Research hotspots and trends in bone cancer pain: a bibliometric analysis from 1994--2023

huang jinzhao, houming kan, ping lu, chi wang, wen shen

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huang jinzhao[1, 2, 3*]; houming kan[1, 2, 3*]; ping lu[3*]; chi wang[3]; wen shen[4]

[1]Jiangsu Province Key Laboratory of Anesthesia and Analgesia Application Technology, Xuzhou Medical University, Xuzhou, Jiangsu, People's Republic of China xuzhou CN
[2]NMPA Key Laboratory for Research and Evaluation of Narcotic and Psychotropic Drugs, Xuzhou, Jiangsu, People's Republic of China xuzhou CN
[3]Jiangsu Province Key Laboratory of Anesthesiology, Xuzhou Medical University, Xuzhou, Jiangsu, People's Republic of China xuzhou CN
[4]Department of Pain, Affiliated Hospital of Xuzhou Medical University, Xuzhou, Jiangsu, People's Republic of China xuzhou CN
[*]these authors contributed equally

Corresponding Author:
wen shen
Department of Pain, Affiliated Hospital of Xuzhou Medical University, Xuzhou, Jiangsu, People's Republic of China
Xuzhou City, Jiangsu Province, China
jiangsu province
xuzhou
CN

Abstract

Background: Bone cancer pain is caused primarily by the invasion of bone tissues and surrounding structures, such as nerves and blood vessels, by primary bone tumors or metastatic bone tumors, which poses significant challenges for both patients and healthcare providers. However, there is currently no effective treatment for BCP.

Objective: In the last few years, there has been an increasing amount of research on bone cancer pain, and by analyzing and visualizing the literature on this topic, our objective has been to gain an understanding of the current state of research and the major issues in this field. This will allow us to make informed predictions about the future trajectory of research in this area.

Methods: Relevant literature in the field of bone cancer pain was retrieved from the Web of Science core ensemble search, relevant literature in the field of bone cancer pain was retrieved, and then Citespace, Gunnmap online world maps and Microsoft Excel 2020 were used for bibliometrics and visualization analysis.

Results: A total of 1976 WoS core databases were included. The visual analysis results indicate a year-over-year increase in the number of publications. Pain is the most influential journal (981 cocitations). The most productive nations and organizations were China (666) and Huazhong University of Science and Technology (54), respectively. Yao Ming (18) was the most prolific author, and Robert E Coleman (477 cocitations) was the most influential author. Bone metastases resulting from breast cancer, as well as the mechanisms of bone cancer pain, are currently hot topics of research.

Conclusions: The studies conducted thus far have demonstrated that the peripheral mechanisms implicated in the genesis of bone cancer pain encompass the tumour microenvironment, bone tissue damage, peripheral nerves and dorsal root ganglion sensitisation. However, there is a paucity of research investigating the role of the central nervous system in this phenomenon. Furthermore, there is a need to explore more efficacious treatments to further optimise the clinical management of patients with bone cancer pain.

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Research hotspots and trends in bone cancer pain: a bibliometric analysis from 1994--2023

Jinzhao Huang[1-3,*]

Houming Kan[1-3,*]

Ping Lu[1,*]

Chi Wang[1]

Liping Chen[4]

Wen Shen[4]

[1]Jiangsu Province Key Laboratory of Anesthesiology, Xuzhou Medical University, Xuzhou, Jiangsu, People's Republic of China; [2]Jiangsu Province Key Laboratory of Anesthesia and Analgesia Application Technology, Xuzhou Medical University, Xuzhou, Jiangsu, People's Republic of China; [3]NMPA Key Laboratory for Research and Evaluation of Narcotic and Psychotropic Drugs, Xuzhou, Jiangsu, People's Republic of China; [4]Department of Pain, Affiliated Hospital of Xuzhou Medical University, Xuzhou, Jiangsu, People's Republic of China

*These authors contributed equally to this work

Correspondence: Wen Shen; Liping Chen
Tel: +86-516-85609999
Email: shenwenxmu@163.com; 1132927346@qq.com

Background: Bone cancer pain is caused primarily by the invasion of bone tissues and surrounding structures, such as nerves and blood vessels, by primary bone tumors or metastatic bone tumors, which poses significant challenges for both patients and healthcare providers. However, there is currently no effective treatment for BCP. In the last few years, there has been an increasing amount of research on bone cancer pain, and by analyzing and visualizing the literature on this topic, our objective has been to gain an understanding of the current state of research and the major issues in this field. This will allow us to make informed predictions about the future trajectory of research in this area.

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and then Citespace, Gunnmap online world maps and Microsoft Excel 2020 were used for bibliometrics and visualization analysis.

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Conclusion: The studies conducted thus far have demonstrated that the peripheral mechanisms implicated in the genesis of bone cancer pain encompass the tumour microenvironment, bone tissue damage, peripheral nerves and dorsal root ganglion sensitisation. However, there is a paucity of research investigating the role of the central nervous system in this phenomenon. Furthermore, there is a need to explore more efficacious treatments to further optimise the clinical management of patients with bone cancer pain.

Keywords: Bone cancer pain, cancer-induced bone pain, bibliometrics, CiteSpace, Web of Science

Introduction

Cancer has emerged as a significant social and public health issue in the 21st century.[1] The International Agency for Research on Cancer (IARC) reported that in 2022, approximately 20 million new cancer cases and 9.7 million cancer-related deaths are expected worldwide, with the largest number of new cases being lung cancer, accounting for one-eighth of all cases.[2] Bone cancer pain (BCP) is chronic pain caused by the destruction of bone by primary bone tumors and/or tumor metastasis and is the most common type of chronic cancer pain.[3] Breast, prostate, and lung cancers are the three types of cancers that are most likely to metastasize to bone.[4] There are 300,000 cases of cancer bone metastases each year in the United States. The treatments for BCP mainly include medication, physiotherapy, psychotherapy and surgery. Drug treatment is the main treatment method for BCP.[5,6] The World Health Organization (WHO) recommends the use of three-step cancer therapy, but prolonged use of nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids frequently results in adverse effects, including gastrointestinal reactions, addiction, nausea, and severe respiratory depression.[7]

Bibliometric analysis is a scientific approach used to evaluate published academic literature, identify relevant data, and forecast future trends in a specific research field.[8,Error: Reference source not found] Furthermore, CiteSpace software has been extensively utilized for quantitative analysis and the visualization of maps.[9] Specifically, data about journals, countries, institutions, authors and keywords can be analyzed.

Currently, there are no papers that focus on BCP bibliometric analyses. Therefore, we conducted a comprehensive search of the Web of Science Core Collection database and analyzed the results via Microsoft Excel (version 2020), CiteSpace and other software to summarize the results of previous studies and provide a basis for future research.

