Review Article

The Global Research Landscape of Knee Osteoarthritis Pain Management: A Bibliometric Analysis

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ABSTRACT

Background

Knee osteoarthritis (OA) is a significant public health concern among the elderly due to the global aging population. It is a widespread and crippling type of joint ailment that results in pain and immobility for millions around the globe. Nonetheless, even with such treatments like medications and physical therapy, effective pain management remains a significant challenge. This study aimed to measure the quantitative impact of publications in knee OA and its pain management.

Materials and methods

Article titles from the Scopus database were screened as of March 31, 2024, utilizing keywords related to knee OA and pain management or conservative therapy. The documents underwent frequency analysis using Microsoft Excel, data visualization employing VOSviewer, and citation metrics analysis using Harzing's Publish or Perish software.

Results and discussion

A total of 1087 documents analyzed revealed a consistent upward trajectory in the number of publications focused on knee OA and pain management strategies since 1975 until March 2024. The United States of America (USA) ranked first as the leading contributor to research activity in this field. The analysis encompassed contributions from 160 scholars representing 77 countries and 160 institutions. The publications spanned articles in multiple languages and involved multiple authors. In terms of publication numbers, the top three institutions were the University of Sydney, the University of Melbourne, and Harvard Medical School.

Conclusion

This study provides a comprehensive bibliometric overview of the published literature on pain management strategies for knee OA patients over the past five decades. The findings underscore the need for future research efforts to prioritize the exploration of novel pain management approaches for individuals with knee OA, as well as elucidate the underlying mechanisms contributing to pain manifestation in this patient population. Continued interdisciplinary collaboration and knowledge dissemination will be crucial in advancing our understanding and management of knee OA-related pain.

Keywords

Bibliometrics; conservative therapy; knee osteoarthritis; pain management; VOSviewer

INTRODUCTION

Musculoskeletal disorders (MSD) affect over one billion people worldwide[1–3] and are associated with various disabilities, including OA, rheumatoid arthritis, gout, and lower back and neck pain[4]. Among MSDs, knee OA is particularly prevalent and ranked 38th out of 291 diseases in terms of overall burden measured by years of disability-adjusted life[5,6] It can be described as a multifaceted and intricate condition marked by the gradual deterioration

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of articular cartilage, subchondral bone sclerosis, and a significant contributor to pain and functional limitations, particularly among older individuals [7–9]. The condition hinders simple daily activities and contributes to work loss, declines in productivity, increases in healthcare spending[10], and major disabilities [11–13].

Due to its comparatively high prevalence and the significant impact of its symptoms, OA incurs substantial costs for both individuals affected by the condition and society [14,15]. The pain stemming from knee OA significantly diminishes the quality of life and imposes limitations on daily activities [16]. Moreover, knee OA can lead to the development of depression and anxiety [17,18] and impose a significant economic burden [19]. Although effective pharmaceutical treatments for pain and functional disability are limited, various non-surgical approaches such as physical therapy, weight loss, oral non-steroidal anti-inflammatory medications (NSAIDs), injections of corticosteroids or hyaluronic acid (HA), and shockwave therapy can significantly reduce pain and improve quality of life [20–24]. It is crucial to regularly update and adapt pain management strategies to ensure their efficacy.

A series of bibliometric analyses have shed light on the research trends and hotspots in knee OA. This allows researchers to quantify and analyze publications in a specific database [25]. Liu et al, conducted a bibliometric analysis of the global research status and trends related to unicompartmental knee arthroplasty (UKA) as a treatment for knee OA [26]. In extending the scope, the following studies suggested that there was an increasing focus of physical exercise in treating knee OA with leading authorities in the United States as well as the University of Melbourne[27]. Joshi et al, chose a different approach by assessing the effectiveness of research articles using the productivity of the physiotherapy treatments for knee OA[28]. Additionally, Chen (2022) examined the knowledge network and trends of knee OA with meniscectomy and stem cell therapy, demonstrating that there are various techniques for the treatment of this disease under research[29]. Joshi (2023) specifically studied the efficiency of research articles based on productivity concerning physiotherapy treatment[28], whereas Chen (2022) elaborated on the knowledge structure and research trends on knee OA with meniscectomy and stem cell therapy[30]. Altogether, these studies emphasize the global interest to investigate knee OA and the opportunities to develop new therapies. However, a comprehensive analysis of the broader landscape of knee OA and pain management research is lacking. To address this gap, the present study conducted an in-depth bibliometric analysis and network visualization of knee OA and pain management research published from 1975 to March 2024, utilizing the Scopus database. The research questions addressed in this study are as follows:

RQ1: What are the general descriptions of knee OA and documents related to pain management?

RQ2: What is the annual trend in knee OA related publications and pain management research?

RQ3: Who are the most prolific and collaborative authors in the field of knee OA research and pain management?

RQ4: Which countries/institutions are the most productive and collaborative in knee OA research and pain management?

RQ5: What are the most frequently referenced articles in knee OA research and pain management?

RQ6: What are the most relevant journals in the publication of knee OA research and pain management?

RQ7: What are the most frequently used keywords in research related to knee OA and pain management?

RQ8: What are the main themes in knee OA research and pain management and their evolution?

MATERIALS AND METHODS

Search Strategy

The Scopus database, known for its extensive collection of academic literature, includes over 25,100 active titles, 7000 publishers, 82 million documents, 17 million author profiles, 234,000 books, 80,000 institutional profiles, and 1.7 billion cited references across 240 fields. This database provides a comprehensive overview of global scientific research and is widely recognized as a primary source of information [31,32]. The materials for this study were sourced from the Scopus science database, a comprehensive scientific literature repository. To identify relevant publications, the keywords "knee osteoarthritis" AND "pain management" OR "conservative therapy" were utilized to screen articles based on their titles, without any language restrictions. Using the Scopus database, a bibliometric analysis of all types of publications related to knee OA and pain management was conducted covering the period from 1975 to March 2024. This

temporal scope allowed for the identification of long-term trends, influential work, and emerging themes in this critical area of medical research. To ensure the rigor of the analysis, two investigators independently reviewed each article to determine inclusion and exclusion. No articles were excluded if they related to OA of the knee and pain management.

Data Processing

Datasets from 1087 documents were exported into comma-separated values (CSV) and research information system (RIS) formats, as summarized in Figure 1. The year, country, source of publication, institution, and authors of each article were identified. After that, the statistical analysis was performed via Microsoft Excel 2019 (Microsoft, USA) to obtain the frequency and percentage for each publication and produce an appropriate graphical representation. Additionally, the VOSviewer (version 1.6.16) (Leiden University, Leiden, The Netherlands) was used to construct and visualize bibliometric networks, while Harzing's Publish and Perish open-source software was used to calculate citation metrics.

