



Research article

Research priorities and trends in pulmonary tuberculosis in Latin America: A bibliometric analysis

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ABSTRACT

Tuberculosis (TB) poses a significant global public health challenge, particularly in developing countries. Over the years, scientific research has played a pivotal role in addressing this disease. In this study, we aimed to analyze and outline the trends in scientific output on TB and identify research priorities in Latin America (LA) from 1990 to 2021. Scientific production was analyzed, and the number of publications, financing sources, and journal characteristics were evaluated. Collaboration networks and keywords were visualized using mapping analysis with VOSviewer software. Research themes were prioritized by country based on co-occurrence frequency. In total, 4399 documents were identified, a significant trend was evident in the number of publications per year ($R^2 = 0.981$), and research substantially contributed to the reduction of TB-related mortality ($R^2 = -0.876$). Most publications were original articles (83.8 %). The *International Journal of Tuberculosis and Lung Disease* had the highest publication and citation rates per document. International collaboration was predominantly with the United States, France, and Canada. Brazil, Argentina, and Mexico had the highest number of publications and external collaborations. In LA, interest in researching studies related to treatment and diagnosis (32.5 %) was notably high, followed by epidemiology and screening (26.9 %). Among the 20 countries in LA, research priorities varied, with the highest emphasis on HIV/AIDS (14/20), epidemiology (9/20), anti-TB agents (6/20), and mortality (5/20). TB resistance was only considered a research priority in Brazil, Peru, and Haiti. Therefore, LA experienced significant growth in its scientific output, playing a crucial role in TB control. Strategic adaptation to the region's specific challenges was observed, particularly in HIV/AIDS coinfection, epidemiological studies, and drug resistance. This progress was achieved by outstanding international scientific collaboration. This holistic approach emphasizes the importance of research in the fight against TB in LA.

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1. Introduction

Pulmonary tuberculosis (TB) is a serious public health problem worldwide and is caused by *Mycobacterium tuberculosis*. According to World Health Organization (WHO) Global TB 2021, it was the leading cause of death from infectious diseases, with 1.6 million and an incidence of 10 million new cases [1]. Meanwhile, according to the Global Burden of Disease, Latin America (LA) recorded over 169,000 cases of pulmonary TB and 18,000 related deaths in 2019 [2].

In recent years, the mortality and incidence of TB have declined, with a reduction of <4 %; however, the burden of this disease remains significantly higher than those of other infectious diseases because of its complexity and characteristic epidemiological factors [3–5]. In this context, since 2015, the WHO has set a goal to reduce the incidence and mortality of TB by 90 % and 95 %, respectively, with the aspiration of achieving its eradication by 2030 [6]. Enhancement of research and development (R&D) of technological innovations specific to TB are two of the fundamental axes to meet this goal.

TB remains a persistent challenge for public health in LA, demanding a strategic approach in research to mitigate its spread and effect effectively. The complexity of TB is exacerbated by the socioeconomic conditions of the region and the prevalence of drug-resistant strains, highlighting the pressing need for research that addresses both biological and social determinants [7]. The development of more efficient and accessible diagnostic tools that facilitate early detection, particularly in rural areas, and the exploration of new therapeutic approaches that include shorter treatments and effective vaccines for adults to improve treatment adherence and counteract drug resistance to anti-TB drugs are crucial [8]. Simultaneously, investigating how factors such as poverty, urbanization, and migration affect TB transmission is crucial in designing public health interventions that address the underlying causes of vulnerability in at risk populations, promoting equitable access to health services [9,10].

In this context, a bibliometric study on TB in LA emerges as an essential tool, offering a detailed overview of the current state and research trends on this disease in the region. Such analysis would identify underexplored research areas, facilitate optimal resource allocation, and foster strategic collaborations [11,12]. In addition, by analyzing mortality and collaborative networks, the research effect on TB could be determined. This approach would shed light on scientific advancements and outstanding needs and establish a solid foundation for policy and funding decisions, accelerating progress toward eradicating TB in the region and contributing to the global effort against it [13].

In this study, we aimed to comprehensively analyze and describe in detail scientific research on TB in LA from 1990 to 2021. In addition, we sought to identify key research priorities and map the network of scientific collaborations within this area to contribute to a broader understanding and cooperative efforts against TB.

2. Materials and methods

2.1. Study design and database

A bibliometric study of documents published between 1990 and 2021 in journals indexed in Scopus was performed. The search encompassed documents published in 1990 because this year corresponds to the first efforts of the WHO to reduce the incidence of TB

Table 1
Search strategy for tuberculosis research in Latin America on Scopus.

