

Global Asthma Research with Special Reference to India: A Scientometric Assessment of Publication Output during 2007-16

Gupta BM¹, Jeevanjyot Kaur², Kiran Baidwan² and Ritu Gupta^{3*}

¹Formerly CSIR –NISTADS, New Delhi, 11012, India

²Postgraduate Institute of Medical Education & Research, India

³Formerly Sri Venkateshwara University, India

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***Corresponding author:** Ritu Gupta, Sri Venkateshwara University, Andhra Pradesh, India; E-mail: ritu7648@gmail.com

Abstract

The paper examines 2094 Indian publications on asthma research, as covered in Scopus database during 2007-16, registering an annual average growth rate of 12.14%, global share of 2.72%, qualitative citation impact averaged to 10.857 citations per paper and international collaborative publication share of 13.51%. The top 12 most productive countries individually contributed global share from 2.72% to 31.27%, with largest global publication share coming from USA (31.27%), followed by U.K. (10.45%), Germany (5.60%), Canada (5.44%), etc. Together, the 12 most productive countries accounted for 83.80% share of global publication output during 2007-16. Medicine, among subjects, accounted for the highest publications share (61.32%), followed by pharmacology, toxicology & pharmaceuticals (35.05%) biochemistry, genetics & molecular biology (20.25%), immunology & microbiology (7.78%), agricultural & biological sciences (3.44%) and chemistry (2.88%) and during 2007-16. Among different type of asthma, allergic asthma contributed the highest number of publications, followed by bronchial asthma, atopic asthma, occupational asthma and seasonal asthma, etc. during 2007-16. The top 15 most productive organizations and authors together contributed 33.48% and 19.96% respectively as their share of global publication output and 43.88% and 36.93% respectively as their share of global citation output during 2007-16. Among 2059 journal papers, the top 15 journals contributed 25.89% share to the Indian journal output during 2007-16. Only 29 publications registered citations from 100 to 868 and received 6792 citations, with citations per paper of 234.21.

Keywords: Asthma research; India; Publications; Citations; International Collaborative Papers; Scientometrics; Bibliometrics

Introduction

Asthma is a disease of the bronchial tubes in the lungs (the “airways”). People with asthma typically experience “wheezing”, a high-pitched whistling sound heard during breathing, especially when breathing out. However, wheezing does not always occur, and asthma can also involve breathlessness, chest tightness or coughing. The underlying process includes chronic inflammation of the airways, reversible obstruction of the flow of air in and out of the airways, and the tendency of the airways to over-react to stimuli [1].

There are two types of asthma depending on the type of trigger – extrinsic and intrinsic asthma. Extrinsic asthma is an immune response to an external allergen such as pollen, animal dander, dust, etc. Intrinsic asthma is caused due to inhaling certain chemical agents such as cigarette smoke, paint vapours, etc. In some cases it may also be worsened by a chest infection, stress, laughter etc. The most common allergens that cause asthma are pollen, dust, pollution like smoke from vehicles, animal dander, certain smells like that of diesel and petrol combustion, peeling paint and fungus in enclosed areas. There are mainly two types of reactions a delayed hypersensitive response (where the person experiences symptoms after a long period of time) and an instant hypersensitive response (where the person immediately develops symptoms to the allergen). Some drugs like aspirin and other NSAIDs are also known to cause asthma attacks [2].

Asthma most commonly develops in early childhood, and more than three-quarters of children who develop asthma symptoms before age 7 no longer have symptoms by age 16. However, asthma can develop at any stage in life, including adulthood. The current estimates of global burden of asthma: (i) 334 million people have asthma; (ii) 14% of the world’s children experience asthma symptoms; (iii) 8.6% of young adults (aged 18-45) experience asthma symptoms; (iv) 4.5% of young adults have been diagnosed with asthma and/or are taking treatment for asthma; (v) The burden of asthma is greatest for children aged 10-14 and the elderly aged 75-79 [1].

Asthma causes limitations in daily activities, loss of school and work days, lung function impairment, reduced quality of life, and an adverse socioeconomic burden. About 15 million disability-adjusted life years are lost annually due to asthma, which represents 1% of the total global disease burden. There are about 489,000 deaths attributable to asthma annually and the majority of deaths occur in low- and middle-income countries,

particularly Oceania, South and Southeast Asia, the Middle East, and Africa [3]. Of 334 million people suffering from asthma worldwide, about one-tenth live in India. A recent Indian Study on Epidemiology of Asthma, Respiratory Symptoms and Chronic Bronchitis (INSEARCH) done with 85,105 men and 84,470 women from 12 urban and 11 rural sites in India estimated the prevalence of asthma in India to be 2.05% among those aged >15 years, with an estimated national burden of 18 million asthmatics [3].

