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Collaborative Studies Increase the Impact of Osteoarthritis Publications: A Bibliometric Analysis

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ABSTRACT

Background and Aims: Using bibliometrics in research titles is a recent approach to highlighting specific topics. This study aimed to evaluate the academic impact of collaborative studies in osteoarthritis (OA) research within the European Union (EU) and associated non-EU European countries using a scientometric approach. We hypothesized that collaborative studies would enhance citation impact (CI), category-normalized citation impact (CNCI), and impact relative to the world (IREW). Additionally, we assessed the distribution of publications across journal quartiles (Q1-Q4) and explored how interdisciplinary and international collaboration influence research visibility and quality.

Materials and Methods: A comprehensive bibliometric analysis was conducted using data from the Web of Science (WoS) Core Collection and InCites databases. All English-language articles published between 2015 and 2024 with "osteoarthritis" in the title were retrieved. Research performance indicators included CI, CNCI, IREW, types of collaboration (domestic vs. international), and journal impact factor (JIF) quartile distribution. Leading countries, authors, institutions, funding agencies, and research disciplines were identified and ranked based on these metrics.

Results: The number of OA publications increased from 2015 to 2024 among EU countries. The United Kingdom, Germany, and the Netherlands led in both publication volume and citation impact, followed by non-EU associated countries such as Switzerland and Norway. Finland and Lithuania stood out for their high CNCI values, indicating field-normalized excellence. Collaborative studies, particularly those involving international partnerships, were significantly more likely to be published in Q1 and Q2 journals compared to single-author or domestic studies. Funding sources were dominated by UK-based organizations such as UK Research and Innovation (UKRI), the Medical Research Council (MRC), and Versus Arthritis, while pharmaceutical companies contributed significantly but showed lower normalized citation impacts. *Osteoarthritis and Cartilage, Arthritis & Rheumatology, and Annals of the Rheumatic Diseases* emerged as the most influential journals, with several open-access titles gaining prominence

Conclusion: Collaborative and multi-disciplinary research enhances the visibility, citation impact, and journal quality of osteoarthritis publications. EU countries lead in both research quantity and quality. Certain non-EU associated countries demonstrate comparable or even superior performance when normalized for field-specific expectations. Strategic international and institutional collaborations are key drivers of impactful OA research. These findings underscore the importance of international and interdisciplinary partnerships in advancing OA research and improving public health outcomes.

Keywords: Bibliometrics, citation impact, collaboration, European research, osteoarthritis, scientometrics.

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Significance and Innovation

Bibliometric analysis for osteoarthritis (OA) publications is a new approach. This multidisciplinary research highlights the importance of international and interdisciplinary collaborations. Institutional and multidisciplinary partnerships were shown to increase the impact of OA publications. Organizations may find the results of this study helpful in guiding future OA research investments. For the first time, European institutions, authors, and their collaborations were evaluated not only for their scientific publication output but also for their citation impact, category-normalized citation impact, and impact relative to the world. The study documents the disciplines, funding organizations, leaders, authors, and countries that publish osteoarthritis research.

INTRODUCTION

Osteoarthritis (OA) is a multifactorial, disabling chronic disease with a high incidence of morbidity and an increased risk of mortality.[1] Genetic predisposition,[2] excessive mechanical loading[3] of the joints, and post-traumatic injuries[4] are major contributing factors. The incidence and prevalence[5] of OA in individuals aged 65+ and 55+ are 30% and 13%, respectively.

Comprehensive scientometric analyses of OA over the past five years[6-14] have primarily focused on regions, countries, institutions, journals, authors, annual publication counts, keywords, and cited references. Publication trends revealed that both the number of publications and citations have increased. This could be also related to the inclusion of new journals, additional publications, and expanding indexing coverage. Journal impact factor (JIF) and first-author H-index were also extracted in a recent study.[15] Two studies[16, 17] analyzed bibliographical coupling, co-authorship, co-citation, and co-occurrence. Another study[18] additionally employed text mining and cluster network analysis. Scientometric OA articles have mostly examined global output,[6] non-surgical interventions,[16] rehabilitation,[11] pain management,[8] acupuncture,[9] hyaluronic acid,[12] platelet-rich plasma,[13, 19] bone marrow aspirate concentrate,[18] stem cells,[7] macrophages,[20] chondrocytes and mRNA,[21] arthroscopy,[14] high-tibial osteotomy,[12] unicompartmental knee arthroplasty,[10] primary total knee arthroplasty,[15] and shoulder arthroplasty,[22] Three studies[23-25] focused on the social dimension of scientific activities and the academic impact of OA articles. However, the ratio of open-access to highly cited articles has not yet been evaluated. The productivity and impact of European Union (EU) and non-EU associated (non-EU) countries have also not been determined. Academic impact, measured through citation impact (CI), category-normalized citation impact (CNCI), and impact relative to the world (IREW), has likewise not been assessed to date. Names of authors and their institutions leading the OA research field by citations, as well as funding agencies and their disciplines in the EU and non-EU associated countries, were not previously explored. The impact of collaborative studies was also not highlighted. We asked whether the number of articles with the keyword "osteoarthritis" in their title, produced by EU and non-EU countries, increased from 2015 to 2024. We then investigated whether the distribution of Web of Science (WoS) documents, defined as "DT=article" with "TI=osteoarthritis" in the title (WOS field tags: DT=Document Type, TI=Title), along with times cited (citations), citation impact, category-normalized citation impact, and impact relative to world, was higher compared to the world average. The aim of this study was to highlight the importance of institutional and interdisciplinary collaboration in OA research.

METHODS

Data Source and Scope

This study employed a bibliometric analysis using data retrieved from the Web of Science Core Collection and InCites databases (Clarivate Analytics), accessed on June 21, 2025. The search was limited to English-language original research articles published between 2015 and 2024, with the term "osteoarthritis" in the title. Only documents classified as "articles" in English were included. The number of retrieved articles were 21,151 for the world, 6,089 for EU countries, and 1,480 for non-EU associated countries (Table 1).

