

# Global Bibliometric Analysis of Leishmaniasis Literature for the Last 20 Years and Investigating the Contribution of Türkiye

## *Leishmaniasis Literatürünün Son 20 Yıllık Küresel Bibliyometrik Analizi ve Türkiye'nin Katkısının Araştırılması*

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Cite this article as: Alkan S, Evlice O, Şahinoğlu MS. Global Bibliometric Analysis of Leishmaniasis Literature for the Last 20 Years and Investigating the Contribution of Türkiye. Türkiye Parazit Derg 2023;47(3):144-50.

### ABSTRACT

**Objective:** Leishmaniasis is a global health problem seen in more than 98 countries. The aim of this study is to conduct a bibliometric analysis of worldwide scientific outputs related to leishmaniasis and to provide a perspective for researchers on this topic. It also aimed to investigate the contribution of Türkiye to the leishmaniasis literature.

**Methods:** This study was conducted using scientometric methodologies on leishmaniasis in the Web of Science database between 2003 and 2022. The visualizations were made with Vosviewer program. The most published institutions and organizations, countries, authors, trends in the number of publications and citations by year, H-indexes of the mostly publishing countries, the most popular keywords, scientific collaborations between countries, and many other bibliometric parameters were analyzed.

**Results:** In the last 20 years, research on *Leishmania* has been conducted in 143 different countries/regions. Brazil is the leading country with 4.463 articles (29.071%). The United States of America, India, Iran, and Spain published more than 1.000 articles, followed by European countries (Spain, United Kingdom, France, Germany, and Italy).

**Conclusion:** The number of publications, especially in endemic areas, was found to be limited other than Brazil. Studies in this area should be supported to ensure the eradication of the disease.

**Keywords:** Leishmaniasis, bibliometric analysis, network analysis, Web of Science

### ÖZ

**Amaç:** Leishmaniasis 98'den fazla ülkede görülen küresel bir sağlık sorunudur. Bu çalışmanın amacı, leishmaniasis ile ilgili dünya çapındaki bilimsel çıktılarının bibliyometrik bir analizini yapmak ve bu konuyla ilgili araştırmacılara bakış açısı sunmaktır. Ayrıca Türkiye'nin leishmaniasis literatürüne katkısının araştırılması amaçlanmıştır.

**Yöntemler:** Bu çalışma, 2003-2022 yılları arasında Web of Science veri tabanında leishmaniasis üzerine bibliyometrik metodolojiler kullanılarak gerçekleştirildi. Görselleştirmeler Vosviewer programı ile yapıldı. En çok yayın yapan kurum ve kuruluşlar, ülkeler, yazarlar, yıllara göre yayın ve atıf sayılarındaki eğilimler, en popüler anahtar kelimeler, ülkeler ve kurumlar arasındaki bilimsel iş birlikleri ve diğer birçok bibliyometrik parametre analiz edildi.

**Bulgular:** Son 20 yılda 143 farklı ülkede/bölgede *Leishmania* konusunda araştırma yapıldığı saptanmıştır. Brezilya 4,463 makale ile (%29,071) lider ülke konumundadır. Amerika Birleşik Devletleri, Hindistan, İran ve İspanya 1,000'den fazla makale yayınlamış olup, bu ülkeleri Avrupa ülkeleri (İspanya, İngiltere, Fransa, Almanya ve İtalya) takip etmektedir

**Sonuç:** Özellikle endemik bölgelerde yapılan yayın sayısının Brezilya dışında sınırlı olduğu görülmüştür. Hastalığın ortadan kaldırılmasını sağlamak için bu alanda yapılacak çalışmalar desteklenmelidir.

