A decade bibliometric analysis of global research on leishmaniasis in Web of Science database

Masoud Soosaraeia, Ali Akbar Khassehb, Mahdi Fakhar*c, Hajar Ziaei Hezarjaribic

a Student Research Committee, Department of Parasitology, Mazandaran University of Medical Sciences, Sari, Iran
b Department of Knowledge and Information Sciences, Payame Noor University, Tehran, Iran
c Molecular and Cell Biology Research Center, Department of Parasitology, Mazandaran University of Medical Sciences, Sari, Iran

ABSTRACT

Background: Leishmaniasis is an extremely relevant tropical disease, with global distribution. It still remains a main public health concern in low-income countries, and it is necessary to support more research on this common disease. Thus, a bibliometric analysis of the global scientific production on leishmaniasis was carried out.

Methods: All the articles registered in Web of Science with the subject of leishmaniasis between 2006 and 2015 were analysed, using Pajek and VOS viewer as tools.

Results: 13,658 records in the field of leishmaniasis were indexed in the Web of Science database for this ten-year study period (2006–2015). This shows that studies on leishmaniasis have been growing, from 1071 in 2006 to 1537 in 2015. “Sundar S” is the most active researcher in the field of leishmaniasis, compiling and participating in 232 Articles. Brazil ranks first in scientific production, by performing 3315 studies on leishmaniasis. The United States, United Kingdom and Australia had the most collaboration in performing the studies of leishmaniasis with each other. In addition, PLOS NEGLECTED TROPICAL DISEASES published the most articles, with 483.

Conclusion: Our data shows an increase in the number of publications in the field of leishmaniasis. In addition, Brazil, USA, and India lead scientific production on leishmaniasis research.

1. Introduction

Leishmania parasites are obligate intracellular protozoa that cause leishmaniasis, a neglected tropical disease responsible for extensive morbidity and mortality in the developing world. Leishmaniasis is endemic in tropical America, Africa, the Indian subcontinent and subtropical areas of Southeast Asia and the Mediterranean region [1]. It represents a group of diseases with very diverse health consequences (from disfiguring lesions spontaneously remitting in a small number of people to severe epidemics with high mortality rates) [2,3]. The global incidence of visceral leishmaniasis (VL) is estimated 50,000 to 90,000 cases each year. Currently, more than 90% of new cases occurred in seven countries: Brazil, Ethiopia, India, Kenya, Somalia, South Sudan and Sudan. While, the global incidence of cutaneous leishmaniasis (CL) is estimated 0.6 million to 1 million new cases annually. About 95% of CL cases occur in the Americas, the Mediterranean basin, the Middle East and Central Asia. Actually, about 70% of new CL cases occur in 6 countries: Afghanistan, Algeria, Brazil, Colombia, Iran and the Syrian. Moreover, Over 90% of mucocutaneous leishmaniasis (MCL) cases occur in Bolivia, Brazil, Ethiopia and Peru [4]. These estimates also include those that are not considered in many endemic countries due to the lack of reporting of many new cases of disease (in rural areas) or the unwillingness to report these cases [5,6]. VL creates large-scale epidemics and the number of patients per year varies greatly. During 1991, large outbreaks occurred in India. The number of patients in India alone amounted to about 250,000 people. Because the fatality rate in diagnosed and treated cases was between 5 and 10% (in Sudan up to 14%), and in untreated cases 100%, it is estimated that about 75,000 people were killed by VL in 1991 [7]. Infection with CL is less severe, but still causes great physical discomfort, and also affects the psychological and social aspect of day-to-day life [6]. For over 70 years, antimonials were used to treat the leishmaniasis [1]. The drug most commonly used in single regimen treatment was sodium stibogluconate (SSG, 56.9%), followed by meglumine antimoniate (glucantime, 20.4%) [5].