Data and methods

Data collection and strategy for data retrieval

The Web of Science Core Collection (WoSCC) is a high-quality digital literature resource database that is considered the most suitable database for bibliometric analyses and is accepted by most scholars; thus, the Wo SCC database was chosen as the search database for this study. We conducted a literature search on 18 November 2024 and retrieved a total of 2313 articles. The search strategy was as follows: TS= (“bone cancer pain” or “cancer-induced bone pain” or “bone metastasis”) AND TS = (“pain”). Articles were retrieved from the years 1994--2023, and the type of literature was article or review. We then examined the titles, abstracts, author keywords and subject headings of all the documents and removed those that were not relevant. In the end, 1976 documents remained after deletion, and all of them were cited by CiteSpace (Figure 1).

Data analysis

CiteSpace is a renowned bibliometric tool that facilitates the visualization of research trends by analyzing the interconnections among various elements (such as authors, journals, and keywords) within the academic literature. We utilize this software to convert quantitative literature data into visual maps and networks that reveal crucial information, such as research hotspots, boundaries, and international collaborations among countries/regions/institutions. The various CiteSpace visualization graphs contain numerous nodes and links. Nodes can represent different journals, institutions, nations, keywords, etc. The size of a node corresponds to the frequency or citation count in that area. The relationship between them can be represented by the connecting lines between the nodes. If the nation/district/institution represented by the node is mentioned in

the same document, a connecting line appears between them. Different colors represent different publication years. The more recent the date is, the warmer the color of the node/link, and the earlier the date is, the cooler the color of the node/link. The magnitude of centrality represents the importance of the node in the network. In CiteSpace, nodes with purple circles are considered central nodes with high centrality.

Results

Annual Publication Outputs

A total of 1,749 articles were included in this study. During the period from 1994--2019, the number of papers published each year on the BCP showed a steady upward trend. (Figure 2) The publication volume of articles on BCP reached its zenith in 2021, with a total of 144 articles, closely followed by 2019, which accounted for 142 articles. Since 2014, the number of publications per year has stabilized at more than 100. Overall, 80% of all publications were original research articles, and 20% were review articles.

Analysis of journals

The search on BCP covered a total of 226 journals. Table 1 shows the top 10 cocited journals. The journal *Pain* is the most cocited journal, with a total of 981 citations. This shows that the journal has some authority in the field of BCP research and that its articles represent, to some extent, the research hotspots in the field, indicating future research directions. Five out of ten journals belong to the USA, indicating that the USA has a great deal of influence in this field. According to the JCR journal classification criteria, eight of the top ten journals are classified as Q1, and the other two are classified as Q2. The journal *Proceedings of the National Academy of Sciences of the United States of America* had the highest median centrality (centrality = 0.63,).

Analysis of coauthors' countries

According to CiteSpace bibliometric analyses, research teams from 66 countries produced 1976 publications. Table 2 shows the top ten countries in terms of the number of articles published. Figure 4 shows a world heatmap of the number of articles issued in each country. The most productive country was China (n=666, centrality= 0.13). The three countries following China were the United States (n = 460, centrality = 0.63), Japan (n = 208, centrality = 0.26) and the United Kingdom (n = 119, centrality = 0). Although China is well ahead of other countries in terms of the number of publications, its centrality is low, and the United States is at

a higher level in terms of both the number of publications and centrality. Figure 5 illustrates the representativeness of international cooperation between countries/regions.

Analysis of coauthors' institutions

Error: Reference source not found shows the most prolific institutions in BCP publications. The most prolific institution was Huazhong University of Science and Technology (n=54, centrality=0.15), followed by the University of Minnesota System (n=40, centrality=0.01) and the University of London (n=36, centrality=0.09). Most of the top ten most productive institutions are from China and the United States. Figure 6 illustrates the partnerships between the different institutions. The bibliometric and visual analyses show a low-density plot (density=0.0125), indicating less collaboration between different research institutions.

Analysis of cocited references

The citation frequency of a study's published literature can be employed to illustrate its academic impact within the research domain. The ten most cited papers on BCP are listed in Table 4.[5,11-19] The ten most cited papers range from 27--47 citations. The most cited paper is Patrick Mantyh's 'Bone cancer pain: causes, consequences, and therapeutic opportunities' published in the Pain in 2013.[11] Figure 7 illustrates the top 20 references with the most significant citation bursts.[5,11-29] The citation bursts of Zajączkowska R's article continue into 2023; in the paper, he introduced the epidemiology, clinical features and underlying mechanisms of BCP; suggested that a multimodal analgesic approach should be adopted for BCP; and introduced some emerging therapeutic approaches, such as drugs targeting the tumor microenvironment and drugs targeting the nerve growth factor signaling pathway.[5]

Analysis of authors and cocited authors

A total of 305 authors have contributed to this specialty. According to the data in Error: Reference source not found, Yao Ming, who is affiliated with The First Hospital of Jiaxing, has the highest number of published articles with 18, followed by Mantyh PW with 16 articles and Chen ShuPing with 11 articles. The number of publications by core authors is calculated according to Price's law, which is N=0.749× √ Nmax, where Nmax is the number of publications by the author with the highest number of publications. If the number of articles published by an author is greater than N, the author can be considered a core author. By calculation, N=3.17, so the minimum number of publications for core authors in this field should be 4 publications. Finally, we

found that there are 56 core authors, accounting for only 18% of the total authors, indicating that there is a lack of a relatively stable core author group in the field of BCP. Figure 8 illustrates the collaboration of the authors. These authors form multiple research teams with close relationships within the teams but lack collaboration between different teams, which may become a trend in the future to promote teamwork.

Error: Reference source not found shows the top ten cited authors. The notion of cocited authors pertains to groups of two or more authors who are cited together in a single publication, thereby forming a cocitation link. A total of 292 authors were cited. The most frequently cited author was Robert E Coleman, affiliated with the University of Sheffield, with 477 citations. The next most frequently cited authors were Sebastiano Mercadante and Prisca Honore, with 275 and 267 citations, respectively.Figure 9 depicts the discernible cocitation network among many scholars.

Analysis of keywords

The results of the keyword analysis helped to identify research centers and predict emerging trends in a specific field. We retrieved a total of 182 keywords from 1976 documents. Error: Reference source not found reported that the most commonly used keywords were bone metastasis (n = 484, centrality=0.55), bone cancer pain (n=447, centrality=0.45), neuropathic pain (n=385, centrality=0.13), and breast cancer (n=272, centrality=0.77). Figure 10 demonstrates the relationship between them. Among all the keywords, breast cancer has the highest centrality.

The top 25 keywords with the strongest citation bursts are listed in Figure 11. In the last decade, upregulation ranked first, with the highest bursts (11.55), closely followed by cancer-induced inhibition (9.65) and central sensitization (8.33). On the basis of the time of the end of the bursts, researchers have focused their attention in recent years on cancer-induced bone pain, models, contributes and lung cancer.

