

Bibliometric Analysis of Acupuncture Therapy for Cancer Pain Over the Past 10 Years

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Purpose: Cancer pain is a common symptom of cancer patients and greatly affects quality of life. Acupuncture has certain curative effects on cancer pain. The aim of this study was to analyze and visualize the current status and research trend of acupuncture treatment for cancer pain over the last 10 years and provide directions for future development.

Methods: A search of the Web of Science Core Collection from 2012–01–01 to 2022–08–20 was performed to collect studies related to acupuncture therapy for cancer pain. CiteSpace was used to conduct bibliometric analysis and visualization from the perspective of the volume of annual publications, journals, nations, institutions, authors, keywords, and references.

Results: A total of 302 studies were included in the analysis. The number of publications increased steadily with some fluctuations over the past decade. Integrative Cancer Therapies was the journal with the most relevant publications, and the Journal of Clinical Oncology was the most frequently cited journal. China had the highest volume of publications, and the USA contributed most to international collaboration. The most prolific institution was Memorial Sloan Kettering Cancer Center. The most productive author was Mao JJ, and the most influential author was Lu WD. “Acupuncture” was the top keyword in frequency and centrality. The references with the highest frequency and centrality were published by HE, Y, and Ting Bao, respectively.

Conclusion: A stable development trend has formed in this field. The overall collaborative network needs to be strengthened. Breast cancer and multiple myeloma, electroacupuncture and bee venom acupuncture, postoperative pain, peripheral neuropathic pain syndrome, and aromatase inhibitors-associated arthralgia syndrome are research hotspots in this field. Randomized controlled trials (RCTs), evidence-based evaluations and mechanisms (cancer-induced bone pain) are research trends and frontiers.

Keywords: acupuncture analgesia, cancer, pain, bibliometric analysis, CiteSpace

Introduction

Cancer pain, one of the most common symptoms in cancer patients, can be caused by cancer itself, including bone metastasis and cancer infiltrating soft tissues or pressing on nerves, and can also be induced by cancer treatment–related effects, including chemotherapy, surgery, or radiation. It is estimated that the annual incidence of cancer will rise to 19.3 million by 2025.¹ A meta-analysis revealed that the prevalence rates of cancer pain were 55% among patients undergoing cancer treatment, 66.4% among patients with advanced disease, and 39.3% among patients after curative treatment.² Unrelieved cancer pain contributes to the poor quality of life of cancer patients, followed by common symptoms including fatigue, sleep disturbance, and emotional distress, such as anxiety and depression.³ The main approaches to manage cancer pain recommended by the World Health Organization (WHO) consist of pharmacologic and radiotherapeutic approaches;⁴ of these, the appropriate application of opioids plays a vital role in alleviating pain for patients with cancer pain. However, side effects such as bowel dysfunction, nausea, vomiting, respiratory depression and

neurotoxicity with the overuse of opioids⁵ and the possibility of tumor growth accelerated by opioids pose critical challenges to pain management in cancer patients.⁶ Therefore, the application of supplementary treatment for cancer pain has broad application prospects.

Complementary therapies correspond to growing demand in patients with cancer pain,⁷ and complementary therapies for the treatment of cancer pain include acupuncture, dietary supplements, massage, guided imagery and cryotherapy.⁸ Acupuncture, as a nonpharmacologic intervention, has been widely used to relieve many different types of pain based on traditional Chinese medicine theories,⁹ such as lowback pain, knee osteoarthritis pain, headache pain, myofascial pain, other pain syndromes, etc.¹⁰ Many clinical trials have confirmed that acupuncture is effective in treating cancer pain.^{11–13} A systematic review and meta-analysis showed that acupuncture not only reduces cancer pain but also decreases the use of analgesics with moderate certainty of evidence.¹⁴ Acupuncture achieved curative effects in alleviating cancer pain, as verified by clinical studies, and several clinical guidelines suggest the use of acupuncture for managing cancer pain.^{15,16} Acupuncture has received increasing attention in this field. It is essential to investigate the current status, hotspots and research trends of acupuncture treatment for cancer pain through a quantitative analysis of the literature.

Bibliometric analysis, as a method of quantitatively analyzing publications using mathematics and statistics, can explore research advances, hot topics and potential problems in a specific field to promote future research and clinical application. In this study, CiteSpace was used to analyze the literature through multiple perspectives of journals, countries, institutions, authors, keywords, and references to obtain the current research hotspots and trends in the use of acupuncture treatment for cancer pain during the last decade.

Methods

Data Sources and Search Strategy

All articles in this study were abstracted from the SCI-EXPANDED database in the Web of Science Core Collection through the Chengdu University of Traditional Chinese Medicine Library website from 2012–01-01 to 2022–08-20. The search was completed on August 21, 2022, and was restricted to English language articles but without limitations regarding the country of publication. The data search strategy included the topics “cancer”, “pain” and “acupuncture therapy”. The specific search strategy and results are shown in Table 1. Finally, we retrieved 655 papers. Of these, letters (19), meeting abstracts (19), book chapters (1), and articles not related to the search topic (314) were excluded. As a result, 302 records were included for further visualization and analysis.

Data Analysis

This study utilized CiteSpace 6.1. R3, a bibliometric software package, to organize and visualize the data from the included studies. The main results are presented in the form of a map, which consists of citation tree rings and lines. The citation tree rings indicate the frequency of appearance and citation frequency of the analyzed data. The lines between nodes represent the co-occurrence or citation relationships among the elements. The variation in color with node and line indicates different times.^{17,18} The greater the thickness of the node and line is, the greater the intensity of occurrence. Nodes with a larger centrality, especially represented by purple on the node ring, indicate the importance of nodes in a network.¹⁹

Table 1 The Topic Search Query

Set	Results	Search Query
#1	14,210	TS=(acupuncture OR acupuncture therapy OR manual acupuncture OR acupoint* OR electroacupuncture OR electroacupuncture OR acupressure OR warm acupuncture OR wrist-ankle acupuncture OR scalp acupuncture OR skin acupuncture OR transcutaneous electrical acupoint stimulation OR acupoint injection OR auricular acupuncture OR laser acupuncture OR eye acupuncture OR moxibustion OR catgut embedding OR catgut implantation at acupoint)
#2	2,229,105	TS=(Neoplasm* OR neoplasm OR cancer* OR carcino* OR malignan* OR tumor* OR tumour*)
#3	479,173	TS=(Pain OR pain* OR analges* OR nocicept* OR neuropath*)
#4	655	#1 AND #2 AND #3

First, we clarified the annual output counts, prolific journals, countries (regions) and institutions to present the general information of the included papers. Then, CiteSpace showed the individual contributions of and cooperation between authors and cited authors. Furthermore, co-occurrence analysis, clustering analysis of keywords and citation burst analysis of keywords and references were performed to anchor research hotspots and target frontier areas. The parameters of CiteSpace were as follows: The threshold of “Top N% per slice” was 50 for all calculations. The time span was from January 2012 to February 2022, and the time slices were “1 year per slice”. Clustering labels were extracted by using the log-likelihood ratio (LLR) algorithm.

