



Global research hotspots and trends of osteoporosis and osteoarthritis comorbidity from 2005 to 2025: a bibliometric and visualized analysis

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Abstract

Aim: Osteoporosis and osteoarthritis are two common skeletal disorders that often occur together, a condition known as comorbidity. Bibliometrics were used to visualize the literature on osteoporosis and osteoarthritis comorbidity and to explore the research progress and trends in this field.

Methods: A bibliometric analysis of literature on osteoporosis and osteoarthritis comorbidity from 2005 to 2025 in the Web of Science database was conducted using CiteSpace and VOSviewer to map and visualize authors, countries/institutions, journals, and keywords in the field.

Results: A total of 3,021 articles were retrieved, and the overall number of articles was on the rise. The author with the most publications was Reginster, Jean-Yves (53). The country with the most publications was China (880). The journal with the most publications was *Osteoporosis International* (102). It was found that universities had the highest number of publications in this field. The most frequently cited literature was “Radiological assessment of osteo-arthritis”. The most frequent keyword was osteoporosis. A total of 4 clusters were obtained using keyword cluster analysis: #0 bone mineral density, #1 stem cells, #2 subchondral bone, and #3 disease. The keywords with the highest burst intensity were subchondral bone, mesenchymal stem cells, oxidative stress, inflammation, and apoptosis. These keywords have remained important since their emergence.

Conclusions: This field is generally on the rise. The focus of research has shifted to the study of comorbid cellular and molecular pathological mechanisms. There are still many challenges in this area. In the future,



the path of comorbidity should be identified to promote the translation of basic research findings into clinical applications.

Keywords

osteoporosis and osteoarthritis comorbidity, osteoporosis, osteoarthritis, bibliometrics, CiteSpace, VOSviewer

Introduction

Osteoarthritis (OA) and osteoporosis (OP) are both degenerative diseases that are related to age and more common in older women [1]. OA can affect the entire synovial joint, typically manifesting as articular cartilage damage, subchondral bone degeneration, synovial and tissue vascular proliferation, and reduced tendon and ligament stability [2, 3]. Articular cartilage undertakes joint load transfer and buffers and protects subchondral bone by virtue of its unique mechanical properties. With the influence of factors such as age and mechanical overload, its structure and mechanical properties change, resulting in progressive degeneration of joint tissue [4]. OA can cause cartilage structure damage, increase joint friction, reduce bearing capacity, and accelerate cartilage degradation [5]. In the process of joint degeneration, the imbalance of trace element homeostasis can regulate oxidative stress, inflammatory response, and apoptosis, and participate in cartilage tissue injury and joint degeneration [6]. OP is primarily characterized by impaired bone strength and deterioration of bone tissue [7–9]. Studies have found that OA can cause morning stiffness, joint swelling and even deformity, joint pain, and tenderness [10], and OP can increase the risk of fracture [11]. Traditionally, OP and OA are considered to be two independent and inversely related diseases. OP can reduce the incidence of OA (including knee OA and hip OA) [12, 13]. However, more and more evidence shows that OP and OA comorbidity is not a simple superposition of two diseases. They share multiple risk factors, including oxidative stress, inflammation, and apoptosis, and there is a causal relationship between them [14]. The essence is the disorder of the osteochondral unit, with the destruction of the subchondral bone microenvironment as the core [15]. OP and OA comorbidity is common in postmenopausal women with estrogen deficiency. Estrogen deficiency is the core common driving factor of OP and OA comorbidity, which can integrate and activate inflammation, oxidative stress, and apoptosis pathways, resulting in the overall damage of the osteochondral unit [16]. With aging, the risk of OP and OA comorbidity significantly rises, reducing the quality of life of patients and increasing the economic burden [12]. Therefore, OP and OA comorbidity cannot be simply treated according to the diagnosis and treatment principles of isolated OP or OA, but constitutes a unique and important clinical and scientific problem, which is worthy of further study.

In recent years, OP and OA comorbidity has attracted increasing attention in the medical community and has emerged as a key research focus. Although its clinical significance has been recognized, at present, this field focuses more on the interpretation of a single pathway or local pathological mechanism and lacks a systematic quantitative analysis of the overall research pattern, hot spot evolution, and frontier direction in this field. For example, the pathogenesis, pathological location, diagnosis, and treatment of comorbidity need further investigation. Therefore, it is of great significance to sort out the results of research in the field of OP and OA comorbidity, which is conducive to the future development of this field. Bibliometric visualization can objectively reveal the research hotspots and evolution trends in this field and provide a reference for the optimization of diagnosis and treatment strategies for OP and OA comorbidity patients.

Materials and methods

The flowchart for literature screening is shown in [Figure 1](#). This paper used Web of Science (Core Collection) as the data source, SCI-E and SSCI as the indexes, and the search formula was TS= (("osteoporosis" OR "porosis" OR "OP") AND ("osteoarthritis" OR "osteoarthrosis" OR "OA")). The search period was 2005-01-01–2025-12-31, and the literature types were Article and Review. A total of 3,167 articles were retrieved. The screening language was English, and the literature types Early Access,

Proceedings Paper, Book Chapters, and duplicate literature were excluded. And 3,031 articles were selected. After CiteSpace deduplication, 10 articles marked as 2026 by Web of Science were found. Because the research time had been exceeded, they were manually excluded. Finally, 3,021 articles were retrieved and exported in plain text format, and the retrieval data are documented in [Supplementary material 1](#) and [Supplementary material 2](#). Sensitivity analysis was carried out under the same database and CiteSpace parameters, and only comorbidity-related search terms were added to the search formula ([Supplementary material 3](#)). A total of 304 valid articles were obtained by the restricted search. The keyword clustering results no longer show clusters of stem cells and subchondral bone. The reason is that a strict search will rule out literature that only studies the pathological mechanism of OP or OA. Therefore, this study used a relatively broad search strategy to carry out the main analysis to show the complete research landscape. No full-text-based topic screening was performed on the main dataset, and the restricted dataset is only used for robustness evaluation.

