

ORIGINAL RESEARCH

Tuberculosis among health care workers treated at a university hospital in Bogotá D.C., Colombia. 2008-2018

Tuberculosis en trabajadores de la salud atendidos en un hospital universitario de Bogotá D.C., Colombia. 2008-2018

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Abstract

Introduction: Worldwide, three people die of tuberculosis (TB) every minute. The risk of TB transmission among healthcare workers is up to 40 times higher than in the general population. Nevertheless, in Colombia, little importance has been given to this situation.

Objective: To describe the demographic and clinical characteristics of healthcare workers with TB treated in a university hospital from Bogot3 D.C. (Colombia), as well as their laboratory, histologic, and imaging findings, and the main criteria for their TB diagnosis.

Materials and methods: Case series study. The medical records of 24 healthcare workers with TB who were treated in a quaternary care university hospital in Bogot3 D.C. between January 2008 and December 2018 were reviewed. Sociodemographic and clinical data, as well as imaging and laboratory findings data, were collected.

Results: There was no predominant sex (50% women and 50% men). The median age was 33.5 years (IQR: 24-52.7). Pulmonary TB was the most frequent form of TB (62.50%); in addition, acid-fast bacillus sputum stain was positive in 2 patients (8.33%). The histopathology report was useful for diagnosing TB in 66.66% of cases, and mycobacterial culture was positive in 75% of patients. Most of them were physicians (41.66%) and medical students (16.66%).

Conclusions: A high proportion of women was found in the study population (1:1 ratio), and the histopathology report was useful for reaching a rapid TB diagnosis in most cases. In addition, physicians and medical students were the healthcare workers most affected by TB. In this sense, health institutions in the country should pay greater attention to biosafety measures among these workers; also, occupational epidemiological surveillance programs enhancing TB-transmission control are necessary.

Resumen

Introducci3n. Cada minuto tres personas mueren de tuberculosis (TB) en el mundo. El riesgo de transmisi3n en trabajadores de la salud es hasta 40 veces mayor que en poblaci3n general. Sin embargo, en Colombia se ha dado poca importancia a esta situaci3n.

Objetivo. Describir las caracter3sticas demogr3ficas y cl3nicas de trabajadores de la salud con TB atendidos en un hospital universitario de Bogot3 D.C., Colombia, as3 como los hallazgos paracl3nicos (de laboratorio, histol3gicos y radiol3gicos) y los principales criterios de diagn3stico de TB en estos pacientes.

Materiales y m3todos. Estudio de serie de casos. Se revisaron las historias cl3nicas de 24 trabajadores de la salud con TB atendidos en un hospital universitario de cuarto nivel de Bogot3 D.C. entre enero de 2008 y diciembre de 2018. Se recolect3 informaci3n sociodemogr3fica y sobre las caracter3sticas cl3nicas de estos pacientes, as3 como sobre hallazgos radiol3gicos y de laboratorio.

Resultados. No hubo un g3nero predominante (50% mujeres y 50% hombres). La mediana de edad fue 33.5 a3os (RIQ: 24-52.7). La TB m3s frecuente fue la TB pulmonar (62.50%); adem3s, en 2 pacientes (8.33%) la baciloscoopia de esputo fue positiva. El estudio histopatol3gico fue 3til en el diagn3stico del 66.66% de los casos, y el cultivo de micobacterias fue positivo en el 75% de los casos. La mayor3a de los pacientes eran m3dicos (41.66%), seguidos de estudiantes de medicina (16.66%).

Conclusi3n. Se encontr3 una alta proporci3n de mujeres (relaci3n 1:1), y el estudio histopatol3gico permiti3 el diagn3stico r3pido de TB en la mayor3a de los casos. Adem3s, los trabajadores de la salud m3s afectados fueron los m3dicos y los estudiantes de medicina. En este sentido, las instituciones de salud del pa3s deben prestar mayor atenci3n a las pr3cticas de bioseguridad de esta poblaci3n, y se debe contar con programas de vigilancia epidemiol3gica ocupacional que favorezcan un mejor control de la transmisi3n.



