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Malaria research in India during 2003-2012: a bibliometric analysis

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Malaria research in India during 2003-2012: a bibliometric analysis

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Abstract

Purpose – The aim of this paper is to analyze Indian researchers' publications on malaria research and to serve as a guide to libraries needing to collect information on malaria. It also seeks to compare malaria affected Asian countries global rank with their publication and death rates.

Design/methodology/approach – For the purpose of the study Indian researchers' publication data which were indexed in Thomson Reuters Web of Science (WoS) were used. Various statistical techniques and bibliometric measures have been employed for further analysis.

Findings – The present study found out 2,020 documents with h-index of 48, published by Indian researchers which were indexed in WoS during 2003 to 2012 and the majority of them were articles (81.43 percent). *Malaria Journal* is the most favored research journal among the Indian research community which covers 97 papers. A.P. Dash contributed maximum number of 136 (6.74 percent) papers. Council for Scientific and Industrial Research (CSIR) is the largest Indian funding agency with 184 (9.11 percent) research grants.

Research limitations/implications – Limitation by geographical area and time, i.e. the study only focuses the research publication of Indian researchers on malaria research during 2003 to 2012.

Originality/value – This is the first attempt to apply bibliometric techniques to analyze malaria research by Indian researchers, and, more generally for a country which is very badly affected by the disease.

Keywords India, Asia, Bibliometrics, H-index, Bradford's distribution, Malaria

Paper type Research paper

Introduction

Malaria is a mosquito-borne infectious disease of humans and other animals caused by parasitic protozoans (a type of unicellular microorganism) of the genus Plasmodium. Commonly, the disease is transmitted via a bite from an infected female Anopheles mosquito, which introduces the organisms from its saliva into a person's circulatory system. In the blood, the protists travel to the liver to mature and reproduce. Malaria causes symptoms that typically include fever and headache, which in severe cases can progress to coma or death. The disease is widespread in tropical and subtropical regions in a broad band around the equator, including much of Sub-Saharan Africa, Asia, and the Americas. A range of organizations have led a global movement to combat malaria. In 2007, the Bill and Melinda Gates Foundation renewed a call, originally set forth by the WHO in 1995, for malaria eradication; in 2011, the UN Secretary-General declared a goal of reducing malaria deaths to zero by 2015 (United Nations News Service Section, 2011).

Bibliometric methods have been used to measure scientific progress in many disciplines of science and engineering and are a common research instrument for systematic analysis (Van Raan, 2005). It involves the quantitative analysis of the literature of a subject domain (Garcia-Rio *et al.*, 2001), as represented by bibliographic entities such as keywords, classification codes, authors and citations (Chuang *et al.*, 2007; Li and Ho, 2008). Conventional bibliometric methods generally evaluate the research trend by investigating the publication outputs of different countries (Rahman *et al.*, 2005), research institutes (Rajendram *et al.*, 2006), journals (Dannenberg, 1985), and research fields (Davis and Gonzalez, 2003) or by doing the citation analysis (Chiu and Ho, 2005). The purpose of the present study is to analyze the malaria research output by Indian researchers which were indexed in Web of Science during 2003 to 2012. Various studies on author collaboration have been analyzed by various authors in various fields (Macias-Chapula, 2000). But there has been no study conducted so far on the author collaboration, country's research output etc. in the area of malaria research. An attempt was made by Macias-Chapula (2000) to identify the patterns of the growth in AIDS literature, as well as the types of documents published, authorship pattern, institutional affiliations of authors, and subject content. Hartinah *et al.* (2001) studied on nutrition problems in Indonesia published during the period 1979-2000, and discussed the authorship pattern, institutional affiliation, and the half-life of the literature on nutrition. Arunachalam and Gunasekaran (2002) have mapped

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Collection Building
33/2 (2014) 53–59

[DOI 10.1108/CB-01-2014-0004]

Received 29 December 2013
Revised 8 January 2014
Accepted 19 January 2014

tuberculosis research in India and China and identified institutions and cities active in research, journals used to publish the findings, use of high impact journals, and extent of international collaboration.