CiteSpace software and the log-likelihood ratio (LLR) algorithm were used to perform keyword clustering analysis, and a keyword clustering diagram was generated, as shown in Figure 12. The value of Q of this clustering module is 0.8167, and the value of S is 0.9447. Since Q > 0.3 and S > 0.7, the keyword clustering structure is significant, and the clustering results are convincing. A total of 10 cluster markers were obtained and numbered 0--9. Keyword cluster analysis revealed that breast cancer was the most researched area.

Discussion

BCP is a form of persistent or sudden pain caused by a primary bone tumor or bone metastases. It involves complex interactions at multiple levels, including direct damage to tumor cells and bone tissue, formation of the tumor microenvironment, sensory nerve damage and central nervous sensitization.[13] It has been demonstrated that up to 70% of individuals diagnosed with cancer experience BCP, which can present as persistent or sudden discomfort and significantly impair the quality of life of the affected individual.[31] At present, the principal approaches to the management of BCP are palliative anticancer therapy and the provision of symptomatic analgesia. Palliative anticancer therapy encompasses local surgical and/or radiotherapeutic procedures, in addition to systemic therapies, including chemotherapy, hormone therapy, immunotherapy and molecular therapy. The category of symptomatic analgesia encompasses the utilization of analgesics, encompassing both nonopioid and opioid analgesics, in addition to bone-targeted therapies, including NGF inhibitors and osteoclast inhibitors such as bisphosphonates and denosumab.[32] Furthermore, adjuvant medications, such as corticosteroids and anticonvulsants, are also included in this category.[33] However, some of these treatments have numerous adverse effects and risks, including respiratory depression, kidney damage, infections, and addiction.[34,35] However, the majority of patients still have poor pain control. Therefore, identifying an alternative, effective, and safe treatment for BCP is crucial. In conclusion, a comprehensive assessment of the current state of research in this specific area is essential.

General information

This study used bibliometric methods to visualize and analyze 1976 publications on BCP between 1994 and 2023, mainly articles (80%) and reviews (20%). Research on BCP fluctuates and grows between 1996 and 2023, peaking in 2021. This curve suggests that the field of BCP research is strengthening. Researchers are increasingly focusing on understanding the mechanisms and treatments of BCP.

In terms of cocited journals, *Pain* is representative of the field of BCP, as evidenced by the number of publications and citations, providing a valuable platform for scientific discussion and exchange. *Pain* is an international medical journal covering a wide range of clinical, basic and translational research in the field of pain, including BCP.

In terms of research institutions and publications, China and the United States lead the field of BCP, with Huazhong University of Science & Technology and the University of Minnesota System being the two most

cited universities that have made outstanding contributions to BCP research.

Among the authors and cocited authors, Yao Ming from the First Hospital of Jiaxing was the most productive. Over the past decade, he and his team have focused on exploring the mechanisms of BCP occurrence at the spinal cord level and finding treatments for BCP; however, more recently, their attention has shifted to the epigenetic mechanisms of BCP.[36] In a recent study, N-acetyltransferase 10 (NAT10) was shown to mediate neurexin 2 mRNA acetylation while promoting neurexin 2 expression, leading to spinal synaptic remodeling and nociceptive hypersensitivity.[37] The most cited author is Robert E Coleman from the University of Sheffield, whose research focuses on the prevention, detection and treatment of cancer.

Research hotspots and trends

By analyzing keywords, keyword bursts and keyword clustering, we can summarize the current hotspots of BCP research and the outlook for the future. Some of the keywords are related to the keywords of BCP itself, which may be the reason for their high frequency. In addition, some of the high-frequency keywords are related to the study of the mechanism of BCP, such as the spinal cord, expression, activation, and mechanisms. The mechanism of BCP is complex and involves interactions between tumor cells, sensory nerves and immune cells.[38] Tumor cells activate sensory nerves by releasing acids, cytokines, etc., leading to the onset of pain.[3939] Moreover, tumor cells can also affect the function of immune cells, e.g., macrophages can differentiate into proinflammatory or anti-inflammatory types, promoting or inhibiting tumor growth and metastasis, whereas T cells can be involved in antitumor immune responses or inhibited, leading to immune escape.[40,41] Sensory nerve damage and axonogenesis are also important mechanisms of BCP. Tumor cells can invade and destroy sensory nerves, leading to nerve damage and pain, and induce axonogenesis in sensory nerves, which can exacerbate pain.[42] Receptors and channels on sensory nerves, such as acid-sensitive ion channels (ASICs), transient receptor potential channels (TRPs) and P2X receptors, can mediate pain signaling caused by factors released by tumor cells.[38] Imbalanced neurotransmitter expression in the dorsal horn of the spinal cord, overactivation of glial cells and activation of signaling pathways can also lead to pain sensitization.[5] Many scholars have focused on the mechanism of BCP. However, further research on the involvement of the CNS in the regulation of BCP is needed.

Figure 12 shows, not surprisingly, that “#0 breast cancer” is the largest cluster term. The bone is the site where breast cancer cells are most likely to metastasize, with 75% of patients with advanced breast cancer developing bone metastases. An increasing number of studies have reported factors that promote the escape of breast cancer cells from the primary site and their ability to colonize the bone, which can help doctors identify the tendency of bone metastases early in the clinical setting.[43]

Error: Reference source not found lists the ten most cited papers, including six reviews and four animal studies. Several of the most cited papers were reviews that focused on the mechanisms of BCP and current treatments, as well as the outlook for future research.

Limitations

Although this paper provides a systematic review of the current state of BCP research, it suffers from several shortcomings. First, this paper only searched the WOS core collection, which may have resulted in the omission of relevant data. Second, to reduce statistical bias, we included only studies written in English and journals published in English. Third, we may have omitted the most recent literature with significant impact but fewer citations.

Conclusion

This study used bibliometric methods to conduct an in-depth review of scientific papers related to BCP. The analyses covered a number of aspects, including the number of published documents, geographical distribution, academic journals, authorship, keywords and references. Research into BCP has focused on basic science, and further exploration of the mechanisms of BCP, such as how the central nervous system is involved in the regulation of BCP, and the identification of new therapeutic approaches and targets for the treatment of BCP to improve the quality of life of patients with late-stage cancer are needed.

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Author Contributions

Jinzhao Huang: Writing – review & editing, Writing – original draft. **Houming Kan:** Supervision. **Ping Lu:**Formal analysis. **Chi Wang:** Methodology. **Jinzhao Huang:**Visualization.

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Disclosure

The authors declare no potential conflicts of interest in this research.