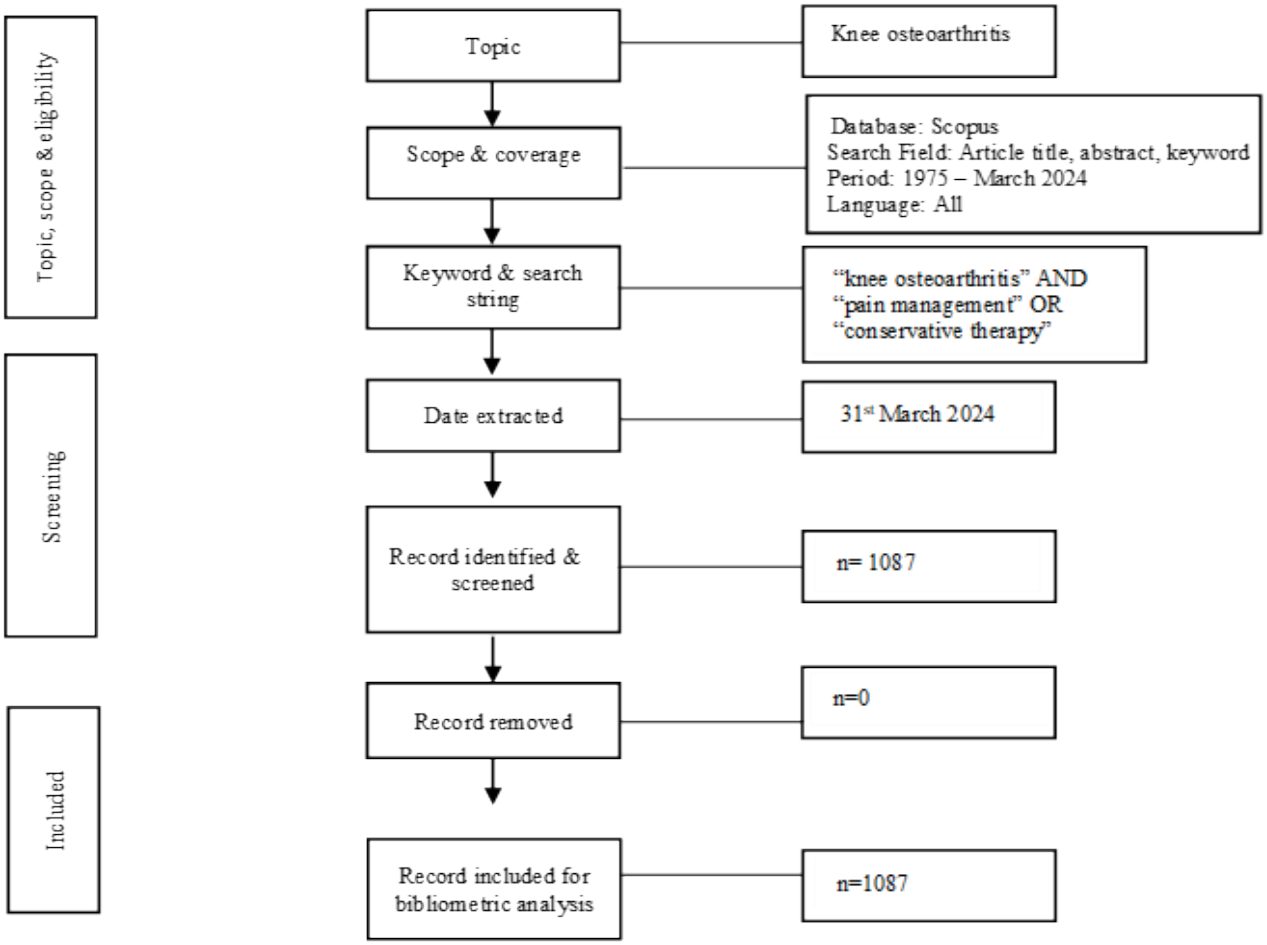

Figure 1 Flow diagram of the search strategy

RESULTS

General description related to knee OA and pain management documents:

The data were sorted based on type of document (original articles, reviews, letters, editorials, notes, conference papers, short surveys, and book chapters) and source (journals, books, book series, trade journals, and conference proceedings). Sweileh et al. [33] highlighted that conference papers might be categorized differently under document types compared to source documents. For instance, a paper presented in a conference is classified as a conference paper under the document type category. However, they can also be categorized as

a full journal article, conference proceedings, or book chapter depending on their publication status under the document source.

Table 1 provides a summary of the ten document types published on knee OA and pain management. More than half of the publications, specifically 799 documents (73.51%), were classified as articles. On the other hand, Table 2 illustrates the classification of documents into five sources: journals, books, trade journals, book series, conference proceedings, and one unidentified source. Journals serve as the primary source, accounting for 1073 documents or 98.71% of all publications.

Table 1 Document types

Document	Total publication	(%)
Article	799	73.51%
Review	221	20.33%
Letter	16	1.47%
Editorial	13	1.20%
Note	12	1.10%
Conference Paper	9	0.83%
Book Chapter	7	0.64%
Short Survey	6	0.55%
Erratum	2	0.18%
Book	1	0.09%
Retracted	1	0.09%

Table 2 Source types

Source	Total publication	(%)
Journal	1073	98.71%
Book	8	0.74%
Trade Journal	2	0.18%
Book Series	2	0.18%
Conference Proceeding	1	0.09%
Undefined	1	0.09%

According to the data presented in Table 3, the research papers focusing on knee OA and pain management were published in a total of 18 languages. English emerged as the most used language, accounting for 1028 (94.57%) of the documents. Additionally, publications were found in languages such as German, Chinese, Russian, Spanish, Japanese, French, Polish, and Portuguese. Conversely, the lowest percentage of publications was observed in Croatian, Czech, Dutch, Hebrew, Hungarian, Norwegian, Persian, Slovak, and Turkish.

Table 3 Languages used for publications.

Language	Total publication	(%)
English	1028	94.57%
German	18	1.66%
Chinese	13	1.20%
Russian	8	0.74%
Spanish	7	0.64%
Japanese	3	0.28%
French	2	0.18%
Polish	2	0.18%
Portuguese	2	0.18%
Croatian	1	0.09%
Czech	1	0.09%
Dutch	1	0.09%
Hebrew	1	0.09%
Hungarian	1	0.09%
Norwegian	1	0.09%
Persian	1	0.09%
Slovak	1	0.09%
Turkish	1	0.09%

The publications were also categorized based on the subject areas listed in Table 4. Medicine, health professions, biochemistry, genetics, and molecular biology were the top three subject areas for knee OA and pain management. Moreover, engineering, neuroscience, pharmacology, toxicology and pharmaceutics, nursing and immunology, and microbiology are among the subject areas that have significantly contributed to knee OA and pain management research.

Table 4 Subject area

Subject area	Total Publications	(%)
Medicine	976	89.79%
Health Professions	92	8.46%
Biochemistry, Genetics and Molecular Biology	58	5.34%
Engineering	50	4.60%
Neuroscience	46	4.23%
Pharmacology, Toxicology and Pharmaceutics	36	3.31%
Nursing	31	2.85%
Immunology and Microbiology	30	2.76%
Multidisciplinary	13	1.20%
Agricultural and Biological Sciences	8	0.74%
Chemical Engineering	8	0.74%
Environmental Science	8	0.74%
Computer Science	6	0.55%
Materials Science	4	0.37%
Social Sciences	3	0.28%
Chemistry	2	0.18%
Decision Sciences	2	0.18%
Earth and Planetary Sciences	2	0.18%
Economics, Econometrics and Finance	2	0.18%
Physics and Astronomy	2	0.18%
Psychology	2	0.18%
Business, Management and Accounting	1	0.09%
Dentistry	1	0.09%
Energy	1	0.09%
Veterinary	1	0.09%

Annual Publication Trends:

Table 5 details the statistics on annual publications related to knee OA and pain management from 1975 to March 2024. Based on the Scopus database, the first study on knee OA and pain management was conducted by researchers from Russia in 1975 with 2 citations. Furthermore, most articles in this field (132 documents) were published in 2020 (12.14%). Documents published in 2017 received the most citations (total citations = 2,943; average citation per publication = 37.25), while the documents published in 2001 were the least cited (each publication has the average number of citations). Figure 2 presents the total publications and citations per year.

