

A Scopus-Based Bibliometric Analysis of Global Tuberculosis Publications: 1849-2020

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Abstract

OBJECTIVE: Tuberculosis continues to become a serious public-health concern in many countries despite efforts to prevent and control global tuberculosis infections.

MATERIAL AND METHODS: This study aims to present bibliometric analysis of the period 1849-2020 tuberculosis publications that are published by global researchers and indexed in the Scopus database. Although many studies have been carried out on tuberculosis, there is no study that performs bibliometric analysis of publications in this field in such a wide range of dates. Tuberculosis publications searched in the Scopus database between the period 1849-2020 were analyzed. Data on tuberculosis were presented by analyzing the number of publications, the language of publication, the countries that contribute the most to the literature, the most active institutions, the most cited publications, active authors and active journals, using appropriate quantitative and qualitative bibliometric indicators.

RESULTS: 263,234 articles, published between 1849 and 2020 and searched in the Scopus database, were evaluated. The most articles (n= 8.344) were published in 2020. A total of 112,121 articles were published between 2001 and 2020. The most used publication language in the articles was English (62.48%), followed by Russian (7.25%). The country that contributed the most to the literature was the United States (13.81%), followed by India (7.18%). 3.9% of the articles were published in the journal "Tuberculosis and Lung Diseases".

CONCLUSION: The results of the present bibliometric study are expected to shed light on the planning of future tuberculosis studies and the development of health policies toward tuberculosis. Research output is low in some countries, which should make larger investments in international and national collaborative research projects in the field of tuberculosis. If doing so, many countries of limited source will benefit from research that offer novel diagnostic and screening technology of tuberculosis.

KEYWORDS: Bibliometric, database, publications, tuberculosis, mycobacterium

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INTRODUCTION

Tuberculosis (TB) is one of humanity's oldest diseases, although being discovered by Robert Koch in 1882. The death record of a patient producing bloody sputum along the Nile River dates back to even 3000 years before Christ. *Mycobacterium tuberculosis* DNA was discovered in Egyptian mummies.¹ *M. tuberculosis* complex causes TB, which is a chronic necrotizing bacterial infection characterized by the presence of granulomatous lesions.² Tuberculosis is a disease that could affect other parts of the body (extrapulmonary TB), besides mostly affecting the lungs (pulmonary TB).³

According to the latest Global Tuberculosis Report (2020) of the World Health Organization (WHO), TB is regarded as 1 of the top 10 causes of death worldwide and is the leading mortality caused by a single infectious agent. The highest rate of infections and death toll rate abound mostly in developing and low-income countries.⁴ Approximately, 10.0 million (range, 8.9-11.0 million) individuals suffered from TB in 2019 worldwide. Number of those affected by TB has been steadily reducing in recent years.³ The 30 high TB burden countries constitute almost 90% of those who fall ill with TB each year. Tuberculosis is a disease of poverty. People afflicted with TB mostly encounter economic distress, vulnerability, discrimination, stigma, and marginalization.³ Africa and Southeast Asia have the highest incidence and mortality worldwide. Turkey is found in the WHO European Region.⁵ According to the Turkey Tuberculosis Control 2019 Report, the mortality and incidence rates of TB per 100 000 people were 0.53 and 17, respectively, in 2017 when cases of TB totaled 12 046 in Turkey.^{5,6}

It is difficult to monitor and evaluate research on intensified TB cases quantitatively, unlike routine TB surveillance and program activities. Research differs in type, end point, and outcome, from basic scientific research to operational research. In addition, research is carried out by the whole scientific community, which includes academic and research institutions that are not absolutely connected with national TB programs.⁷ The latest WHO Global Tuberculosis Report (2020) has demonstrated that among priorities are the development of vaccine and/or novel drug treatment to reduce the risk of infection and minimize the risk of TB disease in about 2 billion people being infected currently, rapid diagnostics for use at the point-of-care, and easier, shorter treatments for TB disease.³ Technological advances are required to reach the goals for TB

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research. Thus, TB incidence can reduce at an average rate of 17% per year after 2025.⁸

The present global research scenario indicates that the priorities of high-income countries are centered upon demands or short-term outcomes of a transactional nature. Therefore, the countries (especially those with low- and middle-incomes) most affected by TB must act, assume leadership, and make investments in research in an attempt to prevent and control TB.⁹

Moreover, many global studies have been carried out on TB based on the infection incidence.¹⁰ Although TB incidence and mortality are regularly predicted, it is very tricky to monitor the process of scientific production in the field.¹¹ In this context, basic bibliometric data are needed to examine the status of TB research and define their characteristics.¹² Bibliometric analysis is a tool commonly used to assess research productivity and growth in the health sciences. Bibliometric analyses have been reported in various research fields, including cancer, respiratory medicine, and public health.¹¹ This tool utilizes publication patterns in the research areas with the help of quantitative investigation and statistics to analyze citation data, summarize, visualize, and characterize a set or group of publications. The data or information obtained from the visualizations or maps can be used to examine the history of scientific research outputs in a particular or specific field, determine the prospective research directions, and seek opportunities for collaboration.¹⁰

Considering that TB research is of great importance for global health, it is important to analyze the globally published research outputs and generate comprehensive knowledge. This study aimed to retrieve worldwide publication data on TB from 1849 to 2020 intervals and analyze them. It is the first and unique study that employs bibliometric techniques to analyze globally published TB research from 1849 to 2020. The present bibliometric study was conducted to understand the strength and capability of TB research and reveal the historical process of TB research. In this study, bibliometric indicators for data derived from the Scopus database will be

presented chronologically. Therefore, information gaps about TB research activity will be filled. The present results would also help health policy makers and scientists to give fresh impetus to TB research.

