

A bibliometric profile of lymphatic filariasis research in India

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ABSTRACT

Background & objectives: Tropical and vector borne diseases have always been a challenge for the medical science and society and exerted high impact on society in terms of financial, economical and psychological relevance. Lymphatic filariasis (LF) is one of the tropical diseases which is prevalent in under developing and developed countries. The objective of this study is to analyze the literature published in the area of filariasis research. The focus is to see the Indian contribution and its impact in terms of global publication and share, citation analysis and its impact, productive Indian institutions engaged in filariasis research and their impact, international collaborative research, productive journals, and highly cited papers published by Indian authors.

Methods: The data for this study was obtained from Scopus, a multidisciplinary database, for the period of forty years (1973–2012) using key words lymphatic filariasis, elephantiasis, *Wuchereria bancrofti*, *Brugia malayi* and *Brugia timori* available in the title, abstract and key words fields. The citation count has been taken as the number of citations scored by the papers since their publication. The international collaboration by Indian authors in filariasis research has been manually analyzed through author's affiliation field.

Results: The search strategy using key words yielded 13,598 articles on different aspects of filariasis published during the forty years period. Indian authors have published 1970 articles which is 14.49% of global share, making it second highest productive country on filariasis research. United States holds first rank with 2956 articles (21.74% share). In terms of citation count, Indian research have quite good impact and has been ranked third; and in terms of average citation per paper it is far behind, while Ghana and Nigeria holds top two ranks.

Interpretation & conclusion: There have been continued efforts in providing better facilities for research, though Indian filariasis research has to go long way in order to remove the incidence of the disease from Indian population and the results presented through this study shall be helpful for stakeholders in framing policies in this direction.

Key words Bibliometric analysis; citation analysis; Indian research output; lymphatic filariasis

INTRODUCTION

Medicine, science and technology are the major forces of our society. They are also assuming an increasingly important role in the conduct and structure of domestic and foreign business. The interaction between these domains of human knowledge is the nursery of all research and development activities. The significant feature of scientific and technological knowledge is that the cognitive boundaries of the fields keep on changing. At the same time, certain new specialists emerge while some existing merges together. This has important implications on science policy. The emergence and development in every aspect of the medicine, science and technology has direct impact on society. These developments are reflected in research and documented for future research. The study of available documents on specific subjects highlights the importance of the subject. This study is focused on the available literature in the area of lymphatic filariasis (commonly known as filariasis/elephantiasis); one of the old-

est and most debilitating neglected tropical diseases. Filariasis now has emerged as one of the challenging research fields in medical science and getting popularity in global world. WHO progress reports and strategic plan 2010-2020 reports reveal that nearly 1.4 billion people in 73 countries worldwide are threatened by lymphatic filariasis and >120 million people are currently infected, with about 40 million disfigured and incapacitated by the disease. Further, WHO estimates show that 1.34 billion live in areas where filariasis is endemic and are therefore at risk of infections¹.

Filariasis is caused by three species of parasitic worms, *Wuchereria bancrofti* (90% cases), *Brugia malayi* and *B. timori*, which are transmitted to humans by mosquitoes. Different mosquito species act as vectors for filariasis. *Culex* genus is found to be the vector in urban and semi-urban areas for *W. bancrofti*; *Anopheles* in rural areas and *Aedes* in endemic islands of the Pacific¹. The vector for *B. malayi* is *Mansonia*, whereas an *Anopheles* mosquito is vector for *B. timori*¹⁻². *W. bancrofti* is

transmitted throughout the tropics in Asia, Africa, the Pacific and the Americas. Brugian parasites are confined to areas in east and south Asia³.

The global incidence studies on LF shows its prevalence in African region (Benin, Madagascar, Mali, Uganda and the United Republic of Tanzania, and Indian Ocean Islands—Mauritius and the Seychelles); region of the Americas (Brazil, the Dominican Republic, Guyana and Haiti); the Eastern Mediterranean region (three endemic countries Egypt, Sudan and Yemen); the Southeast Asia region, carrying the largest burden of the disease, in which 4 out of 11 countries are endemic (India, Maldives, Sri Lanka and Bangladesh); western Pacific region; China; the Republic of Korea; Cambodia; the Lao People's Democratic Republic; Malaysia; Philippines and Viet Nam⁴⁻⁵. The WHO has launched global programme to eliminate LF through its largest public health programme using MDA⁶.