Table 5 Publication trend

Year	TP	(%)	NCP	TC	C/P	C/CP	h	g
2024	22	2.02%	0	0	0.00	0.00	0	0
2023	98	9.02%	49	129	1.32	2.63	5	8
2022	79	7.27%	79	322	4.08	4.08	9	13
2021	123	11.32%	108	1464	11.90	13.56	19	33
2020	132	12.14%	123	1984	15.03	16.13	24	35
2019	99	9.11%	97	2568	25.94	26.47	28	44
2018	107	9.84%	99	2759	25.79	27.87	30	47
2017	80	7.36%	79	2943	36.79	37.25	30	53
2016	59	5.43%	58	2137	36.22	36.84	25	45
2015	50	4.60%	46	1678	33.56	36.48	24	40
2014	45	4.14%	38	1333	29.62	35.08	19	36
2013	44	4.05%	43	1537	34.93	35.74	24	39
2012	39	3.59%	36	1359	34.85	37.75	22	36
2011	23	2.12%	23	1077	46.83	46.83	15	23
2010	14	1.29%	13	315	22.50	24.23	10	13
2009	9	0.83%	8	179	19.89	22.38	5	8
2008	9	0.83%	9	660	73.33	73.33	7	9
2007	15	1.38%	11	477	31.80	43.36	8	11
2006	5	0.46%	5	588	117.60	117.60	5	5
2005	8	0.74%	7	224	28.00	32.00	5	7
2004	10	0.92%	6	282	28.20	47.00	5	6
2003	8	0.74%	7	328	41.00	46.86	5	7
2002	3	0.28%	3	35	11.67	11.67	3	3
2001	1	0.09%	1	1	1.00	1.00	1	1
2000	1	0.09%	1	21	21.00	21.00	1	1
1998	1	0.09%	1	12	12.00	12.00	1	1
1996	1	0.09%	1	13	13.00	13.00	1	1
1993	1	0.09%	1	198	198.00	198.00	1	1
1975	1	0.09%	1	2	2.00	2.00	1	1

Notes: TP = total number of publications; NCP = number of cited publications; TC = total citations; C/P =average citations per publication; C/CP = average citations per cited publication; h = h-index; g = g-index

Most productive authors:

Table 6 illustrates the contributions of 20 leading researchers on knee OA and pain management studies. Bennell, K. L. from Melbourne School of Health Sciences in Australia, is the most well-known author in this field with 25 publications. He is also the most-cited author with 882 total citations, an h-index of 16, and a g-index of 23.

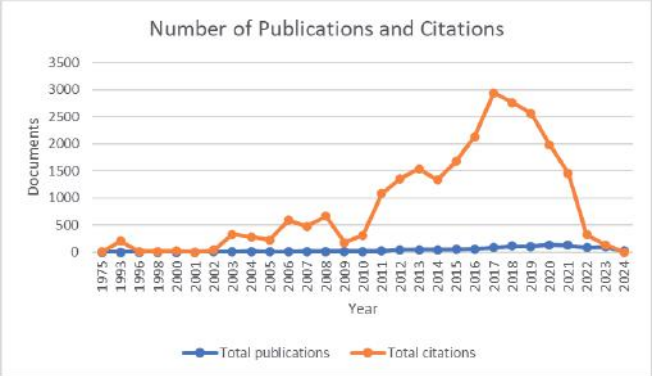

Figure 2 Number of publications and citations by year (1975 – March 2024)

Table 6 Authorship analysis

Authors name	Affiliation	Country	TP	NCP	TC	C/P	C/CP	h	g
Bennell, K.L.	University of Melbourne	Australia	25	23	882	35.28	38.35	16	23
Hunter, D.J.	University of Sydney	Australia	18	18	619	34.39	34.39	10	18
Hinman, R.S.	University of Melbourne	Australia	15	14	190	12.67	13.57	8	13
Arendt-Nielsen, L.	Aalborg University	Denmark	10	9	366	36.60	40.67	7	9
Kasza, J.	Monash University	Australia	10	10	346	34.60	34.60	7	10
Ahn, H.	Florida State University	United States	9	8	200	22.22	25.00	7	8
Allen, K.D.	University of North Carolina	United States	9	9	153	17.00	17.00	6	9
Oddone, E.Z.	Duke University Medical Center	United States	9	9	153	17.00	17.00	6	9
Coffman, C.J.	Duke University Medical Center	United States	8	8	147	18.38	18.38	6	8
Skou, S.T.	University of Southern Denmark	Denmark	8	8	234	29.25	29.25	7	8
Keefe, F.J.	Duke University	United States	7	7	283	40.43	40.43	6	7
Losina, E.	Boston University School of Public Health	United States	7	7	120	17.14	17.14	5	7
Roos, E.M.	University of Southern Denmark	Denmark	7	7	188	26.86	26.86	7	7
Bierma-Zeinstra, S.M.A.	University Medical Center Rotterdam	Netherlands	6	5	49	8.17	9.80	4	5
Bryant, C.	University of Melbourne	Australia	6	6	255	42.50	42.50	5	6
Doherty, M.	University of Nottingham	United Kingdom	6	6	222	37.00	37.00	4	6
Fillingim, R.B.	University of Florida	United States	6	5	86	14.33	17.20	3	5
Jüni, P.	University of Toronto	Canada	6	6	680	113.33	113.33	6	6
Katz, J.N.	Havard Medical School	United States	6	6	131	21.83	21.83	5	6
Miao, H.	Florida State University	United States	6	5	98	16.33	19.60	5	5

The VOSviewer software was utilized for co-author analysis and to examine the authors' collaboration [25]. Influential authors with more than five citations are used in this analysis and counted using the full count method. The color, circle size, font size, and thickness of the connecting lines denote the relationship between the authors. Generally, connected authors are grouped and displayed in the same color, as illustrated in Figure 3. For example, Bennel KL, Hinman RS, Kasza J, Byrant C, Ahmed Y and Keefe FJ worked closely, while the blue circles indicated the group of authors (blue) that had collaborated with Hunter DJ.

Figure 4 presents the network visualization of the authors' countries. The analysis only included countries that have cited more than three articles and have more than five citations. Based on the score-counting method, the USA is highly active in cooperating with other countries, particularly Egypt, Hong Kong, India, Japan, Jordan, Saudi Arabia, South Korea, and Taiwan. Meanwhile, China is highly collaborative with Ireland, Malaysia, Portugal, Thailand, Turkey, and United Kingdom.