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Introduction

The risk of tuberculosis (TB) transmission among healthcare workers (HCWs) is a world-wide issue that has been reported by all countries, regardless of their burden of disease. However, it has not received the attention it deserves in low-income countries such as Colombia.¹

In the country, most healthcare institutions lack the resources and policies to prevent the transmission of *Mycobacterium tuberculosis* (the bacterium responsible for most TB cases), not only between the patient-HCW duo, but also between visitors, administrative staff and other collaborators. Moreover, due to the lack of recognition of this problem, the epidemiological link is difficult to demonstrate in most cases.^{2,3}

The risk that HCWs have of contracting TB depends on many factors, including the time they spend in the health facility, the area where they perform their duties (emergency room, radiology department, clinical laboratory, morgue, etc.), their position (respiratory therapist, pulmonologist, otolaryngologist, diagnostic imaging technician), the use of personal protective equipment, their training in infection control and, of course, their immune status.⁴

The World Health Organization (WHO)⁵ estimated that in 2018, around the world, there were 10 million (range: 9.0-11.1 million) new cases of all forms of TB —8.6% among individuals with HIV (human immunodeficiency virus)— and that 1.2 million people (range 1.1-1.3 million) died from TB disease (137 deaths per hour), of which 251 000 (range: 223 000-281 000) were HIV positive.

In Colombia, the Instituto Nacional de Salud (National Health Institute)⁶ established that 14 480 cases of all forms of TB were reported in 2017, being more frequent in men (64.33%). Likewise, it was established that 20.04% of the cases corresponded to people over 65 years of age; 83.30% were cases of pulmonary TB; 78.99% were admitted as laboratory-confirmed cases, with acid-fast bacillus (AFB) stain in sputum being the most used diagnostic method; incidence was 26.5 cases per 100 000 inhabitants, and HIV co-infection was 11.09%.

Also in 2017, the Health Department of Bogotá⁷ stated that 1 455 cases of TB in all forms had been reported in the city, also with a predominance in males (64%). Furthermore, it revealed that the overall mortality was 16.66%; that 20.83% of the cases had HIV co-infection, making Bogotá the city with the highest TB/HIV co-infection rate in the country; that 2.40% of the cases occurred in HCWs; and that of the 1 128 cases in which the type of TB could be determined, 68.70% corresponded to pulmonary TB, 22.78% to extra-pulmonary TB, and 8.52% to meningeal TB.

Huaroto & Espinoza⁸ suggest that the first step that healthcare institutions should take to prevent TB transmission, regardless of their size or level of care, is to assess the risk of the facility in order to recognize the areas with the highest risk of transmission; they should then design and implement appropriate interventions.

In Colombia, research on the real impact of TB on HCWs is limited; moreover, until 2019, national standards on specific measures to control TB transmission in health institutions were virtually non-existent.^{3,9}

Recently, in order to prevent TB, the Colombian Ministry of Health and Social Protection issued Resolution 227 of 2020,¹⁰ whereby “the technical and operational guidelines of the National Program for the Prevention and Control of Tuberculosis” were adopted. Although two of its chapters state that HCWs should be prioritized in the diagnosis of active and latent TB, the measures described are comparable to the recommendations made for other populations, such as diabetic patients or smokers. In this sense, on the

one hand, it is considered that the intentions of government authorities are not yet in line with the relevance of this problem in the country and, on the other hand, it is evident that the recommendations made in this document are far from being a reality, even in health institutions with available resources.

In 2017, Ochoa *et al.*¹¹ published a study carried out in 1 218 HCWs in Medellín, Colombia, who were administered a latent tuberculosis infection (LTBI) prevalence survey, using the tuberculin skin test (TST), and a Quantiferon test (QFT), in which they found that the marginal estimate of the prevalence P(LTBI+) was 62.1% (95%CI: 53.0-68.2).

Given this scenario, the present study aimed to describe the demographic and clinical characteristics of HCWs with TB treated in a university hospital in Bogotá, D.C., the histological and radiological findings, and the main criteria for diagnosing TB in these patients.

Materials and methods

Case series study conducted in a quaternary care university hospital in Bogotá, D.C., whose users belong to both the contributory and subsidized insurance regimes of the Colombian health system.

Information on TB cases diagnosed between January 2008 and December 2018 in the hospital was extracted from the Institutional Office of Hospital Epidemiology's databases, where it was found that the institution reported 199 confirmed cases of TB in all forms to the National Public Health Surveillance System (SIVIGILA), of which 24 (12%) were healthcare workers. The medical records of these patients were consulted in the hospital's medical records system in order to collect information on their clinical and sociodemographic characteristics, as well as on radiological and laboratory findings (pathology, microbiology, and molecular biology).