Literature Review

Only a few studies have been published in this field. Among studies carried out, Klaewsongkram and Reantragoon [4] studied and analyzed asthma research from Asia-Pacific in the last decade by bibliometric method during 1998-2007, using PubMed database. Most of published asthma articles in Asia-Pacific are from affluent countries in northeast Asia and Oceania. Australia and Japan contributed more than half of regional articles on asthma. Emerging economies in Asia such as South Korea, Taiwan, Hong Kong, and Singapore, have dramatically increased in the last decade in terms of quantity and quality aspects and were considerable sources of basic and translational research in the region. Mainland China and India have significantly increased their research capacity as well, but quality needs to be improved. New Zealand and Australia, countries with the highest asthma prevalence rates in the world, yielded highest citation counts per articles and were published in journals with high impact factor. Asthma research parameters per million population correlate well with gross domestic product per capita. Gupta and Bala [5] analyzed the research output of India in asthma during the period from 1999 till 2008. It analyzes the growth, rank and global publications share, citation impact, share of international collaborative papers, contribution of major collaborative partner countries and contribution of various subject fields. It also analyzes the characteristics of most productive institutions, authors and high-cited papers. Sweileh, Al-Jabi, Zyoud and Sawalha [6] analyzed research output (1304) originating from 22 Arab countries in the field of bronchial asthma and COPD, using Scopus database. Research productivity was evaluated based on: (a) total and trends of contribution of each Arab country to asthma and COPD research and (b) journals in which researchers from Arab countries published their research. Research output can be improved by investing more in international and national collaborative research projects in the field of asthma and COPD. In addition, bibliometric studies were also carried out on asthma in children and animal models in asthma. Chen, Chiu and Ho [7] evaluated the publication output associated with research on asthma in children during 1991-2002, Using

SCI database. Parameters analyzed included language, type of document, page count, publication output, country of publication, authorship, publication pattern, and the most frequently cited paper. Börger, et al. [8] studied 3489 records connected to animal models of asthma from 52 countries during 1900-2006, the first being published in the year 1968. Assessing numbers of published items in relation to animal species it was found that mice were the preferred species followed by guinea pigs. There are also differences in the use of species. These differences are based on variations in the research focus as assessed by subject category analysis.

Objectives

The objectives of the present study are to study the performance of Indian asthma research during 2007-16, using on publications data indexed in Scopus database. In particular, the study analyzed the global research output and the research output of top 12 most productive countries, the growth of Indian research output, its global share and citation impact; the share of international collaboration publications in its India's output and significant contribution of foreign partner countries; distribution of the Indian research output by broad subject areas and the dynamics of its growth and decline, the distribution of Indian output by types of asthma, the productivity and citation impact of top 15 Indian most productive organizations and authors; the modes of communication and the characteristics of high cited papers.

Methodology

The asthma research publications landscape from 2007 through 2016 were identified using the Scopus database (<http://www.scopus.com>). An keyword search was used to identify publications that contained the terms "asthma" in the "Article title tag" or "keyword tags" or "source Title tag" and restricting it to the period 2007-16 in "date range tag" was used for searching the global publication data and this become the main search string. The search has resulted into 77118 publications on asthma research during 2007-16. The main search string with restricted to individual country name in "country tag", the publication data on individual top 10 most productive countries

(including India) one by one was obtained. The Indian search string is further refined using provisions in Scopus database by "subject area tag", "country tag", "source title tag", "journal title name" and "affiliation tag", to get information on distribution of publications by subject, collaborating countries, author-wise, organization-wise and journal-wise, etc. Separate search strategies were also developed to get information on different type of asthma research. For citation data, citations to publications were also collected from date of publication till 19 April 2018. A number of bibliometric indicators (both absolute and relative) have been used in this study to measure the performance of asthma research in India.

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(KEY (asthma) OR TITLE (asthma) OR SRCTITLE (asthma)) AND PUBYEAR > 2006 AND PUBYEAR < 2017
(KEY (asthma) OR TITLE (asthma) OR SRCTITLE (asthma)) AND PUBYEAR > 2006 AND PUBYEAR < 2017
AND (LIMIT-TO (AFFILCOUNTRY, "India"))
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Analysis

The total research output of World and India's asthma research cumulated to 77118 and 2094 publications in 10 years during 2007-16, using a Scopus database. The annual global and Indian output in asthma research increased from 7004 and 98 in the year 2007 to 7953 and 238 publications in the year 2016, registering 1.48% and 12.14% growth per annum. The cumulative global and Indian output in asthma research computing in 5 years increased from 36994 and 834 during 2007-11 to 40124 and 1260 during 2012-16, registering growth rate of 8.46% and 51.08%. India is ranked at 12th position in global output and its global publication share in asthma research was 2.72% during 2007-16, which increased from 2.25% to 3.14% from 2007-11 to 2012-16. Of the total global publications output, 64.47% (1350) was published articles, 23.35% (489) as reviews, 5.40% (113) as letters, 2.20% (46) as editorials, 2.05% (43) as conference papers, 1.43% (30) as notes and the rest as book chapters (12), short surveys (9) and articles in press (2). The citation impact of Indian publications on asthma research averaged to 10.85 citations per publication (CPP) during 2007-16; five-yearly impact averaged to 17.17CPP for the period 2007-11 which declined to 6.67CPP in the succeeding five-year 2012-16 (Table 1).

