



Scientometric Analysis of Indian Chikungunya Research Output during 2006-15

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Abstract

The present study examines 521 Indian publications on “Chikungunya” as covered in Scopus database during 2006-15, experiencing an annual average growth rate of 17.56% and citation impact per paper of 10.79. The global publications on Chikungunya from top 10 most productive countries accounted for 87.93% publication share during 2006-15. The top 15 organizations and authors contributed 46.45% and 42.03% publication share and 63.5% and 101.67% citation share respectively of the Indian output and citations. Medicine among subjects, contributed the largest publication share of 77.35% followed by immunology and microbiology (29.75%), biochemistry, genetics and molecular biology (23.22%), agricultural & biological sciences (9.6%), pharmacology, toxicology & pharmaceuticals (6.91%) etc. during 2006-15. Of the total global publications, top 15 journals contributed 34.93% of the total Indian output.

Keywords : Chikungunya, Disease, Publications, India, Bibliometrics, Scientometrics

1. Introduction

Chikungunya is a viral infection transmitted by the bite of *Aedes albopictus* and *Aedes aegypti* mosquitoes. The *Aedes* mosquitoes and some other animals like birds and rodents act as carriers of Chikungunya virus and spread the disease (CDC, n.d.). The term ‘Chikungunya’ has its origin from the Kimakonde language and means ‘to become contorted’ (“Chikungunya”, n.d.). The incubation period varies between 2-12 days. Chikungunya has an abrupt onset with fever, chills, headache, nausea, vomiting, joints pain and rash. Severe joints pain is the characteristic feature of this disease. Infection provides lifelong immunity. Joints pain may persist for a long time (NVBDCP, n.d.). The Chikungunya virus is an RNA virus and a member of the alpha virus genus in the *Togaviridae*. Chikungunya virus is also known as arbo virus as it is transmitted by arthropods, especially mosquitoes. This virus is susceptible to high mutation rates which helps the virus to evade the immune response (Med India, n.d.). The

Aedes mosquito is the primary vector of Chikungunya infection in humans. These mosquitoes are especially found in tropics and therefore the Chikungunya is predominant in Asian countries. The mosquito is an aggressive daytime feeder and breeds in stagnated water around human dwellings (Chikungunya Fever Guide, n.d.).

Chikungunya was first detected in 1952 in Southern Tanzania. The disease is tropical and occurs predominantly in Africa, Asia and the Indian subcontinent. The mosquito vectors have also spread to Europe and the Americas. The incidence of Chikungunya has grown dramatically around the world during the last 50 years. According to a WHO factsheet, in 2015 over 13, 79,788 suspected cases of Chikungunya have been recorded in the Caribbean islands, Latin American countries, and the United States of America (WHO, n.d.).

The Directorate of National Vector Borne Disease Control Programme (NVBDCP) (one of the technical departments of Directorate General of Health Services, Govt. of India), is the central nodal agency for the prevention and control of vector borne diseases i.e. Malaria, dengue, lymphatic filariasis, kalaazar, Japanese encephalitis and Chikungunya in India. There was a sudden upsurge of Chikungunya in India in 2006 when around 13, 90,322 clinically suspected cases were reported. According to Indian health minister, 27,553 cases have been reported in India in 2015 by NVBDCP. Diagnostic facilities for Chikungunya have been augmented by opening Sentinel Surveillance Hospitals (SSHs) and Apex referral laboratories. The number of SSHs has been increased from 110 in 2007 to 521 in 2015 (NVBDCP, n.d.).

2. Literature Review

Few studies have been undertaken in the past on bibliometric analyses of vector control diseases research output including Chikungunya. Shri Ram (2016) analysed global research output (1783 papers) in Chikungunya (with largest contribution from India), as covered in Scopus multidisciplinary database from 2004 to 2013. The literature growth during the latter half of decade is indicative of high incidence of Chikungunya during the period. Among other vector diseases, bibliometric analysis of research has been conducted on diseases such as malaria (Gupta & Bala, 2011), dengue (Gupta et al., 2014), Japanese encephalitis (Gupta & Gupta, 2016), etc.