In all cases, it was found that the laboratory received more than one sample for each test (microbiological, histological, molecular) and that the first test reported as positive was the one considered as the diagnostic criterion. Antibiotic sensitivity tests were performed using the law of multiple proportions.

Once collected, data were entered into a Microsoft Excel spreadsheet and a descriptive analysis was performed, calculating median and interquartile ranges for quantitative variables and relative and absolute frequencies for qualitative variables.

The study, which was approved by the Corporate Research Ethics Committee of the Hospital Universitario Fundación Santa Fe in accordance with Minutes No. 3 of February 18, 2019, took into account the ethical principles for medical research involving human subjects established by the Declaration of Helsinki¹² and the provisions on health research of Resolution 8430 of 1993 of the Colombian Ministry of Health.¹³

Results

Of the 24 HCWs with TB reported to SIVIGILA during the study period, 12 were women (50%). The median age of the patients was 33.5 years (IQR 24-52.7), 4 patients had simultaneous lung and other organ involvement, 4 had diabetes *mellitus* (DM), 4 had TB/HIV coinfection, 2 suffered from autoimmune diseases requiring immunosuppressive therapy, and 1 was on immunosuppressive treatment after receiving a liver transplant. Most cases (41.66%) occurred in physicians, followed by medical students (16.66%), and the most frequent form of TB was pulmonary TB (62.5%). All patients were classified as new TB cases (Table 1) and one case of mono-resistance to isoniazid and one to ethambutol were found.

Table 1. General characteristics of the healthcare workers with tuberculosis analyzed.

	Profession	Sex	Age (years)	Form of TB	History	RS
1	Medical student	M	19	Pulmonary	-	Yes
2	Radiology Secretary	F	23	Pulmonary	-	Yes
3	General practitioner	M	25	Pulmonary	-	No
4	Dentist	F	25	Pulmonary and pleural	-	Yes
5	Nurse	M	29	Pulmonary and cutaneous	HIV	Yes
6	General services and housekeeping	F	38	Pulmonary	--	No
7	Otolaryngologist *	M	56	Laryngeal	DM	No
8	Anesthesiologist	M	63	Pulmonary	Liver transplantation	Yes
9	Anesthesiologist	M	68	Pulmonary	DM	Yes
10	Emergency department assistant	F	24	Pleural	Cigarette consumption	No
11	Radiology Secretary	F	47	Pulmonary	Rheumatoid arthritis	Yes
12	Medical student	F	22	Pulmonary	--	Yes
13	Occupational health physician	M	54	Miliary, peritoneal	Cirrhosis, NAFLD, DM	No
14	General surgeon	M	47	Pulmonary	--	No
15	General practitioner	M	30	Pulmonary, miliary	HIV, ART: Yes, VL: 292 copies, CD4 lymphocytes: 97/mm ³	Yes
16	Medical student	F	24	Pleural	--	Yes
17	Medical student	M	21	Pulmonary	--	No
18	Dietitian	F	49	Pulmonary	--	ND
19	General practitioner	F	48	Pulmonary	HIV, ART: No, VL -, CD4 lymphocytes: 7/mm ³	Yes
20	General practitioner	M	62	Pulmonary	DM	Yes
21	Health visitor	F	37	Pulmonary	SLE, systemic sclerosis, dermatomyositis	No
22	Gastroenterologist	M	66	Pulmonary	HIV, ART: No, VL 5 400 000 copies, CD4 lymphocytes: 93/mm ³	Yes
23	Medical student *	F	23	Pulmonary, peritoneal	--	No
24	Dietician	F	26	Pulmonary, lymph node	--	Yes

TB: tuberculosis; RS: respiratory symptom; M: male; F: female; HIV: human immunodeficiency virus; DM: diabetes *mellitus*; NAFLD: nonalcoholic fatty liver disease; ART: antiretroviral therapy; VL: viral load; SLE: systemic lupus erythematosus; ND: no data.

* Previously reported cases: references 3 and 9, respectively.

Source: Own elaboration.