	World	India					
	TP	TP	TC	CPP	%TP	ICP	%ICP
2007	7004	98	2629	26.83	1.4	10	10.2
2008	7264	107	1954	18.26	1.47	13	12.15
2009	7518	154	4436	28.81	2.05	20	12.99
2010	7300	193	2297	11.9	2.64	22	11.4
2011	7908	282	3004	10.65	3.57	31	10.99
2012	8044	276	2214	8.02	3.43	32	11.59
2013	8233	254	2137	8.41	3.09	27	10.63
2014	7907	233	2551	10.95	2.95	42	18.03
2015	7987	259	815	3.15	3.24	41	15.83
2016	7953	238	690	2.9	2.99	45	18.91
2007-11	36994	834	14320	17.17	2.25	96	11.51
2012-16	40124	1260	8407	6.67	3.14	187	14.84
2007-16	77118	2094	22727	10.85	2.72	283	13.51
TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper							

Table 1: India's Output in Asthma Research during 2007-16.

International Collaboration

India's share of internationally collaborative papers (ICP) in asthma research was 13.51% during 2007-16, which increased from 11.51% to 14.84% from 2007-11 to 2012-16. Among the leading countries contributing to internationally collaborative papers, USA topped the list with 51.24% share, followed by U.K. (19.79%), Australia (15.19%), Germany (11.66%), France, Netherland and

Sweden (8.48% each), China (7.42%), Switzerland (7.07%) and Malaysia (6.71%) during 2007-16. India's international collaborative publications share increased by 14.48% in USA, 3.85% in Malaysia, 1.77% in China and 1.24% in Switzerland, as against decrease by 12.39% in France, 9.15% in Germany, 6.08% in Netherlands, 4.51% in Sweden, 2.23% in Australia and 1.58% in U.K from 2007-11 to 2012-16 (Table 2).

S.No	Collaborative Country	Number of Papers			Share of Papers		
		2007-11	2012-16	2007-16	2007-11	2012-16	2007-16
1	USA	40	105	145	41.67	56.15	51.24
2	U.K.	20	36	56	20.83	19.25	19.79
3	Australia	16	27	43	16.67	14.44	15.19
4	Germany	17	16	33	17.71	8.56	11.66
5	France	16	8	24	16.67	4.28	8.48
6	Netherlands	12	12	24	12.5	6.42	8.48
7	Sweden	11	13	24	11.46	6.95	8.48
8	China	6	15	21	6.25	8.02	7.42
9	Switzerland	6	14	20	6.25	7.49	7.07
10	Malaysia	4	15	19	4.17	8.02	6.71
	Indian Total	96	187	283			

Table 2: Share of Leading Foreign Countries in India's Collaborative Research Output in Asthma Research during 2007-16.

Top 12 Most Productive Countries in Asthma Research

The global research output in the field asthma research had originated from as many as 165 countries in the

world during 2007-16, of which 61 countries contributed each 1-10 papers, 52 countries each 11-100 papers, 34 countries each 101-1000 papers, 15 countries each 1001-5000 papers and 1 country each 8060 and 24113 papers. Top 12 most productive countries in asthma research had

contributed 2094 to 24113 publications each during 2007-16 (Table 3). Top 12 most productive countries in asthma research accounted for 83.80% global publication share during 2007-16. Their five-yearly output accounted for 82.17% global publication share during 2007-11 which increased to 85.31% during succeeding 5-year period 2012-16. Each of top 12 countries accounted for 2.72% to 31.27% global publication share during 2007-16, with USA accounting for the highest publication share

(31.27%), followed by U.K (10.45%), Germany and Canada (5.60% and 5.44%), Italy, China and Australia (4.80%, 4.24% and 4.21%), etc. The global publication share in five years increased in China (3.0%), India (0.89%), Netherlands (0.69%), Australia (0.35%), Spain (0.22%), USA (0.16%), Japan (0.04%) and Canada (0.02%), but decreased in Germany (1.41%), France (0.52%), Italy (0.25%) and U.K. (0.04%) from 2007-11 to 2012-16

