

Original Article

The orthopedics and sports medicine research in India from 2013 to 2022: Comparison with South Asia, European Union, China, and USA

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ABSTRACT

Objectives: In the present study, we explored the research progress in Orthopedics and Sports Medicine within India and South Asia from 2013 to 2022.

Materials and Methods: In November 2023, the data were retrieved from Scopus databases. Key indicators such as the number of publications, citations, citations per paper, field-weighted citation impact (FWCI), and distribution across journal quartiles were analyzed.

Results: While India demonstrated a substantial contribution to the field, comparative analysis revealed it lags behind China, Europe, and the USA in both quantity and quality of research output. Specifically, India (6,498) and South Asia (6,983) exhibit lower scholarly outputs as compared with China (30,350), European Union (EU) (105,228), and the USA (100,041). Citations per publication reveal gaps, with the USA leading (17), followed by the EU (15.5), China (7.7), and India (7.6). FWCI placed the USA at 1.22, EU at 1.2, and lower values were noted for South Asia (0.74), India (0.70), and China (0.69).

Conclusion: The distribution across quartiles indicated that India and South Asia's comparatively lower emphasis on Q1 (21.30% and 21.72%, respectively), while the EU, China, and the USA demonstrated higher proportions (49.29%, 27.07%, and 53.05%). Conversely, in Q4, India and South Asia (15.04% and 14.87%) have higher concentrations, signaling a potential area for improving research quality. Recommendations include increased funding, interdisciplinary collaboration, investment in advanced technologies, and a focus on high-impact journals.

Keywords: Orthopedics research, Scopus, India, South Asia, European Union, China and USA

INTRODUCTION

Orthopedics and Sports Medicine (OSM) is a dynamic and multifaceted domain that intersects medicine, physiology, biomechanics, and rehabilitation.^[1] The ongoing research in OSM is pivotal for evidence-based practices, guiding patient care, and optimizing athletic performance.^[2,3] With the escalating prevalence of musculoskeletal disorders and sports-related injuries worldwide, the importance of cutting-edge research in OSM cannot be overstated.^[4]

Bibliometric analysis serves as a systematic tool for comprehensively understanding the scholarly landscape of OSM.^[5-8] By mapping the intellectual structure, identifying influential authors and institutions, and tracking emerging trends, bibliometric analyses offer valuable insights into research growth and impact, thus guiding future investigations and resource allocation.^[9-11]

The previous studies have delved into orthopedic research trends, particularly focusing on India, showcasing substantial contributions to the global orthopedic literature.^[9-11] However, a notable gap persists in systematically collected information concerning India's contributions to OSM. This study endeavors to bridge this gap by conducting rigorous bibliometric analyses, extending beyond India to encompass South Asian nations and European Union (EU) countries. This comparative analysis will not only shed light on regional and global trends but also evaluate India's position in the international OSM research landscape, juxtaposed with leading nations such as China and the USA. Understanding collaborative networks through bibliometric analyses aids in optimizing research strategies, fostering collaboration, and disseminating high-impact findings. This not only accelerates scientific progress but also informs clinical practice, ensuring that advancements in OSM translate directly into improved

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patient outcomes and enhanced sports performance.^[7,8] Through bibliometric analyses, researchers gain insights into the evolving landscape of OSM, identify key contributors and trends, and pave the way for future advancements. By conducting comprehensive analyses that extend beyond borders, this study aims to provide a holistic understanding of OSM research, thereby facilitating evidence-based decision-making and ultimately improving patient care and athletic performance on a global scale.