The histopathological study, which was performed on biopsies from 19 patients (16 pulmonary specimens, 2 mediastinal lymph node specimens, and 1 bone marrow specimen), was useful in the diagnosis of 66.66% of cases. Necrotizing granulomas were the most frequent finding in this study (14 cases), followed by acid-alcoholic resistant bacilli using the Ziehl Neelsen staining technique (10 cases). Diagnostic imaging scans were available for all cases, and findings, in both plain radiography and tomography, were diverse; however, the result of the plain radiography was interpreted as normal in 2 patients (Table 2).

Table 2. Histological and radiological characteristics of the analyzed healthcare workers with tuberculosis.

	Main diagnostic criteria	Histological findings	Radiological findings		Drug sensitivity (RHZE)
			Rx	CT	
1	Histological, microbiological	EGC	Left apical opacity	-	SSSS
2	Microbiological	-	Right basilar opacity	-	SRSS
3	AFB+, histological, microbiological	NCGI	Left basilar opacity	-	SSSS
4	Microbiological	-	Right basilar opacity and PE	-	SSSS
5	Histological, microbiological	NCGI	-	Miliary pattern	SSSR
6	Histological, microbiological	NCGI	Right basilar opacity	-	SSSS
7	Histological, microbiological	NCGI	Normal	-	SSSS
8	Histological, microbiological	NCGD	Normal	-	SSSS
9	Histological, microbiological	NCGD	Left apical opacity	-	SSSS
10	Histological, molecular	NCGI	-	PE	SSSS
11	AFB+, histological, molecular, microbiological	NCGI	-	Nodules, cavitation, tree-in-bud sign	SSSS
12	Microbiological, molecular	--	-	Nodules, tree-in-bud sign, PE	SSSS
13	Histological, microbiological	NCGD (BM)	-	Miliary pattern	SSSS
14	Microbiological (AAFB in BAL)	--	-	Consolidation in RUL and LLL, tree-in-bud sign	-
15	Histological, microbiological	NCGI	-	Miliary pattern, nodules, generalized adenopathies	SSSS
16	Histological, molecular	NCGI	PE, atelectasis	-	-
17	Molecular	Acute inflammation	-	Tree-in-bud sign	SSSS
18	Molecular, microbiological (AAFB in BAL)	--	Opacity in RUL	-	SSSS
19	Clinical, imaging	Cellular augmentation, PMN	-	Consolidation in LML and LLL	-
20	Molecular, microbiological (AAFB in BAL)	NCGD	Opacity in lingula	-	SSSS
21	Microbiological	Chronic inflammation	-	Consolidation of the anterior segment of the RUL	-
22	Histological	CGD (mediastinal lymph nodes)	Frosted glass	-	-
23	Microbiological, molecular	NCGI	-	Cavitating nodule in RUL, pleural thickening	SSSS
24	Histological	NCGI (mediastinal lymph nodes)	-	Consolidation in RUL, cavitation, tree-in-bud sign	-

CGD: chronic granulomatous disease; AFB, acid-fast bacilli smear (R: rifampicin, H: isoniazid, Z: pyrazinamide, E: ethambutol, S: sensitive, R: resistant); NCGI: necrotizing chronic granulomatous inflammation caused by *Mycobacterium*; PE: pleural effusion; NCGD: necrotizing chronic granulomatous disease; BM: bone marrow; AAFB: acid-alcohol-fast-bacilli; BAL: bronchoalveolar lavage; RUL: right upper lobe; LLL: left lower lobe; PMN: polymorphonuclear cells; LML: left middle lobe.
Source: Own elaboration.

Discussion

TB is an infectious disease to which HCWs are highly exposed. Joshi *et al.*¹ state that the risk of contracting the disease in this population may be up to 40 times higher than in the general population. It has also been established that the risk of contagion depends on many factors such as the local prevalence of TB, the area where professionals work, the specific work they carry out, the correct use of personal protective equipment, their training on infection control and, of course, their immune status.^{14,15}

Studies such as Cascante & Hueto¹⁴ have categorized some healthcare-related activities as high, intermediate, and low risk of TB infection; the first group includes cough induction procedures, bronchoscopy, and emergency room tasks; the second refers to work in units where patients with TB are typically treated, such as outpatient clinics, and surgical and diagnostic imaging rooms; and the third involves work activities in areas such as archives, neonatology, obstetrics, etc. In the series described here, most cases (54.2%) occurred in the HCWs group who had recently carried out high-risk activities, followed by those that carried out intermediate-risk activities (45.8%). It should be noted that none of the patients performed or had performed low-risk activities and that the difference between the other two groups was not greater (Table 1).