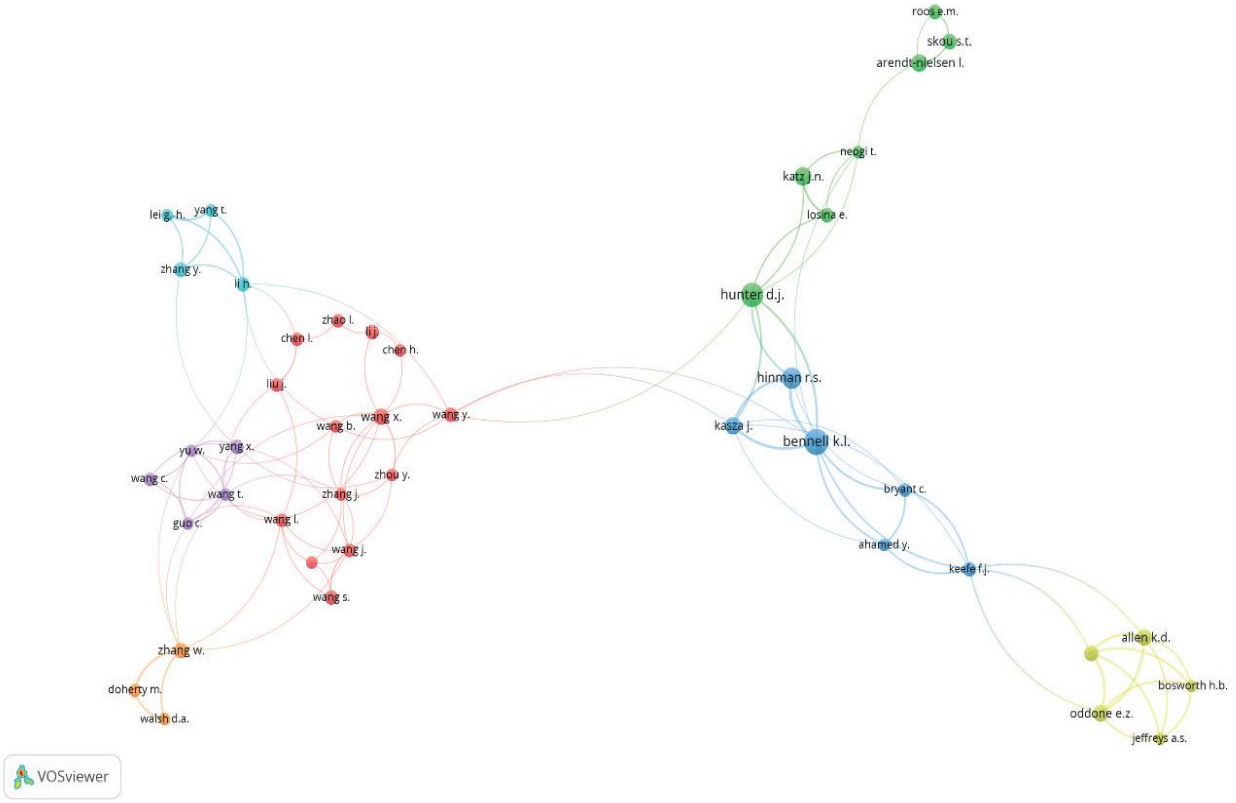

Figure 3 Network visualization map of co-authorship based on authors that have a minimum of five citations (full count).

Most productive countries:

This study also analyzed the present state of collaborations and identified the country based on the authors' affiliations. Table 7 exhibits the top 20 active countries contributing to knee OA and pain management publications in Scopus from 1975 to March 2024. Scholars from 77 countries have published on this research area; the USA ranked first with 367 documents (33.76%), followed by China (12.97%), Australia (7.73%), the United Kingdom (7.36%), and Canada (5.06%) (Figure 5).

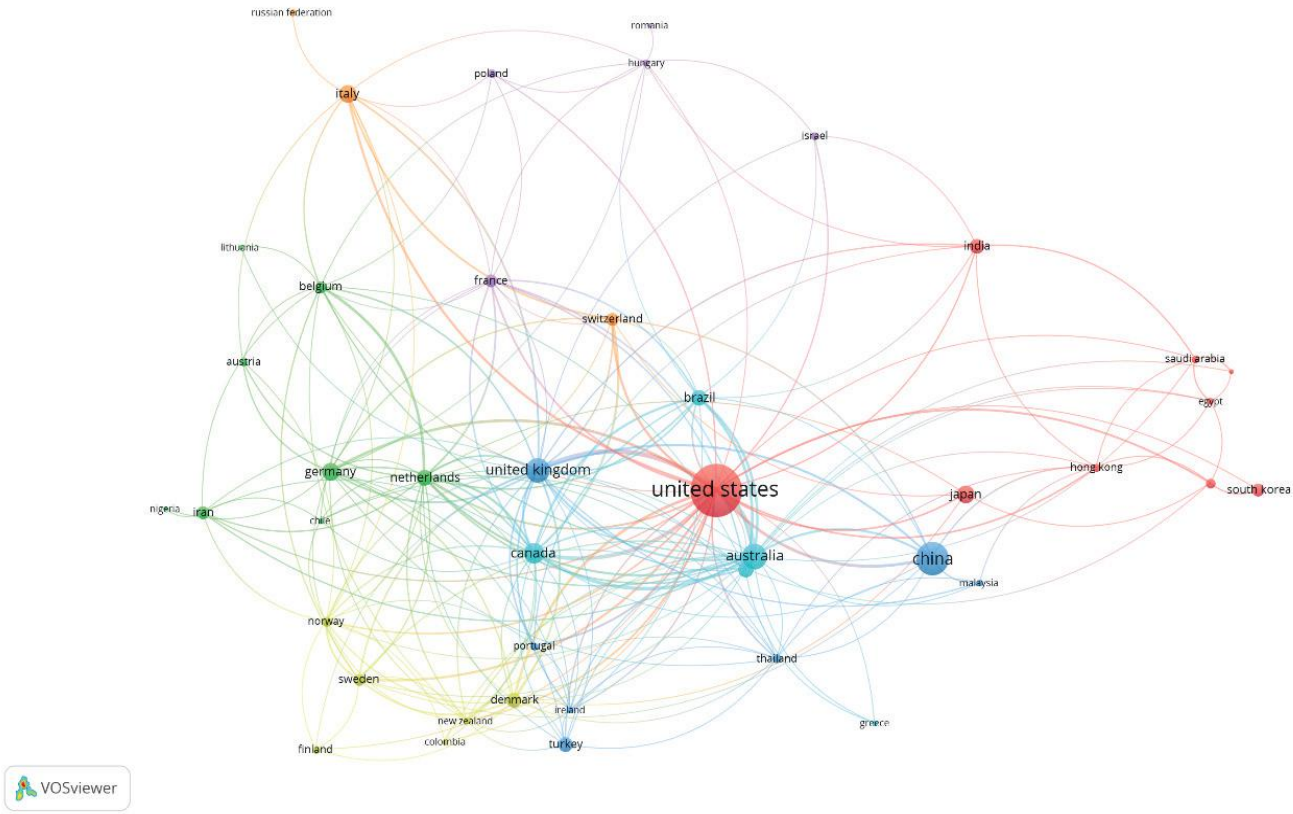

Figure 4 Network visualization map of co-authorship based on countries that have a minimum of five citations and three documents (full count).

Table 7 Top 20 contributing countries on knee OA and pain management publications

Country	TP	%	NCP	TC	C/P	C/CP	h	g	Continent
United States	367	33.76%	337	10296	28.05	30.55	52	82	North America
China	141	12.97%	117	2563	18.18	21.91	30	45	Asia
Australia	84	7.73%	81	3242	38.60	40.02	31	56	Oceania
United Kingdom	80	7.36%	75	2300	28.75	30.67	29	46	Europe
Canada	55	5.06%	48	2649	48.16	55.19	27	48	North America
Germany	44	4.05%	35	1429	32.48	40.83	15	35	Europe
Italy	44	4.05%	39	1288	29.27	33.03	20	35	Europe
Japan	42	3.86%	37	659	15.69	17.81	14	25	Asia
Netherlands	35	3.22%	33	1005	28.71	30.45	15	31	Europe
Brazil	34	3.13%	30	948	27.88	31.60	15	30	South America

Country	TP	%	NCP	TC	C/P	C/CP	h	g	Continent
Spain	34	3.13%	25	760	22.35	30.40	12	25	Europe
India	30	2.76%	24	344	11.47	14.33	10	18	Asia
Turkey	30	2.76%	27	447	14.90	16.56	14	20	Europe
Denmark	28	2.58%	27	834	29.79	30.89	17	27	Europe
Iran	24	2.21%	22	623	25.96	28.32	13	22	Asia
Switzerland	24	2.21%	19	1057	44.04	55.63	13	19	Europe
South Korea	23	2.12%	23	543	23.61	23.61	10	23	Asia
France	21	1.93%	21	946	45.05	45.05	14	21	Europe
Belgium	19	1.75%	16	514	27.05	32.13	10	16	Europe
Sweden	18	1.66%	14	615	34.17	43.93	10	14	Europe

