Review Article

India's Publications on Rheumatoid Arthritis: A Bibliometric Analysis of Research Output from 1994 to 2023 A.D.

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ABSTRACT

Background: Over the years, several studies have been conducted by utilizing bibliometric techniques to reveal research trends in various sub-fields of medical sciences, including arthritis research. Although no bibliometric study has been conducted at the global level on RA, bibliometric studies do exist in the Indian situation.

Methods: In this study, we examined the publications of Indian scholars on Rheumatoid Arthritis (RA) in the last three decades, using various quantitative and qualitative bibliometric indicators. The publications on RA (from 1994-2023) in the Scopus database were identified, analysed and evaluated using a pre-defined search strategy, and specialised software.

Results: 1603 papers were published on RA research that was cited 36814 times (averaging 11.48 citations per paper or CPP). The 18.65% and 16.71% of India's total publications indicated received external funding. The most productive Indian organizations were AIIMS, (New Delhi), SGPGIMS (Lucknow) and PGIMER (Chandigarh). The most impactful organizations were AMU (Aligarh), Fortis Healthcare Ltd. (Gurgaon), and Punjab University (Chandigarh). The most productive authors were A. Aggarwal, R. Misra, A. Chopra and U. Kumar. The most impactful authors were A. Aggarwal, A. Ghosh, S. Shankar, R. Misra. Medicine (64.2% share), Pharmacology, Toxicology and Pharmaceutics (22.0% share), Biochemistry, Genetics and Molecular Biology (19.8% share) and Immunology & Microbiology (12.8% share) contributed the most publications in this area. Clinical studies (40.9% share), pathophysiology (13.2% share) and the treatment outcome (9.0% share) accounted maximally. The most significant keywords appearing in the area were: "Rheumatoid Arthritis", "Methotrexate", and "Rheumatoid Factor".

Conclusions: This study provides insight into past, present, and future areas of India on research in RA and will help scholars identify the areas of collaboration.

Keywords: Bibliometric; highly cited papers; India; research; rheumatoid arthritis.

INTRODUCTION

Rheumatoid arthritis (RA) is a systemic autoimmune disease with potential multisystem involvement, with the main affection of multiple joints.[1-3] and often leads to joint deformation and functional limitations.[4,5] It is crucial to determine the global burden of RA, such as prevalence, incidence, and disability-adjusted life years (DALYs). In 2019, 18 million people worldwide were living with RA. The estimated prevalence of RA in India falls within the range of 0.3% to 0.75% of the total population, with the projected RA cases amounting to 36 million.[6]

Bibliometrics analysis is a powerful tool for understanding research trends and evaluating scholarly output. It uses statistical methods to analyze data about publications, such as articles, books, and conference proceedings. These studies can effectively reveal the research activity by analyzing publication volume over time to

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identify growing or declining research areas. Citation analysis reveals how often a work is referenced by others, indicating its impact within a field. In addition, they help to identify research collaborations between institutions and authors, and can track publication output of individual researchers or research groups.[7,8] Although, some bibliometric studies have been conducted to reveal research trends in various sub-fields of medical sciences, including arthritis. Still, no bibliometric study has been conducted at the global level on RA, and on India.[9-11] Keeping the significance of RA research in the Indian context, we decided to undertake a compressive bibliometric assessment of the core RA research papers from India that were published during the last 30 years (1994-2023). We also identified the core journals in the field of RA and studied the characteristics of highly-cited papers (HCPs).

METHODS

Publications data on RA from India was identified and retrieved from the Scopus database, from 01.01.1994 to 03.09.2023. From these records, complete bibliographical information was downloaded related to countries, institutions, journals, keywords, citation counts, collaboration, funding, and the document and source type. Data analysis was performed using Microsoft Excel and co-author and co-occurrence data visualization were conducted using VOSviewer (https://www.vosviewer.com) and Bibliometrix R (https://www.bibliometrix.org) software. The VOSviewer tool was utilized to visualize the co-authorship field or domains, aiming to explore collaborations and institutional influence within a specific research field.

