Profile and gaps in tuberculosis preventive treatments among health professionals: an ecological study (2018-2023)

Perfil e lacunas no Tratamento preventivo da tuberculose em profissionais de saúde: estudo ecológico (2018-2023)

Perfil y brechas en el tratamiento preventivo de la tuberculosis entre profesionales de la salud: estudio ecológico (2018-2023)

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ABSTRACT
Objective: to analyze the sociodemographic and clinical-epidemiological profile of health professionals that initiated tuberculosis preventive treatments in Brazil between 2018 and 2023, as well as their geographical distribution. **Method**: an ecological study conducted with 829 professionals registered in the Information System regarding tuberculosis preventive treatments. The analysis involved descriptive statistics and a thematic map. **Results:** predominance of white-skinned individuals (41.1%), women (77.6%), in the age group from 45 to 59 years old (34.7%) and with normal X-ray results (81.9%) was observed. Of all the participants, 88.8% underwent a tuberculin test, 50.1% reported no contact with tuberculosis, 89.0% were vaccinated with BCG and 68.2% had negative HIV results. The most frequent treatment was with Isoniazid (63.7%). An increase in the number of notifications was noticed, especially in São Paulo. **Conclusion:** the results evidence that TPT provision is insufficient for the actual number of professionals exposed to tuberculosis in the country, indicating flaws in workers' protection and inequalities in access to preventive measures.
Descriptors: Health personnel. Latent tuberculosis. Workers' health. Tuberculosis. Public Health Surveillance.

RESUMO
Objetivo: analisar o perfil sociodemográfico, clínico-epidemiológico e a distribuição geográfica de profissionais de saúde que iniciaram o tratamento preventivo da tuberculose no Brasil entre 2018 e 2023. **Método**: estudo ecológico com 829 profissionais notificados no Sistema de Informação sobre tratamento preventivo da tuberculose. A análise incluiu estatística descritiva e mapa temático. **Resultados:** observou-se predomínio de indivíduos brancos (41,1%), mulheres (77,6%), na faixa etária de 45 a 59 anos (34,7%), com radiografias normais (81,9%). Entre os participantes, 88,8% realizaram prova tuberculínica, 50,1% não relataram contato com tuberculose, 89,0% foram vacinados com BCG e 68,2% tiveram resultado negativo para HIV. O tratamento mais comum foi isoniazida (63,7%). Observou-se aumento nas notificações, especialmente em São Paulo. **Conclusão:** os resultados evidenciam que a oferta do TPT permanece aquém da real magnitude de profissionais da saúde expostos à tuberculose no país, indicando fragilidades na proteção ocupacional e desigualdades no acesso à prevenção.
Descritores: Saúde do Trabalhador; Pessoal da Saúde; Tuberculose; Tuberculose Latente; Vigilância em Saúde Pública.

RESUMEN
Objetivo: analizar el perfil sociodemográfico, clínico-epidemiológico y la distribución geográfica de los profesionales de la salud que iniciaron tratamiento preventivo de tuberculosis en Brasil entre 2018 y 2023. **Método:** estudio ecológico con 829 casos de profesionales notificados en el Sistema de Información sobre tratamiento preventivo de tuberculosis. El análisis incluyó estadística descriptiva y un mapa temático. **Resultados:** se observó un predominio de individuos blancos (41,1%), mujeres (77,6%), en el rango de edad de 45 a 59 años (34,7%), con radiografías normales (81,9%). Entre los participantes, el 88,8% se sometió a una prueba cutánea de tuberculina, el 50,1% no reportó contacto con tuberculosis, el 89,0% fue vacunado con BCG y el 68,2% obtuvo resultado negativo para VIH. El tratamiento más común fue la isoniazida (63,7%). Se observó un aumento en las notificaciones, especialmente en São Paulo. **Conclusión:** los resultados muestran que la disponibilidad de servicios de prevención y tratamiento de la tuberculosis (TPT) permanece por debajo del número real de profesionales de la salud expuestos a la tuberculosis en el país, lo que indica debilidades en la protección laboral y desigualdades en el acceso a la prevención.
Descriptores: Personal sanitario. Tuberculosis latente. Salud de los trabajadores. Tuberculosis. Vigilancia de la salud pública.

INTRODUCTION

Tuberculosis (TB) is still one of the main causes of death due to infectious diseases in the world. In 2024, approximately 8.3 million people were diagnosed with the disease, a figure slightly higher than the 8.2 million recorded in 2023 and representing nearly 78% of the estimated incidence cases (95%CI=72%-84%)[1]. A progressive increase in the incidence

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coefficient has been observed in Brazil since the pandemic of the disease caused by the Type 2 Coronavirus (COVID-19). Between 2021 and 2023, the rate rose from 34.6 to 40.0 cases for every 100,000 inhabitants, distributed across all country regions[2]. This scenario not only reflects the impact exerted by the pandemic period on surveillance but also resumption of the diagnostic activities, evidencing the need to strengthen prevention and control strategies.

What draws the attention in this context is the expressive increase in the number of new cases of the disease among groups considered in a situation marked by greater epidemiological vulnerability. It is known that early diagnosing latent infections by *Mycobacterium tuberculosis* and providing Tuberculosis Preventive Treatments (TPT) represent fundamental pillars in the policies to combat the disease, integrating the guidelines set forth in the National Plan to End Tuberculosis as a Public Health Problem[3]. In the occupational scope, TB has consolidated itself as an important work-related risk, especially among health professionals. These workers are more frequently exposed to closed environments, to aerosol-generating procedures and to direct contact with people infected by pulmonary TB, oftentimes even before diagnoses are made. Between 2015 and 2023, for example, the number of notifications among health professionals rose from 837 to 1,134 cases in the nation[2].

In a meta-analysis involving 16 countries, it was noticed that the Latent Tuberculosis Infection (LTBI) risk was two times higher among health professionals (OR=2.27)[4]. In this sense, studies conducted in different contexts such as Saudi Arabia, Peru, South Korea and Italy highlight the relevance of the LTBI issue among health professionals from the occupational health perspective, even in countries with average and low burdens of the disease[5–8]. Such findings point to the need for active surveillance and for improving biosafety practices in health services.

The World Health Organization acknowledges health professionals as a priority group for prevention and recommends implementing TPTs as an essential measure to achieve the "End TB" strategy targets. Thus, protecting this group is not only an occupational health principle but also a strategic component to interrupt transmission of this disease in health services.

Consequently, identifying and managing LTBI among health professionals are essential strategies to reduce the risk of contracting the disease, promoting better individual health conditions and collectively contributing to interrupting the disease transmission change.

In Brazil, it is estimated that millions of health workers develop their activities in environments with risk of exposure to *Mycobacterium tuberculosis*, which underscores the need for LTBI systematic monitoring and for TPT expansion. The discrepancy between the health workforce size and the number of professionals initiating preventive treatments evidences a relevant coverage gap.

