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Research Article

India's Contribution and Research Impact in Leishmaniasis Research: A Bibliometric Analysis

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ABSTRACT

Background: Neglected Tropical Diseases identified by World Health Organization (WHO) have always been a challenge for the medical science and society. These diseases exerted high pressure on society in terms of financial, economic and psychological aspects. The three forms of Leishmaniosis (cutaneous, mucocutaneous and visceral) is one of the tropical diseases which is posing challenge in South America, East Africa, Middle East and South East Asian region. The various institutions and researchers are working towards the better health facilities. Objectives: The purpose of the study is to trace the growth of literature in leishmaniosis research for fifty years focusing the contribution and research impact made by India over global research. The specific objectives are to analyze the Indian research in terms of global publication and share, top productive countries compared with Indian research output, productive Indian institutions, authors, and their citation impact, journals publishing Indian research and highly cited articles published by Indian authors. Methods: The bibliographic data was obtained from SCOPUS database, for a period of fifty years (1968–2017) using keywords 'leishmania', 'leishmaniasis', 'kala azar', 'kala-azar' available in the title, abstract and keywords fields. The geographical location was kept 'India' to assess the publication and research impact for India. The citation scored by each article were taken as the number citation accumulated by the articles since its publication till 2017. The international collaboration by Indian authors in leishmaniasis was analyzed for the authors affiliation with international institutions. The individual quality measure was considered using Hirsch-index. Results: The SCOPUS has indexed 39302 articles on Leishmaniasis during the period of 1968 till 2017, of which there were 3391 published by Indian authors. It was 8.64% of global share, making it fifth most productive country on leishmaniasis research, while United States was most productive with 19.36% global share. In terms of citation count, Indian research have quite good impact and has been ranked fifth. Indian Institute of Chemical Biology was most productive Indian institute, but Banaras Hindu University Institute of Medical Sciences was most impact full. Conclusion: The continued efforts are being made to strengthen the better facilities for the research in Tropical and Neglected Disease care. The researcher working with the Indian leishmaniasis research are making good impact globally. Indian researchers have to go long way in order to eradicate the incidence of the leishmaniasis from Indian population. The results presented in this study shall be helpful for the perspective researchers and policy makers to analyse the strength of Indian Leishmaniasis research.

Keywords: Leishmaniasis, Bibliometric analysis, Citation analysis, Indian research output.

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INTRODUCTION

The health sector is very critical towards the right information on certain diseases. The critical input for policy decision making, it is essential to provide right source of information about the descriptive epidemiology of diseases, risk factors and liable source.[1] There are thirteen Tropical Neglected Diseases as identified by World Health Organization (WHO) and are common infection condition among the world population.[2] The statistics on Global Burden Disease casualties are becoming alarming day by day and year by year with new cases,[3]even though, continued research are being taken by various institution at different level from all over World. Leishmaniasis is one of the Neglected Tropical Diseases becoming a challenge for medical science in about 98 countries of the World with a mortality rate of over 50,000 per year.[4]Leishmaniasis, a

parasitic disease, spread by the bite of female Phlebotomine Sandflies. There are three forms of the disease; cutaneous, mucocutaneous, or Visceral leishmaniasis; of which later has been estimated as most dangerous among all. It is sharing a 90% of prevalence across the globe but frequent in the population residing in the region of Bangladesh, Brazil, Ethiopia, India, Nepal, Saudi Arabia, Afghanistan and the Sudan.[5]

The research focused on Neglected Tropical Disease across the globe has posed a quite challenge for everyone being medical practitioners or policy makers. World Health Organization report on the leishmaniasis is in alarming situation due to new cases in the region of East Africa (Ethiopia, Kenya, South Sudan and Sudan) have caused high morbidity and mortality due to Visceral leishmaniasis. Similarly, cutaneous Leishmaniasis have affected different parts Afghanistan and the Syrian Arab Republic.[6-7] Visceral leishmaniasis have affected about 67% Global Burden of Diseases in India, Bangladesh, Nepal.[8]

Governmental and Non-Governmental agencies are playing a key role in elimination of the disease from the affected communities with the help of effective medication, vaccination and community services. Simultaneously, the medical practitioners are engaged in discovering the effective medication to control the disease. The scientists are working specially the countries of the most affected region to discover new medicine and treatment methods. These efforts are available as published literature and available as guiding path for future.