The method used in this study was bibliometrics. Bibliometrics is a statistical analysis that describes or displays relationships among published information, such as books, documents, and other publications [17]. Since 1958, bibliometrics has gradually become a core research method for research groups across various fields worldwide [18]. In this study, CiteSpace (version 7.0.1) and VOSviewer (version 1.6.20) were used to analyze the retrieved literature. CiteSpace provides detailed literature and clear research results, serving as an important reference for scholars to deepen their understanding of research progress in this field, promote academic exchange, and grasp research trends [19]. CiteSpace is primarily used for co-citation analysis, generating a timeline diagram, and detecting burst words within a time slice [20]. VOSviewer can use citation data to generate a network diagram of authors, countries, journals, and related entities, and to construct a keyword correlation map based on co-occurrence data analysis [21]. In this study, CiteSpace was used to analyze keywords. The Time Slice was set to 2005–2025. #Years Per Slice was set to 1 year. Term Source was set to select the Title, Abstract, Author Keywords (DE), and Keyword Plus (ID). The Node Type was the keyword, and the selection criterion was g-index ($k = 2$).

Results

Basic quantitative information

The 3,021 articles used in this study were written by 15,616 authors from 3,953 institutions in 96 countries, and published in 921 journals. These articles received 140,569 citations from 13,652 journals.

Publication volume information

The trend in the number of articles on OP and OA comorbidity can be analyzed using the 3,021 retrieved articles (see [Figure 2](#)). The number of papers published during 2005–2010 is small, and the change is modest, indicating that the field is in its infancy. In 2012, the number of publications exceeded 100 for the first time; it then increased exponentially, peaking in 2025. The overall trend indicates substantial progress in the field in recent years and significant potential for future development.

Author

A total of 15,616 authors published literature on OP and OA comorbidity. [Table 1](#) shows the top 6 authors: Reginster, Jean-Yves, with 53 articles; Cooper, Cyrus, with 50 articles; and Yoshimura, Noriko, with 46 articles. According to Price's law, the minimum number of papers published by core authors in this field is $m = 0.749 \times \sqrt{n_{max}} \approx 5.45$ (n_{max} represents the number of papers published by the authors with the largest number of papers, that is 53), that is, the authors with the number of papers greater than or equal to 6 are the core authors. A total of 116 authors were selected, and 1,480 papers were published, accounting for 49% (< 50%) of the total number of papers, indicating that an influential core author group has not yet formed.