Search Strategy

Conference abstracts, review articles, news items, conference papers, and retractions were excluded (Fig. 1). A trend analysis was initially conducted to address our first research question. To answer the second research question, the distributions of CI, CNCI, and IREW were analyzed over the same time span and for the same country groups. Outcomes were compared across global, EU, and non-EU countries. To address our third research question, we examined variables such as the authors and affiliations of the most highly cited institutions, top institutions, leading funding agencies, and key research disciplines driving OA research. Each country was further analyzed and documented using these same variables. Journal quartiles (Q1, Q2, Q3, and Q4) of the publications were then extracted

Articles were identified using Boolean queries with the following criteria:

Document Type: Article

Language: English

Timeframe: 2015-2024

Title: "Osteoarthritis"

Table 1. Query codes used to retrieve articles in the field of osteoarthritis

	Osteoarthritis (OA) **Web of Science**
World (N=21,151)	TI="Osteoarthritis" AND PY=2015-2024 AND DT=Article
EU Countries (N=6,089)	TI="Osteoarthritis" AND CU=(Austria OR Belgium OR Bulgaria OR Croatia OR Cyprus OR "Czech Republic" OR Denmark OR Estonia OR Finland OR France OR Germany OR Greece OR Hungary OR Ireland OR Italy OR Latvia OR Lithuania OR Luxembourg OR Malta OR Netherlands OR Poland OR Portugal OR Romania OR Slovakia OR Slovenia OR Spain OR Sweden OR (England OR United Kingdom)) AND PY=2015-2024 AND DT=Article
Non-EU Associated Countries (N=1,480)	TI="Osteoarthritis" AND CU=(Albania OR Armenia OR "Bosnia & Herceg" OR "Faroe Islands" OR Georgia OR Iceland OR Israel OR Moldova OR Montenegro OR Norway OR Serbia OR Switzerland OR Macedonia OR Tunisia OR Turkey OR Ukraine OR Morocco) AND PY=2015-2024 AND DT=Article

Boolean Operators Used: AND, OR. Field Tags: TI: Title; PY: Year Published; DT: Document Type; CU: Country.

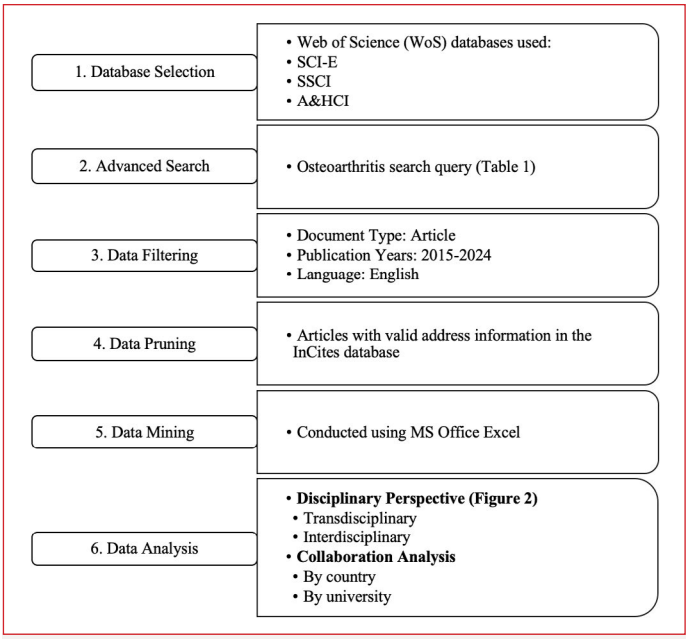

Figure 1. Data extraction process.

Country groups were defined as follows:

EU countries: 27 member states, including Germany, France, the UK, the Netherlands, etc.

Non-EU European countries: Switzerland, Norway, Türkiye, Iceland, etc.

The full search syntax is provided in Table 1.

Data Extraction and Cleaning

We first extracted full records and cited references from the WoS database, covering the Science Citation Index Expanded (SCI-E), Social Sciences Citation Index (SSCI), and Arts and Humanities Citation Index (A&HCI). The data download format was "tab-delimited (Win, UTF-8)", which included publication year, journal name, authors, title, and keywords. All articles were collected online (Fig. 1).[26] The first stage involved selecting the database. The second stage focused on preliminary data retrieval. The third stage consisted of data cleaning and sample selection. English was selected as the language. Only "articles" were included as the document type. The fourth stage involved data pruning based on address selection. The fifth stage was data parsing, during which articles were categorized according to their address information, discipline, and collaboration data. The sixth stage was bibliometric analysis. We analyzed publication trends from 2015 to 2024 to assess the research status and frontier developments in OA research. The current state of inter- and trans-disciplinarity in OA research, along with the path of knowledge evolution on OA, was revealed through scientometric analysis.

Analytical Framework

Key indicators used to assess academic impact included:

Citation Impact (CI): Total citations divided by the number of documents.

Category-Normalized Citation Impact (CNCI): A field-normalized metric comparing actual citations to expected global citation rates.

Impact Relative to World (IREW): CI of a country or institution compared to the world average.

Collaboration types were categorized as: domestic collaboration and international collaboration. Journal impact factor (JIF) quartiles (Q1-Q4) were also recorded.

Statistical Analysis

Descriptive statistics (means, frequencies) and comparative metrics were calculated using Microsoft Excel 365. Pivot tables and regression tools were employed to analyze collaboration trends and journal quartile distributions.

This study did not involve human participants or animals, therefore, informed consent and ethics committee approval were not applicable. The study was conducted in accordance with the Declaration of Helsinki. The authors declare that no artificial intelligence (AI)-assisted technologies were used in the preparation of this manuscript.

RESULTS

Overview of Research Output and Regional Disparities

Table 2 shows significant disparities in research output and impact between EU and non-EU European countries. Among EU nations, the United Kingdom led in both volume (1,664 documents; 700 Q1 papers) and influence (1.49× world impact), followed by Germany (1,022, documents; 420 Q1 papers) and the Netherlands (929 documents; 443 Q1 papers), the latter excelling in citation impact (1.85× normalized). Between 2015 and 2024, Europe accounted for 7,569 osteoarthritis (OA) research publications, with 6,089 (80.5%) originating from EU countries and 1,480 (19.5%) from non-EU European nations. The United Kingdom (1,664), Germany (1,022), and the Netherlands (929) were the most prolific contributors within the EU, not only in terms of publication volume but also in academic impact, as reflected in citation impact and category-normalized citation impact metrics.

Notably, smaller EU countries such as Finland and Lithuania demonstrated exceptional research quality, with CNCI values of 2.46 and 2.31, respectively—well above the global baseline of 1.29. This indicates that their research is cited significantly more than the world average in OA-related fields.

In contrast, Eastern European EU members such as Poland and Romania lagged behind in citation impact, suggesting that while they contribute to research output, their visibility and influence remain limited. Among non-EU countries, Switzerland (407 documents) and Norway (309) emerged as strong performers, with Norway's CNCI at 2.35, surpassing many EU counterparts. Iceland, despite its small number of publications, achieved the highest relative impact (IREW=2.03) among non-EU nations.