Results

Annual Publications and Trends

In total, 302 articles were selected in accordance with the application of acupuncture for cancer pain over the past 10 years. From 2012 to 2022, the number of articles on acupuncture for cancer pain showed a fluctuating but steady upward trend (Figure 1). In 2012, there were only 8 articles published on this topic, which peaked with 23 articles on acupuncture for cancer pain in the next year. From 2013 to 2015, the number of publications experienced a steep decline. Along with the increasing attention, the number of publications experienced a second peak with steady and sustained growth from 2015 to 2018. After a mild decline in 2019 with 29 articles, the number of publications continued to grow until 2021. To date, there have been 32 articles published over 8 months in 2022, which predicts a considerable number of publications this year, and the research focus in this field will continue.

Analysis of Journals

The number of journals that published 302 articles on acupuncture treatment for cancer pain was 50. Table 2 lists the top 10 active journals. Of these, the three highest-ranked journals were “Integrative Cancer Therapies” with 24 publications, ‘Medicine’ with 18 publications, and ‘Evidence-based Complementary and Alternative Medicine’ with 16 publications.

Analysis of Cited Journals

The analysis of the co-citation of journals shows a distribution of substantial knowledge sources and can be used to identify important journals in a particular field. As shown in Figure 2, we obtained a co-citation map of journals on acupuncture therapy for cancer pain with frequencies above 50 outputs generated by CiteSpace. The 5 most cited journals on acupuncture for cancer pain are listed in Table 3. The most frequent journal was the Journal of Clinical Oncology (202 counts), followed by Supportive Care in Cancer (154 counts), Evidence-based Complementary and Alternative Medicine (152 counts), Acupuncture in Medicine (143 counts), and Pain (137 counts). Table 4 lists the top 8 journals with high

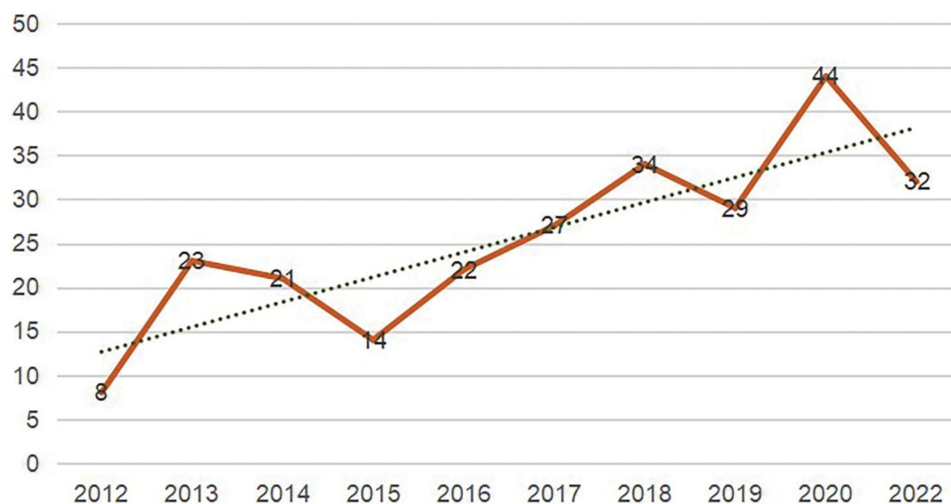


Figure 1 The number of annual publications on acupuncture for cancer pain.

Table 2 Top 10 Journals with the Highest Frequency Values for Studies on Acupuncture Treatment for Cancer Pain

Ranking	Journal	Frequency	IF (2021)
1	Integrative Cancer Therapies	24	3.077
2	Medicine	18	1.817
3	Evidence-based Complementary and Alternative Medicine	16	2.650
4	Supportive Care in Cancer	12	3.359
5	Acupuncture in Medicine	11	1.976
6	Complementary Therapies in Clinical Practice	8	3.577
7	Journal of Alternative and Complementary Medicine	8	2.381
8	Complementary Therapies in Medicine	7	3.335
9	BMJ Open	6	3.006
10	TOXINS	6	5.075

centrality in the field of acupuncture treatment for cancer pain. It should be noted that all the centrality values of the cited journals on acupuncture for cancer pain were below 1.

Analysis of Countries/Regions

The country collaboration network map (Figure 3) generated by CiteSpace shows that articles on acupuncture therapy for cancer pain mainly came from 39 countries/regions. In terms of the number of publications, the top five countries/regions were China (117 articles), the USA (96 articles), South Korea (26 articles), Taiwan (16 articles) and Australia (13 articles) (Table 5). China, where acupuncture originated, has formed cooperative relations with some countries, but such cooperative relations are far from sufficient. The USA, with the strongest centrality value of 0.46, cooperates with 16 countries and has formed a relatively mature cooperative network. However, China and the USA, as the top publishers with the greatest centrality, formed two cooperative networks and had fewer cooperative relations with each other. In addition, there was a relatively mature network between Brazil, Switzerland, Argentina, France, and India.

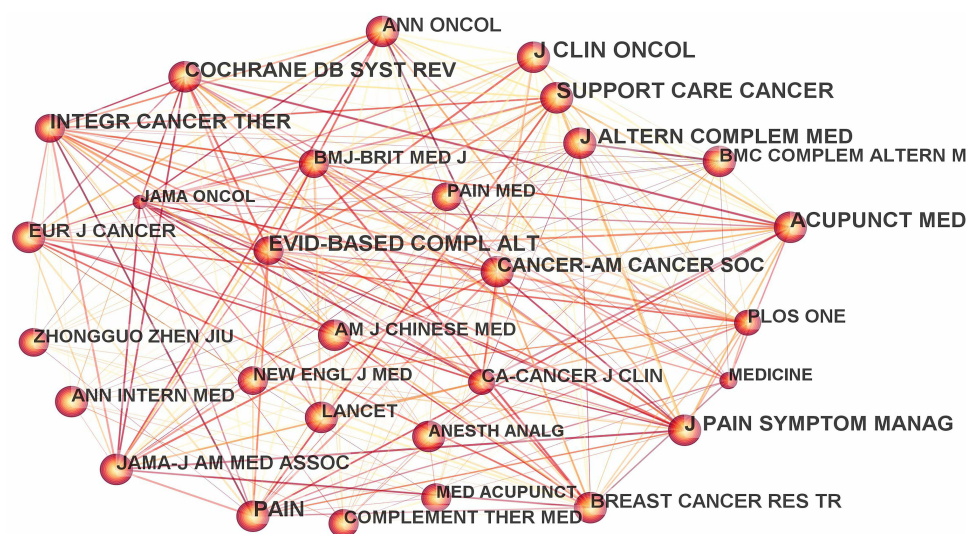
**Figure 2** Co-citation map of journals on acupuncture therapy for cancer pain.