#	Search strategy	Result
A	#1 (TITLE-ABS-KEY (tuberculos*) AND TITLE-ABS-KEY (pulmonary OR consumption* OR silico OR bronchus OR lung OR cavernous OR "pulmonary consumption")) OR TITLE-ABS-KEY (phthis* W/2 pulmonary) OR TITLE-ABS-KEY (lung W/1 caseation) OR TITLE-ABS-KEY ("tuberculous pneumonia" OR "infective silicosis" OR pneumonophthisis) #2 (TITLE-ABS-KEY (pulmonary W/4 tuberculosis) AND TITLE-ABS-KEY (drug* OR treatment OR therapeutic*)) #3 AFFILCOUNTRY (argentina OR bolivia OR brazil OR chile OR colombia OR "Costa Rica" OR cuba OR ecuador OR "El Salvador" OR guatemala OR haiti OR honduras OR mexico OR suriname OR nicaragua OR panama OR paraguay OR peru OR "Puerto Rico" OR "Dominican Republic" OR uruguay OR venezuela OR "Latin America" OR caribbean) #4 (PUBYEAR >1989) AND (LIMIT-TO (SRCTYPE,"j")) AND EXCLUDE (PUBYEAR,2022) #4 #1 OR #2 #5 #4 AND #3	4.399
	MULTIDRUG RESISTANT TUBERCULOSIS	
B	#1 (TITLE-ABS-KEY (Tuberculosis or TB) AND TITLE-ABS-KEY (Multidrug W/2 Resistant)) OR TITLE-ABS-KEY (Tuberculosis W/2 MDR) OR TITLE-ABS-KEY (TB w/1 MDR) OR (TITLE-ABS-KEY(Tuberculosis or TB) AND TITLE-ABS-KEY(multiresistant OR multidrug resistant)) #1 AND #5 (A)	448
	EXTENSIVELY DRUG-RESISTANT TUBERCULOSIS	
C	#1 ((TITLE-ABS-KEY(Tuberculosis) AND TITLE-ABS (Extensively OR extremely)) AND TITLE-ABS-KEY (Drug W/2 Resistant)) OR TITLE-ABS(XDR-TB) #1 AND #5 (A)	49
	HUMAN IMMUNODEFICIENCY VIRUS	
D	#1 (TITLE-ABS(HTLV-III) OR TITLE-ABS ("Human Immunodeficiency" w/2 virus) OR TITLE-ABS (AIDS OR HIV)) #1 AND #5 (A)	960
	DIABETES MELLITUS	
E	#1 TITLE-ABS (Diabetes W/2 Mellitus) OR TITLE-ABS(diabetic) or TITLE-ABS("Wolfram Syndrome") #1 AND #5 (A)	219

[14]. It implies that countries in LA would have started political decisions to face this problem that year.

Scopus was chosen because of its indexing capacity, which includes high-quality journals and multidisciplinary subjects. Furthermore, all of these journals are also indexed in Medline and Embase. Finally, this will allow the creation of bibliometric indicators from an analysis system that complements the ones at SCImago Journal Rank (SJR) [15].

2.2. Searching strategy

The search strategy was developed from the Medical Subject Headings as “Tuberculosis, Pulmonary”, or “Pulmonary Phthisis”. The publications were also limited to at least one author affiliated with a Latin-American country using the terminology “AFFILCOUNTRY” and one journal-type source (SRCTYPE, “j”). The complete search strategy is presented in Table 1.

2.3. Data analysis

The dataset was exported to Microsoft Excel 365 with predefined settings. Bibliometric indicators were outlined, including (1) the number of annual publications, (2) scientific output by country, (3) types of publications, (4) sponsor, and (5) journal metrics as available in SCImago-Scopus, encompassing quartile rankings, SCImago Journal Ranking (SJR), and CiteScore. These indicators provide insights into the overall ranking of journals (from Q1 to Q4), assess citations based on their significance, and deliver a comprehensive overview and transparency regarding their impact (CiteScore). A graph was generated to represent the number of papers published concerning TB incidence and mortality rates for 2022. This was performed using data available from the WHO (available at <https://vizhub.healthdata.org/>) or through the mobile application of the TB Report 2023.

Data analysis was systematically displayed using tables and graphical representations, which detailed the frequency and percentage of various metrics. A Pearson correlation analysis was employed to delve deeper into the trends of the publications over time. This statistical method allowed for a quantitative assessment of the relationship among the years of publication, number of documents, and mortality rate, providing insights into any significant trends or patterns that emerged during the specified period. Student’s t-test was also used to evaluate the differences in the number of publications across different years within the selected range. This test helped identify any statistically significant variations in publication outputs from year to year. For this analysis, a p-value of <0.05 was established as the threshold for statistical significance.

Using data from the study, two maps were generated with VOSviewer version 1.6.6 (Leiden University, Netherlands). The first is a scientific collaboration map between regional and extraregional countries on TB publications. From this data, the intraregional collaboration and the number of publications that share coauthors with the five countries outside LA that published the most were calculated. To enrich our analysis of the collaboration network map, SciVal, an advanced online platform that leverages bibliometric data from Scopus, was utilized [16]. This generated Table S3, which describes the percentage of national and international collaborations between 2012 and 2021.

The second map is a co-occurrence map based on keywords extracted from Scopus. The software constructed a similarity matrix among the network elements to generate the clusters. These data were then exported to Microsoft Excel, where two coauthors conducted a normalization process using thesaurus methods to enhance the interpretation of the relationships. Each keyword was assigned to its respective group—epidemiology and screening, treatment and diagnosis, immunology and bacterial Genetics, and comorbidities and complications—through consensus among three coauthors: an epidemiologist, a pulmonologist consultant in TB, and an internist. This collaborative process ensured an accurate and relevant classification. After the assignment and data normalization, they were exported to a text file (.txt) using the tabulation format for delimitation. This file served as a condition for generating the clusters, leading to a more representative graph.

An individualized search strategy was implemented for each country to determine research priorities in countries in LA. Then, the top five research priorities were identified by analyzing the frequency of the occurrences of key terms and their relevance, measured by the total link strength. This metric reflects the strength of the connections between keywords within coexistence networks, and these values were obtained using VOSviewer. This approach allowed us to highlight the most interesting and connected topics within each country’s scientific field. The files used to generate the map graphics are available in the open-access repository Figshare with the digital object identifier 10.6084/m9.figshare.25529956[17].