Objectives

The major objectives of the study are:

- to examine the growth and development of malaria research in India during 2003 to 2012;
- to identify the malaria affected Asian countries;
- to find out the most favored research area identified by WoS;
- to find out the core research journals using Bradford's distribution;
- to calculate the h-index for malaria research in Asian countries; and
- to identify the most contributing Indian author and funding agency.

Methodology

One common method of bibliometric research is to trace publications using the SCI of the Institute for Scientific Information (ISI), Philadelphia (Fu *et al.*, 2010). The documents used in the present study were taken from a combined search from Science Citation Index Expanded (SCI-Expanded); Social Sciences Citation Index (SSCI) and Arts and Humanities Citation Index (A&HCI) of Thomson Reuters Web of Science (WoS). For retrieval of information, the term "malaria*" was used as topic/subject and "India" was used as authors address/affiliation and "2003-2012" was used as the time span for the present study. As a result 2,020 documents retrieved and matched with the query. For the purpose of analysis the documents were entered into MS-Excel in a logical and statistical order.

Analysis and discussion

Malaria affected Asian countries

Malaria is a preventable and treatable mosquito-borne disease, whose main victims are children below the age of 5. According to the latest WHO (n.d. a, b) estimates, there were about 219 million cases of malaria in 2010 and an estimated 627,000 deaths in 2012. During 2000 to 2010, malaria mortality rates fell by 26 percent around the world. Table I gives world rank of malaria affected Asian countries with death rate per 100,000 and total deaths from 1980 to 2010 (Murray *et al.*, 2012). Which shows India is the 53rd world malaria affected country and third in Asia. But if we consider the number of deaths caused by malaria during 1980 to 2010 India comes in first position among the Asian countries.

Africa is the most affected continent where about 90 percent deaths occur due to malaria (World Life Expectancy, 2013).

Annual distribution of publication

The present study found out 2,020 documents published during 2003 to 2012. Table II shows the annual distribution of publication on malaria research by Indian researchers. In 2003 only 97 (4.81 percent) documents were published but it has grown more than thrice in 2012 (336, 16.64 percent). The literature growth was slow initially but gradually picked up over time. Again it shows a positive and continuous growth during the period under study. The annual average growth rate percent is 11.88.

Published document types

The 2,020 publications related to malaria research by the Indian researchers identified by WoS between 2003 to 2012 included nine document types. Articles were the dominant document type comprising of 81.43 percent of the total production. The remaining publications were reviews (130, 6.44 percent); meeting abstracts (101, 5 percent); letters (77, 3.81 percent); editorial materials (38, 1.88 percent); proceedings papers (24, 1.19 percent); book chapter (3, 0.15 percent) and book review and news item with 1 (0.05 percent) document each (Table III).

Most favored research area

The 2,020 documents were published in 90 subject categories in WoS. Table IV lists the 20 major disciplines related to malaria research during the period under study, which shows Tropical Medicine (22.93 percent) is the most favored research discipline among the Indian researcher community. Again it shows parasitology; biochemistry molecular biology and pharmacology and pharmacy with 22.83; 13.97 and 13.17 percent stood with second, third and fourth positions.

Favored research journal

Bradford stated that "if scientific journals are arranged in order of decreasing productivity of papers on a given subject,

Table I List of malaria affected Asian countries

Sl. No.	World rank	Country	Death rate per 100,000 *	Total deaths (from 1980-2010)	Rank (most number of deaths)
1	47	Yemen	4.2	9,413	4
2	49	Indonesia	3.1	65,540	2
3	53	India	1.8	161,212	1
4	54	Bangladesh	1.6	28,405	3
5	58	Maldives	0.9	815	7
6	61	Pakistan	0.5	9,301	5
7	63	Thailand	0.5	1,414	6
8	70	Bhutan	0.2	149	8
9	78	Malaysia	0.1	47	9
Total deaths due to malaria				276,296	–