3. Objectives

The main objective of this study is to examine the research output of Indian publications on “Chikungunya” during 2006-15, based on publication output, as indexed in Scopus database. The study is particularly focused on the following objectives: (i) To study the growth of world and Indian literature and study its distribution by types of documents and sources; (ii) To study the contribution and global share of top 10 most productive countries; (iii) To study the distribution of Indian research output by broad subject areas and identification of significant keywords; (iv) To study the publication productivity and citation impact of most productive organizations and authors and; (v) To study the medium of communication.

4. Methodology

The study retrieved and downloaded the publication data of the world and of 10 most productive countries on “Chikungunya” from the Scopus database during 2006-15. The keyword “Chikungunya” was used in “Title” or “Keyword” tags and restricting it to the period 2006-15 in “date range tag” for searching the global publication data and this become the main search string. When the main search string was restricted to 10 most productive countries one by one in “country tag” the publication data on these individual countries (including India) were obtained. When the main search string is further restricted to “subject area tag”, ”country tag”, ”source title tag”, and “affiliation tag “, we got information on distribution of publications by subject, collaborating countries, organization wise and journal wise etc. The citation data was collected from the date of publication till the end of 11 August 2016. The study has used few qualitative and quantitative indicators for measuring the performance of research in this area.

(TITLE-ABS-KEY ("Chikungunya") AND AFFILCOUNTRY (India) AND PUBYEAR > 2005 AND PUBYEAR < 2016

5. Data Analysis

5.1 Publication Analysis

The number of publications on Chikungunya consisted of 521 publications during 2006-15 and has increased from 16 in 2006 to 61 in 2015, witnessing an annual average growth rate of 17.56%. The cumulative publication output on Chikungunya increased from 189 to 332 from 2006-10 to 2011-15, witnessing the growth rate of 75.66%. The average citation per paper of all publications on Chikungunya was 10.79 during 2006-15, which decreased from 20.98 to 4.98 from 2006-10 to 2011-15 (Table1). Of the total 521 publications on Chikungunya, 98.96 % (513) appeared as journals, 1.0 % (5) as books, and 0.38% (2) as conference proceedings, 0.19% (1) as book series. Around 8.06% of the Indian publications on Chikungunya involve international collaboration during 2006-15, which increased from 5.82% during 2006-10 to 9.34% during 2011-15. USA contributed the largest share (57.14%) of the international collaborative papers of India on Chikungunya followed by France, Germany, Japan, Switzerland, Thailand, UK (6.12% each); Belgium, Italy and Malaysia (4.08% each). The collaborative publication share of these countries increased in case of United States, France, Germany, Switzerland, Belgium, and Italy, but decreased in case of Japan, Malaysia, Thailand and United Kingdom (Table2).

Table 1
 Growth of World and Indian Publications and Citations
 on Chikungunya during 2006-15

Period	World		India				
	TP	TP	TP%	TC	ACPP	ICP	%ICP
2006	101	16	15.84	647	40.44	1	6.25

2007	143	28	19.58	720	25.71	1	3.57
2008	205	45	21.95	1174	26.09	2	4.44
2009	215	45	20.93	846	18.80	3	6.67
2010	233	55	23.61	579	10.53	4	7.27
2011	255	65	25.49	689	10.60	6	9.23
2012	313	71	22.68	600	8.45	6	8.45
2013	317	56	17.67	14	0.25	7	12.50
2014	447	79	17.67	267	3.38	8	10.13
2015	564	61	10.82	83	1.36	4	6.56
2006-2010	897	189	21.07	3966	20.98	11	5.82
2011-2015	1896	332	17.51	1653	4.98	31	9.34
2006-2015	2793	521	18.65	5619	10.79	42	8.06

TP=Total Papers; TC=Total Citations; ACP=Average Citations Per Paper;
 ICP=International Collaborative Papers

Table 2
 Contribution of Top 10 Foreign Countries in India's Collaborative Output in Chikungunya during 2006-15

