



Review

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

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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 new 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%) [8].

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

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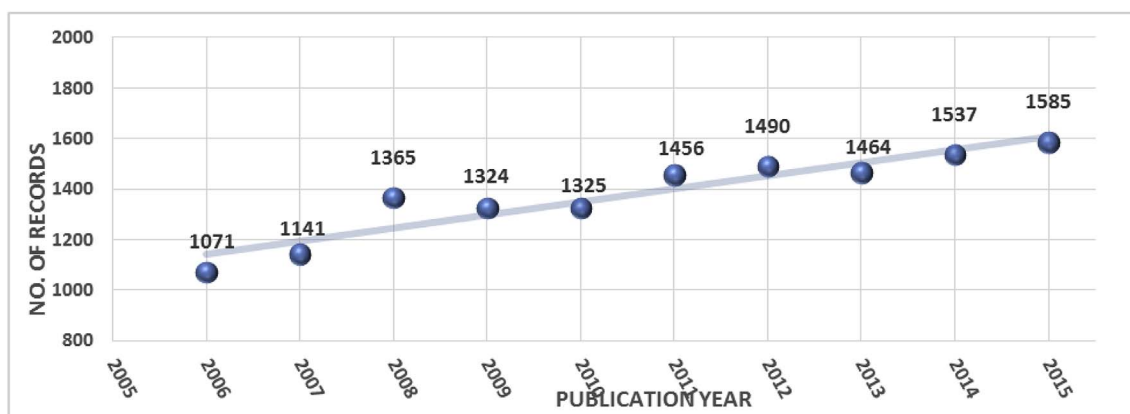


Fig. 1. Quantitative growth process of the studies concerning leishmaniasis in the period of ten years.

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 policy-making. 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 Mohebbi" 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 "Sundar 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*

Table 1
Most cited global research in the field of *Leishmania*.

Principal authors	Title	Publication year	Country	Institutional affiliation	Journal	No. of citations
1 Alvar J, Vélez ID, Bern C, Herrero M, Desjeux P, Cano J, Jannin J, den Boer M.	Leishmaniasis worldwide and global estimates of its incidence.	2012	Switzerland	Department for the Control of Neglected Tropical Diseases (HTM/NTD/IDM), Leishmaniasis Control Program, World Health Organization, Geneva, Switzerland.	PloS one	913
2 Darrah PA, Patel DT, De Luca PM, Lindsay RW, Davey DF, Flynn BJ, Hoff ST, Andersen P, Reed SG, Morris SL, Roederer M, Seder RA.	Multifunctional TH1 cells define a correlate of vaccine-mediated protection against <i>Leishmania</i> major.	2007	USA	Cellular Immunology Section, Vaccine Research Center, National Institute of Allergy and Infectious Diseases (NIAID), National Institutes of Health (NIH), 40 Convent Drive, Bethesda, Maryland 20892, USA	Nature medicine	748
3 Seder RA, Darrah PA, Roederer, M.	T-cell quality in memory and protection: implications for vaccine design.	2008	USA	Cellular Immunology Section, Vaccine Research Center, National Institute of Allergy and Infectious Diseases (NIAID), National Institutes of Health (NIH), 40 Convent Drive, Bethesda, Maryland 20892, USA	Nature Reviews Immunology	708
4 Collison LW, Workman CJ, Kuo TT, Boyd K, Wang Y, Vignali KM, Cross R, Sehy D, Blumberg RS, Vignali DA.	The inhibitory cytokine IL-35 contributes to regulatory T-cell function	2007	USA	Department of Immunology, St. Jude Children's Research Hospital, Memphis, Tennessee 38105, USA.	Nature	700
5 Croft SL, Sundar S, Fairlamb AH.	Drug resistance in leishmaniasis	2006	Switzerland	Drugs for Neglected Diseases Initiative, 1 Place Saint-Gervais, CH-1201 Geneva, Switzerland.	Clinical microbiology reviews	666

Table 2
Most productive researchers in the field of *Leishmania*.

Author name	No. of articles
Sundar S	232
Das P	144
Boelaert M	120
Dujardin JC	120
Mohebbi M	98
Kaiser M	94
Brun R	93
Khamesipour A	85
Dube A	85
Gupta S	83

Table 3
Top researchers based on H-index in the field of *Leishmania*.

Rank	Author name	All articles	All citations	H-index
1	Sundar S	232	6212	38
2	Dujardin JC	120	3508	32
3	Boelaert M	120	3129	29
4	Rijal S	79	2210	26
5	Brun R	93	2055	25
6	Fairlamb AH	42	1789	23
7	Ouellette M	59	1434	23
8	Volf P	78	1283	23
9	Wilson ME	57	1083	23
10	Schonian G	65	1617	22
11	Coombs GH	53	1384	22
12	Reed SG	48	1826	21
13	Mottram JC	57	1751	21
14	Kamhawi S	42	1613	21
15	Kaiser M	94	1372	21

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.