*Source: World Life Expectancy (2013)

Table II Annual distribution of publication

Year	No. of publication	%	Annual average growth percentage
2003	97	4.81	–
2004	106	5.25	8.49
2005	132	6.53	19.69
2006	155	7.67	8.39
2007	175	8.66	11.43
2008	234	11.58	25.22
2009	240	11.88	2.5
2010	246	12.18	2.44
2011	299	14.8	17.73
2012	336	16.64	11.02
Total	2,020	100	Average 11.88

Table III Types of document published

Rank	Types of document	No. of papers	%
1	Article	1,645	81.43
2	Reviews	130	6.44
3	Meeting abstract	101	5
4	Letter	77	3.81
5	Editorial material	38	1.88
6	Proceedings paper	24	1.19
7	Book chapter	3	0.15
8	Book review	1	0.05
8	News item	1	0.05
	Grand total	2,020	100

Table IV Major research disciplines

Rank	Research area	No. of papers (n = 2,020)	%
1	Tropical medicine	463	22.93
2	Parasitology	461	22.83
3	Biochemistry molecular biology	282	13.97
4	Pharmacology pharmacy	266	13.17
5	Public environmental occupational health	254	12.58
6	Infectious diseases	190	9.41
7	Immunology	165	8.17
8	Chemistry	138	6.84
9	General internal medicine	122	6.04
10	Science technology other topics	117	5.8
11	Research experimental medicine	97	4.81
12	Microbiology	85	4.21
13	Pediatrics	74	3.67
14	Biotechnology applied microbiology	51	2.53
15	Biophysics	43	2.13
15	Entomology	43	2.13
15	Environmental sciences ecology	43	2.13
16	Cell biology	42	2.08
17	Plant sciences	40	1.99
18	Genetics heredity	32	1.59
19	Hematology	29	1.44
20	Neurosciences neurology	28	1.39

they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of papers as the nucleus, when the numbers of periodicals in the nucleus and succeeding zones will as $1:n:n^2$ [...]" The journal distribution in Table V shows that there is a tremendous scattering of literature in malaria research of Indian researchers. According to Bradford's law, the first zone or nucleus contain only ten journals covering about one-third of total articles, followed by the second zone with 32 journals accounting for another one-third and the third zone with 240 journals covered remaining one-third during the period under study.

Bradford's distribution of core journals on malaria research by the Indian researchers during the period 2003 to 2012 is listed in Figure 1, it shows a total of 282 journals presented by 1,645 articles with an average of five to six papers per journal. Further, it shows that *Malaria Journal* is the most favored research journal among the Indian research community with 97 (5.9 percent) papers (Table V). According to Bradford's Law of Scattering the journals which lay before on the initial curved part of the "S" shaped plot until it tangentially becomes a straight line are considered as the core journals of malaria research among the Indian researchers during the period under study. Thus, here in Figure 1 the curve decreases slightly after the tenth journal (*Bioorganic Medicinal Chemistry Letters*). Hence, these ten journals may be regarded as the core journals on malaria research which have been published by Indian researchers and indexed in Web of Science during 2003 to 2012.

Web of Science h-index

The h-index has been used to characterize both the quantity and significance of a scientist's research publications, as first proposed by Hirsch (2005). H-index is defined by the h of N_p papers having at least h citations each and the other (N_p-h) papers have $\leq$ h citations each (Hirsch, 2005). Although h-index is generally applied to quantify the scientific output of a single researcher; Rousseau (2000) argued that the index can also be applied to any publication set. The h-index is automatically calculated by most of the citation databases such as Web of Science, Scopus, etc. Since data for the present study have been collected from Web of Science, its citation tracker was used to count h-index for documents published on malaria by the Asian affected countries. Table VI shows that India is the most productive Asian country with 2,020 publications followed by Thailand with 1,354 publications. But if we consider the h-index, then Thailand comes first with 67 and India in second with 48.