Bibliometric studies encompass a wide range of scientific and research communities, and are featured in many journals of different fields. Nowadays, a high volume of bibliometric studies are carried out, in an attempt to analyse the process of collaboration between researchers and medical professionals. Due to the outbreak of a group of infectious diseases, which are particularly endemic in poor populations

https://doi.org/10.1016/j.amsu.2017.12.014
Received 21 July 2017; Received in revised form 22 November 2017; Accepted 29 December 2017
2049-0801/©2018 Published by Elsevier Ltd on behalf of LJS Publishing Group Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/BY-NC-ND/4.0/).
living in tropical and subtropical countries, there are specific journals now available for getting this research published in the literature [9]. A number of international bibliometric studies exist in various medical fields, including tropical medicine [10–16]. Several publications have analysed the research production for other neglected tropical diseases, such as leprosy [17–20] schistosomiasis [17,21] and Chagas disease [17,22].

Given how important research on Leishmania is to global health, it is necessary to create a comprehensive view of the status of research in this area, and a clear picture of the production process and scientific exchanges in the field. This will also aid in any planning and policymaking. Obviously, the improvement of the scientific situation in the field of leishmaniasis over time will lead to progress in preventing, treating and reducing mortality. Thus, the aim of the present study was bibliometric analysis of the global scientific production, and determining the top researchers in the field and their geographic distribution.

2. Methods

This research was conducted using scientometric techniques. In scientometrics, selection of preliminary research data is of utmost importance, as these data have a direct impact on the findings and results. The research analysed included all articles registered with the subject of Leishmania between 2006 and 2015 in Web of Science. The following search strategy was used:

- **TOPIC:** ("leishmania")
- **Refined by:** DOCUMENT TYPES: (ARTICLE OR REVIEW OR PROCEEDINGS PAPER)
- **Timespan:** 2006–2015.
- **Indexes:** SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI.

The use of “[...]” in the above strategy means all kinds of derivatives of the Leishmania search term, such as leishmaniasis, Leishmania spp, leishmaniasis, etc. are also assessed and the records retrieved. Guided by the above approach, 13658 records were identified and studied. The search strategy was done on 21st August 2016. After retrieving the records related to the field of Leishmania and integrating data files, Pajek 4.10 and VOS viewer 1.6.4 were used for data analysis.

3. Results

### 3.1. Quantification of Leishmania studies

Based on the search strategy used in this study, the findings showed that 13658 records were indexed in the field of Leishmania in the Web of Science database over a period of ten years (2006–2015). As shown in Fig. 1, the findings indicate that over the past ten years, there has been a relative growth of studies on Leishmania, so that the number of researches rose from 1071 in 2006 to 1537 in 2015. Studies on Iranian researchers in the field of Leishmania indicate that within this period, 725 articles have been registered by international researchers, with the highest number in 2013 (115 items) and the lowest in 2006 (27 items).

The article titled “Leishmaniasis worldwide and global estimates of its incidence” published in 2012 in the journal PLOS ONE is considered the most highly cited in Web of Science. Most studies conducted are in the field of vaccination of leishmaniasis and its treatment, indicating the importance of prevention, treatment and vaccination against this disease. Full characteristics of the most cited studies on Leishmania are presented in Table 1, divided into Iran and the world.

Preliminary analysis of the data shows that a total of 38,789 researchers have played a role in the publication of 13658 articles, amongst which “Shyam Sundar” is considered the most active researcher in the field, by contributing to 232 of these articles globally. “Pradeep Das “is in second place, with 144 articles. These and other relevant researchers are presented in Table 2. Two Iranian researchers, named “Mahdi Mohebali” and “Ali Khamesipour”, contributed to 98 and 85 articles in the field, ranking fifth and eighth in the world, respectively.

Measuring the productivity of a researcher is not necessarily a measure of their impact; the ideas presented in these studies should be read by others and accumulate citations. Therefore, the impact of a researcher is not only affected by the number of published works, but more importantly, also by the amount of use and citation by others. For this reason, one of the important dimensions in the discussion of the impact of researchers is the attraction of the ideas of a researcher by other researchers in that area. Accordingly, if research is influential, it is necessary to use and cite in other research; and the extent to which these references are made may influence the work of a researcher. The H-index is among the commonest criteria used for identifying effective researchers in a subject area. It is designed to indicate the cumulative effect of research output, and considers the number of article downloads and the number of citations simultaneously.