The most impactful organizations and authors were considered those who have had the highest citation impact in terms of Citations Per Paper (CPP) and Relative Citation Index (RCI). The CPP is a metric used for the evaluation of the impact and quality of a scientific work , on average per publication. It is calculated by dividing the total number of citations by the total number of papers. The RCI is a citation-based metric that is used to measure the influence of a publication. It indicates how a publication has been cited relative to other publications in its co-citation network and this is assumed to be reflective of the article's area of research. The RCI is calculated by dividing the article citation rate by an expected citation rate that is derived from the performance of articles in the same field and benchmarked to a peer comparison group. The HCPs were considered those with 50 or more citations.

The following search strategy was used for the data search from the SCOPUS database:

(TITLE (rheumatoid AND arthritis) OR SRCTITLE (rheutmaid AND arthritis)) AND PUBYEAR > 1993 AND PUBYEAR < 2024 AND (LIMIT-TO (AFFILCOUNTRY, "India")). Only the articles in English with full available text were considered for this analysis.

RESULTS

Overall Picture

In all, 58982 and 1603 global and Indian papers were indexed on RA in the Scopus database from 1994 to 2023 till 3.9.2023. The global and Indian publications annually increased from 1044 and 8 in 1994 to 2203 and 115 in 2023 **(Table 1)**, registering annual average growth rates of 3.15% and 18.30%, respectively. India's global publication share was 2.72% and ranked at 12th position during 1994-2023, which increased from 0.97% during 1994-03 to 1.98% during 2004-13 and to 3.96% during 2014-23.

The quality and citation impact of Indian publications was measured by CPP. India's 1603 total publications on RA received 18467 citations, averaging 11.52 CPP. However, the citation impact of Indian publications had increased from 15.46 CPP during 1994-2003 to 16.30 CPP during 2004-2013 and then decreased to 9.42 CPP during 2014-2023 (due to lesser time and age of the publications in receiving the citations).

The 18.65% share (299) in 1603 Indian publications on RA received external funding support and together registered 4853 citations, averaging 16.23 CPP. The leading funding agencies were: the Department of Science & Technology (DST), India, and the Indian Council of Medical Research (ICMR) (n=53 each), Council of Scientific & Industrial Research (CSIR) (n=43), and University Grants Commission (UGC) (n=29). Among these external funding agencies, the largest CPP (34.70) was registered by NIH, USA-funded papers, followed by ICMR (17.49 CPP), and DBT, India (15.17).

Amongst 1603 Indian papers on RA, 268 (16.71%) were involved in international collaboration and together registered 4984 citations, averaging 18.59 CPP. Of the 268 Indian international collaborative papers (ICPs), 100 (37.64%) received external funding support and together received 2211 citations, averaging 22.11 CPP. The leading foreign countries participating in 268 Indian ICPs were: USA (103 papers, 38.43% share), U.K. (47

papers, 17.54% share), and Saudi Arabia (41 papers, 15.30% share). Among foreign countries participating in 268 India's ICPs, the highest citation impact was made by Japan (50.68 CPP), followed by the Netherlands (45.14 CPP), and South Korea (32.34 CPP).

Amongst 1603 Indian papers, 71.43% (n=1145) appeared as research articles, and 14.78% (n=237) as reviews. Only 1377 out of 1603 Indian publications reported the population age group, with the majority of the papers being published on adults and older people (94.14%) and the least on the paediatric population (5.86%). The clinical studies (40.86%) accounted for the largest group, followed by pathophysiology (13.23%), and treatment outcome (9.05%).

Distribution of Publication by Subjects

Broad Subjects

The 1603 Indian publications were classified by Scopus subject categories, which suggests that Medicine contributed the largest share (1029 papers, 64.19% share), followed by Pharmacology, Toxicology & Pharmaceutics (352 papers, 21.96% share), Biochemistry, Genetics & Molecular Biology (318 papers, 19.84% share), and Immunology & Microbiology (205 papers, 12.79% share). Among these subjects, immunology & microbiology registered the highest citation impact (17.35 CPP) and computer science the least (4.73 CPP).

Subject Keywords

In all 3078 keywords were identified by computer software from the 1603 RA publications from India. For co-occurrence analysis, the 62 important keywords were selected from 3078 keywords, having a frequency of 45 or more. The leading significant keywords were: "Rheumatoid Arthritis" (n=1501), "Methotrexate" (n=389), "Rheumatoid Factor" (n=236), "Antirheumatic Agents" (n=259), and "Inflammation" (n=212).