**Anahtar Kelimeler:** Leishmaniasis, bibliyometrik analiz, ağ analizi, Web of Science

Received/Geliş Tarihi: 09.04.2022 Accepted/Kabul Tarihi: 17.07.2023

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## INTRODUCTION

Leishmaniasis is the general term for a group of zoonotic protozoan parasitic diseases caused by species of the obligate intracellular protozoan *Leishmania* genus. This genus consists of more than 20 *Leishmania* subspecies. There are various types of leishmaniasis in humans. Leishmaniasis is generally classified into three groups: Visceral leishmaniasis (VL) (also known as kala-azar, which is the most severe form of the illness), cutaneous leishmaniasis (CL) (the most common form), and mucocutaneous leishmaniasis. VL may affect multiple internal organs (usually spleen, liver, and bone marrow) (1-5). Leishmaniasis is transmitted to mammalian reservoirs (typically domestic dogs, rodents, marsupials, sloths, or wild dogs) through the bite of infected female sandflies. The people living in the endemic areas and the endemic area visitors become incidentally infected (2,3).

Leishmaniasis is one of the neglected tropical diseases mentioned in the World Health Organization (WHO) report. According to WHO statistics, an estimated 700,000 to 1 million new cases are reported annually and approximately more than 95% of new cases reported from Brazil, China, Nepal, Ethiopia, Kenya, India, Iraq, Somalia and Sudan. Leishmaniasis is prevalent in more than 98 countries across five continents globally, especially in the tropics, subtropics, and southern Europe (5). Almost 80% of CL cases have been reported from seven countries: Afghanistan, Algeria, Brazil, Colombia, Iraq, Pakistan, and Syria Arab Republic (6). Climate and certain other environmental factors have the potential to expand the geographic range of sand fly vectors as well as the areas where leishmaniasis is present across the world (4,5). Except for Australia and Antarctica, humans are infected with leishmaniasis on every continent (4). The disease affects poor people more for the reasons such as malnutrition, forced migration, suppressed immune system and lack of financial sources (5).

Since leishmaniasis is a global health problem, an overview of studies on this topic is necessary. The aim of this study was to review the published literature on leishmaniasis worldwide (most contributing countries, institutions, journals with the highest number of publications, etc.) and to examine the publications from Türkiye.

## METHODS

This study was performed by using the scientometric methodologies like previous studies (7,8-14). The selection of early research data is critical in scientometrics since these data have a direct influence on the findings and conclusions. The study covered all publications registered with the subject of *Leishmania* in the Web of Science (WOS) database between 2003-2022.

We used the following search strategy:

The search terms selected as title in the search bar of the WOS database were "leishmaniasis" OR "*Leishmania*" OR "*Leishmania* spp." OR "kala-azar" OR "Cutaneous Leishmaniasis".

**Document Types:** Research article

**Timespan:** January 1, 2003- December 31, 2022.

**Indexes:** WOS Core Collection.

**Editions:** Science Citation Index Expanded (SCI-EXPANDED) and Emerging Sources Citation Index (ESCI)

On March 17, 2023, all electronic searches were completed.

**Inclusion and Exclusion Criteria:** In this study, research articles published in the WOS database between 2003 and 2022 were analyzed. Publications outside the relevant date range, publications other than articles (such as letters, reviews, etc.) were not included. The search was made in the English language.

## Bibliometric Analysis

The publications obtained after the literature search according to the search strategy were downloaded to the computer in plain text format. They were reviewed again for duplicate publications. The obtained data were transferred to vosViewer program (VOSviewer 1.6.18) for analysis. Graphics and visualizations of the WOS bibliometric database were also used. The data obtained were evaluated both at the global level and in terms of Türkiye. The most published institutions and organizations, countries, authors, trends in the number of publications and citations by year, H-indexes of the mostly publishing countries, the most popular keywords, scientific collaborations between countries and many other bibliometric parameters were analyzed.

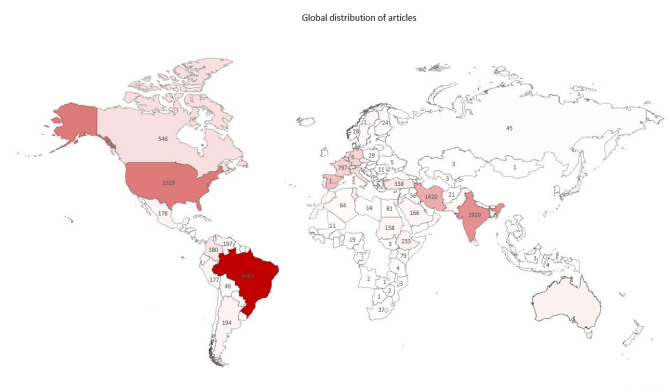
## Statistical Analysis

Statistical analysis was utilized in MS Office Excel 2016 to show the most effective organizations, authors, countries and funding sponsors. The resulting data are expressed in percentages and frequencies. In addition, the annual evolution of published papers was depicted, as well as a trend analysis of these articles.