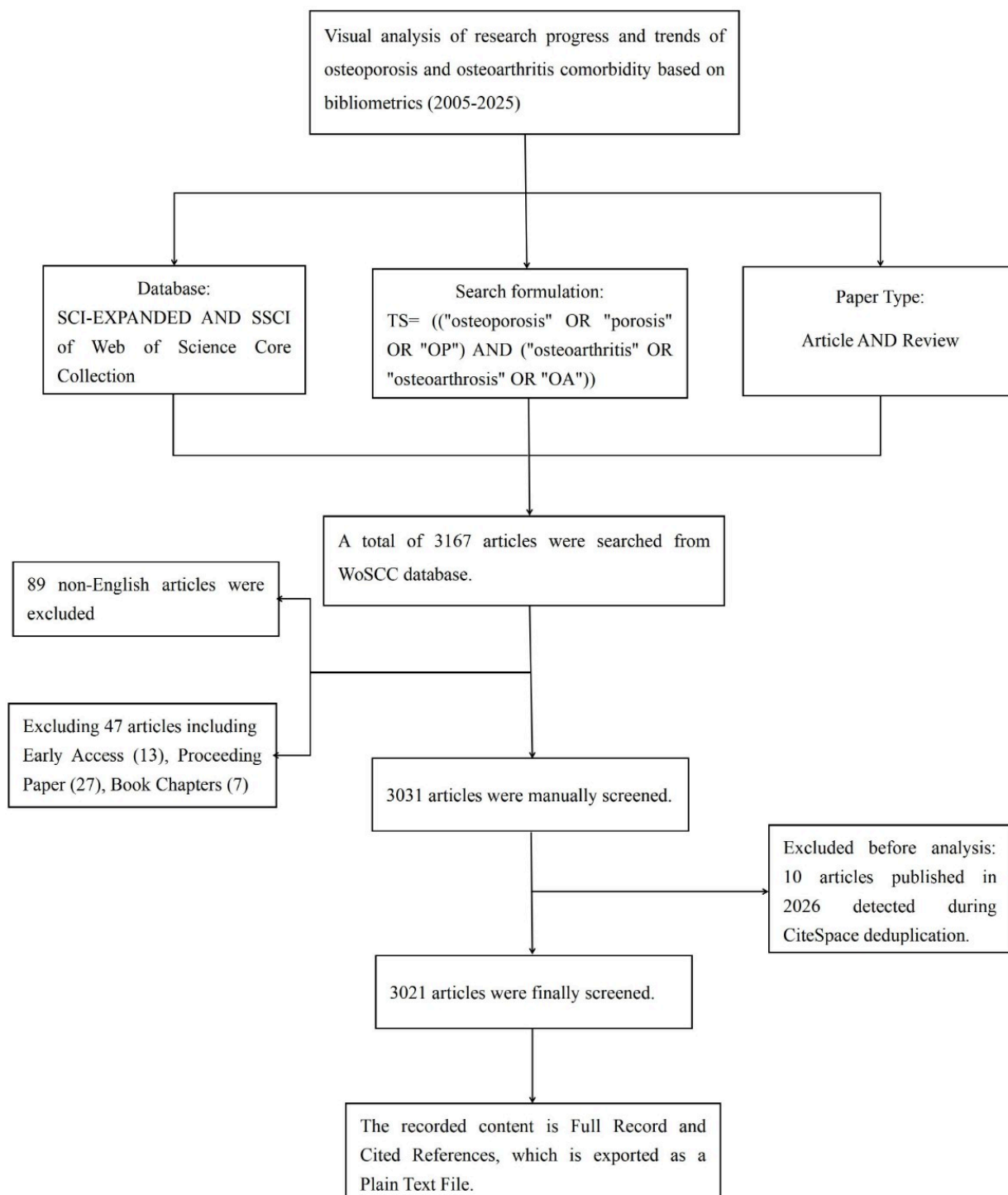


Figure 1. Flow chart of literature retrieval and screening.

Table 1. Authors in the top 6.

Rank	Author	Documents	Citations	Average citation/Publication
1	Reginster, Jean-Yves	53	4,582	86.45
2	Cooper, Cyrus	50	5,336	106.72
3	Yoshimura, Noriko	46	1,882	40.91
4	Muraki, Shigeyuki	44	1,853	42.11
5	Nakamura, Kozo	41	1,804	44.00
6	Oka, Hiroyuki	41	1,721	41.98

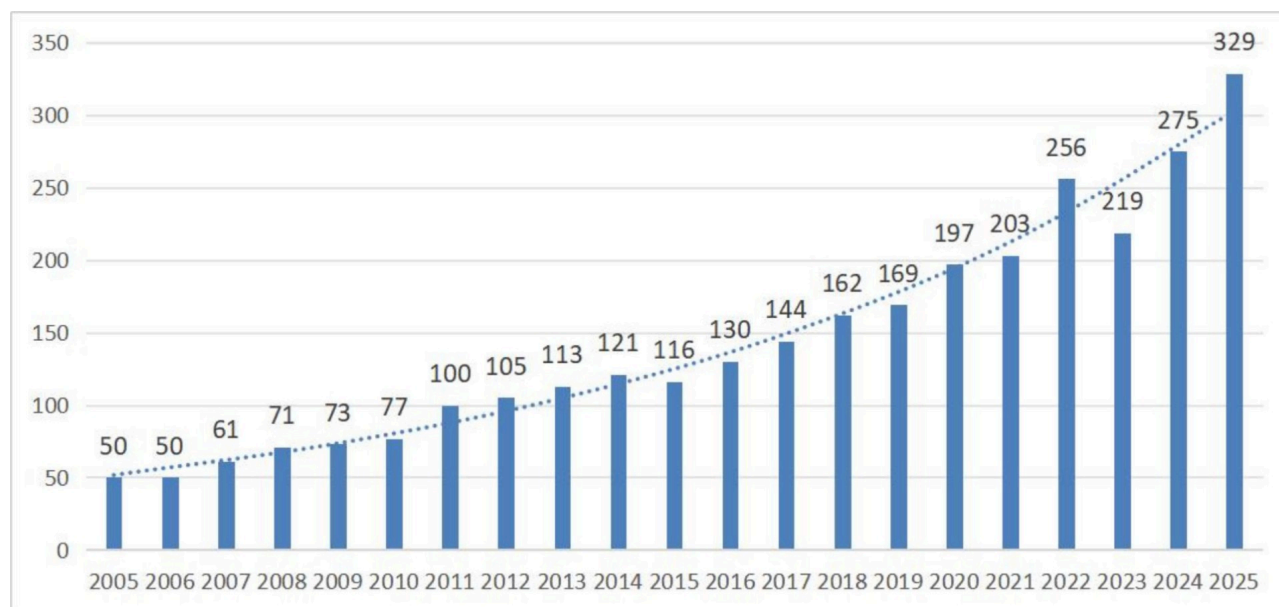


Figure 2. Trend of publication volume. It shows that the number of publications in the field is generally increasing.

Journals

A total of 3,021 articles were published in 921 journals. Table 2 shows the top five journals in the past 20 years. The top three journals are *Osteoporosis International* (102), *Osteoarthritis and Cartilage* (84), and *Bone* (61). The analysis shows that *Osteoporosis International* not only has the highest number of publications but also the highest number of citations per article, up to 103.71, reflecting its high citation impact within this field in the field of OP and OA comorbidity.

Table 2. Top 5 journals.

Rank	Source	Documents	Citations	Average citation/Publication
1	<i>Osteoporosis International</i>	102	10,578	103.71
2	<i>Osteoarthritis and Cartilage</i>	84	3,889	46.30
3	<i>Bone</i>	61	3,061	50.18
4	<i>BMC Musculoskeletal Disorders</i>	57	1,094	19.19
5	<i>International Journal Of Molecular Sciences</i>	54	1,587	29.39

Country

A total of 96 countries published literature on OP and OA comorbidity. This study used VOSviewer to conduct a visual analysis of countries with more than 5 publications (Figure 3). Table 3 shows the top five countries by number of publications. The analysis shows that China has the largest number of publications, up to 880, but its average number of citations per article is low, only 24.46, indicating that China's contribution to this field is large, but its attention in this field is limited. The USA ranked second by the number of publications, with 606 articles published, and the average number of citations was 56.42. The United Kingdom has the highest citation rate per article, up to 75.11, reflecting its high citation impact within this field.

