

Original Article

Worldwide and Brazilian scientific publications on Leishmaniasis in the first 19 years of 21st century: a bibliometric study

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Abstract

Introduction: Leishmaniasis is a set of tropical diseases widely distributed throughout the world. Publications concerning different aspects of leishmaniasis have shown an increasing trend in recent years, especially in Brazil, where this disease has been under continuous expansion. The present study analyzes the data and assess trends in publications on leishmaniasis in Brazil and worldwide.

Methodology: The bibliometric analysis was performed on the Scopus database, addressing data on scientific publications about leishmaniasis in the first nineteen years of the 21st century. The tendency of the annual number of publications was analyzed by mean of linear regression equations.

Results: The literature search identified 19.317 publications. Brazil was the country with the largest number of studies (24.88%). The annual growth rate for Brazilian publications was 4.66%, whereas worldwide publications grew 2.96%. The leading ten international authors contributed to 8.71% of the publications, whereas the ten principal Brazilian authors contributed to 4.31%. The largest collaboration network between authors was between Brazil and the United States. Oswaldo Cruz Foundation occupied the premier position in both worldwide and Brazilian ranking in number of publications. The international journal with the largest number of publications and SCImago Journal Rank indicator was PLOS Neglected Tropical Diseases. The Journal of Immunology had the highest H-index. Most of the research covered topics related to immunology and molecular biology.

Conclusions: The data show relevant characteristics of the scientific production on leishmaniasis and demonstrate the fundamental role played by Brazil in the production of knowledge in this area of study.

Key words: Leishmaniasis; bibliometrics; information science; Brazil.

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Introduction

Leishmaniasis is a group of vector-borne diseases caused by protozoa belonging to genus *Leishmania*. It is transmitted by vector sandflies [1] and classified into four main types according to clinical manifestations: visceral leishmaniasis (VL), localized cutaneous leishmaniasis, muco-cutaneous leishmaniasis, and diffuse cutaneous leishmaniasis (DCL).

Leishmaniasis is prevalent in 98 tropical and subtropical countries, in zoonotic and anthroponotic transmission cycles, with approximately 2 million new cases observed annually [2]. In 2018, approximately 95% of the VL cases occurred in Brazil, China,

Ethiopia, India, Iraq, Nepal, Somalia, Kenya, South Sudan, and Sudan [3].

The number of publications addressing leishmaniasis has increased over time [4]. The same has occurred with networks of scientific collaboration between researchers, which are fundamental for the search for new methods of prevention, control, diagnosis and treatment [5].

The large amount of scientific information produced annually demands different digital systems for data storage and management [6]. Scopus stands out among the different existing databases. It was created in 2004, and includes studies published since the beginning of the 20th century, featuring over 60 million

records, including articles, abstracts, scientific references, scientific journals, books, patents, congress proceedings, and literature citations with peer review [7].

The influence and impact of the literature can be more efficiently assessed through bibliometrics, a field of study that involves the analysis of publications and citations, like the trends of articles and journals, also the impact identified in scientific and academic databases [8]. This quantitative method searches for publications, journals, institutions, words, citations, references, co-citations, phrases and authorship, and provides details on research published on a specific topic at a given time [9,10]. The dissemination of bibliometric studies in the health field and the use of their results in scientific research can favor increased collaboration networks between researchers and professionals [11], in addition to directing the planning and execution of new studies and public health actions [12].

Considering that leishmaniasis is a disease under expansion that presents high rates of morbidity and mortality, it is relevant to understand the progress of scientific research in this field [11]. Bibliometric studies addressing the status and production process of scientific collaborations on leishmaniasis can be found in the literature [5,6,9,13]. However, studies addressing the scientific production on leishmaniasis in the first 19 years of the 21st century and the comparison between global and Brazilian publications in the Scopus database have not been found in the literature. The present study analyzes these data and assesses the trends in publications on leishmaniasis by area of knowledge, authors, journals, institutions and geographic distribution, as well as the SCImago Journal Rank (SJR) indicator of the main journals and authors, the main topics and terms covered, and the collaboration networks from countries with the largest number of publications.