## RESULTS

Based on the search method utilized in this study, the findings revealed that 15,352 entries in the field of *Leishmania* were indexed in the WOS database between 2003-2022. According to WOS sub-indexes, it was found that the majority of the publications (93.708%) were published SCI-Expanded journals while 5.003% of them in ESCI. In our study, 56.931% of the articles were published as open-access publications.

Throughout the past 20 years, *Leishmania* research has been conducted in 143 different countries/regions. Figure 1 illustrates the global geographic distribution heat map that was created when the data was exported from the Excel software. Brazil was



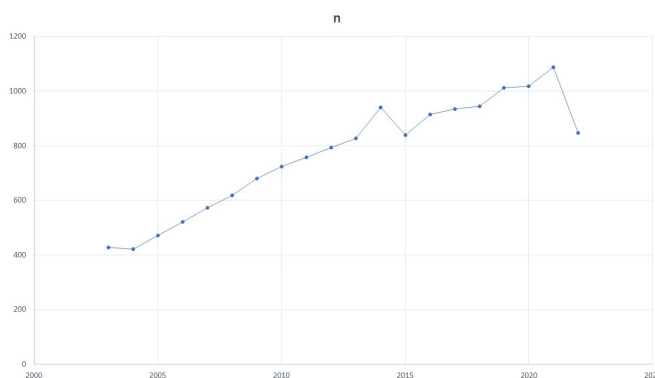
**Figure 1.** Global distribution of the articles

\*\*Regional distribution of *Leishmania* research articles between 2003 and 2022. Map produced using Excel. Most publications are displayed in the reddest regions. Blank spaces indicate that no pertinent literature-related data was gathered

the leading country with 4.463 articles (29.071%) on *Leishmania*. The United States, India, Iran, and Spain have published more than 1.000 articles in *Leishmania* research. And followed by European countries (Spain, England, France, Germany, and Italy). Türkiye ranked 14<sup>th</sup> in the number of publications about *Leishmania* (n=338, 2.202%).

Figure 2 displays the distribution of annual publications during the previous 20 years. In the analysis of the number of publications of Türkiye and the top 5 countries with the highest number of publications according to the time intervals (2003-2012 and 2013-2022), we found that the number of publications increased in all countries in the period 2013-2022, especially in Türkiye, Iran, and Brazil (Table 1).

In the last 20 years, Brazil published the most publications on *Leishmania*. In terms of the total number of citations, Brazilian



**Figure 2.** The distribution of annual publications during the previous 20 years

publications received the highest number of citations. But the USA had both higher H-index and citations per publication (Table 2).

Worldwide, 7.781 organizations/institutions/universities have contributed to *Leishmania* research. The top 3 institutions/organizations/universities in *Leishmania* research between 2003 and 2022 were the Oswaldo Cruz Foundation (n=1.671), the University of São Paulo (n=844), and the Federal University of Minas Gerais (n=680) from Brazil. Top 10 of the most broadcasting organisations were from Iran, France and India (Table 3).

The publications on *Leishmania* were supported by 7.390 funding organisations and 36.862% of them did not have any funding sponsor. The organizations supporting the largest number of *Leishmania* publications were the National Council for Scientific and Technological Development from Brazil (n=1.950), the Coordination for the Improvement of Higher Education Personnel

**Table 1.** Comparison of the number of publications on *Leishmania* in Türkiye and the top 5 countries according to time periods (2003-2012 and 2013-2022)

Country	Time period		
	2003-2012	2013-2022	2003-2022
Brazil	1513	2950	4463
The USA	1058	1271	2329
India	759	1170	1929
Iran	385	1035	1420
Spain	402	676	1078
Türkiye	120	218	338