A co-occurrence network of selected keywords was created to identify thematic clusters as visualised in **Figure 1**, for providing insights into the main topics within the research field. Four clusters, represented by different colours, were finally identified, and Supplementary Table **1.** provides the details of the frequency and cluster numbers of these 62 keywords.

These keywords with the highest TLS collectively accounted for 22,852 cumulative link strengths, with the top 62 keywords contributing 1,755 of these links and forming three distinct clusters. **Figure 1** visually represents this co-occurrence network of the top 62 significant keywords, categorizing them into different clusters based on their relationships and frequencies.

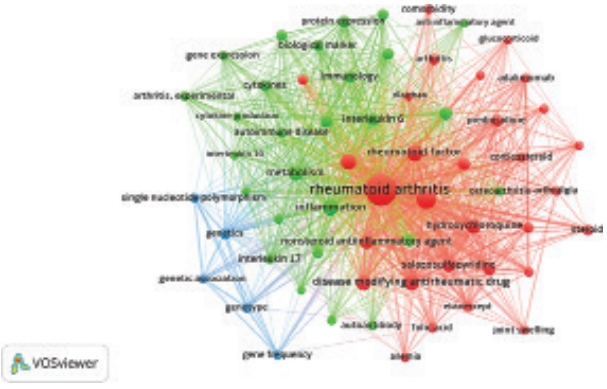

Figure 1: Co-occurrence Network of the Top 62 Significant Keywords

Most Productive & Impactful Organizations

In all, 354 organizations participated in Indian RA research. Individually, the top 30 organizations contributed 13 to 02 papers and collectively published 815 papers which received 11926 citations, forming 50.84% and 32.40% share respectively in India's total papers and citations. The top three most productive organizations were AIIMS, New Delhi (n=102), SGPGIMS, Lucknow (n=93) and PGIMER, Chandigarh (n=69) individually contributed more than the average publication productivity (27.17) of all 30 organizations. The most impactful organizations were AMU-Aligarh (52.14 and 4.54), Fortis Healthcare Ltd., Gurgaon (24.75 and 2.16), Punjab University, Chandigarh (24.0 and 2.09), IPGMER, Kolkata (22.25 and 1.94), and SGPGIMS, Lucknow (20.37 and 1.77) and individually registered CPP and RCI above the average citation impact (14.63 and 1.27) of all 30 organizations. The international collaborative share of the top 30 Indian organizations varied from 0.0% to 19.61%, with an average of 10.04%. **Table 2** presents the publication's profile of the top seven most productive and top 7 most impactful organizations.

The total link strength (TLS) of the top 30 organizations varied from 7 to 254, with the highest reported by SGPGIMS, Lucknow, followed by Chitkara University, Mohali, Punjab (n=230), and AIIMS, New Delhi (n=136), University of Delhi (n=94). It was also observed that AIIMS, New Delhi, SGPGIMS, Lucknow, PGIMER, Chandigarh and the University of Delhi were the top four most influential institutions with the largest number of co-authorship publications.

To explore the thematic clustering of the top 28 organizations, a co-author network was created using VOSviewer software, which can be visualised in **Figure 2**. This visualization indicates six clusters indicated below, represented by different colours. Within this co-authorship network, institutions such as AIIMS, New Delhi, and SGPGIMS, Lucknow, stand out with high TLS of 24 and 17, respectively. These institutions hold significant influence in the research domain and are part of clusters 3 and 1, indicating distinctive collaborative patterns.

Figure 2: Visualization of the collaboration network among the top 28 most productive organizations.

Most Productive and Impactful Authors

In all, 1766 authors participated in Indian RA research. Individually, the top 30 Indian authors contributed 11 to 56 papers. Collectively the top 30 authors published 584 papers which received 9158 citations, forming 36.43% and 24.88% share respectively in India's total papers and citations. **Table 3** presents the publication's profile of the top seven most productive and most impactful authors.

The collaboration network of these 30 authors was constructed using VOSviewer software, leading to the formation of 11 clusters, with only six clusters having three or more members. In **Figure 3** we present a network visualization of the top 30 collaborative authors out of a total of 1766. This network is segmented into nine clusters, each represented by a distinct colour.