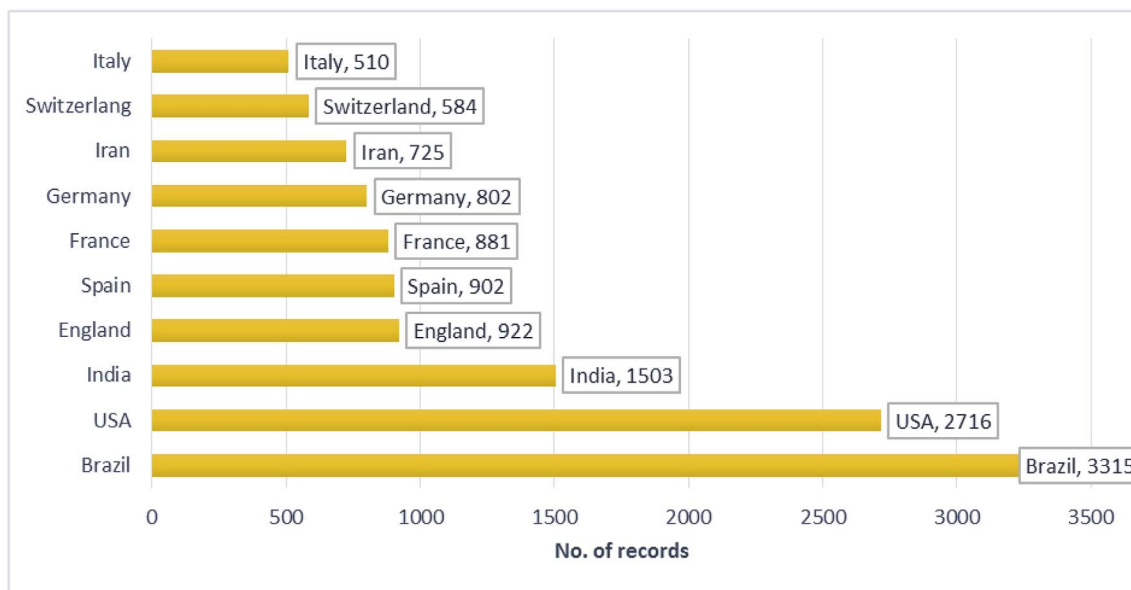


Fig. 2. 10 leading countries in the studies concerning leishmaniasis.

Table 4

Ten primary organizations in the field of *Leishmania*.

Organization name	All articles	Percent of all records
FUNDACAO OSWALDO CRUZ	1207	8.8%
UNIVERSIDADE DE SAO PAULO	641	4.69%
UNIVERSIDADE FEDERAL DE MINAS GERAIS	478	3.49%
LE RESEAU INTERNATIONAL DES INSTITUTS PASTEUR RIIP	411	3%
UNIVERSIDADE FEDERAL DO RIO DE JANEIRO	394	2.88%
COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH CSIR INDIA	345	2.52%
CENTERRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	333	2.45%
TEHRAN UNIVERSITY OF MEDICAL SCIENCES	321	2.35%
UNIVERSITY OF LONDON	316	2.31%
NATIONAL INSTITUTES OF HEALTH NIH USA	273	1.99%

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,



Fig. 3. The cooperation of different scholars in Iran with other regions in the world.