Various qualitative and quantitative assessment measures are being taken to analyze the research progress in scientific disciplines including leishmaniasis. In earlier days, the bibliometric studies were covering the different aspects of neglected tropical diseases such as Latin American studies[9-10]and social science research.[11] But after 2011 onwards specific research were conducted related to leishmaniasis in general;[12-13] or for specific countries and region such as Iran,[14-15] Latin America,[16] South America.[17] The bibliometric study focusing India were reported in parasitic and neglected tropical disease;[18] lymphatic filariasis;[19] and other neglected tropical diseases such as Ascariasis/Toxocariasis,[20] and Schistosomiasis.[21] However, these literature does not reveal any study covering the research impact of India in the field of leishmaniasis. The objective of this study is analyze literature on leishmaniasis published from India and its research impact in terms of total publication compared with global output, productive institutions, productive authors, productive journals, international collaboration, most popular articles on qualitative parameters citation and Hirch-Index (*h*-index).[22]

METHODOLOGY

This study is undertaken on the publications on Leishmaniasis by Indian research community. The data is collected from SCOPUS multidisciplinary bibliographic database available over http://www.scopus.com/home.url. The SCOPUS is having hundred percent coverage of PubMed data. The Medical Subject Heading (MeSH) Terms "Leishmania", "Leishmaniasis", "Cutaneous Leishmaniasis", "Mucocutaneous Leishmaniasis", "Visceral leishmaniasis" available in the article title, abstract and keywords, has been used to retrieve bibliographic data and "India" was used for the country of affiliation of the author using following string for the period 1968 till 2017.

(TITLE-ABS-KEY("Leishmania") OR TITLE-ABS-KEY ("Leishmaniasis") OR TITLE-ABS-KEY("Kala Azar") OR TITLE-ABS-KEY("Kala-Azar") OR TITLE-ABS-KEY ("Visceral leishmaniasis") OR TITLE-ABS-KEY("Cutaneous leishmaniasis") OR TITLE-ABS-KEY("Mucocutaneous leishmaniasis") AND AFFIL (India)) AND PUBYEAR > 1967 AND PUBYEAR < 2018.

The research impact of publication was taken in terms of citation count. The citation study has been taken as the number of citations received by the articles in first year of its publication (C_0) and till the year 2017 (C_{2017}). For the international collaboration, each article published from India was manually analyzed to see the collaboration by Indian authors with International authors. In combination with the above string, separate search strategies have been adopted to retrieve the data for individual, institutional and journal output. Thus, the data obtained using the different search strategies has been subjected to data analysis and interpretation of results. Another quality indicator, *h*-Index, which quantify the individual quality of the author and Institution was obtained from the database. The data thus obtained from SCOPUS was analyzed for global output, Indian output, share of publication, productive country, productive Indian institute, productive Indian authors, journals publishing Indian articles, international collaboration by Indian authors, and most cited articles authored by Indian authors.

RESULTS

There were 39302 articles available in SCOPUS during 1968 till 2017 (50 Years) on Leishmaniasis. Out of these, 3391 articles were published by authors from India. Figure 1 shows the trends of growth of literature output published globally and India. The global output averaged at 6.19% annual growth rate while India achieved an annual average growth rate of 20.60% per year. Indian research on Leishmaniasis was in infancy state till 1987 (3.45% share) and adolescent up to 2007 (36.21% share) and matured thereafter (60.34% share) (Table 1). In case of the global publication, 44.64% literature were

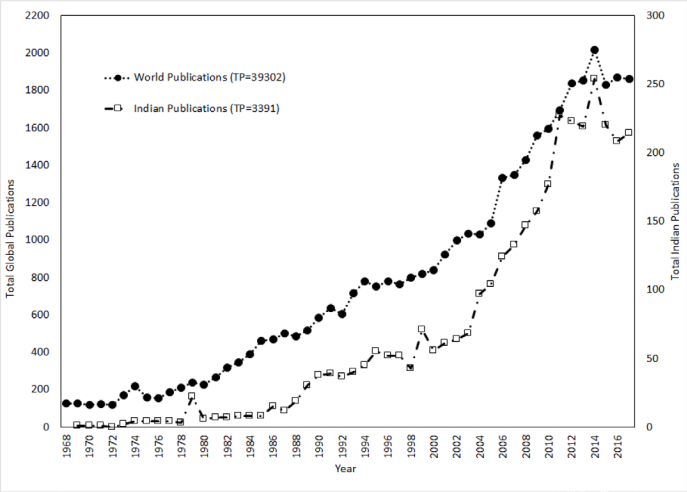

Figure 1: Comparison of Indian and Global Research Publication.

