Research Article

Bibliometric analysis and current status of Leishmaniasis research indexed in Scopus, 2010 -2023

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Background

Leishmaniasis as many Neglected Tropical Diseases conditions is prevalent in impoverished communities in tropical and sub-tropical areas across Africa, Asia, and Latin America. Leishmaniasis is a vector-borne disease caused by different species of protozoan parasites of the genus Leishmania. Approximately 90 sandfly species have been associated with the transmission of more than 90 *Leishmania* species with approximately 350 million people at risk and more than 2 million infections occurring worldwide annually.

Methods

This study employs bibliometric and visual analysis to explore trends in leishmaniasis research, aiming to identify research themes, hotspots, and future development trends. The search strategy used in the Scopus database was ["leishmaniasis" OR "*Leishmania*" OR "leishmania infection" in all fields] from 2010 until 30th March 2023. Neither language nor document type restriction was employed during the search and information analysis.

Results

For the period 2010-2023, a total of 21,362 publications were retrieved, a gradual increase from 6,983 publications between 2010 and 2014 to 14,379 publications from 2015 to March 2023. The research communication on leishmaniasis spans 160 scientific journals, with Plos Neglected Tropical Diseases being the leading journal (4.71%). Brazil leads in the total number of publications (25.58%), followed by the USA (14.71%) and India (11.89%). Notably, the majority of authors and organizational affiliations with the highest number of citations were from Europe. In science mapping, the USA emerges as a leader

in citations, bibliographic coupling, and co-authorship. Authors and organizational affiliations with the highest number of citations predominantly hail from Europe.

Conclusions

This study highlights a steady increase in leishmaniasis research publications, with the USA and Brazil at the forefront. It underscores the need for enhanced collaborations and research infrastructure in low and middle-income countries, where leishmaniasis burden is significant. This recommendation aims to empower these countries to make substantial contributions to leishmaniasis research. Overall, the findings provide valuable insights into the evolving landscape of leishmaniasis research and suggest strategies for fostering global collaboration and inclusivity in addressing this neglected tropical disease.

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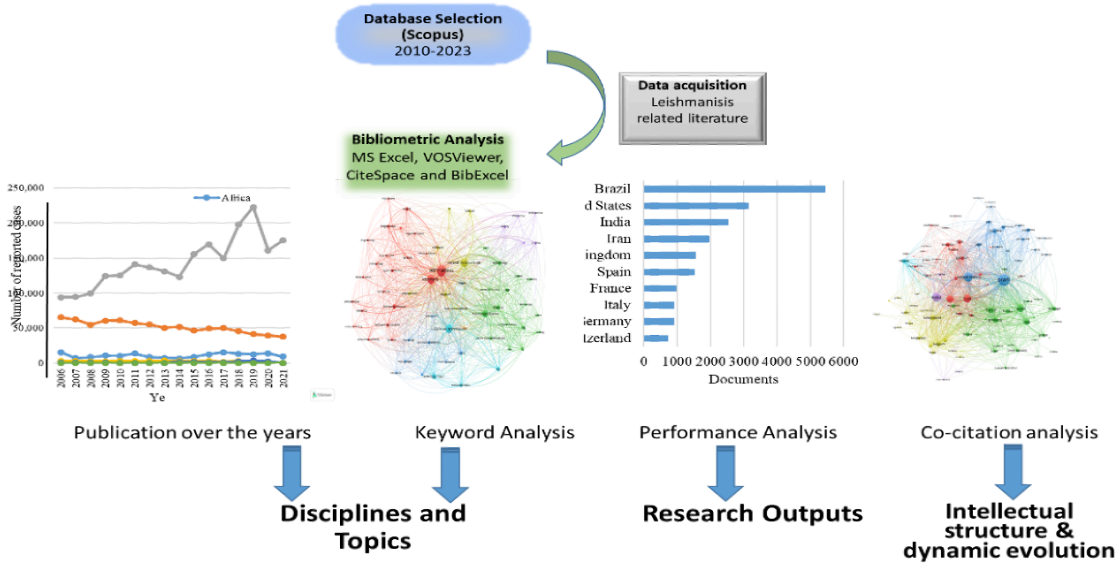
Graphical abstract



Background

Neglected Tropical Diseases (NTDs) are a group of bacterial, parasitic, viral and fungal infections affecting millions of people in tropical and subtropical countries with limited resources [1][2][3][4][5][6]. These diseases include; Buruli ulcer; Chagas disease; dengue and chikungunya; dracunculiasis; echinococcosis; foodborne trematodiases; human African trypanosomiasis; leishmaniasis; leprosy; lymphatic filariasis; mycetoma, chromoblastomycosis and other deep mycoses; onchocerciasis; rabies; scabies and other

ectoparasitoses; schistosomiasis; soil-transmitted helminthiases; snakebite envenoming; taeniasis/cysticercosis; trachoma; and yaws [4][5][7]. Currently, Dracunculiasis (Guinea Worm Disease), Lymphatic Filariasis, Onchocerciasis, Schistosomiasis, Soil-transmitted Helminths (STH) (i.e., Ascaris, Hookworm, and Whipworm), and Trachoma are the only NTDs that can be controlled or eliminated through mass administration of safe and effective medicines and/or the effective interventions [4][7][8].

Leishmaniasis is a vector-borne disease caused by different species of protozoan parasites of the genus *Leishmania* in the order *Kinetoplastida*. Leishmaniasis is a zoonotic disease that is transmitted by a vector sand fly (*Phlebotomus* or *Lutzomyia)* [1][9]. Currently, it is prevalent in four continents and considered endemic in 100 countries across the tropical and subtropical regions of Africa, Asia, the Mediterranean, Southern Europe and South and Central Americas [1][10]. Most of these countries are developing countries of low- and middle-income status [1][7][8][11]. Out of 30 species, which infect mammals, more than 20 *Leishmania* species are considered as human pathogens. Approximately 12 million people are infected with a species of Leishmania at any given time point. It is a major health problem among the NTDs, with more than 350 million people at risk of infection and more than 2 million infections occurring worldwide annually [4][11][12][13][14].

Leishmaniasis is considered as one of the most serious, epidemic prone parasitic disease afflicting the poor and disadvantaged countries in Africa, Asia and Latin America. Poverty determinants including malnutrition, displacement, stigma and gender, poor housing conditions, illiteracy, immune system weakness and unlimited resources have been linked with the emergence and re-emergence of leishmaniasis [4][5][11]. The current control of leishmaniasis rely on chemotherapy and pentavalent antimony preparations. Antifungals, such as amphotericin B and itraconazole, are the second-generation drugs used to treat leishmaniasis. Drug treatments require daily injections over a period of weeks that is associated with side effects and high treatment costs in poor communities [11][14].

Leishmaniasis has different clinical manifestations ranging in severity from self-curing cutaneous lesions to life-threatening visceral leishmaniasis. However, a widely used classification of leishmaniasis is visceral (VL or kala-azar), cutaneous (CL), muco-cutaneous (MCL), diffuse cutaneous (DCL) and post kala-azar dermal leishmaniasis (PKDL) [15][16]. VL is the most severe leishmaniasis caused by *Leishmania donovani*, in which the parasites migrate to the vital organs including spleen, liver and bone marrow leading to a high case-fatality rate of 10-20% [17][18][19][20]. VL is mostly found in South Asia, South America and East Africa [11][21].

Cutaneous leishmaniasis that causes skin sores is the most prevalent clinical leishmanial form. CL is classified into Old World cutaneous leishmaniasis (OWCL) and New World cutaneous leishmaniasis (NWCL) [22][23][24][25]. NWCL that are common parasitic zoonoses in Mexico, Central and South America are caused by at least ten *Leishmania* species including *L. braziliensis, L. panamensis, L. guyanensis, L. amazonensis, L. chagasi, L. naiffi, L. Mexicana, L. shawi, L. venezuelensis, L. iainsoni, L. iindenbergi* and *L. peruviana* [24]. The OWCL which is endemic in the Eastern hemisphere (Asian Middle East, Africa and southern Europe is caused by *L. major, L. tropica, L. aethiopica*, *and L. infantum* [17][19][23][26][27].

Bibliometric analysis is a rigorous method for exploring and analyzing large volumes of scientific data. Previous studies have analyzed research output in leishmaniasis through scientific production, authorship and clinical forms mapping. Network mapping among authors, organizational affiliations and countries is still pending. The aim of this study is to systematically study and analyze the main statistical characteristics and cooperation networks in leishmaniasis research. In the present study, production and scientific mapping in leishmaniasis research have been analyzed using bibliometric and visualization approaches such as co-authorship, citations, and bibliographic coupling (BCO) to explore the history, status and frontier in leishmaniasis research.

Methods

Data source

To retrieve information about leishmaniasis globally between 2010 and 2023, a search was conducted in Scopus database. Scopus database is the largest abstract and citation database of peer reviewed literature from journals, books, books chapters, and conference proceedings. The Scopus database (launched in 2004) is an online database of Elsevier and a hub for various biomedical and non-biomedical journals. Scopus database was selected for this study as it combines features of PubMed and Web of Science, keeping track of citations and offering access to abstracts, full texts and reference lists of indexed journal articles [28]. Importantly, Scopus distinguish highly cited sources, essential for comprehensive coverage of the literature in a narrative review [28][29]. The Scopus database was accessed on 23th April 2023 using Reference Manager Programme, version 11 (Thomson Reuters, Carlsbad, CA, USA) as the online tool for searching the bibliographic database and retrieving literature references.

Search strategies

For the purpose of finding all the articles related to leishmaniasis, the following search string was used ["leishmaniasis" OR "*leishmania*" OR "leishmania infection" in all fields]. The present study was designed to assess the overall number of publications that are related to leishmaniasis disease. The analyzed time span included articles published in the period from 2010 to 2023. Data analysis during screening limited time span to include the years which contained at least 30 articles perform statistics like the average citation per item in the past two decades. However, the search was not limited in term of language, specific sources and/or publication types.

Data extraction and analysis

In this review, a wide range of scholarly sources, including book chapters, articles, reviews, and other relevant publications were reviewed. This approach was selected for the purpose of comprehension and inclusion of all academic and scientific literature on leishmaniasis research globally. Through this, we were able to thoroughly evaluate the existing research and knowledge on leishmaniasis for a better understanding. Relevant data from all publication types included in the review were extracted and exported to Microsoft Excel database for further handling. The impact factor of journals with publication on leishmaniasis research was obtained from the Journal Citation Report (JCR) 2010 Science Edition (ISI, 2023) and Scimago Journal & Country Rank. Moreover, VOSviewer v1.6.11 (Centre for Science and Technology Studies, Leiden University, Leiden, The Netherlands) was used to analyze and visualize relationships among authors, countries, organizations, and keywords [30][31].