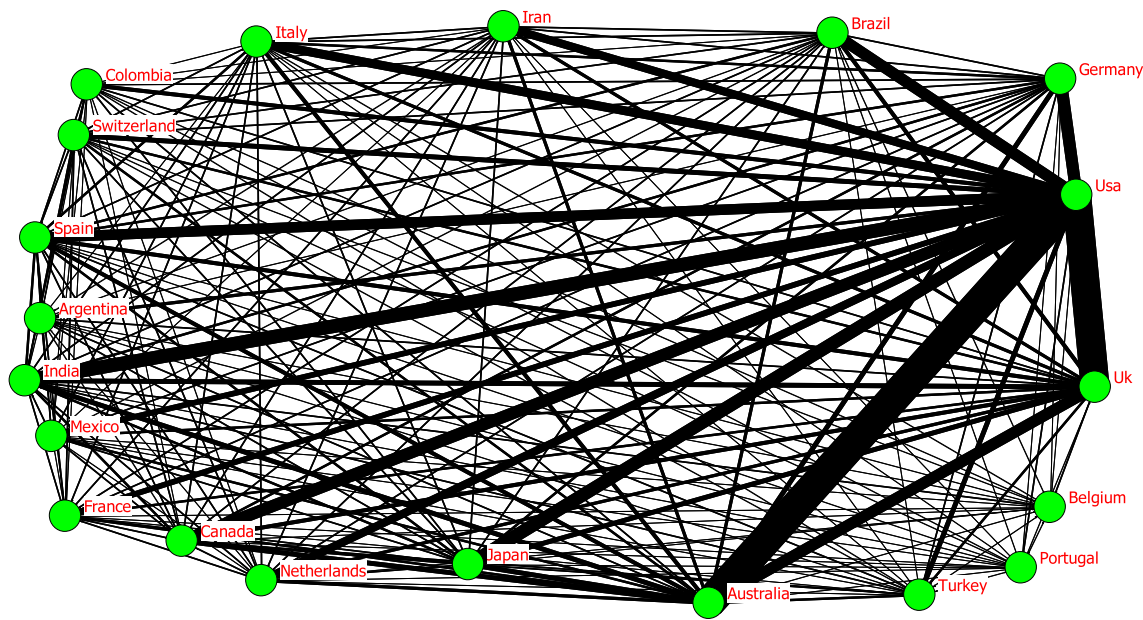


Fig. 4. Cooperation full network between different countries in the field of leishmaniasis.

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

Table 5
Most frequent words used in the title of *Leishmania* studies in Iran and the world.

Rank	World <i>Leishmania</i> Research		Iran <i>Leishmania</i> Research	
	Term	Occurrences	Term	Occurrences
1	Brazil	569	Leishmaniasis	265
2	Activity	557	Iran	213
3	Treatment	493	Effect	53
4	Diptera	450	Evaluation	43
5	Psychodidae	437	Treatment	40
6	Synthesis	418	Balb/c mouse	33
7	Area	325	Diagnosis	28
8	Response	315	Zoonotic cutaneous leishmaniasis	28
9	State	312	Expression	27
10	Expression	282	Dog	21
11	Macrophage	255	Psychodidae	21
12	Cell	227	Diptera	19
13	Antileishmanial activity	215	Synthesis	19
14	Immune response	209	Efficacy	18
15	Efficacy	199	Immune response	18
16	In vitro	198	Protection	17
17	Mouse	195	In vitro	16
18	Derivative	191	Balb/c	15
19	India	176	Glucantime	15
20	Resistance	166	MRHO/IR (strain)	15

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

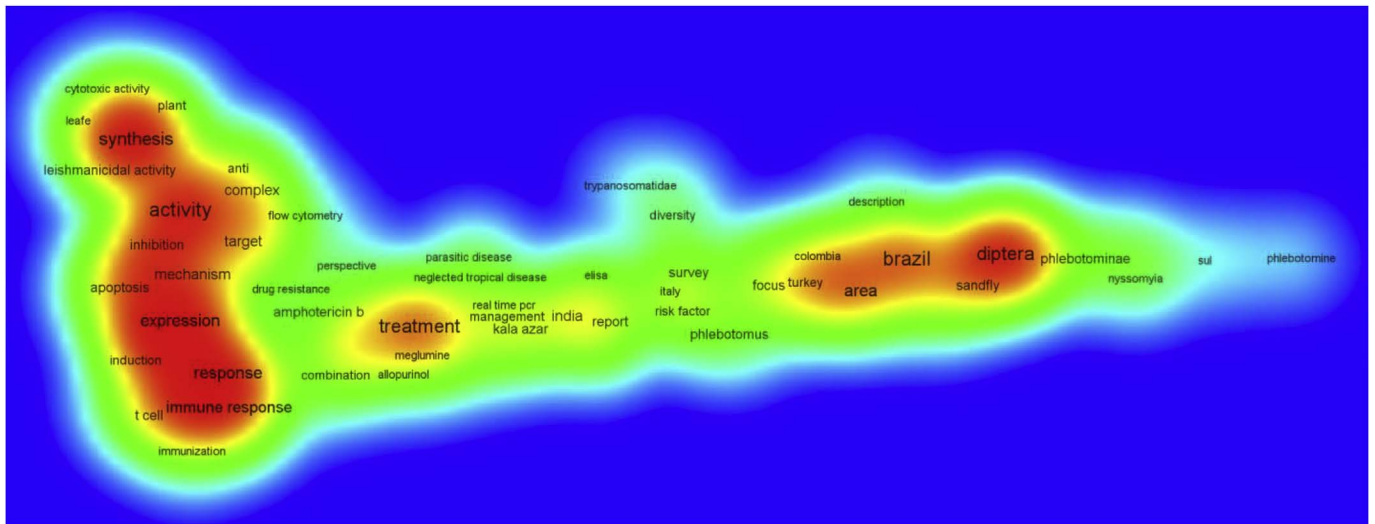


Fig. 5. Density view of the most frequent terms used in the global studies concerning leishmaniasis.