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Table 1 Information of the top 10 cocited journals

Ran	Count	Centrality	Cited Journal	IF(2023)	JCR	Country

k	s					
1	981	0.02	*Pain*	5.9	Q1	United States
2	779	0.02	*Journal of Clinical Oncology*	42.1	Q1	United States
3	722	0.28	*Journal OF Neuroscience*	4.4	Q2	United States
4	603	0.02	*Neuroscience*	2.9	Q2	Netherlands
5	560	0.15	*Cancer*	6.1	Q1	United States
6	556	0.63	*Proceedings of the National Academy of Sciences of the United States of America*	9.1	Q1	United States
7	546	0.39	*Cancer Research*	12.5	Q1	United States
8	507	0.47	*Nature*	50.5	Q1	England
9	485	0.03	*New England Journal of Medicine*	96.2	Q1	England
10	470	0	*PLoS One*	2.9	Q1	United States

Table 2 Top 10 countries/regions for publications in the BCP

Rank	Country	Counts	Centrality
1	PEOPLES R CHINA	666	0.13
2	USA	460	0.63
3	JAPAN	208	0.26
4	ENGLAND	119	0
5	ITALY	111	0.14
6	CANADA	87	0.53
7	FRANCE	80	0
8	GERMANY	64	0.02
9	SOUTH KOREA	43	0.01

10	SPAIN	42	0.1

Table 3 Top 10 institutions for publications of BCP

Rank	Institution	Counts	Country	Centrality
1	Huazhong University of Science & Technology	54	China	0.15
2	University of Minnesota System	40	United States	0.01
3	University of London	36	England	0.09
4	US Department of Veterans Affairs	36	United States	0.04
5	University of Arizona	35	United States	0.01
6	University of Texas System	32	United States	0.28
7	Shanghai Jiao Tong University	32	China	0.16
8	Soochow University	31	China	0.09
9	Fudan University	28	China	0.16
10	Nanjing University	27	China	0.03

Table 4 Top 10 cited articles in the field of BCP

RANK	Author	Counts	Centrality	BURST	Design
1	Mantyh P (2013)	47	0.09	20.91	Review
2	Falk S (2014)	47	0.39	17.83	Review
3	Zajaczkowska R (2019)	42	0.13	23.23	Review
4	Jimenez-Andrade JM (2010)	37	0.07	18.91	Review
5	Yang Y (2015)	35	0.12	16.63	Animal study
6	Mantyh PW (2014)	34	0.01	15.19	Review
7	Lozano-Ondoua AN (2013)	32	0.19	14.09	Review
8	Honore P (2000)	29	0.01	16.44	Animal study
9	Honore P (2000)	28	0.1	15.87	Animal study
10	Luger NM (2002)	27	0.02	13.56	Animal study

Table 5 Top 10 authors for publications on BCP

Rank	Author	Counts	Institution	Country	Centrality
1	Yao, Ming	18	The First Hospital of Jiaxing	China	0
2	Mantyh, PW	17	University of Arizona	United States	0
3	Chen, Shu-Ping	12	Huazhong University of Science & Technology	China	0
4	Bao, Yanju	11	Guang'anmen Hospital	China	0
5	Tian, Yu-Ke	10	Huazhong University of Science & Technology	China	0
6	Hua, Baojin	10	Guang'anmen Hospital	China	0
7	Ma, Zhengliang	10	Nanjing Drum Tower Hospital	China	0
8	Hou, Wei	10	Guang'anmen Hospital	China	0
9	Zhou, Ya-Qun	10	Huazhong University of Science & Technology	China	0
10	Gu, Xiaoping	9	Nanjing Drum Tower Hospital	United States	0

Table 6 Top 10 cocited authors for publications on BCP

Rank	Author	Counts	Institution	Country	Centrality

1	COLEMAN RE	477	University of Sheffield	United States	0.15
2	MERCADANTE S	275	La Maddalena Cancer Center	Italy	0.1
3	HONORE P	267	University of Arizona	United States	0.62
4	MANTYH PW	246	University of Minnesota System	United States	0.18
5	SCHWEI MJ	212	University of Minnesota System	United States	0.74
6	CHAPLAN SR	169	University of Minnesota System	United States	0.11
7	JIMENEZ-ANDRADE JM	156	University of Arizona	United States	0.06
8	LUGER NM	155	University of Arizona	United States	0.3
9	JI RR	153	Duke University Medical Center	United States	0.15
10	MUNDY GR	152	University of Texas Health Science Center	United States	0.21

Table 7 Top 20 keywords for publications on BCP

Rank	Keywords	Counts	Centrality
1	bone metastasis	484	0.55
2	bone cancer pain	447	0.45
3	neuropathic pain	385	0.13
4	breast cancer	272	0.77
5	spinal cord	254	0.62
6	prostate cancer	186	0
7	expression	185	0.04
8	activation	173	0.06
9	bone metastases	173	0.17
10	zoledronic acid	169	0.13
11	rat model	142	0.37
12	management	129	0.02
13	disease	121	0.15
14	mechanisms	114	0
15	model	104	0.02
16	murine model	103	0.26
17	cancer pain	95	0.06
18	cancer-induced bone pain	94	0.02
19	double blind	92	0.12
20	contributes	91	0.08

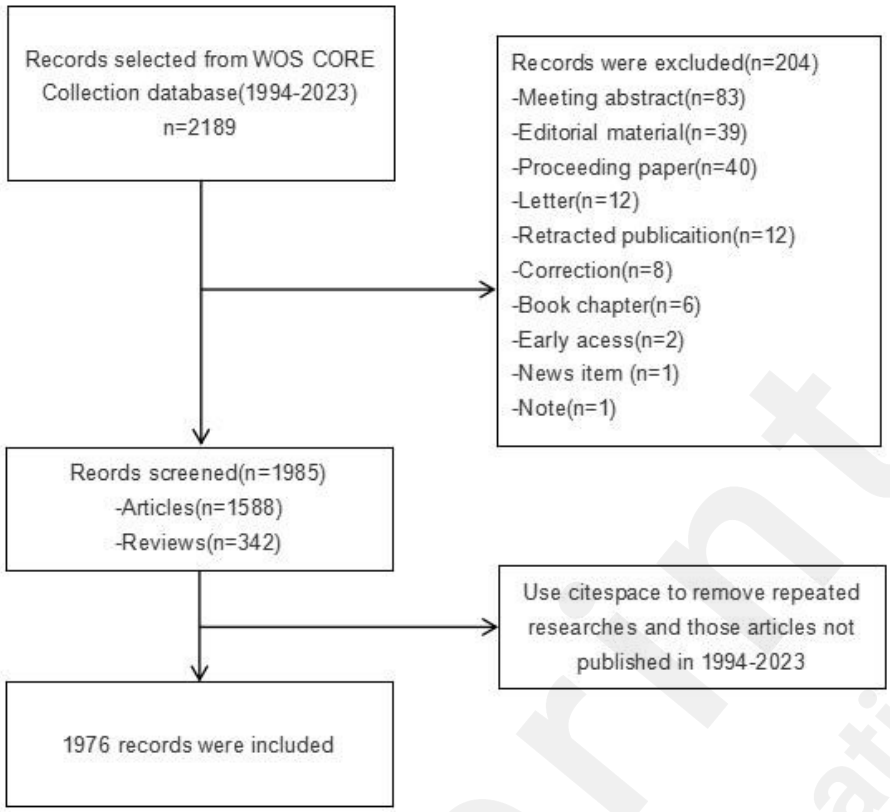

Figure 1 Flowchart of article inclusion selection.