S.No	Name of the Country	Number of Papers			Share of Papers		
		2007-11	2012-16	2007-16	2007-11	2012-16	2007-16
1	USA	11537	12576	24113	31.19	31.34	31.27
2	U.K.	3875	4185	8060	10.47	10.43	10.45
3	Germany	2342	1973	4315	6.33	4.92	5.6
4	Canada	2010	2188	4198	5.43	5.45	5.44
5	Italy	1823	1877	3700	4.93	4.68	4.8
6	China	990	2276	3266	2.68	5.67	4.24
7	Australia	1488	1756	3244	4.02	4.38	4.21
8	Japan	1538	1683	3221	4.16	4.19	4.18
9	France	1550	1472	3022	4.19	3.67	3.92
10	Spain	1264	1461	2725	3.42	3.64	3.53
11	Netherlands	1146	1521	2667	3.1	3.79	3.46
12	India	834	1260	2094	2.25	3.14	2.72
	Total	30397	34228	64625	82.17	85.31	83.8
	World	36994	40124	77118			
	Share of 12 Countries in World Total	82.17	85.31	83.8			

Table 3: Global Publication Output and Share of Top 12 Most Productive Countries in Asthma Research during 2007-16.

Subject-Wise Distribution of Research Output

The Indian asthma research output published during 2007-16 is distributed across five sub-fields (as identified in Scopus database classification), with medicine accounting for the highest publications share (61.32%), followed by pharmacology, toxicology & pharmaceuticals (35.05%) biochemistry, genetics & molecular biology (20.25%), immunology & microbiology (7.78%), agricultural & biological sciences (3.44%) and chemistry (2.88%) and during 2007-16. The activity index, which computes change in research activity in a discipline over time 2007-11 to 2012-16 (world average activity index of a given subject is taken as 100), witnessed increase in

biochemistry, genetics & molecular biology (from 82.31 to 111.71) and chemistry (from 96.57 to 102.27), as against decrease in medicine (from 106.18 to 95.91), pharmacology, toxicology & pharmaceuticals (from 102.28 to 98.49), immunology & microbiology (from 100.12 to 99.92) and agricultural & biological sciences (from 108.10 to 94.64) from 2007-11 to 2012-16. Immunology & microbiology, among five subjects registered the highest citation impact per paper (19.10), followed by biochemistry, genetics & molecular biology (12.53), agricultural & biological sciences (12.33), medicine (11.05), chemistry (9.31) and pharmacology, toxicology & pharmaceuticals (8.76) during 2007-16 (Table 4).

S.No	Subject*	Number of Papers (TP)			Activity Index		TC	CPP	%TP
		2007-11	2012-16	2007-16	2007-11	2012-16	2007-16	2007-16	2007-16
1	Medicine	543	741	1284	106.18	95.91	14192	11.05	61.32
2	Pharmacology, Toxicology & Pharmaceuticals	299	435	734	102.28	98.49	6428	8.76	35.05

2	Biochemistry, Genetics & Molecular Biology	139	285	424	82.31	111.71	5313	12.53	20.25
3	Immunology & Microbiology	65	98	163	100.12	99.92	3114	19.1	7.78
4	Agricultural & Biological Sciences	31	41	72	108.1	94.64	888	12.33	3.44
5	Chemistry	20	32	52	96.57	102.27	484	9.31	2.48
	Total Indian Output	834	1260	2094					
• There is overlapping of literature covered under various subjects									
TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper									

Table 4: Subject-Wise Breakup of Indian Publications in Asthma Research in India during 2007-16.

Break up of Publications by Type of Asthma

On classifying Indian asthma research output by type of asthma, it was observed that the largest number of publications were in allergic asthma (317 papers), followed by bronchial asthma (228 papers), atopic asthma (43 papers), occupational asthma and seasonal asthma (42 papers each), nocturnal asthma (36 papers), acute severe asthma (20 papers), exercise induced asthma and adult-onset asthma (11 papers each), aspirin induced asthma (9 papers), child onset asthma (7 papers) and alcohol induced asthma (2 papers) during 2007-16. In terms of global publication share, acute severe asthma registered the highest share (6.69%), followed by nocturnal asthma (6.59%), by bronchial asthma (3.97%), alcohol induced asthma (2.60%), allergic asthma (2.38%),

seasonal asthma (2.25%), adult-onset asthma (1.87%), aspirin induced asthma (1.75%), occupational asthma (1.59%), child onset asthma (1.40%) and atopic asthma (1.14%) during 2007-16. The global publication share has increased in allergic asthma (from 1.93% to 2.80%), bronchial asthma (from 2.55% to 5.62%), atopic asthma (from 0.95% to 1.31%), occupational asthma (from 1.03% to 2.18%), seasonal asthma (from 1.94% to 2.65%), nocturnal asthma (from 4.82% to 9.35%), exercise induced asthma (from 1.01% to 1.18%), aspirin induced asthma (from 1.64% to 1.85%), child onset asthma (from 0.90% to 1.81%) as against decrease in acute severe asthma (from 7.04% to 6.37%), adult onset asthma (from 2.16% to 1.69%) and alcohol induced asthma (from 6.67% to 0%) from 2007-11 to 2012-16.