Data on autochthonous and imported leishmaniasis cases for both VL and CL were retrieved from WHO database to map the incidence trends between 2006 and 2021 were retrieved (WHO, et al., 2023). Moreover, to calculate publications per million inhabitants (population index), per billion of Gross Domestic Product (GDP), and leishmaniasis cases, data were obtained from Word Development Indicators from the World Bank online database [32]. The productivity by country was analyzed considering the number of articles and the percentage of world production. The first author's affiliation was used for the purpose of analyzing the core institutions in leishmaniasis research.

Results

Epidemiological status

Since 2013, leishmaniasis cases have been reported separately in terms of new autochthonous cases in order to monitor the trends in incidence and the number of imported cases. As of February 2023, a total of 53 VL and 55 CL endemic countries reported new cases to the WHO [33]. A total of 89% of global VL cases were reported from Brazil, Ethiopia, India, Kenya, Somalia, South Sudan, Sudan and Yemen in 2021 (Figure 1A). On the other hand, 88% of the global CL incidence in 2021 is accounted for by Afghanistan, Algeria, Brazil, Colombia, Iran (Islamic Republic of), Iraq, Pakistan, Peru and the Syrian Arab Republic (Figure 2B). Additionally, 385 CL imported cases and 60 VL imported cases were reported globally in 2021 [33].

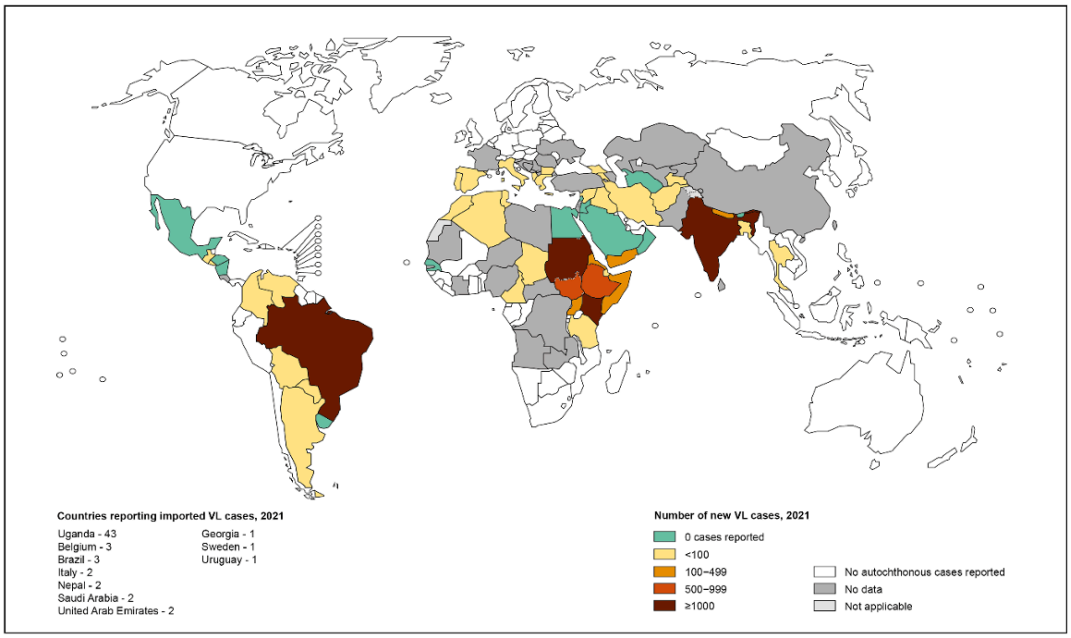


Figure 1A. *The global status of endemicity of visceral leishmaniasis as reported in 2021* [33]

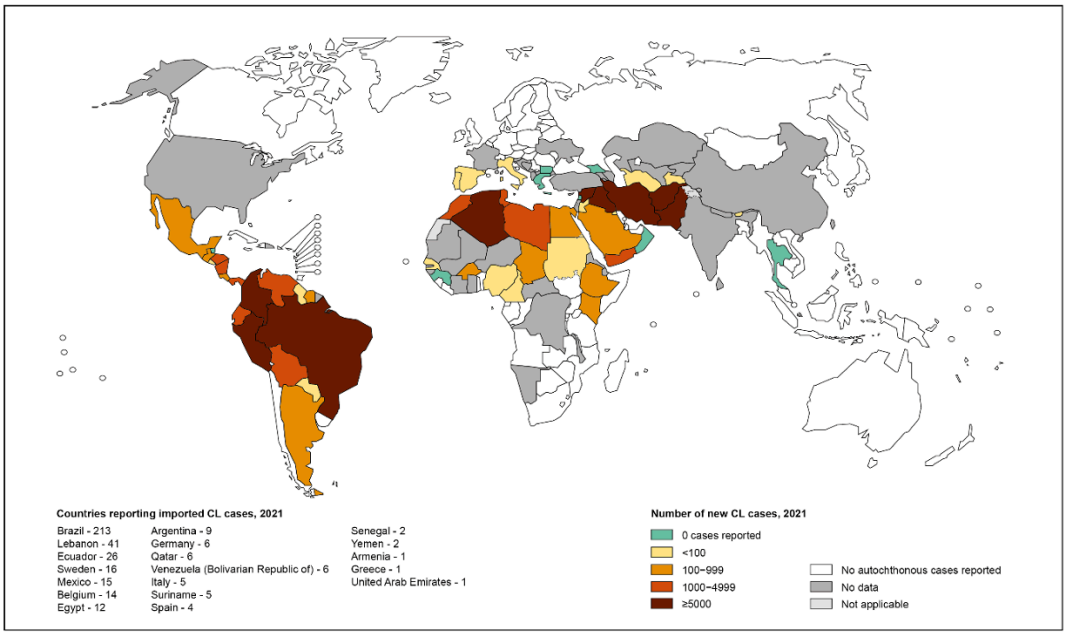


Figure 1B. *The global status of endemicity of cutaneous leishmaniasis as reported in 2021* [33].

Incidence trend

For the purpose of monitoring incidence trends, the WHO Global Leishmaniasis programme started reporting the autochthonous and imported leishmaniasis cases since 2013. Globally, 566,551 VL and 3,353,925 CL cases have been reported in the 2006 – 2021 time period. In this study, findings showed a decrease of visceral leishmaniasis cases across the studied years with the highest number of cases recorded in 2007 (Figure 2A). On the other hand, cutaneous leishmaniasis cases have been reported to increase over the years, with the highest record in 2019 (Figure 2B). High VL cases have been reported from the South East Asia region while CL has been dominant in the Eastern Mediterranean region in the studied years, with 50,900 and 222,566 highest reported cases, respectively. The Western Pacific region has the lowest reported CL cases, with only 21 CL reported cases in the course of studied years. In 2021, a total of 385 imported cases of CL and 60 imported cases of VL were reported, globally.

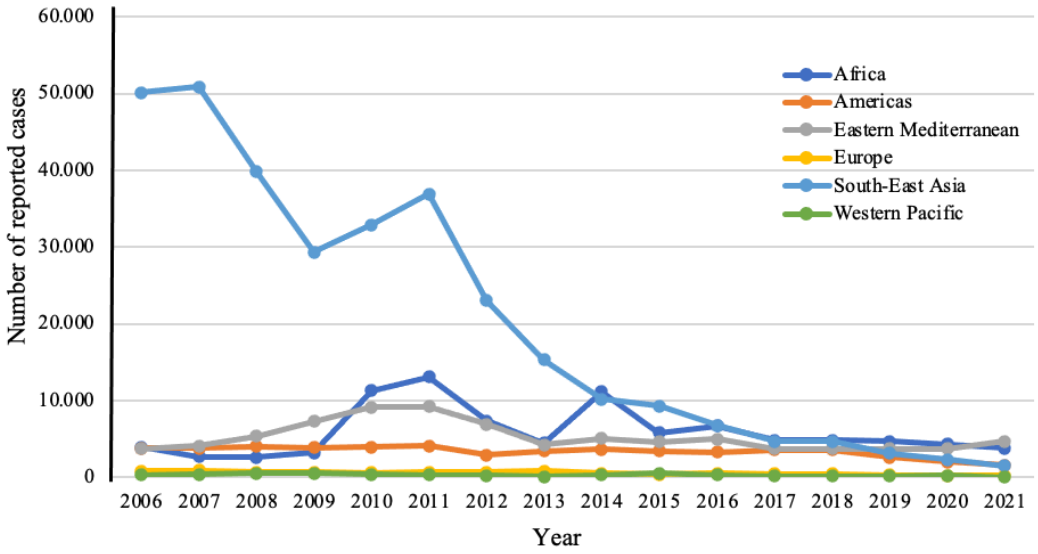


Figure 2A. *Occurrence trend of reported VL cases to the WHO from 2006 to 2021*

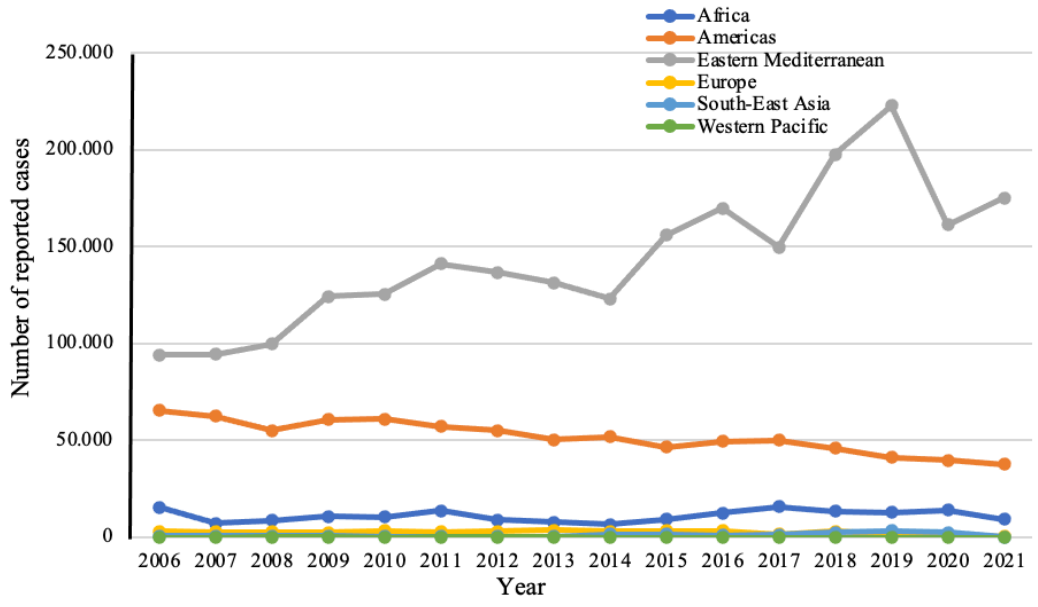


Figure 2B. *Time trend on number of reported CL cases to the WHO from 2006 to 2021*

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Performance analysis

Total Publications

A total of 21,362 records related to leishmaniasis research were retrieved between 2010 and 2023 from the Scopus database. Figure 3 shows the number of leishmaniasis publications in Scopus database over the past 13 years, increasing from 6983 (32.7%) sources between 2010 and 2014 to 8055 (37.7%) documents between 2015 and 2019 to 6324 (29.6%) documents for the period 2020 to March 2023. The growing number of publications on leishmaniasis indicates an increase of leishmaniasis research interest over the covered period. Year 2021 had the highest number of publications, with total number of 2053 documents retrieved, which is followed by a decline of about 8% in the year 2022.