Methodology

A literature search was conducted at the Scopus database, using the terms “Leishmaniasis” OR “sand flies”, between January 2001 and December 2019. Articles, editorials, book chapters, short studies, books, reviews, and conference articles on any clinical form of leishmaniasis were retrieved from the database, as well as entomological studies addressing the relationship between the vector and transmission, dissemination or interaction with the *Leishmania* parasite. The following publications were excluded from the analysis: studies in duplicate, which did not address the theme, or which were not available in full in cases that only the reading

of the title and abstract did not provide enough information to establish a relationship between the study and the topic of interest. Studies that provided only a description of the vector sand flies and the abundance, morphology and classification of the species were also excluded.

The studies were included in or excluded from the analysis after reading of the titles, abstracts and keywords. The documents were stored and managed using the Zotero software and later exported to a Microsoft Excel spreadsheet, where they were organized and analyzed using bibliometrics.

The Scopus database classifies the country of origin of the publication according to the nationality of all authors, using a country/territory filter. This filter was used to classify the publications into general, worldwide, and Brazilian. Documents containing Brazilian and/or international authors were categorized as “general” publications. Publications by authors from all countries except those from Brazil were included in the “worldwide” category. Publications with the presence of at least one author from Brazil were included in the “Brazilian” category. All documents were filtered by year, country, author, affiliation and area of knowledge. For each filter, the number of publications was ranked by the 10 largest contributors. In addition, the knowledge areas and sub-areas of the main journals were analyzed.

The H-index was applied to analyze the productivity and impact of the main international and Brazilian authors of studies on leishmaniasis. Since the Scopus database also categorizes the co-authors' institutions in the affiliation classification, and considering that each publication can be registered in more than one institution and in more than one area of knowledge, the total absolute values for these filters were higher than those of the studies found in the search.

For analysis of the tendency of the annual number of publications, linear regression equations were used, where the angular coefficient represented the growth rate [14]. The values of each variable were linearized so that the angular coefficient of the equation indicated the classification of growth in a specific period. The data for this stage were analyzed using the BioEstat 5.3 software.

The gross number of articles published by the journals and their SJR indicator [15] were analyzed. The latter was analyzed using the SCImago Journal Rank, which provides the journals' number of citations and their H-index. The authors SJR indicator was calculated using the Scopus filter, which identifies the

number of citations per author. A quantification of the most frequently words present in the study titles was produced and the most cited articles were analyzed.

The collaboration network in research on leishmaniasis between the main countries, and the density maps of the words most frequently used in the title of the articles were established using the VOSviewer software. Furthermore, Brazilian international collaborations were analyzed and compared with those of USA and India.

Results

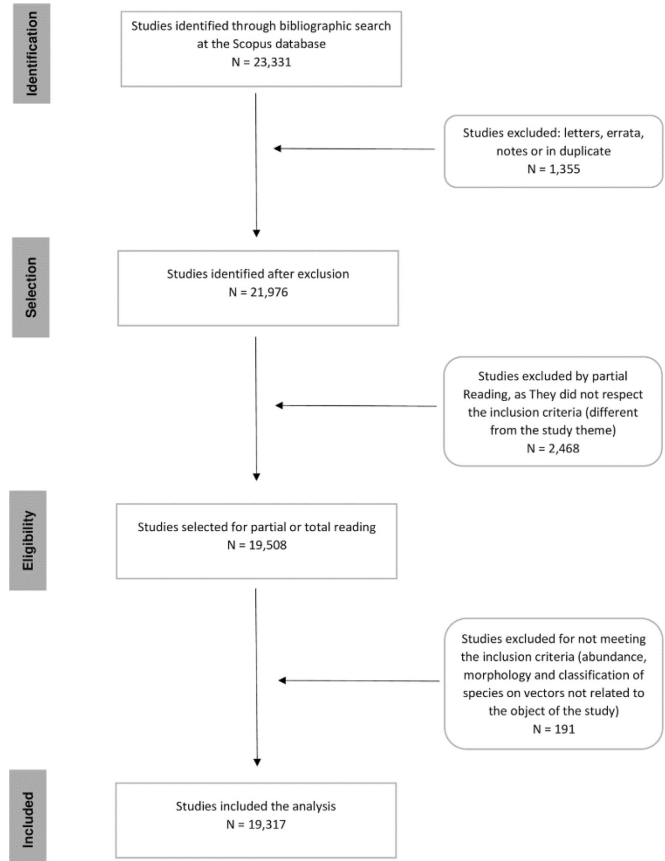
In the initial search, 23,331 publications registered in the Scopus database were identified. After applying the exclusion criteria, 19,317 general publications remained (Figure 1). Of these, 14,510 were worldwide publications and 4,807 were Brazilian.