However, the nationwide analyses describing the epidemiological profile of the health professionals undergoing TPTs are still scarce, especially considering clinical, sociodemographic, exposure and geographical distribution data at the Federation level. This gap hinders planning actions targeted at LTBI surveillance and at strengthening occupational protection in the country.

Thus, the objective was to analyze the sociodemographic and clinical profile and the geographical distribution corresponding to the health professionals that initiated tuberculosis preventive treatments between 2018 and 2023, contributing to understanding the care gaps and the opportunities to strengthen LTBI surveillance.

METHOD

This is an ecological study conducted based on notifications referring to health professionals that initiated TPTs from 2018 to 2023 in Brazil. The population was comprised by all health professionals active in Brazil, notified in the Information System for reporting individuals undergoing LTBI treatments (IL-TB) during the aforementioned period.

This time clipping is justified by the implementation of the LTBI surveillance protocol in Brazil (2018), which increased the flows of information and of instruments used for LTBI monitoring in the country, thus favoring data collection in this population segment[3].

The notifications included were all those corresponding to health professionals aged at least 18 years old recorded in the IL-TB System between 2018 and 2023 and with entry type classified as 'New case', thus avoiding possible duplicity in the records. The Goiás and Santa Catarina FUs were not considered in this study because they have their own notification systems for TPTs. Therefore, the final population was comprised by 829 health professionals.

The data were extracted in January 2024 by requesting them to the Ministry of Health via the Gov.br platform. A data extraction form specifically prepared for this study and based on all the information present in the TPT notification record card was used for data collection. The following variables were considered: Federation Unit (FU), age, gender, race/skin color, BCG, HIV, Interferon-Gamma Release Assay (IGRA), Tuberculin Test (TT), contact with TB, medications

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and closing outcome. Considering that some health professionals were still undergoing TPTs in 2023, only the "Closing outcome" variable differs from the time criterion established in this study, encompassing the 2018-2022 period.

Descriptive and analytical statistics by means of absolute and relative frequencies along with their respective 95% confidence intervals were used for data analysis. The Chi-square test was applied to verify if the distribution corresponding to the frequencies observed fits the one expected under the uniformity hypothesis, considering a 5% significance level. In order to describe the geographical distribution of the health professionals that initiated TPTs in Brazil, a map referring to the 2018-2023 period was prepared, with aggregates by FUs and using the official grid from the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*, IBGE). Microsoft Excel® 365 was employed for data processing; in turn, the data analysis was performed in the R® software (version 4.5.1).

As the study used public domain data and with no personally identifiable information, it was not necessary to submit it to appraisal by any Research Ethics Committee. In addition, the flows set forth in Law No. 12,527/2011 were respected, which regulate the constitutional right to access public information[9].

RESULTS

In the period analyzed, 829 cases of health professionals with records of having initiated TPTs were notified in Brazil, presenting variations across the years under study: 2022 and 2023 with the highest values, at 206 (24.2%) and 192 (22.6%), respectively. Table 1 presents the subjects' sociodemographic data.

Table 1: Sociodemographic characterization of the health professionals that initiated tuberculosis preventive treatments (n=829). Brazil, 2018-2023

Variables	n	f (%)	95%CI	p-value
Gender				<0.001
Female	643	(77.6)	69.5-85.9	
Male	186	(22.4)	19.6-25.4	
Race/Skin color				<0.001
White	341	(41.1)	37.8-44.6	
Brown	329	(39.7)	36.3-43.1	
Black	100	(12.1)	9.9-14.5	
Asian	14	(1.7)	0.9-2.8	
Indigenous	8	(1.0)	0.4-1.9	
Unknown	37	(4.5)	3.2-6.1	
Age group				<0.001
18-34	206	(24.8)	21.9-27.9	
35-44	262	(31.6)	28.4-34.9	
45-59	288	(34.7)	31.5-38.1	
60+	73	(8.8)	7.0-10.9	

Source: IL-TB/SVS/MS, 2024.

The sociodemographic profile corresponded to health professionals self-declared as white-skinned (n=341; 41.1%, 95%CI=37.8-44.6), female (n=643; 77.6%, 95%CI=69.5-85.9) and aged between 45 and 59 years old (n=288; 34.7%, 95%CI=31.5-38.1). Table 2 presents the results regarding the clinical characterization of the health professionals that initiated TB preventive treatments.

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Table 2: Clinical characterization of the health professionals that initiated tuberculosis preventive treatments (n=829). Brazil, 2018-2023*.

Variables	n	f (%)	95%CI	p-value
Chest X-ray				<0.001
Normal	679	(81.9)	79.1-84.5	
Alteration not suggesting TB	89	(10.7)	8.7-13.0	
Not performed	59	(7.1)	5.5-9.1	
Alteration suggesting active TB	2	(0.2)	0.0-0.9	
Active TB ruled out				<0.001
Yes	819	(98.8)	96.7-100.0	
No	10	(1.2)	0.6-2.2	
IGRA				<0.001
Not performed	741	(89.4)	87.1-91.4	
Positive	77	(9.3)	7.4-11.5	
Negative	9	(1.1)	0.5-2.1	
Undetermined	2	(0.2)	0.0-0.9	
Tuberculin test				<0.001
Yes	736	(88.8)	86.4-90.8	
No	93	(11.2)	9.2-13.6	
Contact with TB				<0.001
No	415	(50.1)	46.6-53.5	
Yes	194	(23.4)	20.6-26.4	
Does not know	183	(22.1)	19.3-25.1	
Unknown	37	(4.5)	3.2-6.1	
BCG				<0.001
Yes	738	(89.0)	86.7-91.1	
No	37	(4.5)	3.2-6.1	
Unknown	54	(6.5)	4.9-8.4	
HIV				<0.001
Negative	565	(68.2)	64.9-71.3	
Not performed	254	(30.6)	27.5-33.9	
Positive	8	(1.0)	0.4-1.9	
Ongoing	2	(0.2)	0.0-0.9	
Medications				<0.001
Isoniazid-6H/9H	528	(63.7)	60.3-67.0	
Rifapentine + Isoniazid-3HP	250	(30.2)	27.0-33.4	
Rifampicin-4R	51	(6.2)	4.6-8.0	
Closing outcome				<0.001
Treatment completed	484	(75.3)	66-73.2	
Not evaluated	41	(6.4)	4.6-8.6	
Treatment interrupted	93	(14.5)	11.8-17.4	
Suspended due to adverse reactions	14	(2.2)	1.2-3.6	
Suspended due to unfavorable clinical conditions for the treatment	7	(1.1)	0.4-2.2	
Active tuberculosis	2	(0.3)	0.0-1.1	
Suspended due to TT<5 mm in primary chemoprophylaxis	1	(0.2)	0.0-0.9	
Deaths	1	(0.2)	0.0-0.9	

Source: IL-TB/SVS/MS, 2024.
Note: * The "Closing outcome" variable corresponded to the 2018-2022 period (n=643).