MATERIAL AND METHODS

Data Source and Research Strategy

Various electronic databases can be used for bibliometric studies. The reason why we have selected the Scopus database in this study is that it has several advantages over other databases.¹³ Elsevier, assembling the characteristics of both the Web of Science and PubMed, developed the Scopus database in 2004. Furthermore, Scopus provides a wider range and more accurate data analysis than either PubMed or Google scholar.¹³ These characteristics offer enhanced utility for academic needs, medical literature research, and citation analysis.¹⁴ The search results of Scopus can be displayed as a list of 20-200 items per page. Scopus allows documents to save to a list and/or export.¹⁴ Scopus also enables a new search to initiate through the results that are categorized by document type, source title, author name, year of publication, and/or subject area.¹⁴

On May 24, 2021, we searched for all references with “tuberculosis” in the title, abstract, and keywords at the Scopus.¹¹ The study covers publications between the interval 1849 and 2020. The main reason for choosing this date range is to assess the situation from 1849, on which the oldest TB article was published, to the present. The last of the examined years was 2020, on which the Scopus database presents its complete records. This period has witnessed ample reports of TB. In this study, original research papers were screened for TB.¹¹ The display of the last search query in Scopus is as follows: TITLE-ABS-KEY (tuberculosis) AND PUBYEAR < 2021 AND (LIMIT-TO (DOCTYPE, “ar”)).

The collected data were used to generate the following information: (a) ratio of original TB research articles by year, (b) language of article, (c) country, (d) institution/organization, (e) research area, and (f) author. This study also discusses 20 countries, 10 institutions, 10 authors, and 10 publications with the highest number of citations, which are considered to make the most scientific contribution to the literature. In addition, this study addresses the relationship between the TB data and the number of researches around the world and in Turkey.

The quality of publications is difficult to measure or evaluate directly. However, the total number of citations received, the average number of citations per article, the Hirsch index (h index), percentage of highly cited articles, and impact factor (IF) of journals can be used as an indirect measure of publication impact or quality.^{13,15} The h index for the Scopus data is presented here. Two common performance indicators were assessed for the top 10 ranked journals using data from the most recent year available. First, the journal IF was evaluated with the help of the Journal Citation Report (Web of Knowledge) 2020 science edition by Thomson Reuters (New York, NY, USA). Secondly, the SCImago Journal Rank (SJR) indicator was used to measure the journal performance in the current study. A detailed explanation of how to calculate the SJR is publicly available on the SCImago website.^{14,16,17}

MAIN POINTS

- Our study is the first and unique bibliometric analysis of globally published tuberculosis research between 1849 and 2020. This study also includes the first and only bibliometric analysis results of tuberculosis research in Turkey.
- Most of the articles globally and in Turkey were published in the last 10 years.
- The fact that the largest number of articles were published in 2020 showed that tuberculosis research has not stayed in the background despite the coronavirus disease 2019 pandemic.
- Negative and statistically significant relationships were observed between the annual number of articles and the number of global cases and deaths.
- Our analysis indicates that countries with the highest estimated numbers of tuberculosis cases do not make considerable scientific contributions to tuberculosis research.



Figure 1. Tuberculosis publications per year, 1849-2020.

Ethics Statement

Ethical approval and informed consent are not needed for this study as this includes only a bibliographic analysis of published articles. We did not contact any author for further information about their publications.

Statistical Analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (IBM SPSS Statistics 24) software. Parametric tests were employed for measurement values showing a normal distribution. “ANOVA” test (*F*-table value) was used to compare the measurement values of 3 or more independent groups for parametric tests. Non-parametric tests were used for the measurement values that were not normally distributed. “Kruskal–Wallis H” test (χ^2 -table value) was used to compare the measurement values of 3 or more independent groups for non-parametric methods. Bonferroni’s correction was adopted for pairwise comparisons of variables with a significant difference in 3 or more groups. Pearson’s correlation coefficient was used to measure the relationship between 2 quantitative variables with normal distribution. However, Spearman’s correlation coefficient was employed to measure the relationship between binary variables in which at least 1 variable did not show a normal distribution.

RESULTS

Quantitative Analysis of Articles and Publication Language

A total of 263 234 articles were found in the Scopus database between 1849 and 2020 in this study based on the search strategy mentioned in the “Methods” section. After the first TB article was published in 1849, an average of 11 articles were published annually until the 1900s. A total of 1477 and 5489 articles were published on an annual average in the 1900s and 2000s, respectively. Tuberculosis studies sharply increased in 1945, which had continued over the years (Figure 1). The number of articles has peaked in 2020, with 8344 (3.17%). In order to demonstrate the changes in research productivity in the last 20 years, the annual number of articles and the growth rate in the annual number of articles are presented in Table 1. A total of 112 121 (42.59%) articles were published

between 2001 and 2020, with an annual average growth rate of 0.05.

In order to see the changes in the number of articles in the recent period, we divided the last 50-year period into 10-year periods and analyzed them in 5 periods. Figure 2 shows the distribution of the number of articles within these 5 periods. There was a statistically significant difference between periods in terms of the number of articles ($\chi^2 = 40.984; P = .000$). To determine which group leads to the significant difference,

Table 1. Annual Number of Articles and Annual Growth Rates (2001-2020)

Year	No. of Articles	%*	AAGR ^P
2020	8344	3.17	0.13
2019	7380	2.80	0.05
2018	7050	2.68	0.01
2017	6968	2.65	-0.03
2016	7183	2.73	0.00
2015	7193	2.73	0.01
2014	7119	2.70	0.02
2013	6961	2.64	0.06
2012	6538	2.48	0.07
2011	6107	2.32	0.11
2010	5500	2.09	0.04
2009	5264	2.00	0.10
2008	4800	1.82	0.06
2007	4519	1.72	0.05
2006	4305	1.64	0.17
2005	3692	1.40	0.06
2004	3496	1.33	0.06
2003	3311	1.26	-0.01
2002	3348	1.27	0.10
2001	3043	1.16	0.04

*%, Ratio of the total number of articles.
AAGR^P, annual average growth rate percentage.