Among these authors, Aggarwal A. stands out with the highest TLS of 51, signifying significant collaboration with other researchers and placing them in the highly collaborative Cluster 5. Similarly, Singh S. also demonstrates substantial collaboration, boasting a TLS of 53 and belonging to Cluster 3.

Most Productive and Impactful Journals

Amongst 1603 papers on RA research", 1543 were in journals. Among the top 30 journals, the *Indian Journal of Rheumatology* emerged as the most productive journal (n=122), followed by the *Journal of the Association of Physicians of India* (n=75), and *International Journal of Rheumatic Diseases* (n=57). In terms of citation impact, *Clinica Chimica Acta* registered the highest 94.57 CPP, followed by *Biomedicine & Pharmacotherapy* (44.71 CPP), *PLOS One* (42.06 CPP), and *Annals of Rheumatic Diseases* (33.36 CPP) (**Table 4).**

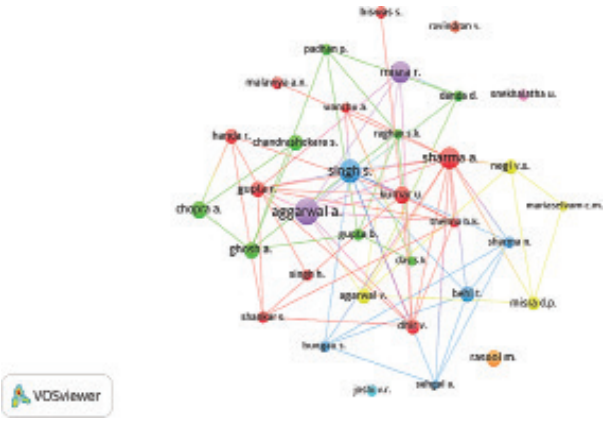

Figure 3: Collaborative mapping of the top 30 most productive authors with over ten articles

Figure 4. Cloud Map of Significant Keywords Appearing in 68 Highly Cited Papers

Highly-Cited Papers (HCPs)

Amongst, 1603 Indian papers on RA, only 68 (4.24%) registered 50 to 338 citations and assumed as HCPs in this study. Collectively, the 68 HCPs received 6361 citations, averaging 93.10 CPP. The 68 HCPs (comprised of 54 research articles and 14 reviews) involved the participation of a single organization (zero collaboratives) in 33 HCPs and the participation of 2 or more organizations in 34 HCPs (13 were National collaborations and 21 ICPs). Amongst the 21 ICPs from India, the largest foreign country participation (n=15)

was from the USA, followed by Japan (n=8), and Netherlands (n=7).

Among Indian organizations publishing HCPs, SGPGIMS, Lucknow contributed maximally with 8 papers, followed by AIIMS, New Delhi and AMU, Aligarh (n=6 each), and IPGIMER, Kolkata and Seth G.S. Medical College & KEM Hospital, Mumbai (n=3 each). The maximum HCPs were contributed by A. Aggarwal (n=7), followed by A.Q. Khan, S. Mateen and S. Moin (n=5 each), and R. Misra (n=4).

These 67 HCPs were published in 45 journals, with the maximum in the *International Journal of Rheumatic Diseases* (n=6). The clinical studies accounted for the largest share (37 papers), followed by pathophysiology (15 papers) in these 68 HCPs.

Table 5 outlines ten top HCPs that focused on RA. These papers offer valuable insights into various aspects of RA, from its treatment approaches to underlying pathophysiological mechanisms. Paper 1 was published in 2012, and stands out with an exceptionally high average CPP per year (28.58), signifying its substantial impact in the field.

For getting an idea about the research areas being currently pursued, a cloud word of keywords appearing in 68 HCPs is shown in **Figure 4**, which reveals that Oxidative stress and Methotrexate were the most significant keywords that appeared in these HCPs.

Table 1. Growth of Global and Indian Literature in Rheumatoid Arthritis during 1994-2023.

