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Review Article
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Artículo de Revisión

Factors associated with latent Mycobacterium Tuberculosis infection in primary care health professionals

Fatores associados à Infecção latente pelo Mycobacterium Tuberculosis em Profissionais de Saúde da Atenção Primária

Factores asociados a la Infección Latente por Mycobacterium Tuberculosis en Profesionales de Salud de Atención Primaria

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ABSTRACT
Objective: to analyze in the scientific literature the factors associated with latent infection by Mycobacterium Tuberculosis in Primary Health Care professionals. **Method:** integrative review of the literature, with collection carried out between November and December 2021. The inclusion criteria were considered: Primary studies related to the theme and which include the following professionals: nurses, doctors, dentists, nursing technicians and oral health technicians, without time or language limitations. Exclusion criteria were: studies originating from expert opinions, editorials, course completion works, monographs, dissertations and theses. The Virtual Health Library, Medline, Scopus databases; Web of Science and Embase were used. **Results:** nine studies were selected, which presented factors associated with age, sex and presence of chronic diseases, lifestyle and working conditions. **Conclusion:** it was possible to analyze the factors associated with LTBI, which could support the implementation of more assertive public policies and contribute to the control of this problem.
Descriptors: Primary Health Care; Social Determinants of Health; Health Personnel; Latent Tuberculosis.

RESUMO
Objetivo: Objetivo: analisar na literatura científica os fatores associados à infecção latente pelo *Mycobacterium Tuberculosis* em profissionais da Atenção Primária à Saúde. **Método:** revisão integrativa da literatura, com coleta realizada entre novembro e dezembro de 2021. Considerou-se como critérios de inclusão: Estudos primários relacionados à temática e que incluam os seguintes profissionais: enfermeiros, médicos, dentistas, técnicos de enfermagem e técnicos de saúde bucal, sem delimitação temporal e de idiomas. Foram critérios de exclusão: estudos oriundos de opiniões de especialistas, editoriais, trabalhos de conclusão de curso, monografias, dissertações e teses. As bases de dados Biblioteca Virtual de Saúde, *Medline, Scopus; Web of Science e Embase* foram utilizadas. **Resultados:** foram selecionados nove estudos, que apresentaram os fatores associados idade, sexo e presença de doenças crônicas, estilo de vida e condições de trabalho. **Conclusão:** foi possível analisar os fatores associados à ILTB, o que poderá subsidiar a realização de políticas públicas mais assertivas e contribuir para o controle deste agravo.
Descritores: Atenção Primária à Saúde; Determinantes Sociais da Saúde; Pessoal de Saúde; Tuberculose Latente.

RESUMEN
Objetivo: analizar en la literatura científica los factores asociados a la infección latente por Mycobacterium Tuberculosis en profesionales de la Atención Primaria de Salud. **Método:** revisión integradora de la literatura, con recolección realizada entre noviembre y diciembre de 2021. Se consideraron como criterios de inclusión los estudios primarios relacionados con el tema y que incluyan a los siguientes profesionales: enfermeros, médicos, odontólogos, técnicos en enfermería y técnicos en salud bucal, sin limitaciones de tiempo ni de idioma. Los criterios de exclusión fueron: estudios provenientes de opiniones de expertos, editoriales, trabajos de finalización de cursos, monografías, disertaciones y tesis. Se utilizaron para las investigaciones: Biblioteca Virtual de Salud, *Medline, Scopus; Web of Science y Embase*. **Resultados:** se seleccionaron nueve estudios que presentaron factores asociados a la edad, sexo y presencia de enfermedades crónicas, estilo de vida y condiciones de trabajo. **Conclusión:** fue posible analizar los factores asociados a la ITBL, que podrían apoyar la implementación de políticas públicas más asertivas y contribuir al control de este problema.
Descriptores: Atención Primaria de Salud; Determinantes Sociales de la Salud; Personal de Salud; Tuberculosis latente.

INTRODUCTION

Latent *Mycobacterium Tuberculosis* infection (LTBI) corresponds to an infectious condition in which the individual affected by the bacillus does not manifest active tuberculosis. Infected people generally go several years without transmitting the disease and with partial immunity. It is estimated that a quarter of the world's population is latently infected with the bacillus, which creates a high risk for potential new cases. In this sense, tracking is essential to break the transmission chain, preventing activation of the disease[1,2].

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This does not mean that all people with LITB will have the disease in an active form, but that these individuals are reservoirs of the bacillus, which can be activated under some circumstances and with greater potential in higher risk groups, such as those with HIV infection, undergoing immunosuppressive treatments, under two or over 60 years of age, being diabetic or malnourished[3].

In this context, the World Health Organization (WHO) published the strategy to end Tuberculosis (TB) (End TB Strategy) in 2015, with robust goals for its eradication by 2035. Among the measures established are: increasing screening, diagnosis and treatment of LTBI, especially in higher risk groups such as children under five years of age in contact with TB and people living with HIV[4].

Furthermore, healthcare professionals are also a risk group, as they can deal directly with patients with active Tuberculosis, and are at increased risk of becoming ill in cases of conversion to LTBI testing. Therefore, the Ministry of Health (MoH) recommends annual screening of this group and prophylaxis for cases that show reactivity to the LTBI diagnostic test[3].

A prospective cohort study conducted in two Brazilian capitals (Vitória, ES and Manaus, AM) with Primary Healthcare (PHC) professionals demonstrated a LTBI prevalence of 23.3%[5], constituting a rate compatible with the incidence of 10 to 30% indicated in a systematic review carried out with health professionals in low and middle income countries[6]. This is in line with the LTBI conversion rate of 14 to 22% among primary and secondary healthcare professionals found in another study performed in countries with a high tuberculosis incidence rate[7]. Such data reinforce the dimension of this problem in the Brazilian scenario.

Workers at secondary and tertiary levels of healthcare are at high risk of being affected by LTBI. However, as PHC professionals are often the gateway for patients into the healthcare network, they are also at high risk of developing this condition and as an important part of the transmission and perpetuation chain of TB[8].