As shown in Table 3, “Sundar S” with an H-index of 38 ranks highest amongst all Leishmania researchers. H-index of 38 means that 38 articles among 232 articles of “Sundra S” have received at least 38 citations. “Dujardin J C “and “Boelaert M”, with an H-index of 32 and 29, respectively, are ranked second and third.

#### 3.2. Geographical distribution of Leishmania studies

The results show that Brazil is ranked first in research output, with 3315 studies on Leishmania. Between 2006 and 2015, the researchers from this country shared over 24% of the studies that were indexed. The top ten countries in terms of research output in the field of Leishmania...
are shown in Fig. 2. Noteworthy is the absence of the United States as the top country, Iran's presence among the leading countries (ranking eighth), and India ranking third.

As it is clear from Fig. 2, in terms of geographical distribution, that European countries are more active regarding the studies of *Leishmania*, and that India and Iran lead the research in Asia. The continents of North America and South America also have a representative amongst them. Africa may not have any representation amongst active countries due to economic problems and lack of properly equipped facilities. One of the reasons Brazil has a high research output is because cutaneous, muco-cutaneous and visceral leishmaniasis diseases is more common there. The researchers of Fundação Oswaldo Cruz, Brazil, participated in the compilation of 1207 articles (8.84%).

The top ten global organizations are mentioned in Table 4. We have also displayed the participation of Iranian cities with other global cities in Fig. 3.

As it can be seen in Fig. 4, in the thick network of links among each of the countries indicate the amount and intensity of their international collaboration. For example, the thickness of the relationship among the United States and two of the United Kingdom and Australia is more than other countries indicating that the researchers of United States with researchers from two countries have the most collaboration in performing the studies of *Leishmania* with each other. Generally, as it can be seen in the following map, many researchers in many countries in line with studying the studies of *Leishmania* with their counterparts in the United States have had the international collaboration.

### 3.3. Analysis of publications on *Leishmania* by journal

The findings showed that studies on *Leishmania* had been published in 1670 different journals over the ten years that were analysed (2006–2015). PLOS NEGLECTED TROPICAL DISEASES published 483 articles, and PLOS ONE and EXPERIMENTAL PARASITOLOGY published 329 and 385 articles, respectively.
3.4. Map of Leishmania research by frequency of the title words

Analysis of Leishmania research based on the frequency of the words used in the title of the articles can achieve a general and conceptual image of the content of these studies. Accordingly, our findings show that the most Leishmania research has been focused on therapy, and to a lesser extent on diagnostic methods in all regions of the world. Findings related to this aspect of the bibliometric analysis are presented in Table 5 and Figs. 5 and 6, divided into studies carried out globally, or Iranian studies.

3.5. Analysis of keywords using the Word Cloud tool

After all relevant keywords were extracted from the articles; they were entered into the Word Cloud tool. As an example, the keywords Leishmania and leishmaniasis appear bigger than other words,
indicating that they have been mentioned most frequently (Figs. 7 and 8).

4. Discussion

The purpose of this research was to perform a bibliometric analysis using scientometric techniques, of ten years of research output in the field of Leishmania. Given how important research on Leishmania is to global health, it is necessary to create a comprehensive view of the status of research in this area, and a clear picture of the production process and scientific exchanges in the field. This will also aid in any planning and policy-making.

Undoubtedly, the universities play an important role in scientific production and acceleration of progress in every country. In recent years, there has been great interest in the use of bibliographic information for the evaluation of research activities. Evaluation of research activities is considered one of the best means to determine the performance standards of scientific research centers [23]. The use of scientometric techniques for these bibliometric analyses is steadily rising [24,25].

In the present study, Iranian scientific research in the field of Leishmania was appropriately explored within the ten-year period (2006–2015), which showed that 13,658 records were recorded in the Leishmania field on the Web of Science database [20]. Given the endemic region of the Middle East in terms of leishmaniasis, Iran has carried out a lot of research in the field of leishmaniasis in the interest of other countries in the Middle East, where lack of suitable research facilities due to civil wars and political conflicts makes this impossible.

Furthermore, we have received adequate insight into the status of Iranian researchers in cooperation with their counterparts around the world the Leishmania area, it will be beneficial if you also draw full network of collaboration among different countries together. The view associated with this network which is related to the top twenty countries in the field of Leishmania and it is drawn using the software of Net Draw. This view reflects the activities and international partnerships of the active researchers in the field of the studies of Leishmania.