Year	Global	India				Year	Global	India			
	TP	TP	TC	CPP	%TP		TP	TP	TC	CPP	%TP
1994	1044	8	58	7.25	0.77	**2011**	2259	51	816	16.00	2.26
1995	1087	5	40	8.00	0.46	**2012**	2305	75	1470	19.60	3.25
1996	1098	16	262	16.38	1.46	**2013**	2402	65	668	10.28	2.71
1997	1076	11	201	18.27	1.02	**2014**	2489	84	1030	12.26	3.37
1998	1029	8	66	8.25	0.78	**2015**	2434	66	905	13.71	2.71
1999	1175	8	87	10.88	0.68	**2016**	2615	82	1676	20.44	3.14
2000	1112	11	185	16.82	0.99	**2017**	2724	123	1939	15.76	4.52
2001	1166	11	333	30.27	0.94	**2018**	2686	99	1067	10.78	3.69
2002	1296	14	130	9.29	1.08	**2019**	2875	109	1340	12.29	3.79
2003	1325	19	354	18.63	1.43	**2020**	2987	118	983	8.33	3.95
2004	1460	25	320	12.80	1.71	**2021**	3432	149	933	6.26	4.34
2005	1821	14	213	15.21	0.77	**2022**	3361	156	393	2.52	4.64
2006	1640	33	619	18.76	2.01	**2023**	2203	114	94	0.82	5.17
2007	1842	30	544	18.13	1.63	**1994-2003**	11408	111	1716	15.46	0.97
2008	1915	38	735	19.34	1.98	**2004-2013**	19768	392	6391	16.30	1.98
2009	2056	30	425	14.17	1.46	**2014-2023**	27806	1100	10360	9.42	3.96
2010	2068	31	581	18.74	1.50	**1994-2023**	58982	1603	18467	11.52	2.72

(TP: total Publication; TC: Total Citations; CPP: Citations Per Paper)

Table 2. Publication Profile of the Top Seven Most Productive and Most Impactful Indian Organizations in Rheumatoid Arthritis Research.

S.No.	Organization Name	TP	TC	CPP	RCI	ICP	%ICP	TLS
Most Productive Organizations								
1	All India Institute of Medical Sciences (AIIMS), New Delhi	102	1506	14.76	1.29	11	10.78	136

2	Sanjay Gandhi Postgraduate Institute of Medical Education & Research (SGPGIMS), Lucknow	93	1894	20.37	1.77	19	18.63	254
3	Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh	69	709	10.28	0.90	3	2.94	68
4	Vellore Institute of Technology (VIT), Vellore	39	704	18.05	1.57	8	7.84	23
5	Jawaharlal Institute of Postgraduate Medical & Research (JIPMER), Pondicherry	31	320	10.32	0.90	9	8.82	41
6	University of Delhi	29	489	16.86	1.47	7	6.86	94
7	Chitkara University, Mohali, Punjab	29	379	13.07	1.14	20	19.61	230
Most Impactful Organization								
1	Aligarh Muslim University (AMU), Aligarh	21	1095	52.14	4.54	5	4.90	26
2	Fortis Healthcare Ltd., Gurgaon	16	396	24.75	2.16	7	6.86	86
3	Panjab University, Chandigarh	18	432	24.00	2.09	6	5.88	54
4	Institute of Post Graduate Medical Education & Research (IPGMER), Kolkata	28	623	22.25	1.94	2	1.96	49
5	Sanjay Gandhi Postgraduate Institute of Medical Education & Research (SGPGIMS), Lucknow	93	1894	20.37	1.77	19	18.63	254
6	Manipal Academy of Higher Education (MAHE), Manipal	14	273	19.50	1.70	6	5.88	48
7	Sri Ramchandra Institute of Higher Education & Research (SRIHER), Chennai	16	311	19.44	1.69	2	1.96	26

TP= Total papers; TC=.Total citations; CPP=Citations per paper; RCI=Relative citation index; ICP= International Collaborative Papers; TLS=Total link strength

Table 3. Publication Profile of the Top Seven Most Productive and Most Impactful Indian Authors in Rheumatoid Arthritis Research.

