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Underreporting of the tuberculosis and AIDS comorbidity: an application of the linkage method

ABSTRACT

OBJECTIVE: To analyze the underreporting of the tuberculosis (TB) and AIDS comorbidity.

METHODS: Surveillance study using records from the Notifiable Diseases Information System – Tuberculosis and AIDS in Brazil from 2000 to 2005. Records of TB without information on the presence of Aids were considered to be underreporting of the comorbidity when paired off with AIDS records in which the year of diagnosis of AIDS was the same or previous to the year of reporting of TB, as well as records from the same patient whose previous records had this information. An indicator was created: recognized TB-AIDS comorbidity, based on the TB records that had information on the presence of AIDS.

RESULTS: The underreporting of TB-AIDS was 17.7%. This percentage varied between states. The incorporation of the underreported records into the previously recognized ones increased the proportion of TB-AIDS in Brazil from 6.9% to 8.4%. The highest proportions of underreporting were noted in Acre (Northern), Alagoas, Maranhão and Piauí (Northeastern) (more than 35% each) and the lowest in São Paulo (Southeastern) and Goiás (Central-western) (around 10% each).

CONCLUSIONS: The underreporting of the TB-AIDS comorbidity found in Brazil will probably trigger modifications in the surveillance system in order to provide information for the national programs.

DESCRIPTORS: Underregistration. HIV Infections. Acquired Immunodeficiency Syndrome. Tuberculosis. Comorbidity. Registries. Disease Notification. Matched-Pair Analysis.

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INTRODUCTION

Underreporting of a health condition whose reporting is compulsory occurs when a case is not reported to the information system, or when it occurs outside the established period.⁹ Wrong estimates of the magnitude of diseases may derive from this, which negatively affects the planning of prevention and control strategies and may lead to under allocation of actions and resources.¹¹

The epidemiological surveillance system of communicable diseases in Brazil is routinely passive. The lack of knowledge of health professionals about which diseases to report and about the reporting flow, as well as changes in the case definition and the belief that another professional has reported the case, may

contribute to the underreporting of cases.^{3,a} In addition, patients or their relatives sometimes request secrecy in relation to the diagnosis of diseases like tuberculosis (TB) and AIDS, even though they know it is a necessary information for official purposes.⁹

The coinfection by the TB bacillus and the human immunodeficiency virus (HIV), and their mutual interference in the evolution of TB and AIDS, have demanded the strengthening of the surveillance network in Brazil. The *Programa Nacional de Controle da TB* (PNCT – National Program for TB Control) and the program directed at sexually transmissible diseases (STD/AIDS) started to establish joint epidemiological surveillance strategies in 2004 and made obligatory the offer of the HIV test for new TB cases, with the need of the patient's consent to testing. However, the magnitude of the association between these two diseases may not be apparent if comorbidity cases are not reported.¹

The aim of the study was to analyze the underreporting of the TB-AIDS comorbidity in Brazil.

METHODS

Surveillance study with data from *Sistema de Informação de Agravos de Notificação de Tuberculose* (SINAN-TB – National Information System for Tuberculosis Notification) from 2000 to 2005 and from the AIDS national database from 1980 to 2005. This database results from the consolidation of information systems such as: *Sistema de Informação de Agravos de Notificação de Aids* (SINAN-AIDS – National Information System for AIDS Notification), *Sistema de Controle de Exames Laboratoriais* (SISCEL – Laboratory Tests Control System), *Sistema de Controle Logístico de Medicamentos* (SICLOM – System for Logistic Control of Medicines), *Sistema de Informação de Mortalidade* (SIM – Mortality Information System).⁷

The SINAN-TB database was extracted in February 2007 and the AIDS national database in April 2007. Both underwent data quality analysis for the recognition, classification and removal of duplicate records (presence of more than one record of the same patient) by means of probabilistic linkage, as described in the literature.^{2,10}

The deputation process applied to SINAN-TB respected the structural logic of SINAN, according to which records of patients in the first treatment episode or in subsequent treatment episodes (retreatments due to return after default or relapse after cure) should be maintained. Records of the same patient in one treatment episode, but coming from different healthcare

units were linked (transfers). Records of the same patient in different treatment episodes were maintained in the database, chronologically ordered by date of diagnosis, report and treatment onset. For the linkage with SINAN-AIDS, the first record of each patient was used.