appeared the period of 2008-17 and in case of India, it was 60.34%. The period from 1978-1987 was highly productive in case of average percent growth rate when World literature growth was 127.94% and Indian literature growth was 357.14% than its previous period. For India, the highly productive year was 1979, 1999, and 2014. These high productive years for India were due to awareness and financial support from national and international organization participated in eradication program in India and South-East Asian region.[23–25]

Table 2 presents the distribution of 11 most productive countries on Leishmaniasis with more than two percent of global publications. The global publication ranges from 2.63% to 19.36%, where United States holds top rank with the highest number of publications (7609 papers; 19.36% share), followed by Brazil (6019 papers; 15.31% share) and United Kingdom (3548 papers; 9.03% share). India ranked fourth in terms of total publication (3391 papers; 8.64% share). France, Spain, Germany, Iran, Italy, Switzerland and Canada ranked from fifth to eleventh. The etiological evidence of Leishmaniasis in these countries ranges epidemics of the disease.[26]

In terms of citation impact by these countries, the articles published from USA have accumulated highest number of citations (317646 citations) with an Average Citation Per Paper (ACPP) of 1.75 citations per paper. The articles published from United Kingdom had 1,39,870 citations with ACPP of 39.42 citations per paper and Brazil had 1,06,261 citations with an ACPP of 17.65 citations per paper. Articles published from Canada were most frequently cited and were more impactful with an ACPP of 44.99 citations per paper, followed by Switzerland (ACPP=43.59). Indian papers accumulated 69,985 citations and ranked fifth, with an ACPP of 20.61 citations.

The quality parameter used for benchmarking[27] based on Hirsch Index, USA has highest value (*h*-Index=211) followed

Table 1: Growth Trends of Indian research output in block period of ten years.

Year Range	Global Publications			Indian Publications		
	TP	% Share	% Growth	TP	% Share	% Growth
1968 - 1977	1503	3.82	-	21	0.62	-
1978 - 1987	3426	8.72	127.94	96	2.83	357.14
1988 - 1997	6614	16.83	93.05	407	12.00	323.96
1998 - 2007	10214	25.99	54.43	821	24.21	101.72
2008 - 2017	17545	44.64	71.77	2046	60.34	149.21
1968 - 2017	39302	100.00	86.8	3391	100.00	20.60

Table 2: Most productive countries of Leishmaniasis research.

Country	TP	%Share	TC	ACPP	h-Index
United States	7609	19.36	317646	41.75	211
Brazil	6019	15.31	106261	17.65	105
United Kingdom	3548	9.03	139870	39.42	149
India	3395	8.64	69985	20.61	93
France	2585	6.58	77440	29.96	108
Spain	2222	5.65	53175	23.93	81
Germany	1980	5.04	67491	34.09	110
Iran	1575	4.01	19741	12.53	53
Italy	1438	3.66	35934	24.99	73
Switzerland	1279	3.25	55754	43.59	105
Canada	1033	2.63	46479	44.99	101
Total	32683	83.16	989776	30.28	

by United Kingdom (*h*-Index=149) and Germany (*h*-Index=110). The India has *h*-Index value of 93, which make it ranked eighth, higher than Spain, Italy and Iran.

In this study, it is found that there were ten Indian institutes, which had published hundred or more articles on various aspect of leishmaniasis during 1968-2017. The publication performance of these ten Indian institutions was measured in terms of total publication, publication share, total citations, average citation per paper and h-Index is given in Table 3. It is found that these ten institutes had contributed 76.41% of total Indian publication on leishmaniasis. 'Indian Institute of Chemical Biology, Kolkata' topped the rank with 566 articles (16.69% share), followed by Banaras Hindu University Varanasi (419 publications; 12.36% share) and Central Drug Research Institute Lucknow (376 publications; 11.09% share). Other institutes ranked from 4th to 10th and the percent share of publication ranges from 9.73% to 3.04%.

These most productive Indian institutions have accumulated a total of 67,250 citations with an ACPP of 25.96 citations. The Banaras Hindu University was most impactful with highest

Table 3: Productive Institutions with more than 100 articles on Leishmaniasis.