S.No.	Name of the author	Affiliation of the author	TP	TC	CPP	RCI	ICP	%ICP	TLS
Top 7 Most Productive Authors									
1	A. Aggarwal	SGPGIMS, Lucknow	56	1544	27.57	2.40	14	25.00	322
2	R. Misra	SGPGIMS, Lucknow	41	960	23.41	2.04	3	7.32	111
3	A. Chopra	Bharati Hospital & Medical College, Pune	29	477	16.45	1.43	16	55.17	161
4	U. Kumar	AIIMS, New Delhi	27	576	21.33	1.86	4	14.81	170
5	A. Sharma	PGIMER, Chandigarh	25	163	6.52	0.57	2	8.00	198
6	T. Bahl	Chitkara University, Mohali, Punjab	23	296	12.87	1.12	18	78.26	293
7	V. Agrawal	SGPGIMS, Lucknow	22	321	14.59	1.27	3	13.64	188
Top 7 Most Impactful Authors									
1	A. Aggarwal	SGPGIMS, Lucknow	56	1544	27.57	2.40	14	25.00	322
2	A. Ghosh	IPGIMER, Kolkata	21	538	25.62	2.23	2	9.52	117
3	S. Shankar	AIIMS, New Delhi	13	323	24.85	2.16	3	23.08	86
4	R. Misra	SGPGIMS, Lucknow	41	960	23.41	2.04	3	7.32	111

5	B.K. Thelma	University of Delhi	12	266	22.17	1.93	3	25.00	74
6	M. Rasool	VIT, Vellore	22	474	21.55	1.88	5	22.73	46
7	U. Kumar	AIIMS, New Delhi	27	576	21.33	1.86	4	14.81	170

TP= Total papers; TC=.Total citations; CPP=Citations per paper; RCI=Relative citation index; ICP= International Collaborative Papers; TLS=Total link strength

Table 4. Publication Profile of Top seven Most Productive and Most Impactful Journals in India's Rheumatoid Arthritis Research.

S.No.	Name of the journal	TP	TC	CPP	%TP
Top seven most Productive Journals					
1	Indian Journal of Rheumatology	122	298	2.44	7.91
2	Journal of the Association of Physicians of India	75	360	4.80	4.86
3	International Journal of Rheumatic Diseases	57	914	16.04	3.69
4	Rheumatology International	43	602	14.00	2.79
5	Clinical Rheumatology	38	728	19.16	2.46
6	Indian Journal of Medical Research	23	282	12.26	1.49
7	Journal of Clinical & Diagnostic Research	21	172	8.19	1.36
Top seven most Impactful Journals					
1	Clinica Chimica Acta	7	662	94.57	1
2	Biomedicine & Pharmacotherapy	7	313	44.71	2
3	PLOS One	16	673	42.06	3
4	Annals of Rheumatic Diseases	14	467	33.36	4
5	Journal of Rheumatology	12	312	26.00	5
6	Clinical Rheumatology	38	728	19.16	6
7	Clinical & Experimental Rheumatology	9	170	18.89	7

TP= Total papers; TC=.Total citations; CPP=Citations per paper

Table 5. Profile of the top ten Highly Cited Papers.

Ranking of Paper	Publishing Year	Paper Title	Authors	Journal Title	Total Citations	Annual Citations Per Year	Citation Span Year
Paper 6	1997	Correlation between blood antioxidant levels and lipid peroxidation in rheumatoid arthritis	Gambhir J.K., et al.	*Clinical Biochemistry*	164	6.07	27
Paper 7	2001	Treatment of active rheumatoid arthritis with leflunomide: Two year follow up of a double blind, placebo controlled trial versus sulfasalazine	Scott D.L., et al.	*Ann. Rheum. Dis.*	161	7.00	23
Paper 5	2003	Antioxidant status in rheumatoid arthritis and role of antioxidant therapy	Jaswal S., et al.	*Clin. Chim. Acta*	199	9.57	21