**Table 2.** Comparison of the number of publications, citations and H-indexes of the top leading 5 countries and Türkiye

Country	Number of publications	Number of total citations	Average number of citations	H-indexes
Brazil	4463*	78297*	17.54	85
The USA	2329	74320	31.91*	104*
India	1929	40477	20.98	77
Iran	1420	18290	12.88	51
Spain	1078	28639	26.57	66
Türkiye	338	4460	13.2	33

\* Accessed from the WOS database

**Table 3.** The 10 most productive organizations/institutions/universities in *Leishmania* research between 2003-2022

Ranking	Organizations/institutions/universities and located country	n	%
1	Oswaldo Cruz Foundation, Brazil	1671	10.885
2	The University of São Paulo, Brazil	844	5.498
3	The Federal University of Minas Gerais, Brazil	680	4.429
4	The Pasteur Institute, France	620	4.039
5	Council of Scientific & Industrial Research, India	581	3.785
6	Tehran University of Medical Sciences, Iran	525	3.420
7	Udice French Research Universities, France	430	2.801
8	The Federal University of Rio de Janeiro or University of Brazil, Brazil	408	2.658
9	The Indian Council of Medical Research, India	344	2.241
10	Federal University of Bahia; University of Bahia, Brazil	336	2.189

from Brazil (n=1.177), and the United States Department of Health Human Services from the USA (n=1.153).

Most of the sponsors ranked in the top 10 were from Brazil. There were also organizations from Europe and India in the top 10 (Table 4).

The top 3 journals that published the most articles on *Leishmania* between 2003 and 2022 were PLOS Neglected Tropical Diseases (n=751), The American Journal of Tropical Medicine and Hygiene (n=492) and Acta Tropica (n=429). The list of the journals with the highest number of publications on this topic is summarised in Table 5.

### Türkiye's Contribution to the Literature on *Leishmania* Between 2003-2022

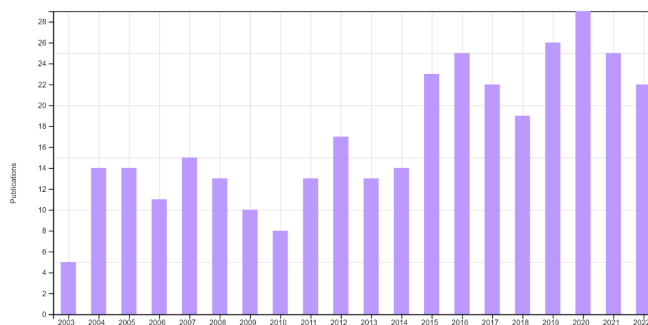
A total of 338 articles on *Leishmania* from Türkiye were published between 2003 and 2022. The years with the highest number of articles published on *Leishmania* from Türkiye were 2020 (n=29), 2019 (n=26) and 2016 (n=25). Although the distribution of publications according to years is irregular, 218 (64.496%) of them were published in 2013 and later. Since 2019, the number of publications has not fallen below 20 publications per year. Figure 3 shows the number of publications on *Leishmania* from Türkiye between 2003 and 2022.

Of these publications, 306 (90.533%) were published in SCIE-indexed journals and 32 (9.467%) in ESCI-indexed journals.

These publications were published by authors from 314 different institutions/affiliations/universities. Ege University (n=96,

28.402%), Manisa Celal Bayar University (n=44, 13.018%), and Çukurova University (n=41, 12.130%) were the institutions from Türkiye that published the most articles on *Leishmania* in the last 20 years. While the number of publications in Türkiye was limited to certain universities in previous years, other universities (Acıbadem University, University of Health Sciences Türkiye) have also contributed to the *Leishmania* literature in the last decade. Table 6 summarizes the institutions/organizations/universities from Türkiye that published most on *Leishmania* between 2003 and 2022.