Therefore, the present investigation becomes relevant given the impact of the topic on public health, the need for greater elucidation of this problem, as well as the gaps which could be filled with future intervention research. In turn, the objective of this study is to analyze the factors associated with latent infection by *Mycobacterium Tuberculosis* in Primary Healthcare professionals in the scientific literature.

METHOD

This is an integrative literature review. This method enables grouping studies with different research designs, from observational studies to true experiments, in order to contribute to improve evidence-based practice. On the other hand, its purpose is not to make inferences, but rather to compile scientific knowledge produced at national and international levels on the investigated topic and thereby identify gaps in knowledge[9].

The study was developed based on the methodological framework of Mendes, Galvão and Silveira[9], which establishes the following steps: 1 - Formulation of the research question; 2 - Sampling; 3 - Data extraction; 4 - Critical evaluation; 5 - Analysis and synthesis of results; and 6 - Synthesis of knowledge.

The study's research question was constructed based on the PICo[10] strategy (P: problem or target population I: intervention or phenomenon of interest and Co: context), with P = health professionals; I = factors associated with latent *Mycobacterium Tuberculosis* infection; Co = Primary Healthcare. Therefore, the following research question was created: What are the factors associated with latent *Mycobacterium Tuberculosis* infection in Primary Healthcare professionals?

Primary studies related to the topic performed with nurses, doctors, dentists, nursing technicians and oral health technicians were included, without time or language delimitation. Studies originating from expert opinions, editorials, course completion works, monographs, dissertations and theses were excluded.

The databases were accessed from November to December 2021 through the Coordination for the Improvement of Higher Education Personnel (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES*) journal portal. The bibliographic search was conducted in the Virtual Health Library (VHL) and in the Medline databases via (Pubmed), Scopus, Web of Science, Embase and Cinahl. The controlled and uncontrolled vocabulary of the respective databases mentioned was accessed and combinations were made with the Boolean operators OR and AND to construct the search expressions. The syntax of combinations and final search expressions are shown in Figure 1.

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VIRTUAL HEALTH LIBRARY
((mh:("Pessoal de Saúde")) OR ("Profissionais da Saúde") OR ("Trabalhador da Saúde") OR (mh:("Enfermeiras e Enfermeiros")) OR (enfermeira) OR (enfermeiras) OR ("Enfermeira e Enfermeiro") OR (mh:(enfermeiros)) OR (enfermeiro) OR (mh:(médicos)) OR (médico) OR (mh:(odontólogos)) OR ("Cirurgião-Dentista") OR ("Cirurgiões-Dentistas") OR (dentista) OR (dentistas) OR (mh:("Técnicos de Enfermagem")) OR ("Técnico em saúde bucal")) AND ((mh:("Tuberculose Latente")) OR ("Infecção Tuberculosa Latente")) AND ((mh:("Atenção Primária à Saúde")) OR ("Atenção Básica") OR ("Atenção Básica à Saúde") OR ("Atenção Primária") OR ("Atenção Primária em Saúde") OR ("Cuidados Primários")) **Quantity of recovered articles:** 14
MEDLINE VIA PUBMED
((((((((((((((("health personnel"[MeSH Terms]) OR ("health care provider"[All Fields])) OR ("healthcare worker"[All Fields])) OR ("health care professional"[All Fields]))) OR ("nurses"[MeSH Terms])) OR ("nurse"[All Fields])) OR ("physicians"[MeSH Terms])) OR ("physician"[All Fields])) OR ("physicians, primary care"[MeSH Terms])) OR ("dentists"[MeSH Terms])) OR ("dentist"[All Fields])) OR ("licensed practical nurses"[MeSH Terms])) OR ("licensed practical nurse"[All Fields])) OR ("oral health technicians"[All Fields])) AND (((((("latent tuberculosis"[MeSH Terms])) OR ("latent tuberculosis"[All Fields])) OR ("latent tuberculosis infection"[All Fields])) OR ("latent tuberculosis infections"[All Fields]))) AND ((("primary health care"[MeSH Terms]) OR ("primary healthcare"[All Fields])) OR ("primary care"[All Fields])) **Quantity of recovered articles:** 25
CINAHL
((MH "Health Personnel") OR "Health Personnel" OR “Health Care Provider” OR "Healthcare Worker" OR "Health Care Professional" OR (MH "Nurses") OR "Nurses" OR "Nurse" OR "Nursing Personnel" OR "Physician" OR (MH "Dentists") OR "Dentist" OR "Physicians" OR (MH "Practical Nurses") OR "Licensed Practical Nurses" OR "Licensed Practical Nurse" OR "oral health technicians") AND ("Latent Tuberculosis" OR (MH "Latent Infection") OR "Latent Tuberculoses" OR "Latent Tuberculosis Infection" OR "Latent Tuberculosis Infections") AND ((MH "Primary Health Care") OR "Primary Health Care" OR "Primary Healthcare" OR "Primary Care") **Total number of recovered articles:** 9
EMBASE
('health care personnel'/exp OR 'health care personnel' OR 'health care practitioner' OR 'health care professional' OR 'health care provider' OR 'health care worker' OR 'health personnel' OR 'health profession personnel' OR 'health worker' OR 'healthcare personnel' OR 'healthcare practitioner' OR 'healthcare professional' OR 'healthcare provider' OR 'healthcare worker' OR 'home health aides' OR 'personnel, health' OR 'public health officer' OR 'nurse'/exp OR 'anaesthesist nurse assistant' OR 'anesthetist nurse assistant' OR 'community health nurse' OR 'community health nurses' OR 'nurse' OR 'nurse, community health' OR 'nurses' OR 'nurses, community health' OR 'nurses, public health' OR 'nursing assistance' OR 'public health nurse' OR 'public health nurses' OR 'physician'/exp OR 'doctor' OR 'medical doctor' OR 'medical practitioner' OR 'physician' OR 'physician associate' OR 'physicians' OR 'practitioner' OR 'private physician' OR 'dentist'/exp OR 'dentist' OR 'dentists' OR 'dentists, women' OR 'licensed practical nurse'/exp OR 'licensed practical nurse' OR 'licensed practical nurses' OR 'licensed vocational nurse') AND ('latent tuberculosis'/mj OR 'latent tuberculosis') AND ('primary health care'/mj OR 'first line care' OR 'health care, primary' OR 'primary care nursing' OR 'primary health care' OR 'primary healthcare' OR 'primary nursing care') **Total number of recovered articles:** 25
WEB OF SCIENCE
(TS=("Health Personnel") OR TS=("Health Care Provider") OR TS=("Healthcare Worker") OR TS=("Health Care Professional") OR TS=(Nurses) OR TS=(Nurse) OR TS=("Nursing Personnel") OR TS=(Physicians) OR TS=(Physician) OR TS=("Physicians, Primary Care") OR TS=(Dentists) OR TS=(Dentist) OR TS=("Licensed Practical Nurses") OR TS=("Licensed Practical Nurse") OR TS=("oral health technicians")) AND (TS=("Latent Tuberculosis") OR TS=("Latent Tuberculoses") OR TS=("Latent Tuberculosis Infection") OR TS=("Latent Tuberculosis Infections")) AND (TS=("Primary Health Care") OR TS=("Primary Healthcare") OR TS=("Primary Care")) **Total number of recovered articles:** 16
SCOPUS
((TITLE-ABS-KEY("Health Personnel") OR TITLE-ABS-KEY("Health Care Provider") OR TITLE-ABS-KEY("Healthcare Worker") OR TITLE-ABS-KEY("Health Care Professional") OR TITLE-ABS-KEY(Nurses) OR TITLE-ABS-KEY(Nurse) OR TITLE-ABS-KEY(Physicians) OR TITLE-ABS-KEY(Physician) OR TITLE-ABS-KEY(Dentists) OR TITLE-ABS-KEY("Licensed Practical Nurses") OR TITLE-ABS-KEY("Licensed Practical Nurse") OR TITLE-ABS-KEY("oral health technicians"))) AND ((TITLE-ABS-KEY("Latent Tuberculosis") OR TITLE-ABS-KEY("Latent Tuberculoses") OR TITLE-ABS-KEY("Latent Tuberculosis Infection") OR TITLE-ABS-KEY("Latent Tuberculosis Infections"))) AND ((TITLE-ABS-KEY("Primary Health Care") OR TITLE-ABS-KEY("Primary Healthcare") OR TITLE-ABS-KEY("Primary Care"))) **Total number of recovered articles:** 30