Table 3. Top 5 countries.

Rank	Country	Documents	Citations	Average citation/Publication
1	China ^a	880	21,521	24.46
2	USA ^b	606	34,192	56.42
3	United Kingdom ^c	324	24,337	75.11
4	Japan	232	8,072	34.79
5	Italy ^d	225	12,454	55.35

^aThe People's Republic of China; ^bThe United States of America; ^cThe United Kingdom of Great Britain and Northern Ireland; ^dThe Republic of Italy.

Institution

A total of 3,953 institutions published literature on OP and OA comorbidity. In this study, VOSviewer was used to visualize the institutions with more than 16 articles (Figure 4). Table 4 shows the top five institutions by number of publications: University of Southampton (94), University of Liège (83), University of Oxford (80), University of Tokyo (69), and University of Sheffield (53). Among them, the institution with the highest citation rate per paper is the University of Sheffield, indicating that its research results have received close academic attention in this field. It is worth noting that the top five institutions are well-known universities, reflecting that universities dominate this field.

Table 4. Top 5 institutions.

Rank	Institution	Country/region	Documents	Citations	Average citation/Publication
1	University of Southampton	United Kingdom ^a	94	10,086	107.30
2	University of Liège	Belgium ^b	83	9,115	109.82
3	University of Oxford	United Kingdom ^a	80	9,272	115.90
4	University of Tokyo	Japan	69	3,317	48.07
5	University of Sheffield	United Kingdom ^a	53	11,102	209.47

^aThe United Kingdom of Great Britain and Northern Ireland; ^bThe Kingdom of Belgium.

Keyword analysis

Keywords co-occurrence

CiteSpace was used to draw the keyword co-occurrence network of OP and OA comorbidity, and high-frequency keywords with a frequency of 70 or more were displayed. The keyword co-occurrence map with 78 nodes and 602 connections was obtained (see Figure 5). The top five frequent keywords (Table 5) were OP (640), OA (627), bone mineral density (BMD) (388), knee OA (329), and rheumatoid arthritis (264). The top five central keywords (Table 5) were OP (0.36), OA (0.29), knee OA (0.15), rheumatoid arthritis (0.12), and articular cartilage (0.10). According to the analysis, the connections and distinctions between OA and rheumatoid arthritis, and between BMD and articular cartilage, are the research hotspots in this field.

Table 5. Top 5 keywords in frequency and centrality.

Rank	Count	Keywords	Centrality	Keywords
1	640	Osteoporosis	0.36	Osteoporosis
2	627	Osteoarthritis	0.29	Osteoarthritis
3	388	Bone mineral density	0.15	Knee osteoarthritis
4	329	Knee osteoarthritis	0.12	Rheumatoid arthritis
5	264	Rheumatoid arthritis	0.10	Articular cartilage

Keyword clustering

Based on the keyword co-occurrence network, the Log-Likelihood Ratio (LLR) algorithm was used to cluster keywords in the literature on OP and OA comorbidity. The cluster analysis map (Figure 6) showed that the Q value was 0.2752, which was lower than 0.3, indicating some cross-fusion among clusters in the research field. This may be because OP and OA comorbidity itself has a high degree of intersectionality. In a large number of studies, the pathological mechanisms and risk factors of these two diseases are discussed at the same time. Therefore, the themes of the literature naturally overlap, and the boundaries between clusters are not clear. At the same time, the keywords used in Web of Science retrieval are also relatively broad, which may further reduce the degree of separation between clusters. The S value was 0.6213, which was greater than 0.5, indicating that the clustering results were reasonable and reliable. A total of 4 clusters

