Vol. 3, No. 1, 1-19. DOI: 10.47909/ijsmc.465

Pro-Metrics

ORIGINAL ARTICLE

International Orthopaedics journal: A bibliometric analysis during 1977-2022

Raju Vaishya[1], Brij Mohan Gupta[2], Mallikarjun Kappi[3], Abhishek Vaish[4]

[1] Department of Orthopaedics, Indraprastha Apollo Hospitals, New Delhi 110076, India.
Department of Orthopaedics, Indraprastha Apollo Hospitals, Sarita Vihar New Delhi 110076, India.
Email: raju.vaishya@gmail.com
Corresponding author.
[2] Formerly with CSIR-NISTADS, New Delhi 11012, India.
[3] Government First Grade College, Library and Information Centre, Jagalur - 577528, Davanagere Karnataka, India.
[4] Department of Orthopaedics, Indraprastha Apollo Hospitals, Sarita Vihar New Delhi 110076, India.

ABSTRACT

Objective. We aimed to examine the current research trends published by the International Orthopaedics (INOR) journal using bibliometric analysis.

Design/Methodology/Approach. Using the Scopus database, we have retrieved all articles published by the International Orthopaedics journal from 1977 to 2022. The key players, such as countries, institutes, and authors, were identified, and their collaborative linkages were analyzed using MS Excel and VOSviewer software.

Results/Discussion. We identified 7645 publications from 107 countries, of which 40 were from Europe and 32 from Asia. The most contributing countries were China, Germany, and France. The Netherlands, Canada, and Switzerland were the most impactful countries regarding citations. Hospital Henri Mondor (France) and IRCCS Rizzoli Orthopaedic Institute (Italy) were the most productive organizations. The most cited organizations were Harvard Medical School (USA) and Klinikum der Universität München (Germany). The most productive authors were Hernigou P (n=91) and Scarlat MM (n=56), and the most cited ones were *Mont MA* and *Rouard H*. The most active research areas were "Fracture Fixation" (n=1189), "Hip Arthroplasty" (n=1129), and "Osteosynthesis" (n=754). Hip received the most attention (n=2008), followed by Knee (n=1548), Spine (n=775), and Shoulder (n=517). 128 (1.67%) papers received >100 citations (high-cited papers or HCP) with an average of 150.11 citations per paper (CPP). *Giannoudis PV* and *Mont MA* published the maximum number of HCP.

Conclusions. INOR has become a popular destination for global Orthopaedic researchers and is publishing their research from all the continents. The total number of publications in it has been progressively increasing and is receiving a more significant number of citations, thus helping to improve the journal's ranking and reputation.

Keywords: International Orthopaedics journal; bibliometrics; scientific production, research trends.

Received: 09-02-2023. **Accepted:** 06-05-2023

Editor: Carlos Luis González-Valiente

How to cite: Vaishya, R., Gupta, B. M., Kappi, M., & Vaish, A. (2023). International Orthopaedics journal: A bibliometric analysis during 1977-2022. *Iberoamerican Journal of Science Measurement and Communication; 3*(1), 1-19. DOI: 10.47909/ijsmc.465

1. INTRODUCTION

Academic publications have a peer review system that maintains novelty, applicability and advancement in a given knowledge field. They make scientific results publicly available. Journals provide a communication channel for researchers within a field, a repository of significant research efforts, and a recognition mechanism for researchers and institutions. Publications form the basis for both new research and the application of findings. They can affect not only the research community but also, indirectly, society at large (Kaur, 2013).

In orthopedics, a large number of professional journals are currently published, which focus both on national and international publications. Journals vary in research coverage, scope and peer review mechanism in this field. Among the professional journals of international coverage, International Orthopaedics (INOR), the Official Journal of the *Société Internationale de Chirurgie Orthopédique et de Traumatologie (SICOT),* covers basic and clinical influential research and informed opinions in the field of orthopedics, with contributions from leading clinicians, researchers and organizations. The first volume of INOR was published in 1977 and had four issues, 57 papers and 344 pages. The journal was then published in French and English (Scarlat *et al.,* 2016).

INOR provides an international perspective to advance musculoskeletal system research, diagnoses, and treatment knowledge. Because of its extensive global coverage, it is considered an essential source for identifying global research players, their contributions, and their research focus areas (Int. Orthop, 2023). INOR is one of the top orthopedic and sports medicine journals globally and is indexed by all the major indexing bodies, like Medline, PubMed, Index Medicus, PubMed Central, Scopus and Web of Science. It has excellent journal metrics (as of 2021), viz. journal impact factor of 3.479 and journal citation indicator of 1.25 (Int. Orthop, 2023), CiteScore of 5.8 (Scopus, 2023), h-index of 96, and SCImago Journal Ranking of 57 (out of 294). Amongst Orthopedics and Sports Medicine journals, it stands in Quartile 1 (Q1) (SCImago, 2023).

A few past bibliometric studies have been published on the analysis of publications indexed in INOR. Stratos *et al.* (2021) analyzed bibliometric characteristics of orthopedic articles originating from Gramophone countries till November 24, 2020. Likewise, Mavrogenis *et al.* (2017) studied and categorized the most frequently cited articles published by INOR since its launch till November 2016, attempting to provide insights into which type of articles represent the highest academic impact. This study aims to study the bibliometric characteristics of 7645 orthopedic publications of INOR from 1977 to 2022.

2. METHODS

Since INOR is indexed in Scopus, we downloaded all data from the database from 1977 to 2022. The search strategy used was:

> SRCTITLE ("International Orthopaedics") AND PUBYEAR > 1976 AND PUBYEAR < 2023 AND PUBYEAR > 1976 AND PUBYEAR < 2023

We considered the following bibliometric indicators:

- the global contributions of various continents and countries and identify top countries,
- the major organizations and scholars and their contributions and research impact,
- the collaboration linkages among important contributing countries, institutions and scholars,
- the subject areas of research focus, and
- the research characteristics and trends of research as reflected in HCP.

All the required information was recorded and downloaded in MS Excel and CSV files for further statistical analysis. Publication data was further classified by research types and population age groups focused. The key players, such as countries, institutes, and authors, were identified, and their collaborative linkages were analyzed using MS Excel and VOSviewer software. The VOSviewer was used for institution collaboration maps and clustering analysis. In addition, various additional features available in Scopus were used to analyze data from different perspectives.

3. RESULTS

3.1. Publication trends

We found 7645 publications of INOR in the Scopus database. The annual growth of publications during the last 46 years (1977 to 2022) shows an increasing trend, which has increased from 43 in 1977 to 384 in 2022, witnessing an average growth rate of 7.98%. The annual average publications per year were 55.69 from 1977-1992, which increased to 102.6 during 1993-2007 and 347.67 during 2008-2022. The total INOR publications registered 149208 citations, averaging 19.52 per paper (CPP). The average CPP increased from 18.28 CPP during 1977-1999 to 19.83 CPP during 2000-2022 (Table 1).

Year	TP	TC	CPP	Year	TP	TC	CPP	Year	TP	TC	CPP
1977	43	221	5.14	**1993**	109	1436	13.17	**2009**	305	8938	29.30
1978	67	421	6.28	**1994**	87	2267	26.06	**2010**	225	8200	36.44
1979	35	712	20.34	**1995**	94	1764	18.77	**2011**	298	9980	33.49
1980	49	634	12.94	**1996**	80	1732	21.65	**2012**	399	11093	27.80
1981	46	748	16.26	**1997**	95	1875	19.74	**2013**	409	9980	24.40
1982	39	459	11.77	**1998**	107	3054	28.54	**2014**	407	9607	23.60
1983	39	459	11.77	**1999**	104	2280	21.92	**2015**	370	6896	18.64
1984	41	526	12.83	**2000**	82	1788	21.80	**2016**	364	6077	16.70
1985	56	1002	17.89	2001	120	3679	30.66	2017	346	5817	16.81
1986	46	817	17.76	2002	93	2676	28.77	2018	403	5085	12.62
1987	62	999	16.11	2003	100	2637	26.37	2019	364	4736	13.01
1988	58	913	15.74	2004	92	2550	27.72	2020	368	2828	7.68
1989	55	1329	24.16	2005	95	2302	24.23	2021	425	1519	3.57
1990	77	1246	16.18	2006	118	3591	30.43	2022	384	320	0.83
1991	91	1977	21.73	2007	163	5880	36.07	Total	7645	149208	19.52
1992	87	1769	20.33	2008	148	4389	29.66				

Table 1. Growth of Papers in the International Orthopaedics journal during 1977-2022.
Note: (TP- Total papers; TC- Total citations; CPP- Citations per paper).