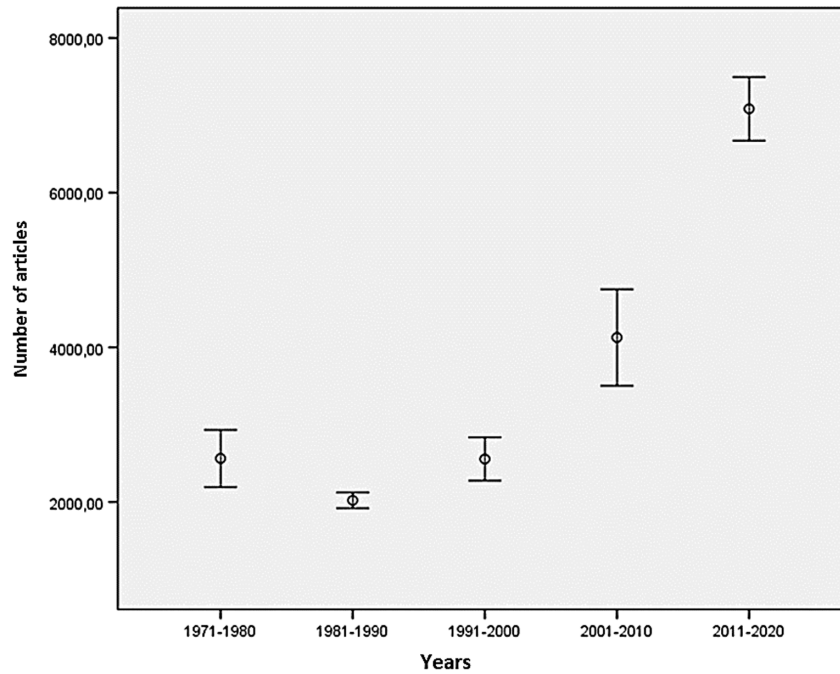


Figure 2. Annual distribution of the number of articles.

we performed Bonferroni-adjusted pairwise comparisons. As a consequence of pairwise comparisons, the number of articles between 1971 and 1980 was significantly higher than that between 1981 and 1990 but was significantly less than that between 2001 and 2010, and 2011 and 2020. Similarly, the number of articles between 1991 and 2000, 2001 and 2010, and 2011 and 2020 was significantly greater than that between 1981 and 1990. In addition to those, the number of articles between 2001 and 2010, and 2011 and 2020 was significantly higher than that between 1991 and 2000. Besides all these, the number of articles between 2011 and

2020 was significantly higher than that between 2001 and 2010 (Table 2).

There existed a statistically significant difference between periods in terms of the article percentage ($\chi^2 = 40.992$; $P = .000$). To establish from which group there is a significant difference in the results, we made Bonferroni-adjusted pairwise comparisons. The article percentage between 1971 and 1980 was significantly higher than that between 1981 and 1990 while it was significantly lower than that between 2001 and 2010, and 2011 and 2020. Likewise, the article percentage between

Table 2. Comparison of the Number and Percentages of Article, and Growth Percentages According to 10-Year periods

Variable	Number of Article		Percentage of Article		Growth Percentage	
	X±S.S.	Median [Min-Max]	X±S.S.	Median [Min-Max]	X±S.S.	Median [Min-Max]
Years						
1971-1980 ⁽¹⁾	2563.30 ± 518.38	2423.5 [1955 to 3567.0]	0.97 ± 0.20	0.9 [0.7 to 1.4]	-0.017 ± 0.146	-0.020 [(-0.20) to 0.31]
1981-1990 ⁽²⁾	2022.00 ± 141.98	2027.5 [1868.0 to 2364.0]	0.77 ± 0.05	0.8 [0.7 to 0.9]	0.010 ± 0.088	0.015 [(-0.18) to 0.14]
1991-2000 ⁽³⁾	2556.10 ± 391.15	2729.0 [1975.0 to 872.5]	0.97 ± 0.15	1.0 [0.8 to 1.1]	0.036 ± 0.063	0.020 [-0.04 to 0.16]
2001-2010 ⁽⁴⁾	4127.80 ± 872.50	3998.5 [3043.0 to 5500.0]	1.57 ± 0.33	1.5 [1.2 to 2.1]	0.067 ± 0.048	0.060 [(-0.01) to 0.17]
2011-2020 ⁽⁵⁾	7084.30 ± 575.47	7084.5 [6107.0 to 8344.0]	2.69 ± 0.22	2.7 [2.3 to 3.2]	0.043 ± 0.051	0.035 [(-0.03) to 0.13]
Analysis* Probability difference	$\chi^2 = 40.984$ $P = .000$ [1-2,4,5] [2-3,4,5] [3-4,5] [4-5]		$\chi^2 = 40.992$ $P = .000$ [1-2,4,5] [2-3,4,5] [3-4,5] [4-5]		$F = 1.368$ $P = .260$	

*"ANOVA" test (F -table value) was used to compare 3 or more independent groups that were normally distributed. "Kruskal-Wallis H" test (χ^2 -table value) was used to compare 3 or more independent groups that did not show normal distribution.

1991 and 2000, 2001 and 2010, and 2011 and 2020 was significantly greater than that between 1981 and 1990. In addition, the article percentage between 2001 and 2010, and 2011 and 2020 was significantly higher than that between 1991 and 2000. Besides all those, the article percentage between 2011 and 2020 was significantly higher than that between 2001 and 2010. A statistically significant difference existed in terms of growth rate between periods ($P > .05$).