In the structural logic of the AIDS national database, each patient should have only one record. This database had 419,795 records, each referring to one patient. Of this total, 99,276 (23.7%) had died before 2000 (current situation/date of death) and were not used for the linkage.

The linkage between databases was performed in two consecutive cycles, the second to enhance linkage sensitivity. The first cycle had three stages: pre-processing of the database, probabilistic linkage and identification of true matching pairs. In pre-processing, the databases underwent reformatting of the variables: date of report; date of diagnosis; date of birth; and corrections in the variables: patient's name; patient's mother's name. Besides, the most common non-discriminatory addresses were removed, like those of the penitentiary system, and any mentions referring to the patient not having a home or that it was unknown (homeless, street dweller, etc.). In the probabilistic linkage, the following variables were used: patient's name, mother's name, and date of birth. The sex variable was used to divide the databases into smaller blocks and increase linkage speed. The probabilities used in the linkage were extracted by indirect method. The identification of linked records was performed by the program Link Plus,^b which calculates the probability of agreement and disagreement of the variables selected for linkage. The higher the score, the higher the probability that the linked pair refer to the same individual. The value three was empirically defined as the cutoff point, above which the program should list the linked pairs. True matching pairs were the ones in which both records belonged to the same individual, confirmed by manual deputation. To achieve this, information on age was also considered, as well as federative unit, municipality of residence, street and number. When in doubt, we decided on the conservative alternative of not considering the linked records as true matching pairs. Manual revision was carried out on pairs with scores from three to 13.5. Those with scores from 13.5 to 23.5 (the highest value found) were considered true matching pairs without manual revision.

There were many records in the AIDS national database with TB diagnosis not linked with the SINAN-TB. Thus, a new linkage cycle was performed of these records with those of SINAN-TB with HIV-positive and/or AIDS associated health condition. The program's configuration parameters were altered and patient's name and date of birth were chosen as linkage variables.

^a Glatt R. Análise da qualidade da base de dados de aids do Sistema de Informação de Agravos de Notificação (Sinan) [Master's dissertation]. Rio de Janeiro: Escola Nacional de Saúde Pública da Fiocruz; 2004.

^b Centers for Disease Control and Prevention. Link Plus Program. Atalanta; 2007[cited 2010 Feb 09]. Available from http://www.cdc.gov/cancer/npctr/tools/registryplus/lp_tech_info.htm

Sex remained as the blocking variable and the cutoff point was altered to 0.1. After a new manual deputation, the true matching pairs were tagged in the original databases of SINAN-TB and AIDS.

The comorbidity records identified in SINAN-TB belonged to four types:

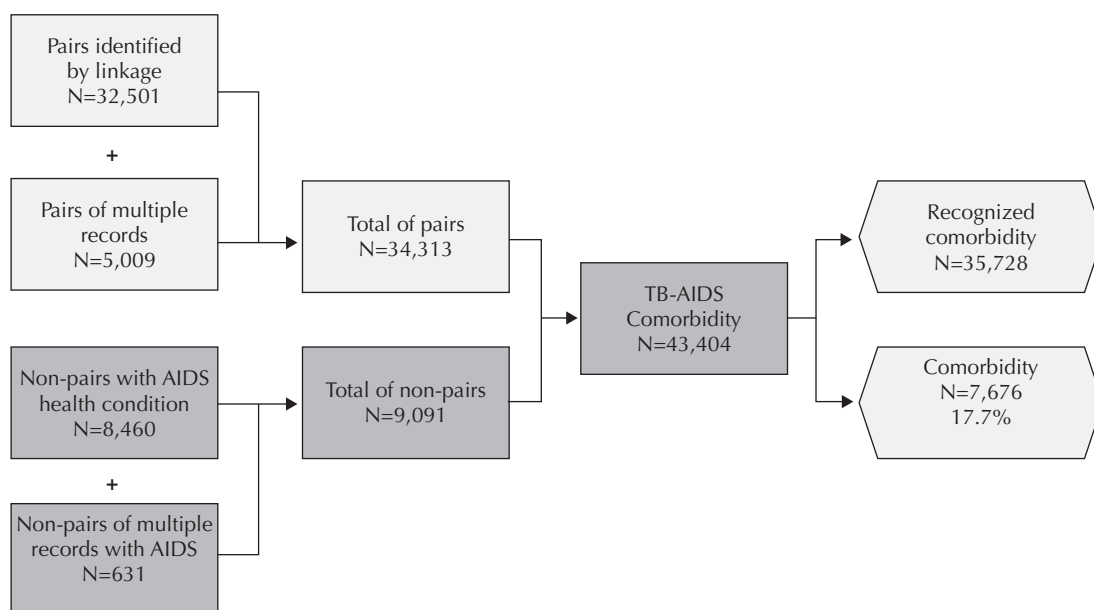
- type 1 – first or only record of each patient linked to a record of the AIDS national database;
- type 2 – patients with multiple records, with the first linked to a record of the AIDS national database. In case of linkage between one record of SINAN-TB and the AIDS database, all records of the same patient were considered linked. If the year of TB report was previous to the year of AIDS diagnosis, the record would not be considered TB-AIDS because, in 2000, pulmonary TB (the most prevalent form of the disease) was not considered an AIDS defining condition in the CDC Modified criterion;¹² thus, these records might characterize a coinfection condition and not a comorbidity;
- type 3 - health conditions associated with AIDS not linked to the AIDS national database, i.e., which were not type 1 or 2. This variable should be filled with one of the mutually exclusive values: AIDS, alcoholism, mental disease, diabetes and others;
- type 4 – without information on AIDS associated health condition, not found by means of linkage with the AIDS national database, but with information on AIDS associated health condition in one of the previous records of the same patient.