Table 3 Top 5 Cited Journals with the Highest Frequency Values for Acupuncture Treatment for Cancer Pain

Ranking	Frequency	Cited Journal	IF (2021)	Country
1	202	Journal of Clinical Oncology	50.717	USA
2	154	Supportive Care in Cancer	3.359	Germany
3	152	Evidence-based Complementary and Alternative Medicine	2.650	England
4	143	Acupuncture in Medicine	1.976	England
5	137	Pain	7.926	USA

Table 4 Top 8 Cited Journals with the Highest Centrality Values for Acupuncture Treatment for Cancer Pain

Ranking	Centrality	Cited Journal	IF (2021)	Country
1	0.09	Neuroscience Letters	3.197	The Netherlands
2	0.08	Cancer-am Cancer Soc	6.072	USA
3	0.08	BMC CANCER	4.638	England
4	0.07	Pain	7.926	USA
4	0.07	Complementary and Alternative Medicine	2.838	England
4	0.07	Pain Medicine	3.637	England
4	0.07	Anesthesia and Analgesia	6.627	USA
4	0.07	Journal of Traditional Chinese Medicine	2.547	China

Analysis of Institutions

There were 252 institutions in the included articles. As shown in Table 6, the top 5 institutions with high volumes were Memorial Sloan Kettering Cancer Center (21 articles), Beijing University of Chinese Medicine (14 articles), Guangzhou University of Chinese Medicine (13 articles), Kyung Hee University (13 articles), and University of Texas MD Anderson Cancer Center (8 articles). Memorial Sloan Kettering Cancer Center had the highest centrality of 0.1, followed by Guangdong Province Academic Chinese Medicine Science (0.07), Beijing

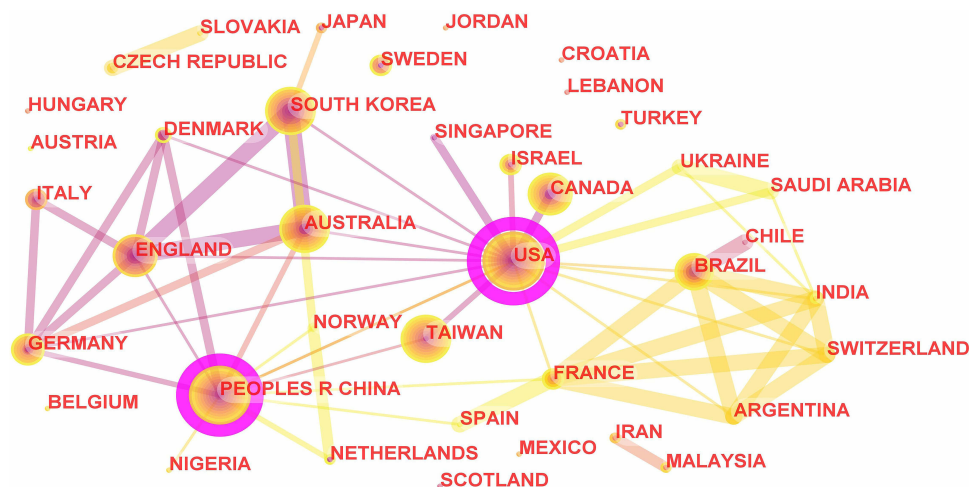
**Figure 3** Co-country map related to acupuncture treatment studies for cancer pain.

Table 5 Top 5 Countries with the Highest Frequency and Centrality Values for Acupuncture Treatment for Cancer Pain

Ranking	Frequency	Country	Centrality	Country/Region
1	117	China	0.46	USA
2	96	USA	0.2	China
3	26	South Korea	0.08	South Korea
4	16	Taiwan	0.07	Brazil
5	13	Australia	0.05	France

Table 6 Top 5 Institutions with the Highest Frequency and Centrality Values for Acupuncture Treatment for Cancer Pain

Ranking	Frequency	Institution	Centrality	Institution
1	21	Memorial Sloan Kettering Cancer Center	0.1	Memorial Sloan Kettering Cancer Center
2	14	Beijing University of Chinese Medicine	0.07	Guangdong Prov Acad Chinese Med Sci
3	13	Guangzhou University of Chinese Medicine	0.05	Beijing University of Chinese Medicine
3	13	Kyung Hee University	0.04	Guangzhou University of Chinese Med
4	8	University of Texas MD Anderson Cancer Center	0.04	Columbia University

University of Chinese Medicine (0.05), Guangzhou University of Chinese Medicine (0.04), and Columbia University (0.04). Memorial Sloan Kettering Cancer Center had the highest number of articles and the highest centrality, indicating that it makes substantial contributions to this topic. Figure 4, generated by CiteSpace, shows the interinstitutional collaboration network.

Analysis of Authors and Cited Authors

A total of 295 authors were involved in the research on acupuncture therapy for cancer pain. The top 7 active authors are shown in Table 7. Mao JJ (19 studies) ranked first, followed by Bao Ting (10 studies) and Cohen Lorenzo (6 studies).

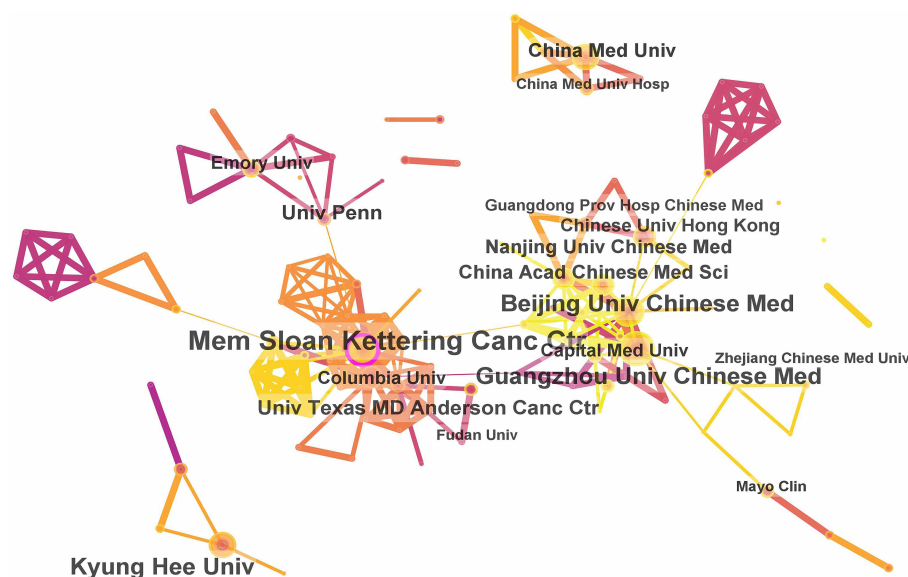
**Figure 4** Map of the interinstitutional collaboration network for acupuncture treatment for cancer pain.