Name of Collaborative Countries	Number of Collaborative Papers			Share of Collaborative Papers		
	2006-10	2011-15	2006-15	2006-10	2011-15	2006-15
United States	6	22	28	50	59.46	57.14
France	0	3	3	0	8.11	6.12
Germany	0	3	3	0	8.11	6.12
Japan	1	2	3	8.33	5.41	6.12
Switzerland	0	3	3	0	8.11	6.12
Thailand	2	1	3	16.67	2.7	6.12
United Kingdom	2	1	3	16.67	2.7	6.12
Belgium	0	2	2	0	5.41	4.08
Italy	0	2	2	0	5.41	4.08
Malaysia	1	1	2	8.33	2.7	4.08
Total (for India)	12	37	49	100	100	100

5.1.1 Country Wise Distribution of Publications and Citations

A large number of countries participated in research on Chikungunya during 2006-15, of which the top 10 most productive countries published 68 to 625 publications and together contributed 87.93% share of the global output during 2006-15, which increased from 84.17% to 89.72% from 2006-10 to 2011-15. The largest publication share (22.38%) was contributed by United States, followed by India (18.76%), France (18.62%), United Kingdom, Italy, Singapore, Australia (4.08% to 5.26%), Germany (3.9%), Thailand (3.4%) and Netherlands (2.43%). The global publication share increased by 11.28% in United States, followed by

Thailand (2.39%), Singapore (2.38%), Australia (2.07%), Netherlands (1.13%) and UK(0.86%) as against decrease by 8.71% in France, India (3.89%), Germany (1.31%) and Italy (0.65%) from 2006-10 to 2011-15 (Table3).

Table 3
Global Publication Share and Output of Top 20 Countries in Chikungunya during 2006-15

Country	Number of Publications			Share of Publications		
	2006-10	2011-15	2006-15	2006-10	2011-15	2006-15
United States	132	493	625	14.72	26	22.38
India	192	332	524	21.4	17.51	18.76
France	220	300	520	24.53	15.82	18.62
United Kingdom	42	105	147	4.68	5.54	5.26
Italy	47	87	134	5.24	4.59	4.8
Singapore	24	96	120	2.68	5.06	4.3
Australia	24	90	114	2.68	4.75	4.08
Germany	43	66	109	4.79	3.48	3.9
Thailand	16	79	95	1.78	4.17	3.4
Netherlands	15	53	68	1.67	2.8	2.43
Total of 10 countries	755	1701	2456			
Total of the world	897	1896	2793			
Share of Top 10 countries	84.17	89.72	87.93			

5.2. Subject Wise distribution of Publications

The publications were classified according to Scopus bibliographical database classification. The largest share of publications (77.35%) came from medicine, followed by immunology and microbiology (29.75%), biochemistry, genetics and molecular biology (23.22%), agricultural & biological sciences (9.6%), pharmacology, toxicology & pharmaceuticals (6.91%), environmental science (3.65%), etc. during 2006-15. The publication activity, as reflected in activity index, has increased in medicine (from 46.90 to 129.26), immunology and microbiology (from 48.74 to 126.63), biochemistry, genetics & molecular biology (from 58.17 to 115.04), pharmacology, toxicology & pharmaceuticals (from 0 to 112.5), environmental science (from 76 to 108.57), as against decrease in agricultural & biological sciences (from 185.45 to 76.5). Immunology and microbiology registered the highest citation impact per paper (14.74), followed by medicine (11.81), biochemistry, genetics & molecular biology (9.53), pharmacology, toxicology & pharmaceuticals (8.28), agricultural & biological sciences (8.2), environmental science (4.11), etc.