As for the chest X-rays, most of the participants had a record of "Normal" (n=679; 81.9%, 95%CI=79.1-84.5); only 0.2% (n=2, 95%CI=0.0-0.9) of the professionals had "Alteration suggesting active TB" as a result. In relation to the "Active TB ruled out" variable, it was verified that 819 (98.8%, 95%CI=96.7-100.0) of the health professionals were examined and had the disease discarded.

Regarding the variable related to undergoing the IGRA, 741 (89.4%, 95%CI=87.1-91.4) of the 829 professionals notified did not undergo the test. Among those that did undergo an IGRA, 9.3% (n=77, 95%CI=7.4-11.5) were positive. In turn, the variable related to undergoing a TT, it was observed that 88.8% (n=736, 95%CI=86.4-90.8) of the health professionals had been subjected to it, when compared to using IGRA for the LTBI diagnosis. As for the "Contact with TB" variable, 50.1% (n=415, 95CI: 46.6-53.5) of the health professionals stated not having had contact with people infected by TB. Regarding the "BCG" variable, there was predominance of health professionals that had already been

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vaccinated, when compared to those who had not: 738 (89.0%, 95%CI=86.7-91.1) and 37 (4.5%, 95%CI=3.2-6.1), respectively. It is noted that no statistical significance was detected for any of these results.

The frequencies presented a statistical difference in relation to the "HIV" variable, with 30.6% (n=254, 95%CI=27.5-33.9) of these health professionals not undergoing the test. As for the "Medications" variable, preference to use Isoniazid was verified (n=528; 63.7%, 95%CI=60.3-67.0), followed by Rifapentine + Isoniazid-3HP (n=250; 30.2%, 95%CI=27.0-33.4) and by Rifampicin-4R (n=51; 6.2%, 95%CI=4.6-8.0). Regarding the treatment closing outcomes, 75.3% (n=484) of the health professionals notified finished their treatments duly meeting the number of doses of the initially established regime.

The geographical distribution corresponding to the health professionals that initiated TPTs in Brazil between 2018 and 2023 presented important variations across the Federation Units (FUs) (Figure 1).
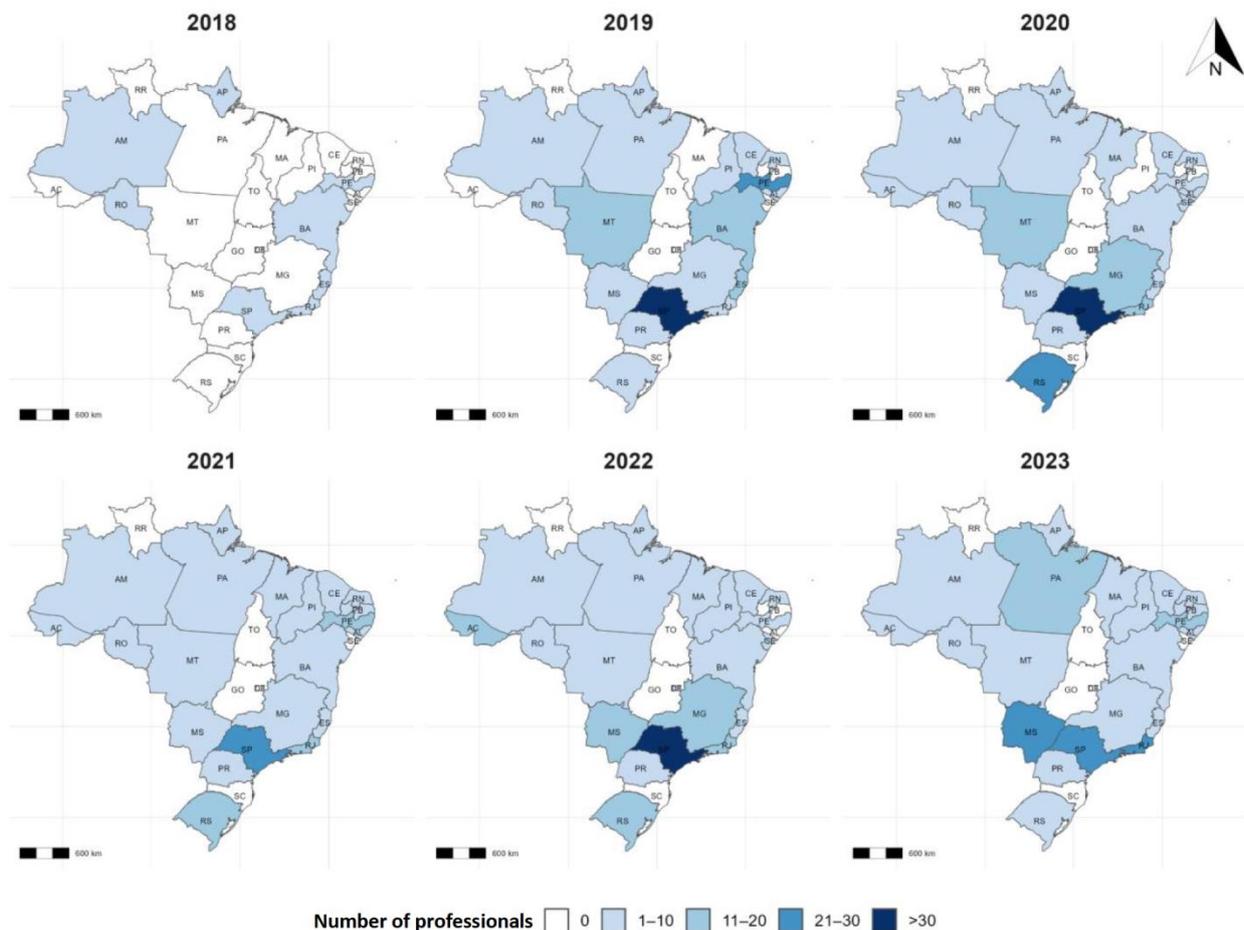

Figure 1: Geographical distribution by year corresponding to the health professionals that initiated tuberculosis preventive treatments (n=829). Brazil, 2018–2023.

Considering the entire period, the states with the most notifications were as follows: São Paulo (n=191; 23.0%), Pernambuco (n=78; 9.4%) and Rio de Janeiro (n=76; 9.2%), concentrating 41.6% of the notifications altogether. In contrast, two FUs (Roraima and Tocantins) recorded no notifications during that period, whereas the Federal District only presented two notifications in 2022.

In relation to the regions, the Southeast one concentrated the highest proportion of notifications (n=350; 42.2%), followed by the Northeast (n=213; 25.7%) and South (n=78; 9.4%) regions. North and Midwest presented lower proportions, with 14.8% (n=123) and 7.9% (n=66), respectively.

DISCUSSION

Based on the results presented, a gradual increase in the number of health professionals notified in the IL-TB system that underwent TPTs is observed during the last few years in Brazil. In this sense, it is relevant to note that an

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increase in the number of new TB cases was observed during the same 2015-2023 period in groups subjected to situations marked by greater vulnerability to the disease, including health professionals[2].