Majority of publications in leishmaniasis research during the study period 2010-2023 were published on *Plos Neglected Tropical Diseases* journal (Figure 3). The articles identified were published in 34 languages, of which 33 were known languages and 1 undefined language. The main language used is English (90.9%) followed by Portuguese (2.3%), Spanish (2.2%), French (1.7%), German (0.7%) and others (2.1%).

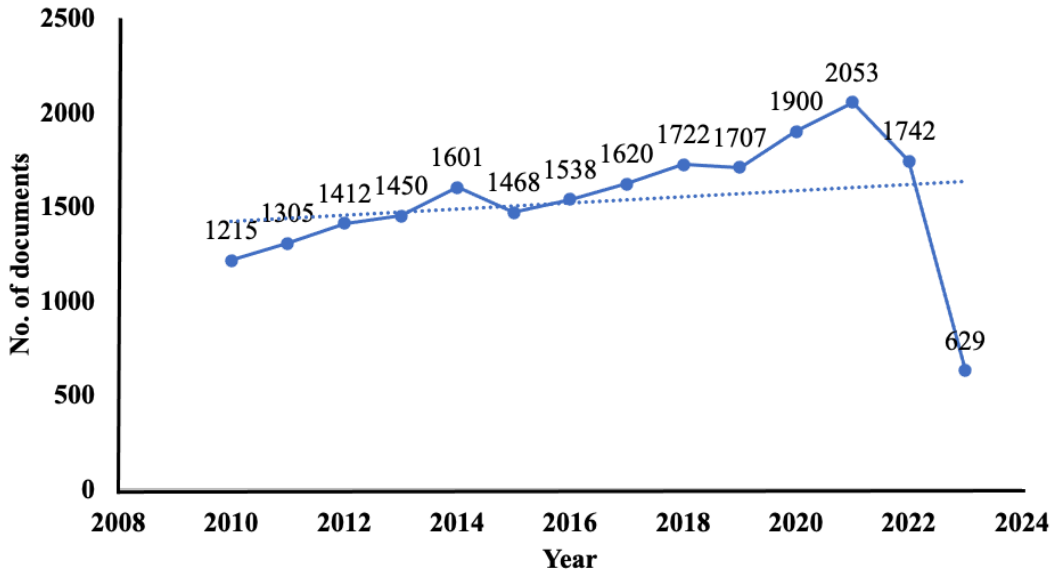

Figure 3. *Number of publications in leishmaniasis research in Scopus database per year between 2010 and 2023.*

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Analysis of Document Types in Publications

When looking at document type, *original or journal articles* were the most common form of publication observed, accounting for about 16,540 published materials (77.43%) (Figure 4). *Reviews, Letters and Book Chapters* followed, with 2,680 (12.55%), 528 (2.4%) and 506 (2.3%) documents respectively. A total of 1,106 (5.1%) documents were grouped under *Notes, Editorials, Short Surveys, Conference papers, Erratum and Books*. The remaining 25 (0.1%) documents that were grouped as others included *Retracted, Data Paper, Conference Review* and *Undefined* published materials (Table 1). Moreover, 21,288 (99.7%) publications in leishmaniasis disease research were at their final stage of publication, and only 74 (0.3%) were articles in press.

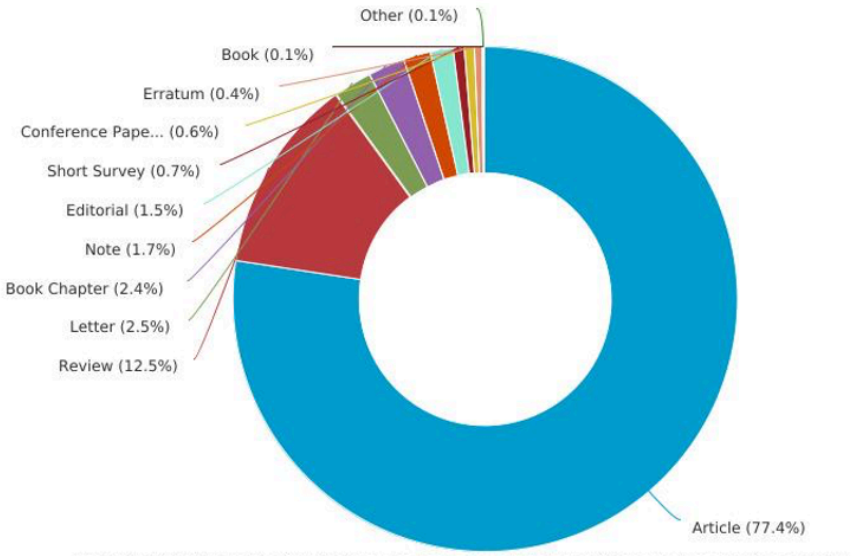

Figure 4. *Categories of document types related to leishmaniasis research published between 2010 and 2023 and retrieved from Scopus.*

Main research areas and choice of journal

A total of 27 research areas were identified in the present study from the leishmaniasis' publications between 2010 and 2023. Within the publication sample, medicine was the most predominant field, accounting for 13,807 documents (36.7%), followed by immunology and microbiology 7962 documents (21.2%), biochemistry, genetics, and molecular biology 3939 documents (10.5%), pharmacology, toxicology and pharmaceutics 2777 documents (7.4%), veterinary 2389 documents (6.4%) and agricultural and biological Sciences 2281 documents (6.1%) (Figure 5). The principal subject areas of the

top 40 journals publishing leishmaniasis research was Medicine including Parasitology (n = 18), Microbiology (n = 11), Tropical Medicine (n = 10), Infectious diseases (n = 7) and Immunology (n = 6).

Out of retrieved publications, 16,628 publications were published in 160 journals with 19 journals accounting for 43.0% of the journal literature in leishmaniasis research. The *PLOS Neglected Tropical Diseases* journal had the most articles followed by *Parasites and Vectors*, *Acta Tropica*, *Plos One*, *American Journal of Tropical Medicine and Hygiene*, and *Experimental Parasitology* (Table 1). The minimal number of published articles in each journal was 25 publications. Journals with least publications in leishmaniasis research were *Biochemical and Cellular Archives*, *Dermatology Online Journal*, *Geospatial Health*, *Indian Journal Of Medical Research*, *Indian Journal of Medical Research* and *Iranian Journal of Basic Medical Sciences* with 25 published articles in each journal. Table 1 shows a list of journals with at least 100 documents about leishmaniasis research published between 2010 and 2023; their impact factors, language and subject category according to the JCR classification as of 2021.

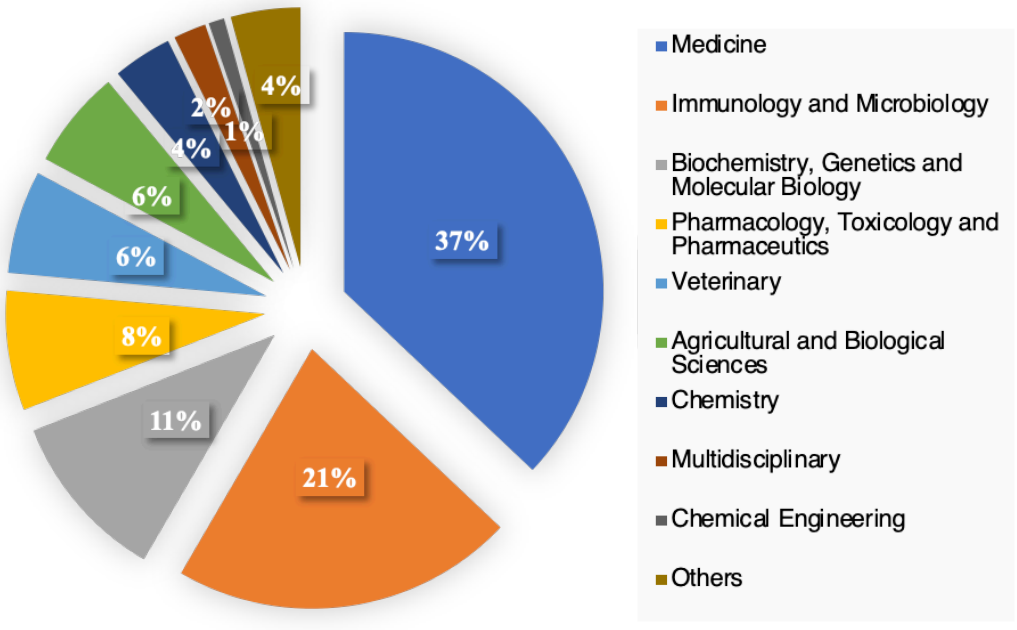

Figure 5. *Representation of research areas analysis in leishmaniasis research according to publications retrieved from Scopus database between 2010 and 2023*