Brazil was the leading country in publication output on leishmaniasis, unlike previous years where USA was a pioneer in the field [10–12]. There are more cases of leishmaniasis reported in South America, and Brazil’s scientific system has been making progress, becoming the principal scientific power for South America [26].

Among the interesting points available in the network of international collaboration in the studies of Leishmania is related to Brazil; as it was mentioned earlier, the researchers in Brazil have the largest scientific production in the field of Leishmania in the last decade, but with a review at the following map, it is revealed that the researchers of this country compared to the researchers from a number of countries including the United States have done so much collaboration with their counterparts in other countries and they have more intend to do the studies of Leishmania in the country. The relationship between people and different countries and exchange of technology can be of great importance to the fight and prevention of the disease.

India and Iran, countries with a high prevalence of leishmaniasis [27–30], were ranked third and eighth in scientific output, respectively, and are leading scientific production on leishmaniasis in Asia.

Gonzalez-Alcaide et al. (2013) in a study concerning worldwide
scientific production on leishmaniasis between 1945 and 2010 demonstrated that 735 authors contribute in 154 top research clusters. Brazil led the pack in their research, with various Brazilian researchers heading different clusters in the focal point of the collaboration network. They believed that leishmaniasis research should be promoted in poor countries such as Sudan, Bangladesh, and Nepal where there is annually a high morbidity and mortality rate of CL and VL forms of the disease, however limited research progress with reference authors incorporated into the collaboration networks [31]. Additionally, Ramos et al. (2013) appeared among leishmaniasis
records, which published in 1846 scientific journals, “Transactions of the Royal Society of Tropical Medicine and Hygiene” was the main one. The USA, Brazil, and India were the most important countries by considering the first author's affiliation address, respectively; however, Brazil drives the logical scientific yield throughout 2001 to 2010 period [32].

Moreover, Huamani et al. (2014) and Perilla-Gonzalez et al. (2014) expressed that South American is core of the major logical scientific network in leishmaniasis and also scientific production on leishmaniasis have published in journals indexed in SCOPUS with emphasis on Brazilian research activity. Thus, it is important to reinforce the collaboration networks [33,34].

Overall, the investigation of scientific co-authorship through social network analysis takes into account a more exact examination of the cooperation structures inside an order or area of knowledge than studies in view of bibliometric markers alone. All such investigations report an expansion in both scientific productions on leishmaniasis and collaboration among institutions and countries. In any case, the collaboration among authors and the formation of research groups in the field have been less noted and assessed.

Our findings have shown that in total, 38,789 researchers had a role in creating 13658 articles, among which Shyam Sundar was considered the most active researcher in the field of Leishmania, by compiling and participating in the production of 232. His articles are cited 6212 times, and his H-index of 38 is a suitable number for leading researchers in the field. It is shown in this study that Brazil and India are two leading countries in scientific production on leishmaniasis, the reason being that it is endemic in these areas.

5. Conclusions

We studied and evaluated the global scientific production in the field of Leishmania, analysing records indexed in Web of Science and determining the current top researchers, mapping their geographical distribution and mapping the journals publishing the research. It is hoped that with more and better cooperation amongst different countries, we can take an effective step in producing a vaccine for leishmaniasis.

Ethical approval

This project was funded by Mazandaran University of Medical Sciences (no: 2052).

Funding

There has been no financial support for this work that could have influenced its outcome.

Author contribution

Study concept: Mahdi Fakhar.
Data collection: Masoud Soosaraei, Ali Akbar Khasseh.
Data interpretation: Masoud Soosaraei, Mahdi Fakhar, Ali Akbar Khasseh, Hajar Ziaei Hezarjaribi.
Writing the paper: Masoud Soosaraei, Mahdi Fakhar.

Conflicts of interest

All authors declare that they have no conflicts of interest.

Research registration unique identifying number (UIN)

Research registry 2052.

Guarantor

Mahdi Fakhar.

Grant information

The authors declare that no grants were involved in supporting this work.