S.No	Type of Asthma	World			India			% India		
		2006-11	2012-16	2007-16	2006-11	2012-16	2007-16	2006-11	2012-16	2007-16
1	Allergic Asthma	7363	7822	15185	142	219	361	1.93	2.8	2.38
2	Bronchial Asthma	3096	2653	5749	79	149	228	2.55	5.62	3.97
3	Atopic Asthma	1786	1991	3777	17	26	43	0.95	1.31	1.14
4	Occupational Asthma	1356	1282	2638	14	28	42	1.03	2.18	1.59
5	Seasonal Asthma	1033	831	1864	20	22	42	1.94	2.65	2.25
6	Nocturnal Asthma	332	214	546	16	20	36	4.82	9.35	6.59
7	Acute Severe Asthma	142	157	299	10	10	20	7.04	6.37	6.69
8	Exercise Induced Asthma	596	424	1020	6	5	11	1.01	1.18	1.08
9	Adult-Onset Asthma	231	356	587	5	6	11	2.16	1.69	1.87
10	Aspirin Induced Asthma	244	270	514	4	5	9	1.64	1.85	1.75
11	Child Onset Asthma	222	277	499	2	5	7	0.9	1.81	1.4
12	Alcohol Induced Asthma	30	47	77	2	0	2	6.67	0	2.6

Table 5: Breakup of Global and Indian Publications by Type of Asthma, 2007-16.

Profile of Top 15 Most Productive Indian Organizations

In Indian asthma research, the productivity of 15 most productive organizations varied from 18 to 142 publications and together they contributed 33.48% (701) publication share and 43.88% (9972) citation share to its cumulative publications output during 2007-16. The scientometric profile of these 15 organizations is presented in Table 6.

- a) Five of these organizations registered publications output greater than the group average of 46.73: Post graduate Institute of Medical Education & Research, Chandigarh (142 papers), Institute of Genomics & Integrated Biology, Delhi (98 papers), University of Delhi (88 papers), All India Institute of Medical Sciences New Delhi (87 papers) and Vallabhai Patel Chest Institute, Delhi (51 papers) during 2007-16.
- b) Six organizations registered impact above the group average of 14.23 citations per publication during 2007-16: University of Delhi (20.72), Jamia Hamdard University, Delhi (20.04), Dr Harisingh Gour University, Sagar (18.80), University of Pune (18.32), Institute of Genomics & Integrated Biology, Delhi (17.96) and All India Institute of Medical Sciences, New Delhi (17.14) during 2007-16.

- c) Five organizations registered h-index above the group average of 11.53: Institute of Genomics & Integrated Biology, Delhi (23), Postgraduate Institute of Medical Education & Research, Chandigarh (20), All India Institute of Medical Sciences, New Delhi (19), University of Delhi (17) and Vallabhai Patel Chest Institute, Delhi (14) during 2007-16.
- d) Eight organizations contributed international collaborative publications share above the group average of 9.27%: Kasturba Medical College, Manipal (16.0%), Institute of Genomics & Integrated Biology, Delhi (15.31%), University of Delhi (14.77%), Vallabhai Patel Chest Institute, Delhi (13.73%), Jamia Hamdard University, Delhi (13.04%), Indian Institute of Toxicological Research, Lucknow (11.11%), All India Institute of Medical Sciences, New Delhi (10.34%) and Panjab University, Chandigarh (9.52%) during 2007-16.
- e) Six organizations registered the relative citation index above the group average (1.31) of all organizations: University of Delhi (1.91) Jamia Hamdard University, Delhi (1.85), Dr. Harisingh Gour University, Sagar (1.73), University of Pune (1.69), Institute of Genomics & Integrated Biology, Delhi (1.66) and All India Institute of Medical Sciences, New Delhi (1.58) during 2007-16.

S.No	Name of the Organization	TP	TC	CPP	HI	ICP	%ICP	RCI
1	Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh	142	1721	12.12	20	8	5.63	1.12
2	Institute of Genomics & Integrated Biology (IGIB), Delhi	98	1760	17.96	23	15	15.3	1.66
3	University of Delhi	88	1823	20.72	17	13	14.8	1.91
4	All India Institute of Medical Sciences (AIIMS), New Delhi	87	1491	17.14	19	9	10.3	1.58
5	Vallabhai Patel Chest Institute (VPCI), Delhi	51	716	14.04	14	7	13.7	1.29
6	Chhatrapati Shahiji Maharaj Medical University, Lucknow	37	229	6.19	9	1	2.7	0.57
7	Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS), Lucknow	26	241	9.27	8	1	3.85	0.85
8	Kasturba Medical College (KMC), Manipal	25	60	2.4	4	4	16	0.22
9	Banaras Hindu University (BHU), Varanasi	24	173	7.21	7	0	0	0.66
10	Jamia Hamdard University, Delhi	23	461	20.04	9	3	13	1.85
11	Saveetha Dental College	22	43	1.95	4	0	0	0.18
12	Panjab University, Chandigarh	21	293	13.95	8	2	9.52	1.29
13	Dr Harisingh Gour University, Sagar	20	376	18.8	10	0	0	1.73
14	University of Pune	19	348	18.32	11	0	0	1.69
15	Indian Institute of Toxicological	18	237	13.17	10	2	11.1	1.21