In the period studied, there was a growth rate of 1.86% in the number of general publications on the theme. Regarding the worldwide publications, the number increased from 495 in 2001 to 839 in 2019. With respect to the Brazilian publications, the number increased from 76 in 2001 to 394 in 2019 (Figure 2).

In the ranking of the leading 10 countries regarding scientific production on leishmaniasis, Brazil ranked first, followed by the United States. From 2001 to 2004, the United States led this ranking, but in 2005, Brazil started to occupy the first position. The top 10 countries accounted for 92.49% of total publications. As for geographical distribution, European countries were more active in scientific contribution on leishmaniasis (32.75%). India and Iran led the research in Asia, occupying the third and fourth positions in the ranking, respectively (Supplementary Table 1).

The variation in the number of publications generated coefficients of determination (R^2) of 0.91 for

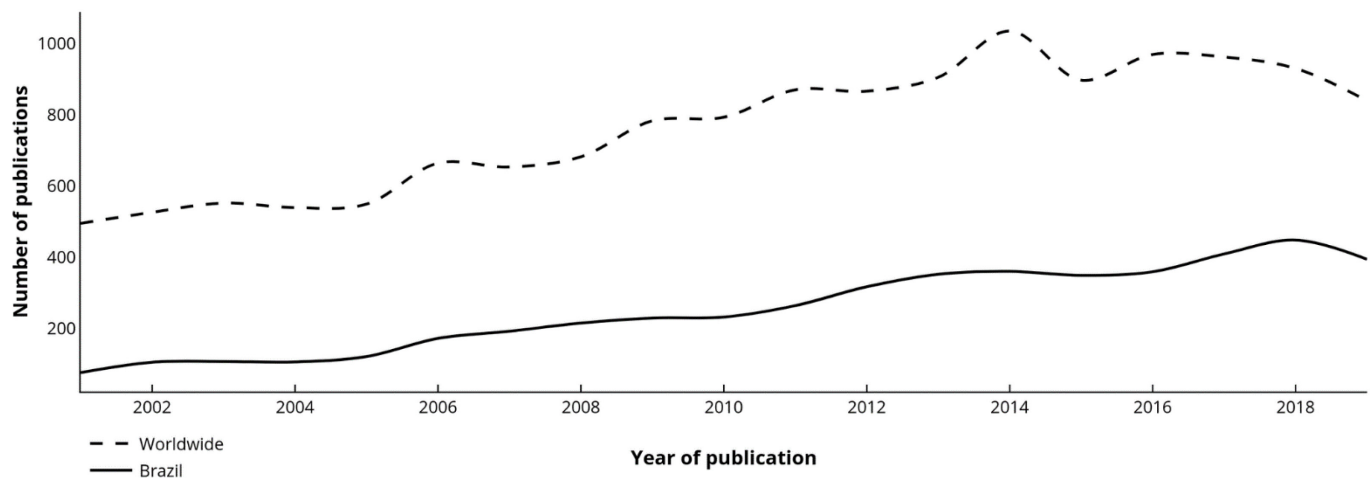
Figure 1. Flow diagram of the different phases for selection of publications for bibliometric analysis.



N: Number of publications.

worldwide publications and 0.98 for Brazilian publications. The growth rates of publications in the period evaluated, generated by the linear regression slope, were 2.96% and 4.66% per year for world and Brazilian publications, respectively.

Figure 2. Historical series of Worldwide and Brazilian publications between 2001 and 2019.



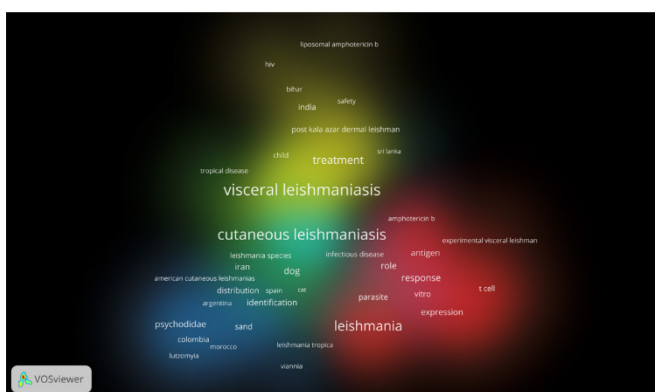
In the ranking of the 10 authors who published the most on research leishmaniasis in the period studied, Sundar, S. was the author with the largest number of publications (1.79%). The top 10 Brazilian authors contributed with 833 (4.31%) of the general publications, with Barral, A. as the Brazilian author who published the most, with 108 items published. In the analysis of productivity and SJR indicator of the main authors, Sundar, S. was the author with the highest H-index (72) among all researchers. In the exclusively Brazilian ranking, Barral, A. obtained the highest H-index (49) (Supplementary Table 2).

