

Scenario of scientific production on health technologies in the context of latent tuberculosis

HIGHLIGHTS

1. The year 2022 was the most productive.
2. The documents were published in 133 data sources.
3. The United States has excelled in scientific production.
4. The most common terms were "tuberculosis" and "latent tuberculosis".

Reinaldo de Souza Guimarães¹ 
Marcia Helena Machado Nascimento¹ 
Bruna Renata Farias dos Santos¹ 
Sara Valena do Rosário Sales Miranda¹ 
Lucrecia Aline Cabral Formigosa¹ 
George Pinheiro Carvalho¹ 
Rubenilson Caldas Valois¹ 

ABSTRACT

Objective: To analyze scientific production on the use of health technologies in the context of latent tuberculosis. **Method:** A descriptive, quantitative study with bibliometric analysis, carried out in the Scopus and Web of Science databases in December 2024, with descriptive statistical analysis and application of bibliometric laws based on the *Bibliometrix* package in *Script R®*. **Results:** 176 studies were identified, with a peak in production in 2022; of these, 159 studies were published in scientific article format and 156 in English. Wang Y was the most productive author, with 13 published documents. The United States stood out in terms of production by country, and Johns Hopkins University had 15 affiliated authors. The *International Journal of Tuberculosis and Lung Disease* was the primary source of publications. The terms "tuberculosis" and "latent tuberculosis" were the most common terms used to index the documents. **Conclusion:** The behavior of information on the subject has risen.

DESCRIPTORS: Tuberculosis; Latent Tuberculosis; Biomedical Technology; Scientific and Technical Publications; Bibliometrics.

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INTRODUCTION

Tuberculosis (TB) is an infectious disease characterized by infection and subsequent inflammation of the lung tissue, which can also affect other organs. Considering its severity, the causative agent of the disease is *Mycobacterium tuberculosis*, an acid- and alcohol-resistant bacillus that has a high capacity for dissemination and persistence in the human body. It is transmitted by inhalation of aerosols containing the bacillus from infected individuals¹⁻².

It is a condition of great relevance to public health, affecting approximately 80,000 people annually in Brazil, with an incidence rate of 38 cases per 100,000 inhabitants in 2023³. Furthermore, susceptibility to TB is linked to vulnerable populations, especially homeless people, people with Human Immunodeficiency Virus (HIV), people deprived of their liberty, and indigenous people, among others. It is estimated that 10% of people who have been infected with *M. tuberculosis* will become ill, of which 5% in the first two years following infection. 5% over the course of their lives if they do not receive the recommended preventive treatment¹.

Primary TB occurs immediately after infection and is a severe form, but with a low risk of transmissibility. In general, the immune system can contain this infection, at least temporarily, keeping the bacilli inactive (latent) for many years until reactivation occurs, producing the so-called post-primary or secondary TB¹.

In this context, when a healthy person is exposed to the bacillus that causes TB, there is a 30% chance of infection, depending on the degree of exposure, the infectivity of the case, and individual immunological factors. Infected individuals generally remain healthy for many years, developing partial immunity to the bacillus, which characterizes latent *M. tuberculosis* infection (LTBI). This is a period during which there are no symptoms, and the disease is not transmitted; however, it is recognized by tests that detect immunity against the bacillus².

Technology refers to the use of artificial instruments, as well as their design, development, and implementation based on scientific evidence. They are products used to reduce effort and solve existing difficulties in the workplace. The health sector is constantly enhanced by the development of new technologies, which contribute to improving the service provided, enhancing work dynamics, and improving the population's quality of life⁴.

Bibliometrics is an area of study that provides standardized indicators to map various aspects of a field of research in the scientific community, using quantitative methods to analyze scientific literature. In this way, the application of the bibliometric method enables the assessment of productivity and impact of researchers, institutions, and locations, as well as journals and the most frequently used keywords. Additionally, it facilitates the analysis of scientific policies through information on the formulation and implementation of scientific and technological strategies⁵.

Therefore, the development of a bibliometric review aimed at analyzing the scientific production on the use of health technologies in the context of latent TB is justified to understand and critically analyze the current state of knowledge in this field, since ambitious goals have been set for the elimination of TB in the Americas by 2035, which makes the use of health technologies essential, especially in the latent phase of the disease⁶.