3.2. Type of publications

The majority of 6273 publications (82.05%) were original research articles, followed by reviews (557), letters (515), editorials (103), erratum (86), conference papers (71), notes (34) and short surveys (6). Of the 7645 publications, 7513 (98.27%) were published in English and 141 in French. The majority of publications were related to the problems of adults (4541 papers, 59.4%), followed by aged (3186 papers, 41.67%), and middle-aged (3099 papers, 40.53%). The publications on pediatric problems in adolescents (1565 papers, 20.47%) and Children (893 papers, 11.68%) were lesser. However, there is substantial overlapping of papers among the various population age groups, as many scholars cover different age group populations in many papers together.

Among the research type, clinical studies account for the most significant number and share (4844 papers, 66.36% share), followed by treatment outcome (1028 papers, 13.45% share), pathophysiology (736 papers, 9.63% share), risk factor (550 papers, 7.19% share), epidemiology (433 papers, 5.66% share), complications (361 papers, 4.72% share), genetics (23 papers, 0.30% share), etc. Among the nature of studies, controlled studies account for the largest share (2346 papers, 30.69% share), followed by retrospective studies (1910 papers, 24.98%), procedures (1428 papers, 18.68%), prospective studies (864 papers, 11.30%), comparative studies (703 papers, 9.19%), case reports (478 papers, 6.25%), randomized controlled trials (282 papers, 3.69%) and clinical trials (274 papers, 3.58%), etc. Only 603 (7.89%) of 7645 publications received external support from more than 150 national and international funding agencies. China accounted for the largest number (253) of funded papers, followed by the USA (85) and Japan (65).

3.3. Geographical distribution

Authors from 107 countries contributed to the INOR, of which 40 European countries contributed maximally with 4175 papers (54.61% share), followed by 32 Asian countries (2777 papers; 36.32% share), 23 African countries (258 papers; 3.37% share), 11 South American countries (170 papers; 2.22% share), 3 North American countries (837 papers; 10.95% share) and 2 Oceania countries (124 papers; 1.62% share) (Figure 1). The 40 European countries together contributed 4175 papers (54.61%) and received 88758 citations, with an average of 21.26 CPP. Of these 12 countries contributed maximally (103 to 797 publications), and these were Germany (797 papers), followed by France (755 papers) U.K. (630 papers), and Italy (457 papers). Thirty-two Asian countries contributed 2777 papers (36.32%) and 47155 citations, averaging 16.98 CPP. The top 5 contributing countries were China (985 papers), Japan (577 papers, 7.55% share), India (339 papers, 4.43% share), South Korea (263 papers, 3.44% share) and Turkey (190 papers and 2.49% share). Three North American countries contributed 837 papers and received 19786 citations. The USA and Canada contributed 842 papers and received 20529 citations, with Canada registering 28.85 CPP, followed by the USA with 23.88 CPP. Compared to the share of papers, citations were higher in Europe, North America and Oceania and lesser in Asia, South America and Africa. In terms of RCI, the Oceania countries registered the highest 27.91 CPP, followed by 23.64 CPP by North America, 21.26 CPP by Europe, 16.98 CPP by Asia, 14.17 by South America, and 13.24CPP by Africa (Supplementary Table 1).

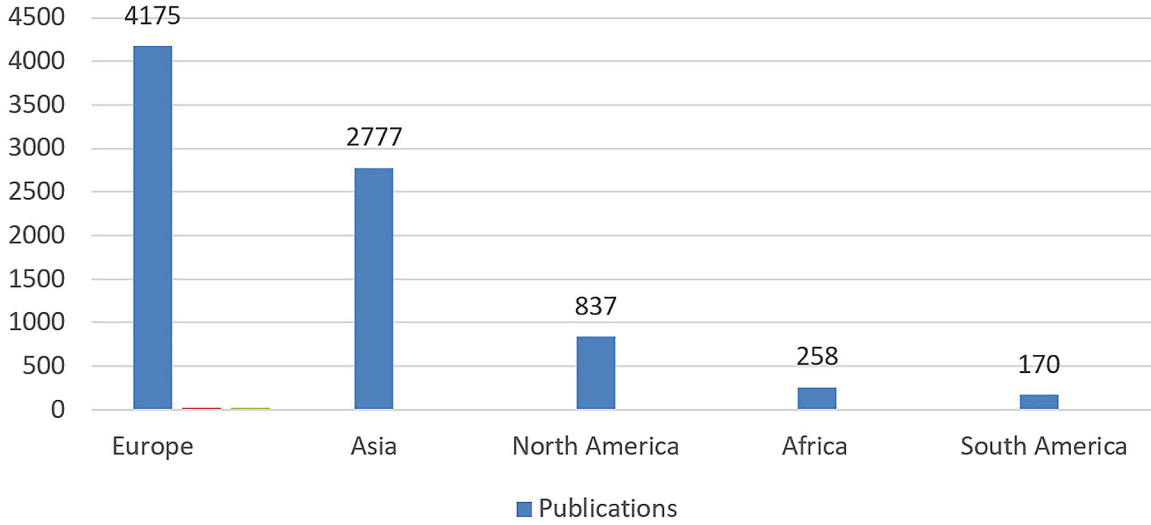

Figure 1. Major geographical distribution of the publications of International Orthopaedics, continent-wise.

3.4. Profile of top countries

The authors of 21 countries contributed 100 or more papers (range: 100 to 997), published 7482 papers, and received 151532 citations, constituting 97.87% and more than 100.0% share in global papers and citations. The bibliometric profile of the top eight most productive and impactful countries is detailed in Table 2. The most productive countries are considered with a maximum number of publications, and the most impactful being with the higher CPP and RCI.

3.4.1. Countries' collaboration

The top 21 most productive countries collaborated in global orthopedic research. The three top countries in terms of total collaborative link strength (TLS) were the USA (346 linkages), France (262), and Germany (242). The top 21 countries' collaborative network map is depicted in Figure 2, where all countries are shown in five main clusters (represented by different colors). The degree and strength of research collaboration can be gauged through the extent of the thickness of links and distance between countries in the collaboration map.

No.	Country	TP	TC	CPP	RCI	ICP	%ICP
Top 8 Most Productive Countries							
1	China	985	14713	14.63	0.75	92	9.23
2	Germany	797	18637	23.46	1.20	227	28.81
3	France	755	13699	18.53	0.95	245	33.56
4	USA	735	17549	23.96	1.23	350	48.21
5	U.K.	630	14437	23.02	1.18	229	36.76
6	Japan	577	11422	19.15	0.98	49	8.46
7	Italy	457	10282	22.94	1.18	142	31.98
8	India	339	4667	13.90	0.71	54	16.17
Top 8 Most Impactful Countries							
1	Netherlands	169	4985	29.50	1.51	34	20.12
2	Canada	107	2980	27.85	1.43	57	53.27
3	Switzerland	288	7248	25.17	1.29	25	8.68
4	USA	735	17549	23.88	1.22	350	47.62
5	Germany	797	18637	23.38	1.20	227	28.48
6	U.K.	630	14437	22.92	1.17	229	36.35
7	Italy	457	10282	22.50	1.15	142	31.07
8	Finland	98	2189	22.34	1.14	18	18.37

Table 2. Bibliometric profile of top 8 most productive and 8 most impactful countries.
Note: TP- Total papers; TC- Total citations; CPP- Citations per paper;
RCI- Relative Citation Impact; ICP- International collaborative papers.