Bonifacio *et al.*¹⁶ conducted a study involving 54 in-house physicians and 45 residents who began their training in April 2000 at the Hospital Carrion in Lima, Peru, and found that physicians exposed to a large number of TB cases had an annual infection rate of 17%, which is slightly lower than that described in the present study, where it was 20.83% (n=5). Moreover, in a study conducted in 17 Canadian hospitals, Menzies *et al.*¹⁷ reported that the risk of TB transmission was associated with nursing work (adjusted risk ratio: 4.3; 95%CI: 2.7-6.9), respiratory therapy (adjusted risk ratio: 6.1; 95%CI: 3.1-12), physiotherapy (adjusted risk ratio: 3.3; 95%CI: 1.5-7.2), and the cleaning service (adjusted risk ratio: 4.2; 95%CI: 2.3-7.6).

An analysis of the most affected occupations in the studies carried out in Colombia shows that this variable has a low consistency. Llerena & Zabaleta¹⁸ conducted a study involving 128 HCWs with TB and reported that most cases (21.4%) occurred in physicians, which is similar to the findings of this series. In turn, Castillo *et al.*¹⁹ studied the behavior of TB among HCWs and established that of the 532 TB cases reported in this population between 2008 and 2012, most (26.12%) were nurses and dental assistants, followed by physicians (14.09%). This is in line with the findings of Vargas-Restrepo²⁰ and described in his master's thesis, in which he found that of the 715 cases of TB in HCWs reported in Colombia between 2011 and 2017, 36.4% were nurses and dental assistants and 20.1% were physicians.

The present series included the cases of two women (case 6 and 21, Table 1) who were not healthcare workers but worked at the hospital. This shows that the risk of infection/disease not only affects healthcare workers and their collaborators directly but extends to all those who work in a facility where TB patients are cared for.

Regarding the distribution by sex, it has been established in the world literature that TB affects mainly men,^{5,21} which contradicts the results of the present investigation, where there was no predominant sex. It is particularly notable that three studies carried out in Colombia¹⁸⁻²⁰ show that most of the people involved are women (more than 60% of the cases). This could be explained from a biological perspective because hormonal factors may condition a differential immune response;^{22,23} however, from an environmental point of view, it would be more appropriate to consider a higher exposure of technical and professional nurses, who are mostly female,^{14,16} to smear-positive patients.^{19,20}

In the general population, it has been demonstrated that pulmonary TB is observed in the majority of cases ($\approx 80\%$),^{3,5} as reported in in the present series (79.16%) and by Llerena-Zabaleta¹⁸ (78.9%). However, Castillo-Rico *et al.*¹⁹ and Vargas-Restrepo,²⁰ who analyzed the totality of TB cases reported in HCWs in Colombia during specific periods of time, reported slightly higher rates of extrapulmonary TB (33.1% and 33.6%, respectively). This difference could be explained by the combination of biological and environmental factors that may put a person with a predisposing condition, in this case HCW, at a higher risk of contracting the disease and developing an extrapulmonary or disseminated form.

This scenario was identified in 4 of the 6 patients with extrapulmonary or disseminated TB in the present series.

Medical history, particularly immune response factors, are risk factors for developing TB, with HIV infection being the most important. However, it is known that diseases such as DM and conditions such as smoking and the use of immunosuppressive drugs, which are common in the general population, may have a greater impact on the epidemiology of TB.²³ In this regard, studies such as that of Sepkowitz & Eisenberg²⁴ have described that up to one third of cases of active TB in HCWs are associated with immunosuppressive entities such as HIV.

In the present study, half of the patients had immune response determinants and, therefore, risk factors for developing TB; 4 of these 12 patients had HIV/TB co-infection, and in 3 of them, histological and laboratory findings confirmed that they already had AIDS. The Llerena & Zabaleta¹⁸ and Vargas-Restrepo²⁰ studies reported TB/HIV co-infection of 7.9% and 14%, respectively.