TUBITAK (the Scientific and Technological Research Council of Türkiye) (n=37), the European Commission (n=12), Çukurova



**Figure 3.** The number of publications from Türkiye on *Leishmania* between 2003-2022

**Table 4.** Leading funding sponsors/organisations of *Leishmania* publications

Funding agencies, country/region	n	%
National Council for Scientific and Technological Development, Brazil	1950	12.702
Coordination for the Improvement of Higher Education Personnel, Brazil	1177	7.667
United States Department of Health Human Services, the USA	1153	7.510
National Institutes Of Health, the USA	1127	7.341
The European Commission, Europe	684	4.455
São Paulo Research Foundation, Brazil	626	4.078
National Institute of Allergy Infectious Diseases, the USA	528	3.439
Minas Gerais State Agency for Research and Development – FAPEMIG, Brazil	520	3.387
Council of Scientific & Industrial Research, India	428	2.788
Rio de Janeiro State Research Foundation (FAPERJ), Brazil	412	2.684

**Table 5.** The list of journals with the highest number of articles on *Leishmania* between 2003 and 2022

Journals	n	%
PLOS Neglected Tropical Diseases	751	4.892
The American Journal of Tropical Medicine and Hygiene	492	3.205
Acta Tropica	429	2.794
PLOS ONE	411	2.677
Experimental Parasitology	382	2.488
Parasites & Vectors	347	2.260
Parasitology Research	293	1.909
Revista da Sociedade Brasileira de Medicina Tropical	262	1.707
Veterinary Parasitology	233	1.518
Memórias do Instituto Oswaldo Cruz	215	1.400
Transactions of the Royal Society of Tropical Medicine and Hygiene	202	1.316



University (n=9), Ege University (n=8), and Hacettepe University (n=5) were the leading organizations in Türkiye that supported the most publications on *Leishmania*. Only 37.574% were supported by the funding agency/organization.

The publications on *Leishmania* from Türkiye in the last 20 years were mostly published in the Bulletin of Microbiology (n=30), Acta Tropica (n=18), the American Journal of Tropical Medicine and Hygiene (n=10), the International Journal of Dermatology (n=5), Experimental Parasitology (n=7), Journal of Vector Ecology (n=4), Journal of Vector Borne Diseases (n=7), and Acta Parasitologica (n=7).

Figure 4 summarizes the most published journals on *Leishmania* from Türkiye in the last 20 years.

Yusuf Özbel (n=55) (Ege University Faculty of Medicine), Seray Toz (n=54) (Ege University Faculty of Medicine), Mehmet Karakuş (n=27) (İstanbul University Health Sciences Institution), Ahmet Özbilgin (n=26) (Manisa Celal Bayar University Faculty of Medicine) and Hatice Ertabaklar (n=24) (Adnan Menderes University Faculty of Medicine) were the authors who published most of the publications on *Leishmania* from Türkiye in the last 20 years.



**Figure 4.** Journals with the most publications on *Leishmania* from Türkiye in last 20 years

**Table 6.** Mostly publishing institutions/affiliations/universities on *Leishmania* from Türkiye between 2003-2022

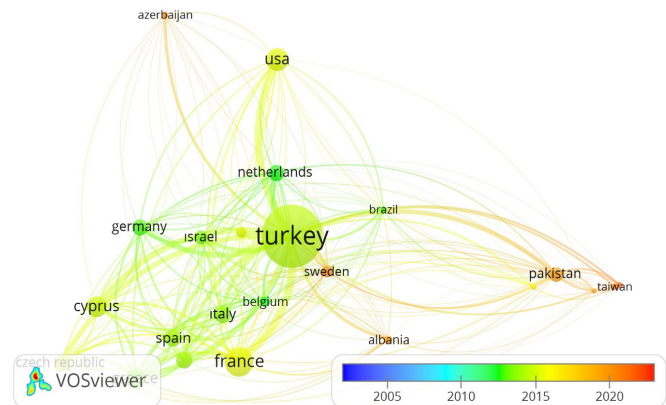
Publishing institutions/affiliations/universities	n	%
Ege University	96	28.402
Manisa Celal Bayar University	44	13.018
Çukurova University	41	12.130
Adnan Menderes University	39	11.538
Harran University	38	11.243
Hacettepe University	30	8.876
Mustafa Kemal University	26	7.692
Akdeniz University	18	5.325
Yıldız Technical University	17	5.030
University of Health Sciences	15	4.438
Fırat University	14	4.142
Dicle University	13	3.846
Mersin University	11	3.254
Acıbadem University	10	2.959
Başkent University	10	2.959
Gülhane Military Medical Academy	10	2.959
İstanbul University	10	2.959

