG, Garcia LP. Identificação de microrregiões com subnotificação de casos de tuberculose no Brasil, 2012 a 2014. Epidemiol Serv Saúde. 2020;29(1):e2018485. https://doi.org/10.5123/S1679-49742020000100025.

13. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. Vigilância epidemiológica da tuberculose: Análise de indicadores operacionais e epidemiológicos a partir da base de dados Sinan versão 5.0. Brasilia, 2019.

14. Côco CR, Garcia EM, Martinelli KG. A Incidência De Tuberculose No Estado Do Espírito Santo: Análise Do Período De 2005 A 2016. Rev Bras Pesq Saúde. 2019; 21(1): 104-113. https://doi.org/10.21722/RBPS.V21I1.26474.

15. Canto VB, Nedel FB. Completude dos Registros de Tuberculose no Sistema de Informação de Agravos de Notificação (Sinan) em Santa Catarina, Brasil, 2007-2016. Epidemiol Serv Saúde. 2020; 3: 29. https://www.scielo.br/j/ress/a/CDg6f39h5FKnSQFk6h5czSh/?lang=pt.

16. Rocha MS, Bartholomay P, Cavalcante MV, et al. Sistema De Informação De Agravos De Notificação (Sinan): Principais Características da Notificação e da Análise de Dados Relacionada à Tuberculose Epidemiol Serv Saúde. 2020; 29(1). https://www.scielo.br/j/ress/a/K8Bh4JKPmdqySDZBj6JBPxn/

17. Magnabosco GT, Andrade RLP, Arakawa T, et al. Desfecho dos Casos de Tuberculose em Pessoas com HIV: Subsídios para Intervenção. Acta Paul Enferm. 2019; 32.(5): 554-63. https://www.scielo.br/j/ape/a/h463tyNGw5wC3qL8hFHjP8S/?format=pdf.

18. Mangal TD, Meireles MV, Pascom ARP, et al. Determinants of survival of people living with HIV/AIDS on antiretroviral therapy in Brazil 2006–2015. BMC Infect Dis. 2019; 19, 206. https://doi.org/10.1186/s12879-019-3844-3.

19. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. Manual de Recomendações para o Controle da Tuberculose no Brasil. 2° edição. Brasilia, DF, 2019.

20. Genet C, Melese A, Worede A. Effectiveness of directly observed treatment short course (DOTS) on treatment of tuberculosis patients in public health facilities of Debre Tabor Town, Ethiopia: retrospective study. BMC Res Notes. 2019; 12: 396. https://doi.org/10.1186/s13104-019-4424-8.

21. Campoy LT, Arakawa T, Andrade RLP, et al. Qualidade e Gestão da Atenção à Coinfecção Tuberculose e HIV no Estado de São Paulo. Texto Contexto Enferm. 2019; 28. https://www.scielo.br/j/tce/a/BtXRQwYwLkfD6r5wprqDYmH/?lang=en.

22. Medeiros DA, Palácio MAV, Nogueira ILM, et al. Avaliação da Completitude de Formulários de Admissão de Pessoas Vivendo com HIV em um Centro de Testagem e Aconselhamento do Interior da Bahia. Rev Med (São Paulo) 2022; 101(1): 1-9. https://pesquisa.bvsalud.org/portal/resource/pt/biblio-1368797.

23. Li T, Chen W, Zhao Y, Wang L, et al. Underreporting of Notifiable Pulmonary Tuberculosis Cases to the National Tuberculosis Information Management System - China, 2015. China CDC Wkly. 2020; 2(12):185-189. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8393166/pdf/ccdcw-2-12-185.pdf

24. Platt VB, Coelho EBS, Bolsoni C, et al. Completitude, Consistência e Não Duplicidade dos Registros de Violência Sexual Infantil no Sistema de Informação de Agravos de Notificação em Santa Catarina, 2009-2019. Epidemiologia e Serviços de Saúde. 2022; 31(2). https://www.Scielo.Br/J/Ress/A/G3cgh3bvszqnjj9hgryzvtb/?Format=Pdf&Lang=Pt.

25. Long Q, Guo L, Jiang W, et al. Ending tuberculosis in China: health system challenges. The Lancet Public Health. 2021; 6(12): e948-e953. https://doi.org/10.1016/S2468-2667(21)00203-6.

Author's Contributions:

Karllian Kerlen Simonelli Soares data interpretation and manuscript elaboration. **Wilian Hiroshi Hisatugu** conceptualization and study design. **Thiago Nascimento do Prado** conceptualization, study design, data analysis and critical review of the manuscript. **Romildo Luiz Monteiro Andrade e Ana Paula Rodrigues Costa** project

conceptualization, data collection and relevant critical review of the intellectual content. **Fernanda Mattos de Souza** data analysis and critical review of the manuscript**. Ethel Leonor Noia Maciel** project conceptualization and relevant critical review of the intellectual content. All authors approved the version to be published and agreed to be accountable for all aspects of the study, including the assurance of its accuracy and integrity.