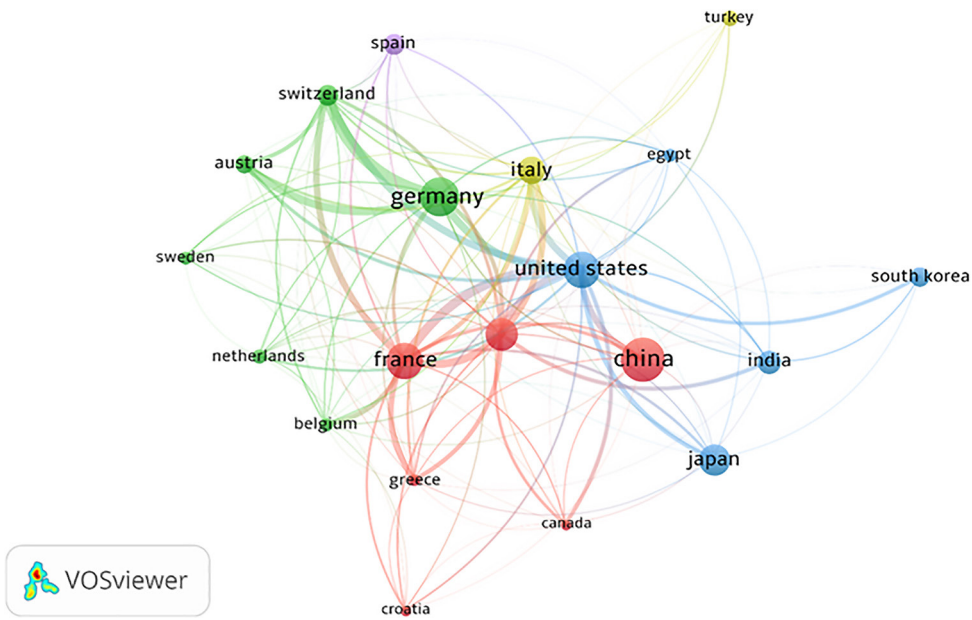

Figure 2. Top 21 countries' collaboration network.

3.5. Profile of top 50 organizations

The top 50 organizations individually contributed 31 to 98 papers and together contributed 2262 papers and 47216 citations, accounting for 29.59% and 31.64% share in publications and citations. Of the top 50 organizations, 8 (each) were from China and Germany, followed by France (5), USA and Austria (4 each), Hong Kong and Italy (3 each), Belgium and India (2 each), and 1 each from Croatia, Czech Republic, Greece, Egypt, Israel, Netherland, Sweden, Spain, Switzerland, Taiwan and U.K. Supplementary Table 2 lists the top 8 most productive and 8 most impactful organizations.

3.5.1. Institutional collaboration

Only 21 out of the top 50 most productive organizations collaborated among themselves in global orthopedic research; their collaborative linkages varied from 8 to 162 (see Figure 3). The top 3 organizations with the most collaborative TLS were: IRCCS Rizzoli Orthopaedic Institute, Bologna, Italy (162), Hospital for Special Surgery, New York, USA (161), and National and Kapodistrian University of Athens, Greece (138). The bilateral collaborative linkages between the top 50 organizations varied from 1 to 69. West China School of Medicine/West China Hospital of Sichuan University, China, Sichuan University, China, and France, registered the most collaborative linkages (34).

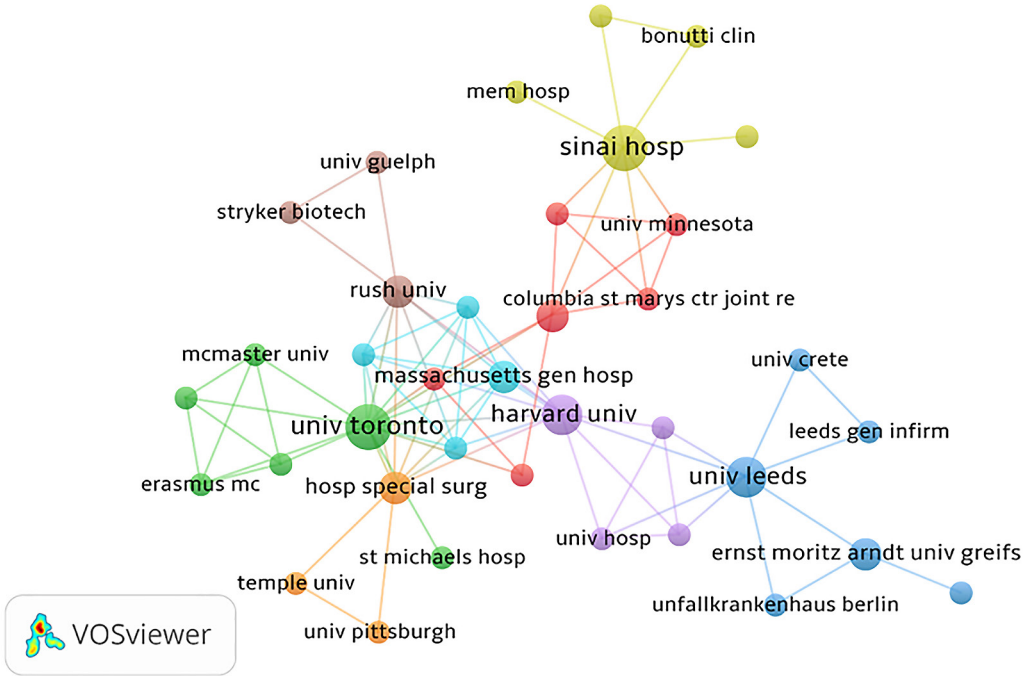

Figure 3. Map of institutional collaboration network.

3.6. Profile of top authors

The top 50 authors individually contributed 17 to 91 papers and together contributed 1295 papers and received 28428 citations, accounting for 16.94% and 19.05% share in the publications and citations. The bibliometric profile of the top 8 most productive and 8 most impactful authors is presented in Table 3.

3.6.1. Collaboration among Top 50 authors

Only 27 out of 50 authors collaborated among themselves (Figure 4). The maximum collaborative linkages were depicted by Hernigou, P. (272 linkages), Kurosaka, M (271 linkages), and Kuroda, R. (248 linkages). The bilateral collaborative linkages among the top 50 authors varied from 1 to 22, with maximum collaborative links (22 each) depicted by author pairs "M. Kurosaka and R. Kuroda" and "M.M. Scarlat and A.F. Mavgrogenis", followed by "P. Hernigou and A. Dubory" and "S. Imura and S. Baba" (20 linkages each).

3.7. Research distribution

3.7.1. Broad subject areas

More than 15000 author keywords were reported in 7645 papers published in INOR. From the author keywords, we have identified 128 subfields. Among the most productive 59 subfields (having contributed 100 to 1189 papers), the most significant contribution was made on Fracture Fixation (1189 papers), followed by Surgery (663 papers) and Osteosynthesis (754 papers) etc. (Supplementary Table 3). In terms of RCI, Bone Morphogenetic Proteins (BMP) registered the highest (43.9) CPP, followed by Bone Regeneration (31.9) and Osseointegration (27.99) etc.