METHOD

This is a descriptive, bibliographical, quantitative study based on bibliometric analysis. Quantitative research aims to determine indicators and trends present, in other words, representative and objective data, with systematic distrust of evidence and immediate experience⁷.

Descriptive studies express reality and are fundamental when there is little information on a given topic⁸. This aligns with the bibliometric study, which aims to tabulate the frequency of scientific studies produced over a given period on a specific subject.

Bibliometrics is based on the principle of analyzing scientific or technical activity through quantitative studies of publications. In this approach, quantitative data is obtained through statistical counts of publications or elements using various statistical techniques. The aim is to quantify written communication processes⁹.

Thus, bibliometric studies provide information on the number of authors, papers, countries, or journals in each productivity category. This method aims to quantify, describe, and forecast the process of written communication, enabling the evolution of literature and knowledge to be observed over time. Consequently, the study presents the state of the art of knowledge¹⁰.

Data were collected from the Scopus and Web of Science databases, as well as the CAPES (Coordination for the Improvement of Higher Education Personnel) Journal Portal, in December 2024. The first stage of the research involved establishing the problem, a stage guided by the question formulated using the PICo technique, in which P (person/problem), I (interest), Co (context)¹¹. In this case, "P" is characterized by latent tuberculosis; 'I' is expressed by technologies, and "Co" relates to health. Establishing the following research question: What is the scenario of scientific production on the use of health technologies for latent tuberculosis?

To gather scientific productions pertinent to the subject under study, standardized terms from the Medical Subject Headings (MeSH) platform in English were used, via an advanced search (including titles, abstracts, and keywords) in each of the databases. The Boolean operators "AND" and "OR" were used to optimize the search results, corresponding to the following search strategy: ("Infection, Latent Tuberculosis" OR "Infections, Latent Tuberculosis" OR "Latent Tuberculosis" OR "Latent Tuberculosis Infection" OR "Latent Tuberculosis Infections" OR "Tuberculosis, Latent" OR "Tuberculosis Infection, Latent" OR "Tuberculosis Infections, Latent" OR "Tuberculosis, Latent") AND ("Technology" OR "Technologies" OR "Technology, Health" OR "Technology, HealthCare" OR "Health Care Technology" OR "Health Technology" OR "Medical Technology").

A total of 214 documents were identified in the databases above, with the inclusion criterion being the period from first production to November 2024. The files were retrieved in *BibExcel* format, and the data were then consolidated and standardized using the *Bibliometrix* package in *Script R®*, making it possible to exclude 38 duplicate studies.

The program enabled the conduct of descriptive analyses of the documents, based on the evaluation of metric indicators that covered the volume of publications over time, the languages used, and the definition and classification of production typologies. It also included the data sources used and the associated impact factors. The most

productive authors were also identified, along with characteristics related to the country of origin of the studies and institutional affiliation. Finally, the keywords used to index the documents in the databases were analyzed. Approval from the Research Ethics Committee was not required, as this research is based on data obtained directly from databases.

RESULTS

The research resulted in a total of 176 publications distributed as follows: 123 in *Scopus* and 53 in *Web of Science*. Figure 1 shows that the first publication occurred in 2003, with productivity peaks between 2018 and 2022, the latter being the most productive year. It can also be seen that treatment of the subject has risen considerably in the last decade, with 96 publications representing approximately 54.55%.