Journal	No. of documents (%)	Impact factor (2021)	Journal Category (Ranking)	Language	Country	Total Citations	Publisher
Plos Neglected Tropical Diseases	1006 (4.71)	4.781	Tropical Medicine, Parasitology	English	USA	40061	PUBLIC LIBRARY SCIENCE
Parasites and Vectors	505(2.36)	4.052	Tropical Medicine, Parasitology	English	England	22882	BMC
Acta Tropica	498 (2.33)	3.707	Tropical Medicine, Public, Environmental & Occupational Health	English	USA	28341	AMER SOC TROP MED & HYGIENE
Plos One	480 (2.25)	3.752	Multidisciplinary Sciences	English	USA	944441	PUBLIC LIBRARY SCIENCE
American Journal of Tropical Medicine and Hygiene	402 (1.88)	3.707	Tropical Medicine, Public, Environmental & Occupational Health	English	USA	28341	AMER SOC TROP MED & HYGIENE
Experimental Parasitology	264 (1.24)	2.132	Parasitology	Multi-Language	Netherlands	7027	ACADEMIC PRESS INC ELSEVIER SCIENCE
Parasitology Research	264 (1.24)	2.383	Parasitology	English	Germany (Fed Rep Ger)	15838	SPRINGER
Revista da Sociedade Brasileira de Medicina Tropical	263 (1.23)	2.141	Tropical Medicine, Parasitology	English	Brazil	4102	SOC BRASILEIRA MEDICINA TROPICAL

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Journal	No. of documents (%)	Impact factor (2021)	Journal Category (Ranking)	Language	Country	Total Citations	Publisher
Frontiers in Immunology	260 (1.22)	8.787	Immunology	English	Switzerland	127486	FRONTIERS MEDIA SA
Veterinary Parasitology	217 (1.02)	2.821	Parasitology, Veterinary Sciences	English	Netherlands	19701	ELSEVIER
Frontiers in Cellular and Infection Microbiology	209 (0.98)	6.073	Microbiology, Immunology	English	Switzerland	19950	FRONTIERS MEDIA SA
Memorias do Instituto Oswaldo Cruz	183 (0.86)	2.747	Tropical Medicine, Parasitology	English	Brazil	7706	FUNDACO OSWALDO CRUZ
Parasite Immunology	174 (0.81)	2.206	Parasitology, Immunology	English	England	3450	WILEY
Parasitology	164 (0.77)	3.243	Parasitology	English	England	12586	CAMBRIDGE UNIV PRESS
Iranian Journal of Parasitology	161 (0.75)	1.217	Parasitology	English	Iran	1372	IRANIAN SCIENTIFIC SOCIETY MEDICAL ENTOMOLOGY
Antimicrobial Agents and Chemotherapy	157 (0.73)	5.938	Microbiology, Pharmacology & Pharmacy	English	USA	81074	AMER SOC MICROBIOLOGY
Scientific Reports	142 (0.66)	4.997	Multidisciplinary Sciences	English	England	696335	NATURE PORTFOLIO
Transactions of The Royal Society of Tropical	142 (0.66)	2.455	Tropical Medicine, Public, Environmental &	English	England	9617	OXFORD UNIV PRESS

Journal	No. of documents (%)	Impact factor (2021)	Journal Category (Ranking)	Language	Country	Total Citations	Publisher
Medicine and Hygiene			Occupational Health				
Molecules	130 (0.61)	4.927	Biochemistry & Molecular Biology, Chemistry, Multidisciplinary	English	Switzerland	128386	MDPI
Revista do Instituto de Medicina Tropical de Sao Paulo	129 (0.60)	2.169	Tropical Medicine, Parasitology, Infectious Diseases	English	Brazil	2675	INST MEDICINA TROPICAL SAO PAULO
Journal of Medical Entomology	126 (0.59)	2.435	Entomology, Veterinary Sciences	English	USA	12667	OXFORD UNIV PRESS INC
Journal of Parasitic Diseases	122 (0.57)	1.43	Parasitology, Immunology And Microbiology	English	India	NI	SPRINGER INDIA
Plos Pathogens	121 (0.57)	7.464	Parasitology, Virology, Microbiology	English	USA	62235	PUBLIC LIBRARY SCIENCE
European Journal of Medicinal Chemistry	118 (0.55)	6.688	Immunology	English	USA	26109	WILEY
BMC Infectious Diseases	106 (0.50)	3.669	Infectious Diseases	English	England	28295	BMC
Pathogens	100 (0.47)	4.531	Microbiology	English	Switzerland	9479	MDPI
Revista Brasileira De	100 (0.47)	1.415	Veterinary Sciences, Parasitology	BRAZIL	BRAZIL	1916	BRAZILIAN COLL VETERINARY PARASITOLOGY

Journal	No. of documents (%)	Impact factor (2021)	Journal Category (Ranking)	Language	Country	Total Citations	Publisher
Parasitologia Veterinaria							

Table 1. *List of journals with at least 100 published materials about leishmaniasis research published between 2010 and 2023, their impact factors for the year 2021, language and journal category from the Journal Citation Report.*

Country of publication

The retrieved publications in leishmaniasis research include a representation from a total of one hundred and fifty-nine countries. In Table 2, the top thirty ranking countries are shown in crude numbers of retrieved documents, numbers corrected per number of inhabitants, GDP and estimated leishmaniasis cases between 2010 and 2023. Brazil is the predominant country in the total number of retrieved publications (Figure 6). Other leading countries in the total number of publications were United States, India, Iran and United Kingdom that together contributed to the 46.1% of all research documents published during the study period (2010-2023) (Table 3). When normalised by population, the order of prominence was French Guiana, Anguilla and Switzerland. When data was normalized by GDP, Micronesia, Fed. Sts., Tunisia, Cyprus, Sudan and Nepal, Tunisia, Ethiopia, Sudan and Kenya were the most productive. Calculating the ratio of number of leishmaniasis publications to number of leishmaniasis cases.

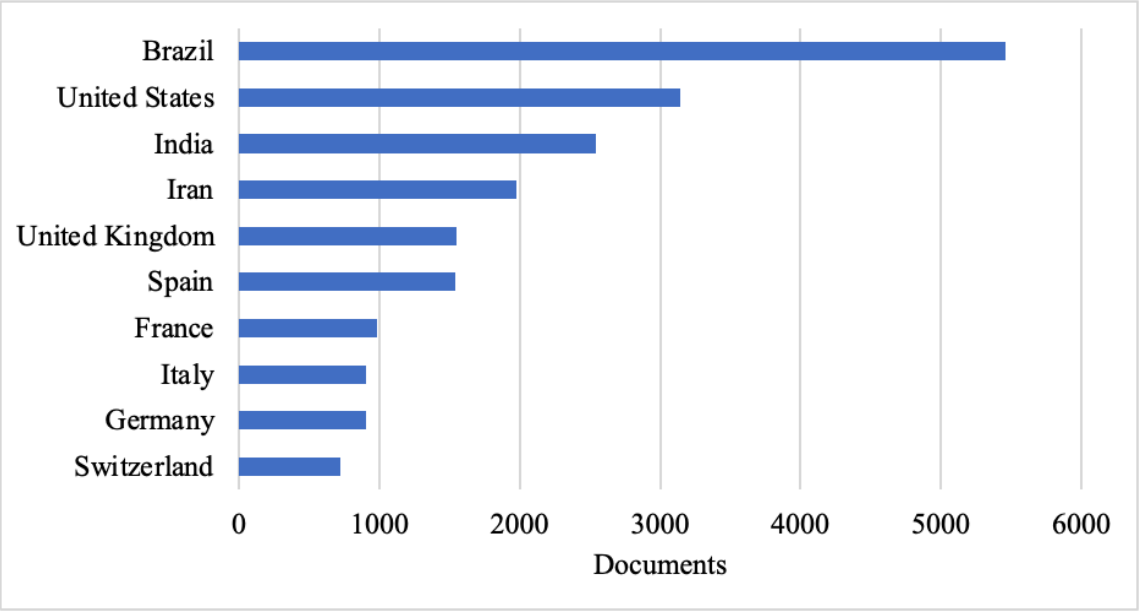

Figure 6. *Representation of the countries/territories with the highest number of documents published in leishmaniasis research between 2010 and 2023.*

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Countries ranked by number of publications		Countries ranked by publications per inhabitant		Countries ranked by GDP		Countries ranked by leishmaniasis cases	
Country	**Articles n (%)**	**Country**	**Population index***	**Country**	**GDP index†**	**Country**	**Leishmaniasis case index‡**
Brazil	5464 (25.58)	French Guiana	200.88	Micronesia, Fed. Sts.	957.85	United States	463000.00
United States	3142 (14.71)	Anguilla	133.31	Tunisia	9.64	Portugal	16633.33
India	2541 (11.89)	Switzerland	116.01	Cyprus	9.12	Iran	12205.26
Iran	1974 (9.24)	Saint Kitts and Nevis	75.19	Sudan	7.63	Nigeria	9000.00
United Kingdom	1551 (7.26)	Belgium	60.66	Nepal	6.78	Thailand	8250.00
Spain	1537 (7.20)	Malta	54.35	Iran, Islamic Rep.	6.45	Bulgaria	3200.00
France	978 (4.58)	Monaco	50.97	Suriname	5.03	Spain	2200.00
Italy	905 (4.24)	Portugal	48.94	Brazil	4.32	Greece	1633.33
Germany	904 (4.23)	Israel	47.14	Mali	3.60	Italy	1301.00
Switzerland	719 (3.37)	Spain	44.70	Gambia, The	3.43	Cameroon	712.50
Canada	590 (2.76)	Tunisia	38.08	Ethiopia	3.40	Bangladesh	705.71
Belgium	555 (2.60)	Greece	37.61	Lebanon	3.20	Brazil	465.95
Colombia	554 (2.59)	United Kingdom	33.78	Bhutan	2.76	Guyana	400.00

Countries ranked by number of publications		Countries ranked by publications per inhabitant		Countries ranked by GDP		Countries ranked by leishmaniasis cases	
Country	**Articles n (%)**	**Country**	**Population index***	**Country**	**GDP index†**	**Country**	**Leishmaniasis case index‡**
Turkey	470 (2.20)	Brazil	32.71	Afghanistan	2.57	Iraq	295.45
Netherlands	423 (1.98)	Netherlands	32.10	Colombia	2.29	India	280.12
Australia	410 (1.92)	Cyprus	28.16	Congo, Rep.	2.17	Syrian Arab Republic	206.90
Portugal	398 (1.86)	Iran	27.61	Bolivia	2.13	Argentina	117.73
Pakistan	381 (1.78)	Suriname	25.57	Mauritius	2.08	Nepal	102.50
China	360 (1.69)	Luxembourg	25.56	Portugal	1.97	Kuwait	100.00
Tunisia	325 (1.52)	France	25.05	Morocco	1.95	Georgia	93.33
Japan	318 (1.49)	Czech Republic	24.19	Greece	1.82	Jordan	82.14
Israel	311 (1.46)	Iceland	23.44	Grenada	1.78	Mexico	76.63
Argentina	301 (1.41)	Bahrain	22.92	Paraguay	1.60	Albania	71.43
Greece	294 (1.38)	Denmark	22.10	Burkina Faso	1.57	Paraguay	58.33
Mexico	288 (1.35)	Italy	21.52	Kenya	1.54	Saudi Arabia	54.00
Ethiopia	278 (1.30)	Sweden	21.29	Guyana	1.49	Senegal	46.15
Venezuela	266 (1.25)	New Caledonia	21.02	Spain	1.46	Ghana	41.56
Saudi Arabia	249 (1.17)	Canada	20.56	Burundi	1.44	Uganda	37.21
Peru	238 (1.11)	Australia	20.43	Croatia	1.41	Armenia	30.00
Morocco	213 (1.00)	Uruguay	18.14	Peru	1.37	Egypt	27.75

Table 2. *The top 30 countries along with their world regions ranks according to total number of publications, publications per inhabitant, per GDP and estimated leishmaniasis cases from retrieved data between 2000 and 2023, based on first author's affiliation*

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* Number of publications per million population.