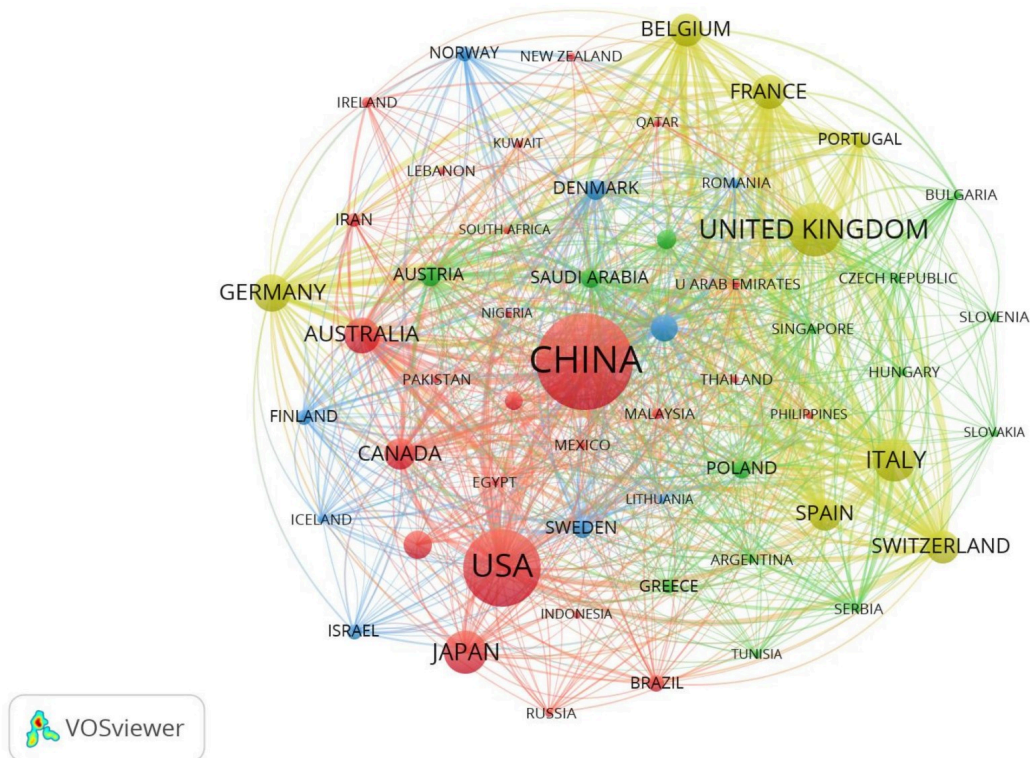


Figure 3. A map of the co-occurrence of countries. It shows the number of publications and cooperative relations between different countries. Among them, the size of the circle indicates the number of national publications; the larger the circle, the more publications. The connections between circles represent the degree of correlation. The thicker the line, the stronger the degree of correlation.

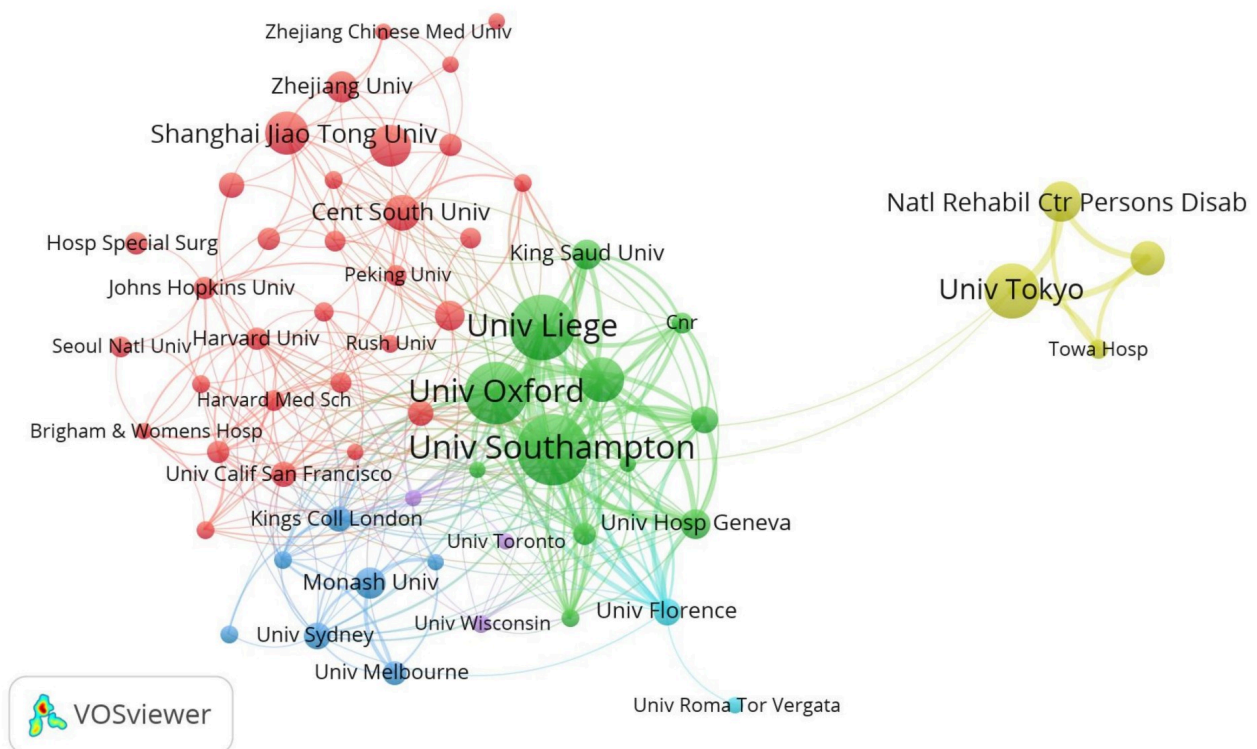


Figure 4. Co-occurrence map of relevant institutions. It shows the number of publications and cooperative relations among different institutions. Among them, the circle's size indicates the number of papers the institution has published. The larger the circle, the more papers are published; the connection between circles represents the degree of correlation. The thicker the line, the stronger the degree of correlation.

CiteSpace, v. 7.0.1 (64-bit) Advanced ✓
 September 7, 2026, 9:25:49 PM CST
 WoS: C:\Users\huangyue\Desktop\big data\Odata
 Timespan: 2005-2025 (Slice Length=1)
 Selection Criteria: g-index (k=2), LRF=2.5, L/N=10, LBY=5, e=1.0
 Network: N=78, E=602 (Density=0.2005)
 Largest CC: 78 (100%)
 Pruning: None