The interpretation of the graph relies on several crucial elements: 1) Nodes, whose size reflects the importance of each component, as determined by the number of documents or the frequency of keywords. 2) Proximity to the center, indicating a node’s level of connectivity; nodes closer to the center have more connections, which facilitates collaboration and information flow among various nodes. 3) Colors, which distinguish clusters by grouping nodes with similar characteristics or related thematic areas. 4) Connections, where each line between nodes signifies collaborative relationships or citations among documents; the line’s thickness indicates the strength of the connection. Nodes that are closer together suggest a higher degree of similarity. 5) Clusters, which represent specific thematic areas within a field of study or documents that address related topics [18].

2.4. Ethics considerations

The data were downloaded from available published research, thereby no ethics approval was required.

3. Results

The preliminary search yielded a total of 131,704 TB-related documents. Within the scope of countries in LA, a subset of 4399 documents was also analyzed (Fig. 1).

A strong and statistically significant positive correlation was observed between the number of publications and the year of publication, with a correlation coefficient (R^2) of 0.981 and a p-value of <0.001. The annual average of publications was 137 documents, with a growth rate of 11.9 % per year, and most of the publications were published between 2020 and 2021 (Fig. 2-A). Of all documents, the most researched topic is TB in relation to HIV/AIDS (with 25.1 %), followed by multidrug-resistant TB (MDR-TB) (22.5 %), diabetes mellitus (5.1 %), and extensively drug-resistant TB (XDR-TB) (2.4 %) (Fig. 2-B)

In the last 12 years, scientific production significantly increased ($P < 0.001$; mean difference, 344) by up to 3.3 times compared with 1990–2009. Thus, the highest percentage of publications were original articles (83.8 %) and review articles (8.1 %) (Table S1).

Table 2 analyzes the 10 journals with the highest publication counts on TB research in LA from 1990 to 2021. The findings were as follows.

- Six of the ten journals analyzed were based in LA. USA had the highest quartile score (Q1), and the rest of the journals belonging to LA had lower scores (Q3 = 3/6, Q4 = 2/6). Notably, *Memórias Do Instituto Oswaldo Cruz* attained a Q2 ranking, distinguishing itself within the region.
- The *International Journal of Tuberculosis and Lung Disease* obtained the majority of publications and citations for the published documents (23.4).
- *BMC Infectious Diseases* secured the highest SJR score of 1.042. Meanwhile, *Plos One* emerged as the most cited journal, boasting an average of 5.6 citations per article, as indicated by its CiteScore metrics.
- Moreover, journals originating outside LA demonstrated an international collaboration rate ranging from 28.9 % to 59.7 %. In contrast, journals within LA exhibited a significantly lower minimum collaboration rate of 10.5 %.

Extraregional collaborations were mainly with the USA, the UK, France, Canada, and Spain (Table S2). All 56 of the 170 countries with a minimum of 10 publications were registered. Fifteen were countries in LA. The most prolific countries were Brazil, Mexico, and Argentina (Fig. S1). The central network of collaborations was in Brazil (51), Argentina (48), Peru (48), Mexico (47), and Chile (47). Guatemala (12) and Paraguay (11) demonstrated minor collaboration, and the interregional association between countries in LA was low (Fig. 3). Between 2012 and 2021, publications with extraregional collaboration accounted for 43 % of the total and had a significant effect in terms of citations, with a field-weighted citation impact (FWCI) of 3.68. Conversely, publications with only authors from the same country accounted for 35 % but had a below-average citation impact, with an FWCI of 0.49 (Table S3).

In the top 10 countries in LA, Haiti recorded the lowest scientific output and the highest TB incidence in 2022, with 154 cases per 100,000 inhabitants. Conversely, Peru recorded the highest TB mortality rate, with 15 deaths per 100,000 inhabitants. In contrast, Cuba, Chile, and Argentina demonstrated the lowest TB incidence and mortality rates, with <30 cases and <1.5 deaths per 100,000

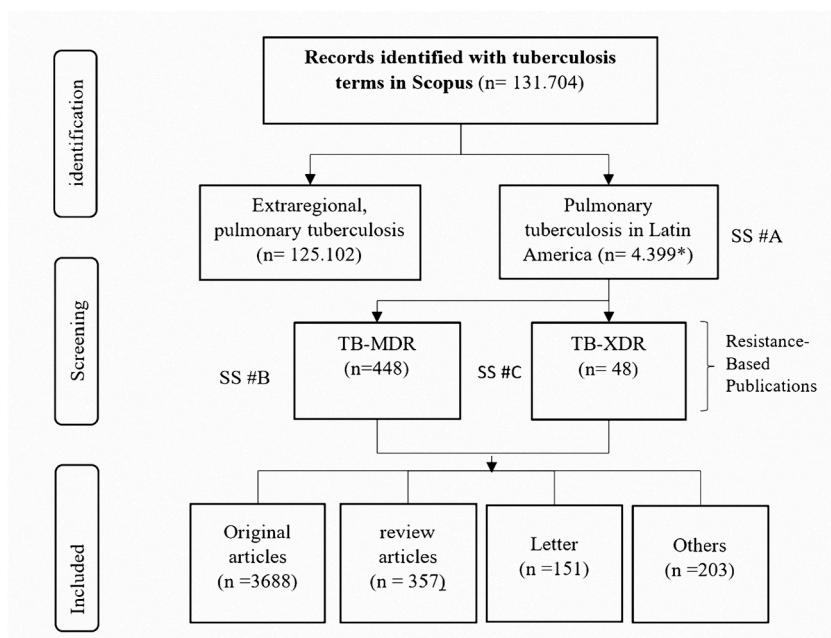


Fig. 1. Flowchart of published studies on pulmonary tuberculosis. Footnote: SS: Search Strategy **: Values obtained by applying limitations on the search terms.