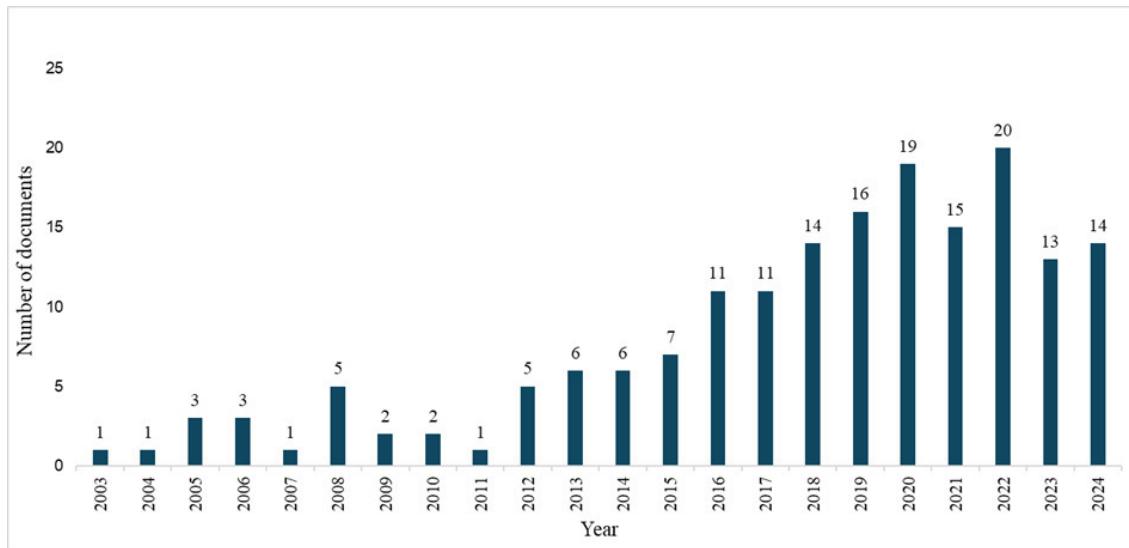


Figure 1. Annual distribution of publications related to the use of health technologies for latent tuberculosis, 2003-2024. Belém, PA, Brazil, 2024

Source: The authors (2024).

When analyzing the publications according to their language of origin, a decreasing distribution was observed, as follows: English (156), Russian (8), Chinese (7), Japanese (3), Italian (1), and Portuguese (1). The formats in which the documents were presented were as follows: original articles (104), review articles (55), conference papers (9), editorials (3), short research papers (3), and book chapters (2).

Based on the research data, the analysis of the 176 documents revealed 1,221 different authors, considering authorship and co-authorship. The applicability of Lotka's Law showed the following distribution of authorships: one author has 13 publications, another has 11 publications, three authors have 10 documents each, one author has produced nine studies, six authors have published eight documents each, three authors have seven publications, five authors have participated in six documents, five authors have contributed five publications, 25 authors have published four studies each, 25 authors have published three publications each, 241 authors have published two documents, and, finally, 899 authors have only one publication.

Figure 2 illustrates a breakdown of the most productive authors in the field of utilizing health technologies for latent TB, specifically those who have published seven or more documents.