In India, to control the endemicity of LF, the National Filariasis Control Programme (NFPCP) was launched in 1955 and again the national health policy 2002 aims at elimination of transmission and the prevention of disability due to LF by the year 2015⁷. Different reports and case studies on epidemiology of filariasis have been published from time-to-time presenting the status of the filariasis in global scenario and its prevalence in India^{3, 8-9}. These reports and surveys presented the epidemiology as well as steps taken to eradicate the filarial worm from Indian population especially from the states like Andhra Pradesh and Karnataka. This disease is so endemic and life threatening, that the World Health Organization as well as Ministry of Health, Government of India has launched special programme to eradicate the disease from the population. Simultaneously, the research is under way to assess its impact as well as to discover new therapeutics to prevent it from further spreading. In order to assess the progress in research in this field, analysis of literature helps to understand the patterns of publication. Bibliometrics, a field of study, is traditionally associated with the quantitative measurement of documentary materials and results presented in variety of forms. As far as the analysis of literature in the field of LF is concerned, no such study has been traced, except few studies on drug administration¹⁰⁻¹¹. Thus, the purpose of this study is to analyze the quantity and quality of Indian research output in LF research in global and Indian context, patterns of international collaboration, most productive Indian institutes, characteristics of high cited papers, patterns of research communications in most productive journals as reflected in their publication output, during 1973–2012.

MATERIAL & METHODS

This study is based on literature published in the area of lymphatic filariasis and indexed in Scopus multidisciplinary database. Scopus has full coverage of NCBI PubMed along with the other disciplines and also provide citation data. Geographically, only the publication originated from India has been taken into consideration. The medical subject heading (MeSH) terms Lymphatic filaria*, Elephantiasis*, *Wuchereria bancrofti*, *Brugia malayi*, and *Brugia timori* available in the title, abstract and key words fields were used to retrieve data. For citations data, the number of citations received by each paper since it is published (up to 15 August 2013) has been taken into consideration. For finding out international collaboration by Indian authors, the affiliation field is manually analyzed. For analyzing the institutional and journals output, separate search strategies was developed. Results obtained in this way were subjected to data analysis using statistical package SPSS and techniques of summation, counting, and percentage.

RESULTS

Global publication share and rank

The global publication share of the top 23 most productive countries in filarial research varied from 0.75 to 21.74% during 1973–2012. United States of America (USA) ranked first while India ranked second in terms of total publications among the top 23 most productive countries engaged in filariasis research. India's global publication share was 14.49% during the study period, while USA had publication share of 21.74% of global output. Compared to India, United Kingdom (UK) ranked third (10.84% share), Germany ranked fourth (5.81% share) and France ranked fifth with 5.5% share. India's global publications share increased from 1.49% during 1983–92 to 5.16% in 1993–2002 and further increase of 8.09% was recorded during 2003–2012 (Table 1).

United States, India and United Kingdom have maintained their rankings throughout, while Germany and France have fluctuating global publications ranking. During 1973–1992, Germany ranked fifth while France had fourth rank, but thereafter both the countries have exchanged their ranking and maintained till 2012. Rest other countries have fluctuating ranking as can be seen from Table 1.

In terms of global citation count scored by the papers since their publication, publications originating from USA ranked first with 36,283 citations, UK ranked second with

Table 1. Global publication share, rank and citation impact of filariasis research (1973–2012)