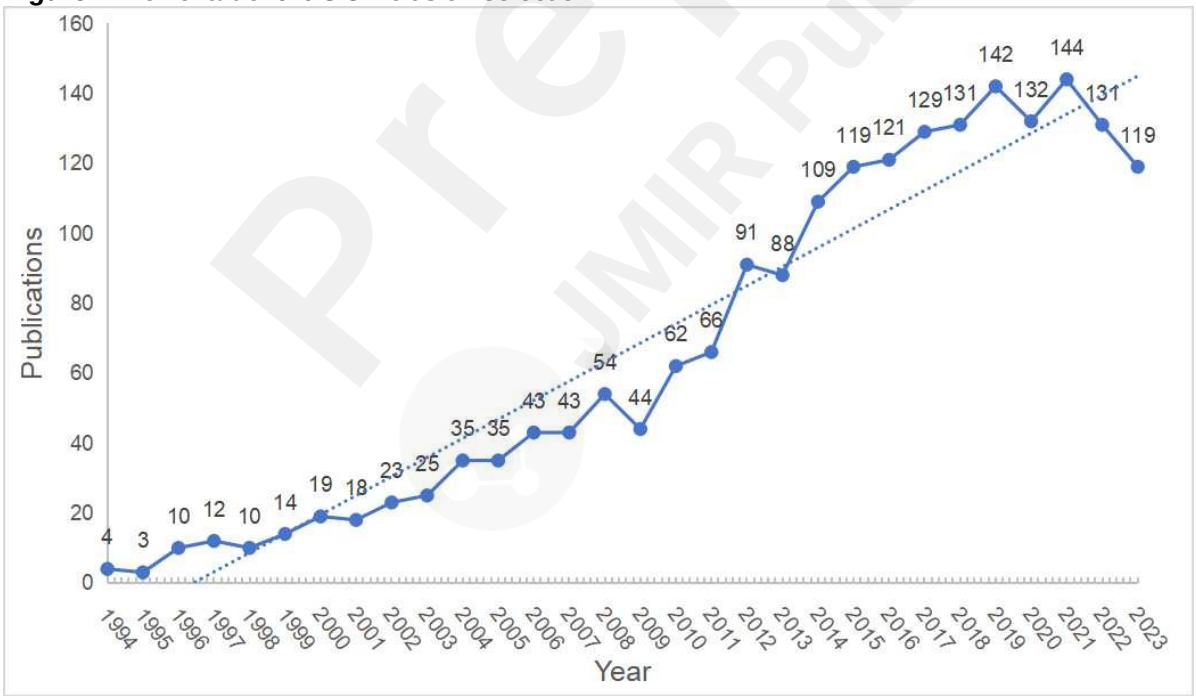

Figure 2 Bibliometric analysis of publication output. A total of 1976 publications were included from 1994--2023.

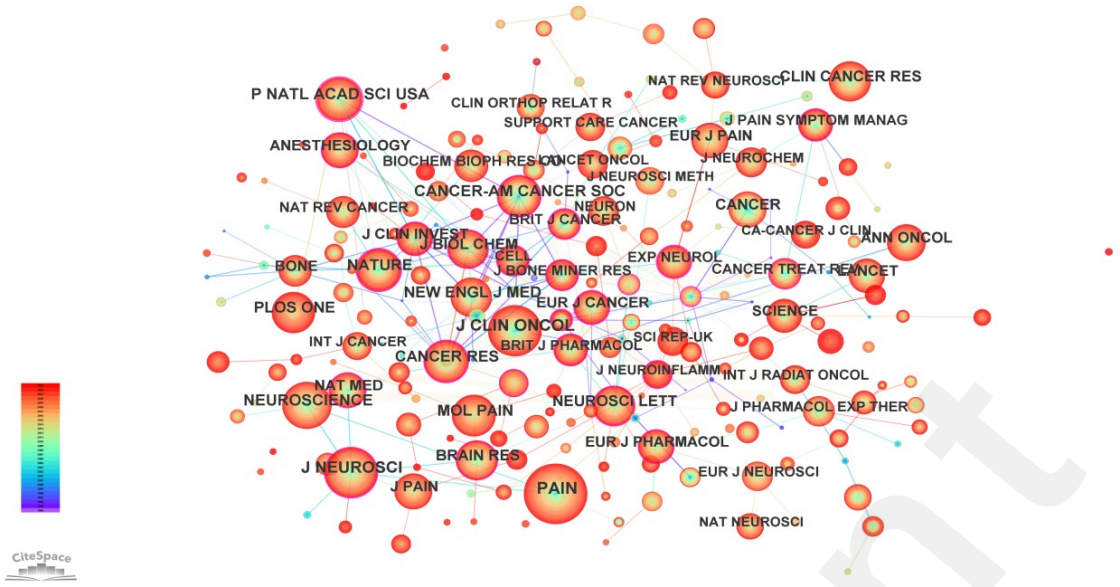

Figure 3 Cocitation analysis of journals. The larger the node is, the more often the journal appears. Nodes with purple circles around the edges are central mediators. The straight lines between nodes represent two journals that appear together in the same paper.

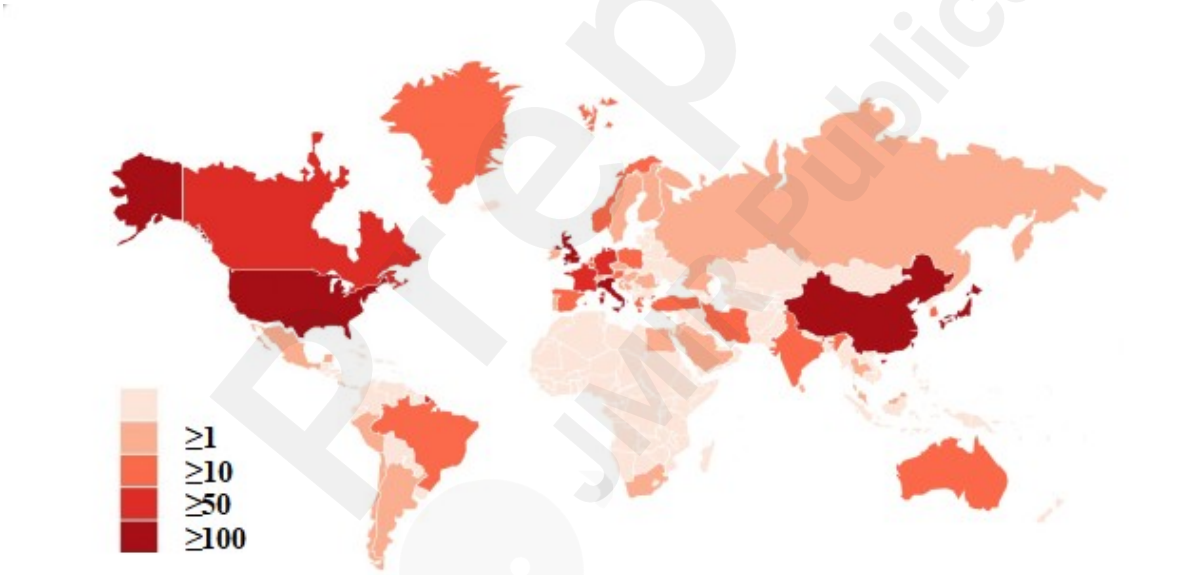

Figure 4 World map showing the country analysis of the coauthors. North America, East Asia, and Western Europe had more publications.