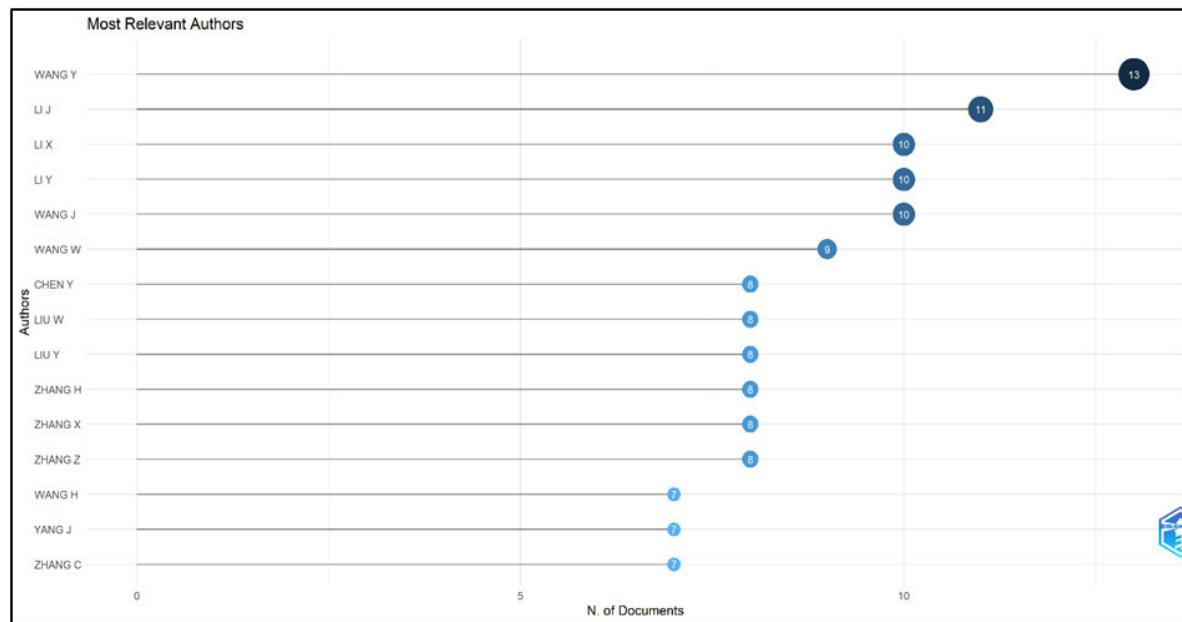


Figure 2. Most productive authors regarding the use of health technologies for latent tuberculosis, 2003-2024. Belém, PA, Brazil, 2024

Source: The authors (2024).

Figure 3 illustrates the evolution of scientific production by country over the years, highlighting that the first contribution was registered in 2003, coming from the United States. There has also been a continuous increase in the number of publications by American authors, demonstrating their current leadership in advancing scientific research and disseminating knowledge.

Concerning the institutional affiliation of the authors, the 10 most prominent institutions within the thematic field were identified, organized according to the number of publications associated with each of them: *Johns Hopkins University* (15), *University of California - San Francisco* (eight), *University College London* (eight), *University of Cape Town* (eight), *Chinese Academy of Medical Sciences and Peking Union Medical College* (six), *Fudan University* (six), *Makerere University* (six), *University of Groningen* (six), *Capital Medical University* (six) and *Monash University* (five).

Bradford's Law uses a zoning approach, where each zone corresponds to approximately 33.3% of the total number of documents, and is organized into three parts: core (those that contribute most to the subject), first zone (intermediate production), and second zone (reduced production). From the analysis of the 176 publications, 133 different data sources were identified, revealing that each zone contains around 58 documents. As a result, the core of scientific production on the subject comprises 18 data sources, all of which are scientific journals, containing 58 studies, which represent 32.95% of the total.

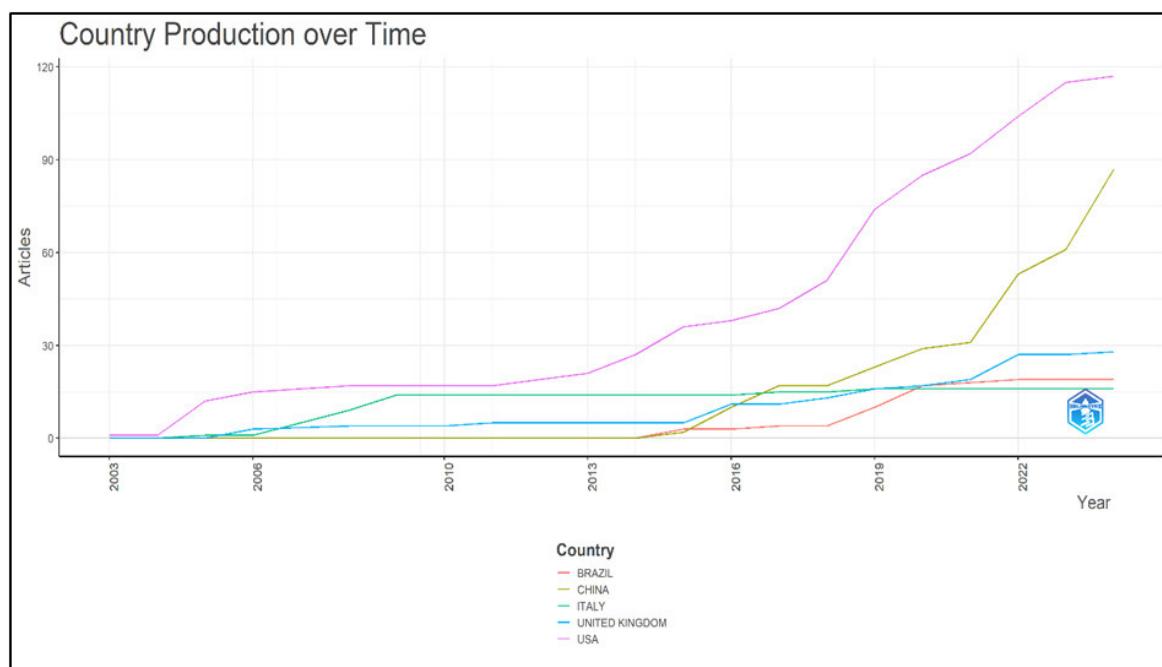


Figure 3. Scientific production by country over time regarding the use of health technologies for latent tuberculosis, 2003-2024. Belém, Pará, Brazil, 2024

Source: The authors (2024).