Among the 10 journals that concentrate the largest number of general publications, PLOS Neglected Tropical Diseases ranked first with 599 publications, followed by the American Journal of Tropical Medicine and Hygiene, which registered 394 publications. The Brazilian periodicals included in this ranking were *Revista da Sociedade Brasileira de Medicina Tropical*, with 281 publications, and *Memórias do Instituto Oswaldo Cruz*, with 218 publications, which occupied the fifth and seventh position, respectively. In the

Figure 3. Density of the terms used in the Brazilian studies concerning leishmaniasis.



Figure 4. Density of the terms used in the global studies concerning leishmaniasis.



analysis of productivity and SJR indicator of the main journals, the Journal of Immunology presented the highest H-Index (345) and the PLoS Neglected Tropical Diseases presented the highest SJR indicator (2.67) (Supplementary Table 3).

Analysis of the institutions that published the most were divided between worldwide and Brazilian institutions. In the worldwide ranking, Tehran University of Medical Sciences led with 599 publications, whereas in the Brazilian ranking, Oswaldo Cruz Foundation (FIOCRUZ) led with 1,745 publications (Supplementary Table 4).

The 10 main areas of knowledge concentrated 29,762 of the general publications on leishmaniasis research. Of these, 8,772 exclusively Brazilian publications were registered. The area with the highest concentration of productions was “Medicine”, both in Brazil and in worldwide (Supplementary Table 5). For the ten most productive journals, 90% were in the “medicine” category. Of those, 78% were in the infectious diseases sub-area (Supplementary Table 6).

The words “Leishmaniasis” and “*Leishmania*” appeared in greater proportions with 9,455 and 8,291 entries respectively, followed by “Visceral” (3,792) and “Cutaneous” (3,132) (Supplementary Table 7). In density view the clusters of Brazilian (Figure 3) and world (Figure 4) productions were similar, although for the latter there was a greater diversity of terms, especially with regard to the treatment of leishmaniasis. In both cases, there was a predominance of studies related to immunological and molecular aspects. The most cited article with the presence of Brazilian authors was “The genome of the kinetoplastid parasite, *Leishmania major* [16] with 981 citations in Scopus. The article “Leishmaniasis worldwide and global estimates of its incidence” [17] presented 2,653 citations in Scopus and was the most cited worldwide (Supplementary Table 8).

Brazil, India and the USA showed an increase in the number of publications with international collaborations. Scientific collaboration between Brazil and other countries has significantly increased in all years, especially between 2010 and 2015. India, in turn, had a less marked increase in international scientific collaborations (Supplementary Table 9). Figure 5 shows the collaboration network between the 30 main countries found in the study. The lines connecting the countries indicate the amount and intensity of the collaboration. It can be observed that the relationship between the United States and Brazil is thicker than between other countries, which demonstrates that researchers from these countries have a great deal of

collaboration in carrying out leishmaniasis studies. In addition, Brazil is the main collaborator to studies in Latin American countries. India has the United States and the United Kingdom as direct collaborators.

Discussion

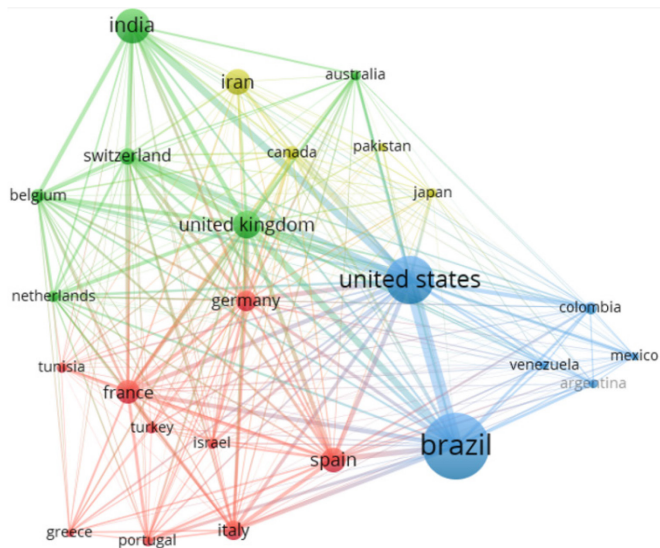
The present study analyzed the research on leishmaniasis published in the 21st century and identified relevant characteristics of the production carried out in Brazil and in the world.