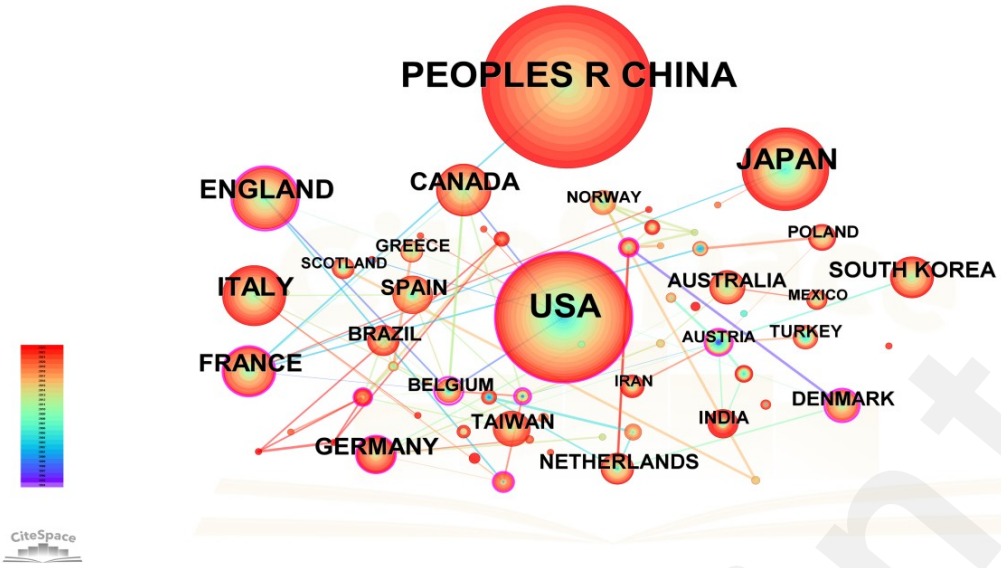

Figure 5 Network map of the country analysis of the coauthors. The larger the node is, the more frequently the country appears. Nodes with purple circles on the edges indicate central mediators. The straight lines between nodes represent two countries that cooccur in the same paper. The top three countries in terms of size were China, the United States, and Japan. The United States has central intermediacy.

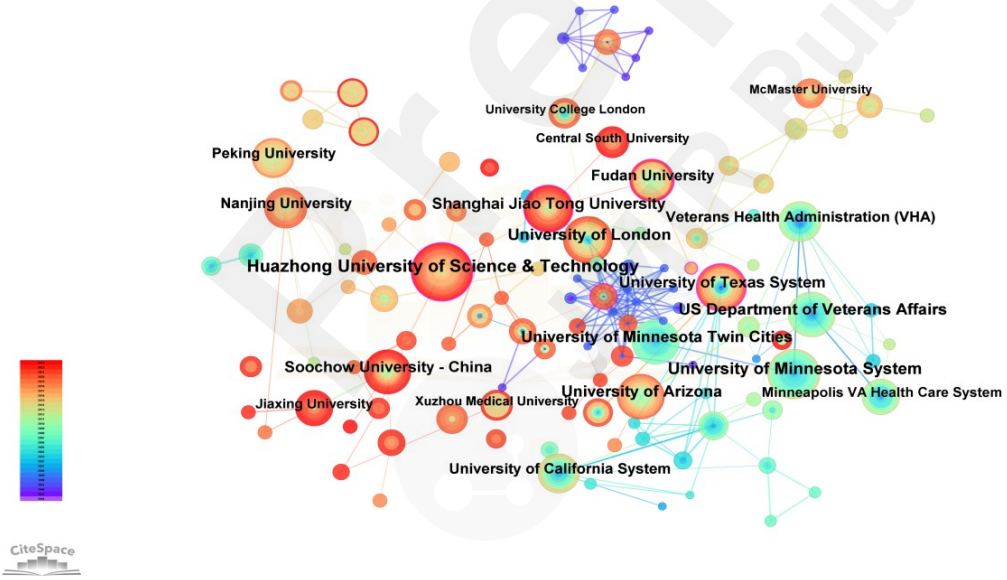

Figure 6 Network map of the institution analysis of the coauthors. The larger the node is, the more frequently the institution appears. Nodes with purple circles on the edges indicate central mediators. The straight lines between nodes represent two instances that cooccur in the same paper. The top three institutions in terms of size were Huazhong University of Science and Technology, University of Minnesota System and University of London.