It is noted that the Southeast region is the one concentrating the highest number of TPTs among health professionals notified in the country (42.2%). Considering this context, two relevant aspect deserve to be underscored: in the first place, the Southeast region concentrated the highest number of new cases of the disease (TB) in the country in 2023, if we consider the adult population in general; secondly, this same region is responsible for the highest concentration of workers in the health area, with the Nursing category standing out as the largest in the country[2,10].

The regional disparities in terms of TPT initiation suggest possible asymmetries in how services are organized, in capillarity of the surveillance teams and in access to the diagnostic tests preceding the treatments. States with better radiological diagnosis capacity installed, more workers' surveillance centers and well-defined flows for the evaluation of contacts tend to identify and treat more professionals exposed. In contrast, weaker care structures can contribute to underdiagnosis and to TPT underprovision, even in places that concentrate a high TB burden. These differences reinforce that the TPT coverage is directly related to maturity of the local surveillance systems and to investments in occupational health.

In relation to the FUs, the highest number of notifications regarding health professionals that initiated TPTs during the entire period considered was found in São Paulo. On the other hand, in 2021 and in relation to the most frequent indications for TPTs in this state, health professionals were the least indicated[11]. Such scenario is not in contrast to the current reality of the country, where, in relation to the most frequent indications to undergo TPTs, the condition of being a health professional also ranks last in the list of indications suggested by the strategy, which is based on the criterion of risk for developing the disease[2].

This reality draws the attention because, despite the advances in subsequent years, it may point to certain weakness in relation to preventing TB and to managing LTBI among active health professionals. It is important to remember that this is one of the measures deemed as fundamental for advancing in the fight against TB in Brazil, highlighted in the National Plan to End Tuberculosis as a Public Health Problem and in the Ministry of Health's LTBI Surveillance Protocol[3]. The low TPT indication for health professionals may not only signal an operational gap but also some misalignment with national guidelines that treat this population segment as a strategic one to combat the disease. In this regard, it is indispensable for TB prevention and control actions to be targeted at this group, emphasizing the essential role played by undergoing TPTs in this sense, in relation to individual and collective health conditions alike.

As for race/skin color, this study detected a statistical relationship in the predominance of health professionals who self-declared as white-skinned and initiated TPTs; however, when adding up black- and brown-skinned subjects, predominance of the black race was noticed. In this aspect and regarding TB in Brazil, there was a higher percentage of white-skinned health professionals (47%) when compared to black-skinned subjects (45%)[12]. This signals that, in relation to this specific population group, race/skin color seems not to exert any influence on access to prevention tools such as TPTs.

In this study, belonging to the female gender was statistically associated with initiating TPTs. Corroborating this finding, when evaluating the LTBI occupational risk in health professionals, studies conducted in hospitals from South Korea and Saudi Arabia and considering the TT and IGRA (QFT-GIT) tests, respectively, found a significant association in relation to LTBI prevalence and female gender[13,14]. Likewise, a study developed in Brazil with the objective of estimating the prevalence of LTBI among Primary Health Care professionals also found higher LTBI prevalence in female health professionals, although with no statistically significant association[15].

In contrast to what was observed in terms of LTBI prevalence, the epidemiology of tuberculosis reveals a pattern marked by gender inequalities, with adult men concentrating the largest part of the global disease burden. The estimate in 2024 was 5.8 million new cases in males aged at least 15 years old, which corresponds to more than half of the cases recorded at the global level (54%). A total of 3.7 million cases (35%) were recorded among adult women. In addition to considering historically observed trends, these data highlight that men remained as the group that is most vulnerable to the disease, even presenting larger gaps in access to its diagnosis and increased under-reporting, factors that contribute to perpetuating transmission and hinder global control of the disease[1].

In an integrative review conducted with the objective of systematizing the knowledge available about the prevalence and exposure factors related to LTBI in health workers identified that the male gender presented a higher frequency of positive test results, reasserting the risk pattern observed in various epidemiological scenarios and suggesting possible interactions among social, occupational and behavioral factors[16].

Given this set of diverse evidence, it is observed that the higher TB risk among men (widely documented at the global level) is also reflected to some extent in the latent infection patterns described in the international literature. In turn, in the Brazilian context and especially among health workers, caution should be used when interpreting this

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variable. The predominance of the female gender in the sector's workforce[10,17] can act as a confounding factor, influencing the distribution of the cases and modulating the relationship between gender and LTBI. Thus, although the literature signals greater vulnerability in the male gender, the findings of this study need to be examined in the light of the occupational and demographic specificities inherent to the professional category, reinforcing the need for analyses that simultaneously consider structural, organizational and behavioral factors in determining the infection risk.

This study showed that the frequency for initiating TPTs was significantly higher among health professionals aged from 45 to 59 years old. Corroborating these findings, a Brazilian study that analyzed LTBI prevalence in health professionals and possible risk factors identified a significant association in the age group over 50 years old[15]. Similar results were observed in a study conducted in Saudi Arabia, a country with low TB incidence, which analyzed a broad and diversified population of health professionals with the objective of identifying the prevalence of LTBI and its associated factors. The authors verified that the chances for positive results in the tuberculin test increased progressively with age, with a statistically significant association ($p<0.001$). Taking the workers aged less than 30 years old as a reference, those between 41 and 50 presented a 62% increase in the reactive result chances (OR=1.62; 95%CI=1.26–2.09). Among the professionals aged over 50, this risk was even higher, corresponding to almost two times the chances of positive test results when compared to the younger group (OR=1.95; 95%CI=1.43–2.64)[5].

Advanced age and female gender were also associated with a higher LTBI risk in a research study conducted with health professionals at a central hospital from Nampula (Africa), which, among its findings, detected that being immunocompromised increased the LTBI chances by 5.97 times (95%CI=1.89-18.87)[18]. In this sense, it is noted that immunosuppression is an essential factor that increases the risk for LTBI to evolve to active TB[2]. In this regard, a review developed with the objective of describing the main determinants associated with mortality due to TB in the Brazilian population revealed that advanced age was one of the most frequently reported ones in the studies found[19].

Nevertheless, it is indispensable to consider that, in addition to the biological aspects related to aging, health professionals' living and working conditions in Brazil constitute core determinants that modulate vulnerability to TB. The occupational reality of this group is frequently marked by insufficient remunerations, prolonged workdays, high workloads and multiple employment contracts, strategies adopted to complement the workers' income but which result in continuous physical and emotional wear out[20]. From this perspective, the combination between advanced age, prolonged history of exposure to risk factors and adverse working conditions creates a possible scenario of increased TB risk in health professionals.

As for the clinical characterization of the health professionals that initiated TPTs in Brazil, it can be seen that most of them underwent chest X-rays to rule out active TB, in consonance with the current recommendations set forth by the Ministry of Health[3,12]. This finding is consistent with the national guidelines, which underscore the importance of this imaging test to ensure that a person is not infected by the active disease before initiating an LTBI treatment. However, a group of professionals that did not undergo the chest X-ray test was identified and there is no information in the database that may allow determining the reasons for them not to do so.