Table 7 Top 7 Authors with the Highest Frequency Values for Acupuncture Treatment for Cancer Pain

Ranking	Frequency	Author	Nationality
1	19	Mao JJ	USA
2	10	Bao TING	USA
3	6	Cohen Lorenzo	USA
4	5	Carlson Linda E	Canada
5	4	Chao Hsing Yeh	USA
6	4	Du Junying	China
7	4	Fang Jianqiao	China

The top 3 authors came from the USA. [Figure 5](#) shows that the top 2 authors maintain considerable network cooperation with other authors. Interestingly, the top 2 authors came from the same institution. [Figure 5](#) shows that a small network of collaborative relationships formed around high-frequency authors.

Cited Authors

There were 412 cited authors involved in studies on acupuncture therapy for cancer pain. [Table 8](#) lists the top 5 most frequently co-cited authors. Lu WD and Bao Ting were the most frequently co-cited authors, with 66 counts, followed by Hershman DL and Garcia MK (59 counts) and Mao JJ (56 counts). Notably, all the top 5 co-cited authors came from the USA. The top 5 co-cited authors with the greatest centrality shown in [Table 8](#) were Molassiotis A, Lu WD, Bao T, Alimi D, and Lee JH. [Figure 6](#) shows the cited authors with a frequency greater than 20.

Keyword Co-Occurrence Analysis

Keywords with high frequency and high centrality can summarize current research hotspots in a specific field. Generated by CiteSpace, we obtained a map of co-occurrence with a total of 296 keywords ([Figure 7](#)). The 10 top most frequent

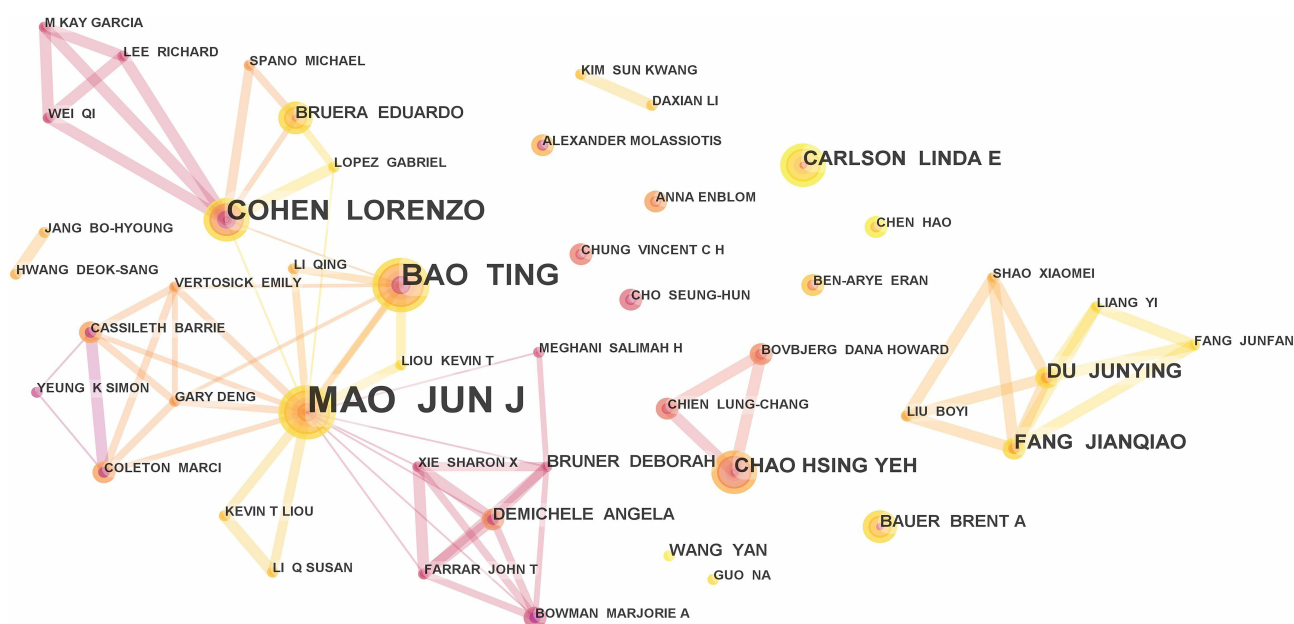


Figure 5 Map of authors' cooperation network for acupuncture therapy for cancer pain.

Table 8 Top 5 Cited Authors with the Highest Frequency and Centrality Values for Acupuncture Treatment for Cancer Pain

Ranking	Frequency	Cited Author	Nationality	Centrality	Cited Author	Nationality
1	66	Lu WD	USA	0.14	Molassiotis A	England
2	66	Bao Ting	USA	0.13	Lu WD	USA
3	59	Hershman DL	USA	0.12	Bao Ting	USA
4	59	Garcia MK	USA	0.12	Alimi D	USA
5	56	Mao JJ	USA	0.10	Lee JH	Korea

keywords are listed in Table 9. The five most frequent keywords were “acupuncture”, “management”, “quality of life”, “breast cancer”, and “pain”. Table 9 shows the top 10 keywords with the greatest centrality, and “acupuncture”, “breast cancer”, “electroacupuncture”, and “randomized controlled trial” were ranked in the top four.

All the keywords were classified into 9 clusters based on the co-occurrence map. As shown in Figure 8, the five largest clusters were “bee venom acupuncture”, “multiple myeloma”, “postoperative pain”, “breast cancer patient”, and “acupuncture use”, which were the most talked about topics in this area.

A burst keyword is a keyword that emerges substantially within a short period. This information shows the elevation of research hotspots over time, indicates the research trends in recent years and may suggest those of the future. Figure 9 shows the top 7 keywords with the strongest citation bursts over the last 10 years. The most recent burst keywords were “mechanism”, “integrative medicine”, and “pain management”, and these words were the most highly ranked in terms of burst strength.