Major contributing institution/organization

Table VII gives a detailed list of major contributing Indian institutions/organizations to malaria research during the period under study, which shows Council for Scientific and Industrial Research (CSIR) with 184 (9.12 percent) documents stood in the first position. Again it shows contributors affiliated to Department of Biotechnology (DBT) and Indian Council for Medical Research (ICMR) with 132 and 118 contributions stood at the second and third position. Contributors from AICTE, New Delhi and Delhi University with nine contributions each hold the eighth position.

Table V Bradford's distribution of core journals

Rank	Name of the journal	No. of paper (n = 1,645)	%	Cumulative No. of paper	Cumulative %
1	Malaria Journal	97	5.9	97	5.9
2	Parasitology Research	80	4.86	177	10.76
3	American Journal of Tropical Medicine and Hygiene	62	3.77	239	14.53
4	Acta Tropica	60	3.65	299	18.18
5	Current Science	59	3.59	358	21.77
6	Indian Journal of Medical Research	56	3.4	414	25.17
7	Journal of Vector Borne Diseases	54	3.28	468	28.45
8	Plos One	39	2.37	507	30.82
9	Transactions of the Royal Society of Tropical Medicine and Hygiene	39	2.37	546	33.19
10	Bioorganic Medicinal Chemistry Letters	34	2.07	580	35.26
11	Molecular and Biochemical Parasitology	34	2.07	614	37.33
12	Annals of Tropical Medicine and Parasitology	33	2.01	647	39.34
13	Tropical Medicine International Health	33	2.01	680	41.35
14	Bioorganic Medicinal Chemistry	25	1.52	705	42.87
15	Experimental Parasitology	22	1.34	727	44.21
16	Journal of Biological Chemistry	22	1.34	749	45.55
17	Infection Genetics and Evolution	20	1.22	769	46.77
18	Tropical Doctor	20	1.22	789	47.99
19	Indian Journal of Pediatrics	18	1.09	807	49.08
20	Infection and Immunity	17	1.03	824	50.11
21	Vaccine	17	1.03	841	51.14
22	Antimicrobial Agents and Chemotherapy	16	0.97	857	52.11
23	European Journal of Medicinal Chemistry	16	0.97	873	53.08
24	Biochemical and Biophysical Research Communications	15	0.91	888	53.99
25	Indian Pediatrics	15	0.91	903	54.9
26	Journal of Medicinal Chemistry	15	0.91	918	55.81
27	Medicinal Chemistry Research	15	0.91	933	56.72
28	Asian Pacific Journal of Tropical Medicine	14	0.85	947	57.57
29	International Journal of Infectious Diseases	14	0.85	961	58.42
30	Journal of Environmental Biology	14	0.85	975	59.27
31	Journal of Ethnopharmacology	13	0.79	988	60.06
32	Journal of The American Mosquito Control Association	13	0.79	1,001	60.85
33	Lancet	13	0.79	1,014	61.64
34	Journal of Tropical Pediatrics	12	0.73	1,026	62.37
35	Febs Journal	11	0.67	1,037	63.04
36	Tropical Biomedicine	11	0.67	1,048	63.71
37	Journal of Infectious Diseases	10	0.61	1,058	64.32
38	Journal of Medical Entomology	10	0.61	1,068	64.93
39	Journal of Postgraduate Medicine	10	0.61	1,078	65.54
40	2 journals with nine articles	18	1.09	1,096	66.63
41	5 journals with eight articles	40	2.43	1,136	69.06
42	4 journals with seven articles	28	1.7	1,164	70.76
43	9 journals with six articles	54	3.28	1,218	74.04
44	8 journals with five articles	40	2.43	1,258	76.47
45	16 journals with four articles	64	3.89	1,322	80.36
46	34 journals with three articles	102	6.2	1,424	86.56
47	56 journals with two articles	112	6.81	1,536	93.37
48	109 journals with single article	109	6.63	1,645	100
	Grand total	1,645	100	–	–