Identifying radiological alterations suggestive of active TB in professionals who, even so, were classified as eligible for TPTs evidences important flaws in the care flows and in the rigorous application of the clinical-epidemiological criteria that guide TB and LTBI management. This finding is in direct opposition to the global clinical norms[21] for managing the tuberculosis infection and implementing a TPT, which soundly establish that the active disease must be ruled out before initiating any preventive therapy and that all TPT candidates should undergo mandatory baseline examinations. The existence of these consensus-based guidelines reinforces that a number of normative, technical and operational instruments are already available to guide clinicians, managers and surveillance teams, which further evidences that the main gap lies in adhering to the already established protocols. In this sense, the scenario observed not only reveals diagnostic inconsistencies but also reasserts the need to strengthen permanent education strategies targeted at interpreting imaging tests and at a proper clinical definition of the cases, in addition to pointing to opportunities to incorporate innovating technologies such as Artificial Intelligence, capable of supporting decision-making and reducing variability in the diagnostic process in the routines of health services.

As for the evaluations of the health professionals, the expressive proportion of subjects with no chest X-ray or HIV testing records evidences important flaws in the stages that ensure safe care and adequate decision-making about initiating TPTs or not. Not undergoing these essential examinations not only impairs clinical management of each case but also epidemiological surveillance quality, with the possibility of resulting both in active TB delayed detection and in unnecessary exposure to preventive medications. Such gaps underscore the need to structure care flows that ensure integrality in pre-treatment assessments and minimize the risk of adverse outcomes.

A recent study conducted in Brazil about Primary Health Care timeliness in capital cities shows that structural weaknesses also impair proper evaluation of contacts and TPT expansion[22]. Most of the units failed to offer them and had few certified professionals to perform TTs *in situ*, in addition to limitations in terms of PPD storage and low IGRA availability. Ruling out active TB was equally hindered by lack of radiological devices in most of the clinics. These findings indicate that, in addition to low adherence to the clinical protocols, there are still organizational barriers that hinder properly identifying the infection and safely performing TPTs in the routines of the services.

Referring to the diagnostic methods, the Tuberculin Test was the most frequently used examination in this study. In turn, an integrative review identified the IGRA as the predominant method to diagnose LTBI. It was also observed that a lower percentage of the participants resorted exclusively to PPD and that only a limited part used both methods simultaneously: IGRA and PPD[16]. This methodological heterogeneity evidenced important differences across the contexts researched, especially regarding availability of inputs, institutional guidelines and technological resources adopted in the health services analyzed. However, it is worth noting that, in Brazil, it is only recommended for health professionals to undergo IGRA tests when there is an additional therapeutic indication, as in the case of people living with HIV, individuals on immunobiologicals and/or immunosuppressors or those in a pre-transplant situation (solid organs or stem cells)[23], as opposed to what happens in other countries where IGRA is widely disseminated, even in researching LTBI prevalence among health professionals[16].

Although IGRA was employed in a significantly lower proportion, its application among health professionals gave rise to relevant questions in the study under consideration. The current study did not allow identifying whether the IGRA tests were performed in the public or private system or if the workers evaluated met the specific clinical or epidemiological criteria to indicate this method. This missing information limits interpretation of the findings, especially when considering the potential impact of inequalities in accessing these tests and of the variability in clinical indications across different occupational groups.

As for contact with individuals infected by TB, most of the professionals notified stated not having had such contact. In consonance with this finding, a study conducted in China and which evaluated LTBI in health professionals subjected to the IGRA test identified a statistically significant relationship between not having any previous occupational contact with TB and positive test results[24]. In contrast, the prevalence of positive results in Saudi Arabia was higher among those with a history of having had contact with people infected by TB[14]. In Poland, the risk of a positive result was increased by eight to twelve times among the professionals that reported continuous contact with tuberculosis patients, identifying contact with active TB cases as the main risk factor for LTBI in this group[25]. In Peru, workers with an occupational exposure history presented a significantly higher risk of LTBI, with an adjusted prevalence ratio of 2.21[26]. In the Latin America and Caribbean region, LTBI was also consistently associated with exposure to patients, family members or other people diagnoses with TB, which reinforced the decisive influence of contact closeness and intensity in determining the infection risk[27].

The literature confirms that occupational contact with TB is consistently associated with LTBI risk among health professionals. However, elements such as exposure history under-reporting, presence of environmental transmission sources and workers' individual characteristics may have contributed to apparently divergent results. Thus, risk assessments should not be limited to declared contacts but also consider a broader set of factors influencing the infection chances[14,25-27].

In addition, although the IL-TB System does not allow identifying the professional category or type of service where these professionals develop their activities, it is fundamental to acknowledge that exposure to *Mycobacterium tuberculosis* is not homogeneous across the different segments that comprise the health workforce. The higher concentration of professionals in large-sized hospitals, emergency units and services with high turnover of patients with suspected TB represents an increased occupation risk. Likewise, Primary Health Care workers are in the front line for screening respiratory symptomatic patients, which also demands constant surveillance and safe screening protocols. The absence of structured information about the paper *locus* and nature limits the managers' ability to implement targeted prevention, monitoring and TPT systematic provision strategies, especially in environments acknowledgedly more critical in terms of exposure to *Mycobacterium tuberculosis*.

As for BCG vaccination, predominance of vaccinated professionals was observed, reflecting the Brazilian epidemiological scenario. Not being vaccinated increased the LTBI chances by 2.10 times (95%CI=1.28–3.43) among primary care workers in Brazil[15]; in turn, another study (also conducted in the country with primary care professionals) did not find any statistical association between the high vaccination rate and LTBI incidence. Even so, the authors highlighted that the broad vaccination coverage and the possible exposure to environmental mycobacteria might be related to positive results in the tuberculin test[28]. The information about BCG vaccination status was inconsistent across

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the findings of the systematic review with meta-analysis in health workers from the Latin America region: some studies reported that having the BCG scar or a vaccination antecedent was associated with higher LTBI rates, whereas others indicated that not having the BCG scar was associated with higher prevalence[27].

When interpreting the findings related to LTBI, it is necessary to consider the BCG vaccination status and, especially, the time elapsed since immunization, as the vaccine effect on reactivity in the tuberculin test declines progressively with age. Previous vaccination was associated with the risk of false positive results in the TST, indicating that this influence is more pronounced in younger individuals or in those that have been vaccinated more recently[25]. In order to minimize this bias, some authors proposed raising the TT cutoff point in contexts marked by high vaccination coverage[29,30]; from this point of view, TST values equal to or higher than 15 mm are more comparable to IGRA in people aged over 45 years old[25]. This evidence reinforces that the BCG vaccine tends to further confound diagnoses in younger adults, which warrants analytical and interpretive adjustments to increase screening precision and reduce instances of incorrect classification of the infection.