S. No.	Country	Total publications					% Share of publications					Publication rank					TC*	ACPP
		1973–1982	1983–1992	1993–2002	2003–2012	1973–2012	1973–1982	1983–1992	1993–2002	2003–2012	1973–2012	1973–1982	1983–1992	1993–2002	2003–2012	1973–2012		
1.	USA	447	803	685	1021	2956	16.60	22.05	21.35	25.22	21.74	1	1	1	1	1	36283	12.29
2.	India	220	350	474	926	1970	8.17	9.61	14.78	22.87	14.49	2	2	2	2	2	12225	6.21
3.	United Kingdom	207	314	412	541	1474	7.69	8.62	12.84	13.36	10.84	3	3	3	3	3	28780	19.62
4.	Germany	131	180	205	274	790	4.86	4.94	6.39	6.77	5.81	5	5	4	4	4	9557	3.39
5.	France	193	174	173	208	748	7.17	4.78	5.39	5.14	5.50	4	4	5	5	5	4324	12.35
6.	Japan	88	164	82	111	445	3.27	4.50	2.56	2.74	3.27	6	5	8	10	6	2425	5.45
7.	Italy	33	42	103	165	343	1.23	1.15	3.21	4.08	2.52	11	9	6	6	7	4338	12.65
8.	Malaysia	25	18	95	146	284	0.93	0.49	2.96	3.61	2.09	12	16	7	7	8	3265	11.5
9.	Australia	34	58	62	125	279	1.26	1.59	1.93	3.09	2.05	10	7	9	8	9	3556	12.75
10.	Switzerland	46	49	55	125	275	1.71	1.35	1.71	3.09	2.02	20	13	16	19	18	2909	10.58
11.	Canada	4	19	54	91	168	0.15	0.52	1.68	2.25	1.24	22	14	12	11	11	2175	12.95
12.	Sri Lanka	25	42	22	62	151	0.93	1.15	0.69	1.53	1.11	13	10	22	15	12	1120	7.42
13.	Nigeria	25	42	22	62	151	0.93	1.15	0.69	1.53	1.11	16	21	15	12	16	3265	21.62
14.	Netherlands	11	19	55	66	151	0.41	0.52	1.71	1.63	1.11	7	8	10	9	10	928	6.15
15.	Brazil	9	19	51	66	147	0.33	0.52	1.59	1.63	1.08	17	15	13	14	13	1069	7.27
16.	Thailand	38	30	26	49	143	1.41	0.82	0.81	1.21	1.05	8	12	20	21	14	810	5.66
17.	Indonesia	18	15	27	73	133	0.67	0.41	0.84	1.80	0.98	15	17	18	13	15	1432	10.77
18.	Ghana	20	10	38	60	128	0.74	0.27	1.18	1.48	0.94	14	19	17	22	21	6181	48.29
19.	Denmark	9	9	54	53	125	0.33	0.25	1.68	1.31	0.92	21	22	14	17	20	1747	13.98
20.	Cameroon	3	9	55	54	121	0.11	0.25	1.71	1.33	0.89	23	20	11	18	17	2115	17.48
21.	China	9	31	17	53	110	0.33	0.85	0.53	1.31	0.81	9	18	21	23	22	2296	20.87
22.	Spain	4	19	54	91	110	0.15	0.52	1.68	2.25	0.81	18	11	23	20	19	796	7.24
23.	Kenya	9	5	27	61	102	0.33	0.14	0.84	1.51	0.75	19	23	19	16	23	1705	16.72
	World	2693	3641	3208	4049	13598												

*2000 most cited papers; TC—Total citations; ACPP—Average citations per paper.

28,780 citations and India ranked third with 12,225 citations. It is interesting to note that in terms of average citations per paper (ACPP), Ghana has scored highest ACPP of 48.29, and in terms of cumulative publication share it is ranked 18th (128 publications; 0.94% share). Nigeria and China are other two top countries which have ACPP of 21.62 and 20.87 respectively. India is at 19th position in terms of ACPP (6.21) as inferred from Table 1.

India's contribution on filariasis research

As evidenced from Table 1, India's contribution consists of 1970 papers during 1973–2012, with an average of 49.25 papers per year, rising from 220 papers in 1973–82 to 926 papers during 2003–12 witnessing a growth rate of 320.9%. In comparison to Indian publication output, during same period USA, UK, Germany and France have 2956, 1474, 790 and 748 publications, with an average of 73.9, 36.85, 19.75 and 18.7 papers, respectively. It is noticeable that these countries have lower average papers per year than Indian average papers per year. Indian average annual growth rate during the period 1973–2012 is 8.02% which is higher than all countries—USA (3.21%), UK (4.03%), Germany (2.73%) and France (0.19%).

In terms of citation quality and impact, the average citations per paper (ACPP) registered by Indian publications during the study period was 5.92, declining from 10.08 in 1998–2002. In comparison to India, highest ACPP was registered by Germany (52.04), followed by UK (17.31), USA (14.07) and France (6.07). Each of these countries have observed decline in ACPP from the period 1998–2002 to 2003–12.

International collaboration in Indian filariasis research output

Indian international collaborative research consists of 172 papers during 1973–2012, accounting for 8.96% share in the cumulative publications on filariasis. The international collaborative papers (ICP) have been analyzed based on the author's affiliation from international institutes as well as Indian institutes. The highest internationally collaborated papers appeared from USA (88 publications), followed by Germany (17 publications), Switzerland (16 publications), Malaysia (14 publications), Netherlands (12 publications), Australia (8 publications), Sri Lanka (6 publications) and Canada (5 publications). Four Indian papers each have collaboration from Brazil, Ghana and Poland; three papers each have collaboration

from Tanzania, Egypt, Ethiopia, Japan, and Indonesia; while two papers each appeared with Indian authors from Belgium, Denmark, France, Kuwait, Kenya and Tunisia. Other countries have collaborated one paper with Indian authors (Table 2).