Table 4

Subject Wise Distribution of Publications on Chikungunya Research during 2006-2015

Subject*	Total Documents			Activity Index		%TP	Total Citations	ACP P	HC P	%H C
	2006-10	2011-15	2006-15	2006-10	2011-15					
Medicine	140	263	403	46.90	129.26	77.35	4761	11.81	22	5.46
Immunology & microbiology	53	102	155	48.74	126.63	29.75	2284	14.74	13	8.39
Biochemistry, genetics and molecular biology	32	89	121	58.17	115.04	23.22	1153	9.53	4	3.31
Agricultural & biological sciences	11	39	50	185.45	76.5	9.6	410	8.2	1	2
Pharmacology, toxicology and pharmaceuticals	4	32	36	0	112.5	6.91	298	8.28	2	5.56
Environmental Science	5	14	19	76	108.57	3.65	78	4.11	0	0
Total of India	189	332	521	100	100					

TP=Total Papers; TC=Total Citations; ACP=Average Citations Per Paper

*There is a duplication of papers under various subjects

5.3. Distribution of Publications by Population Age-Groups

On classifying the publication output of India on Chikungunya by population age-group, it was observed that the largest emphasis has been placed on adults (140 papers, 26.87% share), adolescent (84 papers, 16.12% share), child (79 papers, 15.16% share), middle aged (72 papers, 13.82% share) and aged (63 papers, 12.09% share) (Table 5).

Table 5

Distribution of Publications by Population Age Group during 2006-15

Population Age Group	Total Documents			%TP (2006-15)
	2006-10	2011-15	2006-15	
Child	31	48	79	15.16

Adolescent	33	51	84	16.12
Adult	50	90	140	26.87
Middle Aged	30	42	72	13.82
Aged	30	33	63	12.09
Total (for India)			521	

5.4. Contribution & Citation Impact of 15 Most Productive Organizations

The top fifteen institutions involved in Chikungunya have individually published 8 to 43 papers and together contributed 242 papers and 3568 citations, accounting for 46.45% and 63.50% share of cumulative publication and citation output of India during 2005-16. The publication profile of these fifteen Indian institutions along with their research output, citations received and h-index values are presented in Table 6. The average productivity per organization was 16.13 and four organizations have registered a higher publication share than the group average productivity: National Institute of Virology, Pune (43 papers), Defence Research & Development Establishment, Gwalior (40 papers), Indian Council of Medical Research, New Delhi (25 papers), Regional Medical Research Centre, Bhubaneswar (20 papers). The average citation per paper registered by total papers of these 15 organizations was 13.37 and six organizations have registered higher citation impact than the group average citation impact: National Institute of Mental Health and Neurosciences, Kolkata (32.75), National Institute of Virology, Pune (23.16), Defence Research & Development Establishment, Gwalior (16.4), Vector Control Research Centre, Puducherry (16.27), Regional Medical Research Centre, Bhubaneswar (16), Bharathiar University, Coimbatore (15.67) during 2006-15. The average h-index of 15 most productive organizations was 6.8 and five organizations have scored a higher h-index value than the group's average: National Institute of Virology, Pune (17), Defence Research & Development Establishment, Gwalior (16), Regional Medical Research Centre, Bhubaneswar & Indian Council of Medical Research, New Delhi (8 each), Bharathiar University, Coimbatore (7) during 2006-15. The average share of international collaborative papers (ICP) of these 15 organizations was 11.16% and seven organizations have registered higher share of ICP than the group average: World Health organization (50%), Bharathiar University, Coimbatore (44.44%), National Institute of Mental Health and Neurosciences, Kolkata (25%), Indian Council of Medical Research, New Delhi (20%), All India Institute of Medical Sciences, New Delhi (18.18%), Regional Medical Research Center, Bhubaneswar(15%), National Institute of Malaria research, India(14.29%) during 2006-15.

Table 6
 Productivity and Citation Impact of the Top Fifteen Indian Institutions
 in Chikungunya Research, 2006-15