As for HIV, only a small proportion of these professionals presented positive results for the infection. This study was not able to identify if this test was offered to these professionals during the consultations or if they had already undergone it. Considering that immunosuppression is one of the main determinants of LTBI evolving to active tuberculosis[2], a study conducted in a university hospital from Goiânia found that having HIV, smoking and using immunosuppressors were associated with LTBI treatment indications[31]. Given these elements, it becomes essential to reflect on allocating immunosuppressed health professionals to environments with higher tuberculosis transmission potential, taking into account that these workers' immunological vulnerability can increase th e risk for LTBI to evolve to the active form, which reinforces the need for institutional strategies that consider both individual protection and safe work organization. Measures such as periodic risk assessments, strategic reallocation and strengthening biosafety practices can contribute to reducing unnecessary exposure and to promoting safer work environments.

As for the variables related to the medications used in TPTs and to the outcomes of the cases, this study revealed a statistically significant association in the predominant use of Isoniazid (6H/9H) when compared to Rifampicin (4R) and to the Rifapentine + Isoniazid (3HP) combination. On the other hand, a study conducted in South Korea with the objective of evaluating the TPT acceptance and completion rates among health professionals presented a higher proportion in using the combined Isoniazid + Rifampicin (3HR) scheme, followed by the Rifampicin (4R) one. However, regardless the scheme proposed, the study also concluded that both the health professionals' TPT acceptance and completion rates were not considered satisfactory[32].

A meta-analysis developed in the United States with the objective of comparing the efficacy and safety of the Rifapentine + Isoniazid (3HP) combination for three months to Isoniazid for nine months (9H) evidenced superiority of the 3HP scheme, which increased by 2.92 times the chances for the "Treatment completed" outcome in relation to the 9H scheme (95%CI=2.07-4.12). In addition to that, the hepatotoxicity rates (considered clinically relevant) were significantly lower in the shorter scheme (3HP). The study also noticed a reduction in the number of active tuberculosis cases among patients treated with 3HP, but with no statistically significant association[33].

The diverse evidence synthesized in the articles analyzed indicate that not finishing the LTBI treatment results from the interaction between the characteristics of the therapeutic regime, the patients' clinical profiles and the structural conditions inherent to care. Longer regimes based on Isoniazid (6–9H or 9H) alone present lower treatment completion rates when compared to shorter schemes with Rifampicins[34,35], which reinforces the role of treatment extension in time and of the number of doses as determinants of adherence. In addition to that, adverse events such as hepatotoxicity and systemic reactions were among the main causes of early treatment interruptions, especially in population groups with comorbidities[34,36].

Until 2021, the treatment schemes offered by the Brazilian SUS for LTBI were Isoniazid for six (6H) or nine months (9H), or Rifampicin for four months (4R). From 2021 onwards, a new therapeutic scheme was incorporated (3HP), which was considered as with more advantages when compared to the previous alternatives[2]. Thus, a hypothesis emerging from the study is that the higher use of Isoniazid as a therapeutic option can be related to the recent implementation of the 3HP scheme. Even so, it is fundamental for prescribing professionals to take 3HP into account as a preferred method, as it favors adhering to the treatments and finishing them.

As for the closing outcome, the study was not able to relate the positive outcomes to the therapeutic schemes used; however, it is important to consider that, when not motivated by clinical indication or adverse effects, TPT refusal

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or interruption can be associated with the very asymptomatic nature of LTBI. The fact that a person perceives their health status as good can reduce their motivation to undergo the treatment, which can cause undesirable effects[37,38].

In addition to that, it is important to consider that the 3HP scheme was recently incorporated to the SUS and that its consolidation as the first choice for TPTs is still in its implementation phase. Operational challenges such as irregular Rifapentine provision, need for logistic adjustments and specific training of professionals may have contributed to the predominance of the Isoniazid-based schemes observed in this study. Thus the therapeutic patterns identified not only reflect clinical decisions but also the pace at which the health system adapts to the updates in national guidelines.

In addition to delineating the profile of the professionals that initiate TPTs, these results reveal structural and operational barriers that need to be addressed to implement the role of preventive treatments as an instrument to protect the health workforce.

Study limitations

The study limitation lies in having used secondary data that can be subject to under-reporting and which, in turn, may especially affect the epidemiological profile of the population group under study. In addition to that, it is important to consider that under-reporting is still an intrinsic limitation of the IL-TB System, resulting in an underestimate of the actual number of professionals exposed and undergoing treatment. The absence of detailed information about professional categories or types of institution where these professionals develop their activities is added to the aforementioned, which restricts specific occupational risk analyses.

For being an ecological study, interpretation of its findings is subject to ecological error, aggravated by the heterogeneity found in how the services are organized and in the surveillance efforts across the country regions. Collectively, the variables do not necessarily mean that there is an association at the individual level[39].

In addition, incompleteness of important variables such as HIV, chest X-ray and history of contact limits understanding the integrality inherent to pre-treatment assessments and can create biases in the clinical and epidemiological interpretation of the results. Nevertheless, the data presented assist in understanding the national reality about the characteristics of the health professionals that initiated TPTs.

CONCLUSION

The results show that TPT adoption among health professionals is still not institutionalized as an occupational protection practice in the country. It is indispensable for health managers and services to treat LTBI monitoring and the provision of preventive treatments as strategic components in the national response to TB. Associated with permanent education and with strengthening biosafety policies, systematically incorporating these actions in the care routine is a determining factor to ensure safer work environments and contribute to attaining the eradication targets.

Given the results, it is crucial to consider some aspects: in the epidemiological scope, it would be relevant to include pre-populated fields in the TPT notification forms to record information such as type of profession and health institution (hospital or basic health unit) where each worker notified develops their activities. Consequently, future studies could analyze associations and identify which of these professional categories and health institutions present higher risks of exposure to *Mycobacterium tuberculosis*. Another consideration is for health institutions themselves to periodically follow-up these health professionals, especially those with some type of immunosuppression, for being individuals who are more susceptible than others in a group that is already vulnerable to *Mtb*. In this regard, it becomes necessary for health institutions to implement measures involving various sectors, such as workers' health and permanent education.

Educational initiatives are recommended in this context in order to: (i) promote that health professionals adopt preventive measures in their work environment; (ii) make early LTBI diagnoses; (iii) ensure TPT administration when necessary; and (iv) implement proper monitoring procedures to early identify active TB development among these workers. All these measures have the potential to significantly contribute to reducing TB transmission in health services and to improving these professionals' quality of life, in addition to achieving the targets for ending TB as a Public Health problem in Brazil.

An aspect to be considered is that the number of health professionals notified with LTBI does not properly reflect the actual extension of this scenario. This is because only health professionals that initiate TPTs are notified, leading us to consider if these numbers may be significantly underestimated. In addition to that and given the above, the hypothesis is proposed that within a group of health professionals (who are already vulnerable to the *Mtb* infection), the Nursing category stands out as the most exposed in the country.

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REFERENCES

1. World Health Organization. Global tuberculosis report 2025. Geneva: WHO; 2025 [cited 2025 Dec 05]. Available from: https://iris.who.int/server/api/core/bitstreams/e97dd6f4-b567-4396-8680-717bac6869a9/content.

