Dovepress
Taylor & Francis Group

ORIGINAL RESEARCH

Research Hotspots and Trends in Acupuncture for Cancer:A bibliometric analysis from 2004 to 2024

Zhe Ji*, Heyuan Niu*, Anqi He, Kaiyu Li, Jinyan Jia, Maorun Zhang, Gang Liu 🆔

Department of General Surgery, Tianjin Medical University General Hospital, Tianjin, People's Republic of China

*These authors contributed equally to this work

Correspondence: Gang Liu, Email lg1059@tmu.edu.cn

Background: Acupuncture is increasingly recognized as a promising intervention modality in cancer treatment. Nevertheless, there has been a paucity of systematic analysis and visualisation of relevant publications through bibliometric methods. This paper conducts a bibliometric analysis of research on acupuncture within the realm of oncological applications, aiming to explore its prospects and emerging trends.

Methods: In this study, we analyzed 2117 documents obtained from the Web of Science Core Collection (WOSCC) to examine the correlations among authors, journals, institutions, countries, and keywords. This analysis was conducted using the Bibliometric R package, CiteSpace, and VOSviewer software.

Results: The evolution of acupuncture can be broadly divided into three time periods: 2004–2008, 2009–2017 and 2018–2024. The WOSCC retrieved 2117 publications on acupuncture for cancer over the past 20 years. Among the top 10 institutions, seven were from the United States, two from China, and one from Korea. Memorial Sloan Kettering Cancer Center had the highest number of publications. At the same time, the journal INTEGRATIVE CANCER THERAPIES published the most articles in this field. Keyword co-occurrence analysis revealed four distinct clusters: "Alternative and Complementary Medicine for Cancer", "Acupuncture for cancer-related fatigue and pain", "Acupressure for anxiety, depression, and insomnia", "Improving quality of life for breast cancer patients". The most recent keyword outbreaks included "sleep", "radiation induced xerostomia", "recovery", "insomnia", and "induced peripheral neuropathy." Breast cancer is the type of cancer for which acupuncture is most commonly used.

Conclusion: The future research focus will be on acupuncture as a treatment for sleep disorders, the alleviation of radiotherapy complications and the improvement of postoperative quality of life. Research on acupuncture in the field of breast cancer is more extensive compared to other cancers. Therefore, it is necessary to strengthen research on acupuncture in different cancer types.

Keywords: acupuncture, bibliometric analysis, cancer, citespace, VOSviewer

Introduction

Cancer is a highly lethal disease characterized by a long course, easy metastasis, and a high mortality rate. According to the GLOBOCAN 2022 database, there were nearly 20 million new cancer cases globally in 2022, with 9.7 million deaths from cancer. It is estimated that in 2050, new cancer cases will reach 35 million.[1] Human cancer development is a product of a multi-step process, including maintaining proliferative signals, evading growth suppressors, and resisting cell death. The acquisition of these functions may somehow be linked to distinguishable steps in tumor pathogenesis.[2] Due to low early diagnosis rates, most patients are already in the middle to late stages when seeking treatment, which significantly reduces the cure and survival rates. Currently, medicine has made insufficient progress in reducing the side effects and off-target risks of chemotherapy drugs. The presence of multidrug-resistant cancer cells poses a challenge to the efficacy of traditional chemotherapy.[3,4] The prolonged utilization of chemotherapeutic agents diminishes the patient's quality of life, while the emergence of drug resistance compromises the effectiveness of the treatment.[5,6] This disheartening information poses a considerable challenge to the world.