Figure 1: Final syntax of controlled and uncontrolled descriptors of the investigated databases, Teresina, PI, Brazil, 2022.

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The searches were performed by the researchers independently, and the (rayyan.qcri.org) application was used to assist in the article screening process. A total of 119 articles were retrieved, but 60 duplicate articles were excluded after analyzing them in the application.

Thus, 59 articles were chosen for the first selection phase (reading the title and abstract). After a peer review of the titles and abstracts, 30 studies were excluded because they did not meet the study objective, research question and/or eligibility criteria. Thus, 29 articles remained for the second selection phase.

After reading the articles in full, 24 articles were excluded for not answering the research question, objective and/or not meeting the eligibility criteria, leaving five articles for the sample composition. A manual search was then conducted in the list of references of the selected articles in order to expand the sample and qualify the search process, which resulted in four more articles that suited the objective of the study and the eligibility criteria.

Figure 2 schematically presents the selection of studies according to the recommendations of the prism flowchart.

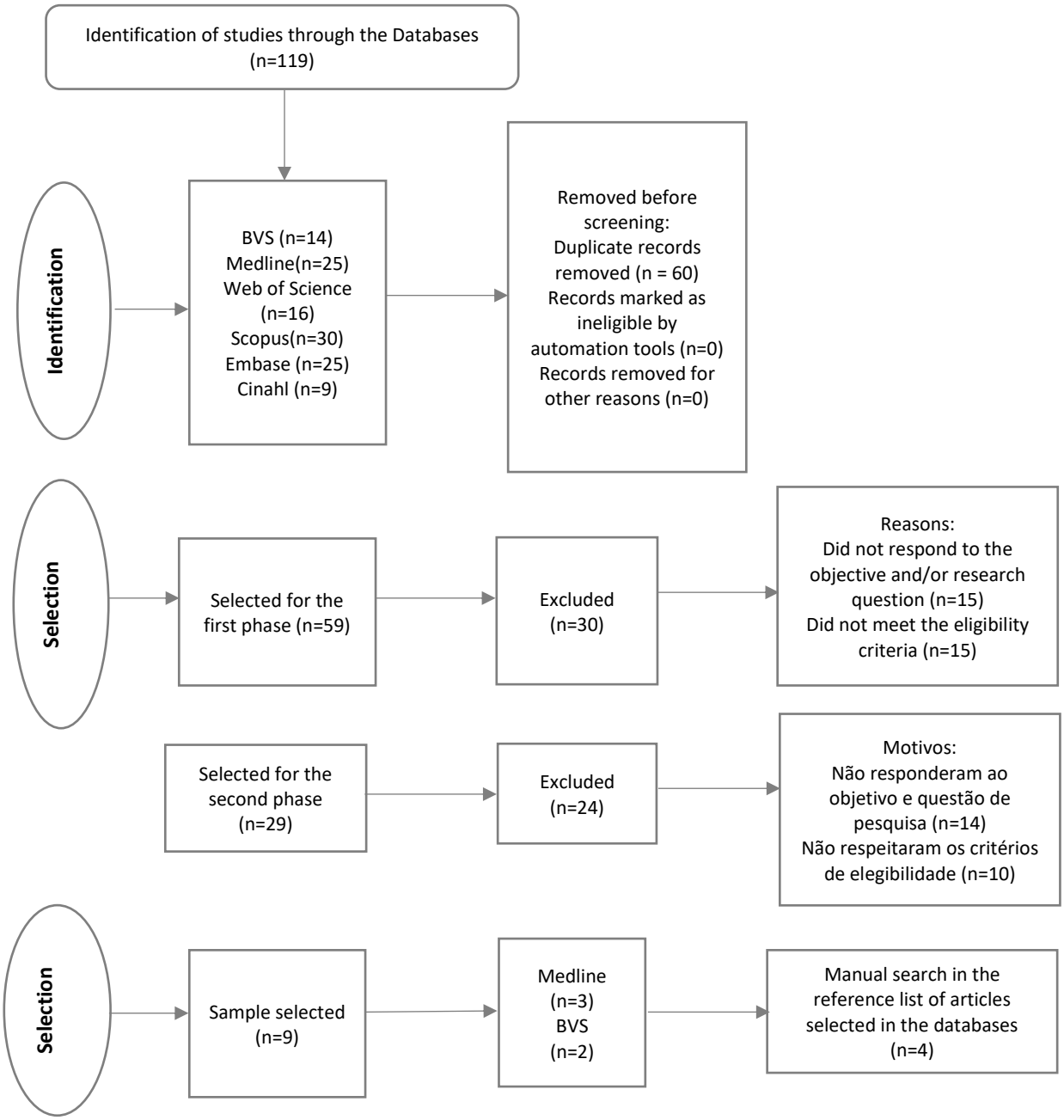

Figure 2: Selection of articles in databases. Teresina, PI, Brazil, 2022.
Fonte: Adaptado de Page *et al*[11].

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Data was extracted using a data collection instrument built by the research author and adapted from Ursi[12]. It includes the following information: author(s), journal, year of publication, study location, objective, outcome, design and level of evidence.

The level of evidence classification followed the Melnyk and Pineout-Overholt[13] framework, namely: Level I – systematic review or meta-analysis of randomized controlled clinical trials; Level II – well-designed randomized controlled clinical trials; Level III – well-designed clinical trials without randomization; Level IV – well-designed cohort and case-control studies; Level V – systematic review of descriptive and qualitative studies; Level VI – descriptive or qualitative study; and Level VII – opinion of authorities and/or reports.

The data were analyzed descriptively using the semantic similarity criterion to guide the synthesis of results and construction of thematic categories, which was supported by the theoretical Social Determination of Health (SDH) framework proposed by Dahlgren and Whitehead[14].

The health-disease process is complex and multifactorial, as it is not just about the absence of diseases. Some models and classifications to understand the relationships that influence the health process help with this systematic understanding. In this sense, the SDH classification proposed by Dahlgren and Whitehead is adopted by the National Commission on the Social Determinants of Health (*Comissão Nacional sobre os Determinantes Sociais da Saúde - CNDSS*) of the Ministry of Health and assists in this analysis through structuring the layer model divided into five, namely: 1 – Age, Sex and hereditary factors; 2 – Individuals' lifestyle; 3 – Social and community networks; 4 – Living and working conditions; 5 – General socioeconomic, cultural and environmental conditions[14,15].

RESULTS

The year 2014 stood out with the largest number of publications (n=3) among the studies selected in the final sample (n=9), the publication period varied between 2007 and 2017, with Brazil being the country with the largest number of publications (n=7). The articles were published in different journals, each in a different one. Observational studies (Level VI) presented the largest number (n=8) regarding research design and level of evidence. The information extracted is detailed in Figures 3 and 4.

A total of 13 factors were identified in the publications that were associated with higher LTBI prevalence, namely: professional category, time working in the service, previous testing to identify LTBI, smoking, alcohol consumption, age, training on TB, household contact, gender, presence of comorbidities such as Systemic Arterial Hypertension and Diabetes Mellitus, monitoring patients with TB, vaccination status and use of Personal Protective Equipment (PPE).