Notes: TP = total number of publications; NCP = number of cited publications; TC = total citations; C/P = average citations per publication; C/CP = average citations per cited publication; h = h-index; g = g-index

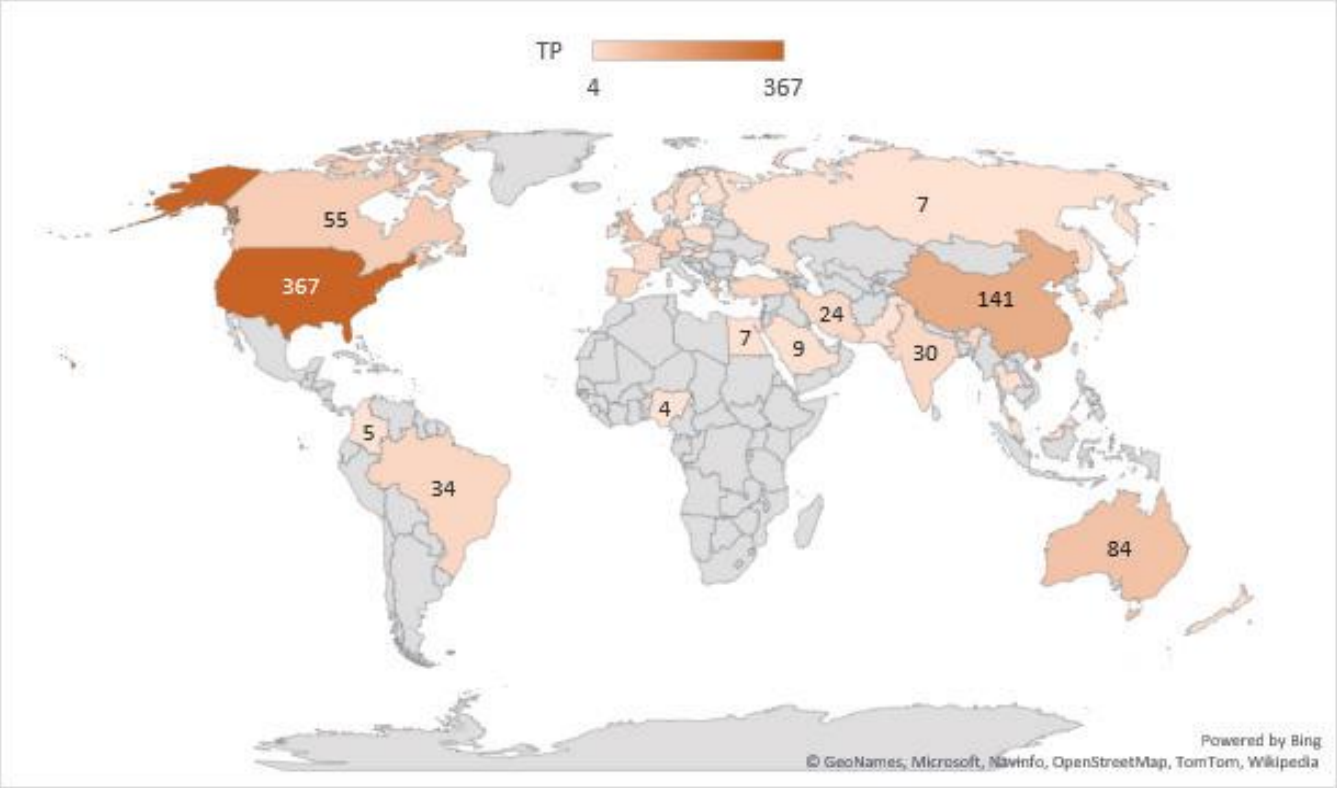

Figure 5 World map for the publication productivity of worldwide countries on knee OA and pain management. (TP= total publications)

Most productive institutions:

This section analyzed the research institutions currently active in knee OA and pain management studies. Table 8 displays the total number of publications produced by the top 20 institutions, with at least twelve publications. The University of Melbourne recorded the highest number of publications (n=32), followed University of Sydney (n=31) and Harvard Medical School (n=24).

Table 8 Top 20 research institutions on knee OA and pain management

Institution	Country	TP	%	NCP	TC	C/P	C/CP	h	g
University of Melbourne	Australia	32	2.94%	30	1240	38.75	41.33	20	30
The University of Sydney	Australia	31	2.85%	31	1450	46.77	46.77	19	31
Harvard Medical School	United State	24	2.21%	23	709	29.54	30.83	14	23
Monash University	Australia	21	1.93%	20	568	27.05	28.40	10	20
Northwestern University Feinberg School of Medicine	United State	19	1.75%	18	641	33.74	35.61	13	18
Brigham and Women's Hospital	United State	18	1.66%	18	407	22.61	22.61	11	18
University of Toronto	Canada	17	1.56%	16	1359	79.94	84.94	13	16
Duke University School of Medicine	United State	15	1.38%	15	390	26.00	26.00	11	15
The University of North Carolina at Chapel Hill	United State	15	1.38%	15	340	22.67	22.67	11	15
Royal North Shore Hospital	Australia	14	1.29%	14	485	34.64	34.64	8	14
Boston University Chobanian & Avedisian School of Medicine	United State	13	1.20%	11	697	53.62	63.36	9	11
The University of British Columbia	Canada	13	1.20%	12	693	53.31	57.75	12	12
Beijing University of Chinese Medicine	China	13	1.20%	11	228	17.54	20.73	6	11
Aalborg University	Denmark	13	1.20%	12	415	31.92	34.58	9	12
University of Oxford	United Kingdom	13	1.20%	12	246	18.92	20.50	10	12
Johns Hopkins University School of Medicine	United State	12	1.10%	10	446	37.17	44.60	6	10
University of Oxford Medical Sciences Division	United Kingdom	12	1.10%	11	256	21.33	23.27	9	11
Duke University	United State	12	1.10%	12	330	27.50	27.50	8	12
UNC School of Medicine	United State	12	1.10%	12	334	27.83	27.83	9	12
Duke University Medical Center	United State	12	1.10%	12	315	26.25	26.25	9	12

Notes: TP = total number of publications; NCP = number of cited publications; TC = total citations; C/P = average citations per publication; C/CP = average citations per cited publication; h = h-index; g = g-index

Most cited papers:

Table 9 presents the top 10 most-cited articles based on the Scopus database. The document entitled "Patients dissatisfaction following total knee arthroplasty: a systematic review of the literature" by R. Gunarathe et al (2017)[34] from the Curtin University, Western Australia, Australia recorded the highest number of citations (427 citations or an average of 60.57 citations per year).