The most popular publication language was “English” ($n = 164\,469$), as expected, that constituted 62.48% of the total publications. English was followed by Russian ($n = 19\,073$; 7.25%), French ($n = 14\,107$; 5.36%), German ($n = 12\,326$; 4.68%), Spanish ($n = 7065$; 2.68%), and other languages ($n = 46\,194$; 17.55%).

The largest portion of the articles was published in the realm of “medicine” ($n = 222\,329$; 84.46%), followed by “biochemistry, genetics, and molecular biology,” “immunology and microbiology,” and “pharmacology, toxicology, and pharmaceuticals” (Figure 3).

Geographical Distribution of Tuberculosis Research

More than 160 countries globally have contributed to TB literature. The heat map in Figure 4 more clearly shows the scientific contributions that countries have made to the total number of TB articles.¹⁸ The United States ranks first with 13.81% ($n = 36\,351$) in terms of the number of articles, followed by India ($n = 18\,902$; 7.18%) and the United Kingdom ($n = 16\,199$; 6.15%). Turkey ranks 17th in the number of publications, with 3131 articles (1.19%). The top 20 countries that have thus far contributed the most to the TB literature are shown in Figure 5.

Top 10 Research Institutions/Organizations and Preferred Journals

The top 10 institutions/organizations contributing to TB literature are presented in Table 3. The top 10 journals preferred

for publication of TB articles and their IF and SJR values are listed in Table 4. A total of 32 447 (12.33%) articles were published in the top 10 journals mentioned in Table 4. About 3.9% ($n = 10\,276$) of the articles were published in the journal *Tuberculosis and Lung Diseases*.

Most Cited Publications and Authors

The top 10 most cited publications are given in Table 5. The article titled “Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: A systematic analysis for the Global Burden of Disease Study 2010” published in *The Lancet* has the most cited publications.¹⁹ Six of the top 10 most cited publications were published in *The Lancet*. Table 6 lists the top 10 authors who have produced the most TB publications.

Relationship of Publications with Global Tuberculosis Cases and Deaths

A negative, moderate, and statistically significant relationship existed between the annual number of articles and the number of global cases²⁰ in the years 2000-2019 ($r = -0.639$; $P = .002$). Accordingly, as the number of articles increases, the number of global cases will decrease (Figure 6). A negative, very high, and statistically significant relationship was determined between the annual number of articles and the annual global death toll¹⁹ ($r = -0.974$; $P = .000$). Therefore, as the number of articles increases, the global death toll will decrease, or as the number of articles decreases, the global death toll will increase (Figure 7). However, no statistically significant correlation was observed between article growth rate and global case growth rate and global death increase rate ($P > .05$).

Analysis of Publications from Turkey

A total of 3131 TB articles were published in Turkey between 1950 and 2020. The first TB article was published in 1950, and a remarkable increase in the number of publications was

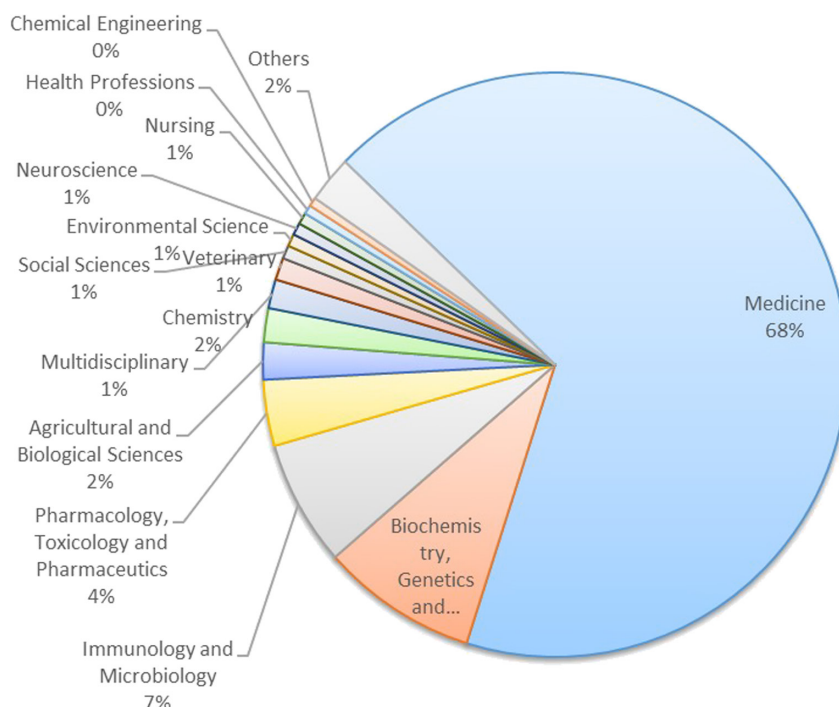


Figure 3. Grouping of articles by subject areas.