	Research (IITR), Lucknow							
	Total of 15 organizations	701	9972	14.23	12	65	9.27	1.31
	Total of India	2094	22727	10.85				
	Share of top 15 organizations in India total output	33.5	43.88					
TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; HI=h-index; ICP=International Collaborative Papers; RCI=Relative Citation Index								

Table 6: Scientometric Profile of Top 15 Most Productive Organizations in Asthma Research in India during 2007-16.

Profile of Top 15 Most Productive Authors

In Indian asthma research, the productivity of 15 most productive top 15 most productive authors varied from 18 to 53 publications. Together they contributed 19.96% (418) publication share and 36.93% (8392) citation share during 2007-16. The scientometric profile of these 15 authors is presented in (Table 7).

- a) Four authors registered publications output above the group average of 27.87: B. Ghosh (53 papers), R. Agarwal (52 papers), A. Agrawal (41 papers) and U. Mabalirajan (33 papers) during 2007-16.
- b) Seven authors registered impact above the group average of 20.78 citations per publication: T. Ahmad (35.85), U. Mabalirajan (29.94), D. Gupta (29.58), A. Chakrabarti (28.85), B. Ghosh (24.62), R. Agarwal (24.38) and A. Agrawal (21.78) during 2007-16.

- c) Eight authors achieved h-index above the group average of 12.2: B. Ghosh (21), U. Mabalirajan (19), R. Agarwal (17), A. Agrawal (16), T. Ahmad, D. Gupta and A.N. Aggarwal (15 each) and A. Chakrabarti (14) during 2007-16.
- d) Six authors contributed international collaborative publications share above the group average of 7.66% of all authors: U. Mabalirajan (18.18%), A. Agrawal (17.07%), P.A. Mamesh (16.67%), B. Ghosh (15.09%), T. Ahmad and A. Chakrabarti (10% each)
- e) Seven authors registered the relative citation index above the group average (1.85) of all authors: T. Ahmad (3.30), U. Mabalirajan (2.76), D. Gupta (2.73), A. Chakrabarti (2.38), B. Ghosh (2.27), R. Agarwal (2.25) and A. Agrawal (2.01) during 2007-16.

S.No	Name of the Author	Affiliation of the Author	TP	TC	CPP	HI	ICP	%ICP	RCI
1	B. Ghosh	Institute of Genomics & Integrated Biology (IGIB), Delhi	53	1305	25	21	8	15.1	2.27
2	R. Agarwal	Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh	52	1268	24	17	2	3.85	2.25
3	A. Agrawal	Institute of Genomics & Integrated Biology (IGIB), Delhi	41	893	22	16	7	17.1	2.01
4	U. Mabalirajan	Institute of Genomics & Integrated Biology (IGIB), Delhi	33	988	30	19	6	18.2	2.76
5	S. Awasthi	Chhatrapati Shahiji Maharaj Medical University, Lucknow	27	148	5.5	8	1	3.7	0.51
6	D. Gupta	Vallabhai Patel Chest Institute (VPCI), Delhi	26	769	30	15	1	3.85	2.73
7	A.N. Aggarwal	Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh	27	535	20	15	0	0	1.83
8	S.N. Gour	Vallabhai Patel Chest Institute (VPCI), Delhi	24	357	15	3	0	0	1.37
9	N. Arora	Institute of Genomics & Integrated Biology (IGIB), Delhi	21	271	13	11	0	0	1.19
10	T. Ahmad	Institute of Genomics & Integrated Biology (IGIB), Delhi	20	717	36	15	2	10	3.3
11	A. Chakrabarti	Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh	20	517	26	14	2	10	2.38
12	S.K. Kabra	All India Institute of Medical Sciences (AIIMS), New Delhi	19	112	5.9	7	0	0	0.54

13	B.P. Sing	Institute of Genomics & Integrated Biology (IGIB), Delhi	19	267	14	12	0	0	1.3
14	R. Lodha	All India Institute of Medical Sciences (AIIMS), New Delhi	18	102	5.7	6	0	0	0.52
15	P.A. Mamesh	Cheluvamba Hospital, Mysore	18	143	7.9	7	3	16.7	0.73
	Total of 15 authors		418	8392	20	12	32	7.66	1.85
	Total of India		2094	22727	11				
	Share of top 15 authors in Indian total output		20	36.93					
TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; HI=h-index; ICP=International Collaborative Papers; RCI=Relative Citation Index									

Table 7: Scientometric Profile of Top 15 Most Productive Authors in Asthma Research in India during 2007-16.