Throughout the study period, there was a growth in the number of publications, mainly in Brazil. In the ranking of the countries with the largest production on leishmaniasis, Brazil and the United States occupied the first and second positions, respectively, corroborating the findings reported in studies carried out in previous periods using other databases [6,9]. The present study also shows that Brazil has undergone a sharp growth in the number of published studies, and that the country continues to lead the global scientific production in this field.

The increase in the number of studies published worldwide in the 21st century may be associated with the spread of the Internet, which facilitated collaboration between researchers [13], as well as with greater public and private investment in scientific research addressing neglected diseases. Mainly in Brazil, there was a significant increase in public investments in science and technology. This reflected in the creation of educational institutions, in an increased public funding for research, and in the training of a larger number of researchers. In 1996, 10.4 thousand Master and 2.8 thousand doctoral students were trained in Brazil. This number increased to 50.2 thousand Master and 16.7 thousand doctors in 2014 [18]. Although the investment trend has been drastically reduced since 2014 [19], its impacts on the number of articles published on leishmaniasis have not yet been noticed, which may occur in the coming years if this trend is not reversed [20]. It should also be noted that the increase in scientific production in Brazil has not reflected in the reduction of case incidence and expansion of the disease in the country, which may be associated with the control actions adopted, which practically have not changed in recent years and continue to be supported by weak evidence [21].

The growth in general publications on leishmaniasis was more marked than that observed in bibliometric studies that evaluated other neglected tropical diseases, such as Chagas or leprosy [8,22,23]. This result may be due to the more recent inclusion of leishmaniasis in the World Health Organization agenda, as well as to the

Figure 5. Collaboration network between different countries in leishmaniasis research.



need to study the disease in endemic areas or with emerging cases in order to establish adequate control and surveillance policies by local health authorities [2]. In addition, there is greater awareness on the part of different sectors about the need to tackle the disease and improve the methods of diagnosis and treatment [2,23].

With regard to journals, the larger number of published studies and the greatest SJR indicator of the PLoS Neglected Tropical Diseases demonstrate the relevance of this multidisciplinary journal. This periodical is often preferred by authors who, among other factors, seek unrestricted access to their publications. The greatest H-index of the Journal of Immunology indicates the relevance of this periodical, which is the oldest in the field of immunology, as well as the predominance of publications and citation of studies on different aspects related to the immunology of leishmaniasis. Regarding Brazilian publications, two journals were highlighted: *Revista da Sociedade Brasileira de Medicina Tropical* and *Memórias do Instituto Oswaldo Cruz*. Both presented high SJR indicator, with values similar to those of renowned international journals. This demonstrates the large number of citations of studies published in the journals and their great international significance.

The top 10 international journals that most published articles encompassed those with wide scope, such as the Journal of Immunology, Infection and Immunity and PLoS One, and those with a focus on tropical diseases such as the PLoS Neglected Tropical Diseases, American Journal of Tropical Medicine and Hygiene, Transactions of the Royal Society of Tropical

Medicine and Hygiene, *Revista da Sociedade Brasileira de Medicina Tropical* and *Memórias do Instituto Oswaldo Cruz*. In general, the more specialized journals have lower SJR indicator despite their undeniable and outstanding reputation in the area. However, this could not be identified in research on leishmaniasis, since even specialized journals had relatively high SJR indicator. While the system of evaluating the relative importance of a journal within its field on the basis of SJR indicator remains controversial, publication in a high impact journal often imparts greater visibility to the study. The acceptance of papers addressing *Leishmania* by wide scope, high impact journals shows the relevance of this disease in the scientific scenario, especially investigations associated with the immunological response to parasite infection.

The data presented in our study show the concentration of a large number of publications in a limited number of journals, which is not exclusive to the theme of *Leishmania*, considering that Vioque *et al.* [24] reported that 20 journals contributed approximately to 25% of the literature on obesity and Ramos *et al.* [25] observed that eight journals contained 25% of the literature on Chagas disease.