The identified TB-AIDS records (sum of type 1 to 4 records) were classified into two conditions: a) recognized comorbidity, in which the information that the patient had AIDS was filled in the variable associated health conditions, and b) underreporting of the comorbidity, in which the information that the patient had AIDS was not filled for this variable.

Possible associations were analyzed between recognized comorbidity or underreporting and sex, age group, type of admission (new case, relapse, return after default and transfer), clinical form (pulmonary, extrapulmonary, pulmonary + extrapulmonary), HIV status (positive, negative, ongoing, not performed or without information), sputum bacilloscopy (positive, negative, not performed) and treatment outcome (cure, default, death, transfer or multiresistant TB). The chi-square test was employed to evaluate statistically significant differences between levels of these variables. The completeness of the variables HIV and associated health conditions was also analyzed.

The results obtained in the linkage were made available to health professionals involved in epidemiological surveillance actions. Individuals' identification data used in the linkage were not disclosed, ensuring the secrecy and confidentiality of this information.

The statistical program Stata 9.0 was utilized in the pre-processing of the database, in the manual deputation of the pairs, in the tagging of the true matching pairs in the original databases and in the analysis.



^a SINAN-TB: *Sistema de Informação de Agravos de Notificação de Tuberculose* (National Information System for Tuberculosis Notification)

Figure 1. Classification of records of SINAN-TB^a according to TB-AIDS comorbidity. Brazil, 2000-2005.

RESULTS

In the study, 99,262 linked records were identified, 32,501 classified as true matching pairs (type 1).

A total of 5,009 type 2 comorbidity records were found, followed by 8,460 type 3 records and 631 type 4 records. Of 43,404 comorbidity records in the sum of the four types, 35,728 (82.3%) were of comorbidity with information of AIDS associated health condition, and 7,676 (17.7%) were underreporting recognized by linkage (16.2%) or because they were multiple records of patients with information of AIDS associated health condition in a previous record (1.5%) (Figure 1).

A total of 8,804 records was identified in the AIDS national database from 2000 to 2005 that presented TB at the moment of the diagnosis, but not linked to records of SINAN-TB and, consequently, not considered comorbidity cases.