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Main author	Journal	Year of publication	Country location	Main results	Design and level of evidence
Lacerda *et al*[16]	J Bras. Pneumologia	2017	Brazil - Vitória (ES)	A higher prevalence of LTBI was observed among Community Health Agents (CHA). The average length of time professionals worked in their specific role in primary care was approximately eight years (95%CI: 7.38-8.95). A logistic regression analysis showed that only "having previously undergone the Tuberculin Skin Test (TST)" maintained a statistical association with a positive TST result for cut-off points ≥ 10 mm (OR = 2.5; 95%CI: 1.17-5.30) and ≥ 5 mm (OR= 2.18; 95%CI: 1.23-3.87).	Cross-sectional Study/Level VI
Prado *et al*[17]	Public Health Notebooks (*Cadernos de Saúde Pública*)	2017	Brazil, Multi-center	Age over 50 years old, have household contact with TB; being male, having comorbidities (Hypertension or diabetes), and being a smoker were factors with a positive association with LTBI. Health professionals with ≥10 years of service in a primary health unit were positively associated with a positive QFT-GIT result when compared with negative LTBI. Healthcare workers without a BCG (Bacillus Calmette-Guerin) vaccination scar (OR = 2.10; 95%CI: 1.28-3.43) were more likely to have LTBI than healthcare workers with a BCG scar; professionals who reported ex-smoker status (OR = 1.80; 95%CI: 1.04-3.11) were more likely to have LTBI than healthcare professionals who never smoked. Being a nurse (OR = 2.97; 95%CI: 1.13-7.83), being a nursing technician (OR = 3.10; 95%CI: 1.26-7.60), being a community health agent (CHA) (OR = 2.60; 95%CI: 1.06-6.40) increased the chances of LTBI compared to being a doctor. Professionals who used N95 masks irregularly (OR = 2.51; 95%CI: 1.11-5.98) were more likely to have LTBI than healthcare professionals who reported regular use of N95 masks.	Cross-sectional Study/Level VI
Martinez et al[18]	Cuban Journal of Tropical Medicine (*Jornal Cubano de medicina tropical*)	2015	Cuba	It was observed that the minimum risk in the bivariate analysis had the lowest LTBI prevalence, and compared to these, those at low risk had a 5.9 times higher prevalence (p = 0.00), those at Intermediate risk had 1.8 times higher prevalence (p = 0.03), and those at high risk had 2 times higher prevalence (p = 0.00). The departments of Laboratory, Family Doctor offices, sexually transmitted diseases, hygiene and epidemiology were classified as those at highest risk, as they were placed in the high or intermediate risk categories in all health areas.	Cross-sectional Study/Level VI
Drobniewski *et al*[19]	PloS Medicine	2007	Russia	LTBI was observed in 40.8% (107/262) of staff and was significantly higher in doctors and nurses (39.1% [90/230]) than in students (8.7% [32/368]) (relative risk [RR] 4.5; 95%CI 3.1-6.5), and in the TB service versus primary health doctors and nurses: 46.9% (45/96) versus 29.3% (34/116) (RR 1.6; 95%CI 1.1–2.3), respectively. The LTBI rate was also high among laboratory workers: 11/18 (61.1%).	Cross-sectional Study/Level VI
Souza *et al*[20]	Plos ONE	2014	Brazil, Multi-center	In a multivariate analysis, 41-45 [OR = 2.11; 95%CI: 1.13-3.93] and 46-64 years of age [OR = 2.02; 95%CI: 1.14-3.58], and years served in a health profession in PHC environments [OR = 1.66; 95%CI: 1.12–2.47] remained significant. BCG vaccination scar was also associated with a positive TST result at the cut-off of 5mm [OR = 1.78: 95%CI: 1.09–2.90].	Cross-sectional Study/Level VI
Borges *et al*[21]	*Rev Bras Promoç Saúde*	2014	Brazil	The prevalence of latent tuberculosis in the studied population was 32.8% (n=45). Being a smoker (OR: 3.03; 95%CI 1.05-8.77) was the only characteristic associated with a higher risk of presenting a positive TST compared to non-smokers.	Cross-sectional Study/Level VI
Machado *et al*[22]	*Epidemiol. Serv. Saúde*.	2014	Brazil	Among the study's target audience of 47 community health agents (CHAs), no association was observed between the variables of age, working time and BCG scar with a positive result through the TST or Interferon-Gamma Release Assay.	Cross-sectional Study/Level VI