Medium of Communication

Of the total Indian publications output in asthma research, 98.33% (2059) appeared in journals. The top 15 most productive journals accounted for 20 to 67 papers each in asthma research and together accounted for 25.89% share (533 papers) of total journal publication output during 2007-16. The publication share of these top 15 most productive journals increased from 22.16% to

27.90% between 2007-11 and 2012-16. The top most productive journal (with 67 papers) was *Lung India*, followed by *Indian Journal of Pharma & Bio Sciences* (57 papers), *Indian Journal of Pediatrics* (44 papers), *Research Journal of Pharmaceutical Biological & Chemical Sciences* (42 papers), *International Journal of Pharmacy & Pharmaceutical Sciences* (41 papers each), etc. during 2007-16 (Table 8).

S.No	Name of the Journal	Number of Papers		
		2007-11	2012-16	2007-16
1	Lung India	20	47	67
2	Indian Journal of Pharma & Bio Sciences	13	44	57
3	Indian Journal of Pediatrics	19	25	44
4	Research Journal of Pharmaceutical Biological & Chemical Sciences	9	33	42
5	International Journal of Pharmacy & Pharmaceutical Sciences	9	32	41
6	Journal of Clinical & Diagnostic Research	9	29	38
7	Indian Pediatrics	16	19	35
8	Asian Journal of Pharmaceutical & Clinical Research	8	26	34
9	International Journal of Pharmaceutical Sciences Review and Research	11	23	34
10	Journal of Ethno-pharmacology	13	14	27
11	Journal of Asthma	9	17	26
12	Research Journal of Pharmacy & Technology	7	17	24
13	Indian Journal of Medical Research	7	16	23
14	International Journal of Pharmtech Research	10	11	21
15	International Journal of Research in Ayurveda & Pharmacy	0	20	20
	Total of 15 journals	160	373	533
	Total India journal output	722	1337	2059
	Share of top 15 journals in Indian journal output	22.16	27.9	25.9

Table 8: Top 15 Most Productive Journals in Asthma Research in India during 2007-16.

High Cited Papers

Only 29 (1.38%) of total 2094 papers in asthma research in India received 100 to 868 citations each since their publication during 2007-16. These 29 high cited

papers were contributed by 801 authors from 585 organizations across 62 countries; together they received 6792 citations, and averaged 234.21 citations per paper. The research productivity among foreign participating

countries in high cited papers was the largest from U.K. (16 papers), Germany and France (10 papers each), USA and Sweden (9 papers each), Australia and Netherlands (8 papers each), Chile and Hong Kong (7 papers each), Brazil, Spain and New Zealand (6 papers each), Norway and South Africa (5 papers each), Malta, Thailand, Peru and Kenya (4 papers each), etc. Amongst 29 highly cited papers, 12 were reviews and 17 articles. Among 29 high cited papers, 11 resulted from solo organizations per paper, and 18 from 2 or more organizations per paper (1 national collaborative and 17 international collaborative paper). The most significant Indian organizations participating (among 31) in high cited papers were: Jaslok Hospital & Research Center, Mumbai (5 papers), Chest Research Foundation, Pune (3 papers), PGIMER-Chandigarh and AIIMS-New Delhi (2 papers each) and 1 paper each by 28 other Indian organizations.

The 29 highly cited papers were published in 21 journals, with 4 papers in *The Lancet*, followed by 2 papers each in *Allergy: European Journal of Allergy & Clinical Immunology*, *International Journal of Pharmaceutics*, *Journal of Allergy & Clinical Immunology*, *The Lancet Respiratory Medicine*, *New England Journal of Medicine*, and *Thorax*, and 1 paper each in 13 other journals: *Asia Pacific Journal of Biomedical Sciences*, *Bulletin of WHO*, *Chest*, *Clinical & Experimental Allergy*, *European Journal of Medicinal Chemistry*, *European Journal of Pediatrics*, *European Journal of Pharmacology*, *Intensive Care Medicine*, *Journal of Ethnopharmacology*, *Journal of Medicinal Chemistry*, *Pediatric Respiratory Review*, *Oxidative Medicine & Cellular Longevity*, *Pediatric Allergy & Immunology* and *Pharmacology*.