Table 9 Top 10 cited articles on knee OA and pain management

No	Authors	Title	Year	TC	C/Y
1	R. Gunaratne, D.N. Pratt, J. Banda, D.P. Fick, R.J.K. Khan, B.W. Robertson	Patient dissatisfaction following total knee arthroplasty: A systematic review of the literature	2017	427	60.57
2	B.R. da Costa, S. Reichenbach, N. Keller, L. Nartey, S. Wandel, P. Juni, S. Trelle	Effectiveness of non-steroidal anti-inflammatory drugs for the treatment of pain in knee and hip osteoarthritis: a network meta-analysis	2017	360	51.43
3	H.-P. Scharf, U. Mansmann, K. Streitberger, S. Witte, J. Krämer, C. Maier, H.-J. Trampisch, N. Victor	Acupuncture and knee osteoarthritis: A three-armed randomized trial	2006	320	17.78
4	C.J. Centeno, D. Busse, J. Kisiday, C. Keohan, M. Freeman, D. Karli	Increased knee cartilage volume in degenerative joint disease using percutaneously implanted, autologous mesenchymal stem cells	2008	272	17.00
5	M. Englund, F.W. Roemer, D. Hayashi, M.D. Crema, A. Guermazi	Meniscus pathology, osteoarthritis, and the treatment controversy	2012	268	22.33
6	U.E. Makris, R.C. Abrams, B. Gurland, M.C. Reid	Management of persistent pain in the older patient: A clinical review	2014	227	22.70
7	G.A. Hawker, M.A.M. Gignac, E. Badley, A.M. Davis, M.R. French, Y. Li, A.V. Perruccio, J.D. Power, J. Sale, W. Lou	A longitudinal study to explain the pain - Depression link in older adults with osteoarthritis	2011	221	17
8	D. Gregori, G. Giacovelli, C. Minto, B. Barbetta, F. Gualtieri, D. Azzolina, P. Vaghi, L.C. Rovati	Association of pharmacological treatments with long-term pain control in patients with knee osteoarthritis: A systematic review and meta-analysis	2018	209	34.83
9	R.W. Chang, J. Falconer, S. David Stulberg, W.J. Arnold, L.M. Manheim, A.R. Dyer	A randomized, controlled trial of arthroscopic surgery versus closed-needle joint lavage for patients with osteoarthritis of the knee	1993	198	6.39
10	NIH Consensus Panel	NIH Consensus Statement on total knee replacement	2003	178	8.48

Most frequent journals:

The most active source titles with nine or more publications on knee OA and pain management were also analyzed in this study. Based on Table 10, BMC Musculoskeletal Disorders is at the top with 47 publications (4.32%).

Table 10 The most active source title

Sources Title	TP	%	Publisher	Cite score	SJR2022	SNIP2022
BMC Musculoskeletal Disorders	47	4.32%	Springer Nature	3.5	0.76	1.288
BMJ Open	38	3.50%	BMJ Publishing Group	4.4	1.059	1.168
Osteoarthritis And Cartilage	31	2.85%	Elsevier	11.8	1.863	2.116
Pain Physician	27	2.48%	Association of Pain Management Anesthesiologists	5.5	0.824	1.353
Medicine United States	26	2.39%	Wolters Kluwer Health	2.9	0.46	0.799
Journal Of Arthroplasty	22	2.02%	Elsevier	7.1	2.028	1.804
Pain Medicine United States	21	1.93%	Wolters Kluwer Health	2.9	0.46	0.799
Arthritis Care and Research	18	1.66%	Wiley-Blackwell	9.1	1.718	1.985
Clinical Rehabilitation	12	1.10%	SAGE	5.7	0.874	1.612
Knee	12	1.10%	Elsevier	3.7	0.782	0.976
Acupuncture In Medicine	11	1.01%	BMJ Publishing Group	3.9	0.468	1.117
Knee Surgery Sports Traumatology Arthroscopy	11	1.01%	Wiley-Blackwell	8.2	1.789	2.028
Journal Of Orthopaedic Surgery and Research	10	0.92%	Springer Nature	4.2	0.744	1.251
Journal Of Pain Research	10	0.92%	Dove Medical Press	4.8	0.667	1.083
Pain	10	0.92%	Wolters Kluwer Health	12.5	2.445	3.151
Pain Research and Management	10	0.92%	Hindawi	4	0.562	1.082
Regional Anesthesia and Pain Medicine	10	0.92%	BMJ Publishing Group	7.6	1.302	1.821
Current Rheumatology Reports	9	0.83%	Springer Nature	8.6	1.319	1.63
Pain Management	9	0.83%	Taylor & Francis	2.9	0.465	0.849
Pain Practice	9	0.83%	Wiley-Blackwell	5.4	0.652	1.2

Notes: TP = total number of publications; TC = total citations; CiteScore = average citations received per document published in the source title; SJR = SCImago Journal Rank measures weighted citations received by the source title, SNIP = source normalized impact per paper measures actual citations received relative to citations expected for the source title's subject field; SIGKDD = special interest group on knowledge discovery in data

Most frequent keywords:

Keywords are crucial in ensuring a successful document search process; thus, the most common keywords could indicate the value of a document. VOSviewer was used to map the keywords and displayed the power of connection between keywords based on colour, circle scale, font, and thickness of connecting lines. Similar keywords are grouped in the same colour. Figure 6 illustrates a network visualization of the authors' keywords with a minimum of five occurrences. According to Mansour et al[35] when two keywords are used together in a single article, the co-occurrence may suggest a connection between the two topics.

A total of 9 clusters with 113 items were identified based on the keywords listed in the knee OA and pain management publications. The first cluster (red) included

20 items, such as capsaicin, chronic musculoskeletal, clinical trials, complementary medicine, and diclofenac (Figure 6). Furthermore, human and knee OA are among the most frequently occurring keywords, accounting for > 10% of all searches. Table 11 demonstrates the top 20 search terms from knee OA and pain management studies. Subsequently, the citation analysis was performed to understand the prevalent themes better. Overall, a VOSviewer figure of a co-occurrence network can provide valuable insights into the relationship between terms in each dataset and can help researchers identify trends, patterns, and knowledge gaps in their field of study.

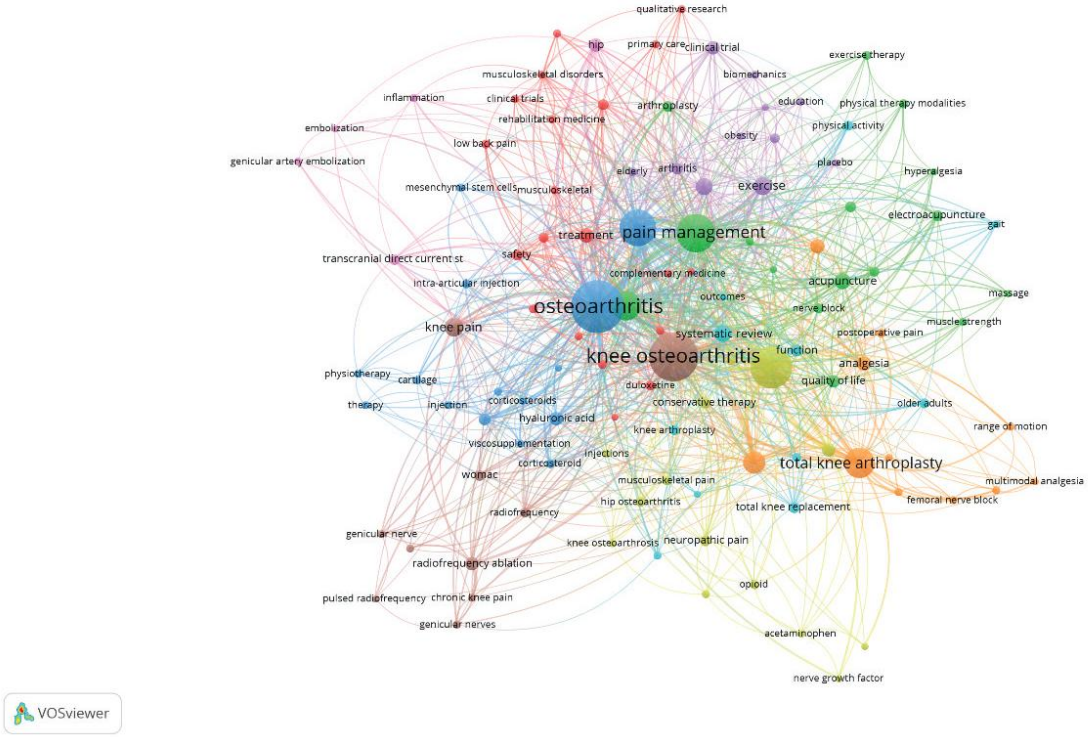

Figure 6 Network visualization map of the keywords.