Table 5. Profile of the top ten Highly Cited Papers.							
Paper 8	2008	Consumption of hydrolyzable tannins-rich pomegranate extract suppresses inflammation and joint damage in rheumatoid arthritis	Shukla M., et al.	*Nutrition*	151	9.44	16
Paper 4	2010	Work disability remains a major problem in rheumatoid arthritis in the 2000s: Data from 32 countries in the QUEST-RA Study	Sokka T., et al.	*Arthritis Res. Ther.*	207	14.79	14
Paper 1	2012	A randomized, pilot study to assess the efficacy and safety of curcumin in patients with active rheumatoid arthritis	Chandran B., Goel A.	*Phytother. Res.*	338	28.58	12
Paper 10	2012	Determinants of discordance in patients' and physicians' rating of rheumatoid arthritis disease activity	Khan N.A., et al.	*Arthritis Care Res.*	145	12.08	12
Paper 2	2016	Understanding the role of cytokines in the pathogenesis of rheumatoid arthritis	Mateen S., et al.	*Clin. Chim. Acta*	276	34.75	8
Paper 3	2016	Increased reactive oxygen species formation and oxidative stress in rheumatoid arthritis	Mateen S., et al.	*PLoS ONE*	260	32.63	8
Paper 9	2018	Experimental animal models for rheumatoid arthritis	Choudhary N., et al.	*Immunopharmacol. Immunotoxicol.*	143	24.33	6

DISCUSSION

This study analysed 1603 papers on Indian RA research publications that were listed in the SCOPSU database, during the period of 30 years (1994-2023). There was an increasing growth in the publications seen in these papers over 3 decades (**Table/Figure 1**). Their average CPP was 11.48 but increased substantially in the papers that received external funding (CPP- 16.23) and that were involved in international collaboration (CPP-18.59). External funding was received from national and international agencies in 18.65% of papers. Unlike other medical fields, a substantial number of Indian external funding agencies, namely DST, India and ICMR (n=53 each), CSIR (n=43), and UGC (n=29) supported research in the area of RA, leading to the output of 233 funded papers registering higher than average CPP of 14.04. A substantial share (16.71%, 268 papers) of the 1603 Indian publications on RA, were involved in international collaboration, registering a higher CPP of 18.59. Among foreign participating countries, Japan registered the highest citation impact (50.68 CPP), followed by the Netherlands (45.14 CPP), and South Korea (32.34 CPP).

The most researched age groups in RA were Adults and Older people and the Paediatric and Adolescent problems were studied much less (5.86%). Paediatric rheumatic diseases are an important cause of acquired disability in India, Southeast Asia and Asia-Pacific Countries. Hence there is more emphasis needed on the research in this area.[12] The Government institutions of India contributed maximally to RA research, with AIIMS, New Delhi (n=102), SGPGIMS, Lucknow (n=93) and PGIMER, Chandigarh (n=69) being the leading organizations. The most productive organization, in terms of impact, was also the Government institution i.e., AMU-Aligarh. Since a significant number of patients of RA are being treated in Private institutions in India, it is prudent that they also contribute useful research to enhance the knowledge and help current and future patient care.

The global ranking of India, in terms of the number of publications, is currently (in 2022) at number 13, and among Asian countries, it is at number 3 preceded by China and Japan and followed by South Korea and Taiwan.[13]

It was estimated that there was a 1.06-fold increase in RA global prevalence from 1990 to 2019.[14] In India, rheumatologic diseases affect 6%-24% of the population [15] and considering its 1.4 billion population there is a vast burden and load of RA and other arthritis.

The Rheumatology branch in India has been evolving in India with an acute shortage of Rheumatologist, considering its vast population.[16] Collaborative efforts to improve training, education and research can facilitate the future growth of Rheumatology in India.[17] Misra et al.[15] noted that the majority of publications on rheumatic diseases from India were on RA, lupus and osteoporosis, and the major collaborating Western nations were the USA, UK and France, and from Asia were Japan, Saudi Arabia and Singapore. We agree with the authors that there is a need to enhance collaborative research, to improve the quality and research output of Indian research. Western world celebrates the success of biological and other novel therapies, which is still not possible in most Asian countries, and hence much-needed assistance is needed to help them improve their standards of clinical practice and research.[18,19] Disease outcomes in India and other low-middle-income countries (LMIC) do not match those reported in high-income countries (HIC). To address the many problems of Rheumatology care in India, curricular reforms, capacity building, patient education and political support are urgently needed.[20] Since most of the research on RA has been done in HIC, the LMIC follow their guidelines, which are either difficult to meet or may not be relevant to their population. Hence, there is an unmet and urgent need for the LMIC to enhance their research in these fields to find cost-effective solutions for their population. Misra et al.[21] also echoed these sentiments of managing patients in a cost-constrained setting, optimizing the uniform government funding for healthcare, use of cheaper medicines, and devising innovative strategies to minimize the use of costlier drugs such as biologic disease-modifying agents.