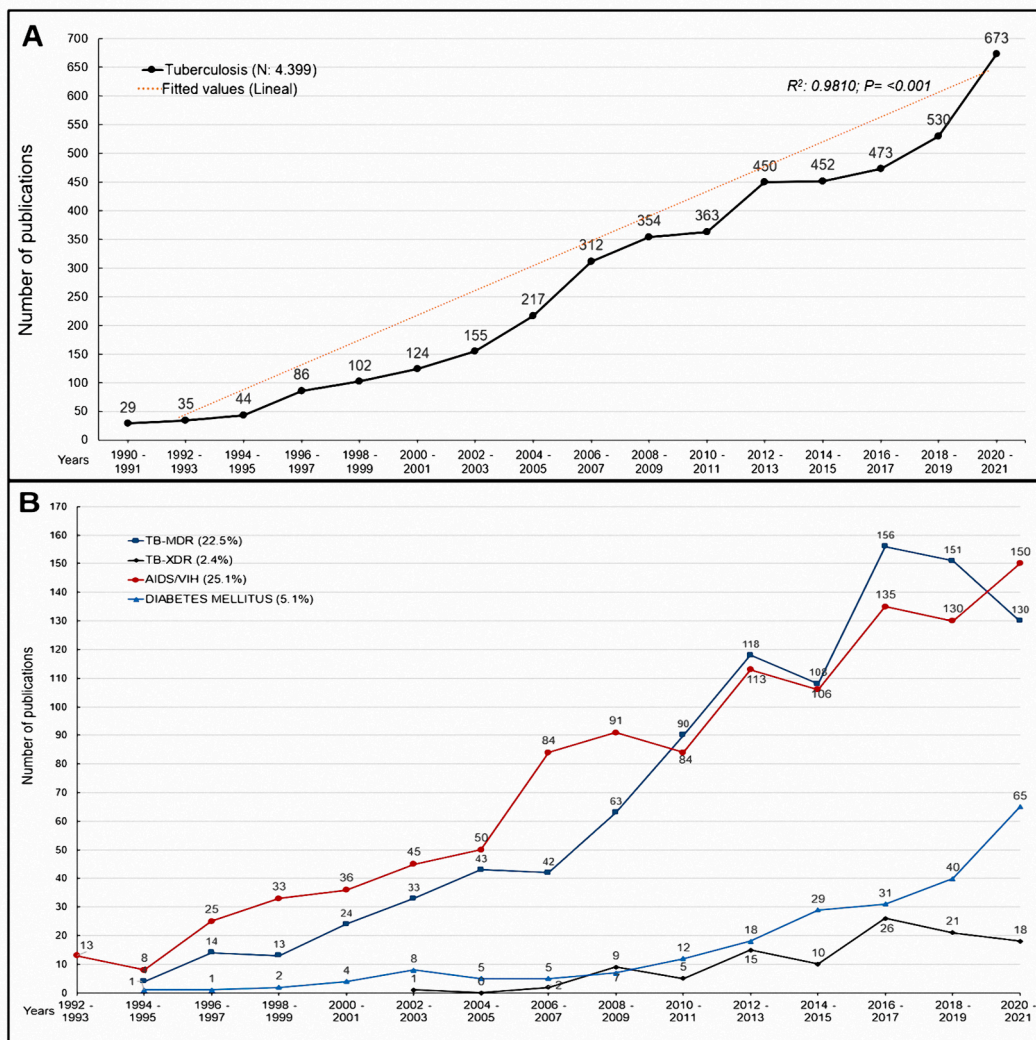


Fig. 2. Trends in the scientific production of Latin American countries on tuberculosis. Footnote: A: Publication trend on Pulmonary Tuberculosis. B: Trend analysis of publications on pulmonary tuberculosis topics.

inhabitants, respectively (Fig. 4-A). A strong and significant association ($R^2 = -0.876$, $p < 0.001$) was identified between TB mortality and the total number of documents published by countries in LA from 1990 to 2019 (Fig. 4-B). Among the countries in LA with <35 publications, Bolivia and Honduras had the highest mortality rates, exceeding 4.5 cases per 100,000 inhabitants (Fig. S2). Cuba, Puerto Rico, and Costa Rica had the lowest incidence and mortality rates in LA.

Moreover, 120 of 19,545 keywords were used in 4399 documents, with a minimum of 20 occurrences. These were then organized and presented in groups as determined by the number of occurrences. Studies based on TB in LA were divided as follows: group 1, comorbidities and complications (2893 occurrences; 17.7 %); group 2, epidemiology and screening (4400; 26.9 %); group 3, treatment and diagnosis (5320; 32.5 %); and group 4, immunology and bacterial genetics (3768; 23 %). Keywords were identified within the groups with the highest number of occurrences. In group 3, the most studied were drugs such as rifampicin and ethambutol and multidrug-resistant TB; as a diagnosis, the tuberculin test, sputum culture, and bronchoalveolar lavage were found. In group 2, studies were presented more frequently in the adolescent and older adult population, and the control and transmission of TB were the main topics of epidemiological surveillance. In group 4, regarding immunology, enzyme-linked immunosorbent assay, and tumor necrosis factor alpha, the analysis of atypical mycobacteria was the most studied. In group 1, topics addressed were HIV infections, pneumonia, diabetes mellitus, and bronchiectasis (Fig. 5).