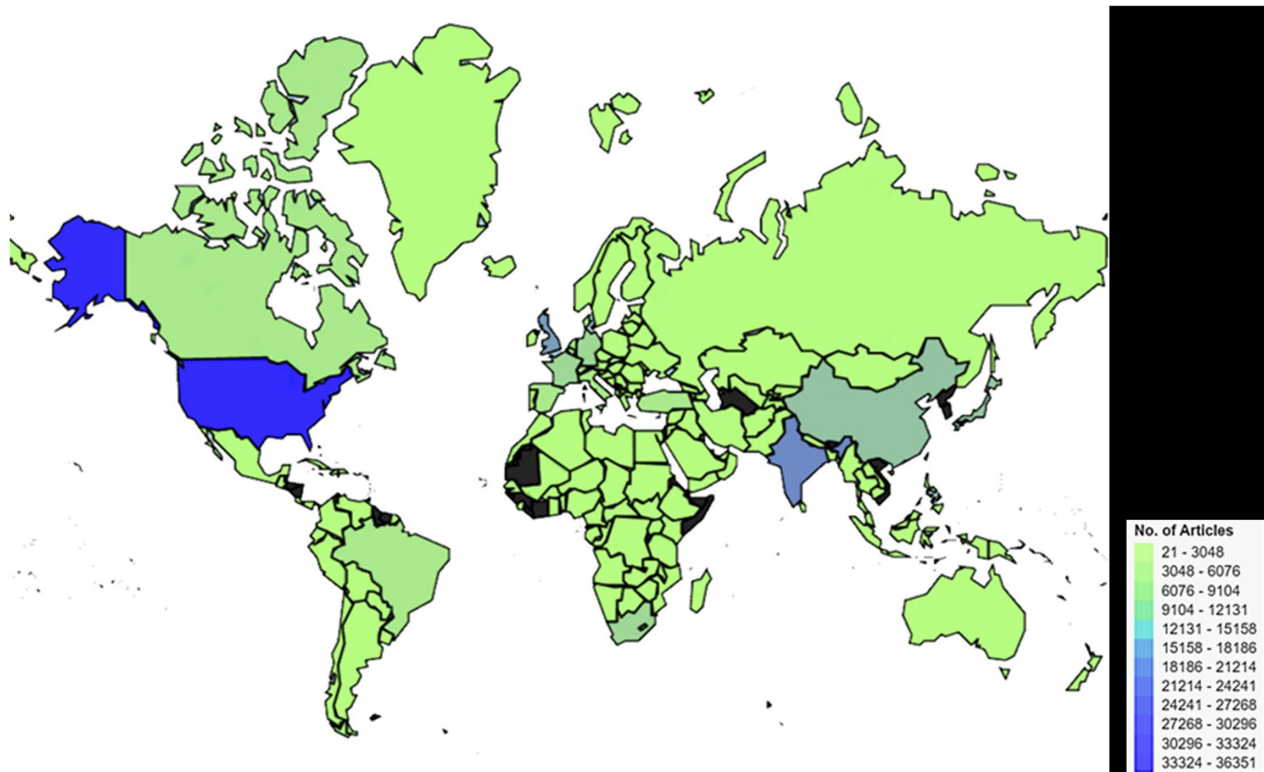


Figure 4. Distribution of the number of articles by countries (18).

observed in the 2000s, with an average of 13 252 publications. The highest number of publications was produced in 2011, with 175 (5.59%). A total of 2719 (86.84%) publications were produced between 2001 and 2020, with an average annual growth rate of 0.04. The most frequent publication language was English (n = 2693), which constituted 86.01% of the total publications. The vast majority of TB articles belonged to the realm of “medicine” in Turkey (n = 2765; 88.31%), followed by “immunology and microbiology,” “biochemistry, genetics, and molecular biology,” “pharmacology, toxicology, and pharmaceuticals,” and “chemistry,” respectively. The Turkish institution that has made the most scientific contribution to the literature was İstanbul Faculty of Medicine,

where 260 (8.30%) publications have been produced, followed by İstanbul University (n = 254; 8.11%) and Hacettepe University (n = 245; 7.82%). Approximately, 3.77% (n = 18) of the articles were published in the *Bulletin of Microbiology*. Ceyhan I. from Balıkesir has ranked first with the number of 32 articles and an h index of 9.

Analysis of the relationship between the annual number of national cases and deaths in 2005-2018 (521) and the annual number of articles during the same period shows that there had been no statistically significant relationship between the number and growth rates of articles published in Turkey and the number of national cases and deaths ($P > .05$).

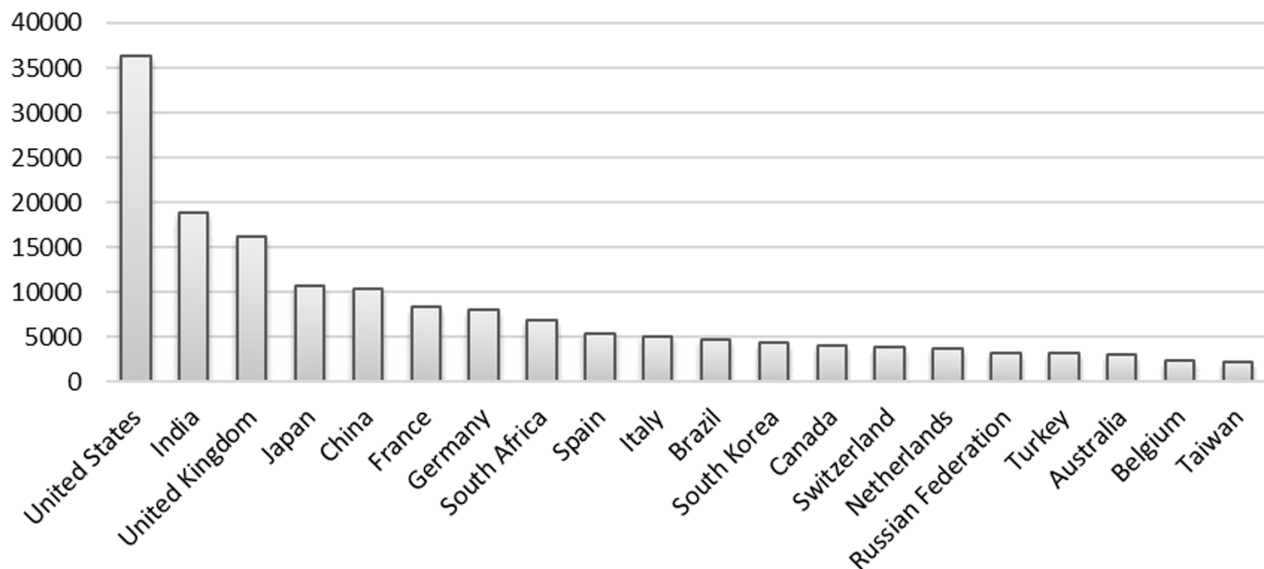


Figure 5. Distribution of the top 20 countries in terms of tuberculosis articles.