A total of 23 countries were analyzed and a total of 6 clusters, 218 links and 32,450 total link strengths were found when the minimum number of publications of a country was set as at least three articles and bibliographic coupling analysis was performed with VosViewer. Türkiye (n=21,835), the USA (n=4,058), and France (n=6,165) have the highest total link strengths (Figure 5). According to our analysis of the overlay visualization of Türkiye's bibliographic coupling, Türkiye had the most publication collaboration with the USA (n=4,058) and France (n=6,165).

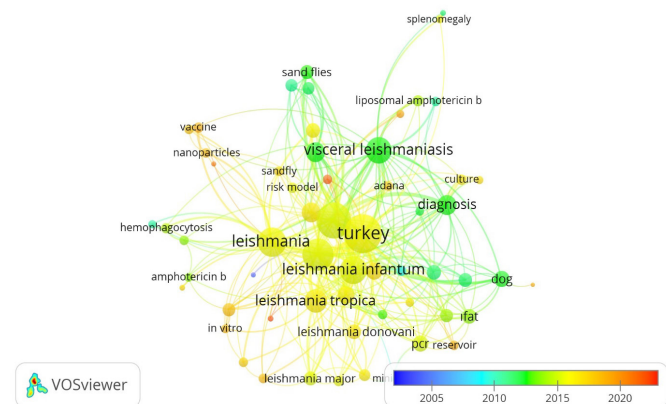
To learn more about the most used keywords, we obtained the visualization graph in Figure 6. We set the minimum number of occurrences of a keyword to at least three and performed keyword analysis with VosViewer. We reached 59 keywords. The size of each point on the map is determined by the number of items there. By default, this color is somewhere between red and blue. 2003 was expressed in shades of blue, 2010- 2015 in green-yellow, and 2015-2022 in yellow and red. The closer the color of a keyword to a time period, the more it appeared in publications in that period.

### DISCUSSION

Leishmaniasis is one of the neglected tropical disease and it is ranked second in terms of mortality and the loss of disability-adjusted life years (5,15). 6<sup>th</sup> World Health Assembly (A60/10)



**Figure 5.** Overlay visualization of bibliographic coupling of Türkiye and other countries on *Leishmania* in the last 20 years



**Figure 6.** Overlay visualization of keywords

published in 2007, states that leishmaniasis patients should be able to receive leishmaniasis treatment for both VL and CL (18). Leishmaniasis has consequently received the attention of both the public health community and funders as a result of becoming a worldwide concern. The WHO has set goals and milestones for the management of leishmaniasis, including the eradication of VL, decreasing case fatality rate of primary VL under 1%, and giving the treatment to at least 90% of CL cases by 2030 (17).

There has been lots of interest in utilizing bibliographic data to analyze scientific research in recent years. This method is regarded as one of the most effective methods for determining the performance criteria of scientific research institutes. In medicine, the use of scientometric approaches for these bibliometric evaluations is constantly increasing (10-26). Although quick databases such as Scopus and WOS have been used in most of these bibliometric studies, sometimes these analyses can be carried out by examining the databases created by the researchers or the materials such as theses and books (8-22). In this study, the analyses were made by examining the WOS database, which is one of the most prestigious databases in the world.

The goal of this study was to conduct a bibliometric analysis of research output of 20 years on leishmaniasis using scientometric methodology. Our results can help to develop a clear picture of the scientific outputs of this field and also help planning and policy development about leishmaniasis. Although there are similar studies on leishmaniasis in the literature (15-24), the current study is the most comprehensive study on leishmaniasis as it examined the global situation of leishmaniasis between 2003-2022. We also aimed to investigate Türkiye's contribution to the leishmaniasis literature because there could not be found any study investigating Türkiye's contribution to the leishmaniasis in the literature.