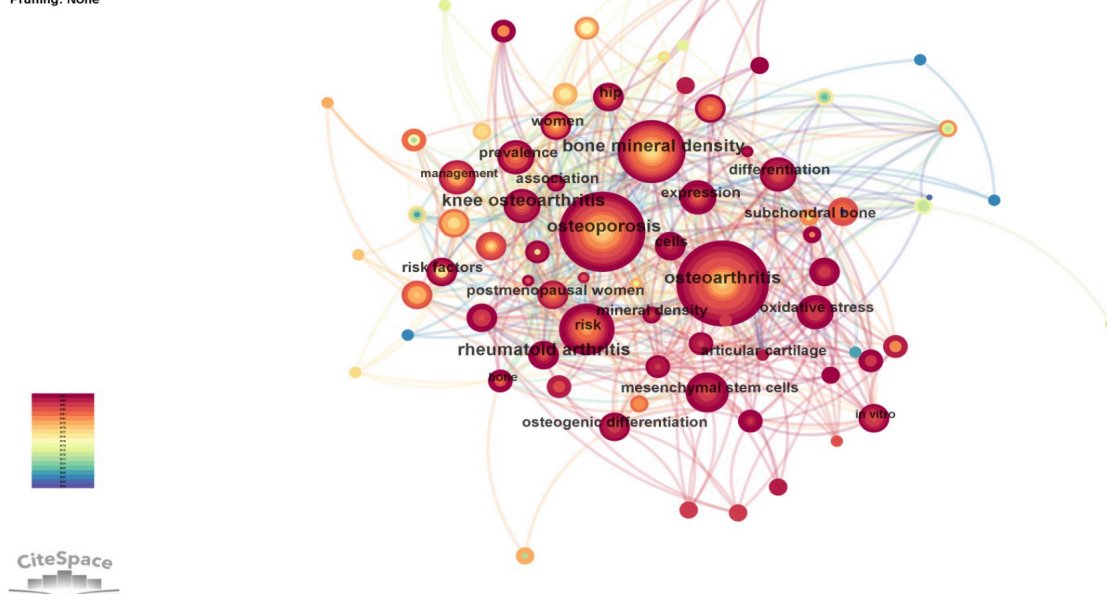


Figure 5. Keyword co-occurrence map. It shows the frequency and co-occurrence intensity of keywords in the field. Among them, the circle represents the keyword. The larger the circle, the higher the frequency of the keyword. The connections between the circles can reflect the correlations among the keywords.

were formed in this study, namely #0 bone mineral density, #1 stem cells, #2 subchondral bone, and #3 disease. Among them, #0 bone mineral density, #2 subchondral bone, and #3 disease mainly focus on the characteristics of OP and OA comorbidity, pathogenesis, and clinical diagnosis and treatment. #0 bone mineral density focuses on measuring BMD and its role in comorbidity. #2 subchondral bone focuses on the pathological changes of subchondral bone and its effect on joint function. #3 disease is related to the epidemiology, pathogenesis, and clinical diagnosis of the disease. #1 stem cells focuses on stem cell-mediated bone and cartilage complex repair, exploring its mechanism for regulating subchondral bone remodeling and cartilage regeneration. These clusters are closely connected. Researchers can explore new research directions at these intersections.

Keyword emergence

Based on the keyword co-occurrence network, the keyword burst intensity over a specific time period was analyzed, with the red line indicating the keyword burst period (see Figure 7). Subchondral bone and cancellous bone have been present since at least 2005, and subchondral bone has emerged from 2005 to 2018 with the highest intensity (17.91), indicating that subchondral bone was the core theme of this field over the previous decade, including how subchondral bone injury leads to OA and the association between its pathology and OP. Among the 10 high-frequency keywords, mesenchymal stem cells (MSCs) (15.98), oxidative stress (16.75), inflammation (16.37), apoptosis (14.39), and cells (13.57) have remained prominent since the burst. There remain many aspects to explore regarding cellular-level physiological activities (e.g., oxidative stress, apoptosis, and intercellular communication) and the dynamic regulation of inflammation. Further investigations are needed to elucidate the pathological mechanisms, diagnosis, and treatment strategies of these two diseases and their comorbidity.

Keyword timeline analysis

Based on keyword co-occurrence, the x-axis shows the year the keywords appear in the cluster, and the y-axis shows the keyword cluster, forming a keyword timeline diagram (Figure 8). The analysis shows that the four clusters all appeared earlier, but only #1 stem cells and #2 subchondral bone have persisted since their emergence, indicating that they are future research hotspots and trends. Many keywords emerged from 2005 to 2015, and all were closely related to those that followed, indicating that the field of OP and OA