However, Türkiye (568 documents), though the most productive non-EU country, had the lowest normalized citation impact (CNCI=0.90), largely due to a high proportion of publications in lower-tier journals.

Citation Impact Across Regions

Figure 2 illustrates the citation impact distribution among EU and non-EU countries. The global CI baseline is 16.88, while the EU and non-EU baselines are 19.32 and 17.37, respectively.

Several EU countries, including the Netherlands (26.98), Finland (33.66), and Lithuania (29.07), significantly outperformed both their regional and global baselines. In contrast, Romania (8.43) and Poland (10.69) fell below both benchmarks.

Among non-EU nations, Iceland (34.33) and Armenia (31.17) exhibited the highest CI values, surpassing many EU countries. This highlights that research excellence is not solely a function of publication volume, and that smaller or non-EU nations can achieve high academic visibility when their work is well-cited and impactful (Fig. 2).

Normalized Citation Impact (CNCI)

Figure 3 presents the Category Normalized Citation Impact (CNCI), which adjusts citation counts based on field, year, and document type. The global baseline is 1.29, with the EU and non-EU baselines at 1.39 and 1.38, respectively. EU

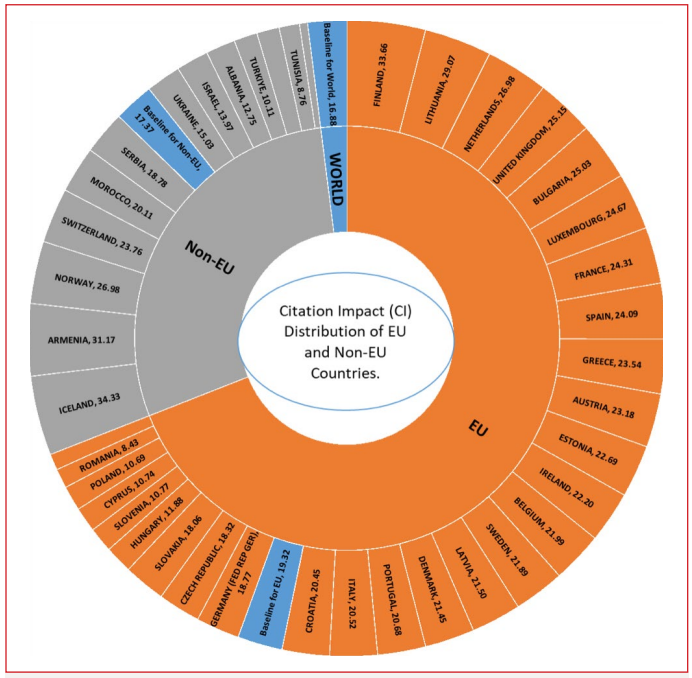

Figure 2. Citation Impact (CI) distribution of European Union (EU) and non-EU countries.

Table 2. Research performance in European Union (EU) and non-EU countries in the field of osteoarthritis (2015-2024)

Category	Rank	Country	Web of Science Documents	Times Cited	Impact Relative to World	Citation Impact	Category Normalized Citation Impact	Documents in Q1 Journals	Documents in Q2 Journals	Documents in Q3 Journals	Documents in Q4 Journals
		Baseline (World)	**21,151**	**357,133**	**1.00**	**16.88**	**1.29**	**6,368**	**4,847**	**2,979**	**1,689**
		Baseline (EU)	**6,087**	**117,586**	**1.00**	**19.32**	**1.39**	**2,277**	**1,503**	**674**	**348**
EU	1	United Kingdom	1,664	4,1851	1.49	25.15	1.68	700	410	174	43
	2	Germany	1,022	1,9186	1.11	18.77	1.47	420	247	94	89
	3	Netherlands	929	25,069	1.60	26.98	1.85	443	227	74	25
	4	Italy	743	15,250	1.22	20.52	1.74	242	195	90	41
	5	France	610	14,829	1.44	24.31	1.84	241	158	56	32
	6	Spain	592	14,262	1.43	24.09	1.80	221	154	56	28
	7	Denmark	493	10,577	1.27	21.45	1.81	202	112	53	11
	8	Sweden	472	10,334	1.30	21.89	1.84	201	119	47	10
	9	Belgium	337	7,412	1.30	21.99	1.83	139	96	24	19
	10	Austria	254	5,887	1.37	23.18	1.53	118	74	17	13
	11	Finland	232	7,810	1.99	33.66	2.46	102	60	22	7
	12	Poland	169	1,806	0.63	10.69	0.84	36	38	34	19
	13	Portugal	133	2,751	1.23	20.68	2.74	46	29	15	13
	14	Romania	100	843	0.50	8.43	1.26	8	18	8	19
	15	Greece	94	2,213	1.39	23.54	1.81	25	27	10	6
	16	Ireland	93	2,065	1.32	22.20	1.94	37	16	4	5
	17	Hungary	50	594	0.70	11.88	0.95	13	11	6	10
	18	Croatia	47	961	1.21	20.45	2.77	12	11	9	8
	19	Lithuania	41	1,192	1.72	29.07	2.31	21	10	1	0
	20	Czech Republic	37	678	1.09	18.32	2.44	13	10	4	5
	21	Estonia	32	726	1.34	22.69	1.40	13	10	2	2
	22	Slovenia	31	334	0.64	10.77	0.83	7	10	6	1
	23	Bulgaria	29	726	1.48	25.03	3.02	6	6	4	3
	24	Cyprus	19	204	0.64	10.74	4.10	4	3	3	0
	25	Luxembourg	18	444	1.46	24.67	1.28	8	3	2	2
	26	Slovakia	16	289	1.07	18.06	2.15	8	3	1	2
	27	Malta	7	49	0.41	7.00	0.49	0	1	3	0
	28	Latvia	6	129	1.27	21.50	1.44	3	1	1	0

Table 2. Research performance in European Union (EU) and non-EU countries in the field of osteoarthritis (2015-2024) (CONT.)