The areas of scientific knowledge and the topics studied were similar in Brazil and in the world, although in Brazil, possibly due to the relevance of dogs in the transmission cycle of VL, there have been a larger proportion of studies on veterinary medicine. Considering that the area classified as medicine covers different topics, there were a larger number of contributions in this area, followed by the area of immunology. Ramos *et al.* [6] reported that the main area of the Medline database in the 1945-2010 period was parasitology. The Scopus database, however, does not specify this topic. It can also be observed a predominance of studies on VL over cutaneous leishmaniasis, which is justified by the higher lethality and burden of diseases attributed to the first [26].

Analysis of author contributions revealed Shyam Sundar (Sundar, S.) as the global leading author. This Indian researcher participated in 347 documents, had an H-Index of 72, and was described at the top of authorship rankings in other bibliometric studies on leishmaniasis [6,9]. In the exclusively Brazilian ranking, Aldina Barral (Barral, A.) was the main author, with 108 documents and an H-Index of 49. This Brazilian author is among the most productive researchers in the world. It is worth noting that the indexes of the authors are directly related to their areas of activity, with predominance of authors of studies

addressing the treatment and immunology of leishmaniasis. This could also be seen in the density of the terms most frequently used in the titles of Brazilian and world articles.

The collaboration networks between researchers influence the productivity, visibility and reputation assessment indexes. The present study showed that the largest network of worldwide collaborations in leishmaniasis occurs between the United States and Brazil. In addition, Brazil also has a vast collaboration network with Latin American countries and the United Kingdom. Collaboration between researchers from different countries is important to seek alternatives to reduce the prevalence and incidence of cases of leishmaniasis, mainly in developing regions [2,5]. Brazil, India and the United States have successively increased the number of studies with international collaborations. However, considering publications from all areas, there was a reduction in the growth trend of the number of articles published in collaboration between Brazilian and foreign authors in the last years [27]. This pattern and its causes must be better evaluated in future studies, as well as the effects that reduction in public research funding in Brazil can have on international collaborations.

Regarding the most productive institutions, FIOCRUZ was responsible for over 9% of the publications and was the institution with the largest number of studies on leishmaniasis in the world. FIOCRUZ is linked to the Brazilian Ministry of Health, and is considered the largest health science and technology institution in Latin America [28]. It has several graduate studies programs and is the main non-university institution responsible for the training and qualification of human resources for the Brazilian Health System [29]. All of the top institutes listed are leading centers of research and postgraduate education, where students have unparalleled access to the knowledge and experience of experts in public health. Furthermore, considering that they have strong links with key universities and research institutes around the world, they enable the exchange of experiences and provide a rich environment for learning.

Conclusions

The retrieval of *Leishmania*-related publications contained in the Scopus database for the 2001-2019 period showed that (i) Brazil is the most productive country in number of publications; (ii) the growth rate in Brazilian publications increased markedly as of 2007, thereby mirroring the worldwide trend; (iii) most Brazilian publications were generated by few

researchers and institutes, with FIOCRUZ highlighted as the leading research center in the world. It is clear that research funding must continue, and preferably increase, so that the transmission of leishmaniasis can be reduced in Brazil. Furthermore, it is important that the Brazilian expertise and institutes are accessible to undergraduate and graduate students from other developing countries where this disease is endemic, so that less privileged populations can benefit from the advances in this research field.

Authors' contributions

All authors: conceptualization, methodology, resources, writing review, supervision and project administration.

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Conflict of interests: No conflict of interests is declared.

Annex – Supplementary Items**Supplementary Table 1.** Top 10 countries ranked according to the total number of scientific publications on leishmaniasis.

Country	Number of publications
Brazil	4,808
United States	3,065
India	2,158
Iran	1,510
United Kingdom	1,498
Spain	1,316
France	1,112
Germany	898
Italy	805
Switzerland	698
Total	17,868

Supplementary Table 2. The top 10 worldwide and Brazilian authors on leishmaniasis research ranked according to the total number of publications and the H-Index.