Institution	TP	%share	TC	ACPP	h-Index
Indian Institute of Chemical Biology, Kolkata	566	16.69	11331	20.02	49
Banaras Hindu University, Varanasi	419	12.36	15582	37.19	62
Central Drug Research Institute India, Lucknow	376	11.09	6024	16.02	39
Banaras Hindu University Institute of Medical Sciences, Varanasi	330	9.73	12420	37.64	54
Rajendra Memorial Research Institute of Medical Sciences, Patna	259	7.64	3406	13.15	30
All India Institute of Medical Sciences, New Delhi	154	4.54	9633	62.55	26
Indian Council of Medical Research, New Delhi	140	4.13	1931	13.79	20
National Institute of Pharmaceutical Education and Research India, Mohali	127	3.75	1608	12.66	20
Postgraduate Institute of Medical Education and Research, Chandigarh	117	3.45	3387	28.95	18
Jawaharlal Nehru University, New Delhi	103	3.04	1928	18.72	26
Total	2591	76.41	67250	25.96	

citations (15,582 citations) with an ACPP of 37.19 citations per paper followed by Banaras Hindu University Institute of Medical Science with 12,420 citations (ACPP=37.64 citations) and Indian Institute of Chemical Biology Kolkata with 11,331 citations (ACPP=20.02 citations). However, the articles of All India Institute of Medical Science were most impactful with highest average citation paper among all. It had ACPP of 62.55 citations for it 154 publications cited by 9633 times. The impact of the research in terms of quality reflected by various parameters and *h*-Index is one of them.[28-29] The top three ranked institutions on parameter of *h*-Index were Banaras Hindu University Varanasi (*h*-Index=62), Banaras Hindu University Institute of Medical Science Varanasi (*h*-Index=54) and Indian Institute of Chemical Biology Kolkata (*h*-Index=49).

The 3391 articles were published by 19788 authors either singly or jointly with authors from national or international institutions. Table 4 presents the status of ten most productive Indian authors and their citation impact who have published more than one percent of Indian leishmaniasis articles during 1968-2017. It is found that these ten authors were associated with five Indian institutes where Rajendra Medical College and Hospital Patna, Central Drug Research Institute Lucknow and Indian Institute of Chemical Technology Kolkata have two authors and Banaras Hindu University Medical Science Varanasi, Jawahar Lal Nehru University Delhi and Vardhman Mahavir Medical College New Delhi have one author each. These ten authors have contributed 1304 articles, which was 38.45% share of cumulative total Indian output. Four authors had published more than hundred articles on Leishmaniasis. Of these most productive author, S. Sunder from Banaras Hindu University Institute of Medical Sciences Varanasi was most productive with 371 articles (10.94% share) followed by P. Das (232 articles; 6.84%), A. Dube (109 articles; 3.21%) and P. Salotra (102 articles; 3.01% share). All other authors had contributed articles ranges between 77 to 100.

P. Salotra from Vardhman Mahavir Medical College, New Delhi was most impactful with highest number of citations for his 102 publication. P. Salotra had scored a total of 68379 citations at the rate of 670.38 citations per paper. Unlike other Bibliometric measures, the *h*-index is another very important parameter to account the lifetime achievement of a scholar's work and *h*-index can give fairer measure of an academic's overall impact.[30,31] P. Salotra has highest *h*-Index value of 93. The second most impactful author was S. Sunder with 16255 citations (*h*-Index=65) with an ACPP of 43.81 citations, followed by C.P. Thakur with 3869 citations (*h*-Index=34) with an ACPP of 50.25 citations. Other than these three most productive authors, P. Das have forth ranked in terms of citation but was ranked eleventh in average citation per paper and H.K. Majumdar ranked tenth in overall publication and ranked sixth on overall citations but ranked fourth on average citation per paper. On the parameter of *h*-Index A. Dubey ranked forth, however, he was ranked fifth on total citations (Table 4).

Most productive journals publishing Indian Leishmaniasis research

The Indian authored papers were published in 3348 national and international journals. Table 5 presents the status of top 18 journals, which have published one percent or more papers on leishmaniasis. These journals have published 938 articles which is 27.66% of total Indian publications. '*Plos Neglected Tropical Diseases*' (IF_{2016}=3.834) was most productive journal which has published 86 articles (2.54% share). As far as the Impact Factor (IF) is concerned, the Indian authors have published four papers in "*Journal of Infectious Diseases*" which has its IF_{2016} 6.273. Thirty-Four papers have been published in "*Journal of Immunology, Neurosurgery and Psychiatry*," which has IF_{2016} of 4.856; Forty-Seven articles in *Antimicrobial Agents and Chemotherapy* (IF_{2016}=4.302) and Forty-Two papers in *Journal of Biological Chemistry* (IF_{2016}=4.125). The other high impact factor journals where Indian authors have published their paper were '*New England Journal of Medicine'* (IF_{2016}=72.406); '*Lancet* (IF_{2016}=47.831) and 'Nature' (IF_{2016}=40.137)

Table 4: Productive Indian Authors contributed more than 1% of Indian articles on Leishmaniasis.