Category	Rank	Country	Web of Science Documents	Times Cited	Impact Relative to World	Citation Impact	Category Normalized Citation Impact	Documents in Q1 Journals	Documents in Q2 Journals	Documents in Q3 Journals	Documents in Q4 Journals
Non-EU		Baseline (Non-EU)	1477	25,658	1.00	17.37	1.38	368	303	184	235
	1	Türkiye	568	5,745	0.60	10.11	0.90	51	73	101	176
	2	Switzerland	407	9,669	1.41	23.76	1.91	146	120	29	24
	3	Norway	309	8,338	1.60	26.98	2.35	123	77	30	4
	4	Israel	77	1,076	0.83	13.97	1.36	21	21	10	4
	5	Serbia	41	770	1.11	18.78	3.01	9	5	5	15
	6	Ukraine	35	526	0.89	15.03	2.96	6	2	0	8
	7	Iceland	33	1,133	2.03	34.33	2.19	21	5	3	0
	8	Morocco	19	382	1.19	20.11	1.35	2	7	3	0
	9	Tunisia	17	149	0.52	8.76	0.66	2	2	4	3
	10	Bosnia and Herzegovina	14	136	0.58	9.71	3.41	4	1	0	4
	11	Armenia	6	187	1.85	31.17	2.09	2	1	0	1
	12	Albania	4	51	0.76	12.75	1.89	2	0	0	1
	13	Montenegro	2	7	0.21	3.50	0.29	1	0	0	1
	14	Faroe Islands	0	0	0.00	0.00	0.00	0	0	0	0
	15	Georgia	0	0	0.00	0.00	0.00	0	0	0	0
	16	Macedonia	0	0	0.00	0.00	0.00	0	0	0	0
	17	Moldova	0	0	0.00	0.00	0.00	0	0	0	0

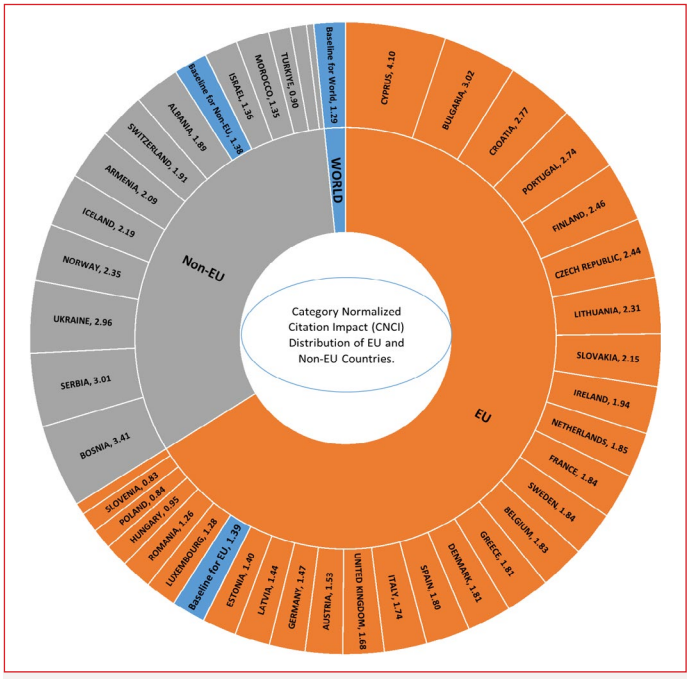

Figure 3. Category Normalized Citation Impact (CNCI) distribution of European Union (EU) and non-EU countries.

Figure 4. Impact Relative to World (IREW) distribution of European Union (EU) and non-EU countries.

countries such as Cyprus (4.10), Bulgaria (3.02), and Croatia (2.70) stood out for their high field-normalized performance. These countries, though modest in publication volume, produced research that was exceptionally well-cited within their disciplines. On the non-EU side, Serbia (3.01), Ukraine (2.96), and Bosnia and Herzegovina (3.14) also demonstrated strong field-normalized impact, outperforming many EU countries. These findings suggest that research excellence can emerge from diverse regions and that citation normalization is essential for fair comparisons.

Impact Relative to the World (IREW)

Figure 4 visualizes the Impact Relative to the World (IREW), which compares a country's average citation impact to the global average. A value above 1.00 indicates above-average performance. The segments are color-coded: orange for EU countries and gray for non-EU countries. The size of each segment visually represents the magnitude of the impact relative to the world average. For example, Finland has the highest IREW at 1.99, indicating that its impact is nearly twice the global average. Conversely, Tunisia has the lowest IREW among the listed countries at 0.52, suggesting its impact is significantly below the world average. This visualization effectively highlights disparities in impact across different regions and countries.

Within the EU section, Hungary serves as the baseline with an IREW of 1.00, providing a reference point for comparing other EU countries. Countries like Finland, Lithuania, and the Netherlands show notably higher impacts, exceeding 1.5 times the EU baseline. In contrast, Poland, Cyprus, and Slovenia have lower IREWs, ranging from 0.63 to 0.70, indicating their impacts are less than the EU average but still above the global baseline. On the non-EU side, Serbia is set as the baseline for non-EU countries, also at 1.00. Iceland stands out with an IREW of 2.03, demonstrating the highest impact among non-EU countries. Other non-EU nations, such as Armenia and Norway, show moderate impacts, while Tunisia and Bosnia and Herzegovina have the lowest impacts in this category. Overall, the graph underscores significant variations in relative impact between EU and non-EU countries, with some showing substantial deviations from global and regional baselines.

Collaboration Patterns and Citation Performance

Table 3 provides a comparative overview of research performance metrics for the top 10 countries based on the number of Web of Science documents. The dataset baseline represents the global average, with an "Impact Relative to World (IREW)" value of 1.00. Several countries, such as the United Kingdom (IREW: 1.49), the Netherlands (IREW: 1.60), and Switzerland (IREW: 1.41), demonstrate above-average citation impact compared to the world baseline. These nations also exhibit strong international collaboration rates, particularly the UK and the Netherlands, suggesting

Table 3. Top 10 European Union (EU) and non-EU countries leading osteoarthritis research

	Country	Web of Science Documents	Times Cited	Citation Impact	Category Normalized Citation Impact	Impact Relative to World	Domestic Collaborations	International Collaborations
	Baseline (World)	21,151	357,133	16.88	1.29	1.00	10,165	4,784
1	United Kingdom	1,664	41,851	25.15	1.68	1.49	356	1,133
2	Germany	1,022	19,186	18.77	1.47	1.11	233	641
3	Netherlands	929	25,069	26.98	1.85	1.60	281	516
4	Italy	743	15,250	20.52	1.74	1.22	253	378
5	France	610	14,829	24.31	1.84	1.44	221	345
6	Spain	592	14,262	24.09	1.80	1.43	214	318
7	Türkiye	568	5,745	10.11	0.90	0.60	339	66
8	Denmark	493	10,577	21.45	1.81	1.27	148	309
9	Sweden	472	10,334	21.89	1.84	1.30	99	345
10	Switzerland	407	9,669	23.76	1.91	1.41	51	324

that global research partnerships may contribute to higher visibility and citation rates. In contrast, Türkiye presented the lowest citation impact (CI: 10.11) and IREW (0.60), significantly below the global average. This may be attributed to its high domestic collaboration rate (339 out of 568 collaborations were domestic) and limited international engagement.