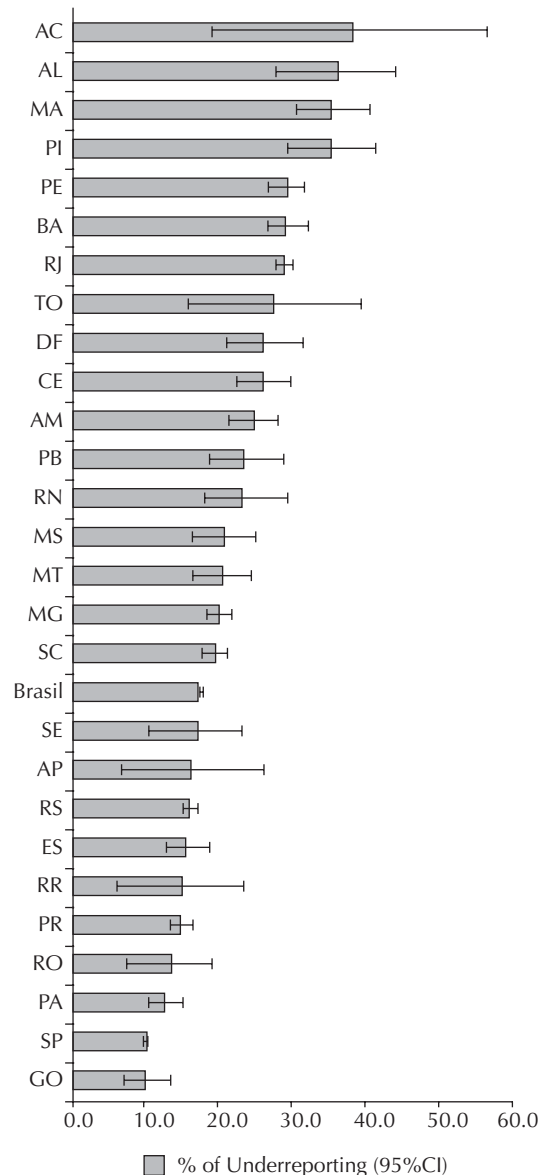
The proportion of underreporting was gradually reduced throughout the studied period, with a mean of 17.7% in the entire period. The proportion of recognized comorbidity was 6.9% and rose to 8.4% (a 21.4% increase; Table 1). The highest underreporting proportions were observed in Acre, Alagoas, Maranhão and Piauí (more than 35% each) and the lowest in São Paulo and Goiás (around 10% each) (Figure 2).

Records of recognized comorbidity and underreporting had distinct characteristics for all the studied variables. The underreporting records presented more advanced age, predominance of new cases, of the pulmonary clinical form, of positive sputum bacilloscopy, of negative HIV test result and of default as outcome. These differences were more remarkable for HIV status and clinical form of TB: while the records of recognized comorbidity presented 93.9% (and not 100%) of HIV-positive result and 58.6% of pulmonary clinical form, the comorbidity underreporting records presented 58.3% of HIV-positive and 70.3% of pulmonary clinical form (Table 2).

Although the proportion of records without information on associated health conditions decreased throughout the period, it still represented the majority of records in 2005 (74.8%). The proportion of records without information on HIV status also decreased over the studied period, reaching 64% in 2005 (Table 3).

DISCUSSION

This study estimated 17.7% of underreporting of the TB-AIDS comorbidity, a phenomenon that has already been described for TB-AIDS and other diseases.^{3,7,9,c}



Source: Sinan/ CGDT/ DEVEP/ SVS/ MS

AC: Acre; AL: Alagoas; MA: Maranhão; PI: Piauí; PE: Pernambuco; BA: Bahia; RJ: Rio de Janeiro; TO: Tocantins; DF: Distrito Federal; CE: Ceará; AM: Amazonas; PB: Paraíba; RN: Rio Grande do Norte; MS: Mato Grosso do Sul; MT: Mato Grosso; MG: Minas Gerais; SC: Santa Catarina; SE: Sergipe; AP: Amapá; RS: Rio Grande do Sul; ES: Espírito Santo; RR: Roraima; PR: Paraná; RO: Rondônia; PA: Pará; SP: São Paulo; GO: Goiás.

Figure 2. Proportion and confidence interval of the underreporting of the TB-AIDS comorbidity by federation unit. Brazil, 2000-2005.

Reporting reliable number of patients with TB-AIDS is essential for the adequate planning of control measures and to provide efficient care for the patient. In addition, a very serious matter would be characterized if TB cases

^c Elkhoury ANSM. Avaliação dos registros de Morbimortalidade da Leishmaniose Visceral em Sistema de informações do SUS [tese de doutorado] Salvador: Instituto de Saúde Coletiva da UFBA;2005.

Table 1. Records of SINAN-TB according to the TB-AIDS comorbidity by year of reporting. Brazil. 2000-2005.