Figure 3: Description of articles from 2007 and 2014 to 2017 included in the integrative literature review according to author, journal, year of publication, country, main results and research design/level of evidence, Teresina, PI, Brazil, 2022.

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Main author	Journal	Year of publication	Country location	Main results	Design and level of evidence
Oliveira *et al*[23]	HCPA Journal (*Rev HCPA*)	2011	Brazil	Contact with TB patients at work was reported by 39 (65%) professionals, of which 13 (31.7%) had a positive TST. When categorized by exposure time, it was found that workers with less than 4 years of exposure to the bacillus had higher TST positivity rates (P = 0.03). It was observed that the majority of positive tests were from workers at Basic Health Units (BHUs) which were not specialized in TB treatment (P = 0.09). A total of 21 professionals were tested in the specialty center where the BHU specializing in TB treatment is located, of which three (18.8%) tested positive, with only one of these professionals working in direct care of patients with TB.	Cross-sectional Study/Level VI
Moreira, Zandonade and Maciel[24]	Public Health Journal (*Rev Saúde Pública*)	2010	Brazil	The conversion incidence of the tuberculin skin test was 24.6% (15 CHAs), corresponding to 41.7% in the exposed group and 13.5% in the unexposed group. The calculated annual risk of infection was 52.8% in the exposed group and 14.4% in the unexposed group. An association was observed between tuberculin skin test conversion and exposure to a patient with TB (p=0.013). The relative risk (RR) was 3.08 (95%CI: 1.20;7.91) times higher than in the unexposed group. It is observed that there is no association between tuberculin skin test conversion, number of patients followed and number of weekly visits to the home of a patient with TB (p > 0.05).	Cohort Study/Level IV

Figure 4: Description of articles from 2010 and 2011 included in the integrative literature review according to author, journal, year of publication, country, main results and research design/level of evidence, Teresina, PI, Brazil, 2022.

DISCUSSION

The SDH model was used to guide the process of analyzing the associated factors found in the studies which resulted in three thematic categories, namely: 1. Age, sex and hereditary factors; 2. Individuals' lifestyle; 3. Living and working conditions that correspond to some of the layers of the aforementioned model.

Age, sex and hereditary factors

According to the SDH model, the individual is at the center of the health and disease process, and some characteristics can have a preponderant effect, such as age, sex and genetic factors[25].

Only three of the nine studies included in the review analyzed the age variable. Among them, only one did not show a significant association between LTBI and age. However, it is worth highlighting that the study that did not identify an association presented a small sample of 47 participants, which may demonstrate a result with low reliability given the small sample analyzed[22]. On the other hand, the two studies that showed a positive association of this variable with LTBI were multicenter investigations carried out in Brazil with a representative sample and with explicit confidence intervals, presenting significant results on the relationship between age greater than or equal to 41 years and the presence of LTBI[17,20,22].

Furthermore, studies indicate that being older than or equal to 50 years old reflects a higher prevalence rate when compared to younger age groups. This finding may be related to the phenomenon of immunosenescence, which is associated with a decrease in the action of the immune system with advancing age, in addition to being associated with a longer exposure time due to age[26,27].

Only one of the studies found showed a relationship with the gender variable, in which female professionals had a lower prevalence compared to males[20]. This result corroborates a study carried out by Weinfurter et al.[28] which also points out this same relationship, but there is no clear evidence that can explain this phenomenon[20].

The absence of a vaccine scar is another individual characteristic of healthcare professionals that may present a greater chance of having LTBI. It should be noted that the vaccine scar may be present or absent even in those vaccinated with BCG. Therefore, the absence of a scar may mean that individuals may be more likely to acquire this infection, either due to an unsatisfactory immunological response to the vaccine and/or prolonged exposure to bacillus[34].

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Individuals' lifestyles

Among the professionals investigated, the literature consulted reports some individual characteristics statistically related to a greater chance of having LTBI. These factors are mainly associated with smoking or ex-smoking and alcohol consumption[17,20,21].

The smoking factor may be related to a decrease in the immune response capacity in lung tissue, which may increase the chance of an individual experiencing respiratory tract infections, including TB. A study carried out by Prado et al.[15] demonstrated a greater probability of developing LTBI in professionals who reported being smokers or ex-smokers. This result corroborates a study carried out with professionals in Taiwan and also a study carried out in Brazil that demonstrated a high risk ratio for the condition of smokers or ex-smokers[22,35].