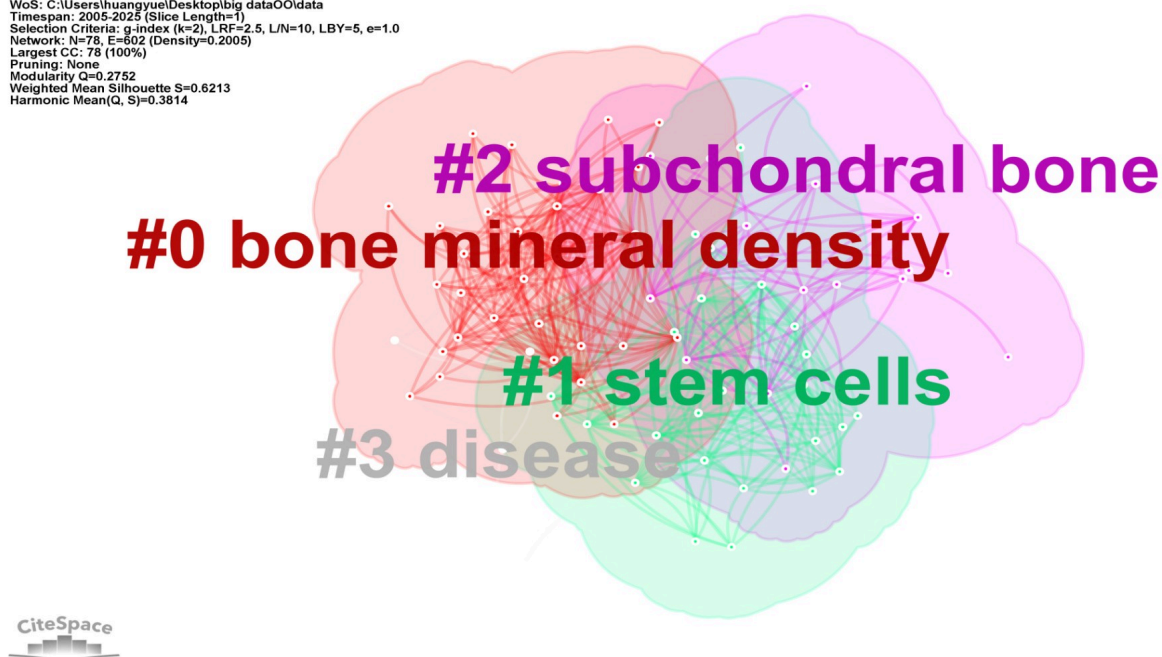


Figure 6. Keyword clustering map. It represents a cluster of all keywords in the field. A total of 4 clusters were formed in this study, namely #0 bone mineral density, #1 stem cells, #2 subchondral bone, and #3 disease.

Top 10 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2005 - 2025
subchondral bone	2005	17.91	2005	2018	
cancellous bone	2005	15.81	2005	2013	
women	2005	15.13	2010	2014	
postmenopausal women	2008	15.69	2013	2016	
management	2017	17.41	2017	2020	
mesenchymal stem cells	2016	15.98	2020	2025	
oxidative stress	2019	16.75	2022	2025	
inflammation	2022	16.37	2022	2025	
apoptosis	2022	14.39	2022	2025	
cells	2013	13.57	2022	2025	

Figure 7. Top 10 keyword burst map of burst intensity. The red line indicates the length of time during which the keyword bursts.

comorbidity had established a stable research direction in the early stage and continued to deepen and expand in subsequent research. In recent years, keywords such as MSCs, oxidative stress, and inflammation have emerged as new hotspots, indicating that researchers are more concerned with the cellular- and molecular-level pathological study of comorbidities.

Co-citation analysis

According to the co-cited journal co-occurrence network (Figure 9), the co-cited journals are divided into four clusters, corresponding to the four colors in the graph. Red clustering focuses on the study of bone metabolism, cell death, and other processes at the in vivo molecular level. Blue clustering mainly focuses on clinical and basic research on BMD and the diagnosis/treatment of OP. Green clustering mainly focuses on rheumatoid arthritis, and yellow clustering mainly focuses on cross-study analysis of hormone regulation of bone metabolism. Among them, *Journal of Bone and Mineral Research* (5,158), *Bone* (4,205), and *Osteoporosis International* (4,117) are the most cited journals.

Table 6. This literature focused on the relationship between OP and OA, the role of BMD in OA, and the application of imaging evaluation methods, which provided an important basis for understanding the pathological mechanisms, diagnosis, and treatment of OP and OA comorbidity [22–27].

Table 6. Top 6 co-cited articles.

Rank	Cited reference	Citations
1	Radiological assessment of osteo-arthritis	177
2	Osteoarthritis and osteoporosis: clinical and research evidence of inverse relationship	109
3	The relationship between osteoarthritis and osteoporosis in the general population: the Chingford Study	89
4	Osteoarthritis	81
5	Association of radiographically evident osteoarthritis with higher bone mineral density and increased bone loss with age. The Rotterdam Study	75
6	Bone density, osteoarthritis of the hip, and fracture of the upper end of the femur	75

Discussion

In this study, CiteSpace and VOSviewer were used to systematically and comprehensively analyze the literature on OP and OA comorbidity. Over the past 20 years, the number of publications in this field has increased steadily. In 2025, it exceeded 300 for the first time, indicating that this field has received more and more academic attention and is a very promising field. At present, many countries around the world are carrying out research on the relationship between OP and OA comorbidity. Although China has published the largest number of publications, the research influence still needs to be improved. Therefore, it is necessary to strengthen academic research and establish academic cooperation with other countries. Universities are the main research institutions, but there is a lack of cooperation between these institutions and authors. Therefore, international exchanges and cooperation among institutions, authors, and countries should be strengthened to improve research quality and promote the generalizability of research results.

According to keyword clustering and timeline analysis, stem cells and subchondral bone are long-term research hotspots in this field. There is evidence that subchondral bone, as the core structure of the osteochondral unit, not only undertakes the function of mechanical conduction, but also regulates the differentiation fate of bone marrow MSCs by constructing a local microenvironment. The plasticity of cell fate regulated by the subchondral bone microenvironment is the key mechanism of OP and OA comorbidity [15]. Studies have found that OP is characterized by trabecular bone remodeling and absorption, while OA is characterized by articular cartilage and subchondral bone remodeling. The integrity of articular cartilage function mainly depends on the mechanical properties of subchondral bone [28, 29]. Subchondral bone not only provides mechanical support for joints but also maintains joint health by promoting material exchange between bone and cartilage. OP and OA comorbidity is a special type of OA characterized by a significant decrease in subchondral BMD [30]. Another experiment used mice with OA and OP to demonstrate that the coexistence of OP in OA mice can increase the activity of subchondral bone cells, thereby exacerbating the pathological process of OA in calcified cartilage and subchondral trabecular bone [31]. MSCs are a main focus in stem cell research. MSCs are a class of fibroblast-like cells with self-renewal and multi-directional differentiation potential. They can migrate to the injured site and promote tissue repair by secreting anti-inflammatory factors and growth factors. Therefore, MSC-derived extracellular vesicles are safe for the treatment of comorbidities, are easy to store and manage, and promote fracture healing and bone tissue regeneration for bone-joint-related disorders [32, 33].