Major contributors

Table VIII gives a detailed list of most prolific Indian contributors in the field of malaria research during 2003 to 2012. Here the contributors having contributions of 31 or more were considered for analysis, which shows A.P. Dash with 136 (6.74 percent) contributions stood in the first position. N. Sihgh; S.K. Puri, V.S. Chauhan with 75, 70 and 67 contributions hold the second, third and fourth positions respectively. Again it shows 18 contributors who have contributed 31 or more contributions.

Figure 1 Bradford's distribution

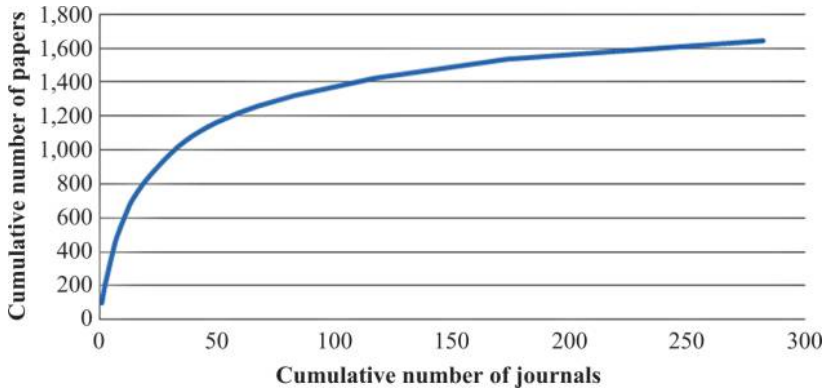

Table VI Web of Science h-index

Sl. No.	Country	No. of publication	Sum of times cited	Sum of times cited without self-citations	Average citations per item	h-index
1	Yemen	33	225	200	6.82	8
2	Indonesia	307	6,274	5,554	20.44	40
3	India	2,020	19,296	15,643	9.55	48
4	Bangladesh	104	1,751	1,623	16.84	20
5	Maldives	–	–	–	–	–
6	Pakistan	152	3,073	2,978	20.22	23
7	Thailand	1,354	26,602	22,822	19.65	67
8	Bhutan	8	49	42	6.12	4
9	Malaysia	167	2,145	1,882	12.84	24

Table VII Major contributing institutions/organizations

Rank	Name of the institute/organization	No. of contribution (n = 2,020)	%
1	Council for Scientific and Industrial Research, CSIR	184	9.12
2	Department of Biotechnology (Government of India)	132	6.54
3	Indian Council For Medical Research (ICMR), New Delhi	118	5.85
4	University Grant Commission, New Delhi	75	3.72
5	Department Of Science And Technology (Government of India)	72	3.57
6	Defence Research And Development Organisations	12	0.59
7	Central Drug Research Institute, Lucknow	10	0.49
8	All India Council Of Technical Education (AICTE), New Delhi	9	0.45
8	University of Delhi, Delhi	9	0.45

Geographical distribution of publications

Geographical distribution of research output on malaria research illustrates the collaboration of foreign countries researchers with Indian researchers during the period under study. Table IX was limited to countries with minimum of ten affiliations and listed 27 countries out of 95 countries. It is a healthy sign of Indian researchers' collaboration with foreign researchers. The percentage of collaboration of contributors geographically affiliated with USA is much higher compared to other foreign countries. England, 95; Switzerland, 54; Australia, 43; Thailand, 37; France, 31; Germany, 27; Spain, 24 and Canada with 23 contributors affiliation were the third, fourth, fifth, sixth, seventh, eighth, ninth and tenth most collaborative country.