Table 11 Top 20 keywords listed in knee OA and pain management publications.

Author Keywords	Frequency	(%)
Human	1032	94.94%
Knee Osteoarthritis	1021	93.93%
Humans	875	80.50%
Analgesia	703	64.67%
Osteoarthritis, Knee	695	63.94%
Pain Management	687	63.20%
Article	651	59.89%
Female	637	58.60%
Male	626	57.59%
Aged	543	49.95%
Adult	477	43.88%
Middle Aged	461	42.41%
Controlled Study	458	42.13%
Pain	408	37.53%
Procedures	405	37.26%
Treatment Outcome	395	36.34%
Knee Pain	356	32.75%
Osteoarthritis	349	32.11%
Major Clinical Study	345	31.74%
Randomized Controlled Trial	305	28.06%

Title and abstract analysis:

This study examined the document titles and abstracts via VOSviewer based on the number of occurrences and co-occurrences. Precisely, the co-occurrence network was using the binary counting method or the frequency of a noun phrase appearing in a publication title but not in the abstract. Noun phrases that only appear once in the title or abstract of a publication are treated in the same way as noun phrases that appear ten times [36].

Figure 7 illustrates the term co-occurrence network, which yields six clusters depending on the title and abstract fields. The systematic review cluster acts as the main cluster, acting as the central node of the entire network in knee OA and pain management research. The node's size indicates the appearance frequency of an item, while the connecting line's density suggests how strongly the items are connected. According to Mansour et al[35], related words are more likely to appear together and indicated by the same colour. For instance, systematic review, meta-analysis, PubMed, Medline, mean difference, Cochrane, and other items in blue are closely related and often appear together. The bibliometric analysis in Figure 7 reveals key themes and relationships, emphasizing clinical evidence, pain relief, and the use of both pharmacological (e.g., opioids) and non-pharmacological (e.g., physical therapy) approaches to the multifaceted challenge of managing knee OA pain.

This study examined the co-occurrence analysis based on the document title instead of combining the title and abstract (Figure 8). The binary counting approach required a minimum of five occurrences of each phrase. Resultantly, the VOS viewer produced eight clusters with 62 items. For example, cluster 1 consists of assessment, chronic knee OA, chronic knee pain, genicular nerve, osteoarthritic knee pain, radiofrequency, radiofrequency ablation, randomized trial, results, and total knee replacement. Meanwhile, cluster 8 included hip OA, intraarticular injection, network meta-analysis, and role.

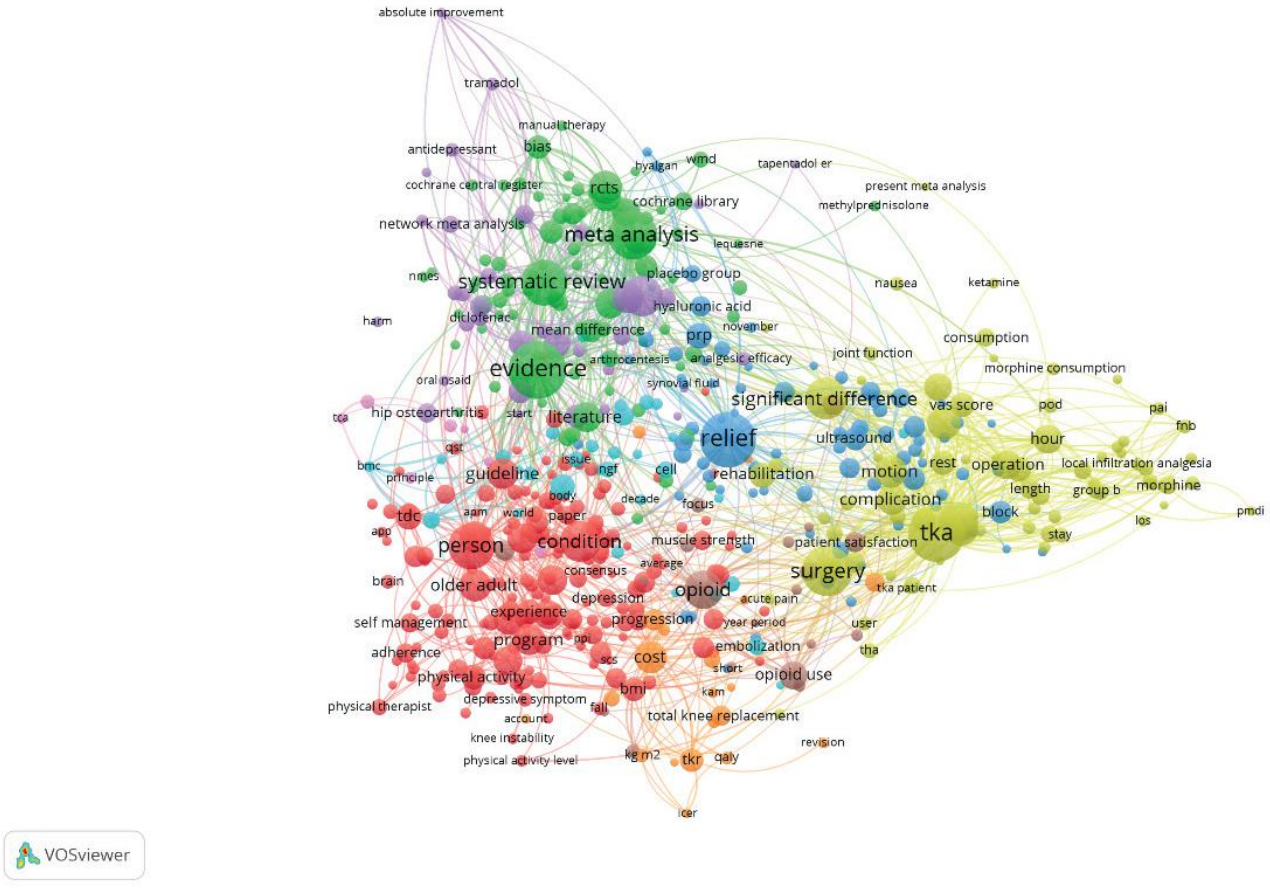

Figure 7 VOSviewer visualization of a term co-occurrence network based on title and abstract fields.