† Number of publications per 1 billion US dollars GDP.

‡ Number of publications per 100 leishmaniasis patients (estimated incidences).

Authors' affiliations, leading authors and funding sources

Researchers who published on leishmaniasis in the studied period were affiliated with 160 organizations led by Fundacao Oswaldo Cruz, Brazil, with 1881 publications. Universidade de São Paulo came second (991), followed by Universidade Federal de Minas Gerais (743), and Tehran University of Medical Sciences (665). Additionally, among the top 15 core organizations investigating leishmaniasis, 8 (66.7%) of are from Brazil, while Iran has 5 organizations, India 3 and France 3, as shown in Table 3.

Table 4 ranks the top 15 productive authors in lesihmania research and publication according to the information retrieved form Scopus in the present study. Majority of these came from Brazil (6), Iran (4), and India (3). Sundar, S.A., a distinguished professor of Banaras Hindu University, India was the leading author in leishmaniasis (n = 292), followed by Das, P. from Memorial Research Institute of Medical Sciences Indian Council of Medical Research in India (n = 245) and Mohebali, M. of Department of Medical Parasitology and Mycology, School of Public Health, Tehran University of Medical Sciences in Iran (215).

The Conselho Nacional de Desenvolvimento Científico e Tecnológico (1953), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (1428), National Institute of Allergy and Infectious Diseases (936), National Institutes of Health (NIH) (727) and Fundação de Amparo à Pesquisa do Estado de São Paulo (603) were the leading funders for leishmaniasis research (Figure 7).

Rank	Organization	No. of documents (%)	Country
1	Fundacao Oswaldo Cruz	1881 (7.69)	Brazil
2	Universidade de São Paulo	991 (4.05)	Brazil
3	Universidade Federal de Minas Gerais	743 (3.04)	Brazil
4	Tehran University of Medical Sciences	665 (2.72)	Iran
5	Universidade Federal do Rio de Janeiro	537 (2.19)	Brazil
6	Universidade Estadual Paulista Júlio de Mesquita Filho	402 (1.64)	Brazil
7	Universidade Federal da Bahia	359 (1.47)	Brazil
8	Banaras Hindu University	355 (1.45)	India
9	Prins Leopold Instituut voor Tropische Geneeskunde	354 (1.45)	Belgium
10	London School of Hygiene & Tropical Medicine	319 (1.30)	United Kingdom
11	Pasteur Institute of Iran	289 (1.18)	Iran
12	Banaras Hindu University, Institute of Medical Sciences	267 (1.09)	India
13	National Institutes of Health (NIH)	262 (1.07)	United States
14	Rajendra Memorial Research Institute of Medical Sciences	258 (1.05)	India
15	Organisation Mondiale de la Santé	255 (1.04)	Switzerland

Table 3. *Top 15 organizations with respect to the number of documents investigating leishmaniasis retrieved from Scopus database, 2010-2023.*

Rank	Author	Documents	% (of 21,362)	Organization	Country
1	Sundar, S.	292	1.37	Banaras Hindu University	India
2	Das, P.	245	1.15	Memorial Research Institute of Medical Sciences	India
3	Mohebali, M.	215	1.01	Center for Research Endemic Parasites of Iran, Tehran University of Medical Sciences	Iran
4	Khamesipour, A.	143	0.67	Tehran University of Medical Sciences	Iran
5	Boelaert, M.	141	0.66	Institute of Tropical Medicine	Belgium
6	Coelho, E.A.F.	140	0.66	Universidade Federal de Minas Gerais	Brazil
7	Sharifi, I.	140	0.66	Kerman University of Medical Sciences	Iran
8	Pandey, K.	122	0.57	Indian Council of Medical Research, Agamkuan	India
9	Volf, P.,	121	0.57	Charles University	Czech Republic
10	Laurenti, M.D.	114	0.53	Medical School of São Paulo University	Brazil
11	Hailu, A.	107	0.5	Addis Ababa University	Ethiopia
12	Carvalho, E.M.	103	0.48	Instituto Gonçalo Moniz, FIOCRUZ	Brazil
13	Roatt, B.M.	101	0.47	Laboratório de Imunopatologia, Núcleo de Pesquisas em Ciências Biológicas/ Universidade Federal de Ouro Preto	Brazil
14	Mondal, D.	99	0.46	International Centre for Diarrheal Disease Research	Bangladesh
15	Rijal, S.	98	0.46	Drugs for Neglected Diseases initiative (DNDi),	Switzerland
16	Lage, D.P.	96	0.45	Universidade Federal de Minas GeraisBrazil	Brazil
17	Chávez-Fumagalli, M.A.	95	0.44	Universidad Católica de Santa María de Arequipa	Peru
18	Valenzuela, J.G.	93	0.44	National Institutes of Health	USA
19	Duarte, M.C.	91	0.43	Universidade Federal de Minas Gerais	Brazil
20	Rassi, Y.	86	0.4	Tehran University of Medical Sciences	Iran

Table 4. *Twenty most productive authors ranked according to publications in leishmaniasis research from Scopus database, 2010-2023*

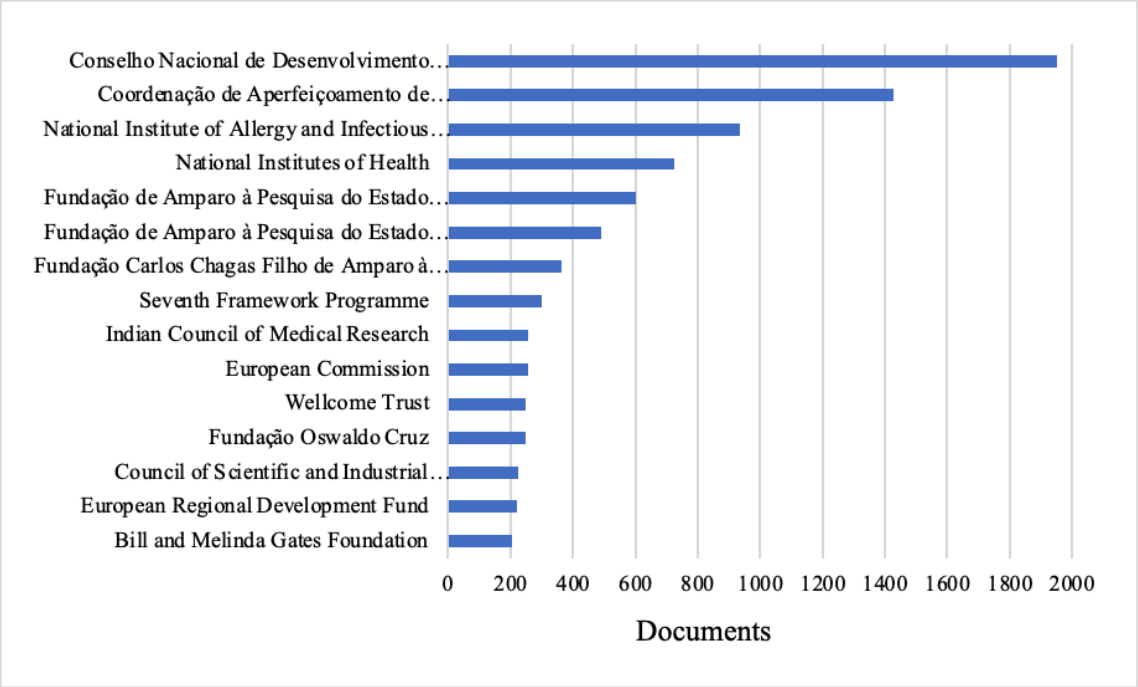


Figure 7. *Representation of number of documents in leishmaniasis research by funding sponsors during 2010 and 2023*