Indian funding agencies

Table X gives Web of Science (WoS) list of major Indian funding agencies to promote malaria research or research which is helpful to eradicate the most dangerous disease malaria in the country, it shows Council for Scientific and Industrial Research (CSIR) is the most active agency and with 184 (9.11 percent) research grants stood in the first positions. Department of Biotechnology, Govt. of India (132, 6.54 percent); ICMR, New Delhi (118, 5.85 percent); UGC, New Delhi (75, 3.72 percent) research grants holds the second, third and fourth positions.

Conclusion

In the present study on malaria research by the Indian researchers which were indexed in WoS during 2003 to 2012,

Table VIII List of contributors with 31 or more contributions

Rank	Name of author	No. of contributions (n = 2,020)	%
1	A.P. Dash	136	6.74
2	N. Singh	75	3.72
3	S.K. Puri	70	3.47
4	V.S. Chauhan	67	3.32
5	A. Sharma	59	2.93
5	S.K. Sharma	59	2.93
6	A. Kumar	57	2.83
7	A. Das	48	2.38
7	S. Kumar	48	2.38
8	V. Dev	47	2.33
9	Y.D. Sharma	45	2.23
10	S. Singh	44	2.18
10	N. Balechan	44	2.18
11	S. Sharma	43	2.13
12	N. Surolian	37	1.84
13	K. Srivastava	33	1.64
13	S.K. Subbarao	33	1.64
14	S. Mohanty	31	1.54

Table IX Geographical distribution of publications

Rank	Country	No. of contribution (n = 2,020)	%
1	India	2,020	100
2	USA	253	12.53
3	England	95	4.71
4	Switzerland	54	2.68
5	Australia	43	2.13
6	Thailand	37	1.84
7	France	31	1.54
8	Germany	27	1.34
9	Spain	24	1.19
10	Canada	23	1.14
11	South Africa	18	0.89
12	Denmark	16	0.79
13	Italy	15	0.75
13	China	15	0.75
13	Sri Lanka	15	0.75
14	Indonesia	14	0.69
14	Mozambique	14	0.69
15	Japan	13	0.65
15	The Netherlands	13	0.65
16	Belgium	12	0.59
16	Brazil	12	0.59
16	Colombia	12	0.59
16	Nepal	12	0.59
16	Scotland	12	0.59
17	South Korea	11	0.55
18	Kenya	10	0.49
18	Papua N Guinea	10	0.49

we obtained following significant points; a total of 2,020 documents were published out of which 1,645 were research articles listed in 282 journals and in 90 WoS research areas. The malaria research outputs of Indian researchers during the period under study presented an upward trend as the research production increased steadily in the last ten years, and the annual research production in 2012 was about thrice that of the research outputs in 2003. As the flagship *Malaria Journal* published the largest number of articles. This information should be useful to libraries collecting information on malaria.

Table X WoS list of Indian funding agencies

Rank	Name of the agency	No. of contributions (n = 2020)	%
1	Council for Scientific and Industrial Research, CSIR	184	9.11
2	Department of Biotechnology (Government of India)	132	6.54
3	Indian Council for Medical Research (ICMR), New Delhi	118	5.85
4	University Grant Commission, New Delhi	75	3.72
5	Department of Science and Technology (Government of India)	72	3.57
6	Defence Research and Development Organisations	12	0.59
7	Central Drug Research Institute, Lucknow	10	0.49
8	All India Council of Technical Education (AICTE), New Delhi	9	0.45
8	University of Delhi, Delhi	9	0.45

Malaria is one of the major Indian diseases which causes high morbidity and mortality rate and being responsible for making India the top Asian country for maximum number of deaths during 1980 to 2010; and force the Indian researches for conducting more and more research, which helps to produce more number of research outputs by the Indian researchers and stood in the first position among the malaria affected Asian country list. The initiative taken by Indian agencies to eradicate malaria is quite appreciated; nearly one-third of the total research was funded by nine Indian agencies. Nationwide involvement of research and academic institutions will yield better research output and helps to eradicate malaria completely form the country.

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About the author

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