Most countries engaged more frequently in domestic research collaborations than in international ones. However, the UK, the Netherlands, and Switzerland presented a more balanced or even internationally oriented collaboration ratio. For instance, the Netherlands recorded 281 domestic and 516 international collaborations, indicating a strong outward research orientation. Citation impact generally aligns with international collaboration levels. Sweden and Switzerland, which have high counts of international collaborations, also displayed above-average citation impacts. The data suggests a positive alignment between international research collaboration and citation performance, reinforcing the importance of global scientific networks in enhancing research visibility and influence. There is a clear correlation between international collaboration and citation impact. Countries with higher international collaboration rates, such as the UK and Switzerland, also showed above-average citation performance, reinforcing the value of cross-country partnerships in advancing research visibility.

Leading Researchers and Institutions

Table 4 ranks the top 10 researchers based on their publication output and citation metrics in the Web of Science database. Sita Bierma-Zeinstra leads with 152 publications, the highest document count on the list, and maintains a strong citation impact (33.81) and an Impact Relative to World of 1.96, indicating that her work consistently exceeds global averages. Nigel Arden from the University of Oxford, although ranked 10th in terms of total publications (71 documents), achieved the highest citation impact (73.68) and IREW (4.28, more than four times the world average), demonstrating that research quality and influence can surpass sheer publication volume. Similarly, Philip Conaghan and Francis Berenbaum achieved high normalized citation impacts despite having fewer than 100 publications, reinforcing the idea that impactful research is not always directly correlated with quantity.

While most researchers in the ranking have between 70 and 150 publications, there are notable differences in how these outputs translate into citations and overall impact. For example, Frank Roemer has 128 publications and a citation impact of 25.92, which is relatively lower compared to others with fewer papers but higher visibility, such as Nigel Arden or I. K. Haugen (42.06 citation impact with only 93 publications). This suggests that factors such as research topic relevance, collaboration networks, and institutional visibility play a significant role in citation performance.

Table 4. Top 10 authors from European Union (EU) and non-EU countries in leading osteoarthritis research

Rank	Author	Web of Science Documents	Times Cited	H-Index	Category Normalized Citation Impact	Impact Relative to World	Citation Impact	Primary Affiliation Country	Affiliation
1	Bierma-Zeinstra, Sita	152	5,139	33	2.32	1.96	33.81	Netherlands	Erasmus MC
2	Roemer, Frank	128	3,318	31	1.63	1.50	25.92	Germany	University of Erlangen Nuremberg
3	Kloppenburg, Margreet	110	2,977	30	1.61	1.57	27.06	Netherlands	Leiden University
4	Englund, Martin	100	2,103	27	1.71	1.22	21.03	Sweden	Lund University
5	Conaghan, Philip G.	99	3,795	28	2.66	2.22	38.33	England	University of Leeds
6	Haugen, I. K.	93	3,912	24	2.86	2.44	42.06	Norway	Diakonhjemmet Hospital
7	Roos, Ewa M.	87	2,296	26	1.93	1.53	26.39	Denmark	University of Southern Denmark
8	Skou, Søren T.	85	2,036	22	2.80	1.39	23.95	Denmark	Naestved Slagelseog Ringsted Sygehuse
9	Berenbaum, Francis	84	2,729	27	2.26	1.89	32.49	France	Sorbonne Universite
10	Arden, Nigel	71	5,231	31	4.00	4.28	73.68	England	University of Oxford

Table 5 presents the top 10 academic and research institutions contributing to osteoarthritis research, highlighting their publication output, citation impact, and collaboration patterns. Erasmus University Rotterdam leads in both publication count (176 documents) and international collaborations (100), with an IREW of 1.22, indicating above-average global influence. Lund University and the University of Southern Denmark also demonstrate strong performance, particularly in normalized citation impact (1.81 and 2.20, respectively), suggesting that their research is highly cited relative to field expectations. Notably, institutions like INSERM (the Institut National de la Santé et de la Recherche Médicale, France) and the University of Oxford (UK) achieved high citation impacts (17.01 and 19.25, respectively) and IREW values of 1.72 and 1.94, indicating a scientific influence significantly above the global average.

While most institutions show a tendency toward international collaboration, some exhibit a stronger domestic focus. For example, INSERM (France) has nearly equal levels of domestic (69) and international (75) collaborations, indicating a balanced approach. In contrast, Keele University and the University of Nottingham maintain relatively high international collaboration rates alongside strong category-normalized citation impacts (2.16 and 2.33, respectively), emphasizing the role of global partnerships in enhancing research visibility. The University of Copenhagen is the only institution with an IREW below 1.00 (0.94), suggesting its research impact is slightly below the world average despite a respectable number of publications (114). Overall, the data highlights how leading institutions combine productivity, citation performance, and collaborative strategies to strengthen their position in osteoarthritis research globally.

Funding Organizations

Table 6 presents the top 20 funding organizations from EU and non-EU countries leading OA research based on publication output, citation impact, and collaboration patterns. UK-based funders dominate the rankings, with UK Research & Innovation (UKRI), Medical Research Council UK (MRC), and Versus Arthritis occupying the top three positions. These organizations not only lead in document count (394-285) but also exhibit high category-normalized citation impacts (1.81-1.93) and IREW values above 2.0, indicating that their funded research significantly outperforms global averages. Notably, pharmaceutical companies like GlaxoSmithKline (UK) and Novartis (Switzerland) also feature among the top funders, although their normalized citation impacts are lower (1.45), suggesting a focus on applied or industry-driven research rather than highly cited academic publications.