2. Ministério da Saúde (BR). Boletim Epidemiológico de Tuberculose - Número Especial. Brasília: Ministério da Saúde; 2024 [cited 2024 Mar 10]. Available from: https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/boletins/epidemiologicos/especiais/2024/boletim-epidemiologico-de-tuberculose-numero-especial-mar-2024.pdf/view.

3. Ministério da Saúde (BR). Protocolo de vigilância da infecção latente pelo Mycobacterium tuberculosis no Brasil. Brasília: Ministério da Saúde; 2022 [cited 2024 Jan 10]. Available from: http://sitetb.saude.gov.br/download-2023/ILTB_Protocolo_de_vigilancia_da_ILTB_2022.pdf.

4. Uden L, Barber E, Ford N, Cooke GS. Risk of tuberculosis infection and disease for health care workers: an updated meta-analysis. Open Forum Infect Dis. 2017 [cited 2024 Abr 14] 4(3):ofx137. DOI: https://doi.org/10.1093/ofid/ofx137.

5. Almohaya A, Aldrees A, Akkielah L, Hashim AT, Almajid F, Binmoammar T, et al. Latent tuberculosis infection among health-care workers using Quantiferon-TB Gold-Plus in a country with a low burden for tuberculosis: prevalence and risk factors. Ann Saudi Med. 2020 [cited 2024 Abr 10] 40(3):191–9. DOI: http://dx.doi.org/10.5144/0256-4947.2020.191.

6. Sedamano J, Schwalb A, Cachay R, Zamudio C, Ugarte-Gil C, Soto-Cabezas G, et al. Prevalence of positive TST among healthcare workers in high-burden TB setting in Peru. BMC Public Health. 2020 [cited 2024 Abr 10] 20(1):612. DOI: http://dx.doi.org/10.1186/s12889-020-08756-9.

7. Lee EH, Son NH, Kwak SH, Choi JS, Kim MC, Seol CH, et al. Decreased annual risk of tuberculosis infection in South Korean healthcare workers using interferon-gamma release assay between 1986 and 2005. BMC Infect Dis. 2021 [cited 2024 Abr 8] 21:1. DOI: http://dx.doi.org/10.1186/s12879-021-06855-5.

8. Coppeta L, Ferrari C, Ferraro M, Baldi S, Grande S, De Zordo Lm, et al. Risk of latent tuberculosis infection among healthcare workers in Italy: a retrospective study with Quantiferon Test. J Prev Med Hyg. 2021 [cited 2024 Mar 20]; 62(3):E759–62. DOI: https://pmc.ncbi.nlm.nih.gov/articles/PMC8639116/pdf/jpmh-2021-03-e759.pdf.

9. Presidência da República (BR). Casa Civil Subchefia para Assuntos Jurídicos. Lei Nº 12.527, 18 de novembro de 2011. Brasília: Presidência da República; 2011 [cited 2024 Jan 19]. Available from: https://www.planalto.gov.br/ccivil_03/_ato2011-2014/2011/lei/l12527.htm.

10. Ministério da Saúde (BR). Centro Nacional de Informação do Trabalho na Saúde. Brasília: Ministério da Saúde; 2024 [cited 2024 Oct 4]. Available from: https://cenits.saude.gov.br/painel-fts/.

11. São Paulo (SP). Prefeitura de São Paulo. Programa municipal de controle da tuberculose. Boletim Epidemiológico de Tuberculose da Cidade de São Paulo. São Paulo: 2023. [cited 2024 Mar 10]. Available from: https://drive.prefeitura.sp.gov.br/cidade/secretarias/upload/saude/Boletim_Epidemiologico_TB_Cidade_SP_2023.pdf.

12. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Doenças de Condições Crônicas e Infecções Sexualmente Transmissíveis. Guia de orientações para prevenção e diagnóstico da tuberculose em profissionais de saúde. Brasília: Ministério da Saúde; 2021 [cited 2024 Mar 10]. Available from: https://www.gov.br/aids/pt-br/central-de-conteudo/publicacoes/2021/guia-de-orientacoes-para-prevencao-e-diagnostico-da-tuberculose-em-profissionais-de-saude.

13. Yoon CG, Oh SY, Lee JB, Kim MH, Seo Y, Yang J, et al. Occupational Risk of Latent Tuberculosis Infection in Health Workers of 14 Military Hospitals. J Korean Med Sci. 2017 [cited 2024 Jun 10]; 32(8):1251–7. DOI: http://dx.doi.org/10.3346/jkms.2017.32.8.1251.

14. Bukhary ZA, Amer SM, Emara MM, Abdalla ME, Ali SA. Screening of latent tuberculosis infection among health care workers working in Hajj pilgrimage area in Saudi Arabia, using interferon gamma release assay and tuberculin skin test. Ann Saudi Med. 2018 [cited 2024 Jul 10]; 38(2):90–6. DOI: http://dx.doi.org/10.5144/0256-4947.2018.90.

15. Prado TN, Riley LW, Sanchez M, Fregona G, Nóbrega RLP, Possuelo LG, et al. Prevalence and risk factors for latent tuberculosis infection among primary health care workers in Brazil. Cad Saúde Pública. 2017 [cited 2024 Jun 10]; 33(12):e00154916. DOI: https://pubmed.ncbi.nlm.nih.gov/29267691/.

16. Santos RS, Santos KM, Abreu AMM, Paula C, Zeitoune RCG. Prevalence and exposure variables of latent infection by Mycobacterium tuberculosis in healthcare workers. Rev Bras Enferm. 2024 [cited 2025 Dec 04]; 77(suppl 2):e20240052. DOI: https://pubmed.ncbi.nlm.nih.gov/39813437/.

17. Barros RSL, Mota MCS, Abreu AMM, Villa, TCS. Performance of the tuberculosis control program in the family health strategy. Esc. Anna. Nery. 2020 [cited 2024 Jul 10]; 24(4). DOI: https://doi.org/10.1590/2177-9465-EAN-2020-0002.

18. Belo C, Naidoo S. Prevalence and risk factors for latent tuberculosis infection among healthcare workers in Nampula Central Hospital, Mozambique. BMC Infect Dis. 2017 [cited 2024 Abr 10] 17(1):408–408. DOI: http://dx.doi.org/10.1186/s12879-017-2516-4

19. Delpino FM, Arcêncio RA, Nunes BP. Determinantes sociais e mortalidade por tuberculose no Brasil: estudo de revisão. Rev Baiana Saúde Pública. 2021 [cited 2024 Abr 10]; 45(1):228–41. DOI: https://rbsp.sesab.ba.gov.br/index.php/rbsp/article/view/3479/2941

20. Machado MH, Coelho MCR, Pereira EJ, Telles AO, Soares Neto JJ, Ximenes Neto FRG, et al. Work conditions and biosafety of health professionals and invisible health workers in the context of COVID-19 in Brazil. Cienc Saúde Colet. 2023 [cited 2025 Dec 04]; 28(10):2809-22. DOI: https://doi.org/10.1590/1413-812320232810.10072023

21. Migliori GB, Wu SJ, Matteelli A, Zenner D, Goletti D, Ahmedov S, et al. Clinical standards for the diagnosis, treatment and prevention of TB infection. Int J Tuberc Lung Dis. 2022 [cited 2025 Dec 05]; 26(3):190–205. DOI: https://pubmed.ncbi.nlm.nih.gov/35197159/

22. Cordeiro DC, Kuabara P, Amaral BC, Portugal LM, Sacramento DS, Rodrigues de Oliveira L, et al. Needs assessment and preparedness of the primary health care network for scaling-up preventive tuberculosis treatment in 5 Brazilian capitals. PLoS One. 2025 [cited 2025 Dec 05]; 20(6):e0326428. DOI: https://doi.org/10.1371/journal.pone.0326428.