Science mapping

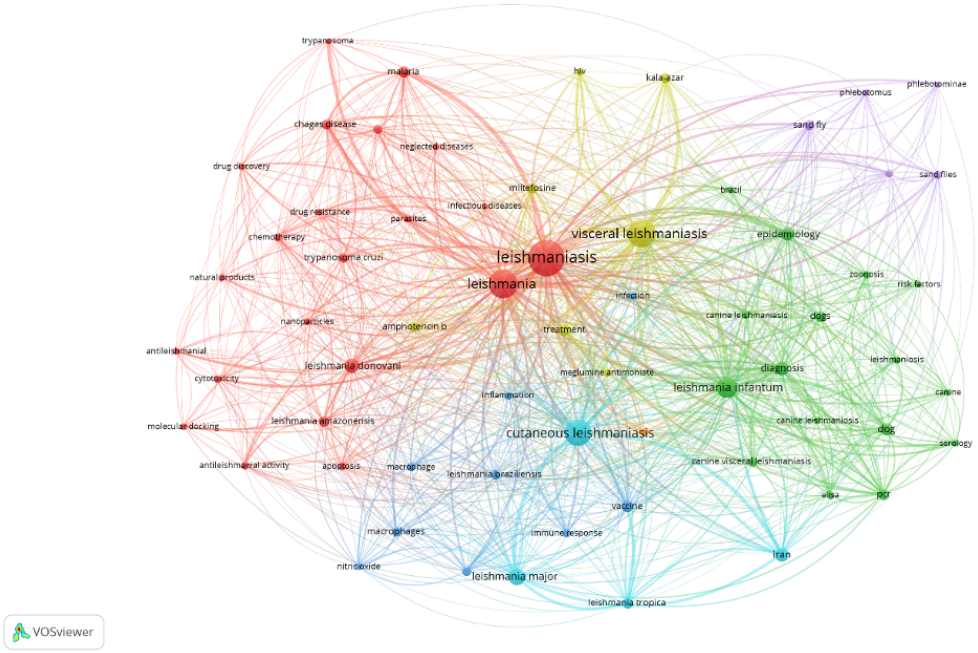
Keywords analysis

Keywords analysis in the 21,362 retrieved publications in leishmaniasis was performed using VOSviewer. The minimum set number of occurrence of a keyword was 100 in titles and abstracts across all retrieved publications. Out of the 23,889 keywords, 64 keywords met the threshold criteria of 100 minimum number of occurrences. For each of the 64 keywords, the total strength of co-occurrence and links with other keywords was calculated. Each keyword is represented by a circle, the diameter and label size symbolizing the frequency of occurrence in titles and/or abstracts of the analyzed publications (Figure 8). The most occoring keywords were leishmaniasis, *leishmania*, visceral leishmaniasis, cutaneous leishmaniasis, *leishmania infantum*, *leishmania major*, and *leishmania donovani*. However, when based on average

doi.org/10.32388/RXCFQE

citations, author's keywords ranked at the top included nanoparticles, trypanosoma, inflammation and infectious diseases. Additionally, leishmaniasis, VC, *leishmania*, CL, and *leishmania infantum* had stronger links with other keywords.

Authors' keywords were clustered into seven clusters whereby each group was identified using a different color (Figure 8). Each node in the network represents an entity and the size of the node indicates the occurrence of the keywords. In cluster 1, 22 keywords were highly used in the analyzed publications, including leishmaniasis (2980 times), *leishmania* (1879 times), *leishmania donovani* (485 times), and malaria (393 times). In cluster 2, 16 keywords were frequently used, including *leishmania infantum* (940 times), diagnosis (448 times), epidemiology (407 times) and dog (330 times). The classified keywords in Cluster 3 (9 keywords) included vaccine (303 times), *leishmania braziliensis* (212 time) and cytokines (207 times) at the top. In cluster 4, 7 keywords were frequently used including visceral leishmaniasis (1810 times), treatment (467 times), and amphotericin (140 time). For Cluster 5, 6 and 7, a total of 4 ((sand fly (232 times), sand flies (175 times), *lutzomyia longipalpis* (152 times), phlebotomus (121 times) and phlebotominae (102 times)); 4 ((cutaneous leishmaniasis (1613 times), *leishmania major* (644 times), Iran (435 times) and *leishmania tropica* (279)); and 1 (cutaneous (140 times)) keywords were used, respectively. Additionally, keywords were color-coded based on average publication year, where blue indicates that a keyword appeared earlier and yellow indicates that a keyword appeared later years.



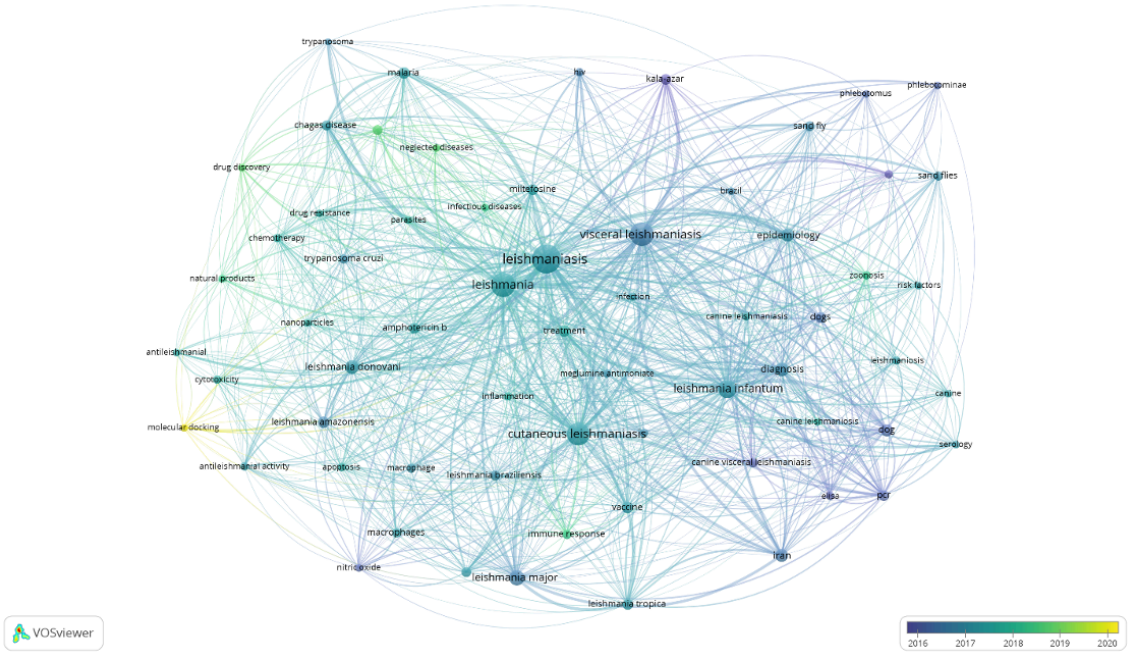


Figure 8. *Visualization map of keyword co-occurrence network **(top)** Mapping of keywords of studies pertaining to leishmaniasis (categorized into seven clusters) and **(bottom)** Distribution of keywords according to average publication year in the study period, 2010-2023 (blue: earlier, yellow: later).*

Authors analysis

The VOSviewer was used to visualize authors' performance and network analysis in leishmaniasis research to map individual's and research group's contribution on leishmaniasis. Co-authorship analysis was performed on 20,682 authors; only 12 authors met threshold criteria of 5 minimum numbers of co-authored articles in leishmaniasis. Table 5 shows the productive authors in number of citations of published documents in leishmaniasis research published during the study period, 2010-2023. Each author is represented by a circle, the diameter and label size symbolizing the number of co-authored articles in Figure 8. Hotez P.J ranked as the top author with most (24) co-authored articles in leishmaniasis research, followed by Jr (19); Sundar S.; and Saudagar., Chakravarty J. (each with 8) documents in leishmaniasis research (Figure 9). While Ready P.D ranked first with most NC and AC in leishmaniasis research as shown in Table 5.

doi.org/10.32388/RXCFQE

Rank	Author	ND	NC	AC
1	Ready P.D.	5	998	199.6
2	Sundar S.; Chakravarty J.	8	893	111.63
3	Rehder D.	8	796	99.5
4	Hotez P.J.	29	574	40.38
5	Dantas-torres F.; Otranto D.	4	320	80
6	Zhang W.W.; Matlashewski G.	4	173	43.25
7	Monge-maillo B.; López-Vélez R.	5	165	33
8	Singh O.P.; Sundar S.	4	156	39
9	Zijlstra E.E.	5	155	31
10	Sasidharan S.; Saudagar P.	6	67	11.16

Table 5.*Top 10 most productive authors in leishmaniasis research based on number of citations, between 2010 and 2023*

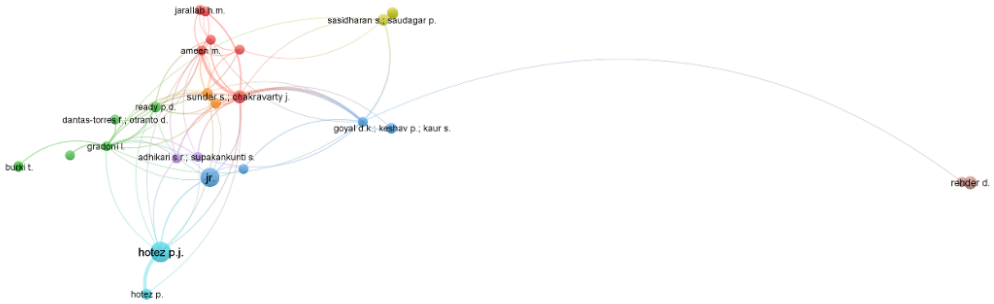


Figure 9. *Network map showing **(top)** Distribution of co-authorship by authors according to the number of documents **(bottom)** Bibliographic coupling of authors of retrieved documents in leishmaniasis research during the study period, 2010-2023.*

Country/Regions analysis

Table 6 shows the top-10 most productive countries/regions and summarizes the number of documents (ND), number of citations (NC) and average citation (AC) for the 21,362 retrieved documents. Brazil has the greatest number of articles (5,418) about leishmaniasis, followed by USA (3,096) and India (2,509). Although the number of documents of the United States is less than Brazil, the number of citations is high (89,847) (Table 6). Furthermore, Hungary, has the highest AC value among the top-10 productive countries/regions. Network analysis among countries/regions was done through co-authorship, citations and BCO analysis using VOSviewer. Figure 10 shows the detailed collaborative patterns of most productive countries and other countries/ regions as clustered in 6 clusters. Brazil had the highest total link strength followed by USA, India, United Kingdom, Spain and Iran.