Top 20 References with the Strongest Citation Bursts

References	Year	Strength	Begin	End	1994 - 2023
Honore P, 2000, NEUROSCIENCE, V98, P585, DOI 10.1016/S0306-4522(00)00110-X, DOI	2000	16.44	2002	2005	
Honore P, 2000, NAT MED, V6, P521, DOI 10.1038/74999, DOI	2000	15.87	2002	2005	
Schwei MJ, 1999, J NEUROSCI, V19, P10886, DOI 10.1523/JNEUROSCI.19-24-10886.1999, DOI	1999	15.34	2002	2004	
Luger NM, 2001, CANCER RES, V61, P4038	2001	13.56	2002	2005	
Medhurst SJ, 2002, PAIN, V96, P129, DOI 10.1016/S0304-3959(01)00437-7, DOI	2002	13.77	2004	2007	
Sabino MAC, 2002, CANCER RES, V62, P7343	2002	13.18	2004	2007	
Sevcik MA, 2005, PAIN, V115, P128, DOI 10.1016/j.pain.2005.02.022, DOI	2005	15.4	2006	2010	
Jimenez-Andrade JM, 2010, ANN NY ACAD SCI, V1198, P173, DOI 10.1111/j.1749-6632.2009.05429.x, DOI	2010	18.91	2012	2015	
Fizazi K, 2011, LANCET, V377, P813, DOI 10.1016/S0140-6736(10)62344-6, DOI	2011	12	2012	2016	
Stopeck AT, 2010, J CLIN ONCOL, V28, P5132, DOI 10.1200/JCO.2010.29.7101, DOI	2010	10.92	2012	2014	
Mantyh P, 2013, PAIN, V154, PS54, DOI 10.1016/j.pain.2013.07.044, DOI	2013	20.91	2015	2018	
Falk S, 2014, J CLIN ONCOL, V32, P1647, DOI 10.1200/JCO.2013.51.7219, DOI	2014	17.83	2015	2019	
Lozano-Ondoua AN, 2013, NEUROSCI LETT, V557, P52, DOI 10.1016/j.neulet.2013.08.003, DOI	2013	14.09	2015	2018	
Liu S, 2013, PAIN, V154, P2823, DOI 10.1016/j.pain.2013.08.017, DOI	2013	12.56	2015	2017	
Shen W, 2014, J NEUROINFLAMM, V11, P0, DOI 10.1186/1742-2094-11-75, DOI	2014	12.05	2015	2017	
Mantyh PW, 2014, CURR OPIN SUPPORT PA, V8, P83, DOI 10.1097/SPC.0000000000000048, DOI	2014	15.19	2016	2019	
Yang Y, 2015, J NEUROSCI, V35, P7950, DOI 10.1523/JNEUROSCI.5250-14.2015, DOI	2015	16.63	2017	2020	
Macedo F, 2017, ONCOL REV, V11, P43, DOI 10.4081/oncol.2017.321, DOI	2017	11.28	2020	2023	
Zajaczkowska R, 2019, INT J MOL SCI, V20, P0, DOI 10.3390/ijms20236047, DOI	2019	23.23	2021	2023	
Fornetti J, 2018, J BONE MINER RES, V33, P2099, DOI 10.1002/jbmr.3618, DOI	2018	13.12	2021	2023	

Figure 7 The top 20 references with the strongest citation bursts about BCP. The length of the red line represents the strength of the citation burst. The start and end times are shown at the beginning and end of the red line. Zajączkowska R's article citation bursts from 2021.

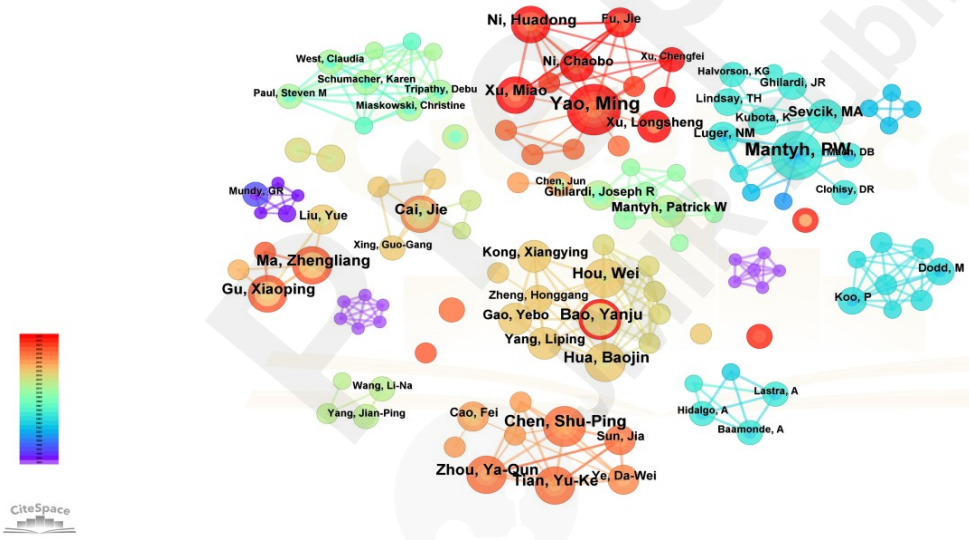

Figure 8 Network map of the authors on the BCP. The larger the node is, the more frequently the author appears. Nodes with purple circles on the edges indicate central mediators. The straight lines between nodes represent two authors that cooccur in the same paper.

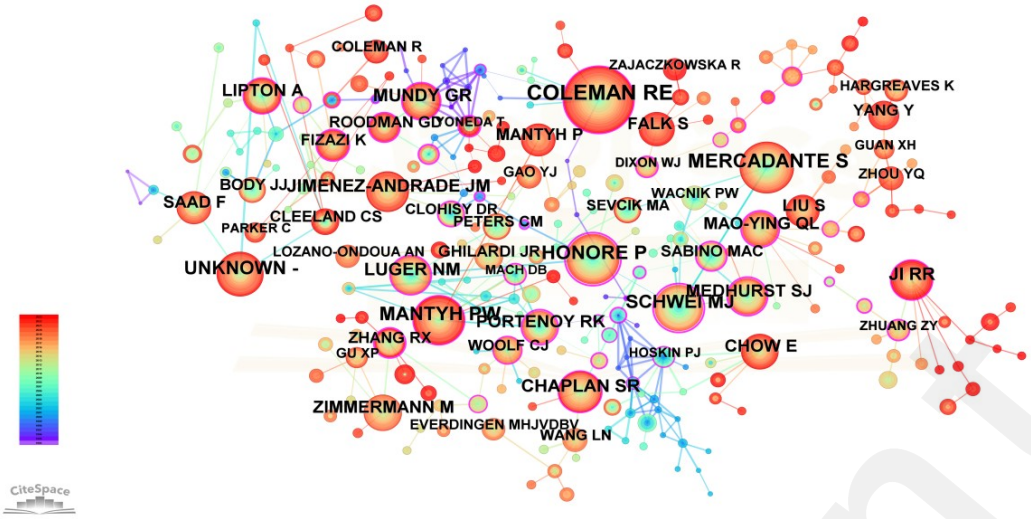

Figure 9 Network map of the cocited authors. The larger the node is, the more frequently the author appears. Nodes with purple circles on the edges indicate central mediators. The straight lines between nodes represent two authors that cooccur in the same paper.