Year	TB records		Recognized comorbidity ^a		Underreporting of comorbidity ^b		Total		Increase in comorbidity
	N	n	%	n	%	n	%	%	
2000	81,478	5,042	6.2	1,446	22.3	6,488	8.0	28.7	
2001	82,844	5,248	6.3	1,486	22.1	6,734	8.1	28.3	
2002	88,082	6,192	7.0	1,288	17.2	7,480	8.5	20.8	
2003	89,657	6,298	7.0	1,215	16.2	7,513	8.4	19.3	
2004	88,297	6,487	7.3	1,140	14.9	7,627	8.6	17.6	
2005	87,619	6,461	7.4	1,101	14.6	7,562	8.6	17.0	
Total	517,977	35,728	6.9	7,676	17.7	43,404	8.4	21.5	

SINAN-TB: *Sistema de Informação de Agravos de Notificação de Tuberculose* (National Information System for Tuberculosis Notification)

^a Recognized comorbidity: tuberculosis records with aids associated health condition

^b Underreporting of comorbidity: tuberculosis records without the information on aids associated health condition identified by the study

with AIDS might not have been identified by PNCT for patients whose records lacked the comorbidity information. The information on the presence of the comorbidity is fundamental to inform the follow-up of the patients, since the natural history of TB is modified by AIDS, with increase in recurrence, as well as its clinical presentation, treatment duration and tolerance and resistance against the available drugs.^{6,8,d}

To increase the completeness of the health conditions associated with AIDS, it is important to increase the completeness of the HIV status variable. The health professionals that follow the case up and the ones who fill in the follow-up card of SINAN-TB must pay attention to fill in the health conditions associated with AIDS in the records of HIV-positive patients. It is necessary not only to ensure the performance of the test for all those who consent to it, but also to ensure that the results are entered into the information systems as soon as they are available. The lower the proportion of patients with TB tested for HIV and HIV-positive patients reported in SINAN-TB, the higher the uncertainty about the real prevalence of HIV among TB patients. According to SINAN-TB data, the prevalence of HIV would be 8.2% in 2005, below the 14% that had been estimated by the World Health Organization (WHO) for Brazil for the same year.^e

PNCT is responsible for feedbacking the analyses of notification data to the health professionals that follow up cases and fill in the reports so that they understand the importance of filling in the records adequately and feel motivated to improve the quality of the collected

data. Furthermore, it is essential that these professionals are instructed in topics of TB epidemiology that are important to the execution of their work. For example, they should be warned that, although patients with extrapulmonary TB have higher risk of having the TB-AIDS comorbidity,⁴ those with pulmonary TB may also present it, and therefore the comorbidity information should be reported both to the extrapulmonary and to the pulmonary forms, which was not happening properly.

The modification of the variable “associated health conditions” was identified as one of the necessary measures to improve the data entry process. Given the structure of the variable, it was possible to inform the presence of only one health condition at a time. This modification has already been incorporated into the last versions of SINAN-TB, in which each comorbidity is now registered in a specific field, marked with the values that indicate its presence, absence or lack of information.^f

The main measure to prevent the underreporting of the comorbidity in SINAN-TB would be to enhance collaboration between the control programs, as recommended by the WHO.^d Information exchange between the two programs should occur routinely in all administrative levels to ensure knowledge of the comorbidity condition and early access to measures of prevention and treatment.

The probabilistic linkage between the databases of SINAN-TB and the AIDS national database may contribute to improve the quality of their data. The underreporting of TB-AIDS per federation unit

^d World Health Organization. Interim policy on collaborative TB/HIV activities. Geneva; 2004[cited 2010 Mar 06]. Available from: http://whqlibdoc.who.int/hq/2004/WHO_HTM_TB_2004.330_eng.pdf

^e Joint United Nations Programme on HIV/Aids. Report on the global AIDS epidemic: Executive Summary. 2006. UNAIDS/06.20E. Geneva; 2006. [cited 2010 Mar 06]. Available from: http://data.unaids.org/pub/GlobalReport/2006/2006_gr-executivesummary_en.pdf

^f Ministério da Saúde do Brasil. Secretaria de vigilância em Saúde. Departamento de vigilância epidemiológica. Coordenação geral de doenças transmissíveis. Sistema de Informação de Agravos de Notificação. Dicionário de dados do Sinan Net para o agravo tuberculose. Brasília; 2004[cited 2010 Mar 06]. Available from: http://ftp.saude.ba.gov.br/ds/arquivos_pdf/dicionarios_dados/DIC_DADOS%20-%20Tuberculose.pdf

Table 2. Sociodemographic and clinical variables according to recognized comorbidity and underreporting. Brazil, 2000-2005.