On the other hand, this association was not noticed in a study carried out in Brazil which compared the use of TST and the interferon-gamma release assay (IGRA), which demonstrates that this association cannot be generalized and that broader investigations must be performed. However, it is beneficial to highlight the limitations of the study for making statistical inferences given a small sample of only 47 participants[22], in addition to some methodological weaknesses that may impact the reliability of the inferences, such as the absence of a sample calculation and the premise of confirming the hypothesis test only related to the level of significance without an effect size analysis, which is a fundamental measure to reduce the risk of interpretation errors and direct a more effective analysis of the sample size[29].

A study performed in a municipality in Cuba showed that a positive relationship was found in health professionals who had a habit of consuming alcoholic beverages with the presence of LTBI. However, as they are service maintenance professionals with a low education level and because they live in places with higher TB rates, this factor cannot be looked at in isolation, as it requires more robust research to more precisely assess this variable[16]. A fact which leads to little confidence in this finding was the absence of a significant association in other studies that also investigated alcohol consumption among the professionals analyzed[30,31,32].

Living and working conditions

Working conditions were factors present in all of the selected studies. CHAs and Nursing stood out among the professional categories. The main factors related to greater risk of LTBI were the workplace, the exposure time (the number of years worked in service) and the inappropriate use of Personal Protective Equipment[16-24].

Health professionals are a risk group for developing LTBI given their closer and longer contact with this bacillus in health services and because biosafety measures are not always followed appropriately[21,22,24].

Some justifications can be raised, with the first being related to the absence or inappropriate use of PPE, as it is not available in the service or even due to the negligence of professionals in not using it due to discomfort of the equipment, mainly the N95 mask. These are risky conditions often adopted by individuals even though they are aware of the risks connected to these actions. The second is related to the new TST interpretation parameter, in which the currently adopted cut-off point is 5mm, and the fact that a professional has recently been exposed to the bacillus, whether due to recent entry into the field of activity or even factors related to a recent immunization, and/or contact with other mycobacteria which may interfere with TST reactivity[16].

In view of the above, it is necessary to adopt important measures such as implementing a new test and evaluating an increase of at least 10mm in relation to the first test. In addition, periodic testing of professionals as they are considered a risk category which can be even higher, especially in services that care for patients with TB. These measures aim to ensure a safe diagnosis of LTBI and prevent the incorrect use of prophylaxis[16].

Health professionals at greatest risk of LTBI development refer to CHAs who are often found in regions with higher TB incidence, followed by nursing professionals from health centers who receive patients for TB treatment. A fact which proves this statement was evidenced by a lower probability of LTBI in professionals in health units that do not treat patients with Koch's bacillus, which leads to interpretation of lower exposure to the aforementioned bacillus[18,33].

The relationship of greater LTBI probability in nursing workers is a reality highlighted in national and international studies, which reinforces the premise that this group deals with patients with *Mycobacterium Tuberculosis* in the active form for longer, which makes them more vulnerable. This fact was observed in countries such as Cuba and Russia[18,19]. Therefore, there is a need for differentiated attention to these professionals who are exposed to a greater risk of contracting LTBI, since some other factors may also be related to working conditions

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such as excessive demand, overload of activities, physical pain and exhaustion, which can make this category more vulnerable to illness[34].

Some measures must be adopted by services to reduce contamination of professionals, such as periodic training, provision of quality PPE, guidelines for proper use and adapting care facilities for respiratory symptomatic patients[33].

Regarding the exposure time of professionals and the infectivity rates of workers, several studies have shown a higher infection rate in professionals with four years or less of working time when compared to professionals with more than four years of service. Some hypotheses can be considered to understand this behavior, such as the fact that a professional with less experience has had recent contact with the bacillus and this leads to developing a recent immunological response in contact with the invading agent[21-23].

In contrast to what was presented by previous studies, a multicenter study carried out in Brazil in which two different methods for detecting LTBI (TST and IGRA) were tested proved to be statistically significant in relation to the time in both methods used, demonstrating that professionals with an exposure period greater than five years obtained a significant association with LTBI positivity[20].

The studies which presented divergent results in the literature have methodological weaknesses that may impact the reliability of the results, since the article did not include the sample calculation, in addition to prioritizing the level of significance analysis without considering the effect size[18,22]. As a result, this can be seen as a limitation, as the risk of bias or interpretation errors in observational studies is greater than in intervention studies, making it important to analyze beyond the level of significance, and considering measures which assess the effect size as a way to avoid possible errors in hypothesis testing[36,37].

In view of the above, this investigation made it possible to analyze the factors associated with LTBI in professionals and understand which SDH are most related to this health situation, and in turn serve as a basis for strategic health planning and developing new studies. Furthermore, the contribution of this study is also evident in demonstrating the professional categories that are most vulnerable, such as nursing professionals. In this sense, public policies must be thought of more individualized and comprehensively given the importance that this category has in executing public health actions.

CONCLUSION

This investigation enabled elucidating individual factors such as age, sex, the presence of chronic diseases, lifestyle (smoking or ex-smoking and alcohol consumption) and working conditions (inadequate use of personal protective equipment, workplaces and exposure time, meaning the number of years worked) associated with LTBI.

It was also possible to identify a gap regarding the scarcity of robust longitudinal studies that evaluate this phenomenon with higher quality, demonstrating the need to develop cohort and experimental studies to make inferences with greater statistical power; this in turn can contribute to knowledge about this problem, which can then also contribute to the resistance of the TB transmission chain in Brazil and the world.

It is concluded that this review can support implementing more assertive public policies for the target audience analyzed, contributing to control LTBI and consequently active TB cases. Furthermore, by highlighting which SDH are associated, more effective measures can be implemented, such as the provision of personal protective equipment compatible with the required biosafety level and with regular supply, better living and working conditions, such as better remuneration and professional development, healthier working environments and occupational health monitoring programs.