Likewise, the present study found that four patients had DM, a disease that modifies the presentation, course, and prognosis of TB, and is also a risk factor for TB treatment failure,²⁵ as animal models have shown that DM is related to a decrease in cellular immunity and the response mediated by interferon γ , a fundamental molecule of the humoral immune response against *M. tuberculosis*.²⁶

In Colombia, the diagnosis of pulmonary TB is mainly made by AFB smear, which has a low sensitivity (30-70%) and requires 5 000 to 10 000 bacilli per cubic centimeter of sample to yield a positive result.²⁷ Another, less commonly used test is culture, which is more sensitive, requires only 10 to 100 viable bacilli per cubic centimeter of sample for yielding a positive result, allows identification of *M. tuberculosis* in more than 80% of cases, and has a specificity of >98%.²⁸ In the present series, 75% of the cases had positive cultures in one of their samples, which was lower than the 100% reported by Llerena & Zabaleta,¹⁸ while 8.33% of the patients had positive AFB test, which was considerably lower than 57% reported by Vargas-Restrepo.²⁰

The low number of cases with a positive AFB test is of special relevance, as it is believed that this phenomenon occurs because most of the patients treated in the hospital sought medical assistance in the early stages of the disease. It could be said that they consulted in a timely manner, as evidenced by the fact that lung damage was insufficient to allow bacilli from the parenchymal lesion to appear in the sputum accompanying cough, which is often seen when the disease is at an advanced stage.⁹

Histopathology has traditionally been regarded as a reliable method for diagnosing tuberculosis, especially when the presentation is extrapulmonary.^{3,9,29} In this case series, the histopathological study, which was performed on 19 biopsies, showed that necrotizing granulomas were the most common finding (14 cases), followed by acid-alcohol resistant bacilli using the Ziehl Neelsen staining technique (10 cases). Thus, the histopathological diagnosis was chronic necrotizing granulomatous disease caused by Mycobacteria in 10 cases. However, in 16 (84%) of these cases, the pathologist's opinion, supported by the histological findings and patient's clinical history, suggested that TB was the cause of the observed histological pattern.

The ineffectiveness of AFB smear for the diagnosis of TB in the series reported here made it necessary to resort to special procedures such as bronchoalveolar lavage and lung biopsy, which significantly favored culture positivity, as well as histological analysis of the affected tissue.

It is worth noting that all of the TB cases in this case series were new, with only two cases of mono-resistance detected (Table 2). Nonetheless, it should be noted that drug-resistant tuberculosis is currently one of the most pressing concerns in tuberculosis control.⁵

Several surveillance studies of drug-resistant tuberculosis in untreated patients have been conducted in Colombia. Leon *et al.*³⁰ carried out a study between 1999 and 2000 with 1 087 patients and reported that totally drug-resistant (TDR) tuberculosis was observed in 15.6% and multidrug-resistant (MDR) tuberculosis occurred in 1.5% of cases. In turn, Garzon *et al.*,³¹ in a study conducted between 2004 and 2005, established that TDR TB was found in 11.8% and MDR TB in 2.3% of 925 untreated patients, while TDR TB was found in 44.3% and MDR TB in 31.4% of 264 previously treated TB patients. Finally, Llerena *et al.*,³² in a study with 128 patients younger than 15 years with TB who underwent susceptibility testing of *M. tuberculosis* between 2001 and 2009, found that 123 of them had not been treated and that among these, TDR TB was found in 21.1% and MDR TB in 6.5%. According to Llerena *et al.*,¹⁸ the prevalence of TDR TB and MDR TB in new TB cases was 7.9% and 4%, respectively, while the prevalence of these two types of resistance was 12.5% in previously treated cases.

One of the strengths of the present study is that it is a good approximation to the TB situation among HCWs in Bogotá between 2008 and 2018 due to the detailed analysis of the demographic, clinical and paraclinical characteristics of the patients. On the other hand, limitations include the fact that only patients from one institution were enrolled, and advanced epidemiological calculations were not possible.

Conclusions

Compared to the literature, this study found a higher proportion of women (1:1), and the histopathological study allowed for the rapid diagnosis of TB in the majority of cases. Moreover, most patients were physicians and medical students.

Due to the fact that the risk of contracting tuberculosis among HCWs in comparison to the general population is one of the indicators proposed by WHO for evaluating the effectiveness of preventive and control measures for disease transmission in health services, the country's health institutions should pay more attention to the biosecurity practices of this population. In addition, the relevant entities should facilitate the development of occupational epidemiological surveillance programs that promote better transmission control.

Conflicts of interest

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