MATERIALS AND METHODS

The primary data source for this study is the Scopus database, a comprehensive bibliographic repository encompassing a vast array of scholarly publications across various disciplines. Scopus was chosen for its extensive coverage, including peer-reviewed journals, conference proceedings, and patents, making it a robust platform for conducting bibliometric analyses. The dataset is stratified based on geographical regions, allowing for a comparative analysis of OSM research output between India, Southeast Asian nations, EU countries, China, and the United States. All types of papers, for example, articles, reviews, books, and conference proceedings are included, ensuring a robust dataset. Following the identification of relevant publications, a structured data extraction process is implemented. The extracted information includes, but is not limited to, author names, affiliations, publication titles, publication dates, citation counts, and keywords. This comprehensive dataset forms the basis for subsequent analyses, allowing for a detailed exploration of publication trends, collaboration patterns, and thematic concentrations. The data retrieval process was conducted in November 2023, ensuring that the most recent publications are included in the analysis, thereby offering an up-to-date snapshot of the OSM research landscape within the specified time frame. Total publications for each continent and country are recorded, providing an overview of research output. We also presented the cumulative number of citations and citations per publication for each continent and country to assess the impact and visibility of research output. The field-weighted citation impact (FWCI) is determined by comparing the actual citation counts of publications to the expected citation rates within the field. This metric accounts for variations in citation practices across disciplines and provides a normalized measure of impact. The FWCI is provided for all nations/regions. This will help in understanding the relative research productivity and impact of OSM publications on a global scale. By adhering to these rigorous methodologies, we tried to provide a robust and insightful analysis of OSM research, unraveling trends and patterns within the context of India and its global counterparts.

RESULTS

India has significantly contributed to the OSM research landscape from 2013 to 2022, with a total scholarly output of 6498 papers with 49,625 citations and 0.7 the FWCI. The per year number of publications, citations, citations per publication, and FWCI are presented in Table 1. The distribution of OSM research publications across journal quartiles showcases a thoughtful and diversified approach adopted by Indian researchers. The quartile (Q1-Q4) details for all countries/regions are presented in Table 2.

The South Asian region, including India, Pakistan, Bangladesh, Nepal, Sri Lanka, Bhutan, and the Maldives, has made a significant scholarly impact on OSM with 6983 papers and 57,518 citations. The scholarly output, citations, citations per publication, and FWCI for each country are presented in Table 1. India leads with 6498 documents, followed by Pakistan, Nepal, Sri Lanka, Bangladesh, Bhutan, and Maldives. While India's commitment is commendable, South Asia as a whole exhibits a growing influence in OSM research.

The EU has published 105,228 scholarly documents in OSM with 1,629,655 citations and an average of 15.5 citations per publication. The scholarly output, citations, citations per publication, and FWCI for each EU country are presented in Table 1.

China has exhibited remarkable progress in OSM research, with a substantial scholarly output of 30,350 publications and 232,736 citations. But the FWCI ($n= 0.69$) was found to be below the global average. The per year number of publications, citations, citations per publication, and FWCI are presented in Table 1.

The United States has demonstrated exceptional strides in OSM research, with an extensive scholarly output totaling 100,041 publications and 1,696,792 citations. With a FWCI of 1.22, surpassing the global average, the USA solidifies its position as a leading force in global OSM research. The per year number of publications, citations, citations per publication, and FWCI is presented in Table 1.

A comparative analysis reveals that while India and South Asia have made significant contributions to OSM research, they lag behind the EU, China, and the United States in terms of scholarly output, citations, and impact metrics. This underscores the need for strategic enhancements to elevate the overall quality and impact of OSM research in India and South Asia.

DISCUSSION

India's significant scholarly output in OSM reflects a commitment to advancing knowledge in musculoskeletal health and sports-related medicine. However, the lower FWCI suggests the need for targeted strategies to enhance the

Table 1: The per year number of publications, citations, citations per publication, and FWCI for India, South Asia, European Union, China, and the USA.