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23. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Doenças de Condições Crônicas e Infecções Sexualmente Transmissíveis. NOTA INFORMATIVA Nº 2/2022-CGDR/DCCI/SVS/MS. Brasília: Ministério da Saúde; 2022 [cited 2024 Jan 18]. Available from: https://www.gov.br/aids/pt-br/central-de-conteudo/notas-informativas/2022/ni_02-2022_recomendacoesigra_assistencia.pdf/view

24. Guo LP, Jiang Y, Liu YM, Cao B. First assessment of interferon gamma release assay results among healthcare workers at a general hospital in China. Clin Respir J. 2018 [cited 2024 Abr 9]; 12(11):2581–9. DOI: http://dx.doi.org/10.1111/crj.12960

25. Szturmowicz M, Broniarek-Samson B, Demkow U. Prevalence and risk factors for latent tuberculosis in polish healthcare workers: the comparison of tuberculin skin test and interferon-gamma release assay (IGRA) performance. J Occup Med Toxicol. 2021 [cited 2024 Dec 5]; 16(1):38. DOI: https://doi.org/10.1186/s12995-021-00326-y.

26. Meregildo-Rodriguez ED, Yuptón-Chávez V, Asmat-Rubio MG, Vásquez-Tirado GA. Latent tuberculosis infection in health-care workers: a cross-sectional study at a northern Peruvian hospital. Front Med (Lausanne). 2023 [cited 2024 Dec 05]; 10:1295299. DOI: https://doi.org/10.3389/fmed.2023.1295299.

27. Meregildo-Rodriguez ED, Ortiz-Pizarro M, Asmat-Rubio MG, Rojas-Benites MJ, Vásquez-Tirado GA. Prevalence of latent tuberculosis infection in healthcare workers in Latin America and the Caribbean: systematic review and meta-analysis. Le Infezioni in Medicina. 2024 [cited 2024 Dec 05]; 32(3):292–311. DOI: https://doi.org/10.53854/liim-3203-4.

28. Lacerda TC, Souza FM, Prado TN, Locatelli RL, Fregona G, Lima RCD, et al. Tuberculosis infection among primary health care workers. J Bras Pneumol. 2017 [cited 2024 May 9]; 43(6):416–23. DOI: https://pubmed.ncbi.nlm.nih.gov/29340489/.

29. Ngo CQ, Manabe T, Vu GV, Chu HT, Vu TTT, Tran TT, et al. Difficulties in tuberculosis infection control in a general hospital of Vietnam: a knowledge, attitude, and practice survey and screening for latent tuberculosis infection among health professionals. BMC Infect Dis. 2019 [cited 2024 Dec 01]; 19:951. DOI: http://dx.doi.org/10.1186/s12879-019-4593-z.

30. Yoon CG, et al. Occupational risk of latent tuberculosis infection in health workers of 14 military hospitals. J Korean Med Sci. 2017 [cited 2024 Dec 01]; 32(8):1251–7. DOI: http://dx.doi.org/10.3346/jkms.2017.32.8.1251.

31. Candini LH, et al. Tratados para infecção latente por tuberculose em hospital universitário de 2017 a 2019. Braz J Infect Dis. 2021 [cited 2024 Dec 04]; 26:102314. DOI: https://doi.org/10.1016/j.bjid.2021.102314.

32. Han SS, Lee SJ, Yim JJ, Song JH, Lee EH, Kang YA. Evaluation and treatment of latent tuberculosis infection among healthcare workers in Korea: a multicentre cohort analysis. PLoS One. 2019 [cited 2024 Abr 10]; 14(9):e0222810. DOI: http://dx.doi.org/10.1371/journal.pone.0222810.

33. Mulinari E, Pereira D da S, Silva TBC, Junior EV de M, Oliveira GLA de. 3HP comparado ao 9H no tratamento da ILTB: Uma Revisão Sistemática e Meta-Análise. J Assist Farm E Farm. 2020 [cited 2024 May 1]; 5:4. DOI: https://ojs.jaff.org.br/ojs/index.php/jaff/article/view/213

34. Winters N, Stagg HR, Chamberlin S, Dixon P, Gnanendran M, White RG, et al. Completion, safety, and efficacy of tuberculosis preventive treatment regimens containing rifampicin or rifapentine: an individual patient data network meta-analysis. Lancet Respir Med. 2023 [cited 2024 Dec 01]; 11(9):782-90. DOI: https://doi.org/10.1016/S2213-2600(23)00096-6.

35. Rustage K, Lobo R, Paquette D, Magalhaes RJS, Dang Z, Waldron N, et al. Initiation and completion of treatment for latent tuberculosis infection in migrants globally: a systematic review and meta-analysis. Lancet Infect Dis. 2021 [cited 2024 Dec 03]; 21(12):1701-12. DOI: https://doi.org/10.1016/S1473-3099(21)00052-9.

36. Yanes-Lane M, Arinaminpathy N, Cohen T, Islam N, Whalen CC, Langley I, et al. Tuberculosis preventive therapy for people living with HIV: a systematic review and network meta-analysis. PLoS Med. 2021 [cited 2024 Dec 04]; 18(9):e1003738. DOI: https://doi.org/10.1371/journal.pmed.1003738.

37. Manoharan A, Siti Nur Farhana H, Manimaran K, Khoo EM, Koh WM. Facilitators and barriers for tuberculosis preventive treatment among patients with latent tuberculosis infection: a qualitative study. BMC Infect Dis. 2023 [cited 2024 Dec 04]; 23:624. DOI: https://doi.org/10.1186/s12879-023-08612-2.

38. Wang J, Zha X, Zhang Q, Chen M, Zhang H, Ding F, et al. Willingness of receiving preventive treatment and its determinants among individuals with latent tuberculosis infection in Shenzhen, China. BMC Infect Dis. 2025 [cited 2024 Dec 03]; 25(651). DOI: https://doi.org/10.1186/s12879-025-11026-x.

39. Medronho A.R. Estudos Ecológicos. In: Epidemiologia, ed. 2ª. São Paulo: Atheneu; 2009. p. 265–99.

Authors contributions

Use of artificial intelligence tools

Authors declare that no artificial intelligence tools were used in the composition of the manuscript "*Profile and gaps in tuberculosis preventive treatments among health professionals: an ecological study (2018-2023)*".