References

[1] World Health Organization, Control of the Leishmaniases: Report of a Meeting of the WHO Expert Committee on the Control of Leishmaniases, (2010).
[2] M.P. Barrett, S.L. Croft, Management of trypanosomiasis and leishmaniasis, Br. Med. Bull. 104 (2012) 175–196.
[3] R. Lozano, M. Naghavi, K. Foreman, S. Lim, K. Shibuya, V. Aboyans, J. Abraham, T. Adair, R. Aggarwal, S.Y. Ahn, 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, Lancet 380 (9859) (2013) 2095–2128.
[4] World Health Organization (WHO), Leishmaniasis, (October;2017) Fact sheet, n. 375 http://www.who.int/mediacentre/factsheets/fs375/en/ (Updated April 2017).
[5] S.A. Ejazi, N. Ali, Developments in diagnosis and treatment of visceral leishmaniasis during the last decade and future prospects, Expert Rev. Anti Infect. Ther. 11 (1) (2013) 79–98.
[6] World Health Organization (WHO), First WHO Report on Neglected Tropical Diseases: Working to Overcome the Global Impact of Neglected Tropical Diseases
[7] Vijay P. Singh, Alok Ranjan, Roshan K. Topno, Rakesh B. Verma, Niyamat A. Siddiqui, Vidya N. Ravidas, Narendra Kumar, Krishna Pandey, Pradeep Das, Estimation of under-reporting of visceral leishmaniasis cases in Bihar, India, Am. J. Trop. Med. Hyg. 82 (1) (2010) 9–11.

[8] World Health Organization (WHO), Weekly Epidemiological Record (WER) vol. 92, (6 October 2017), pp. 589–608 40.

[9] J. Utzinger, S.L. Becker, S. Knopp, J. Blum, A.L. Neumayr, J. Keiser, C.F. Hatz, World Health Organization (WHO), Control of the Leishmaniases, World Health Organ Tech Rep Ser 11 (8) (2010) 603–611.

[10] J. Keiser, J. Utzinger, Trends in the core literature on tropical medicine: a bibliometric analysis from 1957 to 2006, Int. J. Tubercul. Lung Dis. 12 (12) (2008) 1461–1468.

[11] J. Viquez, J.M. Ramos, E.M. Navarrete-Muñoz, M. García-de-la-Hera, A bibliometric study of scientific literature on obesity research in PubMed (1988–2007), Obes. Rev. 11 (8) (2010) 603–611.

[12] H.C. Zheng, L. Yan, L. Cui, Y.F. Guan, Y. Takano, Mapping the history and current situation of research on John Cunningham virus—a bibliometric analysis, BMC Infect. Dis. 9 (1) (2009) 1.

[13] J. Keiser, J. Utzinger, M. Tanner, B.H. Singer, Representation of authors and editors from countries with different human development indexes in the leading literature on tropical medicine: survey of current evidence, BMJ 328 (7450) (2004) 1229–1233.

[14] M.E. Falagas, A.I. Karavasiou, I.A. Blixtiotis, A bibliometric analysis of global trends of research productivity in tropical medicine, Acta Trop. 99 (2) (2006) 155–159.

[15] S.W. Glover, S.L. Bowen, Bibliometric analysis of research published in tropical medicine and international health 1996–2003, Trop. Med. Int. Health 9 (12) (2004) 1327–1330.

[16] J. Keiser, J. Utzinger, Trends in the core literature on tropical medicine: a bibliographic analysis from 1952-2002, Scientometrics 62 (3) (2005) 351–365.

[17] C.M. Morel, S.J. Serruya, G.O. Penna, R. Guimarães, Co-authorship network analysis: a powerful tool for strategic planning of research, development and capacity building programs on neglected diseases, PLoS Neglect Trop. Dis. 3 (8) (2009) 661–666.

[18] D. Schoonbaert, V. Demedts, Analysis of the leprosy literature indexed in Medline, Lepr. Rev. 79 (4) (2008) 387–400.

[19] A.A. Khalab, M. Soosaraei, M. Fakhar, Cluster analysis and mapping of Iranian researchers in the field of parasitology: with an emphasis on the Co-authorship Indicators and H Index, Iranian J. Med. Microbiol. 10 (2) (2016) 63–74.