No.	Name of the author	Affiliation of the author	TP	TC	CPP	RCI	ICP	% ICP
		Top 8 Most Productive Authors						
1	Hernigou, P.	Hopital Henri Mondor, France	91	1735	19.07	0.98	22	24.18
2	Scarlat, M.M.	Groupe ELSAN, France	56	497	8.88	0.45	43	76.79
3	Windhager, R.	Medizinische Universität Wien, Austria	43	841	19.56	1.00	5	11.63
4	Kurosaka, M.	Kobe University, Graduate School of Medicine, USA	37	1009	27.27	1.40	2	5.41
5	Mavrogenis, A.F.	National and Kapodistrian University of Athens, Greece	36	419	11.64	0.60	28	77.78
6	Grifka, J.	Universität Regensburg, Germany	34	868	25.53	1.31	6	17.65
7	Zhang, Y.	Hebei Medical University, China	32	410	12.81	0.66	0	0.00
8	Kuroda, R.	Kobe University, Graduate School of Medicine, Japan	29	793	27.34	1.40	1	3.45
		Top 8 Most Impactful Authors						
1	Mont, M.A.	Sinai Hospitalof Baltimore, USA	18	1128	62.67	3.21	2	11.11
2	Rouard, H.	Hopital Henri Mondor, France	19	835	43.95	2.25	4	21.05
3	Giannoudis, P.V.	University of Leeds, U.K.	26	1034	39.77	2.04	14	53.85
4	Tomita, K.	Kanazawa University, Japan	20	718	35.9	1.84	3	15
5	Vukicevic, S.	University of Zagreb School of Medicine, Croatia	20	698	34.9	1.79	7	35
6	Ferretti, A.	IRCCS Rizzoli Orthopaedic Institute, Bologna, Italy	26	905	34.81	1.78	3	11.54
7	Flouzat Lachaniette, C.H.	Hopital Henri Mondor, France	29	1002	34.55	1.77	3	10.34
8	Matsumoto, T.	Kobe University, Graduate School of Medicine, USA	18	616	34.22	1.75	2	11.11

Table 3. Bibliometric profile of top 8 most productive and top 8 most impactful authors.
Note: TP- Total papers; TC- Total citations; CPP- Citations per paper;
RCI- Relative Citation Impact; ICP- International collaborative papers.

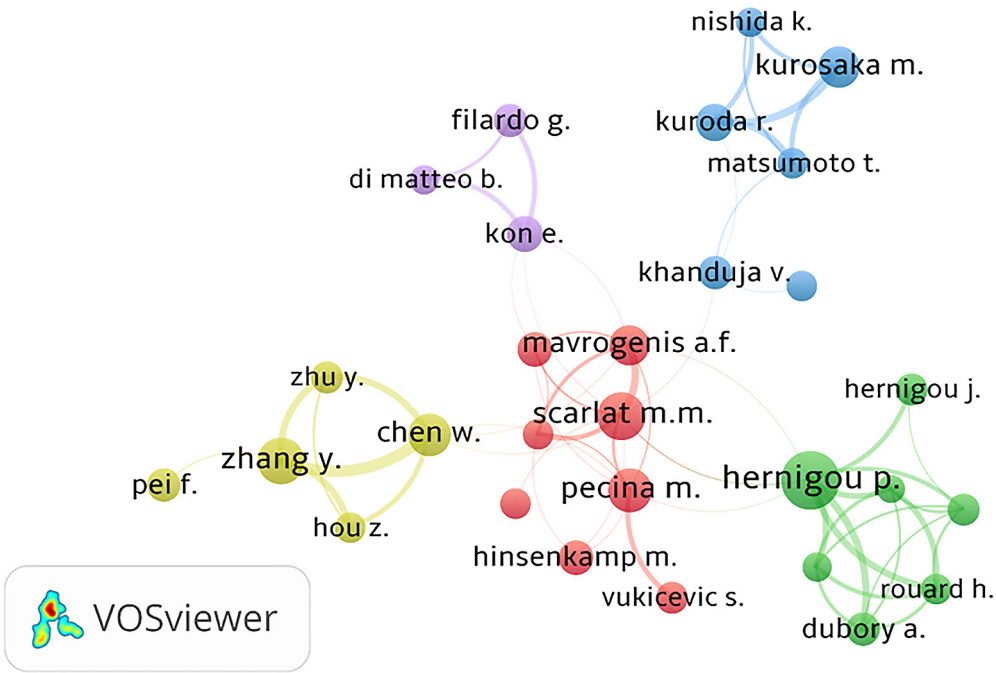

Figure 4. Top authors' collaborative linkages map.

3.7.2. Research distribution by anatomical sites

Hip received the most attention (2008 papers), followed by Knee (1548 papers), Spine (775 papers), Shoulder (517 papers), Leg (440 papers) etc. In terms of RCI, the papers on Knee registered the highest CPP (22.36), followed by Spine (21.74 CPP), Shoulder (19.71 CPP), Hip (19.24 CPP), etc. (Supplementary table 4).

3.7.3. Subject specialty wise

Among site-specific research, the major focus was on Arthroplasty, followed by Prosthesis, Osteoarthritis, Fractures, Dislocation, Injuries, Arthrodesis, Dysplasia, Diseases, Arthroscopy and Arthritis etc., as indicated below (Table 4).

No.	Keyword	TP	TC	CPP	No.	Keyword	TP	TC	CPP
					High Productive Areas				
1	Hip Arthroplasty	1129	23781	21.06	11	Spine/Spinal Fusion	267	7139	2806.74
2	Hip Prosthesis	777	16299	20.98	12	Hip Dysplasia	179	2691	15.03
3	Knee Arthroplasty	697	15760	22.61	13	Knee Injuries	168	5206	30.99
4	Total Hip Prosthesis	682	17973	26.35	14	Spine/Spinal Fracture	124	2284	18.42
5	Total Knee Arthroplasty	600	13676	22.79	15	Rotator Cuff	122	2669	21.88
6	Knee Osteoarthritis	517	13179	25.49	16	Hip Surgery	112	1965	17.54
7	Total Hip Arthroplasty	397	4956	12.48	17	Intervertebral Disc Degeneration	101	2427	24.03
8	Hip Dislocation	385	7241	18.81	18	Reverse Shoulder Arthroplasty	101	2219	21.97
9	Hip Osteoarthritis	317	6583	20.77	19	Rotator Cuff Rupture	100	2265	22.65
10	Hip Fractures	291	6106	20.98					

Table 4. Research distribution by subject-specific sub-fields in highly productive areas.

3.8. Highly-cited papers

Of the 7645 papers, 128 (1.67%) received 100 to 488 citations and were assumed to be high-cited papers (HCPs). These together received 19215 citations, averaging 150.11 CPP. These were published from 1984 to 2020 and increased from 16 during 1984-95 to 36 during 1996-2007 and 76 during 2008-2020. The annual growth of HCPs increased from 1 to 18 but showed fluctuating trends, with the largest numbers of HCPs (18, 16, 15 and 11) reported during 2010, 2011, 2019 and 2007 (Figure 5).

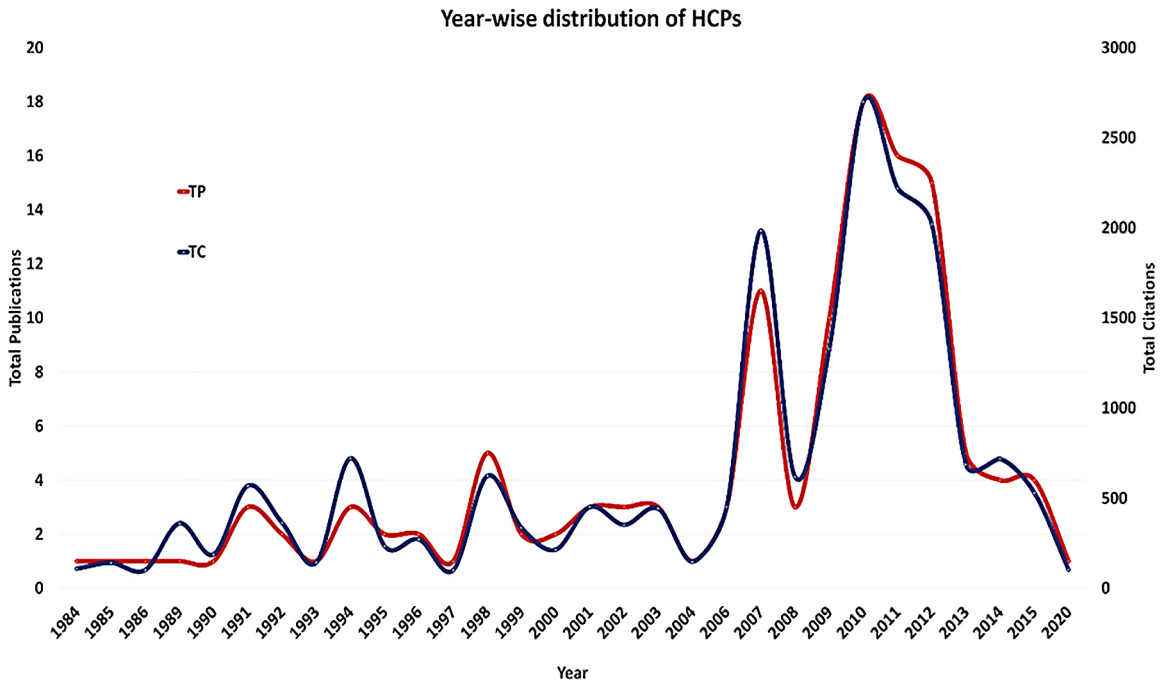

Figure 5. Annual growth and citations of highly cited papers.