Reference Co-Citation Analysis

Reference co-citation refers to two (or more) articles that are cited by one or more articles simultaneously, which can be used to assess the degree of correlation among the articles. Furthermore, co-cited references highlight the key articles contributing to research in the field. Figure 10 shows the reference co-citation map consisting of 451 cited references and 1725 co-citation links from 2012 to 2022. Table 10 and Table 11 outline the top 5 most cited

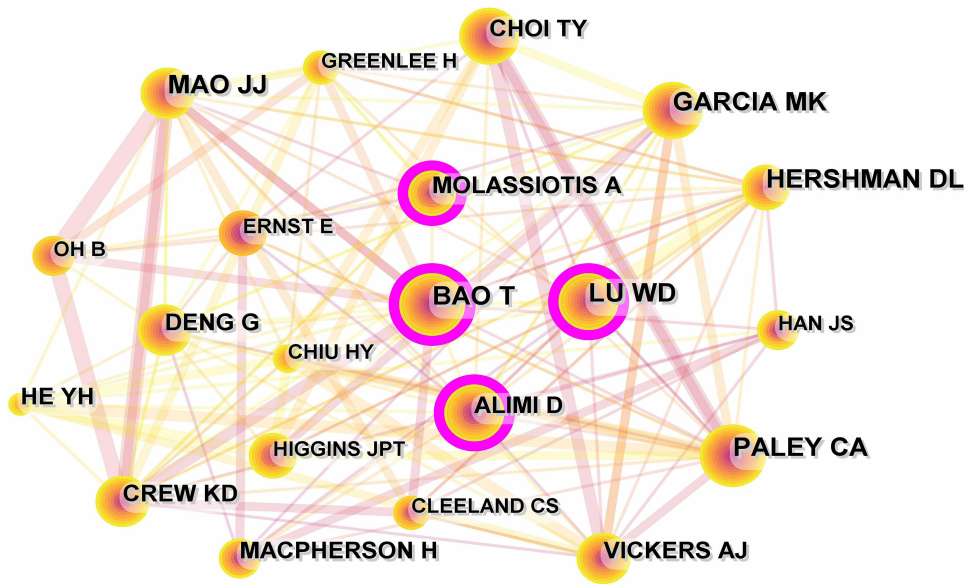


Figure 6 Map of cited authors in studies on acupuncture therapy for cancer pain.

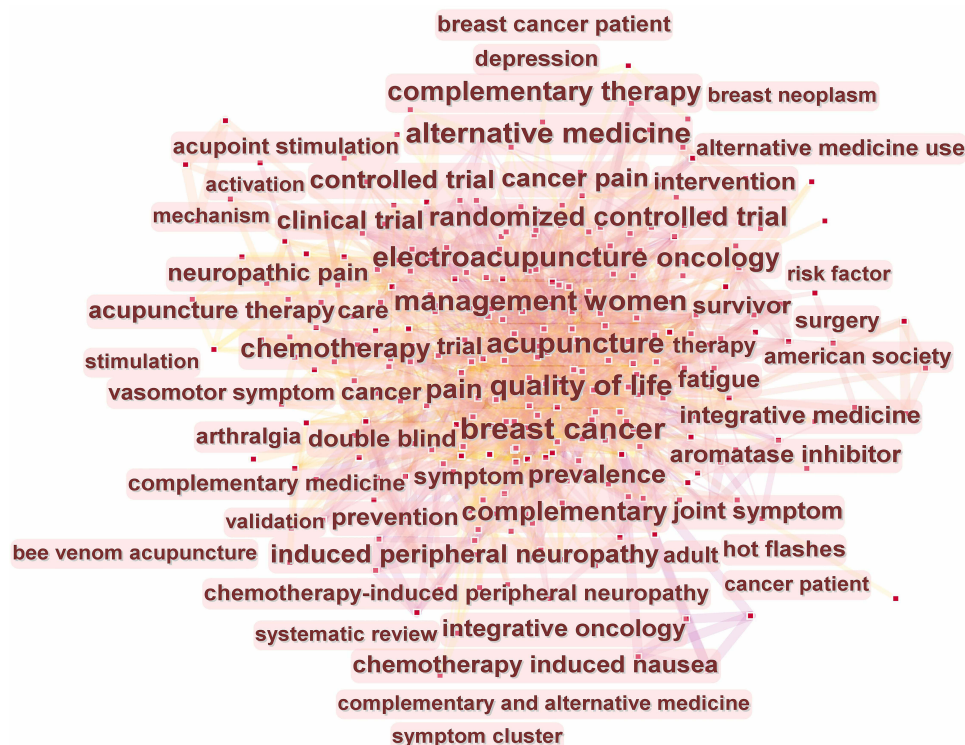


Figure 7 Co-occurrence map of keywords for acupuncture therapy for cancer pain.

references and the highest centrality of acupuncture treatment for cancer pain for the last 10 years, respectively. A cluster analysis of the co-cited references was generated to analyze the common themes in similar articles. Figure 11 shows the 10 clusters of the co-cited references. The five largest clusters were #0 clinical evidence, #1 pilot study, #2 cancer pain, #3 taxane-induced peripheral neuropathy, and #4 pragmatic pilot study.

By analyzing the citation burst of references, a total of 21 citations were extracted for this study and are displayed in Figure 12. The most recent burst references from 2020 to the present were in the articles by Van (2016),² Bao T (2018),⁵⁴

Table 9 Top 10 Keywords with the Highest Frequency and Centrality Values for Acupuncture Treatment for Cancer Pain

Ranking	Frequency	Keyword	Centrality	Keyword
1	79	Acupuncture	0.19	Acupuncture
1	79	Management	0.18	Breast cancer
2	70	Quality of life	0.18	Electroacupuncture
3	64	Breast cancer	0.12	Randomized controlled trial
4	57	Pain	0.11	Quality of life
5	56	Electroacupuncture	0.11	Alternative medicine
6	39	Randomized controlled trial	0.11	Chemotherapy
7	33	Women	0.09	Management
8	26	Therapy	0.09	Pain
9	25	Cancer pain	0.09	Women

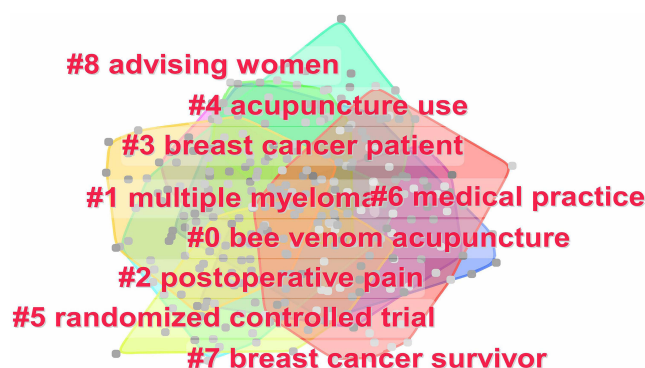


Figure 8 Cluster map of keyword cooccurrence for acupuncture therapy for cancer pain.