Table 3. Top 10 Active Institutions/Organizations in Terms of Tuberculosis Articles (1849-2020)

	Affiliation	Country	Articles (n)	%
1	University of Cape Town	South Africa	2048	0.78
2	London School of Hygiene & Tropical Medicine	United Kingdom	1932	0.73
3	Centers for Disease Control and Prevention	United States	1920	0.73
4	Stellenbosch University	South Africa	1662	0.63
5	Harvard Medical School	United States	1325	0.50
6	All India Institute of Medical Sciences, New Delhi	India	1274	0.48
7	Imperial College London	United Kingdom	1274	0.48
8	South African Medical Research Council	South Africa	1245	0.47
9	Organisation Mondiale de la Santé	Switzerland	1242	0.47
10	Inserm	France	1152	0.44

DISCUSSION

This study aims to provide a bibliometric overview of TB research that sheds light on global efforts to save the lives of millions of people. Our study is the first bibliometric one that covers the articles in the field of TB from 1849 to 2020 at a global level. Given that research into TB is very important for global health, the presentation of comprehensive information about the quantitative status of research on TB and the revelation of time-dependent scientific changes would guide both healthcare professionals and policy makers.

Our study shows that 263 234 articles of TB have been produced and the number of articles has continuously increased, especially in recent periods. Our study also reveals that 26.91% of the articles were published in the last 10 years. This result is an indication that TB is a global health problem, which has still not declined in importance. Garrido-Cardenas et al²² reported a swift increase in the number of publications since 1990 in their analysis covering the years 1925-2018. Similarly, in their analysis covering the years 1977-2017, Ortiz-Martínez²³ showed a marked increase in the number of publications in the last 20 years. Consistent

with the previous study, we found a statistically significant increase in the number of articles and the annual percentage of articles as of 2001. It is also highly satisfactory that the largest number of articles were published in 2020, suggesting that researchers have still taken TB seriously despite the coronavirus disease 2019 (COVID-19) pandemic. One might assert confidently that the publications that especially COVID-19 are associated with the BCG vaccine and TB have also contributed to the TB articles published in 2020. Although *M. tuberculosis* was described by Koch in 1882, our study shows that TB publications were reported since 1849 and researchers had studied TB before the bacillus was identified.

As expected, most of the publications have been written in English (62.48%), which has already been accepted as the scientific language. The presence of the articles originating mainly from the United States and the UK is also an important factor explaining why English is the most common scientific language. The second most common scientific language used in the publications is Russian (7.25%) which shows Russian researchers have a keen interest in the subject. The journal *Tuberculosis and Lung Diseases* that is the leading of

Table 4. Top 10 Journals That Have Published Tuberculosis Articles (1849-2020)

Rank	Journal	No. of Articles	%	SJR	IF
1	<i>Tuberculosis and Lung Diseases*</i>	10.618	4.03	0.206	NA
2	<i>Kekkaku Tuberculosis</i>	4.022	1.53	0.133	NA
3	<i>International Journal of Tuberculosis and Lung Disease</i>	3.903	1.48	1.103	2.268
4	<i>Plos One</i>	3.460	1.31	0.990	10.500
5	<i>Tuberculosis</i>	3.357	1.28	0.977	2.576
6	<i>Journal of Clinical Microbiology</i>	1.723	0.65	2.349	NA
7	<i>American Review of Respiratory Disease</i>	1.616	0.61	6.272	NA
8	<i>Journal of The American Medical Association</i>	1.408	0.53	4.688	NA
9	<i>The Lancet</i>	1.388	0.53	13.103	60.392
10	<i>British Medical Journal</i>	1.294	0.49	1.831	30.223

* Formerly known as *Problemy tuberkuleza*, SJR, SClmago Journal Rank; NA, not available; IF, impact factor.

Table 5. The Top 10 Cited Tuberculosis Articles in Scopus (1849-2020)

SCR	Authors and Year of Publication	Title	Journal Name	Times Cited
First	Lozano, R. et al. 2012	Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: A systematic analysis for the Global Burden of Disease Study 2010	<i>The Lancet</i>	8459
Second	Mathers, C.D., Loncar, D. 2006	Projections of global mortality and burden of disease from 2002 to 2030	<i>PLoS Medicine</i>	6504
Third	Murray, C.J.L., Lopez, A.D. 1997	Alternative projections of mortality and disability by cause 1990-2020: Global Burden of Disease Study	<i>The Lancet</i>	5391
Fourth	Cohen, M.S. et al. 2011	Prevention of HIV-1 infection with early antiretroviral therapy	<i>New England Journal of Medicine</i>	4870
Fifth	Vos, T. et al. 2012	Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010	<i>The Lancet</i>	4604
Sixth	Kenneth G. Castro et al. 1992	1993 revised classification system for HIV infection and expanded surveillance case definition for AIDS among adolescents and adults.	<i>MMWR Recomm Rep.</i>	444
Seventh	Naghavi, M. et al. 2015	Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013	<i>The Lancet</i>	4349
Eighth	Lopez, A.D. et al. 2006	Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data	<i>The Lancet</i>	3872
Ninth	Cobb, S. 1976	Social support as a moderator of life stress	<i>Psychosomatic Medicine</i>	3332
Tenth	Murray, C.J.L., Lopez, A.D. 1997	Mortality by cause for eight regions of the world: Global Burden of Disease Study	<i>The Lancet</i>	3278

SCR, standard competition ranking.

the most preferred journals is of Russian origin, which in turn supports this view.