REFERENCES

1. Houben RMGJ, Dodd PJ. The Global Burden of Latent Tuberculosis Infection: A Re-estimation Using Mathematical Modelling. PLoS Med. 2016 [cited 2021 Dec 10]; 25(13):1002152. DOI: https://doi.org/10.1371%2Fjournal.pmed.1002152.
2. Behr MA, Edelstein PH, Ramakrishnan L. Revisiting the timetable of tuberculosis. BMJ. 2018 [cited 2021 Dec 11]; 362:k2738. DOI: https://doi.org/10.1136/bmj.k2738.
3. Ministério da Saúde (Br). Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. Protocolo de vigilância da infecção latente pelo Mycobacterium tuberculosis no Brasil. Brasília (DF): Ministério da Saúde; 2018.
4. World Health Organization. The End TB Strategy. [Site de Internet]. 2015 [cited 2021 Dec 10]; Available from: https://www.who.int/teams/global-tuberculosis-programme/the-end-tb-strategy.
5. Lima, OC, Souza, FMD, Prado, TND, Andrade, RM, Maciel, ELN. Analysis of the incidence of latent Mycobacterium tuberculosis infection among primary health care professionals in two Brazilian capitals. J Bras Pneumol. 2020 [cited 2021 Dec 11]; 46(2): e20190201. DOI: https://doi.org/10.36416/1806-3756/e20190201.

DOI: http://dx.doi.org/10.12957/reuerj.2023.68910

6. Apriani L, McAllister S, Sharples K, Alisjahbana B, Ruslami R, Hill PC, et al. Latent tuberculosis infection in health care workers in low- and middle-income countries: an updated systematic review. Eur Respir J. 2019[cited 2023 Jul 11]; 53(4):1801789. DOI: https://doi.org/10.1183/13993003.01789-2018.
7. Machado PC, Valim ARM, Maciel ELN, Prado TN, Borges TS, Daronco A, et al. Comparison of tuberculin test and interferon-gamma release assay for diagnosing latent tuberculosis in Community Health Workers, State of Rio Grande do Sul, Brazil. Epidemiol Serv Saude. 2014 [cited 2021 Dec 11]; 23(4):675-81. DOI: https://doi.org/10.5123/S1679-49742014000400009.
8. Rodrigues PM, Moreira TR, Moraes AK, Vieira Rda C, Dietze R, Lima Rde C, et al. Mycobacterium tuberculosis infection among community health workers involved in TB control. J Bras Pneumol, 2009 [cited 2021 Dec 12]; 35(4):351-8. DOI: https://doi.org/10.1590/S1806-37132009000400009.
9. Mendes KDS, Silveira RC de CP, Galvão CM Integrative literature review: a research method to incorporate evidence in health care and nursing. Texto Contexto Enferm. 2008 [cited 2021 Dec 12]; 17(4):758–64. DOI: https://doi.org/10.1590/s0104-07072008000400018.
10. The Joana Briggs Institute. Critical Appraisal Tools. [Site de Internet]. 2017 [cited 2021 Dec 12]; Available from: http://joannabriggs.org/research/criticalappraisal-tools.html.
11. Page MJ, McKenzie, JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Moher D. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Systematic reviews*, 2022 [cited 2021 Dec 13]; 372:n71. DOI: https://doi.org/10.1136/bmj.n71.
12. Ursi ES. Prevenção de lesões de pele no perioperatório: revisão integrativa da literatura. [Master thesis]. Ribeirão Preto: Universidade de São Paulo, Escola de Enfermagem de Ribeirão Preto; 2005.
13. Melny BM, Fineout-Overholt E. Evidence-based practice in nursing & healthcare. A guide to best practice. 4a ed. Philadelphia (US): Wolters Kluwer Health; 2018.
14. Dahlgren G, Whitehead M. Policies and Strategies to promote social equity in health. Stockholm: Institute for Future Studies; 1991.
15. Ministério da Saúde (Br). Comissão Nacional sobre Determinanates Sociais de Saúde. As causas sociais das iniquidades em saúde no Brasil. In: Relatório final da comissão nacional sobre determinantes sociais da saúde (CNDSS). Brasília(DF): Ministério da Saúde, 2008.
16. Lacerda TC, Souza FMD, Prado TND, Locatelli, RL Fregona G, Lima RDCD, Maciel EL. Infecção por tuberculose entre profissionais de saúde da atenção básica. J Bras Pneumol.,2017 [cited 2021 Dec 15]; *43:*416-23. DOI: https://doi.org/10.1590/s1806-37562016000000211.
17. Prado, TND, Riley, LW, Sanchez, M, Fregona, G, Nóbrega, RLP, Possuelo, LG, Maciel, ELN. Prevalence and risk factors for latent tuberculosis infection among primary health care workers in Brazil. Cad Saúde Pública. 2017 [cited 2021 Dec 12]; 33(12):e00154916. DOI: https://doi.org/10.1590/0102-311X00154916.
18. Martínez HD, Borroto GS, Arroyo RL, González OE. Evaluación de riesgo de infección tuberculosa latente en trabajadores de la Atención Primaria de Salud. Rev Cubana Med Trop. 2015 [cited 2021 Dec 15]; *67*(1):11-19. Available from: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0375-07602015000100002.
19. Drobniewski F, Balabanova Y, Zakamova E, Nikolayevskyy V, Fedorin I. Rates of latent tuberculosis in health care staff in Russia. PLoS medicine, 2007 [cited 2021 Dec 16]; 4(2):0273-9. DOI: http://dx.doi.org/10.1371/journal.pmed.0040055.
20. Souza, FM, Prado, TN, Pinheiro, JDS, Peres, RL, Lacerda, TC, Loureiro, RB, Maciel, ELN. Comparison of interferon-γ release assay to two cut-off points of tuberculin skin test to detect latent Mycobacterium tuberculosis infection in primary health care workers. PLoS One. 2014 [cited 2021 Dec 16]; 9(8):0102773. DOI: https://doi.org/10.1371/journal.pone.0102773.
21. Oliveira JS, Possuelo LG, Severo K, Carneiro M, Krummenauer E, Machado CPH. Avaliação da positividade ao teste tuberculínico entre os trabalhadores da rede básica de saúde. Rev HCPA. 2011 [cited 2021 Dec 17]; 31(1):1-5 Available from: https://seer.ufrgs.br/hcpa/article/view/16311.
22. Machado PM, Valim ARM, Maciel ELN, Prado TN, Borges TS, Daronco A. Comparison of tuberculin test and interferon-gamma release assay for diagnosing latent tuberculosis in Community Health Workers, State of Rio Grande do Sul, Brazil, 2012. Epidemiol Serv Saúde. 2014 [cited 2021 Dec 18]; 23(4):675-81. DOI: https://doi.org/10.5123/S1679-49742014000400009.
23. Borges TS, Sonda EC, Daronco, A, Battisti F, Santos MMB, Valim ARM, Possuelo LG. Prevalência de infecção latente por mycobacterium tuberculosis em profissionais da rede básica de saúde. Ver Bras Prom Saúde. 2014 [cited 2021 Dec 18]; 27(2):269-75. Available from: https://periodicos.unifor.br/RBPS/article/view/2459/0.
24. Moreira TR, Zandonade, E, Maciel ELN. Risco de infecção tuberculosa em agentes comunitários de saúde. Rev Saude Publica. 2010 [cited 2021 Dec 19]; 44*:*332-8. DOI: https://doi.org/10.1590/S0034-89102010000200014.
25. Carrapato P, Correia P, Garcia B. Health determinants in Brasil: searching for health equity. Saude Soc. 2017 [cited 2021 Dec 10]; 26(3):676-89. DOI: https://dx.doi.org/10.1590/s0104-12902017170304.
26. Christopher DJ, Daley P, Armstrong L, James P, Gupta R, Premkumar B, et al. Tuberculosis infection among young nursing trainees in South India. PLoS One. 2010 [cited 2021 Dec 10]; 5:0010408. DOI: https://doi.org/10.1371/journal.pone.0010408.
27. Keskiner R, Ergönül O, Demiroglu Z, Eren S, Baykam N, Dokuzoguz B. Risk of tuberculous infection among healthcare workers in a tertiary-care hospital in Ankara, Turkey. Infect Control Hosp Epidemiol. 2004 [cited 2021 Dec 10]; 25:1067-71. DOI: https://doi.org/10.1086/502345.
28. Weinfurter P, Blumberg HM, Goldbaum G, Royce R, Pang J. Tuberculosis Epidemiological Studies Consortium. Predictors of discordant tuberculin skin test and QuantiFERON-TB Gold In-Tube results in various high-risk groups. Int J Tuberc Lung Dis. 2015 [cited 2021 Dec 19]; 8:1056–61. DOI: https://doi.org/10.5588/ijtld.
29. 29.Lindenau JDR, Guimarães LSP. Calculating the effect size in SPSS. Rev HCPA 2012 [cited 2023 jul 27]; 32(3):363-81. Available from: https://seer.ufrgs.br/hcpa/article/view/33160.
30. Schwartzman K, Loo V, Pasztor J, Menzies D. Tuberculosis infection among health care workers in Montreal. Am J Respir Crit Care Med. 1996 [cited 2021 Dec 10]; 154:1006-12. DOI: https://dx.doi.org/10.1164/ajrccm.154.4.8887599.