Authors	Name of the Institute	TP	%Share	TC	ACPP	h-Index
S. Sundar	Banaras Hindu University Institute of Medical Sciences	371	10.94	16255	43.81	65
P. Das	Rajendra Memorial Research Institute of Medical Sciences, Patna	232	6.84	2625	11.31	25
A. Dube	Central Drug Research Institute India, Lucknow	109	3.21	1939	17.79	26
P. Salotra	Vardhman Mahavir Medical College, New Delhi	102	3.01	68379	670.38	93
K. Pandey	Rajendra Memorial Research Institute of Medical Sciences, Patna	97	2.86	1289	13.29	18
S. Gupta	Central Drug Research Institute India, Lucknow	89	2.62	1604	18.02	23
S. Roy	Indian Institute of Chemical Biology, Kolkata	82	2.42	1837	22.40	25
C.P. Thakur	Balaji Utthan Sansthan, Kala-azar Research Centre, Patna	77	2.27	3869	50.25	34
R. Madhubala	Jawaharlal Nehru University, New Delhi	74	2.18	1466	19.81	22
H.K. Majumder	Indian Institute of Chemical Biology, Kolkata	71	2.09	1721	24.24	24
Total		1304	38.45	100984	77.44	

Table 5: Productive Journals Publishing Indian Articles.

Name of the Journal	TP	% Share	IF_{2016}
Plos Neglected Tropical Diseases	86	2.54	3.834
Indian Journal of Medical Research	82	2.42	1.534
Transactions of The Royal Society of Tropical Medicine and Hygiene	74	2.18	2.279
Plos One	72	2.12	2.806
American Journal of Tropical Medicine and Hygiene	65	1.92	2.549
Experimental Parasitology	58	1.71	1.724
Journal of Communicable Diseases	49	1.45	-
Annals of Tropical Medicine and Parasitology	48	1.42	1.203
Antimicrobial Agents and Chemotherapy	47	1.39	4.302
Indian Journal of Dermatology Venereology and Leprology	47	1.39	1.948
Molecular and Biochemical Parasitology	43	1.27	2.536
Journal of Biological Chemistry	42	1.24	4.125
Parasitology Research	42	1.24	2.329
Bioorganic and Medicinal Chemistry Letters	39	1.15	2.454
Tropical Medicine and International Health	39	1.15	2.85
Acta Tropica	36	1.06	2.218
Journal of Infectious Diseases	35	1.03	6.273
Journal of Immunology	34	1.00	4.856
Total	938	27.66	

International Collaboration by Indian Authors

India had most collaborated research with USA (339 articles; 10% share) followed by UK (144 articles; 4.25%), Switzerland (120 articles; 3.54%) and Belgium (112 articles; 3.30% share). Nepal and Germany have over two percent collaboration, while Australia, Bangladesh, France, Canada, Spain and Brazil have over one percent collaborated articles with India. Netherlands, Sweden and Saudi Arabia have less than one percent collaborated articles with India. Indian authors were more impactful when they have collaborated research with Sweden (8117 citations) with ACPP of 279.9 per paper, followed by Netherlands (8095 citations) with ACPP of 279.84 and Saudi Arabia (7380 citations) with an ACPP of 273.33 citations. (Table 6)

Most Cited Articles Authored by Indian Authors

Out of 3391 papers published from India, 2936 (86.58%) articles received at least one citation till 2017 (TC_{2017}) during 1968–2017 with sum cumulative total of 69,985 citations.

Table 6: International Collaboration by Indian Authors.