Research contribution and impact of prolific Indian Institutions

On the analysis of contribution of Indian institutions in filariasis research, 160 institutes either singly or in association with other national and international institutes contributed 1970 papers. Out of these 160 institutions, there were nine institutes which have contributed forty or more publications on filariasis with a cumulative total of 1014 publications (51.47% of total Indian contribution). Table 3 presents the productive Indian institutions along with their research output, citations received and *h*-index values. The average paper per institution is found to be 101.4 papers. Only four Indian institutions have registered higher publications share than the group average. These are: Vector Control Research Centre, Puducherry (241 publications), followed by Central Drug Research Institute, Lucknow (240 publications), Mahatma Gandhi Institute of Medical Sciences, Sewagram (121 publications), and Regional Medical Research Centre, Bhubaneswar (104 publications).

The average citations per paper scored by the total papers of these nine Indian institutions were 8.30. Only four Indian institutions have registered higher average citations per paper than the group average. Among these, Tuberculosis Research Centre, Chennai has scored the highest impact of 20.28 citations per paper, followed by Anna University, Chennai (with 10.99 citations per paper), and Vector Control Research Centre, Puducherry (with 10.43 citations per paper).

The average *h*-index value of these nine most productive Indian institutions was 14.5. Five Indian institutions have scored higher *h*-index value than the group average. Among them, Vector Control Research Centre, Puducherry had scored the highest *h*-index value of 34 for their papers published during 1973–2012, followed by Central Drug Research Institute, Lucknow (20), Tuberculosis Research Centre, Chennai (19), Regional Medical Research Centre, Bhubaneswar (16), and Anna University, Chennai (15) (Table 3).

Highly productive journals in terms of filarial research

In all, 470 national and international journals together, published 1970 Indian publications. The top 21 most productive Indian and foreign journals, publishing >15 publications on Indian filarial research, together contributed

Table 2. India's International collaboration and collaborative countries in filariasis research

Country	Total ICP	% ICP
United States of America	88	51.16
United Kingdom	39	22.67
Germany	17	9.88
Switzerland	16	9.30
Malaysia	14	8.14
Netherlands	12	6.98
Australia	8	4.65
Sri Lanka	6	3.49
Canada	5	2.91
Brazil	4	2.33
Ghana	4	2.33
Poland	4	2.33
Tanzania	3	1.74
Egypt	3	1.74
Ethiopia	3	1.74
Japan	3	1.74
Indonesia	3	1.74
Belgium	2	1.16
Denmark	2	1.16
France	2	1.16
Kuwait	2	1.16
Kenya	2	1.16
Tunisia	2	1.16
Nepal	1	0.58
Cameroon	1	0.58
Ecuador	1	0.58
French Polynesia	1	0.58
Haiti	1	0.58
New Zealand	1	0.58
Nigeria	1	0.58
Papua New Guinea	1	0.58
Philippines	1	0.58
Bangladesh	1	0.58
Saudi Arabia	1	0.58
South Africa	1	0.58
South Korea	1	0.58
Spain	1	0.58
Taiwan	1	0.58
Thailand	1	0.58
Tuvalu	1	0.58
Hong Kong	1	0.58
Viet Nam	1	0.58
China	1	0.58
Fiji	1	0.58

ICP—International collaborative papers.

861 papers, which accounts for 44.84% share of total cumulative publications output of India during 1973–2012 (Table 4). Of these 22 journals, *Journal of Communicable Diseases* has published highest number of papers

Table 3. Most productive Indian institution engaged in filariasis research (1973–2012)

Indian author's affiliation	TP	TC	ACPP	<i>h</i> -index
Vector Control Research Centre, Puducherry	241	2514	10.43	34
Central Drug Research Institute, Lucknow	240	1549	6.45	20
Mahatma Gandhi Institute of Medical Sciences, Sewagram	112	481	4.29	11
Regional Medical Research Centre, Bhubaneswar	107	808	7.55	16
Anna University, Chennai	72	791	10.99	15
National Centre for Disease Control, Delhi	72	201	2.79	8
Tuberculosis Research Centre, Chennai	54	1095	20.28	19
Banaras Hindu University, Varanasi	41	247	6.02	9
All India Institute of Medical Sciences, New Delhi	40	196	4.90	8
Total	676	5143	8.30	14.5

TP—Total publications; TC—Total citations; ACPP—Average citations per paper.

on filariasis. This journal has published 119 articles which is 6.2% of total publication, though this journal does not have any Impact Factor (IF). The *American Journal of Tropical Medicine and Hygiene* is the journal with highest IF of 2.736, where several Indian filarial research papers have been published.