Table S4 presents a detailed analysis of TB research priorities in LA, highlighting the critical areas of interest (identified using keywords) and the target populations in the 20 countries in the region with the highest number of investigations. HIV emerged as the most researched topic (in 14 of the 20 countries), mainly within the three priorities in Brazil, Argentina, Peru, Colombia, Chile, Haiti, Puerto Rico, Panama, Guatemala, and Honduras. This was followed by studies on epidemiology (9 of 20 countries), tuberculostatic agents (6 of 20), TB-related mortality (6 of 20), diagnostic methods (5 of 20), isoniazid (5 of 20), risk factors (5 of 20), and diabetes

Table 2
Top journals with the most commonly published articles on pulmonary tuberculosis in Latin America.

Country	Journals	Number of documents	Citations	Rate Citas/ documents	Quartile score [†]	Citescore ^{††}	SJR ^{††}	% International Collaboration [†]
FR	- International Journal of Tuberculosis And Lung Disease	240	5614	23.4	Q2	4.5	0.845	59.7
BR	- Jornal Brasileiro De Pneumologia	154	1641	10.7	Q3	3.1	0.428	20.9
US	- Plos One	141	2865	20.3	Q1	5.6	0.852	30.3
US	- Tuberculosis	101	1476	14.6	Q2	5.3	0.763	40.4
BR	- Revista Da Sociedade Brasileira De Medicina Tropical	69	532	7.7	Q3	2.4	0.454	8.5
UK	- BMC Infectious Diseases	64	1036	16.2	Q2	4.8	1.042	28.9
MX	- Revista Del Instituto Nacional De Enfermedades Respiratorias ^a	57	57	1	Q4	0.2	0.100	0 %
BR	- Brazilian Journal of Infectious Diseases	56	477	8.5	Q3	3.5	0.613	14.8
BR	- Memorias Do Instituto Oswaldo Cruz	48	670	14	Q2	4.7	0.667	39.6
CH	- Revista Chilena De Infectologia	39	116	3	Q4	0.9	0.222	10.5

^a Journal of the National Institute of Respiratory Diseases: Discontinued in Scopus until 2017. [†] SCImago Journal and Country Rank (2021), ^{††} Scopus (2021).

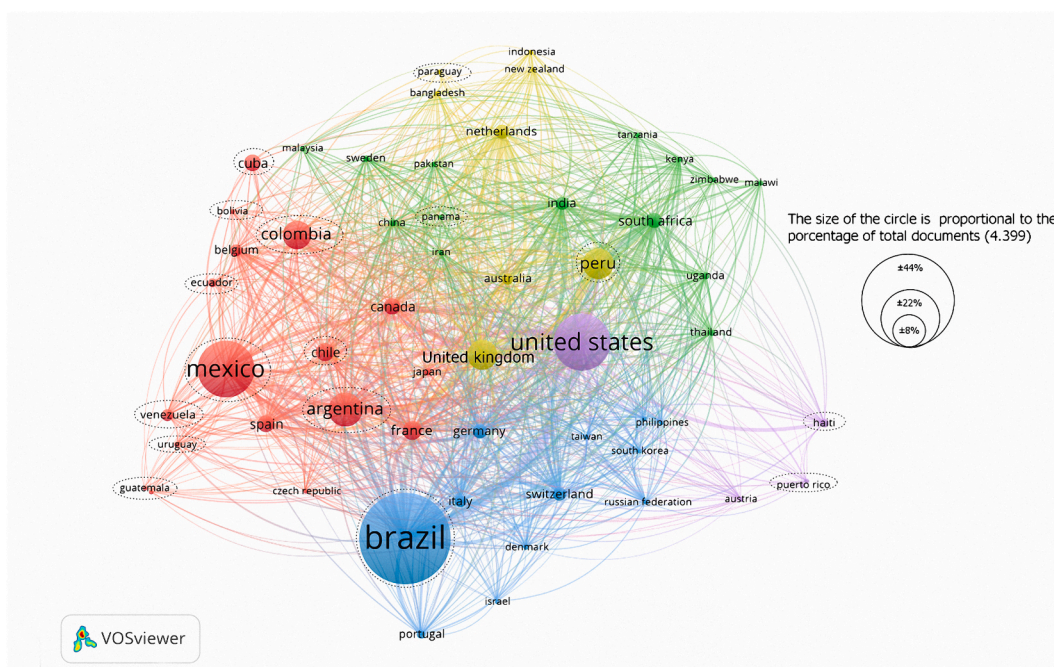


Fig. 3. Extraregional collaborations on pulmonary tuberculosis research.

mellitus (3 of 20). Only Brazil, Peru, and Haiti stood out for prioritizing research into anti-TB drug resistance or MDR-TB. Only Ecuador focused its research priorities on the intersection between COVID-19 and TB.

Six of the ten main sponsors of TB research were from countries outside LA. Among these sponsors, the National Institute of Allergy and Infectious Diseases stood out, having financed 288 projects, followed by the Conselho Nacional de Desenvolvimento Científico e Tecnológico with 274 projects and the National Institutes of Health with 245 studies. These organizations focused primarily on research related to HIV, tuberculostatic agents such as isoniazid, and genetic aspects of the disease (Fig. S3).