[20] A.A. Khalab, M. Fakhar, M. Soosaraei, S. Sadeghi, Present situation of scientific productions of Iranian researchers in parasitology domain in ISI databases, Iranian J. Med. Microbiol. 5 (1) (2011) 53–65.

[21] L.J.A. Costa, R.C.M. Schmitt, M.H. Piegas, A. Peixinho, A. Schmidt, dLAA. Briquet, S.C.A. Marcilio, Analysis of scientific information published in Brazil in 5 years on Chagas disease, schistosomiasis, malaria, leishmaniasis and filariasis, Educ. Med. Salud 19 (2) (1984) 209–226.

[22] E. Handman, Leishmaniasis: current status of vaccine development, Clin. Microbiol. Rev. 14 (2) (2001) 229–243.

[23] A. Uzun, A scientometric profile of social sciences research in Turkey, Int. Inf. Libr. Rev. 30 (3) (1998) 169–184.

[24] Y. Tian, C. Wen, S. Hong, Global scientific production on GIS research by bibliometric analysis from 1997 to 2006, J. Infect. 2 (1) (2008) 65–74.

[25] D. Bharvi, K. Garg, A. Bals, Scientometrics of the international journal scientometrics, Scientometrics 56 (1) (2003) 81–93.

[26] EAD Almeida, A.N. Ramos Junior, D. Correia, M.A. Shikanai Yasuda, Rede Brasileira de Atenção e Estudos na Co-infeção Trypanosoma cruzi/ HIV e em outras condições de imunossupressão, Rev. Soc. Bras. Med. Trop. 42 (2009) 665–668.

[27] Organization WH, Control of the Leishmaniases, World Health Organ Tech Rep Ser 10 (2009) 494.

[28] J. Alvar, I.D. Velez, C. Bern, M. Herrero, P. Desjeux, J. Cano, J. Jannin, M. den Boer, W.L.C. Team, Leishmaniasis worldwide and global estimates of its incidence, PLoS One 7 (5) (2012) e35671.

[29] S. Sundar, P.K. Sinha, D.K. Verma, N. Kumar, S. Alam, K. Pandey, P. Kumar, V. Ravidas, J. Chakravarty, N. Verma, Ambisome plus miltefosine for Indian patients with kala-azar, Trans. Roy. Soc. Trop. Med. Hyg. 105 (2) (2011) 115–117.

[30] V.N.R. Das, N.A. Siddiqui, R.B. Verma, R.K. Topno, D. Singh, S. Das, A. Ranjan, K. Pandey, N. Kumar, P. Das, Asymptomatic infection of visceral leishmaniasis in hyperendemic areas of Vaishali district, Bihar, India: a challenge to kala-azar elimination programmes, Trans. Roy. Soc. Trop. Med. Hyg. 105 (11) (2011) 661–666.

[31] G. Gonzalez-Alcaide, C. Huamani, J. Park, J.M. Ramos, Evolution of coauthorship networks: worldwide scientific production on leishmaniasis, Rev. Soc. Bras. Med. Trop. 46 (6) (2013) 719–727.

[32] J.M. Ramos, G. González-Alcaide, M. Bolaños-Pizarro, Bibliometric analysis of leishmaniasis research in Medline (1945-2010), Parasites Vectors 6 (1) (2013) 1.

[33] C. Huamani, F. Romani, G. González-Alcaide, M.O. Mejía, J.M. Ramos, M. Espinoza, C. Cabezas, South American collaboration in scientific publications on leishmaniais: bibliometric analysis in SCOPUS (2000-2011), Rev. Inst. Med. Trop. Sao Paulo 56 (5) (2014) 381–390.

[34] Y. Perilla-Gonzalez, D. Gomez-Suta, N. Delgado-Osorio, N. Hurtado-Hurtado, J.D. Baquero-Rodriguez, A.F. Lopez-Isaza, G.J. Lagos-Grisales, S. Villegas, A.J. Rodriguez-Morales, Study of the scientific production on leishmaniasis in Latin America, Recent pat. Anti-Infect. Drug Discov. 9 (3) (2014) 216–222.