Affiliation	Total Documents	Total Citations	ACPP	h-Index	ICP	%ICP
National Institute of Virology, Pune	43	996	23.16	17	0	0
Defence Research & Development Establishment, Gwalior	40	656	16.4	16	3	7.5
Indian Council of Medical Research , New Delhi	25	242	9.68	8	5	20
Regional Medical Research Centre, Bhubaneswar	20	320	16	8	3	15
Vector Control Research Center, Puducherry	15	244	16.27	6	0	0
National Institute of Malaria Research, India	14	126	9	6	2	14.29
Sant Parmanand Hospital, Delhi	12	19	1.58	2	0	0
All India Institute of Medical Sciences, New Delhi	11	147	13.36	6	2	18.18
World Health Organisation	10	98	9.8	5	5	50
Ministry of Health and Family Welfare, India	10	82	8.2	4	0	0
Sri Venkateswara University, Tirupathi	9	49	5.44	3	1	11.11
Bharathiar University, Coimbatore	9	141	15.67	7	4	44.44
National Institute of Communicable Diseases, New Delhi	8	102	12.75	4	0	0
Jiwaji university, Gwalior	8	84	10.5	5	0	0
National Institute of Mental Health and Neurosciences, Bangalore	8	262	32.75	5	2	25
Total of 15 organizations	242	3568	13.37	6.8	27	11.16
Total of India	521	5619				
Share of 15 organizations in India's total output	46.45	63.5				

ACPP=Average Citations Per Paper; ICP= International Collaborative Papers

5.6. Contribution and Citation Impact of Top 15 Authors

The productivity of top fifteen authors varied from 8 to 38 and together contributed 219 papers and 5713 citations, accounting for 42.03% and 101.67% share of publication and citation output of India during 2006-15. Table 7 presents the scientometric profile of these 15 most productive authors along with their research output, citations received and h-index value. The average productivity per author was 14.6 and five authors have achieved more than the average productivity (14.6) of all authors: M. Parida (38papers), P.V.L Rao (28 papers), P.K. Dash (17 papers), P. Vijayachari and A. B. Sudeep (16 papers each) during 2006-15. Six authors have shown a higher citation impact per paper than the group average (26.09): R. Paramasivan (61.33), A. C. Mishra (50.18), S. R. Santosh (40.85), A. B. Sudeep (39.94), V.A. Arankalle (38.79), P.K. Dash (31.47). The average h-index of top 15 authors was 7.8 and eight authors have achieved more than the average h-index value of all authors: M. Parida and P.V. L Rao(17 each), S. R. Santosh(11), P.K Dash(10), A. B. Sudeep (9), P. Vijayachari, V. A. Arankalle, A.C. Mishra (8 each) during 2006-15).

Table 7
 Productivity and Impact of 15 Most Productive
 Indian Authors in Chikungunya Research, 2006-15

Name	Affiliation	TP	TC	ACPP	H-Index	ICP	ICP%
M. Parida	Defence Research & development establishment, Division of Virology, Gwalior	38	808	21.26	17	4	10.53
P.V.L. Rao	Bharathiar Univ, DRDO BU Center for Life Sciences, Coimbatore	28	662	23.64	17	3	10.71
P. K. Dash	Defence Research & Development Establishment, Division of virology, Gwalior	17	535	31.47	10	2	11.76
P. Vijayachari	Regional Medical Research Centre, Dibrugarh	16	352	22	8	5	31.25
A.B. Sudeep	National Institute of Virology India, Pune	16	639	39.94	9	0	0
V.A. Arankalle	National Institute of Virology India, Pune	14	543	38.79	8	0	0
S.R. Santosh	Defence Research & Development	13	531	40.85	11	1	7.69

	Establishment, Division of Virology, Gwalior						
S. C. Arya	Sant Parmanand Hospital, N.Delhi	12	19	1.58	2	0	0
A. C. Mishra	National Institute of Virology, Pune	11	552	50.18	8	0	0
N. Agarwal	Sant Parmanand Hospital, N.Delhi	10	9	0.9	2	0	0
S.P. Manimunda	Regional Medical Research Centre, Bhubaneshwar	9	178	19.78	7	1	11.11
R. Paramasivan	Canter for Research in Medical Entomology, New Delhi	9	552	61.33	3	0	0
D. Parashar	National Institute of Virology India, Pune	9	125	13.89	5	0	0
A. N. Shriram	Ministry of Health and Family Welfare, New Delhi	9	65	7.22	4	0	0
A. Chopra	Centre for Rheumatic Diseases, Pune	8	143	17.88	6	0	0
	Total of 15 authors	219	5713	26.09	7.8	16	7.31
	Total of India	521	5619				
	Share of 15 authors in India's total output	42.03	101.67				