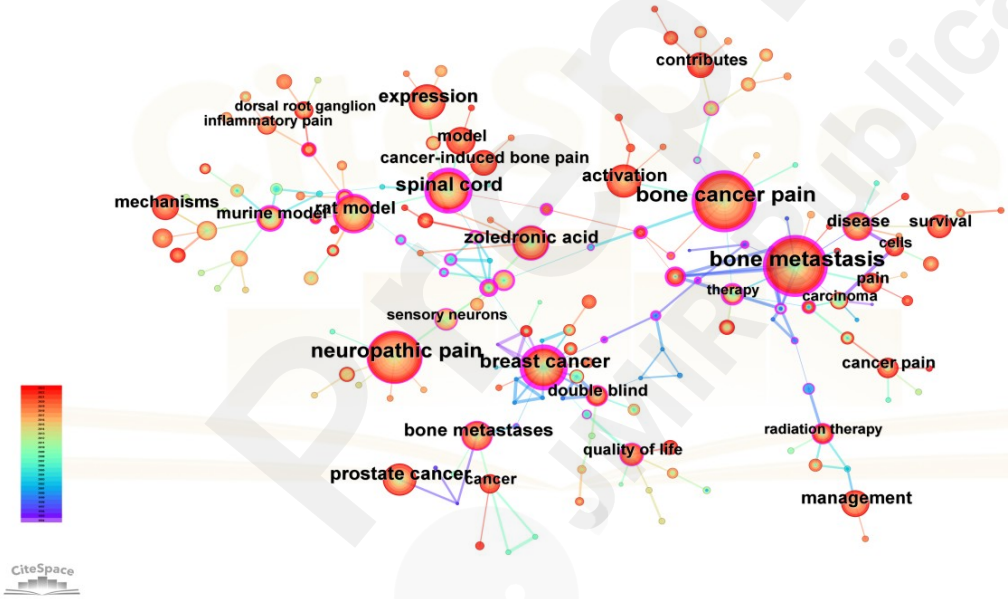

Figure 10 Keyword co-occurrence network. The larger the node is, the more often the keyword appears. Nodes with purple circles on the edges are central mediators. The straight lines between nodes represent two keywords that appear together in the same paper.

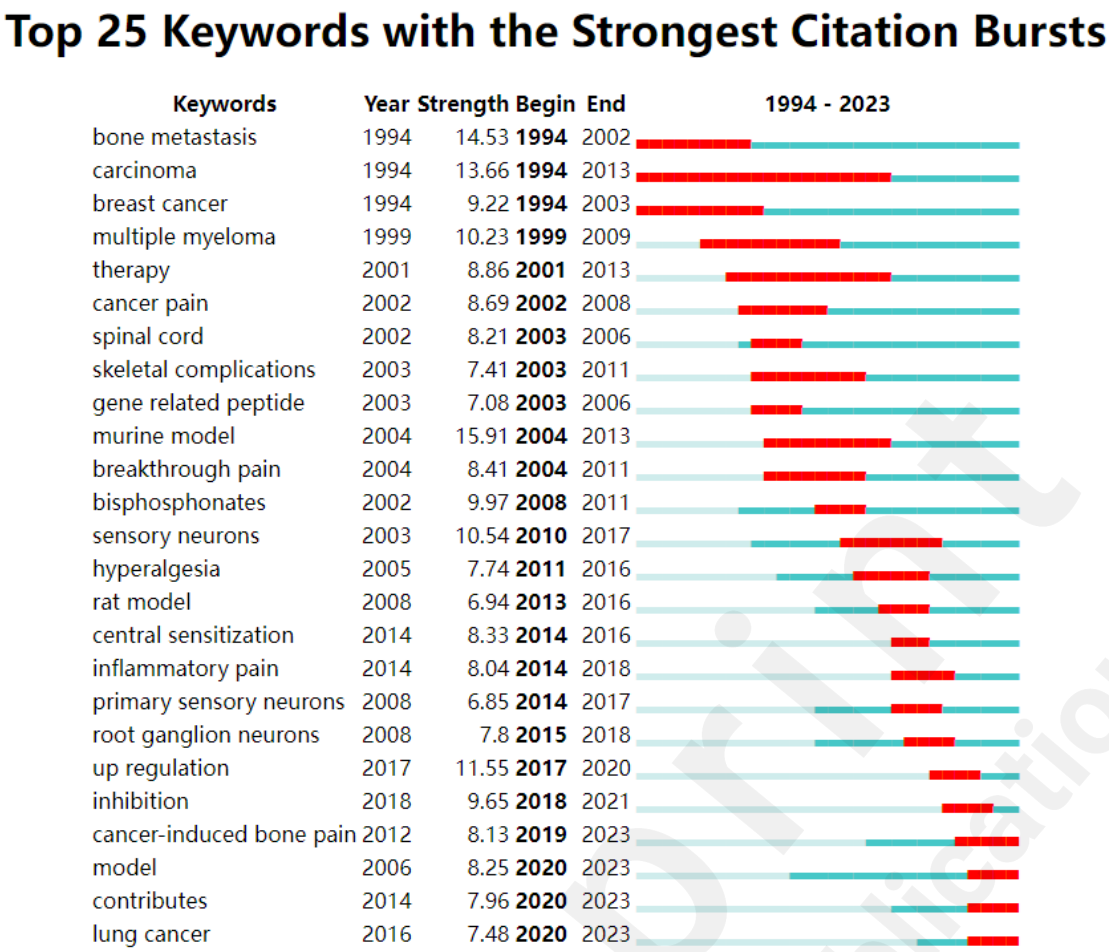

Figure 11 Top 25 keywords with the strongest citation bursts. The length of the red line represents the strength of the citation burst. The beginning and end of the red line represent the start and end times, respectively.

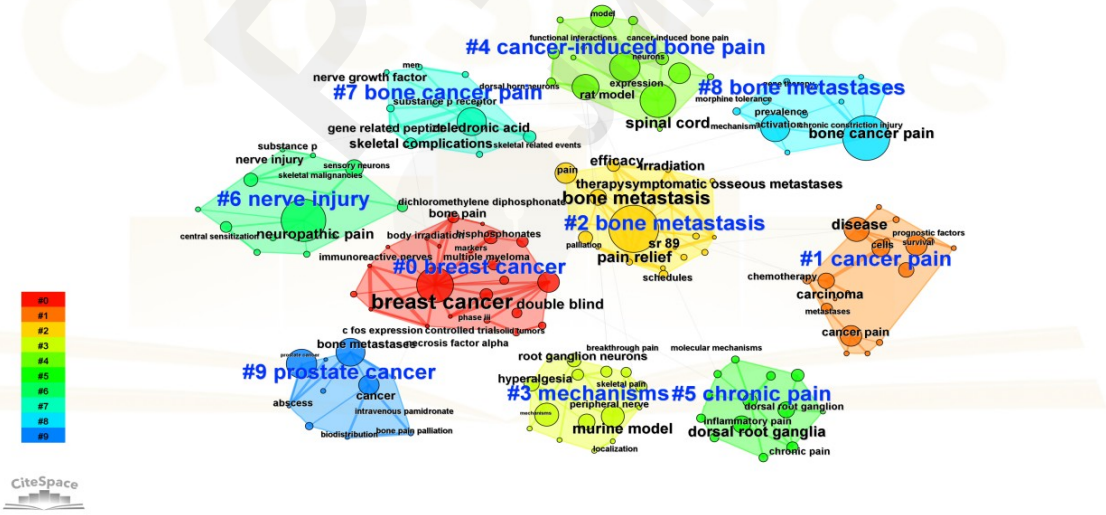

Figure 12 Keyword cluster network. A keyword co-occurrence network cluster is an irregular region with a label. The order is from 0--9, with smaller numbers indicating more keywords. Each cluster consists of

multiple closely related keywords.