Highly cited Indian papers on filariasis

Based on number of citations scored by Indian publications, 100 papers were identified as highly cited pa-

pers. The number of citations received (since their publication till 15 August 2013) were from 25 to 117 during 1973–2012. Of these highly cited papers, 90 appeared as articles, eight as reviews, one as short survey and one as conference paper. Out of these 100 highly cited Indian papers, 44 papers appeared with international collaboration (9 bilateral and 35 multilateral), 24 appeared with national collaboration and 32 appeared without any collaboration. Among these 100 papers, one paper has >101 citations, 16 are in citations range of 51–100, 61 in cita-

Table 4. Productive journals publishing filariasis research (1973–2012)

Name of journal	Total publications	Percentage	Impact factor (2012)
<i>Journal of Communicable Diseases</i>	119	6.20	–
<i>Indian Journal of Medical Research</i>	112	5.83	1.661
<i>Parasitology Research</i>	71	3.70	2.327
<i>Acta Tropica</i>	56	2.92	2.519
<i>Transactions of the Royal Society of Tropical Medicine and Hygiene</i>	56	2.92	1.931
<i>Annals of Tropical Medicine and Parasitology</i>	52	2.71	1.203
<i>Acta Cytologica</i>	49	2.55	1.562
<i>Indian Journal of Experimental Biology</i>	48	2.50	0.753
<i>Tropical Medicine and International Health</i>	38	1.98	2.302
<i>American Journal of Tropical Medicine and Hygiene</i>	29	1.51	2.736
<i>Southeast Asian Journal of Tropical Medicine and Public Health</i>	26	1.35	0.546
<i>Journal of Helminthology</i>	25	1.30	1.303
<i>Experimental Parasitology</i>	24	1.25	1.859
<i>Indian Journal of Pathology and Microbiology</i>	22	1.15	0.642
<i>National Medical Journal of India</i>	22	1.15	0.908
<i>Journal of Biosciences</i>	21	1.09	1.939
<i>Current Science</i>	20	1.04	0.833
<i>Journal of Vector Borne Diseases</i>	19	0.99	1.04
<i>Lymphology</i>	18	0.94	0.878
<i>Parasitology</i>	18	0.94	2.35
<i>Parasite Immunology</i>	16	0.83	1.849
Total	861	44.84	

tions range of 26–50, 189 in citations range of 11–25, 195 in citations range of 6–10, 681 in citations range of 1–5. In this way, a total of 1143 (58.02%) Indian papers have obtained at least one citation.

DISCUSSION

Lymphatic filariasis (LF) is endemic in 81 countries of the world and is the second leading cause of permanent disability^{12–14}. The results of this study indicate that the disease like filariasis is very much prevalent in poor underdeveloped and developing countries such as Ghana, Nigeria, India, Sri Lanka, *etc.* Even after the active involvement of Government and International agencies, this disease has not yet been eradicated from the global population. In India, different programmes have been launched by ministry as well as health department to control the disease. The launch of National health policy 2002 aims at elimination of transmission and the prevention of disability due to LF by the year 2015. Under this health policy, the Government of India (GOI) in 2004 began a nationwide mass drug administration (MDA) campaign in all the known LF endemic districts with an annual single dose of diethylcarbamazine citrate (DEC) with the aim of eliminating it as a public health problem by the year 2015⁵. The prevalence and incidence report make India as one of the most literature productive country (second ranked) in the area of research on filariasis. USA is highest publication rank holder in filariasis research and also tops in terms of number of citations scored, however, it has lower average citation per paper when compared to Ghana (first rank) and Nigeria (second rank). These countries' publication share is very low but average citation ACPP is much higher than USA, India and UK.

CONCLUSION

In order to improve the basic and clinical research there is need of more and more involvement of international agencies as well as research institutions. Through this study it has been found that there is a very less international collaboration in filariasis research. This bibliometric study

could help policy makers and health professionals in understanding the research efforts in filaria, nature of publication and productive institutions.

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