DOI: http://dx.doi.org/10.12957/reuerj.2023.68910

31. Pereira AL, Bolzani FC, Stefani M, Charlín R. Uso sistêmico de corticosteróides: revisão da literatura. Med Cutan Iber Lat Am. 2007 [cited 2021 Dec 20]; 35:35-50. Available: https://pesquisa.bvsalud.org/portal/resource/pt/ibc-053909.
32. Menezes AM, Costa JD, Gonçalves H, Morris S, Menezes M, Lemos S, et al. Incidence and risk factors for tuberculosis in Pelotas, a city in the South of Brazil. Rev Bras Epidemiol. 1998 [cited 2021 Dec 21]; 1(1):50-60.DOI: https://doi.org/10.1590/S1415-790X1998000100006.
33. Kritski A, Dalcolmo M, Souza R, Holanda T, Melo F, Gontijo P. Tuberculose entre profissionais de saúde. Risco ocupacional? J Bras Pneumol. 1993 [cited 2021 Dec 10]; 19:113-21. DOI: https://doi.org/10.5216/rpt.v30i1.15788.
34. Mendes M, Trindade LL, Pires DEP, Biff D, Martins MMFPS, Vendruscolo C. Workloads in the family health strategy: interfaces with the exhaustion of nursing professionals Rev Esc Enferm USP. 2020 [cited 2023 jul 27]; 54:e03622. DOI: https://doi.org/10.1590/s1980-220x2019005003622.
35. Al-Jahdhami I. Latent Tuberculosis in healthcare workers: time to act. Oman Med J. 2013 [cited 2021 Dec 23]; 28(2):146-8. DOI: https://dx.doi.org/10.5001/omj.2013.39.
36. Espirito Santo H, Daniel F. Calculating and reporting effect sizes on scientific papers (1): p < 0.05 limitations in the analysis of mean differences of two groups. Rev Port Invest Comport Soc. 2015 [cited 2023 jul 27]; 1(1):3-16. Available from: https://core.ac.uk/download/pdf/49288485.pdf.
37. Nakagawa S, Cuthill IC. Effect size, confidence interval and statistical significance: a practical guide for biologists. Biol Rev Camb Philos Soc. 2007 [cited 2023 jul 27]; 82(4):591-605. DOI: DOI: https://dx.doi.org/10.1111/j.1469-185X.2007.00027.x.

Authors' contributions

Conceptualization, S.A.S.M.B. e T.M.E.A.; methodology, L.F.O.F. e J.A.C.L.; software, L.F.O.F. e J.A.C.L.; validation, S.A.S.M.B.; formal analysis, S.A.S.M.B., T.M.E.A. e I.S.E.F.; investigation, S.A.S.M.B.; resources, S.A.S.M.B.; data curation, S.A.S.M.B., L.F.O.F. e I.S.E.F.; manuscript writing, L.F.O.F.; manuscript review and editing, S.A.S.M.B. e L.F.O.F.; visualization, T.M.E.A.; supervision, T.M.E.A.; project administration, T.M.E.A.; financial support, not applied. All authors have read and agreed to the published version of the manuscript.