Our study reveals that most publications belonged to the realm of medicine. The reason is that TB has currently been one of the deadliest infectious diseases and has still maintained its importance for human health. In addition, the WHO's EndTB Strategy and the efforts to control and eradicate TB at the global level prompt the researchers in the field

of health and medicine to conduct research and publications in this direction.

The chief countries publishing TB articles are the United States, India, and the United Kingdom. They have been publishing more than 27% of all the TB articles. This result is in line with that reported by Garrido-Cardenas et al.²² Two separate research groups analyzed all kinds of scientific publications^{22,23} that have been produced during the years

Table 6. Top 10 Prolific Authors in the Field of Tuberculosis Over the Period of 1849-2020

SCR	Author	Number of Articles	%	Total Number of Citations (S)	h Index* (S)	Country
First	Tsukamura, M.	281	0.11	4292 (10)	32 (10)	Japan
Second	Jacobs, W.R.	277	0.11	34 526 (2)	102 (2)	United States
Third	Sriram, D.	274	0.10	12 298 (9)	51 (8)	India
Fourth	Franzblau, S.G.	254	0.10	15 448 (7)	62 (7)	United States
Fifth	Van Soolingen, D.	252	0.10	31 933 (3)	81 (5)	Netherlands
Sixth	Rastogi, N.	250	0.09	12 816 (8)	51 (9)	Guadeloupe
Seventh	Kaufmann, S.H.E.	242	0.09	44 901 (1)	112 (1)	Germany
Eighth	Besra, G.S.	241	0.09	30 278 (4)	96 (3)	United Kingdom
Ninth	Harries, A.D.	241	0.09	16 746 (6)	64 (6)	France
Tenth	Ottenhoff, T.H.M.	229	0.09	24 140 (5)	84 (4)	Netherlands

R, ranking; SCR, standard competition ranking.

*Hirsh index.

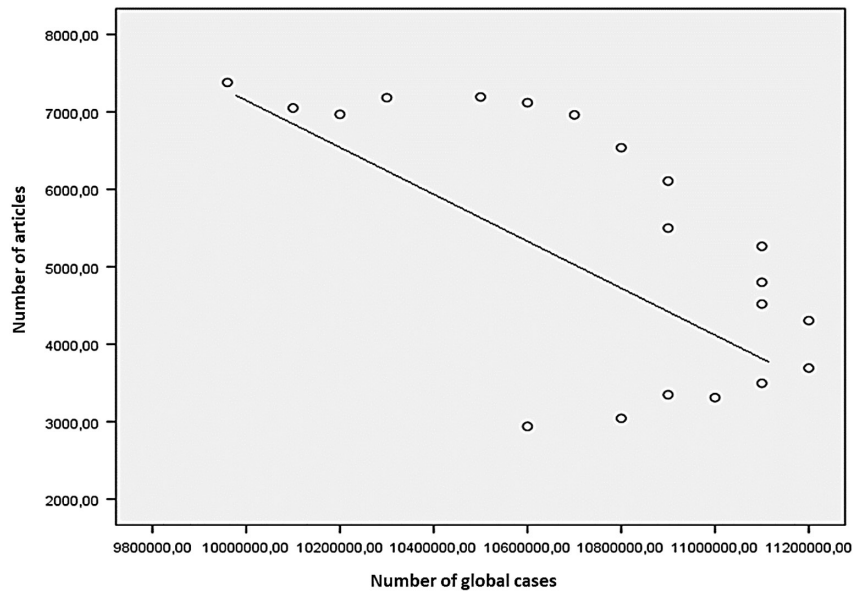


Figure 6. The relationship between the number of publications and of global cases.

1977-2017 and 1925-2018. Their analysis also shows that most articles are published by the United States, UK, and India, respectively. The global publication map showing the distribution of TB publications prepared in previous studies^{22,23} also resembles largely the publication map in our study. Our and other bibliometric analyses have demonstrated that the United States, India, and the UK play a leading role in TB research. The fact that the top 3 countries that have contributed the most to the literature over the years remain unchanged suggests that other countries should also make more scientific contributions to eradicate TB at the global level. The analysis of institutions and organizations contributing to the literature on TB reveals that besides the leading countries for the number of publications, South Africa also makes significant contributions to the literature with some study groups.

As expected, our literature analysis shows that journals publishing TB articles mostly fall into the field of medicine. About 12.45% of the produced articles were published in the top 10 most preferred journals. The IF value of these journals ranges from 2.268 to 60.392. The IF of the journal in which the articles are published does not always mean that the articles are of good quality.²⁴ Furthermore, half of the 10 top journals in which TB research is published did not have an IF. There is no considerable overlap between publications without an IF and non-English language: 2 of the 5 journals without an IF were non-English (Russian and Japanese) language. Different from our study, the analysis of Ramos et al²⁵ shows that only the non-English journals among the top 10 journals did not have IF. We reason that this difference may result from consideration of a wider year range in our study and from the