Rank	Country	ND	Country	NC	Country	AC	Country	Co-authorship	Country	BCO
1	Brazil	5418	United states	89489	Hungary	58.0	United states	3312	Brazil	1210595
2	United states	3096	Brazil	80902	Singapore	52.5	United kingdom	2424	United states	972997
3	India	2509	India	49576	Switzerland	39.3	Brazil	2267	India	667541
4	Iran	1961	United kingdom	42969	New Zealand	31.4	Switzerland	1545	United kingdom	566471
5	United kingdom	1514	Spain	30609	Belgium	30.0	Spain	1421	Spain	527993
6	Spain	1513	Switzerland	27349	South Korea	29.5	France	1351	Iran	438914
7	France	950	Iran	23456	Netherlands	29.4	India	1350	France	353324
8	Italy	887	France	22535	Australia	29.3	Germany	1283	Germany	327976
9	Germany	879	Germany	20681	Uruguay	29.3	Belgium	1051	Switzerland	288556
10	Switzerland	696	Italy	19030	United states	28.9	Italy	881	Belgium	282011

Table 6. *Top 10 productive countries/regions in leishmaniasis research published between 2010 and 2023 based on co-authorship, citations and BCO and analysis*

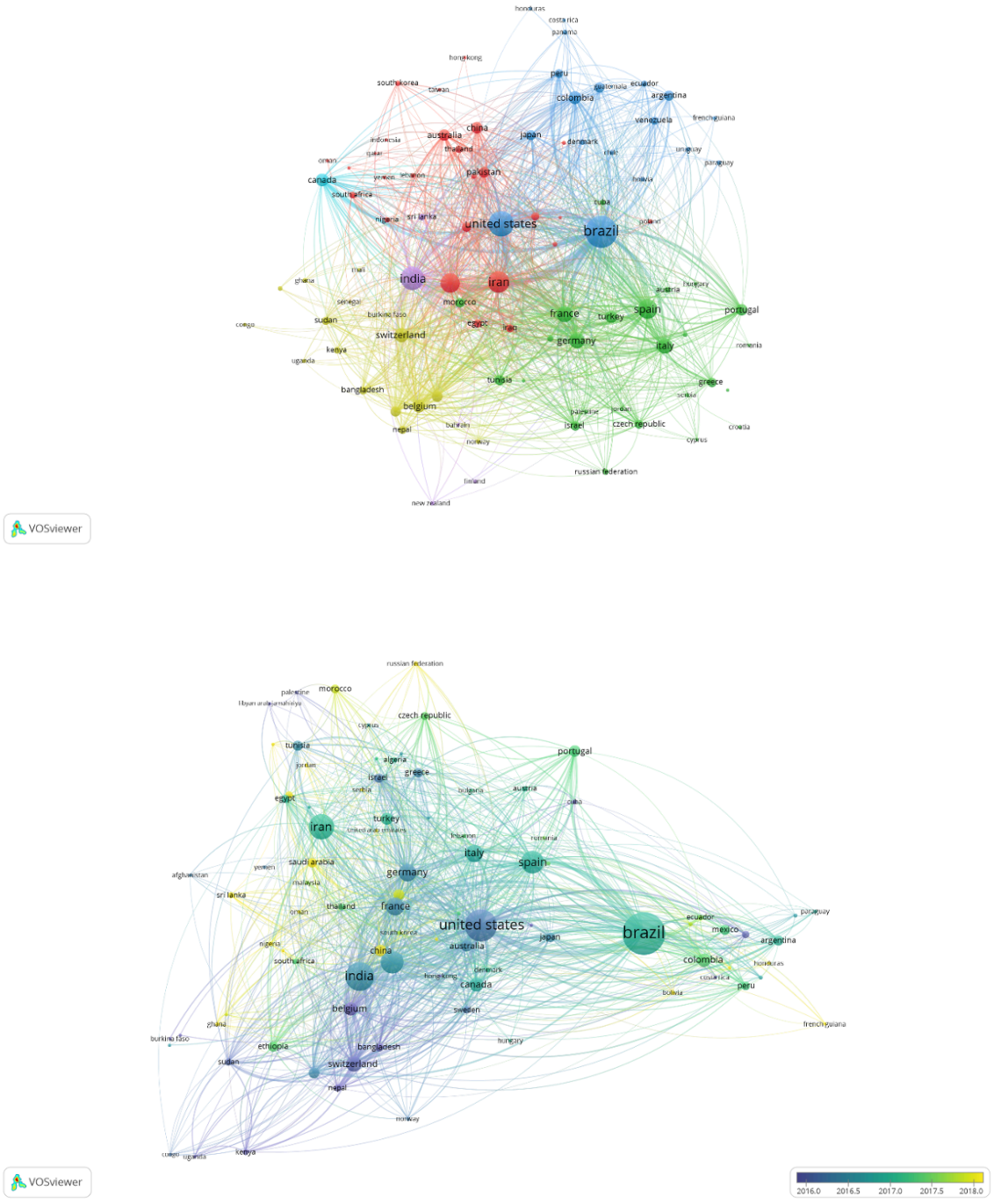


Figure 10. ***(Top)*** *Collaboration networks of 50 countries with at least 60 published documents and citations. Nodes represent a country, and the size of a node represents the total link strength of a particular country and other countries.* ***(Bottom)*** *Distribution of organizations according to citations between 2010 and 2023.*

Organizational affiliations analysis

VOSviewer v1.6.11 was used to analyze co-authorship, citations and BCO of the organizational affiliations in leishmaniasis research. Table 7 presents the top 33 productive organizations that published about leishmaniasis between 2010 and 2023 with 30 as the minimal number of documents and citations. It was found that the Department of Medical Parasitology and Mycology of the School of Public Health, Iran was the most productive in the list with 137 documents about leishmaniasis and highest link strength in co-authorship, followed by Department of Medical Entomology and vector control, Iran (130), Leishmaniasis Research Center, Iran (130) and Center for Research and Training in Skin Diseases and Leprosy, Iran (107). The Institute of Tropical Medicine, Antwerp, Belgium ranked first with number of citations among the top 33 organizations (Figure 11). In terms of AC, the DNDi of Switzerland demonstrated an excellent leadership, with the highest AC value of 29.57 and the fourth highest NC value of 110. Meanwhile, among the top 33 productive institutions, Iran ranked first with 14 institutions, followed by Belgium (5), Brazil (4), India (2), Switzerland (3), USA (2), UK (1), Czech Republic (1), and Peru (1). The Department of Medical Parasitology and Mycology, University of Medical Sciences, Tehran, Iran had the greatest strength links with other organizations in leishmaniasis research following co-authorship, citation and BCO analysis (Figure 11).

Rank	Institution	Country	ND	NC	AC
1	Department of Medical Parasitology and Mycology, School of Public Health, Tehran University of Medical Sciences	Iran	137	1568	11.4
2	Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences	Iran	130	1825	14.0
3	Leishmaniasis Research Center, Kerman University of Medical Sciences	Iran	130	1754	13.5
4	Center for Research and Training In Skin Diseases And Leprosy, Tehran University Of Medical Sciences	Iran	107	1676	15.7
5	Institute of Tropical Medicine	Belgium	78	2474	31.7
6	Department of Parasitology and Mycology, School of Medicine, Shiraz University of Medical Sciences	Iran	77	909	11.8
7	Center for Research of Endemic Parasites of Iran (Crepi), Tehran University of Medical Sciences	Iran	63	1097	17.4
8	Department of Medicine, Institute of Medical Sciences, Banaras Hindu University	India	61	1712	28.1
9	Basic Sciences In Infectious Diseases Research Center, Shiraz University of Medical Sciences	Iran	60	554	9.2
10	Department of Public Health, Institute of Tropical Medicine	Belgium	53	2424	45.7
11	Departamento De Patologia Clú‹Ica, Coltec, Universidade Federal De Minas Gerais	Brazil	51	1043	20.5
12	Department of Parasitology, Faculty of Science, Charles University	Czech republic	49	667	13.6
13	Drugs for Neglected Diseases Initiative	Switzerland	45	1396	31.0
15	Research Center of Tropical and Infectious Diseases, Kerman University of Medical Sciences	Iran	44	548	12.5
16	Department of Parasitology and Mycology, School of Medicine, Isfahan University of Medical Sciences	Iran	44	264	6.0
14	London School of Hygiene and Tropical Medicine	United Kingdom	44	2207	50.2

Rank	Institution	Country	ND	NC	AC
17	Departamento De Bioquúšica E Imunologia, Instituto De Ciências Biológicas, Universidade Federal De Minas Gerais	Brazil	43	1050	24.4
18	Skin Diseases And Leishmaniasis Research Center, Isfahan University of Medical Sciences	Iran	43	151	3.5
19	Drugs for Neglected Diseases Initiative (DNDi)	Switzerland	40	2182	54.6
20	Department of Clinical Sciences, Institute of Tropical Medicine	Belgium	39	739	18.9
21	Department of Immunotherapy and Leishmania Vaccine Research, Pasteur Institute of Iran	Iran	39	617	15.8
23	Skin and Stem Cell Research Center, Tehran University of Medical Sciences	Iran	38	201	5.3
22	University of Basel	Switzerland	38	1955	51.4
24	Vector Molecular Biology Section, Laboratory of Malaria And Vector Research, National Institute of Allergy And Infectious Diseases, National Institutes of Health	USA	37	781	21.1
25	Department of Biomedical Sciences, Institute of Tropical Medicine	Belgium	35	924	26.4
26	Department of Parasitology, Pasteur Institute of Iran	Iran	35	382	10.9
27	Institute of Medical Sciences, Banaras Hindu University	India	34	1680	49.4
29	Instituto de Medicina Tropical Alexander Von Humboldt, Universidad Peruana Cayetano Heredia	Peru	34	685	20.1
28	Department of Biology, Baylor University	USA	34	952	28.0
30	Department of Biomedical Sciences, University of Antwerp	Belgium	32	1214	37.9
31	Department of Parasitology, Faculty of Medical Sciences, Tarbiat Modares University	Iran	32	326	10.2
32	Instituto De BiofúIca Carlos Chagas Filho, Universidade Federal Do Rio De Janeiro	Brazil	31	443	14.3
33	Programa De Pós-Graduação Em Ciências Da Saúde: Infectologia E Medicina Tropical, Faculdade De Medicina, Universidade Federal De Minas Gerais	Brazil	30	411	13.7

Table 7. *Top 33 productive organizations based on co-authorship in leishmaniasis research*