The 128 HCPs comprised 89 research articles, 37 reviews, and 1 each conference paper and short survey. Of the 128 HCPs, only 13 HCPs received external funding support, 58 were involved in the participation of a single organization (zero collaboratives), and 70 papers had the involvement of 2 or more organizations (42 national collaboration and 28 international collaborations). The 28 ICPs together received 4003 citations, averaging 142.96 CPP.

3.8.1. Top countries

The authors from 65 countries participated in 128 HCPs, of which the USA contributed 28 papers, followed by Germany (n=16), France and the U.K. (n=15 each each) (Supplementary Table 5). Among top countries, Australia registered the highest RCI per paper (194.50), followed by the USA (163.89) and Italy (169.25). The USA was the leading country in 23 HCPs out of 128, followed by Germany (13 papers) and France (12 papers). Of the 65 countries, 23 participated in ICPs, with their TLS varying from 1 to 27. The highest TLS (27 with 15 countries) was reported by the USA, followed by Switzerland (20 with 12 countries) and France and Italy (13 with 10 countries each). The top 23 countries' network collaboration map is shown in Figure 6, which depicts them in various clusters represented by different colors.

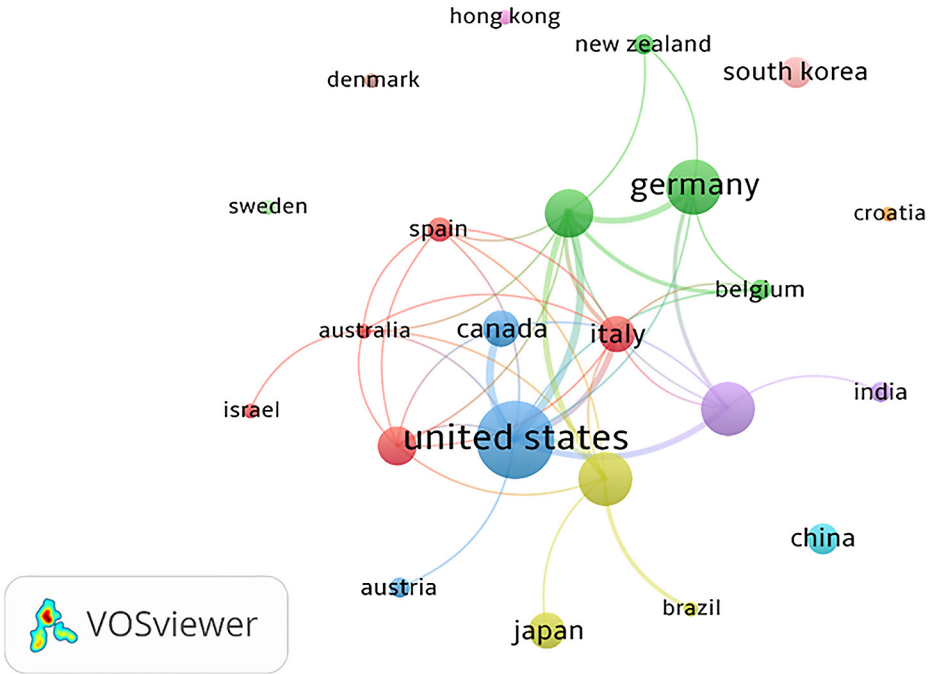

Figure 6. Top 23 countries' network collaboration map of highly cited papers.

3.8.2. Top 15 institutions

Among the top 15 organizations, the largest contribution was made by the University of Toronto (5 papers), followed by Sinai Hospital of Baltimore, USA, and University of Bern, Switzerland; Harvard Medical School, USA, and University of Leeds, U.K. (4 papers each). Among the top 15 organizations, Hopital Henri Mondor, France, registered the highest RCI per paper (195.5), followed by Thomas Jefferson University, and Rothman Institute, Philadelphia, USA (188.33). The University of Bern, Switzerland is among the top 15 was the most collaborative (TLS=23), followed by University of Toronto, Canada and Massachusetts General Hospital, USA (TLS=13 each); the University of Leeds, U.K. (TLS=11), etc. (Supplementary Table 6). The 37 institutions were connected (Figure 3), forming the top institutional collaboration network. All these 37 institutions are connected with 83 links, and 84 TLS and are divided into 8 clusters based on their similarities.

3.8.3. Top authors contributions

The 536 authors participated in 128 HCPs, of which 27 contributed 2 to 4 papers. Among these 27 authors, Giannoudis P.V. and Mont M.A. were the leaders with four publications each, followed by Farizon F. (3 papers) and the rest 2 papers each. In terms of citation impact, Parvizi J. lead in terms of CPP (217.5), followed by Chevallier N, Flouzat Lachaniette, C.H., Hernigou P. and Rouard H. (191 each), Mont, M.A (170.25) (Supplementary Table 7). The total collaborative linkages of the top 27 authors varied from 0 to 8, with the highest collaborative linkages (8) by Kubo S., Kuroda R., Kurosaka M., Matsumoto T., and Matsushita T (Figure 7).

3.8.4. Significant keywords

A total of 1,572 keywords were identified in 128 HCPs. The co-occurrence network of 53 selected significant keywords (Supplementary Table 8) was visualized and clustered (Figure 8) to discover the theme cluster indicated in various colors.

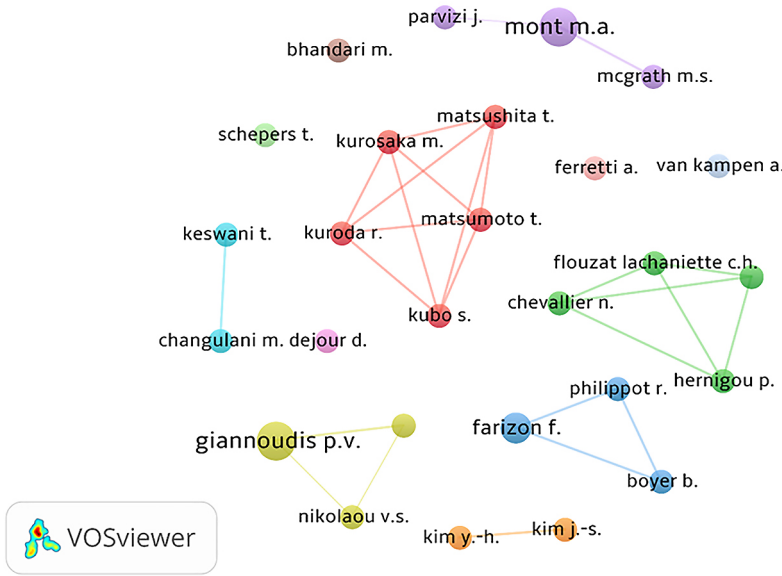

Figure 7. Most collaborative authors' co-authorship network.