While most funders show a balance between domestic and international collaborations, some stand out for their global

Table 5. Top 10 institutions from European Union (EU) and non-EU countries in osteoarthritis research

Rank	Institution	Web of Science Documents	Times Cited	Category Normalized Citation Impact	Citation Impact	Impact Relative to World	Domestic Collaborations	International Collaborations	Country or Region
1	Erasmus University Rotterdam	176	2,119	1.78	12.04	1.22	44	100	Netherlands
2	Lund University	151	1,564	1.81	10.36	1.05	35	101	Sweden
3	Institut National de la Sante et de la Recherche Medicale (INSERM)	145	2,467	2.20	17.01	1.72	69	75	France
4	University of Southern Denmark	138	1,750	2.20	12.68	1.28	48	89	Denmark
5	University of Oxford	123	2,368	1.96	19.25	1.94	38	81	England
6	Assistance Publique Hopitaux Paris (APHP)	114	1,344	1.86	11.79	1.19	45	69	France
7	University of Copenhagen	114	1,059	1.60	9.29	0.94	46	62	Denmark
8	University of Nottingham	111	1,916	2.33	17.26	1.74	26	78	England
9	Keele University	110	1,273	2.16	11.57	1.17	28	80	England
10	Leiden University	108	1,458	2.08	13.50	1.36	31	59	Netherlands

engagement. For instance, the European Commission Joint Research Centre, Sanofi-Aventis, and the Consultative Group on International Agricultural Research (CGIAR) demonstrate high category-normalized citation impacts (2.25-3.09), with CGIAR achieving the highest at 3.09, indicating exceptional influence relative to their research fields. In contrast, public funders such as the German Research Foundation (DFG) and the Swedish Research Council have lower IREW values (1.05 and 1.23 respectively), suggesting more modest global impact despite solid publication outputs. Overall, the data reveals a diverse ecosystem in which both national governments and private-sector actors play crucial roles in advancing osteoarthritis research, with varying degrees of scientific influence and international collaboration.

Disciplinary Trends and Journal Landscape

Figure 5 illustrates the trend in Web of Science documents published across five distinct fields *(Orthopedics, Rheumatology, Surgery, Medicine (Research & Experimental) and Sport Sciences)* from 2015 to 2024. The data reveals significant variations in publication growth across these disciplines over the decade. *Orthopedics* shows the most pronounced increase, with a steady rise from approximately 370 documents in 2015 to over 800 documents by 2024, indicating a substantial surge in research activity within this field. *Rheumatology* also demonstrates robust growth, starting around 450 documents in 2015 and reaching nearly 650 by 2024. In contrast, *Surgery* exhibits a relatively stable trend, with minor fluctuations but no significant increase or decrease over the period.

Medicine (Research & Experimental) and Sport Sciences show comparatively lower publication counts than *Orthopedics* and *Rheumatology*. *Medicine (Research & Experimental)* starts at around 100 documents in 2015 and gradually increases to approximately 150 by 2024, reflecting moderate growth. Similarly, *Sport Sciences* maintains a low publication count throughout the period, hovering between 100 and 150 documents, with minimal changes over time. These trends suggest that while *Orthopedics and Rheumatology* are experiencing rapid expansion in research output, other fields like *Surgery, Medicine (Research & Experimental), and Sport Sciences* are growing at a slower pace or maintaining consistent levels of publication activity. The overall pattern highlights the dynamic nature of research focus, with certain fields gaining prominence over others during this timeframe.

Table 6 presents a comprehensive overview of the top 20 leading journals in osteoarthritis research, ranked

Table 6. Top 20 funding organizations from European Union (EU) and non-EU countries supporting osteoarthritis research

Rank	Funding Organization	Web of Science Documents	Times Cited	Category Normalized Citation Impact	Impact Relative to World	Citation Impact	Domestic Collaborations	International Collaborations	Country
1	UK Research & Innovation (UKRI)	394	14,152	1.81	2.03	35.92	121	224	United Kingdom
2	Medical Research Council UK (MRC)	314	12,495	1.93	2.25	39.79	88	190	United Kingdom
3	Versus Arthritis	285	11,031	1.84	2.19	38.71	96	147	United Kingdom
4	GlaxoSmithKline	399	10,832	1.45	1.54	27.15	140	207	United Kingdom
5	Novartis	390	10,378	1.45	1.51	26.61	136	203	Switzerland
6	European Union (EU)	313	7,828	1.56	1.42	25.01	114	163	Belgium
7	National Institute for Health and Care Research (NIHR)	182	4,674	1.64	1.45	25.68	84	83	United Kingdom
8	Spanish Government	152	3,460	1.41	1.29	22.76	82	58	Spain
9	Wellcome Trust	92	2,911	1.91	1.79	31.64	27	53	United Kingdom
10	Swedish Research Council	103	2,240	1.49	1.23	21.75	21	69	Sweden
11	Instituto de Salud Carlos III	76	2,045	1.48	1.52	26.91	51	21	Spain
12	German Research Foundation (DFG)	95	1,761	1.30	1.05	18.54	36	45	Germany
13	Research Council of Finland	80	1,665	1.32	1.18	20.81	28	45	Finland
14	Sanofi-Aventis	39	1,626	1.63	2.36	41.69	18	18	France
15	CGIAR (Consultative Group on International Agricultural Research)	56	1,606	3.09	1.62	28.68	27	19	France
16	European Commission Joint Research Centre	40	1,590	2.40	2.25	39.75	10	20	Belgium
17	Netherlands Organisation for Health Research and Development	65	1,444	1.53	1.26	22.22	32	18	Netherlands
18	European Research Council (ERC)	70	1,439	1.81	1.16	20.56	21	45	Belgium
19	Netherlands Organisation for Scientific Research (NWO)	44	1,288	1.48	1.66	29.27	12	21	Netherlands
20	Marie Curie Actions	45	1,256	1.91	1.58	27.91	10	29	Belgium

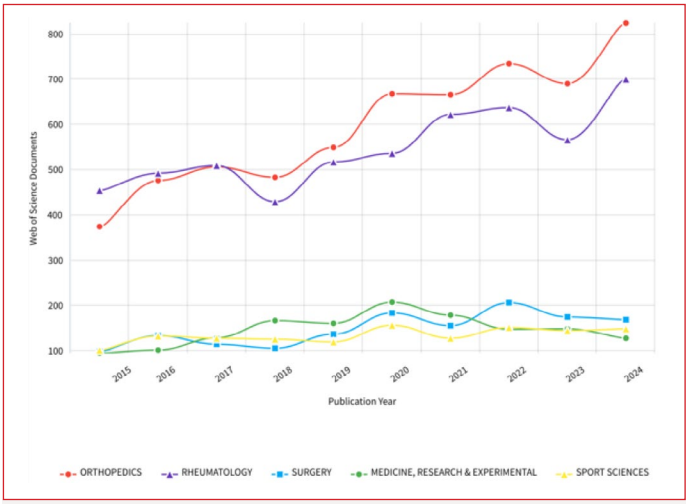

Figure 5. Top five research areas leading osteoarthritis research.

according to various bibliometric indicators. *Osteoarthritis and Cartilage* emerges as the most influential journal in the field, with the highest citation impact (71.98), a Journal Impact Factor of 7.2, and the greatest number of total citations (27,363). It is followed by high-impact journals such as *Arthritis & Rheumatology and Annals of the Rheumatic Diseases*, which demonstrate superior category-normalized citation impacts (3.17 and 4.34, respectively) and JIFs (11.4 and 20.3, respectively), indicating their significant influence within the discipline. Notably, several open-access journals, including *Scientific Reports, PLOS ONE, and BMJ Open*, feature prominently in the rankings, reflecting the growing contribution of open-access platforms to the dissemination of osteoarthritis research.