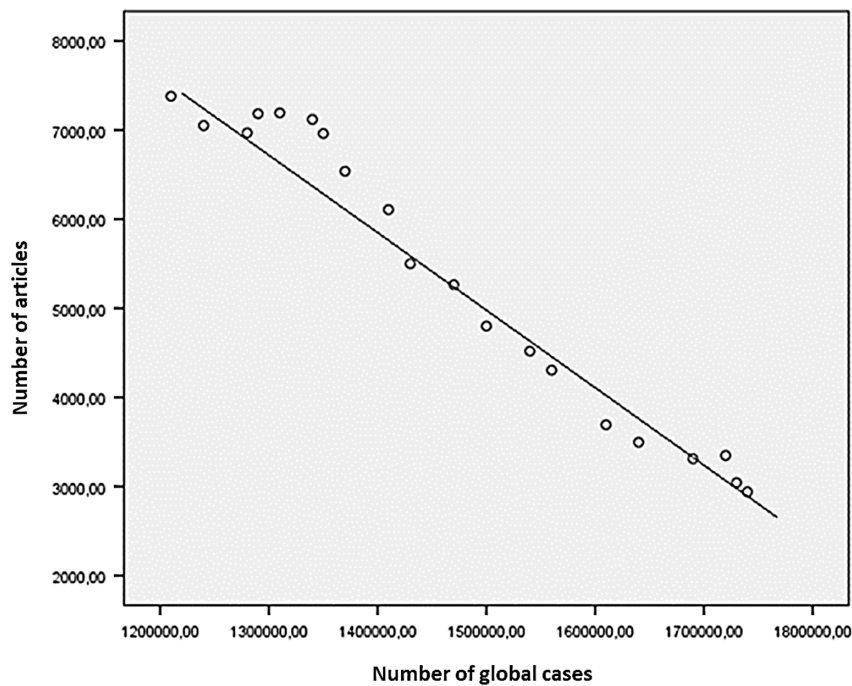


Figure 7. The relationship between the number of articles and of the global death toll.

addition of more and more journals to the Scopus database every day.

Tsukamura M. from Japan is the author who publishes the largest number of TB articles. In addition, there are 2 authors each from the United States and the Netherlands in the top 10. When evaluating the countries, institutes, and authors that have contributed the most, we can say that scientists from the United States, India, United Kingdom, Japan, the Netherlands, and South Africa put more effort into contributing to the literature.

The most cited TB article is the study titled "Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: A systematic analysis for the Global Burden of Disease Study 2010," published in *The Lancet* in 2012. The main subject of the multi-author article was to examine the distribution of diseases that cause the most deaths at the global level. Six articles in the top 10 cover studies on the Global Burden of Diseases. It is readily understandable from ample evidence that TB has maintained its scientific importance at the global level for years and would continue to do so in the next years.

Detailed results of the analysis show that the annual number of TB articles is negatively correlated with the annual global estimated number of cases in a statistically significant manner and with the global annual number of death toll in a highly statistically significant manner. Although this situation has not been associated as the sole reason, it might be asserted that scientific articles do contribute enormously to the prevention of new cases and the death toll at the global level. This shows that the Global Strategy for Tuberculosis Research and Innovation, which is included in WHO's EndTB strategy, should continue and efforts should be boosted further.

This study is the first bibliometric analysis of TB in Turkey. We consider that it is of the utmost importance to know the scientific efficiency of TB, which is a serious public health concern at the national level, and to delve into its changes over the years. For this reason, we consider that the present results would shed light on the measures to be taken at the national level and on the strategies to be planned for future periods. Tuberculosis articles started to be published in 1950, before the discovery of the bacillus in Turkey. In the 2000s, a considerable number of articles were published, which has contributed to the literature. The increase in funds for TB R&D research at the global and national levels may have led to an increase in the number of scientific articles in the 2000s. Turkish researchers have also aimed to share their study outcomes with the global scientific community by presenting articles mostly in English. The highest number of TB articles from Turkey were published in the *Bulletin of Microbiology*, which is a journal from Turkey and also publishes articles in Turkish. The reason for choosing this journal may be that it is thought that the publication of studies conducted especially at the national level into a journal of national origin, which is also searched in international databases, can reach researchers in the country more easily. There was no statistically significant difference between the annual case and death toll

rates in Turkey. The reason for this result, which is different from the worldwide results, may be that most of the journals in which the national articles were published could not be searched at the Scopus database. Based upon this result, we regret to say that the studies carried out at the national level were unable to be useful in preventing new national cases and deaths. But, of course, we should say that the available study results are not the only factor that affects the case and death rate and that enormous national and global efforts have been put into preventing TB at the national and global level and further efforts should be spent. In line with these data, it is obvious that policy managers should provide more funds for TB research, which has still been a serious national public health problem, and scientists should be supported for those investigations.

Our analysis indicates that countries with the highest estimated numbers of TB cases do not make considerable scientific contributions to TB research. We consider that scientific research should be increased in countries with a high incidence of TB rather than those with a low incidence of TB. Thus, more research and international efforts are urgently required in these low-resource countries to stop TB worldwide.

Finally, this study has some limitations: First is the use of a single database (Scopus) and ruling out other databases that are frequently used in the academic world such as the Web of Science. Second is the consideration of a single type of document (original articles) instead of expanding knowledge by using books, book chapters, conference articles, among others. However, the study presents a meticulous methodology for the selected documents and the use of a database deemed reliable among researchers around the world.²⁶ Third, the total number of citations may be unable to reflect the quality and power of the article. While an innovative article that has not been studied extensively does not receive many citations, an article that contains a topic being worked hard may receive more citations. This issue should also be borne in mind in evaluating the power of an article.

CONCLUSION

In conclusion, the available data provide valuable information about the global progress of TB, despite some limitations of the study. Our study shows that TB publications have increased in the past decades. This study is also very useful in following the developments in the field of TB in Turkey, pioneering publications in our field and their characteristics.²⁷ Furthermore, this is the first worldwide bibliometric TB study from 1849 to 2020 even though several bibliometric TB studies have been carried out so far.

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