MSCs, oxidative stress, inflammation, apoptosis, and cells have become the main research directions. The inflammatory response also contributes to the comorbidity of OP and OA. Among them, osteopontin (OPN) is an important inflammatory factor. Its high expression may lead to bone erosion and cartilage degradation in OA and is closely associated with pain and pathological changes in OP. Decreased OPN activity may increase the risk of fracture in OP patients, especially postmenopausal women [34]. On the one hand, oxidative stress interacts with factors such as cell aging, mitochondrial dysfunction, and metabolic disorders to jointly promote the progressive destruction of OA joint structure and increase bone fragility in

OP patients [35]. On the other hand, it can also activate apoptosis, induce apoptosis of bone and cartilage cells, reduce bone regeneration ability, and aggravate bone mass loss [16].

Although important progress has been made in the field of OP and OA comorbidity, there are still many challenges in this field. 1) The association between OA and OP is non-linear, variable, and affected by many factors. The complete pathological process of comorbidity cannot be explained only based on systemic bone loss. 2) There is a lack of ideal animal models for comorbidity, and it is difficult to reproduce the real pathological process of OA and OP comorbidity. 3) The role of key signaling pathways is affected by the environment, and the conclusions obtained under certain conditions cannot be extended to all comorbidity scenarios [15]. 4) The clinical symptoms of OP and OA comorbidity overlap, the imaging manifestations are complex, and the risk factors and cellular and molecular pathways are shared, which makes the differential diagnosis of the disease and the clinical evaluation and management difficult [16]. These challenges are also the main research directions in the future.

In the future, researchers should focus on the pathogenesis and treatment of OP and OA comorbidity, clarify the relationship between MSC-related comorbidity treatment and BMD, inflammation, and oxidative stress, and build an extensive international exchange and cooperation network to benefit patients with the comorbidity.

There are still some limitations in this study. First, this study analyzed only English-language literature in the Web of Science database, potentially overlooking relevant studies published in other databases (such as PubMed and Scopus) or in non-English journals. Secondly, this study used CiteSpace and VOSviewer for analysis. Both require researchers to manually adjust parameters, which may introduce subjective bias into the results. Thirdly, the analysis primarily focused on quantitative metrics (such as publication volume and citation counts), making it difficult to distinguish research quality. Fourth, the retrieval formula of this study is relatively broad, and the comorbidity theme is not strictly limited, which leads to a certain degree of deviation in the dataset, and some literature that only studies OP or OA alone is included. At the same time, a small number of non-target disease-related literature, such as rheumatoid arthritis, were included, and there was data noise. Finally, this study is subject to time-lag bias, which naturally favors older publications and may underrepresent the impact of recent creative work.

Conclusion

This study conducted a bibliometric analysis of the literature on OP and OA comorbidity from 2005 to 2025. The overall number of publications in this field is on the rise. Stem cells and subchondral bone are the focus of long-term research. In recent years, the research focus in this field has gradually shifted to the study of the cellular and molecular pathological mechanisms of OP and OA comorbidity. However, there are still many challenges in this field, including the lack of standardized animal models that can truly simulate OP and OA comorbidity, and difficulties in differential diagnosis and clinical evaluation of diseases. In the future, researchers should strengthen the study of the pathological mechanism of OP and OA comorbidity, establish a standardized comorbidity model, and clarify the specific therapeutic effect of MSCs, so as to translate mechanistic discoveries into clinical benefits for patients with this comorbidity.

Abbreviations

BMD: bone mineral density

MSCs: mesenchymal stem cells

OA: osteoarthritis

OP: osteoporosis

OPN: osteopontin

Supplementary materials

The supplementary material 1 for this article is available at: https://www.explorationpub.com/uploads/Article/file/1007140_sup_1.pdf.

The supplementary material 2 for this article is available at: https://www.explorationpub.com/uploads/Article/file/1007140_sup_2.pdf.

The supplementary material 3 for this article is available at: https://www.explorationpub.com/uploads/Article/file/1007140_sup_3.pdf.

Declarations

Acknowledgments

During the preparation of this work, the authors used generative AI (Dou bao) only for partial sentence polishing within the abstract, introduction, results, and discussion sections. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication. All modified texts were carefully reviewed, revised, and edited manually by the authors. The research design, bibliometric analysis, data interpretation, and conclusions of this work were independently completed by the authors.

Author contributions

YH: Conceptualization, Visualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Software, Writing—original draft, Writing—review & editing. YX: Conceptualization, Visualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Software, Writing—original draft, Writing—review & editing. NC: Conceptualization, Visualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Software, Writing—original draft, Writing—review & editing. FG: Data curation, Formal analysis, Investigation, Methodology, Validation, Software, Project administration, Funding acquisition, Resources, Supervision, Writing—review & editing. All authors read and approved the submitted version.

Conflicts of interest

Fuqiang Gao, who is an Editorial Board Member of Exploration of Musculoskeletal Diseases, had no involvement in the decision-making or the review process of this manuscript. The other authors declare no conflicts of interest.

Ethics approval

Not applicable.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analysed during the current study are available in Web of Science databases and included within the article and its additional files. The datasets supporting the conclusions of this article are included in the [Supplementary materials](#).

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