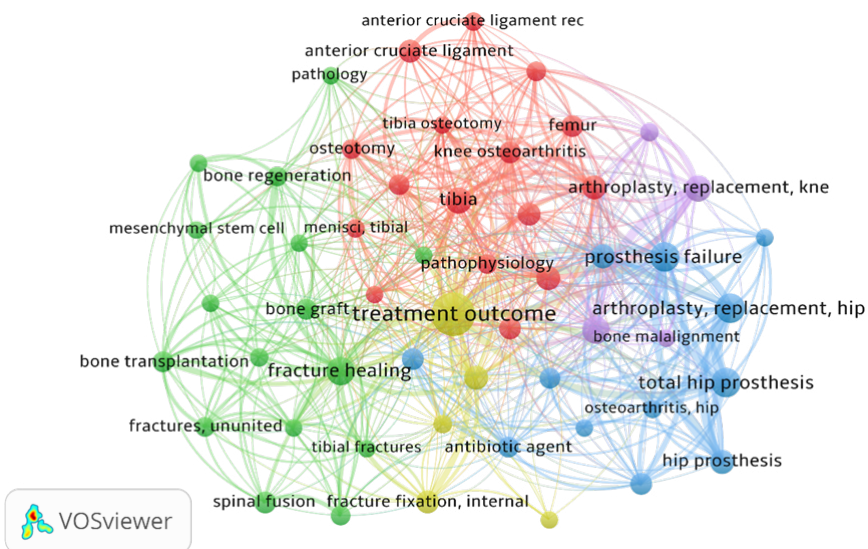

Figure 8. Keyword co-occurrence map.

4. DISCUSSION AND CONCLUDING REMARKS

INOR has provided a valuable research platform for global authors to publish their quality orthopaedic research. It has published articles on all major and sub-specialties of Orthopaedics, Traumatology, and Spine. Most of its publications were original research (82.05%) and review articles (7.28%), with a total of 89.33% share. Our bibliometric analysis revealed an average growth of 7.98% in the publications, with an average CPP of 19.52. The average number of publications in the last 15 years (2008-2022) has risen to 347.67 per year, compared to 55.69 publications per year in the first 15 years of its journey (1977-1992). There were authors from 107 countries and all the continents. Europe, Asia, and North America were the leading contributors, with Europe (54.61%) and Asia (36.22%) contributing to 90.93% of publications. However, the higher citations were received by the papers from Europe, North America and Oceania countries.

A journal's contribution to scientific literature and its impact on the scientific community is reflected by its citations (Vaish et al, 2023; Mavrogenis *et al.,* 2018). Articles related to trauma, arthroplasty, spine and shoulder were published maximally. A 2017 report found that 73% of the papers published in INOR were cited 701 times, with an average CPP of 2.75 (InCites JCR, 2018). The high percentage of citations of the INOR publications indicates its quality and popularity. Vishwanathan *et al.* (2021), in a bibliometric study of the top 50 most cited articles in the Journal of Orthopaedics and Trauma, noticed a steady increase in publications and citation counts. More than 80% of these articles were related to trauma and adult reconstruction. A similar trend was also noticed by us in the INOR publications.

This bibliometric study found the top countries to publish their research were China, Germany, France, the USA, the UK, Japan, and Italy. There was more research collaboration between the authors and institutions of these countries. More than 100 citations were received by 128 (1.67%) of INOR publications, receiving an average of 150.11 CPP, compared to an average of 19.52 CPP for all the publications. The majority of HCP (126/128) were original research (n=89) and review (n=37). Karlapudi *et al.* (2022) studied the Orthopaedic related publications by Indian authors and observed that the basic science related papers were more cited than the 'general category' articles. Similar to our study, Lao *et al.* (2013) reported a significant annual increase in Orthopaedic publications between 2000 to 2012 from the USA, Japan and China, with the USA contributing maximally at 35.3% of the total world output in orthopedics in 2012, and accumulated the highest number of citations. However, China has shown a significant increasing trend in their orthopaedic publications over the years.

Citations are often used to quantify the impact of publications and journals, and the HCPs are used as the indicators for measuring the quality. Several factors, like the number of contributing institutions and authors, area of subspecialty, and institution funding, influence the published research's citation rate. However, Movassaqi *et al.* (2019) did not find the level of evidence of an article being associated with higher citation rates (Movassagi *et al.,* 2019). However, Bozzo *et al.* (2017) found a 'citation skew' in the orthopaedic publications in an analysis of 74 journals. They reported that 85% of published articles were cited fewer times than the journal impact factor (JIF) would indicate. They further found that most of the orthopaedic publications are not cited in the first two years of their publications, and the JIF is the outcome of their HCPs (Bozzo *et al.,* 2017). Lum *et al.* (2019) pointed out that the sub-topics in the field develop more interest and may receive more citation counts. They noticed that the citation count was doubled with an increased rate of 172%, indicating the high volume of orthopaedic research published recently. The authors, however, cautioned that the number of citations of an article might not be an accurate indicator of its quality, nor may it help change the community's practice environment (Lum *et al.,* 2017). In addition, alternative metrics may create a greater impact on the published research, as was seen by Scarlat *et al.* (2015), where a bias was found in the publications of INOR between (a) the most cited papers, (b) the most downloaded papers, and (c) the publications with the most substantial social media impact.

The HCP's analysis has been done for many medical subjects and journals (Vaishya *et al.,* 2022; Vishwanathan *et al.,* 2021; Vaishya *et al.,*

2022) to gauge the impact and quality of the published research. In this bibliometric analysis, all the top 10 HCP (McKay *et al.,* 2007; Milachowski *et al.,* 1989; Valchanou *et al.,* 1991; Ulrich *et al.,* 2008; Tomita *et al.,* 1994; Amendola *et al.,* 2009; Hernigou *et al.,* 2014; Kurtz *et al.,* 2011; Kurtz *et al.,* 2011; Drobetz *et al.,* 2003)) were from the developed or High-Income-Countries (HIC), viz. Europe (n=60, USA (n=2), Japan (n=1), and ICP (n=1), and these were primarily original research (n=8) and review (n=2) articles. These top 10 HCP were published between 1989 and 2011 and received 229 to 486 citations. It is observed that the authors and institutions from HIC publish more scientific papers and are cited more. A study noted that the submissions from the USA were more accepted, ranked more favorably, and cited more than non-USA submissions (Link, 1998). The possible reasons for lesser and good quality research in the Lower- Middle-Income Countries (LMIC) could be due to a lack of adequate resources (academic, financial, collaborative etc.) (Rahman & Fukui, 2003).

Mavrogenis *et al.* (2017) analyzed the 'best' 100 papers of INOR based on their citations, which ranged from 62 to 272 and 26 papers received >100 citations. Our research has found such HCP to increase to 128 now (~5 times). The United States, Japan and Germany ranked as the top three countries of origin. The most common study type was case series; the most common topics were adult reconstruction, sports medicine and trauma. The results of our study also highlight that most papers were clinical studies, which may be because they are directly relevant to patient care. In contrast, basic research does not directly influence diagnosis or treatment. This study showed that among various research areas, the most frequently cited studies related to adult reconstruction, sports medicine and trauma. The fact that these areas are commonly represented in Orthopaedic literature may explain the increased interest in new knowledge and research. Hence, an increased tendency to generate research in a special scientific field is expected to come with a subsequent increase in citation rates (Mavrogenis *et al.,* 2018). In a bibliometric study, Vaish *et al.* (2022) recorded 179 Orthopaedic publications from India that received more than 50 citations. The engineering and technological institutes mainly contributed to these, focusing on the biomaterials and technology related to orthopedics, and suggested an urgent need to expand international and multidisciplinary collaboration to improve research output, impact and quality.

Research and publications across all medical and other specialities have been increasing, and Scientometric/bibliometric methods and indicators are useful measurement tools for academic productivity and research impact (Kaur, 2013). Similar to the present one, bibliometric studies help provide a glance at the prominent areas of medical research and obtain an overview of the landscape of the published literature (Kumar *et al.,* 2022). The Scientometric analysis is valuable for assessing the scientific validity of published articles in a journal (Masic, 2016).