Table 1 below presents, in descending order, the 18 sources that comprise the core of scientific production related to the use of health technologies for latent tuberculosis, including the names of the journals, the number of publications, and their respective impact factors. This is calculated using the Citescore for the year. 2023.

Table 1. Journals present in the core production regarding the use of health technologies for latent tuberculosis, between 2003-2024. Belém, PA, Brazil, 2024

Order	Journals	Productions (n)	Citescore (2023)
1	<i>International Journal of Tuberculosis and Lung Disease</i>	6	4.9
2	<i>The Lancet Infectious Diseases</i>	5	60.9
3	<i>Tuberculosis</i>	5	4.6
4	<i>The Lancet</i>	4	148.1
5	<i>Frontiers in Microbiology</i>	4	7.7
6	<i>PLoS ONE</i>	4	6.2
7	<i>Chinese Journal of Antituberculosis</i>	4	0.5
8	<i>Clinical Infectious Diseases</i>	3	25.0
9	<i>International Journal of Infectious Diseases</i>	3	18.9
10	<i>Scientific Reports</i>	3	7.5
11	<i>Indian Journal of Tuberculosis</i>	3	2.8
12	<i>European Respiratory Journal</i>	2	27.5
13	<i>EBioMedicine</i>	2	17.7
14	<i>Journal of Medical Internet Research</i>	2	14.4
15	<i>Expert Review of Anti-Infective Therapy</i>	2	11.2
16	<i>Clinics in Chest Medicine</i>	2	9.1
17	<i>Frontiers in Cellular and Infection Microbiology</i>	2	7.9
18	<i>Expert Review of Respiratory Medicine</i>	2	6.8
Total		58	

Source: The authors (2024).

The journal most used by the authors to publish their research was the *International Journal of Tuberculosis and Lung Disease*, with 6 publications and an impact factor of 4.9. In terms of impact factors, *The Lancet* and *The Lancet Infectious Diseases* stood out, with impact factors of 148.1 and 60.9, respectively.

Figure 4 illustrates the representation of Zipf's Law, based on the occurrence of terms used to index documents in the databases, allowing for the visualization of words hierarchically in terms of percentage and frequency of use using a *TreeMap*. In this sense, we have the prerogative that a limited number of words are used many times, while many terms are presented only a few times.

The high occurrence of the terms "tuberculosis", "latent tuberculosis", and "mycobacterium tuberculosis" underlines the central importance of TB and, more specifically, its latent presentation, as an object of study. The absence of terms related to health technologies is noteworthy, inferring that their presentation is carried out in the background by the authors.



Figure 4. TreeMap of keywords related to the use of health technologies for latent tuberculosis, between 2003 and 2024. Belém, PA, Brazil, 2024

Source: The authors (2024).

DISCUSSION

The scientific production identified shows that research into technology-mediated LTBI is a relatively recent field, with the first study published only in 2003. The first published study evaluated the impact of implementing guidelines based on electronic medical records in the screening of patients with latent TB in a comprehensive healthcare system. It demonstrated the initial effect of computerization on health services and the contribution of more agile and standardized screening processes, with potential implications for the early detection of diseases¹².

The temporal analysis revealed that scientific production on the subject increased significantly during the decade from 2011 to 2020, with a peak in 2022, comprising 20

studies, accounting for 11.36%. The growing production reflects both the consolidation of global policies to tackle TB⁶ and the expansion of access to technological tools for tracking and following up cases, together with the increased interest of the scientific community and health professionals in the approach to the use of health technologies for latent TB, which is relevant to the diagnosis, tracking, treatment, and post-treatment follow-up of the disease, as well as contributing to the management, care, and educational aspects involved in the health-disease process of individuals¹³.