S.N.	Region	Title	Overall	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1	India	Scholarly output	6498	437	408	431	549	511	535	613	966	1080	968
2	South Asia	Scholarly output	6983	469	438	456	572	547	579	671	1044	1156	1051
3	European Union	Scholarly output	105228	8492	9034	8997	9583	9949	10683	10842	11898	13019	12731
4	China	Scholarly output	30350	2143	2543	2604	2481	2292	2360	2954	3976	4349	4648
5	USA	Scholarly output	100041	7750	8379	8972	8926	9644	10119	10637	11577	12228	11809
1	India	Citations	49625	7671	5194	5033	6423	4946	5677	4305	5326	3450	1600
2	South Asia	Citations	57518	8103	5827	5286	6703	5519	6682	4884	9007	3695	1812
3	European Union	Citations	1629655	228933	229539	213244	201728	196979	174882	146660	122127	77283	38280
4	China	Citations	232736	22805	26092	26454	27050	25139	23981	28353	25880	17816	9166
5	USA	Citations	1696792	246352	254839	230903	211671	205302	183909	152150	114154	66691	30821
1	India	Citations per publication	7.6	17.6	12.7	11.7	11.7	9.7	10.6	7	5.5	3.2	1.7
2	South Asia	Citations per publication	8.2	17.3	13.3	11.6	11.7	10.1	11.5	7.3	8.6	3.2	1.7
3	European Union	Citations per publication	15.5	27	25.4	23.7	21.1	19.8	16.4	13.5	10.3	5.9	3
4	China	Citations per publication	7.7	10.6	10.3	10.2	10.9	11	10.2	9.6	6.5	4.1	2
5	USA	Citations per publication	17	31.8	30.4	25.7	23.7	21.3	18.2	14.3	9.9	5.5	2.6
1	India	FWCI	0.7	0.69	0.63	0.54	0.64	0.63	0.81	0.76	0.73	0.66	0.77
2	South Asia	FWCI	0.74	0.68	0.64	0.54	0.64	0.66	0.87	0.76	0.92	0.67	0.8
3	European Union	FWCI	1.2	1.13	1.13	1.16	1.18	1.2	1.16	1.21	1.25	1.23	1.32
4	China	FWCI	0.69	0.45	0.46	0.52	0.57	0.66	0.7	0.79	0.79	0.83	0.85
5	USA	FWCI	1.22	1.28	1.31	1.23	1.26	1.23	1.24	1.23	1.17	1.12	1.16

FWCI: Field-weighted citation impact

visibility and influence of Indian research. The distribution of publications across journal quartiles highlights the need for a balanced approach to disseminating research, aiming for both high-impact and inclusive journals. Collaborative endeavors among major contributors, such as the All-India Institute of Medical Sciences, New Delhi, are essential for strengthening institutional capacities and advancing the collective impact of Indian research. The collaborative efforts among South Asian countries offer opportunities for cross-border collaboration and shared advancements in OSM research. While India leads in scholarly output, the contributions of other South Asian nations are notable. Collaborative initiatives can leverage regional strengths and

address common challenges in musculoskeletal health- and sports-related medicine.

The EU's extensive scholarly output and high citation counts underscore the effectiveness of collaborative research efforts and investment in OSM. South Asian countries can draw lessons from EU's approach to enhance research quality, impact, and international collaboration. China's remarkable progress in OSM research highlights the importance of a robust research ecosystem and strategic investments in scientific endeavors. Despite a lower FWCI, China's growing influence in the field suggests opportunities for collaboration and knowledge exchange with South Asian

Table 2: The quartile (Q) details in Q1-Q4 for India, South Asia, European Union, China, and the USA.

S.N.	Region	CiteScore quartile (%)	Overall	Percentage
1	India	Q1 (top 25)	1300	21.30
2	South Asia	Q1 (top 25)	1426	21.72
3	European Union	Q1 (top 25)	49104	49.29
4	China	Q1 (top 25)	7971	27.07
5	USA	Q1 (top 25)	49687	53.05
1	India	Q2 (top 26–50)	1264	20.71
2	South Asia	Q2 (top 26–50)	1435	21.86
3	European Union	Q2 (top 26–50)	21716	21.80
4	China	Q2 (top 26–50)	6786	23.05
5	USA	Q2 (top 26–50)	23140	24.71
1	India	Q3 (top 51–75)	2620	42.94
2	South Asia	Q3 (top 51–75)	2727	41.54
3	European Union	Q3 (top 51–75)	18942	19.01
4	China	Q3 (top 51–75)	1969	6.69
5	USA	Q3 (top 51–75)	13283	14.18
1	India	Q4 (top 76–100)	918	15.04
2	South Asia	Q4 (top 76–100)	976	14.87
3	European Union	Q4 (top 76–100)	9857	9.89
4	China	Q4 (top 76–100)	12716	43.19
5	USA	Q4 (top 76–100)	7555	8.07

countries. The United States' exceptional strides in OSM research demonstrate the benefits of sustained investment in research infrastructure and scientific endeavors. South Asian countries can learn from USA's approach to foster innovation, collaboration, and impactful research outcomes in musculoskeletal health- and sports-related medicine. While India and South Asia have made significant contributions to OSM research, there are challenges to be addressed, including enhancing research quality, visibility, and international collaboration. Strategic initiatives focusing on research capacity building, funding allocation, and policy support can propel India and South Asia toward greater prominence in the global OSM research landscape.