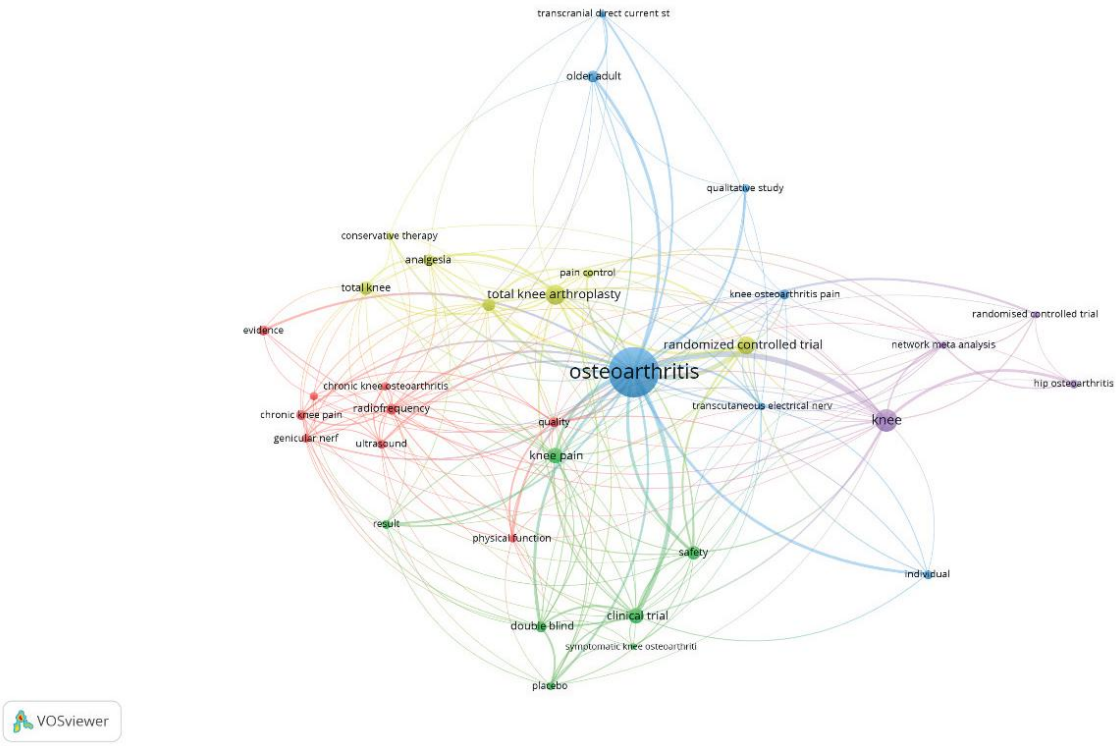

Figure 8 VOSviewer visualization of a term co-occurrence network based on title fields.

The visualization in Figure 8 presented a comprehensive overview of the key research themes and trends in OA. The central 'OA' cluster is surrounded by interconnected topics related to treatment approaches, both surgical (e.g., total knee arthroplasty) and conservative (e.g., analgesia), as well as research methods and patient-centered considerations. The strong links between these treatment modalities and concepts like result, safety, and quality suggest a concerted effort to evaluate the effectiveness and safety of different OA management strategies. The inclusion of methodological terms, such as randomized controlled trial, qualitative study, and network meta-analysis, underscores the emphasis on high-quality research and evidence synthesis in this field. Furthermore, the examination of OA across different joint locations, including the knee and hip, further highlights the multifaceted nature of this condition.

Importantly, the visualization also captures the increasing focus on patient-centered factors, as evidenced by the connections between individual and various treatment-related concepts. This suggests a shift towards personalized approaches to OA management, considering the unique needs and well-being of affected individuals.

DISCUSSION

This bibliometric review, for the first time, presents a comprehensive analysis of knee OA research and pain management using the Scopus database. This method is useful in evaluating the research and publication output on a specific field of study [37] Furthermore, Akhavan et al [38] stated that the findings of bibliometric research can help scholars conduct high-impact research. The current study focused on knee OA and pain management publications from the Scopus database. A total of 1087 documents were collected using a defined search query.

Researchers from Russia initiated the knee OA and pain management study in 1975 entitled "The opinions of district nurses regarding the knowledge, management, and documentation of patients with chronic pain". Since then, the number of publications has increased slightly until 2020, but began to decrease in 2021. More than half of the documents are published as original articles

compared to other document types. Furthermore, most documents were published in English and originated from 72 countries. The top two countries contributing to this research area were the United States and China. Moreover, research on knee OA and pain management are published in medicine, health profession, biochemistry, genetics, molecular biology, engineering, and neuroscience journals. In particular, the medical field focused on managing pain and alternative treatments for chronic pain in knee OA patients.

This study identified the most productive and influential countries, institutions, and authors in the field of knee OA and pain management. Citation metrics are examined in this research and indicate the importance of the selected articles. A total of 1087 articles have been published from 1975 to March 2024 on knee OA and pain management, amounting to > 24,625 citations. The USA recorded the highest number of publications, with 367 publications and 10,296 citations. Studies on knee OA and pain management are actively conducted in the USA and other developed countries because this condition is the most common joint disease and a major cause of chronic pain and disability [39,40]. Additionally, knee OA affects at least 19% of Americans aged 45 and older [41] and is the cause of more than 80% of the overall disease burden [40].

This study explored prevailing themes in knee OA and pain management within scholarly literature. A comprehensive analysis was conducted utilizing VOSviewer, which encompassed an examination of keywords, titles, and abstracts. By employing this approach, researchers aimed to identify and elucidate the most employed themes and concepts within the domain of knee OA and pain management. Among the numerous keywords employed by authors, notable ones included 'osteoarthritis,' 'randomized controlled trials,' 'pain management,' 'total knee arthroplasty,' and 'knee pain.' The selection of 'osteoarthritis' as the principal keyword is attributable to its status as the prevailing form of arthritis that primarily affects the joints, with notable occurrences in the hands, knees, hips, neck, and lower back.

This study identified the most influential articles on knee OA and pain management. Among these articles, the study titled 'Patient Dissatisfaction Following Total Knee Arthroplasty: A Systematic Review of The Literature' authored by Gunaratne et al. in 2017 holds remarkable significance. This study has garnered considerable attention within the field, evident by its substantial citation rate of 427 and an average citation rate of 60.57% per year. Published in the esteemed journal, The Journal of Arthroplasty, this article aimed to explore key factors affecting patient dissatisfaction following total knee arthroplasty.

In recent decades, there has been a notable surge in the number of publications focused on knee OA and pain management, as evidenced by the growing body of research available in the Scopus database. However, it is important to acknowledge that while Scopus serves as a comprehensive repository for academic research [42], it may not encompass all the sources relevant to this study area. To ensure more comprehensive and robust findings, future investigations should consider incorporating other databases such as Web of Science, Google Scholar, Dimensions, and Lens. Despite this limitation, the present study successfully presented the latest advancements in knee OA and pain management research, contributing to the existing knowledge in this field through the application of the bibliometric method.

The bibliometric analysis has specific characteristics; therefore, research limitations need to be set to make it easier for readers to understand this article and strengthen future research. The study outcomes are obtained using keywords such as "knee osteoarthritis" AND "pain management" OR "conservative therapy" in the document titles. This analysis does not involve other fields, such as abstract and other keywords. Future research focusing on other relevant keywords in the abstract or the keyword field might yield results that may not be directly related to their purposes. Therefore, data screening process, including filtering and cleaning, needs to be implemented before the analysis is carried out.

CONCLUSION

This study has contributed to a comprehensive understanding of pain management in knee OA by thoroughly examining relevant literature from the past five decades. The key new knowledge induced is the need to develop: 1) effective pain management in knee OA strategies specifically tailored to knee OA patients, and 2) a deeper understanding of the underlying mechanism of pain in knee OA. Healthcare providers, such as physicians, physical therapists, and pain management specialists, can use this new knowledge

to guide the implementation of more personalized pain management approaches for individuals with knee OA. Researchers in rheumatology, pain science, and clinical medicine can also utilize this knowledge to drive future studies aimed at elucidating the pathophysiology of pain in knee OA and designing targeted interventions. By addressing these research gaps, healthcare providers and researchers can work collaboratively to strive towards more effective and personalized approaches to alleviate pain and improve the quality of life among knee OA patients.

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Conflicts of Interest

The authors affirm that they have no conflicts of interest to disclose.

Data Availability

The dataset of academic publications used in this paper is obtained from the Scopus databases.

Author's Contribution

Data gathering and idea owner of this study: MMG, SI.

Study design: MMG,SI,MRAMZ.

Data gathering: MMG, SI, MRAMZ, JMA, MHJ.

Writing and submitting a manuscript: MMG, SI, MRAMZ, JMA, MHJ.

Editing and approval of final draft: MMG, SI, MRAMZ, JMA, MHJ.

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