In our analysis, we found 4.24% HCPs, that received 50 or more CPP (range 50-338), and they received a highly significant CPP of 93.1%, compared to an average of 11.48 CPP. Garg and Garg[11] also reported an average CPP, which is similar to our study. The HCPs have been published in a variety of subject areas.[22-25] These papers are different from 'ordinary' cited papers. The main characteristic features of the HCPs include being authored by a large number of scientists, which often involve ICPs, and the majority of these papers are research articles (81%) followed by review articles (12%). The HCPs receive citations from a large number of journals and papers representing both close and remote fields.[26] These unique characteristics of HCPs were also present in our bibliometric analysis.

There is paucity of bibliometric studies (from the Scopus) available from India and globally on RA. Gupta et al. [9] studied 1744 Indian publications on RA research from 2007-2016., and reported an annual average growth rate of 8.19% and an average CPP of 9.23. India's share in global output was found to be 3.05%. Amin et al.[10] examined India's publications on RA, from the Web of Science (WoS) from 2002 to 2021. Their analysis found a total of 2007 publications by 10993 authors, with a rate of 3.43% authors per document, and a steady growth with 6.61 publications per year. Garg & Garg [11] did a Scientometric analysis of Indian publications on RA during 2016 to 2021, from the Scopus database. The reported average CPP of 10.0, 61% had an international collaboration, and the top 10 HCPs received 7045 citations.

Bibliometric analysis is often been utilised for research analysis, to uncover emerging trends in article and journal performance, collaboration patterns, and research constituents, and to explore the intellectual structure of a specific domain in the existing literature.[27] Keywords are of utmost importance in research papers, through the analysis of keyword co-occurrence relationships, one can gain insights into the internal composition, connections, and structure of a particular academic domain, ultimately unveiling its research frontiers.[28] Collaborative mapping involves the creation of visual networks that portray author collaborations within a specific research field or domain.[29] This analysis provides valuable insights into the collaborative landscape among institutions within the field of research. Co-authorship analysis plays a vital role in assessing research quality within an academic discipline [30]

Being a bibliometric study, it suffers from the drawbacks and limitations of such a scientific study. Although, bibliometrics analysis is a valuable tool, but it should be used alongside other methods for a comprehensive understanding of research activity and impact and should not be taken as the sole measure of research quality. Their accuracy is higher when used to identify broad trends or compare publication activity across institutions or fields. It is less accurate for evaluating the quality of individual research papers or the impact of a specific researcher[7,8]

The reliability and reproducibility of findings in bibliometric studies are important aspects to consider when evaluating their credibility. The factors impacting reliability in bibliometric studies include search strategy, data collection and analysis methods. A clear and comprehensive search terms along with transparent inclusion/exclusion criteria ensure consistent retrieval of relevant publications. Using standardized procedures for data extraction from bibliographic databases

minimizes errors, and applying well-established methods and reporting them clearly allows for verification and potential replication. The challenges to reproducibility in bibliometric studies include database coverage, evolving search terms, and subjectivity in analysis etc. Different databases (like Web of Science, Scopus, Cochrane etc.) have varying coverage, potentially impacting the retrieved data. The field under study might require adjustments to search terms over time to capture the latest research. In addition, interpretation of results, especially in qualitative analysis of research themes, can introduce some level of subjectivity.[22-27]

We acknowledge that there may be some questions around the reliability of rankings of institutions and authors based solely on bibliometric studies. Bibliometrics often rely on citations or publications, which might favour large institutions with more resources and researchers. Moreover, collaborative research can inflate citation counts for institutions, not necessarily reflecting individual strength. Furthermore, self-citations by the authors may artificially inflate their h-index or other metrics .[31,32]

CONCLUSIONS

We studied 1603 Indian publications on RA over 30 years. There were 68 highly-cited papers. The articles that were funded and had international collaboration were more impactful and received a higher number of citations. All Institute of Medical Sciences, New Delhi was the most productive organization and Aligarh Muslim University was the most impactful organization. A. Aggarwal of SGIPGIMS, Lucknow was the most productive and impactful author.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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