The distribution of research publications across journal quartiles, particularly focusing on Q1 (top 25%), serves as a valuable indicator to depict the impact of research output. In the context of OSM, India and South Asia (SA) exhibited a percentage of 21.30 and 21.72, respectively, in the top quartile (Q1). While these figures suggest a commitment to publishing in high-quality journals, it is noteworthy that the EU, China, and the United States (USA) demonstrated more substantial or higher proportions at 49.29, 27.07, and 53.05, respectively. Higher percentages in Q1 reflect a greater emphasis on disseminating research in journals with superior impact factors and scholarly influence. This nuanced analysis underscores the need for India and South Asia to strategically enhance their presence in top-tier journals, aligning with global standards and contributing to the elevation of the overall quality and impact of OSM research in these regions. India and South Asia (SA) also demonstrated higher percentages (15.04 and 14.87,

respectively) in the lower quartile (Q4) as compared with the USA and EU. A higher concentration of papers in Q4 indicates a relatively lower emphasis on publishing in high-impact journals, suggesting a potential area for improvement in the quality of research output.

Elevating the quality and standard of OSM research in India and South Asia requires a multifaceted approach involving policy initiatives, infrastructure development, and a conducive research environment. The Indian government has consistently increased its investment in scientific research and development over the years. However, when compared to more developed or developing nations, the expenditure seems disproportionately small. According to Dr. Harsh Vardhan, the Minister of Health and Family Welfare, the Minister of Science and Technology, and the Minister of Earth Sciences, India's National Gross Expenditure on Research and Development in science and technology rose from Rs. 73,892.79 crore in 2012/13 to Rs. 1,04,864 crore in 2016/17. Despite this increase, the gross expenditure on R and D as a percentage share of India's GDP remains around 0.7%. This figure is notably lower compared to countries such as Israel, South Korea, Japan, Germany, the USA, France, the UK, and Canada. In fact, at 0.7% of GDP, India's R and D expenditure in science lags behind that of BRIC nations.^[12] Similarly, North America emerges as a frontrunner in research investment, contributing 29.2% of the world's total at 706.1 billion U.S. PPP dollars. Following closely is Europe, allocating 21.9% or 529.6 billion U.S. PPP dollars to research endeavors. East and Southeast Asia command the largest share, investing a substantial

36.8% (891.3 billion U.S. PPP dollars) of the global total. In contrast, the Middle East, South Asia, and other regions allocate comparatively smaller proportions. The Middle East contributes 3.4% (81.5 billion U.S. PPP dollars), and South Asia contributes 2.6% (63.8 billion U.S. PPP dollars), showcasing noteworthy but relatively modest investments. While these regions play crucial roles in the broader global research community, their smaller percentages indicate opportunities for increased research funding to bolster scientific and technological advancements.^[13]

Our study has some limitations, for instance, sole reliance on Scopus may lead to an incomplete representation of the research landscape. In addition, the study's timeframe from 2013 to 2022 may not capture all trends in OSM research. While key indicators such as publications, citations, FWCI, and journal quartiles were employed, they may not fully capture research quality and impact nuances. Future research is encouraged, which could address these limitations.

CONCLUSION

In OSM, while India made significant contributions, it falls behind China, Europe, and the USA in both quantity and quality of research output. This highlights the need for strategic initiatives and policies to improve research quality, as indicated by lower FWCI and distribution toward lower quartiles. Suggestions include increased funding, interdisciplinary collaboration, investment in advanced technologies, and focus on high-impact journals. Implementing these measures can bridge existing gaps, elevate research standing, and enhance contributions to the global discourse in OSM.

Ethical approval

Our study does not involve human or any living subjects. Therefore, ethical approval was not required.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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