Figure 9 Map of the top 7 keywords with the strongest citation bursts.

Note: In this figure, "bold number" represents the start times of the burst.

Fallon M (2018),²⁹ Hershman DL (2018),⁴⁰ and Bray F (2018).²⁰ Of these, the article published by Hershman DL (2018) had the highest strength value of 7.68.

Discussion

General Information

From 2012, with 8 publications, to 2021, with 48 publications, the annual volume of publications showed a steady growth trend with a micro fluctuation for acupuncture therapy for cancer pain. The substantial annual publications that have emerged since 2020 indicate that this topic is in a period of rapid development and augurs well for the future. In terms of the impact factor (IF) of the most frequent journals, the IFs of the top 10 journals ranged from 1.817 to 5.075, and the generally low IFs of high-frequency journals indicated that research on acupuncture treatment for cancer pain needs to be published in high-quality journals to improve influence worldwide.

In terms of the distribution of nations, China, as the birthplace of acupuncture, ranked first with 117 studies, followed by the USA with 96 studies. Studies from China and the USA, accounting for 70% of 302 papers, indicated that the two nations made a substantial contribution to the progress of acupuncture therapy for cancer pain. China and the USA formed their own networks but maintained a weak degree of cooperation with each other. Therefore, academic barriers should be eliminated by researchers and institutions from different nations to seek more cooperation for high-quality and in-depth Research.

In terms of institutions, the USA and Asia (China and South Korea) had the top 5 institutions with a high frequency of studies and values of centrality. Memorial Sloan Kettering Cancer Center, as a level 2 hospital for cancer in America,

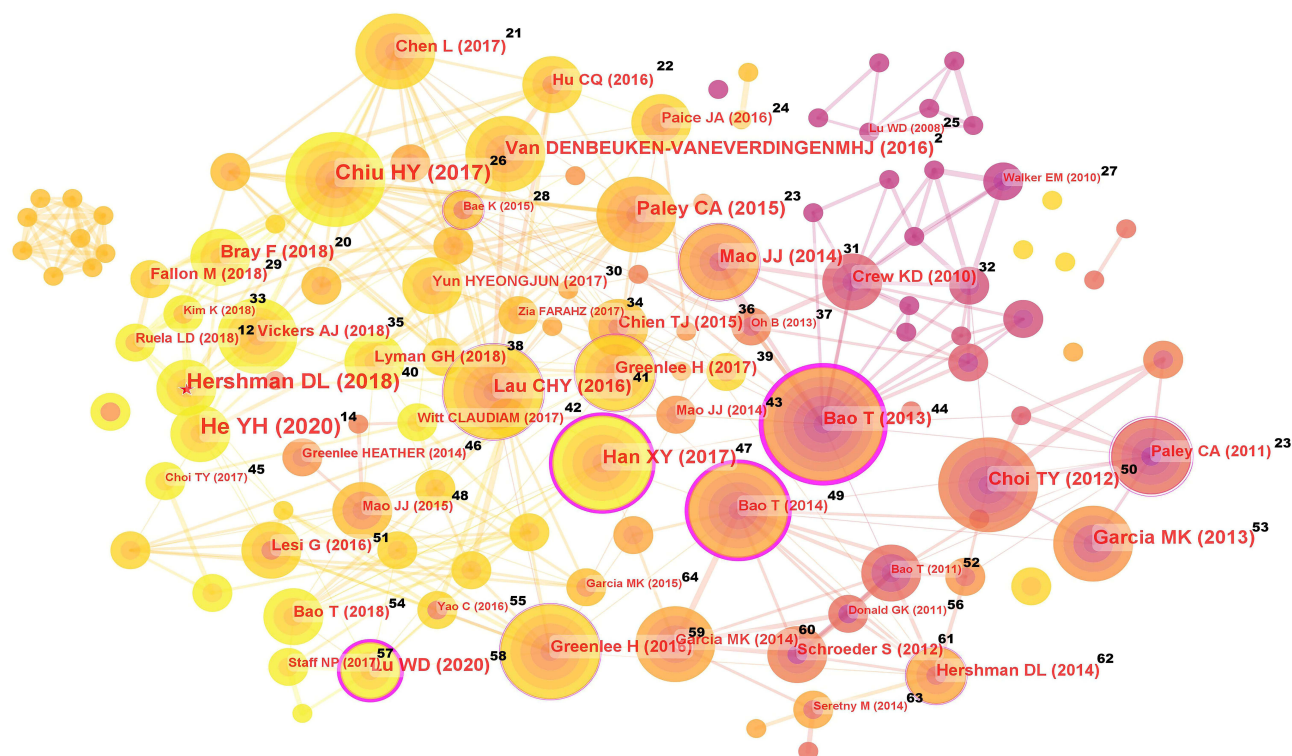


Figure 10 Co-citation map of references on acupuncture therapy for cancer pain.

plays a key role in the research of acupuncture therapy for cancer pain, with the most number of studies (21) and top centrality value (0.1) of the 252 institutions. In addition, all the values of centrality of institutions were less than 0.1 other than Memorial Sloan Kettering Cancer Center, which showed that most institutions are collaborating on a small scale. It is important to strengthen cooperation between institutions to promote the development and dissemination of acupuncture treatment for cancer pain.

In terms of authors, Mao JJ from Memorial Sloan Kettering Cancer Center published the most papers (19) with his partners. Bao Ting, the second ranked author with 10 articles, came from the same organization as Professor Mao. In recent years, Mao JJ's team has been dedicated to research on acupuncture treatment for cancer. Of these studies, a systematic review and meta-analysis published in 2020 on acupuncture therapy for cancer pain with a high IF of 33.006, which was cited 94 times, has an important influence in this field. In this paper, acupuncture was further proven

Table 10 Top 5 Cited References with the Highest Frequency Values for Acupuncture Treatment for Cancer Pain

Ranking	Frequency	Cited Reference	Representative Author (Publication Year)
1	30	Clinical Evidence for Association of Acupuncture and Acupressure with Improved Cancer Pain: A Systematic Review and Meta-Analysis	HE, Y (2020) ¹⁴
2	25	Effect of Acupuncture vs Sham Acupuncture or Waitlist Control of Joint Pain Related to Aromatase Inhibitors Among Women with Early-Stage Breast Cancer	Dawn L. Hershman (2018) ⁴⁰
3	25	Systematic review and meta-analysis of acupuncture to reduce cancer-related pain	H.Y. Chiu (2017) ²⁶
4	19	Acupuncture for cancer pain in adults	Paley, CA (2015) ²³
5	18	Systematic Review of Acupuncture in Cancer Care: A Synthesis of the Evidence	M. Kay Garcia (2013) ⁵³