TP=Total Papers; TC=Total Citations; ACP=Average Citations Per Paper; ICP= International Collaborative Papers

5.7. Research Communication in High Productive Journals

The fifteen most productive journals publishing papers on Chikungunya individually published 7 to 33 papers and together contributed 182 papers, accounting for 34.93% share of the total output of India during 2006-15. The total research output of these journals showed a decrease in publication output from 39.15% during 2006-10 to 32.53% during 2011-15. The largest number of papers (33) have been published in *Indian Journal of Medical Research*, followed by *Parasitology Research* (921 papers), etc. (Table 9).

Table 9
Media of Communication in Indian Research in Chikungunya during 2006-15

Name of Journal	No. Of articles		
	2006-2010	2011-2015	2006-2015
Indian Journal of Medical Research	13	20	33
Parasitology Research	3	18	21
Journal of Communicable Diseases	7	8	15
Journal of Vector Borne Diseases	5	10	15
Indian Journal of Rheumatology	4	7	11
PLOS One	0	11	11
Current Science	8	2	10
Virology Journal	7	3	10
Indian Pediatrics	6	3	9
Plos Neglected Tropical Diseases	1	8	9
Asian Pacific Journal of Tropical Medicine	4	4	8
Indian Journal of Medical Microbiology	5	3	8
Journal of Association of Physicians of India	4	4	8
Emerging Infectious Diseases	6	1	7
International Journal of Pharma and Bioscience	1	6	7
Total of 15 Journals	74	108	182
Total of India	189	332	521
Share of 15 Journals in India's total output	39.15	32.53	34.93

6. Major Findings

521 Indian publications were identified on “Chikungunya” during 2006-15 from the Scopus database, using a well-defined search strategy, which depicted an annual average growth rate of 17.56%. The average citation impact per article on “Chikungunya” was 10.79 during 2006-15, which decreased from 20.98 during 2006-10 to 4.48 during 2011-15. India is ranked at 2nd position among 10 most productive countries in “Chikungunya” with its global publication share of 18.76%, which decreased from 21.4% during 2006-10 to 17.51% during 2011-15. India has collaborated with several countries, of which the largest collaborative output came from USA with publication share of 57.14%, followed by France, Germany, Japan, Switzerland, Thailand, United Kingdom(6.12 each), Belgium, Italy and Malaysia(4.08%) etc. In terms of classification of Indian publications (according to Scopus classification) on “Chikungunya”, medicine contributed the largest publication share of 77.35%, followed by

Immunology and microbiology (29.75%), biochemistry, genetics and molecular biology (23.22%), agricultural and biological sciences (9.6%), pharmacology, toxicology & pharmaceuticals (6.91%), environmental science (3.65%),ETC.

Adults contributed the largest share (26.87%) among population age group of population, followed by adolescents(16.12% share), child (15.16% share), middle aged (12.09% share) and aged (12.09% share) during 2006-15. The top fifteen most productive organizations and authors together contributed 46.45% and 42.03% publication share and 63.5% and 101.67% citation share to the total Indian publication and citation output on Chikungunya during 2006-15. The fifteen top productive journals involved in Chikungunya research together accounted for 34.93% share of the cumulative output of India during 2006-15, which decreased from 39.15% during 2006-10 to 32.53% during 2011-15.

7. Conclusion

The upsurge of epidemics of Chikungunya has necessitated for effective remedial measures for its prevention and control. Chikungunya mortality rate is very low but it is a debilitating disease and incapacitating the patient for several months in some cases. The government need to strengthen the principles of integrated vector management, augment diagnostic facilities and suitable medicare to the affected. Research plays a vital role to improve the existing support system for the surveillance, prevention and control of the disease. India needs to uplift its research output on Chikungunya and also increase its research impact through national and international collaboration. The government should provide adequate infrastructure, special laboratories and financial assistance for promoting the research in this area.

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