In the literature although the USA ranked first in most of the global bibliometric studies (8-14), Brazil was ranked first in the current study with 4.463 articles. According to the results of our study, Brazil has always ranked first in both the 2003-2012 and 2013-2022 periods. This may be a result of scientific interest about *Leishmania* in Brazil or the disease's being endemic. In addition, it has been observed that the institutions that produce most of the articles on this subject are often located in Brazil. The USA, India, Iran and England were other productive countries on leishmaniasis. India and Iran, both of which have a significant prevalence of leishmaniasis (5,6), were ranked third and fourth in research output, respectively, and are Asia's leaders in leishmaniasis research. When we compare the results of González-Alcaide et al. (23) with our study, it has been determined that Iran was found to rise in the ranking with the number of publications. Although Türkiye ranked 14<sup>th</sup>, the number of publications and citations have increased over the years. Türkiye is among the endemic countries for this disease. CL is the most common form in Türkiye. And it is endemic in Şanlıurfa, Osmaniye, Adana, Kahramanmaraş, Hatay, and Mersin provinces (25). Within the scope of the "Parasitological, Molecular and Geographical Epidemiological Approach to the Control of Cutaneous Leishmaniasis in Türkiye" project, carried out in cooperation with the General Directorate of Public Health of the Turkish Ministry of Health, with the participation of the Turkish Dermatology Association, in 2018, in Şanlıurfa, "Diagnosis and Treatment of Oriental Boils" treatment training was carried out. The training was attended by people, from Şanlıurfa and surrounding provinces, as

well as physicians who are members of the Turkish Dermatology Association. In addition, the geographical information system based oriental sore notification system developed within the scope of the project was introduced (26). With this meeting, the importance given to the subject by the Turkish Ministry of Health was revealed. This may lead to an increase in the number of publications on *Leishmania* from Türkiye.

Ege University was the institution that published most of the articles on leishmaniasis. Other institutions were also located in regions where the disease was endemic. 37.574% of the studies were not funded from Türkiye and the articles were mainly published in the journals from Türkiye.

In the last 20 years, the advancement of technology has drastically changed the characteristics of research work in Türkiye. The use of high technology (polymerase chain reaction, sequencing, MALDI-TOF, etc.). The first reports of *Leishmania hybrid* isolates, *Leishmania* subtypes associated with Syrians and *Leishmania Virus* positive clinical isolates were reported in Türkiye after 2010 (1,27). While the number of publications in Türkiye was limited to certain universities in previous years, other universities (Acıbadem University, University of Health Sciences Türkiye) have also contributed to the *Leishmania* literature in the last decade due to the reasons mentioned above.

In conclusion, the number of publications, especially in endemic areas, is limited outside Brazil. There was an increase in publication trend in European countries. This may be due to the migration-related to the Syrian civil war in 2011. However, although the number of publications in our country has increased up to 2 times compared to the first 10 years, the number of publications in our country is limited. Ege University ranked first in Türkiye in terms of *Leishmania* publications. However, none of the other institutions have published more than 50 publications in total. Studies should be supported to ensure the eradication of the disease.

### Study Limitations

A single database was used in the study. In addition, only research articles published in the last 20 years were included. English was used as the search language. Therefore, it may not reflect the entire scientific literature due to the WOS database not covering all medical literature. Data visualization was performed in our study.

### CONCLUSION

However, content analysis was not performed and the most cited articles were not analyzed. The database is constantly updated with articles added every day. Although the study has some limitations it is the first study that makes comparisons between global and Turkish *Leishmaniasis* literature, so it may give an idea to researchers in this field.

#### \* Ethics

**Ethics Committee Approval:** Ethics committee approval was not obtained because there was no animal or human study and it was a document review study.

**Informed Consent:** Since the study was a document review study, the data of the patients were not used. Open data of websites were evaluated. Patient consent is not required.

**Peer-review:** Internally and externally peer-reviewed.

### \* Authorship Contributions

Concept: S.A., M.S.Ş., Design: S.A., O.E., M.S.Ş., Data Collection or Processing: S.A., M.S.Ş., Analysis or Interpretation: O.E., S.A., Literature Search: M.S.Ş., S.A., Writing: S.A., M.S.Ş., O.E.

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declared that this study received no financial support.

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