Table 11 Top 5 Cited References with the Highest Centrality Values for Acupuncture Treatment for Cancer Pain

Ranking	Centrality	Cited Reference	Representative Author (Publication Year)
1	0.30	A dual-center randomized controlled double-blind trial assessing the effect of acupuncture in reducing musculoskeletal symptoms in breast cancer patients taking aromatase inhibitors	Ting Bao (2013) ⁴⁴
2	0.24	Acupuncture for cancer pain in adults	Paley, CA (2011) ²³
3	0.15	Electroacupuncture for fatigue, sleep, and psychological distress in breast cancer patients with aromatase inhibitor-related arthralgia: A randomized trial	Jun J. Mao (2014) ⁴³
4	0.14	Clinical practice guidelines on the evidence-based use of integrative therapies during and after breast cancer treatment	Heather Greenlee (2017) ³⁹
5	0.13	Randomized sham-controlled pilot trial of weekly electro-acupuncture for the prevention of taxane-induced peripheral neuropathy in women with early stage breast cancer	Heather Greenlee (2016) ⁵⁹

to reduce cancer pain and decrease the use of analgesics.¹⁴ In another review by Mao JJ, the safety of acupuncture therapy was confirmed, and practical tips on how to integrate acupuncture into cancer care were suggested.⁷⁸ Thanks to the efforts of Professor Mao's team, the application and spread of acupuncture for cancer pain has been promoted in the United States.

Research Hotspots and Trends

It was believed that research hotspots or emerging trends could be identified via keyword or reference co-occurrence analysis, clusters and bursts in citations over a period of time.

Research Hotspot: Types of Cancer

The common cancer types for acupuncture treatment for cancer pain include breast cancer, lung cancer, gastric cancer, pancreatic cancer, colon cancer and multiple myeloma. Based on the frequency, centrality, clusters, and citation burst of the keywords and references, we can conclude that breast cancer is of great concern in this field. Breast cancer accounts

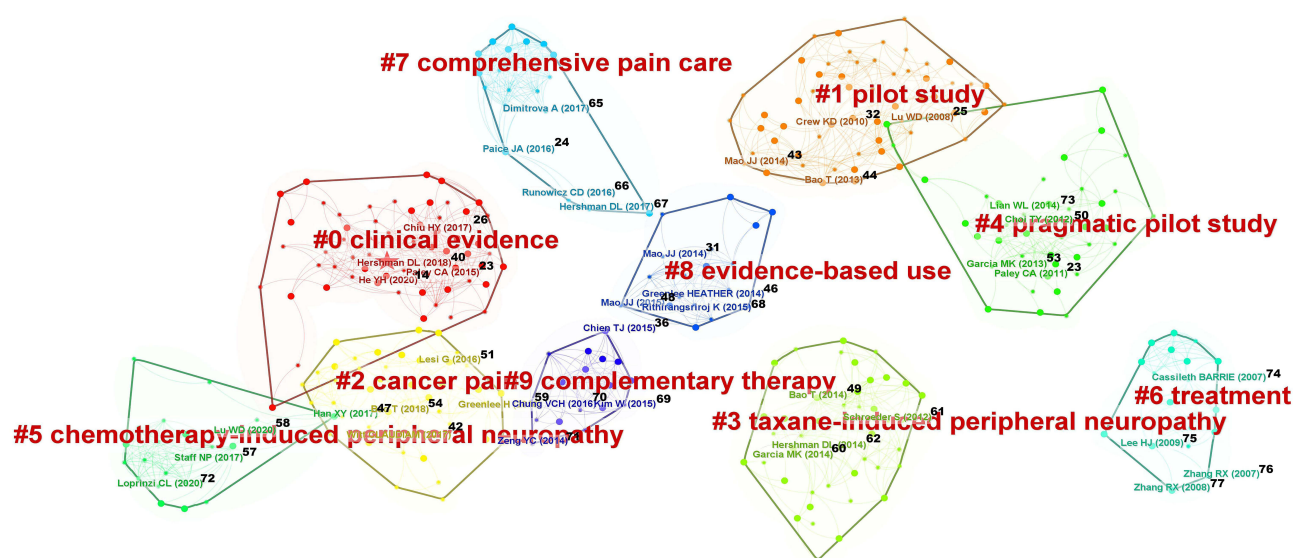
**Figure 11** Cluster map of co-cited references on acupuncture therapy for cancer pain.



Figure 12 Map of the top 21 references with the strongest citation bursts.

Note: In this figure, "bold number" represents the start times of the burst.

for approximately 30% of female cancers⁷⁹ and has become the top cancer among women. Breast cancer has a high survival rate after aggressive treatment. However, some side effects that emerge with chemotherapy, surgery, or pharmacological treatment affect the quality of life and even the treatment process. In recent years, some RCTs have verified that acupuncture is effective in alleviating pain in breast cancer, including chemotherapy-induced peripheral neuropathy,⁵⁹ musculoskeletal symptoms and arthralgia caused by aromatase inhibitors.⁴⁴ In addition, a feasibility study showed that acupuncture is a feasible option for postoperative breast cancer patients.⁸⁰ These studies supplied solid evidence on acupuncture for breast cancer pain. A clinical guideline suggested that acupuncture could be considered for the management of pain in breast cancer patients.³⁸

Based on the cluster of keywords, multiple myeloma is probably the hotspot disease of cancer in this field. Multiple myeloma is a hematologic malignancy, with a prevalence of 588,161 people worldwide per year.⁸¹ Some studies confirm that acupuncture can decrease peripheral neuropathy in patients with multiple myeloma caused by chemotherapy⁶⁰ and reduce the use of pain medications in multiple myeloma patients undergoing autologous hematopoietic stem cell transplantation.⁸²

Intervention Techniques

In conformity with the frequency and centrality of the keywords, we conjectured that electroacupuncture may be the most therapeutic technique in this field. Electroacupuncture could exert continuous stimulation on specific acupoints. Electroacupuncture blocks pain by activating a variety of bioactive chemicals through peripheral, spinal, and supraspinal mechanisms.⁸³ A study showed that electroacupuncture attenuates morphine tolerance via inhibiting the PI3K/Akt/JNK1/2 signaling pathway of rats with bone cancer pain.⁸⁴ Electroacupuncture alleviates paclitaxel-induced peripheral neuropathic pain by suppressing TLR4 signaling and upregulating TRPV1 in dorsal root ganglion neurons of rat.⁸⁵ A study proved that electroacupuncture decreased the symptoms of fatigue, sleep, and psychological distress in breast cancer patients by alleviating aromatase inhibitor-related arthralgia.⁴³ An RCT showed that electroacupuncture reduced postoperative analgesic requirements of colorectal cancer patients.⁸⁶