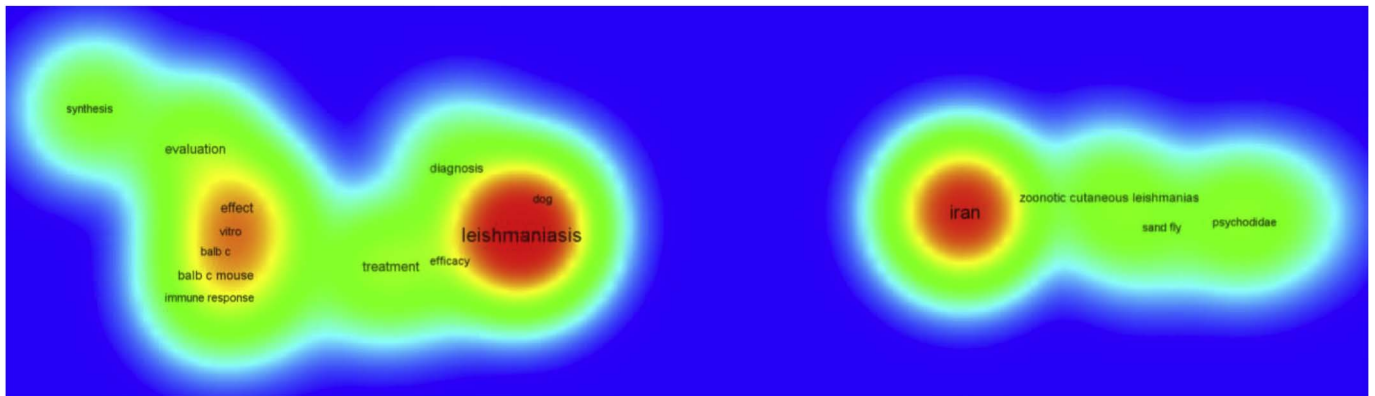


Fig. 6. Density view of the most frequent terms used in Iranian studies concerning leishmaniasis.

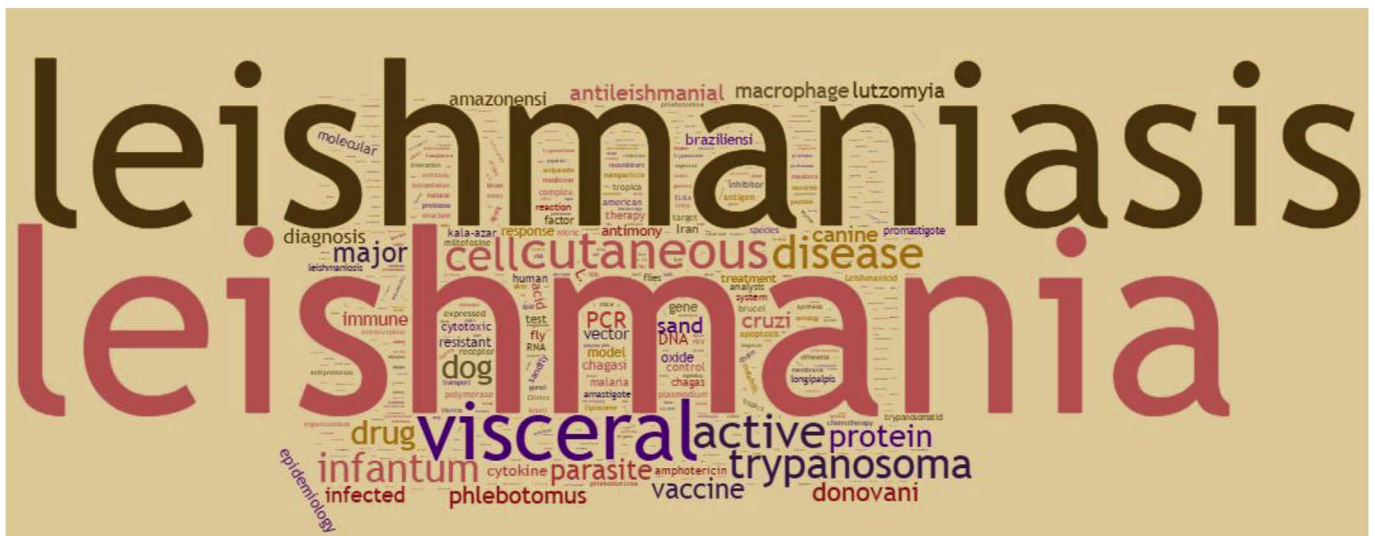


Fig. 7. Word cloud of global research keywords of *Leishmania*.

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

- vol. 1, (2010), pp. 91–96 WHO/HTM/NTD/.
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