The peak of publications observed in 2022 may be directly related to the impact of the adaptations and changes in the health system brought about by the COVID-19 pandemic, caused by the SARS-CoV-2 virus. This required increased investment in technological solutions to qualify the scope of health actions and surveillance, whether sanitary, epidemiological, or environmental, which implies controlling other infectious diseases, especially TB¹⁴.

The growing treatment of LTBI indicates its relevance in the public health scenario, considering the magnitude of the pathology in Brazil and worldwide, since around 25% of the world's population is infected by *M. tuberculosis*¹⁵. This scenario highlights the importance of understanding health technologies, which can be categorized as hard, soft-hard, or soft. Technological equipment, norms, and routines, as well as organizational structures, are integral to complex technologies. In contrast, soft technologies encompass clinical protocols and therapeutic guidelines based on evidence. Ultimately, soft technologies are products of communication, autonomy, bonding, and welcoming—fundamental elements for managing TB within the health system¹⁶⁻¹⁸.

The analysis of the publications indicated that English was the primary language of origin, reflecting the centrality of this language for global scientific collaboration and communication. Its importance for sharing knowledge¹⁹, particularly in the context of latent TB and health technologies. Linked to this is the prevalence of document presentation formats for generating data and synthesizing knowledge through articles, whether original or review, as these types have greater visibility and a standardized structure²⁰.

Given the applicability of Lotka's Law, a select group of authors was found to be responsible for the highest productivity among the others. Thus, this prerogative suggests that most scientific documents originate from a limited number of authors, while many authors contribute a smaller proportion to scientific production. To this end, the authors Wang Y (13), Li J (11), Li X (10), Li Y (10), Wang J (10), Wang W (nine), Chen Y (eight), Liu W (eight), Liu Y (eight), and Zhang H (eight) stood out as being the most productive in health technologies for latent TB. They featured in 95 productions when analyzed individually in terms of authorship.

In the scientific production of countries over time, it has been observed that many authors originate from the United States, reflecting the American predominance as a central element in the generation and dissemination of scientific knowledge in this field. This was evidenced in a bibliometric study on LTBI²². On the other hand, several countries, including Brazil, China, Italy, and the United Kingdom, are gaining prominence on the global scientific scene, expanding the production of studies in various epidemiological contexts, which could alter this dynamic in the years to come.

Additionally, Johns Hopkins University in the United States has distinguished itself as one of the most influential institutions in research on health technologies for latent tuberculosis. Other American institutions, along with research centers in China, the United Kingdom, the Netherlands, Australia, South Africa, and Uganda, also stood out

on the scientific scene, albeit in the background. In this case, various research and teaching establishments are producing knowledge on LTBI, thereby contributing to the internationalization of this thematic field²².

Considering Bradford's Law, the data collected showed the existence of a core of specialized data sources on the subject in question, as well as the diversity of sources with a smaller number of documents published on the subject. Thus, the degree of relevance of the sources working in the area studied was estimated, primarily expressed by scientific journals. In this way, the journals with the highest number of published articles on a given subject tend to establish a core of supposedly higher quality and greater relevance. Thus, the *International Journal of Tuberculosis and Lung Disease* stands out as one of the leading journals used for publications in area²¹.

Alongside Bradford's Law, bibliometric indicators assess the impact and visibility of journals through the relationship between the number of citations and the number of scientific publications²³, one of the metrics being the CiteScore. The CiteScore, provided by Scopus, is a systematic tool for evaluating and comparing journals in various scientific areas. It is calculated by adding up the citations received by articles published in the journals over three years, then dividing by the total number of documents published during the same period, resulting in the journal's impact in the year of evaluation²⁴.

Based on the evaluation of the impact factor of the journals present in the core of scientific production on the subject, using CiteScore, it was possible to identify their importance to the scientific community. The Lancet, The Lancet Infectious Diseases, and Clinical Infectious Diseases had the upper hand, with 148.1, 60.9, and 25.0, respectively. This illustrates the relationship between productivity, measured by the number of publications, and the impact of data sources, as well as the factors that influence authors' choices for disseminating knowledge about health technologies in the context of latent TB²⁵.

Zipf's Law establishes a relationship between the frequency of keywords and the order of classification of themes in texts, describing how the frequency of occurrence of a word is directly related to its position in the ordered list. Thus, it becomes possible to estimate the most recurring themes in a field of knowledge. The primary objective of the law is to quantify the frequency of words, thereby generating an ordered list of the most frequent terms²⁶.