Table 6 also highlights varying levels of national and international collaboration across these journals. Leading journals such as *Osteoarthritis and Cartilage and Arthritis & Rheumatology* exhibit substantial international collaboration, suggesting strong global engagement in osteoarthritis research. In contrast, journals like *Medicine and International Immunopharmacology* report relatively lower normalized citation impacts (0.52 and 1.57, respectively) despite higher document outputs, indicating potential discrepancies in research visibility or specialization. Overall, the table underscores the dominance of Q1 journals in terms of impact metrics and collaborative efforts, reinforcing the importance of high-quality, internationally collaborative research in advancing osteoarthritis studies.

DISCUSSION

This study offers new insights into how collaboration and interdisciplinary approaches shape the visibility and impact of osteoarthritis research in Europe. Unlike previous scientometric studies that focused primarily on publication counts, we emphasize the role of academic impact metrics, such as CNCI and IREW, which offer a more nuanced view of research excellence.

The number of articles with the keyword "osteoarthritis" in their title, generated by EU and non-EU countries, increased from 2015 to 2024. Our findings align with earlier studies that analyzed publication trends.[6-10,12-14,17-21,27,28] Furthermore, we focused on comparing the impact of OA research in Europe by analyzing trends from 2015 to 2024 for articles published in EU and non-EU associated countries. We limited our search to articles only and did not include all document types. Reviews often do not contain original research data, and most abstracts presented at conferences are typically published as articles in journals shortly after being presented. Our search was also limited to the WoS database; we did not include other databases such as Scopus or PubMed.

We focused on CI, CNCI, and IREW as they reflect academic impact rather than outcomes. Citation impact refers to the number of times a publication is cited by subsequent publications. Category-normalized citation is calculated by dividing the actual number of citing items by the expected citation rate for the same manuscript type, year of publication, and subject area. The Impact Relative to the World indicator is the ratio of the CI of a set of documents divided by the world CI for a given period. These three indicators provide impact rather than outcome metrics. Two previous studies[23, 29] focused on the impact of open-access publication, but not specifically on OA. In contrast to those studies, we did not assess social media mentions/citations, but instead concentrated on academic indicators. The distribution of impact scores was not measured. However, we did rank journals according to the Scimago JIF. We measured the h-index only for authors, institutions, and funding organizations leading osteoarthritis research in Europe. Our approach was consistent with previous studies.[8, 12, 15] Unlike some prior studies,[17, 18] we did not analyze coupling, co-authorship, co-occurrence, or co-citations, but focused exclusively on countries, authors, institutions, funding bodies, and research areas. Our findings for these parameters were consistent with those in earlier research.[8,9,11,16,19,27] We did not use bibliometric visualization software such as CiteSpace or VOSviewer.[20] Instead, we aimed to focus on the academic impact of collaborative studies.

The UK, Germany, and the Netherlands led the field in OA research in Europe when the number of articles and

Table 7. Top 20 leading journals in osteoarthritis research

	Journal	Web of Science Documents	Times Cited	Category Normalized Citation Impact	Journal Impact Factor	JIF Quartile	Citation Impact	Domestic Collaborations	International Collaborations
1	Osteoarthritis and Cartilage	901	27,363	2.17	7.2	Q1	30.37	356	413
2	BMC Musculoskeletal Disorders	585	8,051	1.18	2.2	Q2	13.76	305	144
3	Scientific Reports	389	8,772	1.61	3.8	Q1	22.55	191	111
4	Arthritis Care & Research	354	9,919	1.62	3.7	Q1	28.02	165	163
5	PLOS ONE	310	5,294	1.04	2.9	Q1	17.08	178	71
6	Journal of Orthopaedic Surgery and Research	247	2,942	1.82	2.8	Q1	11.91	111	21
7	Journal of Orthopaedic Research	238	4,170	1.28	2.1	Q2	17.52	123	63
8	Arthritis Research & Therapy	233	5,671	1.63	4.4	Q1	24.34	104	79
9	Arthritis & Rheumatology	210	11,032	3.17	11.4	Q1	52.53	89	93
10	Clinical Rheumatology	195	2,896	0.87	2.9	Q2	14.85	115	34
11	Medicine	193	1,428	0.52	1.4	Q2	7.40	96	16
12	Knee Surgery, Sports Traumatology, Arthroscopy	183	4,852	2.18	3.3	Q1	26.51	90	61
13	BMJ Open	183	1,797	0.69	2.4	Q1	9.82	98	56
14	International Journal of Molecular Sciences	181	2,760	0.92	4.9	Q1	15.25	83	50
15	Cartilage	181	2,314	1.47	2.7	Q1	12.78	84	51
16	Journal of Clinical Medicine	170	1,232	0.98	3	Q1	7.25	96	50
17	International Immunopharmacology	169	2,768	1.57	4.8	Q1	16.38	97	7
18	Annals of the Rheumatic Diseases	161	11,589	4.34	20.3	Q1	71.98	52	99
19	Knee	151	1,711	1.02	1.6	Q2	11.33	75	30
20	Rheumatology	142	2,480	1.00	4.7	Q1	17.46	53	59

citations were considered. Their CI, CNCI, and IREW values were above the global baseline. The USA, China, and Japan were previously reported to have published the highest number of documents, followed by the UK and Germany.[17] France, Italy, and the Netherlands were also among the top-ranking European countries in that study. The same top three countries (UK, Germany, and the Netherlands) were identified in another previous study.[6] Our findings for country-level analysis are in line with these studies, with slight differences in ranking. Previous studies retrieved all document types, while our study focused on articles only. These differences in ranking could be due to how our dataset was clustered. The highest CI was observed in the Netherlands and Switzerland. In contrast, Romania, Türkiye, and Russia had the lowest CI values among the top 25 countries evaluated. A recent study[27] ranked countries based on average citations.