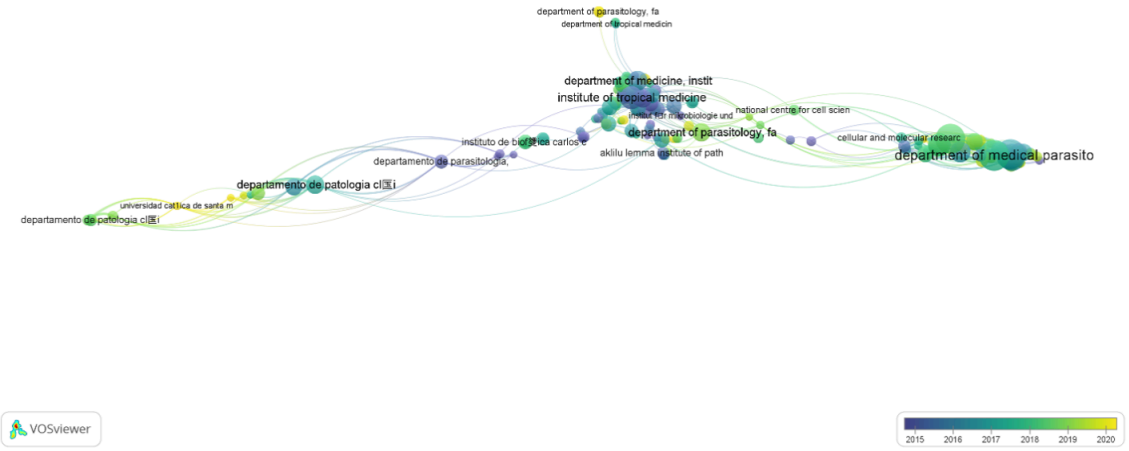


Figure 11. *Collaboration networks of the 33 organizations that published more than 30 documents on leishmaniasis between 2010 - 2023 retrieved from Scopus. Nodes represent one research institution, and the size of a node represents its total link strength. The Department of Medical Parasitology and Mycology of the University of Medical Sciences, Iran had the greatest strength links with other organizations between 2010 and 2023.*

Discussion

A long history of leishmaniasis dating back to 2,500 B.C. has been reported. Several primitive descriptions of the disease in ancient writings and molecular findings from ancient archeological material have been recorded (add references). Many decades later, the endemicity of leishmaniasis has increased to 90 countries in the subtropics and tropics regions globally (add references). Unlikely VL, a steady increase of CL cases has been reported in the studied years, especially in the WHO Eastern Mediterranean region [33]. Factors like poor socioeconomic conditions, human behavior, malnutrition and population mobility have been associated with leishmaniasis incidences [33]. Moreover, with climate change, the incidence and geographical distribution of leishmaniasis is expected to increase, thus challenging the current control and management interventions [34]. Significant advancement in multiple areas including early detection and treatment, disease surveillance, local management of reservoir hosts, and reporting of cases to the local, national and international agencies for effective leishmaniasis prevention are necessary. Given the

limitations in cost, toxicity, and availability of treatment regimens, a safe, effective, affordable, and widely available vaccine is the best hope for controlling leishmaniasis [35].

The performance analysis examined the contribution of research constitutes (authors, institutions, countries and journals) in leishmaniasis research. The analysis of the retrieved data in the last decade revealed a steady increase of publications during the study period OF 2010-2023. Journal articles were the most common type of scientific documents among those retrieved from Scopus, accounting for over 77.4% of the total published materials. Similar observations have been reported in other bibliometric studies [36][37][38][39][40]. The growing number of published journal articles about leishmaniasis can be associated with different factors like social awareness, WHO effects in controlling leishmaniasis particularly in endemic settings, the role of various funding agencies, and efforts of academic and research institutions [8][38][41].

The current bibliometric analysis highlights the introduction of new journals over the studied period, including multilingual and non-English journals. Although the most used language among the retrieved leishmaniasis research output was English (90.9%), other languages were used at different rates including Portuguese (2.3%), Spanish (2.2%), French (1.7%), German (0.7%) and others (2.1%). Of the 60 top ranking journals publishing leishmaniasis research, 4 journals; *Experimental Parasitology* of Netherlands, *European Journal of Medicinal Chemistry* of France, *Revista Brasileira de Parasitologia Veterinaria* of Brazil were multilingual and *Anais Brasileiros de Dermatologia* of Brazil used Portuguese. This indicates growing interest in leishmaniasis research as a result of WHO coordinated eradication efforts and increased flow of funding. Using other languages than English in scientific publications in indexed journals allows participation of a wider scientific community and the public in leishmaniasis research in non-English speaking regions, especially in endemic regions like South America, Asia and Africa [8].

As shown in this bibliometric study, reviews were the second most abundant type of documents accounting for 12.5% of all published materials. Review articles critically identify and synthesize relevant literature by evaluating varying types of published materials from different perspectives. Generally, *they* aim at providing a current state of knowledge and an integrated overview of a particular topic/ field. The high number of reviews about leishmaniasis is incredibly useful for researchers in terms of intellectual enrichment and enhancing standards of research towards the scientific progress in leishmaniasis research [14][42]. They fuel scientific research by highlighting knowledge gaps, best practices and effective interventions.

Unlike citation, co-citation and bibliographic coupling analysis, keyword analysis examines the actual content of publications [43]. The identified keywords and their co-occurrence in this study indicate current trends and relationship among various topics in leishmaniasis research. They can inform future directions in the field towards eradication of the diseases. For example, more than 20 *Leishmania* species are associated with various leishmaniasis conditions, however, the most common keywords were of *leishmania infantum, leishmania major* and *leishmania donovani*, signifying their importance in leishmaniasis research [17][21][22][44][45]. Likewise, molecular docking, drug discovery and neglected tropical diseases keywords indicate the ongoing efforts of understanding leishmaniasis hosts and vectors through molecular approaches as well as drugs for effective control and management in recent years [10][23][46][47][48][49][50].

Brazil, United States, India, Iran and United Kingdom lead production of published materials about leishmaniasis, while French Guiana, Anguilla and Switzerland ranked at top with population normalized data. USA has the highest number of citations and co-authorship links, as it has also been reported in other biomedical-bibliometric studies [36][37][41][51]. Surprisingly, our analysis point out that countries with the highest estimated numbers of leishmaniasis cases do not lead the scientific production on leishmaniasis research. Of the 15 countries with the highest estimated leishmaniasis incidence rate, 6 (40%) are in Africa, whereas the African country with the highest number of publications (Tunisia) ranks twenty first in research production based on number of documents [7][8]. Remarkably, several African countries with a very low GDP have still managed to make great strides in leishmaniasis research than high-income countries, whereas Tunisia (2^{nd}) and Sudan (4^{th}) rank among the top five countries. Similar findings have been reported with other diseases common in developing world [36][39][52]. An intriguing discovery within the network of international collaboration, notably between North and South collaboration has led to article documents with scientists from the South as first authors However, challenges with less-than-ideal research systems and prevalence and collaboration dominance in the South has been pointed [53].

Co-authorship and BCO analysis present an intellectual collaboration among scholars, organizations and countries [43][54]. Analyses of authors and organizational affiliations based on number of publications revealed that Asian authors and organizations published a large number of studies in leishmaniasis research. The contribution of Asia to leishmaniasis research has gradually increased in the studied period. Other studies have indicated that scientific output from Asian countries in leishmaniasis as in other poverty-related areas of “parasitology” and “tropical medicine” has increased over the past 20 years [36]

[39], contrasting the expected high research output from Europe and North America [38]. However, authors and organizational affiliations with most citations were from Europe including the Institute of Tropical Medicine (Belgium), Department of Public Health, Institute of Tropical Medicine (Belgium), London School of Hygiene and Tropical Medicine (United Kingdom), and DNDi (Switzerland). High citations and strong co-authorship links among North-American and European organizations support the traditional high productivity of these regions. These strong collaboration links amongst European scholars might partly be attributed to developed research infrastructure and the early adoption of computer-based communication associated with rapid development of the world-wide-net in the 1990's [55][56]. Although citations might not be the best indicator of "quality" of publications, improvement in the quality of publications from Asia, Africa and South America where the disease is endemic is compulsory [57][58][59][60]. To increase the participation of authors from these mentioned geographical regions, we recommend strengthening of the research infrastructure. Establishing and fostering scientific research networks, particularly collaborative platforms involving developing countries with high leishmaniasis prevalence and counterparts from North American and/or European countries, is a crucial step towards advancing our understanding of the disease and enhancing global efforts for effective control and management.

We acknowledge that there might be an overlap between this study and previous bibliometric studies in leishmaniasis [41][52]. However, unlike these previous studies, the current study analyses the latest scientific literature in leishmaniasis in the period between 2010 and 2023. Further, the findings present a novel contribution in terms of network analysis of keywords, organizational affiliations and countries in leishmaniasis research. Additionally, the use of Scopus database enabled inclusion of all important leishmaniasis journal articles and references included in those articles, which allowed authors to search both forward and backward in time [61].

Conclusions

This study sought to analyze scientific literature in leishmaniasis indexed in the Scopus database over a period of 2010 -2023. We report a steady increase in the number of publications related to leishmaniasis research. Mapping of performance of authors and organizations indicate that North American and European countries are leading research in leishmaniasis despite having low burden of the diseases. The study, calls for increased north-south collaboration in order to effectively prevent and control the disease in endemic regions. Funders and governing bodies such as WHO have an important role to play in making sure that research is conducted on the ground where the diseases incidences are high and findings feed directly into control and eradication measures. International collaboration and increased funding are

essential for creating a united front against leishmaniasis, ensuring that no population is left behind in the pursuit of a world free from the burden of leishmaniasis.

Failure to group retrieved publications according to various leishmaniasis forms (VL, CL, MCL, DCL and PKDL) is one of limitations from this particular study. This gap would have provided insightful information as to whether publications are influenced by incidences of leishmaniasis forms in the top ranked countries. Moreover, the study could not estimate the number of documents, citations and average citations that resulted from multi/inter-national collaborations. This could have resulted to poor research productivity in developing countries such as Africa, where international collaboration is uncommon.

Abbreviations

- AC Average citations
- BCO Bibliographic coupling
- CDC Centers for Disease Control and Prevention
- CL Cutaneous leishmaniasis
- DCL Diffuse cutaneous leishmaniasis
- DNDi Drugs for Neglected Diseases Initiative
- GDP Gross Domestic Product
- JCR Journal Citation Report
- MCL Muco-cutaneous leishmaniasis
- MEXT Ministry of Education, Culture, Sports, Science and Technology
- NC Number of citations
- NTDs Neglected Tropical Diseases
- NWCL New World Cutaneous Leishmaniasis
- OWCL Old World Cutaneous Leishmaniasis
- PKDL Post kala-azar dermal leishmaniasis
- STH Soil-transmitted Helminths
- VL Visceral leishmaniasis
- WHO World Health Organization

Statements and Declarations

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Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Author's contribution

CY: Conceptualization, Literature review, Literature search, Data analysis and Interpretation, Writing- Original draft. RB: Conceptualization and Data Interpretation; SG: Writing- review and editing; DAB: Supervision, and Writing- review and editing. All authors have read and agreed to the published version of the manuscript.

Ethics approval and consent to participate

Not Applicable.

Consent for publication

Not Applicable.

Competing interest

The authors declare that they have no competing interests.

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