In addition, bee venom acupuncture (BVA), as a new acupuncture treatment, is probably the hotspot in this field according to the cluster of keywords. BVA involves stimulating the acupoint with diluted bee venom, which has been proven effective in osteoarthritis of the knee, rheumatoid arthritis, peripheral neuropathies, pain, stroke and Parkinson's disease.^{87,88} Strikingly, BVA has been proven to be effective for neuropathic pain induced by chemotherapy in animal models.^{89,90}

Type of Cancer Pain

Postoperative Pain

Based on the clusters of keywords (#2 postoperative pain), postoperative pain is probably the most common type of cancer pain in this field. Surgery is a common therapy for cancer patients, while pain induced by surgery remains a serious problem. A bibliometric analysis of acupuncture for postoperative pain showed that acupuncture is involved in analgesia in lung cancer surgery and gastric cancer surgery.⁹¹ An RCT showed that transcutaneous electrical acupoint stimulation could be a feasible approach for sedation and postoperative analgesia in thoracoscopic pulmonary resection.⁹² A clinical study revealed that transcutaneous electrical acupoint stimulation pretreatment could reduce chronic pain 6 months after mastectomy.⁹³

Peripheral Neuropathic Pain Syndrome

Based on the clusters of references (#3 taxane-induced peripheral neuropathy, #5 chemotherapy-induced peripheral neuropathy), peripheral neuropathic pain is probably the most common type of cancer pain in this field. Some chemotherapy drugs can damage the peripheral nerves, ultimately resulting in chemotherapy-induced peripheral neuropathy (CIPN), which presents severe neuropathic pain syndrome. The severity of the acute syndrome may require reducing the dose of chemotherapy or even ceasing it, with potential impact on tumour control and survival. CIPN can persist for months or year after the cessation of chemotherapy.^{94,95} Currently, we have no effective preventive and limited treatment options to relieve pain symptoms in CIPN.⁹⁶

Acupuncture, as a early form and foundation of peripheral stimulation,^{97,98} provide an alternative or adjunctive therapy for neuropathic pain via increasing the level of spinal or brain 5-hydroxytryptamine (5-HT), norepinephrine (NE), and opioid peptides.⁹⁹ Acupuncture are beneficial and cost-effective approaches for easing peripheral neuropathic pain and hence can be considered for peripheral neuropathic pain management.¹⁰⁰ A study showed that acupuncture resulted in significant improvement in CIPN symptoms compared with usual care.¹⁰¹ An RCT of 104 patients suggested that acupuncture combined with methylcobalamin in the treatment of CIPN in patients with multiple myeloma showed a better outcome than methylcobalamin administration alone.⁴⁷ A systematic review and meta-analysis of 386 cancer patients revealed that acupuncture could effectively relieve CIPN pain and functional limitation.¹⁰²

Aromatase Inhibitors-Associated Arthralgia Syndrome

Aromatase inhibitors have radically changed the prognosis of hormone receptor positive breast cancer in postmenopausal women. However, side-effects induced by aromatase inhibitors impact the effect and quality of breast cancer. Among them, Aromatase inhibitors-associated arthralgia syndrome(AIA), which consists of symmetrical joint pain, mainly affecting hands, wrists and knees, and sometimes lower back, hips, shoulders and feet, is one of the leading causes of therapy discontinuation.¹⁰³ According to the co-cited references analysis, the article published by Dawn L. Hershman (2018)⁴⁰ and (2013)⁴⁴ with the most frequency and centrality respectively, which indicated that acupuncture for joint pain induced by aromatase inhibitors in patients with breast cancer has aroused much attention. A systematic review and meta-analysis of 603 breast cancer patients showed that acupuncture is a safe and effective treatment for breast cancer patients with AIA.¹⁰⁴

Research Trends and Frontiers

The clusters of keywords, “#5 Randomized controlled trial”, and the high frequency and centrality of keywords indicated that RCTs are an important research method in this topic, and the high frequency and centrality of cited references verified this. Evidence-based evaluation is also a current trend in this topic from the reference co-citation analysis.

According to the newest burst keywords, “mechanism”, with the highest strength value, may be a research trend in acupuncture for cancer pain. To date, research on the mechanism of acupuncture for cancer pain has mainly concentrated on cancer-induced bone pain in rat models. Bone is one of the most common sites for metastasis in cancer, particularly in patients with multiple myeloma, breast, prostate or lung cancer,^{105,106} and bone pain is one of the most common types of

chronic pain in these patients.¹⁰⁷ The underlying mechanism of cancer-induced bone pain includes reducing the expression of CXCL12 by inhibiting the activation of NF- κ B,¹⁰⁸ suppressing the expression of 5-HT and 5-HT3AR, and increasing the expression of MOR and endomorphin-1 in the RVM-spinal cord pathway.¹⁰⁹ Recently, animal research revealed mTOR as a potential target in bone cancer pain and electroacupuncture analgesia.¹¹⁰ For better development and application in this field, more experiments need to be conducted to explore the mechanism of acupuncture for cancer pain.

Strengths and Limitations

The strength of this study is that we performed a visual analysis of the literature related to acupuncture treatment for cancer pain and summarized the current research status and research frontiers in this field. However, this study also has certain limitations that need to be addressed. First, due to CiteSpace being unable to analyze cited references for other databases, we only extracted publications from the Web of Science Core Collection, which may lead to publication bias. In addition, with the continuous addition of publications, the findings of this study may have a certain lag.

Conclusion

This study discloses the research status and emerging trends of acupuncture for cancer pain during the past decade from the perspective of bibliometric analysis via CiteSpace. The annual volume of publications suggests that the field of acupuncture therapy for cancer pain has been on the rise. The general quality of research on acupuncture therapy for cancer pain needs to be further improved. More studies without language and academic barriers need to be performed to enhance global cooperation and communications. The current research hotspots concentrate on breast cancer and multiple myeloma, electroacupuncture, bee venom acupuncture, postoperative pain, peripheral neuropathic pain syndrome, and aromatase inhibitors-associated arthralgia syndrome. The research trends and frontiers include clinical trials, evidence-based evaluations and the mechanism of acupuncture for cancer pain. Furthermore, more rigorous clinical trials and more research exploring related mechanisms are needed in the future.

Abbreviations

RCT, randomized controlled trial; WoS, Web of Science; IF, impact factor; CIPN, chemotherapy-induced peripheral neuropathy; BVA, bee venom acupuncture; AIA, Aromatase inhibitors-associated arthralgia syndrome.

Data Sharing Statement

The raw data of this article can be obtained by contacting FL, XL, and WQ directly.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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