Spain, the UK, France, Germany, Italy, and Türkiye were identified as top-performing countries in that study. Our CI findings differ

from that study. The reason for this difference could be that our focus was limited to Europe. The highest CNCI was recorded in Finland, followed by Switzerland and the Netherlands. Sweden and Norway also performed strongly. Romania, Türkiye, and Russia had the lowest CNCI values among the top 25 countries. Their CNCI values were below the world average. Switzerland showed the highest IREW value, followed by the Netherlands, Greece, and the Czech Republic. The lowest IREW value belonged to Türkiye. These findings indicate that some countries focused on the quantity of publications rather than quality. Previous studies did not evaluate CNCI and IREW as outcome metrics. The evaluation of these parameters in our study is novel. We therefore conclude that the quality of publications should be prioritized in future OA studies. Leading authors in OA research in Europe were affiliated with the Manchester University NHS Trust (UK), the University of Erlangen Nuremberg (Germany), and Erasmus University (the Netherlands). Leading authors varied depending on the research topic. For example, a recent publication[20] on the role of macrophages in OA identified Tak PP, van den Berg WB, van der Kraan PM, Straub RH, van Lent PLEM and van OSCH GJVM as leading authors. Boileau P (France), Simovitch RW (Switzerland), Levigne C (France), Gerber C (Switzerland), and Levy O (UK) were recognized as leading authors in studies on shoulder arthroplasty, based on top-cited documents.[22] Compared to these studies, we analyzed authors who published articles with the keyword "osteoarthritis" in the title of their manuscripts.

We conclude that author analysis should be conducted for specific research areas or subtopics. The top institutions identified in our study were UDICE-French Research Universities, the University of Oxford (UK), and Assistance Publique Hopitaux Paris (APHP). These institutions had CI, CNCI, and IREW values above the global baseline. In line with our findings, a recent publication[19] on publication trends for platelet-rich plasma use in OA evaluated the performance of institutions globally using PubMed and Scopus databases. The Rizzoli Orthopedic Institute was the only European institution listed among the top 10 organizations in that study. It did not appear in our list, possibly because Rizzoli has a specific research focus on platelet-rich plasma. Another study,[14] which focused on arthroscopic treatment of OA, published a visualization map of contributing institutions. McMaster University, the University of Bern, the University of Southern Denmark, and Lund University appeared in this map. As with author rankings, the research area determines the ranking of institutions. The United States Department of Health & Human Services, the National Institutes of Health (NIH-USA), and the National Natural Science Foundation of China (NSFC) funded 6,070 (40%) of the 14,949 OA-related articles analyzed as outcomes of funded studies.

However, we did not assess the monetary value of funding, as we did not have access to that database. Only 3,313 (22%) articles were funded by EU sources, with the European Commission being the top funding body in Europe. Funding patterns were evaluated in a previous study focused on unicompartmental knee arthroplasty.[10] In that study, the National Institute for Health Research (NIHR), Biomet, and the University of Oxford were identified as the top three funding bodies.[10] The difference between our study and the referenced study may be attributed to the specificity of the research focus. The top research areas driving OA research in Europe were rheumatology, orthopedics, and sport science. Sports injuries can lead to the early onset of secondary OA, which should be prevented to reduce the burden on healthcare systems. Unlike a previous study,[19] we did not rank the journals publishing OA research in Europe. However, our findings highlight that orthopedics and sports medicine were prominent research areas following rheumatology.

The limitations of this study were primarily due to our focus on research quality rather than productivity. We evaluated quality through CI, CNCI, and IREW distributions and therefore did not perform coupling analysis. Co-authorship, co-citation, co-occurrence analyses, and total link strength[8] were not measured in order to stay aligned with our primary objectives. These types of analyses can easily be undertaken in future studies. Altmetric indicators,[15] the composite reliability index, average variance extracted,[24] and mentions on social platforms[12,13,23] were not calculated due to the low reliability of such data. We also assessed quality through journal quartiles, particularly in relation to multidisciplinary and collaborative work. Highly cited papers[10] and research direction distribution maps were not included. Instead, we focused on the quality of articles with a European institutional address. Establishing collaborations and networking with European authors and institutions remains our future goal. Citation bursts[16] were also not explored. Another limitation of the study was the exclusion of other databases. For example, Google Scholar does not provide citation data, and thus the impact of outcomes cannot be evaluated precisely.

This study revealed that multidisciplinary and collaborative research tends to have higher impact compared to single-centered, non-collaborative work. We evaluated research quality using CI, CNCI, and IREW distributions in article titles containing the keyword "osteoarthritis." The articles analyzed were affiliated with European institutions and published between 2015 and 2024. Our aim was to identify the authors and institutions leading OA research in Europe.

Scientometric information on OA research may enhance collaboration and help expand our research network. Web of Science articles, citations, and CI, CNCI, and IREW distributions

varied between EU and non-EU countries. The EU baseline for CI, CNCI, and IREW was higher than the global baseline. The United Kingdom, Germany, and the Netherlands were the leading countries in terms of the number of articles. Leading authors and institutions were identified. Research funding was sourced primarily from outside Europe. Rheumatology, orthopedics, and sport sciences were the three leading OA research areas identified in this study. Articles published with multidisciplinary and collaborative approaches were more frequently published in Q1 and Q2 journals compared to Q3 and Q4 journals from 2015 to 2024 in the field of OA research. This was the most important outcome of the study.

CONCLUSION

This study demonstrates that multidisciplinary and international collaborative research significantly enhances the academic impact of osteoarthritis publications in Europe. The United Kingdom, Germany, and the Netherlands lead in both research output and citation impact, while non-EU countries such as Switzerland and Norway show comparable performance in normalized citation metrics.

Collaborative studies, particularly those involving international partnerships, are more likely to be published in high-impact journals (Q1-Q2), indicating a strong correlation between collaboration and research visibility. Public funding bodies, especially those based in the UK (e.g., UKRI, MRC, Versus Arthritis), are associated with higher citation impact compared to industry-funded research.

The findings highlight the importance of cross-border and cross-institutional collaborations in advancing OA research. Encouraging strategic partnerships and interdisciplinary approaches can enhance both the quality and global influence of OA studies. From a policy and clinical perspective, increasing investment in collaborative research and supporting open-access platforms may help translate high-impact findings into improved patient outcomes and healthcare strategies.

Ethics Committee Approval: Ethics committee approval was not required for this study.

Informed Consent: Written informed consent was not required for this study.

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