4. Discussion

4.1. Challenges of TB research in LA

Research on TB in LA has notably grown between 1990 and 2021, evidenced by an annual average of 137 scientific publications and

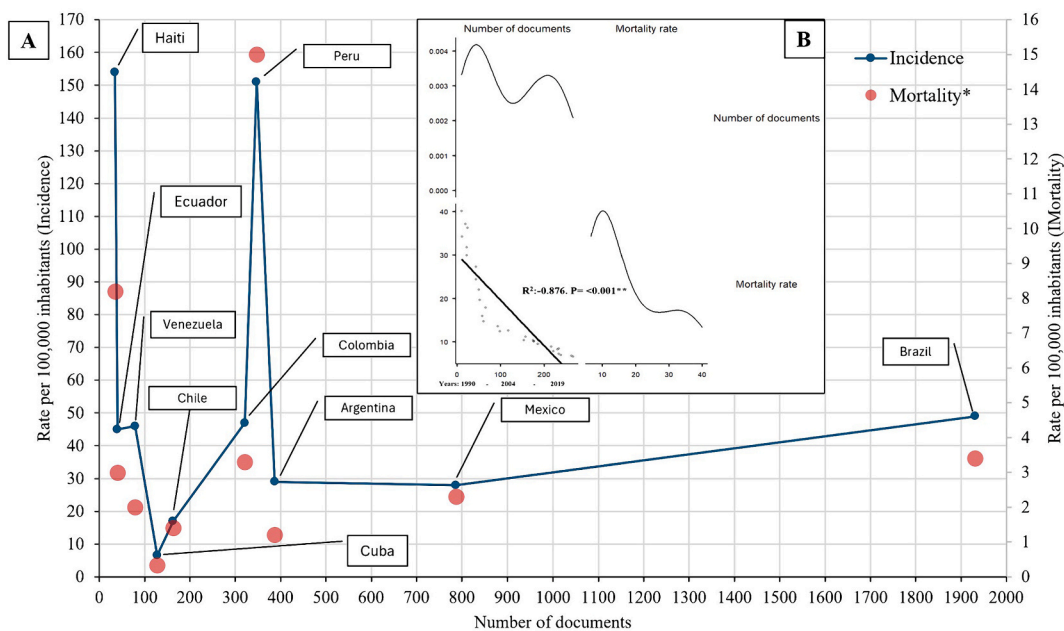


Fig. 4. Incidence and mortality of tuberculosis per 100,000 inhabitants in Latin America Footnote: *Calculated mortality in patients without HIV
**A significant P value was found between the number of documents published per year and the tuberculosis mortality rate from 1990 to 2019.

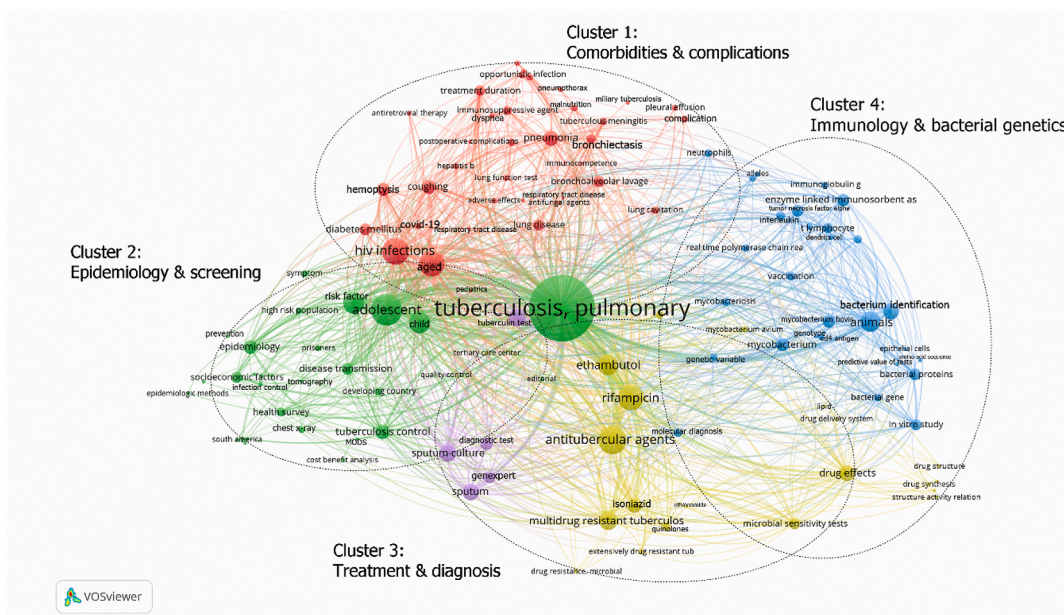


Fig. 5. Co-occurrence network of keywords map on pulmonary tuberculosis in Latin America.

a projected annual increase of 11.9 %. This boom in scientific production on TB exceeds the research on other highly transmissible infectious diseases, such as influenza, rotavirus, or measles, which register an average of <50 documents annually in the region [19–21]. This preference for TB research over other diseases can be attributed to several critical factors.

First, TB represents a significant regional epidemiological and socioeconomic burden, distinguished for its unique complexities. This is due, in part, to the emergence of MDR-TB strains and their interactions with HIV infection, factors that considerably complicate its control and eradication [22]. Second, addressing TB demands extensive and in-depth research to develop more effective diagnostic methods, treatments, and prevention strategies, presenting particular challenges in clinical research [22,23].

Third, although diseases such as measles, influenza, and rotavirus are important public health problems, effective vaccines, and

well-established control strategies exist. In contrast, the management of TB in LA could be improved by the need for adequate tools for its control and by the adaptation and mutation capacities of the causative agent [24].

Fourth, TB continues to be a global health priority because of its profound effect on public health and significant economic burden. The costs associated with TB treatment can exceed \$23,000 per person susceptible to the disease and rise to up to \$430,000 for XDR-TB cases [25,26]. This panorama would indicate the urgency of intensifying R&D efforts to combat this disease more effectively.