Author	World		Author	Brazil	
	Number of publications	H-Index		Number of publications	H-Index
Sundar, S.	347	72	Barral, A.	108	49
Das, P.	240	43	Coelho, E.A.F.	93	22
Mohebal, M.	194	33	Laurenti, M.D.	91	21
Boelaert, M.	164	54	Reis, A.B.	90	30
Khamesipour, A.	134	36	Brazil, R.P.	84	24
Dujardin, J.C.	130	45	Silveira, T.G.V.	80	18
Volf, P.	124	41	Barral-Neto, M.	78	45
Hailu, A.	121	38	Melo, M.N.	78	36
Rijal, S.	120	41	Lonardoni, M.V.C.	69	18
Pandey, K.	109	21	Galati, E.A.B.	62	26
Total	1,683			833	

Supplementary Table 3. The top 10 journals according to the number of publications and SJR indicator in leishmaniasis research.

Journal	Number*	H-Index	SJR indicator	Country
PLoS Neglected Tropical Diseases	599	110	2.67	USA
American Journal of Tropical Medicine and Hygiene	394	135	1.41	USA
Acta Tropica	312	89	1.22	Netherlands
Parasites and Vectors	285	64	1.56	United Kingdom
Revista da Sociedade Brasileira de Medicina Tropical	281	47	0.70	Brazil
PLoS One	255	268	1.10	USA
Memorias do Instituto Oswaldo Cruz	218	79	1.25	Brazil
Transactions of The Royal Society of Tropical Medicine and Hygiene	201	97	1.17	United Kingdom
Infection and Immunity	181	204	1.59	USA
Journal of Immunology	174	345	2.52	USA

* Number of publications; SJR: SCImago Journal Rank indicator.

Supplementary Table 4. Ranking of the world and Brazilian institutions that have published the most on leishmaniasis.

World		Brazilian	
Institution	(N)*	Institution	(N)*
Tehran University of Medical Sciences	599	Fundação Oswaldo Cruz (FIOCRUZ)	1,745
Banaras Hindu University	393	Universidade de São Paulo	887
London School of Hygiene and Tropical Medicine	358	Universidade Federal de Minas Gerais	723
Prins Leopold Instituut voor Tropische Geneeskunde	341	Universidade Federal do Rio de Janeiro	588
Indian Institute of Chemical Biology	291	Universidade Federal da Bahia	360
All India Institute of Medical Sciences, New Delhi	286	Universidade Estadual Paulista	328
Pasteur Institute of Iran	286	Universidade Federal de Ouro Preto	195
Organisation Mondiale de la Santé	263	Universidade Estadual de Maringa	165
Rajendra Memorial Research Institute of Medical Sciences	258	Universidade Estadual de Campinas	161
National Institutes of Health, Bethesda	239	Universidade de Brasília	151
Total	3,314		5,303

*Number of publications.

Supplementary Table 5. The 10 primary areas in leishmaniasis research.

World		Brazil	
Area	(N)*	Area	(N)*
Medicine	7,692	Medicine	3,052
Immunology and Microbiology	5,106	Immunology and Microbiology	2,234
Biochemistry, Genetics and Molecular Biology	2,538	Biochemistry, Genetics and Molecular Biology	858
Pharmacology, Toxicology and Pharmaceutics	1,891	Veterinary	829
Agricultural and Biological Sciences	1,404	Agricultural and Biological Sciences	804
Veterinary	1,303	Pharmacology, Toxicology and Pharmaceutics	542
Chemistry	632	Chemistry	293
Environmental Science	165	Multidisciplinary	62
Chemical Engineering	154	Environmental Science	50
Engineering	105	Chemical Engineering	48
Total	20,990	Total	8,772

*Number of publications.

Supplementary Table 6. The primary areas and sub-areas of research in leishmaniasis of the top 10 journals.

Area	(N)
Medicine	9
Immunology and Microbiology	7
Agricultural and Biological Sciences	1
Pharmacology, Toxicology and Pharmaceutics	1
Veterinary	1
Multidisciplinary	1
Sub-area (Medicine)	(N)
Infectious Disease	7
Medicine (miscellaneous)	3
Microbiology (medical)	2
Public Health, Environmental and Occupational Health	2
Immunology and Allergy	1
Multidisciplinary	1

Supplementary Table 7. Most frequently used words in leishmaniasis research.

Ranking	Term	Occurrence
1 st	Leishmaniasis	9,455
2 nd	Leishmania	8,291
3 rd	Visceral	3,792
4 th	Cutaneous	3,132
5 th	Infection	2,801
6 th	Infantum	1,344
7 th	Major	1,262
8 th	Disease	1,241
9 th	Against	1,197
10 th	Cell	1,156
11 th	Treatment	1,130
12 th	Brazil	1,094
13 th	Donovani	1,032
14 th	Patient	1,003
15 th	Dog	987
16 th	Canine	960
17 th	Case	890
18 th	Diptera	867
19 th	Parasite	851
20 th	Human	832

Supplementary Table 8. The 10 most cited articles in Brazil and worldwide.