INOR has become a popular destination for global Orthopaedic researchers and is publishing their research from all the continents. The total number of publications in it has been progressively increasing and is receiving a more significant number of citations, thus helping to improve the journal's ranking and reputation. It is a leading Orthopaedic journal, which has been publishing regularly for the last 46 years and has published 7645 papers until 2022, with an average citation per paper of 19.52 and 128 papers with more than 100 citations.

Contribution statement

RV: Conceptualization, literature search, writing and editing the manuscript, final approval, and submission.

BMG: Conceptualization, literature search, data curation, formal analysis, writing and editing the manuscript, final approval.

MK and AV: Literature search, data curation, formal analysis, writing and editing the manuscript, final approval.

Conflict of interest

The authors do not have any conflict of interest.

Statement of data consent

The numeric data generated through Python-based programs during the development of the study has been included in the manuscript. ●

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APPENDIXES

	Region	No. of countries	1977-92	1993-07	2008-22	TP	TC	CPP
1	Europe	40	541	865	2769	4175	88758	21.26
2	Asia	32	236	510	2031	2777	47155	16.98
3	North America	3	76	127	634	837	19786	23.64
4	South America	11	15	32	123	170	2409	14.17
5	Oceania	2	4	28	92	124	3461	27.91
6	Africa	23	29	58	171	258	3416	13.24
	TOTAL	**112**	**901**	**1620**	**5820**	**7645**	**149208**	

Supplementary Table 1. Distribution of global publications by continents.
Note: (TP- Total papers; TC- Total citations; CPP- Citations per paper)

S. No.	Name of the organization	TP	TC	CPP	RCI	ICP	%ICP
	Top 8 Most Productive Organizations						
1	Hopital Henri Mondor, France	98	1838	18.76	0.96	23	23.47
2	IRCCS Rizzoli Orthopaedic Institute, Bologna, Italy	96	2516	26.21	1.34	27	28.13
3	Medizinische Universität Wien, Austria	78	1701	21.81	1.12	12	15.38
4	Hebei Medical University, China	72	724	10.06	0.52	1	1.39
5	West China School of Medicine/West China Hospital of Sichuan University, China	71	1213	17.08	0.88	1	1.41
6	Sichuan University, China	70	1223	17.47	0.90	2	2.86
7	University of Zagreb School of Medicine, Croatia	68	1548	22.76	1.17	22	32.35
8	Hospital for Special Surgery - New York, USA	61	1700	27.87	1.43	28	45.90
	Top 8 Most Impactful Organizations						
1	Harvard Medical School, USA	42	1405	33.45	1.71	28	66.67
2	Klinikum der Universität München, Germany	40	1282	32.05	1.64	7	17.5
3	Leids Universitair Medisch Centrum, Netherland	31	983	31.71	1.62	5	16.13
4	Massachusetts General Hospital, USA	37	1172	31.68	1.62	22	59.46
5	Hôpitaux Universitaires de Genève, Switzerland	47	1429	30.4	1.56	20	42.55
6	The University of Hong Kong	33	975	29.55	1.51	11	33.33
7	Universität Heidelberg, Germany	52	1517	29.17	1.49	10	19.23
8	Sapienza Università di Roma, Italy	58	1634	28.17	1.44	7	12.07

Supplementary Table 2. Bibliometric profile of the top 8 most productive and top 8 most impactful organizations. Note: TP- Total papers; TC- Total citations; CPP- Citations per paper; RCI- Relative Citation Impact; ICP- International collaborative papers.

S. No.	Keyword Name	TP	TC	CPP	S. No.	Keyword Name	TP	TC	CPP
1	Antibacterial Agents	135	3412	25.27	31	Fracture Healing	575	14092	24.51
2	Antibiotic Agents	322	6847	21.26	32	Fracture Nonunion	396	7549	19.06
3	Antibiotic Therapy	180	3191	17.73	33	Fracture Reduction	173	3810	22.02
4	Arthritis	441	8758	19.86	34	Fracture, Ununited	144	3667	25.47
5	Arthrodesis	152	2656	17.47	35	Joint Instability	104	2843	27.34
6	Arthropathies	112	2015	17.99	36	Limb Salvage	114	2365	20.75
7	Arthroplasty	419	10317	24.62	37	Minimally Invasive Surgery	191	4335	22.70
8	Arthroscopy	369	7839	21.24	38	Open Fracture Reduction	147	3953	26.89

S. No.	Keyword Name	TP	TC	CPP	S. No.	Keyword Name	TP	TC	CPP
9	Autologous Transportation	172	4027	23.41	39	Orthopedic Surgery	386	5849	15.15
10	Avascular Necrosis	204	3545	17.38	40	Osteosynthesis	754	13463	17.86
11	Biomechanics	458	10321	22.53	41	Osseo integration	106	2967	27.99
12	Bone Cement	269	5772	21.46	42	Osteoarthritis	533	11706	21.96
13	Bone Development	103	2870	27.86	43	Osteolysis	270	6478	23.99
14	Bone Grafts	326	8152	25.01	44	Osteomyelitis	137	2577	18.81
15	Bone Morphogenetic Proteins	110	4829	43.90	45	Osteosarcoma	107	2164	20.22
16	Bone Necrosis	125	2498	19.98	46	Osteotomy	551	9071	16.46
17	Bone Neoplasms	294	6135	20.87	47	Periprosthetic Fracture	168	2608	15.52
18	Bone Regeneration	130	4147	31.90	48	Polyethylene	176	3794	21.56
19	Bone Remodeling	162	4409	27.22	49	Polyethylene	176	3794	21.56
20	Bone Transplantation	430	9831	22.86	50	Prosthesis	160	3404	21.28
21	Bone Tumors	177	3485	19.69	51	Prosthetic Design	582	13422	23.06
22	Cancer Surgery	108	2382	22.06	52	Prosthetic Infection	280	7474	26.69
23	Cementation	116	2839	24.47	53	Reverse Shoulder Arthroplasty	101	2219	21.97
24	Collagen	112	2712	24.21	54	Revision Arthroplasty	111	929	8.37
25	Computer-Assisted Surgery	145	3675	25.34	55	Rheumatoid Arthritis	163	3173	19.47
26	Debridement	298	7016	23.54	56	Rotator Cuff Rupture	100	2265	22.65
27	Decompression Surgery	139	3040	21.87	57	Surgery	663	9594	14.47
28	Diagnostic & Imaging	663	5466	8.24	58	Surgical Decompression	139	3040	21.87
29	Fraction Reduction	173	3810	22.02	59	Surgical Infection	295	5959	20.20
30	Fracture Fixation	1189	22736	19.12					

Supplementary Table 3. Most productive sub-fields in orthopaedic research (with frequency of occurrence from 100 to 1189). Note: TP- Total papers; TC- Total citations; CPP- Citations per paper.

S. No.	Organ Name	TP	TC	CPP	Europe	Asia	North America	South America	Pacific	Africa
1	Hip	2008	38641	19.24	1224	622	233	42	44	18
2	Knee	1548	34610	22.36	786	537	172	34	43	18
3	Spine	775	16852	21.74	275	443	73	12	5	15
4	Shoulder	517	10191	19.71	287	362	189	8	6	6
5	Leg	440	7933	18.03	252	179	39	5	9	5
6	Ankle	289	5253	18.18	156	110	41	7	1	4
7	Elbow	192	3009	15.67	94	80	25	10	0	2
8	Hand	122	1965	16.11	60	49	13	5	0	2
9	Wrist	119	1985	16.68	57	52	9	4	0	2
10	Foot	91	1368	15.03	55	28	9	5	0	1
11	Arm	58	1076	18.55	32	18				
12	Finger	46	576	12.52	23	13	8	2	0	4
13	Head	42	588	14.00	29	11	6	1	0	4
14	Skull	19	267	14.05	12	0	2	0	0	1
15	Thumb	18	252	14.00	9	10				

Supplementary Table 4. Distribution of literature by anatomical sites.