As Zipf points out, identifying the most frequently used terms is crucial to determining the central theme of a document, making it easier to assign these terms appropriately during the indexing process²⁷. Thus, a comprehensive overview of the focuses of interest and research in the scientific literature was evident, with a high frequency of the terms "tuberculosis", "latent tuberculosis", and "Mycobacterium tuberculosis", highlighting the central importance of TB, primarily associated with LTBI. However, the absence of terms related to health technologies suggests that these issues are addressed secondarily.

Bibliometrics is a fundamental area of knowledge for identifying new areas of research and emerging topics related to the topic in question²⁸, in this case, the scenario of health technologies for latent TB. Based on the indicators studied, this overview presents the trends, dispersion, and gaps in the studies, exploring the technologies used for screening, diagnosis, health education, treatment, follow-up, and post-treatment in LTBI. These technologies include equipment, procedures, drugs, vaccines, and organizational and operational systems²⁹.

The knowledge and involvement of technologies, in their various forms, are fundamental to addressing the disease, especially among groups that are more susceptible to illness. This includes people living with HIV, immunosuppressive treatment, malnutrition, smoking, and health professionals, among others. In Brazil, there is the National Health Technology Management Policy (PNGTS, in Portuguese) and the National Plan to End Tuberculosis as a Public Health Problem. PNGTS subsidizes the structure of incorporating health technologies into health systems and services, consequently helping to control TB, since the incorporation of technologies qualifies health actions²⁹⁻³⁰.

The limitations of this study may be related to the use of secondary data, which introduces the risk of errors in cataloging and the fragility of publications. Furthermore, the search strategy employed, which utilizes descriptors and Boolean operators, may impact on the effectiveness of the algorithm in retrieving studies and, consequently, the number of identified documents, as there is no entirely effective search *string*. Finally, the use of the Bibliometrix package in Script R can impose technical restrictions, particularly in the automation of filters that may exclude unexpected data, thereby influencing the analyzed dataset.

CONCLUSION

The research revealed that publications on the use of health technologies in the context of latent TB have increased over time, reflecting the growing interest of the scientific community in this subject. Although limited, this trend is essential for health professionals and health agencies, particularly in recognizing the presentations of the infection, diagnostic methods, and treatment regimens. These underpin actions to promote and prevent this health problem, as well as care for these individuals.

The profile of the productions showed that the English language predominates in the process of communication and scientific collaboration, allowing knowledge to be disseminated on a large scale. Likewise, publications in the scientific article format stand out, as this is the primary method researchers use to communicate the results of their research. Other bibliometric indicators evaluated made it possible to highlight the dispersion of countries and research centers, with the United States and *Johns Hopkins University* standing out as having the highest rates of involvement in the subject.

Given the applicability of bibliometric laws, it was possible to recognize that the author Wang Y had the highest number of publications, showing high prestige in this area of knowledge. We also examined the primary data sources utilized by the authors to disseminate information, as well as their influence on the scientific community, as measured by CiteScore. The evaluation of the ranking of terms revealed a close relationship with the research object but lacked the specificity of words referring to technologies in the indexing of studies.

Finally, the study makes significant contributions by presenting bibliometric indicators and the landscape of scientific communication on health technologies for latent TB. This highlights the need to encourage research and development on the subject both nationally and internationally, thereby promoting the incorporation and advancement of new technologies to address the health-disease process.

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Corresponding author:

Reinaldo de Souza Guimarães

Universidade do Estado do Pará

Avenida José Bonifácio, 1289, Guamá – Belém / PA – 66063-425

E-mail: reynaldo_guimaraes@hotmail.com

Role of Authors:

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Guimarães RS, Nascimento MHM, dos Santos BRF, Miranda SVRS, Formigosa LAC, Carvalho GP, Valois RC. Drafting the

work or revising it critically for important intellectual content - **Guimarães RS, Nascimento MHM, dos Santos BRF, Miranda**

SVRS, Formigosa LAC, Carvalho GP, Valois RC. Agreement to be accountable for all aspects of the work in ensuring that

questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved - **Guimarães RS,**

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