Country	Total Publications	% Share	Citation	ACPP
United States	339	10.00	19355	57.09
United Kingdom	144	4.25	13962	96.96
Switzerland	120	3.54	8483	70.69
Belgium	112	3.30	5337	47.65
Nepal	75	2.21	7538	100.51
Germany	71	2.09	5221	73.54
Australia	44	1.30	7867	178.80
Bangladesh	41	1.21	3085	75.24
France	39	1.15	8066	206.82
Canada	38	1.12	8698	228.89
Spain	37	1.09	7992	216.00
Brazil	34	1.00	3310	97.35
Netherlands	29	0.86	8095	279.14
Sweden	29	0.86	8117	279.90
Saudi Arabia	27	0.80	7380	273.33
Total	1179	34.77		

There were 280 articles which have scored one citations, and rest other more than two. There were six articles, which have received 500 or more citations since their publication until 2017 and can be referred as highly cited articles. These six articles appeared in different national and international journals. Of these six articles, five articles were published in collaboration with international institutions and one published from single Indian institution. Two articles appeared in the '*Lancet*' (IF_{2016}=47.831) journal and one each in '*Colloids and Surfaces B: Biointerfaces*' (IF_{2016}=3.887); '*Clinical Microbiology Reviews*' (IF_{2016}=19.958); '*Nature Reviews Microbiology*' (IF_{2016}=26.819) and '*Lancet Infectious Diseases*' (IF_{2016}=19.864). Figure 2 presents the status of most cited Indian articles with more than 500 citations. The article by Lozano *et al.* (2012), scored highest TC_{2017}=4920 with an average annual citation rate of 615 citations pear year ranked 1st. Naghavi *et al.* (2015) was second highly cited article with TC_{2017} of 1744 citations with average annual citation of 581.33 citations. Kumari *et al.* (2010), was the only highly cited article with Indian affiliation which was cited by 1323 times with average annual citation of 147 citations and was ranked third. Other articles were ranked from forth to sixth. The article Naghavi *et al.* (2015), was most impactful as it was early recognized by the number of citations received in its first year of publication. It was immediately get cited in the year it was published (C_0=163) and very early rise in citations. The article which get recognition through early citations can be considered as most impactful.[32] Moreover, the most cited article Lozano *et al.* (2012), was in sleeping state for two years (C_0=1) with two citations only in first two years of publication and nine citations in third year. Thereafter, it had gained momentum and become most cited article (TC_{2017}=4920).

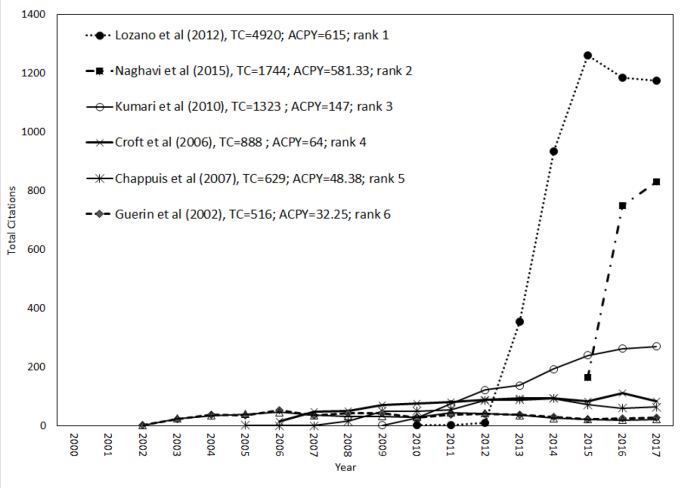

Figure 2: Citation life of seven most cited articles by Indian authors.

CONCLUSION

Leishmaniasis is one of the thirteen Tropical and Neglected Disease identified by WHO. About 98 countries have its etiological impact where Nepal, Bangladesh, India, Afghanistan, Saudi Arabia, Brazil Sudan are most affected region. The agencies are working towards the better health remedies to eradicate the disease from the society. The assessment of research impact helps policy and decision makers to frame

better policies to achieve the Targeted goals. Literature analysis tools such as bibliometrics is helping in such decision making. Leishmaniasis is becoming a global disease due to new cases appearing every year reported through Global Burden of Diseases. The study was aimed to anlyse the productivity of Indian contribution in Leismaniasis research conducted through data obtained from SCOPUS. Globally, about 39302 articles were published where India was ranked fourth in terms of global publication and had contributed 8.64% share of total publication. Indian research impact in terms of citation ranked fifth whereas USA was ranked first. Among Indian institutes, Indian Institute of Chemical Biology was most productive in terms of total publication whereas All India Institute of Medical Science was most impactful. Indian research was most impactful when it was having collaboration with Switzerland. The Indian research was published in some of the very high impact journals such as *New England Journal of Medicine, Nature* and *Lancet*. The Indian research was in infancy state initially but it has matured since last ten year and becoming most impactful with the time. The study highlighted the strength of the Indian research and shall be able to enhance the awareness among the stockholders in better policy decisions.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUMMARY

India shares 8.64% of global publication on Leishmaniasis, making it fifth most productive country in the World.

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