Variables	Recognized comorbidity		Underreporting of comorbidity		p
	n = 35,728	%	n = 7,676	%	
Sex					
Male	25,333	70.9	5,681	74.0	< 0.001
Female	10,395	29.1	1,995	26.0	
Age group (years)					
< 13	822	2.3	122	1.6	< 0.001
≥ 13	34,906	97.7	7,554	98.4	
Type of admission					
New case	27,088	75.8	5,738	74.7	< 0.001
Relapse after cure	3,166	8.9	592	7.7	
Re-admission after abandonment	4,740	13.3	1,109	14.5	
Transfer	697	1.9	127	1.7	
No information	37	0.1	110	1.4	
Clinical form of TB					
Pulmonary	20,951	58.6	5,395	70.3	< 0.001
Extrapulmonary	10,109	28.3	1,645	21.4	
Pulmonary + extrapulmonary	4,668	13.1	546	7.1	
No information	0	0.0	90	1.2	
HIV Status					
Positive	33,537	93.9	4,475	58.3	< 0.001
Negative	214	0.6	383	5.0	
Ongoing	493	1.4	978	12.7	
Not performed	1,432	4.0	1,595	20.8	
No information	52	0.1	245	3.2	
Sputum bacilloscopy					
Positive	11,487	32.2	3,041	39.6	< 0.001
Negative	11,563	32.4	2,082	27.1	
Not performed	12,678	35.4	2,466	32.1	
No information	0	0.0	87	1.1	
Closing situation ^a					
Cure	15,408	43.1	3,320	43.3	< 0.001
Abandonment	5,910	16.5	1,372	17.9	
Death	7,675	21.5	1,334	17.4	
Transfer	2,933	8.2	721	9.4	
Multi-resistant TB	29	0.1	9	0.1	
No information	3,773	10.6	920	11.9	

Source: Sinan/ CGDT/ DEVEP/ SVS/ MS

^a Corresponds to the variable that indicates the outcome of the case

presented here can be compared to that of places that introduce the measures proposed here to prevent this underreporting. Periodicity and the administrative level responsible for the linkage should be defined taking into account the burden of both diseases and the availability and local capacity of human resources, in view of the fact that this activity demands time and relatively skilled work. The comorbidity condition described by the linkage at any level must be immediately transferred to the healthcare units responsible for the follow-up and reporting of the cases.

In relation to the limitations of the study, false records of comorbidity underreporting may have been identified if linked records were erroneously considered as being of the same patient. This situation is improbable given the rigorous manual deputation that was performed. Problems in the quality of the information of the variables selected to the linkage or limitations intrinsic to the Link Plus program may have compromised the identification of records of comorbidity underreporting. There is no gold standard that allows ascertaining the sensitivity of this program. These

Table 3. Non-filling of the associated health conditions and HIV variables. Brazil, 2000-2005.

Year	TB records	No information on associated health condition ^a		No information on HIV ^b	
	n	n	%	n	%
2000	81,478	76,124	93.4	60,395	74.1
2001	82,844	75,892	91.6	61,013	73.6
2002	88,082	74,601	84.7	62,600	71.1
2003	89,657	70,197	78.3	62,029	69.2
2004	88,297	66,816	75.7	58,644	66.4
2005	87,619	65,558	74.8	56,055	64.0
Total	517,977	429,188	82.9	360,736	69.6

^a No information on associated health condition: records whose field "associated health condition" had not been filled in

^b No information on HIV serology: sum of the ongoing, not performed or not filled in records.

reasons may explain at least part of the 8,804 records in the AIDS national bank from 2000 to 2005 with TB when AIDS was diagnosed that were not linked to SINAN-TB. Another possibility is the non-existence of records corresponding to the AIDS national database in SINAN-TB, which would denote underreporting not only of the comorbidity condition, but also of the reporting of the TB case. This amount was not added to the total comorbidity records to avoid duplication of cases, which would happen if the correspondents records of SINAN-TB also indicated AIDS. However, if added, the comorbidity proportion of the total TB records would rise from 6.9% to 10.1%, and the underreporting from 17.7% to 38%. The real proportion of comorbidity underreporting should be understood within this interval.

Another possible limitation of the study would be the

non-utilization of the capture-recapture method, which, in theory, would estimate the total of TB-AIDS cases in Brazil beyond those contained in the studied databases. We chose not to use this method due to the absence of a third source of TB-AIDS data. The use of more than two data sources is essential so that these studies are considered valid. Without this, it is impossible to ascertain and control for independence between sources, which is one of its fundamental premises.⁵

The underreporting of the TB-AIDS comorbidity in Brazil will probably trigger modifications in the surveillance system of these health conditions that offer information to national programs. This information is essential to enhance the quality of the system regarding the development of activities of data collection and analysis, besides greater incentive to and valuation of the health professionals.

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