S. No.	Country	TP	TC	CPP	TLS	Cluster
1	United States	28	4589	163.893	27	Blue
2	Germany	16	2369	148.063	8	Green
3	France	15	2320	154.667	13	Yellow
4	United Kingdom	15	1942	129.467	11	Lavender
5	Switzerland	13	1918	147.538	20	Green
6	Netherlands	9	1466	162.889	9	Red
7	Canada	8	1127	140.875	6	Blue
8	Italy	8	1354	169.250	13	Red
9	Japan	8	1259	157.375	1	Yellow
10	China	6	940	156.667	0	Light Blue
11	South Korea	6	926	154.333	0	Coral Pink
12	Spain	4	612	153.000	6	Red
13	Austria	3	467	155.667	1	Blue
14	Belgium	3	384	128.000	5	Green
15	India	3	415	138.333	1	Lavender
16	New Zealand	3	342	114.000	2	Green
17	Australia	2	389	194.500	10	Red
18	Brazil	2	289	144.500	2	Yellow
19	Croatia	2	220	110.000	0	Orange
20	Denmark	2	277	138.500	0	Chocolate
21	Hong Kong	2	309	154.500	0	Light Pink
22	Israel	2	265	132.500	1	Red
23	Sweden	2	256	128.000	0	Light Green

TP=Total papers; TC=Total citations; CPP=Citations per paper; TLS=Total link strength

Supplementary Table 5. Most productive and collaborative countries in 128 highly cited papers.

No.	Institution	TP	TC	CPP	ICP	%ICP	TLS
1	University of Toronto, Canada	5	755	151.00	4	80.00	13
2	Sinai Hospital of Baltimore, USA	4	686	171.50	0	0.00	9
3	University of Bern, Switzerland	4	611	152.75	3	75.00	23
4	Harvard Medical School, USA	4	617	154.25	3	75.00	7
5	University of Leeds, U.K.	4	481	120.25	3	75.00	11
6	Massachusetts General Hospital, USA	3	392	130.67	3	100.00	13
7	Thomas Jefferson University, Rothman Institute, Philadelphia, USA	3	565	188.33	1	33.33	7
8	St Michael's Hospital, Toronto, Canada	2	346	173.00	1	50.00	4
9	Hospital for Special Surgery, New York, USA	2	226	113.00	1	50.00	6
10	Universita degli studi di Milano, Italy	2	266	133.00	1	50.00	4
11	University of Hong Kong	2	305	152.50	0	0.00	0
12	Hopital Henri Mondor, France	2	391	195.50	1	50.00	3
13	University of Zagreb, School of Medicine, Croatia	2	222	111.00	0	0.00	1
14	Leids Universitair Medisch Centrum, Netherland	2	323	161.50	0	0.00	1
15	Rush University Medical Centre, USA	2	283	141.50	2	100.00	7

Supplementary Table 6. Most productive and collaborative institutions in 128 HCPs.
Note: TP=Total papers; TC=Total citations; CPP=Citations per paper; TLS=Total link strength.

S. No.	Author	TP	TC	CPP	TLS	Cluster
1	Giannoudis P. V.	4	433	108.25	3	Yellow
2	Mont M. A.	4	681	170.25	3	Lavender
3	Farizon F.	3	471	157.00	4	Blue
4	Bhandari M.	2	298	149.00	0	Brown
5	Boyer B.	2	319	159.50	4	Blue
6	Changulani M.	2	303	151.50	2	Light Blue
7	Chevallier N.	2	382	191.00	6	Green
8	Dejour D.	2	313	156.50	0	Light Pink
9	Ferretti A.	2	238	119.00	0	Light Salmon
10	Flouzat Lachaniette C. H.	2	382	191.00	6	Green
11	Hernigou P.	2	382	191.00	6	Green
12	Kanakaris N. K.	2	218	109.00	3	Yellow
13	Keswani T.	2	303	151.50	2	Light Blue
14	Kim J.-S.	2	301	150.50	2	Orange
15	Kim Y.-H.	2	301	150.50	2	Orange
16	Kubo S.	2	301	150.50	8	Red
17	Kuroda R.	2	301	150.50	8	Red
18	Kurosaka M.	2	301	150.50	8	Red
19	Matsumoto T.	2	301	150.50	8	Red
20	Matsushita T.	2	301	150.50	8	Red
21	Mcgrath M. S.	2	233	116.50	2	Lavender
22	Nikolaou V. S.	2	200	100.00	2	Yellow
23	Parvizi J.	2	435	217.50	1	Lavender
24	Philippot R.	2	319	159.50	4	Blue
25	Rouard H.	2	382	191.00	6	Green
26	Schepers T.	2	240	120.00	0	Light Green
27	Van Kampen A.	2	239	119.50	0	Sky Blue

Supplementary Table 7. Most productive and collaborative authors in 128 highly cited papers. Note: TP=Total papers; TC=Total citations; CPP=Citations per paper; TLS=Total link strength.

No.	Keyword	Occurrence	TLS	Cluster	No.	Keyword	Occurrence	TLS	Cluster
1	Treatment Outcome	51	207	Yellow	28	Bone Regeneration	7	38	Green
2	Arthroplasty, Replacement, Hip	19	89	Blue	29	Fractures, Ununited	7	31	Green
3	Prosthesis Failure	19	116	Blue	30	Spine Fusion	7	27	Green
4	Total Hip Prosthesis	19	87	Blue	31	Knee Instability	7	43	Red
5	Fracture Healing	17	78	Green	32	Osteotomy	7	50	Red
6	Total Knee Replacement	16	73	Lavender	33	Pathophysiology	7	41	Red
7	Arthroplasty, Replacement, Knee	15	67	Lavender	34	Osteoarthritis, Hip	6	29	Blue
8	Tibia	14	86	Red	35	Bone Morphogenetic Proteins	6	22	Green

No.	Keyword	Occurrence	TLS	Cluster	No.	Keyword	Occurrence	TLS	Cluster
9	Hip Prosthesis	12	69	Blue	36	Knee Prosthesis	6	37	Lavender
10	Prosthesis Design	12	71	Blue	37	Anterior Cruciate Ligament Reconstruction	6	28	Red
11	Joint Instability	12	68	Red	38	Menisci, Tibial	6	22	Red
12	Osteoarthritis, Knee	12	73	Red	39	Weight Bearing	6	35	Yellow
13	Osteosynthesis	12	60	Yellow	40	Anti-Bacterial Agents	5	27	Blue
14	Biomechanics	11	32	Red	41	Polyethylene	5	31	Blue
15	Anterior Cruciate Ligament	10	36	Red	42	Autograft	5	32	Green
16	Fracture Fixation, Internal	10	39	Yellow	43	Bone Remodeling	5	27	Green
17	Debridement	9	44	Blue	44	Mesenchymal Stem Cell	5	12	Green
18	Osteolysis	9	46	Blue	45	Pathology	5	21	Green
19	Spinal Fusion	9	24	Green	46	Tibia Fracture	5	34	Green
20	Femur	9	38	Red	47	Tibial Fractures	5	29	Green
21	Knee Osteoarthritis	9	59	Red	48	Tissue Engineering	5	20	Green
22	Osteoarthritis	9	34	Red	49	Wound Healing	5	17	Green
23	Antibiotic Agent	8	48	Blue	50	Bone Malalignment	5	27	Lavender
24	Prosthesis-Related Infections	8	41	Blue	51	Deep Vein Thrombosis	5	34	Red
25	Bone Graft	8	50	Green	52	Tibia Osteotomy	5	42	Red
26	Bone Transplantation	8	41	Green	53	Hip Fractures	5	10	Yellow
27	Knee Injuries	8	38	Red					

Supplementary Table 8. List of 53 significant keywords occurring in 128 HCPs.
Note: TLS- Total Link Strength.