Ranking (Brazil)	Title	Authors (year)	Journal	Citations in Scopus
1 st	The genome of the kinetoplastid parasite, <i>Leishmania major</i>	Ivens <i>et al.</i> (2005)	Science	981
2 nd	Cutaneous leishmaniasis	Reithinger <i>et al.</i> (2007)	The Lancet Infectious Disease	825
3 rd	Comparative genomic analysis of three <i>Leishmania</i> species that cause diverse human disease	Peacock <i>et al.</i> (2007)	Nature Genetics	496
4 th	<i>Leishmania amazonensis</i> promastigotes induce and are killed by neutrophil extracellular traps	Guimarães-Costa <i>et al.</i> (2009)	Proceedings of the National Academy of Sciences of the United States of America	309
5 th	<i>Lutzomyia longipalpis</i> and the eco-epidemiology of American visceral leishmaniasis, with particular reference to Brazil - A review	Lainson and Rangel (2005)	Memorias do Instituto Oswaldo Cruz	276
6 th	Current diagnosis and treatment of cutaneous and mucocutaneous leishmaniasis	Goto and Lindoso (2010)	Expert Review of Anti-Infective Therapy	244
7 th	Control of visceral leishmaniasis in latin America - A systematic review	Romero and Boelaert (2010)	PLoS Neglected Tropical Diseases	229
8 th	Up-regulation of Th1-type responses in mucosal leishmaniasis patients	Bacellar <i>et al.</i> (2002)	Infection and Immunity	222
9 th	<i>Lutzomyia</i> vectors for cutaneous leishmaniasis in Southern Brazil: Ecological niche models, predicted geographic distributions, and climate change effects	Peterson and Shaw (2003)	International Journal for Parasitology	221
10 th	Infectiousness in a cohort of brazilian dogs: Why culling fails to control visceral leishmaniasis in areas of high transmission	Courtenay <i>et al.</i> (2002)	Journal of Infectious Diseases	212
Ranking (Worldwide)	Title	Authors (year)	Journal	Citations in Scopus
1 st	Leishmaniasis worldwide and global estimates of its incidence	Alvar <i>et al.</i> (2012)	PLoS One	2,653
2 nd	Leishmaniasis: Current situation and new perspectives	Desjeux (2004)	Comparative Immunology, Microbiology and Infectious Diseases	1,561
3 rd	CD4+CD25+ regulatory T cells control <i>Leishmania major</i> persistence and immunity	Belkaid <i>et al.</i> (2002)	Nature	1,324
4 th	Advances in leishmaniasis			1,196
5 th	Drug resistance in leishmaniasis	Croft <i>et al.</i> (2006)	Clinical Microbiology Reviews	1,119
6 th	Visceral leishmaniasis: What are the needs for diagnosis, treatment and control?	Chappuis <i>et al.</i> (2007)	Nature Reviews Microbiology	988
7 th	Multifunctional TH1 cells define a correlate of vaccine-mediated protection against <i>Leishmania major</i>	Darrah <i>et al.</i> (2007)	Nature Medicine	975
8 th	The immunology of susceptibility and resistance to <i>Leishmania major</i> in mice	Sacks and Noben-Trauth (2002)	Nature Reviews Immunology	826
9 th	The increase in risk factors for leishmaniasis worldwide	Desjeux (2001)	Transactions of the Royal Society of Tropical Medicine and Hygiene	702
10 th	Leishmaniasis - Current chemotherapy and recent advances in the search for novel drugs	Croft and Coombs (2003)	Trends in Parasitology	633

Supplementary Table 9. Rate of increase in publications in collaboration with other countries.

Period (Years)	Brazil	USA	Índia
	N (%*)	N (%*)	N (%*)
2001-2005	19-26 (36.8%)	27-68 (151.8%)	4-18 (525.0%)
2005-2010	26-42 (61.5%)	68-102 (50.0%)	18-48 (92.0%)
2010-2015	42-98 (133.3%)	102-138 (35.3%)	48-50 (4.16%)
2015-2019	98-153 (56.1%)	138-161 (16.6%)	50-57 (14.0%)

* Increase rate of the country's collaborations in that period.