4.2. Link between scientific production, collaboration networks, and the TB burden in LA

Brazil, Argentina, Mexico, and Peru stood out as leaders in TB research in LA, with Brazil contributing >40 % of scientific production in this field. This could be attributed to several factors, such as R&D and economics. As a member of BRICS (Brazil, Russia, India, China, and South Africa), Brazil benefits from its position in a bloc of emerging economies that exert considerable influence on global public health. In addition, the interaction between TB and HIV in these countries was conducive to attracting additional funding [27,28]. A clear example was observed in sponsors such as the National Institute of Allergy and Infectious Disease, the National Institutes of Health, and the Wellcome Trust, which have been noted for supporting research focused on these coexisting diseases (Fig. S3).

TB is a significant global health challenge, particularly affecting developing countries [2]. The situation is dire in LA, where Peru, Haiti, and Bolivia report the highest mortality and incidence rates. These countries experience >8 deaths and 107 cases per 100,000 inhabitants [1]. Peru notably registered a higher number of scientific publications. This research focus could be explained by its status as one of the countries with the highest prevalence of resistance to anti-TB drugs [1]. In addition, 24.9 % of the studies published in LA concentrated on MDR-TB and XDR-TB (Fig. 1).

Scientific research has played a fundamental role in reducing TB-related mortality, as demonstrated by the significant negative correlation reported in this study ($R^2 = -0.876$, $p < 0.001$) (Fig. 4). However, this progress has not been achieved solely through science but is the result of the interactions of multiple factors. The continuous implementation of improvements in public health programs has been decisive; initiatives such as awareness campaigns to destigmatize the disease, early detection programs, promotion of adequate nutrition, and the availability of more effective anti-TB treatments have directly improved the ability to control and eliminate it [29–31]. These advances, in synergy with scientific discoveries, have generated a cumulative impact on the reduction of TB mortality, a similar approach to that observed in the response to COVID-19, where the combination of scientific and public health efforts led to more effective management of the pandemic [32].

These findings underscore the need to strengthen research capabilities in countries with lower scientific output, such as Honduras, Costa Rica, El Salvador, Guatemala, and the Dominican Republic, encouraging them to intensify their research efforts and address the country-specific determinants of TB [33]. In this context, the virtual platform Research4Life emerges as an important resource, acting as a catalyst to democratize access to scientific information. By providing researchers from resource-limited countries access to scientific materials at a reduced or no cost, this initiative promotes the broader inclusion of these nations in the global scientific dialog [34]. This collaborative effort is reinforced by policies of some academic journals that offer waivers in publication costs to researchers from countries in groups A or B, thus strengthening the link between global science and developing scientific communities.

Conversely, Mexico, Argentina, and Peru have implemented research strategies funded by their respective ministries of health, indicating the critical commitment of their governments in the fight against TB [35–37]. These countries have also demonstrated a remarkable ability to explore diverse areas of clinical research, often supported by international collaborations and external funding [38]. This multifaceted approach expands the scope of TB research and strengthens local capacities to address this disease from multiple fronts.

Among the 4399 documents analyzed, 21.4 % involved collaboration with institutions in the USA and 7.7 % with entities in the UK. This underscores the global concern for TB, particularly in LA, with a higher prevalence of the disease than in other geographic areas [39]. Despite the notable international collaboration already in place, further promoting and expanding international alliances is imperative. These collaborations were essential not only to enrich the exchange of knowledge and experience but also to strengthen research capacities and institutional structures in LA [40,41]. As shown in Table S3, it allowed for a notable improvement in the number of citations per publication and an FWCI of 3.68. Therefore, a valuable opportunity would be presented for countries with limited scientific collaboration, including Guatemala, Puerto Rico, the Dominican Republic, and Paraguay, to access advanced technologies and cutting-edge research methodologies. Moreover, it opens the door to integrating experienced researchers specialized in TB into their projects. Securing additional and diverse funding sources must be also considered, which is crucial for ensuring the continuity and development of research projects [42].

4.3. Research priorities in LA

Notably, in 2020, a significant proportion (44 %) of the funding for TB research in LA came from international sources [43]. This flow of resources could have played a crucial role in the ability of researchers in the region to publish their findings in high-impact scientific journals, such as *The International Journal of Tuberculosis and Lung Disease*, *Plos One* and *BMC Infectious Diseases*. Interestingly, these journals exhibit a high percentage of international collaboration (28.9%–59.7 %), in contrast to local journals (0%–39.6 %). This would highlight the critical importance of promoting and maintaining international collaborations, not only as a means to combat TB in the region effectively but also to integrate LA more effectively into the global scientific community [44].

The thematic distribution of TB research in LA reveals a significant concentration in critical areas such as “treatment and diagnosis” and “epidemiology and screening,” which account for nearly 60 % of scientific production. This approach reflects a logical response to

the region's immediate needs in controlling the spread of TB and improving patient clinical outcomes [45]. The prioritization of treatment and diagnosis, which constitutes 32.5 % of research, underlines the urgency of developing more effective and accessible methods to detect the disease and administer effective therapies, particularly in contexts where drug resistance is becoming a growing challenge [29]. However, the emphasis on epidemiology and screening, with 26.9 %, points to the need to better understand TB transmission dynamics and identify populations at risk, which are essential to designing intervention strategies and more targeted and efficient prevention [46].