Summary & Conclusion

Summary

India had produced 2094 publications on asthma research as indexed in Scopus database in 10 years during 2007-16, which increased from 98 to 238 from the year 2007 to year 2016, registering 12.14% annual growth. India's global publications rank was 12th and its global share was 2.72% during 2007-16, which increased from 2.25% to 3.14% from 2007-11 to 2012-16. India's citation impact per paper averaged to 10.85 during 2007-16, which dropped from 17.17 to 6.67 from 2007-11 to 2012-16. The share of international collaborative papers of India in its research output on asthma research was 13.51% during 2007-16, which increased from 11.51% to 14.84% from 2007-11 to 2012-16. Medicine, among subjects, accounted for the highest publications share (61.32%), followed by pharmacology, toxicology & pharmaceutics (35.05%) biochemistry, genetics &

molecular biology (20.25%), immunology & microbiology (7.78%), agricultural & biological sciences (3.44%) and chemistry (2.88%) and during 2007-16. Among different type of asthma, allergic asthma contributed the highest number of publications, followed by bronchial asthma, atopic asthma, occupational asthma and seasonal asthma, etc. during 2007-16.

The top 15 most productive organizations and authors together contributed 33.48% and 19.96% respectively as their share of global publication output and 43.88% and 36.93% respectively as their share of global citation output during 2007-16. The leading most productive Indian organizations contributing to asthma research were Postgraduate Institute of Medical Education & Research, Chandigarh (142 papers), Institute of Genomics & Integrated Biology, Delhi (98 papers), University of Delhi (88 papers), All India Institute of Medical Sciences New Delhi (87 papers), Vallabhai Patel Chest Institute, Delhi (51 papers), etc. during 2007-16. The leading Indian organizations with comparatively higher citation impact per paper were University of Delhi (20.72), Jamia Hamdard University, Delhi (20.04), Dr Harisingh Gour University, Sagar (18.80), University of Pune (18.32), Institute of Genomics & Integrated Biology, Delhi (17.96), All India Institute of Medical Sciences, New Delhi (17.14) etc. during 2007-16. The leading most productive authors contributing to Indian asthma research were B. Ghosh (53 papers), R. Agarwal (52 papers), A. Agrawal (41 papers), U. Mabalirajan (33 papers) etc. during 2007-16. The leading Indian authors with comparatively higher citation impact per paper were T. Ahmad (35.85), U. Mabalirajan (29.94), D. Gupta (29.58), A. Chakrabarti (28.85), B. Ghosh (24.62), R. Agarwal (24.38), A. Agrawal (21.78) etc. during 2007-16.

Of the 2059 journal publications from India on asthma, the top 15 most productive journals accounted for 25.89% share of total Indian journal publication output during 2007-16, which increased from 22.16% to 27.90% between 2007-11 and 2012-16. The top most productive journal was *Lung India* (67 papers), followed by *Indian Journal of Pharma & Bio Sciences* (57 papers), *Indian Journal of Paediatrics* (44 papers), *Research Journal of Pharmaceutical Biological & Chemical Sciences* (42 papers), *International Journal of Pharmacy & Pharmaceutical Sciences* (41 papers each), etc. during 2007-16. Twenty nine papers have been identified as high cited, which received 100 to 868 citations; together they received 6792 citations, and averaged 234.21 citations per paper. These 29 high cited papers were contributed by 801 authors from 585 organizations across 62 countries. U.K. registered the highest participation (16

papers) in high cited papers, followed by Germany and France (10 papers each), USA and Sweden (9 papers each), Australia and Netherlands (8 papers each), Chile and Hong Kong (7 papers each), Brazil, Spain and New Zealand (6 papers each), etc. The 29 highly cited papers were published in 21 journals, with 4 papers in *The Lancet*, followed by 2 papers each in *Allergy: European Journal of Allergy & Clinical Immunology*, *International Journal of Pharmaceutics*, *Journal of Allergy & Clinical Immunology*, *The Lancet Respiratory Medicine*, *New England Journal of Medicine* and *Thorax* and 1 paper each in 13 other journals.

Conclusion

The Indian research output in asthma research is very small and also registered much lower citation impact compared to developed countries. In view of very large prevalence and mortality from asthma cases in India, the research efforts in the country are much less. Therefore, there is argent need to scale up the existing R&D efforts, both in terms of investment and involvement of more qualified and trained personnel. In addition, the government should invest more and encourage scientists to get involved in international collaborative projects and increase bilateral collaborative projects with leading countries in this area. Efforts should be made to recognize asthma as a disease of major public health importance. The national efforts should be made to increase public awareness of the disease to make sure patients and health professionals, recognise the disease and are aware of the severity of associated problems; organise and co-ordinate global epidemiological surveillance to monitor global and regional trends in asthma; develop and implement an optimal strategy for its management and prevention and stimulate research into the causes of asthma to develop new control strategies and treatment. In addition, India needs: (a) An up-to-date approach to the diagnosis and management of wheezing in young children, (b) Provide guaranteed access to quality-assured essential asthma medicines, (c) Provide effective policy action on known, remediable causes of asthma such as parental smoking (for children) and occupational exposures (for adults), (d) Increased capacity building of trained health professionals. This is vital and can be enabled by participation in research. Short courses in research

generally, or asthma research in particular, provide opportunities for 'up- skilling' in research for those with limited time and resources.

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