However, the less attention devoted to “comorbidities and complications” and “immunology and bacteria” suggests possible areas of opportunity to expand the spectrum of TB research within the region. Although treatment, diagnosis, and epidemiological studies are essential, further understanding how comorbidities affect TB progression and treatment could optimize therapeutic approaches. Exploring bacterial immunity and genetics may also uncover new targets for vaccines or innovative treatments [47]. Expanding research in these less-explored areas could provide a more holistic understanding of TB, from prevention to clinical management.

Of all documents published on TB in LA, 25 % demonstrated interest in HIV/AIDS as a central topic. This is reflected in 14 of the 20 countries that include it among their five main research priorities, highlighting the critical intersection between these two diseases in the region. This convergence is not surprising, given the synergistic effect of HIV on TB progression and treatment. TB/HIV coinfection complicates the clinical management of patients, increasing mortality and presenting unique challenges for health systems [48]. Focused attention on HIV/AIDS within TB research reflects an adaptive response to this epidemiological reality, highlighting the need for integrated strategies that address both TB and HIV, thereby improving health outcomes and reducing the burden of both diseases in the population [49].

After HIV, epidemiology emerges as a significant priority, highlighting the need to understand better TB transmission patterns and the social and environmental determinants that contribute to its spread. Attention to epidemiology in 9 of 20 countries denotes the importance of population and field studies to inform public health policies and specific intervention strategies [50]. Furthermore, research on anti-TB drugs and TB-associated mortality reflects a continuing concern to optimize treatment and reduce its deadly effect, respectively. These focus areas are critical to controlling and eliminating TB in the region.

Anti-TB drug resistance, particularly MDR-TB, identified as a priority in Brazil, Peru, and Haiti, highlights an emerging global challenge within the regional context. MDR-TB represents a significant threat to TB control, complicating treatment regimens and requiring innovative solutions in terms of new drugs and therapeutic regimens. These countries' focus on this area indicates a recognition of the urgent need to address drug resistance, which is crucial to prevent a reversal of the gains made in the fight against TB [51].

Resistance to anti-TB drugs, particularly MDR-TB and XDR-TB, affects approximately 500,000 people annually and is an important cause of mortality associated with antimicrobial resistance [52,53]. Therefore, it is emerging as a public health crisis of global magnitude, with a pronounced effect on LA [54]. MDR-TB and XDR-TB, identified as a critical research priority in Brazil, Peru, and Haiti, pose significant challenges to effective TB control, complicating existing treatment regimens and generating a pressing need to develop innovative solutions. Therefore, other countries in LA must address this issue, as demonstrated by some ongoing clinical trials (<https://clinicaltrials.gov/>; NCT05383742, NCT05007821, and NCT05455112). The adoption of shorter and more effective therapeutic regimens, based on solid evidence, could represent an important change in the management of resistant TB.

4.4. Limitations and conclusions

Although this study provides valuable insights into TB research in LA, it was not exempt from certain limitations inherent to its methodological design. First, it is limited by the very nature of the bibliometric analysis used, which did not aim to evaluate the intrinsic quality of the publications analyzed. However, we observed a considerable concentration of documents in prestigious journals, as indicated by their SJR and CiteScore indices, which suggests a trend toward publication in high-quality scientific sources within the field study.

Second, a single database was used for document collection. Despite this, this database was selected based on the criteria of relevance and coverage in the field of TB, justifying its use by the quality and breadth of the information it provides. However, incorporating multiple databases in future research could expand the spectrum of documents analyzed, although this could also entail the inclusion of duplicate documents or documents from less rigorous sources, which would require careful filtering and validation.

Third, the documents that were collected and analyzed cannot be considered an absolute reflection of all the studies on TB in LA. This is due, in part, to the possibility that certain regional authors maintain affiliations with foreign institutions, which could have influenced data representativeness. Finally, the selection of research priorities in TB was based solely on the frequency of keywords recorded in each document. This approach could have underestimated the importance of other relevant topics that must be mentioned explicitly or that did not appear in our results. This situation highlights the inherent complexity of exhaustively mapping scientific production in a specific field, particularly in a globalized environment characterized by frequent international collaborations.

In conclusion, TB research has significantly increased in LA, which played a pivotal role in combating this disease by dynamically adapting to the region's urgent needs and unique challenges. The focus on HIV/AIDS coinfection, epidemiological studies, and research into anti-TB drug resistance has underscored the necessity to continue enhancing diagnostic methods, developing more effective treatments, and crafting robust preventive strategies. Furthermore, the importance of steering research toward less-explored areas, such as immunology and bacterial genetics, has been highlighted. International collaboration in this field has proven essential for enriching scientific output through knowledge exchange, infrastructure improvements, and financial resource provision. This could offer unique opportunities to countries in LA with limited research capabilities. This holistic approach has broadened the scope of TB research and bolstered local capacities to tackle the disease from multiple perspectives, contributing to the global knowledge pool and

health intervention strategies.

Data statement

The authors confirm that the data supporting the findings of this study are available within the article. The extended data on Figshare: <https://doi.org/10.6084/m9.figshare.25529956>.

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

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CRediT authorship contribution statement

Cristian Morán-Mariños: Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Fabrizio J. Visconti-Lopez:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Carlos Espiche:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization. **Felix Llanos-Tejada:** Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Formal analysis. **Renzo Villanueva-Villegas:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Conceptualization. **Renato Casanova-Mendoza:** Writing – review & editing, Visualization, Validation, Supervision. **Capriny Bernal-Turpo:** Writing – review & editing, Writing – original draft, Visualization, Supervision.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Cristian Moran reports writing assistance was provided by San Ignacio de Loyola University. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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