Acupuncture, an esteemed treasure of traditional Chinese medicine, has emerged as one of the most promising medical methodologies globally. Acupuncture involves stimulating specific acupoints, activating surrounding nerves, transmitting

sensory information from the spinal cord to the brain, activating peripheral autonomic neural pathways, and regulating the body's physiological conditions.[7] Previous studies have demonstrated that acupuncture plays an anti-tumor role primarily by enhancing and modulating the tumor immune microenvironment, improving local angiogenesis associated with tumors, and promoting apoptosis in tumor cells. Some researchers have found that grain-sized moxibustion (gMoxi) at the Zusanli acupoint (ST36) for 30 minutes can limit and inhibit the growth of non-small cell lung cancer. Further investigations indicate that moxibustion may promote natural killer (NK) cell anti-tumor immunity and enhance the tumor immune microenvironment by inhibiting adrenergic signaling.[8] Additionally, in a study utilizing intermittent wave electrical stimulation within a cyclophosphamide-induced immunosuppression mouse model, it was observed that electroacupuncture stimulation can increase levels of IL-2, IL-6, IL-12, tumor necrosis factor-α, and interferon-γ, while concurrently reducing IL-10 levels. This stimulation also elevates the expression of phosphorylated NF-κB/P65 inhibitory protein and nuclear factor-kappa B (NF-κB), thereby activating the NF-κB signaling pathway and effectively enhancing immune responses in mice subjected to cyclophosphamide-induced immunosuppression.[9] Moreover, studies have shown that both cisplatin and moxibustion can inhibit the growth of Lewis lung cancer (LLC), resulting in reduced tumor area and weight. The combined treatment of cisplatin and moxibustion demonstrates promising results, as it influences macrophage polarization, increases the infiltration of M1 macrophages, significantly enhances the secretion of M1-related pro-inflammatory factors such as TNF-α, nitric oxide (NO), and IL-1, and improves the body's immune function. Furthermore, this combination therapy may promote vascular normalization by increasing microvessel density and inhibiting vascular endothelial growth factor (VEGF) expression.[10] Acupuncture therapy is grounded in adjusting the body's immune function without producing toxic side effects. This makes it a significant part of multidisciplinary approaches to combating tumors, especially for patients unsuitable for surgery or those with weakened immune systems in the late stages of radiotherapy and chemotherapy. In recent years, acupuncture has achieved significant progress in pain relief, reducing chemotherapy reactions and alleviating cancer-related fatigue.[11–13] This provides a theoretical foundation for related research on acupuncture treatment in cancer.

Bibliometric analysis involves quantitatively using mathematical and statistical methods to analyze the knowledge system within a given discipline. This enables the examination of research focuses and hotspots within a research field and the assessment of the scientific productivity of countries, institutions, and researchers.[14,15] We aim to further explore the current research status and future research trends of acupuncture in the field of oncology through systematic bibliometric methods.

Materials and Methods

Data Sources and Search Criteria

Web of Science (WoS) is one of the most widely accessed academic databases, covering over 12,000 academic journals, and is frequently used by researchers.[15,16] We selected the Web of Science Core Collection (WOSCC) as the main database. We searched for related articles published between January 1, 2004, and September 30, 2024, using the following formula: ((TS=(Acupuncture*)) OR TS=(Electroacupuncture*)) OR TS=(Acupotom*)) OR TS=(Pharmacopunct*)) AND (((((TS=(cancer*)) OR TS=(Tumor*)) OR TS=(Carcinoma*)) OR TS=(Neoplasia*)) OR TS=(Neoplasm*)) OR TS=(Malignanc*)).The publication types were limited to Articles and Review Articles, and only regular articles written in English were included. Complete records and cited references were extracted from relevant publications and saved in plain.txt format for further study. Figure 1 depicts the flowchart.

Software for Bibliometric Analysis

The bibliometric tools used in our study include the Bibliometrix R package,[17] VOSviewer,[18] and CiteSpace.[19] Bibliometrics is an R software package that offers a comprehensive suite of features for conducting quantitative research in scientometrics.[20,21] In this article, we utilize version 4.2.0 of Bibliometrics to count the number of publications and their respective citation counts, assess the strength of collaboration between countries and authors, and generate a three-field graph for keyword analysis. In addition, R studio we use is version 4.3.3.

CiteSpace(6.3.3R (64-bit) Advanced Edition) can effectively assist researchers in gaining a comprehensive understanding of the research fields in which they are actively engaged. It not only offers an overview of specific domains but also highlights key literature that plays a crucial role in the overall development trajectory.[22] This article employs
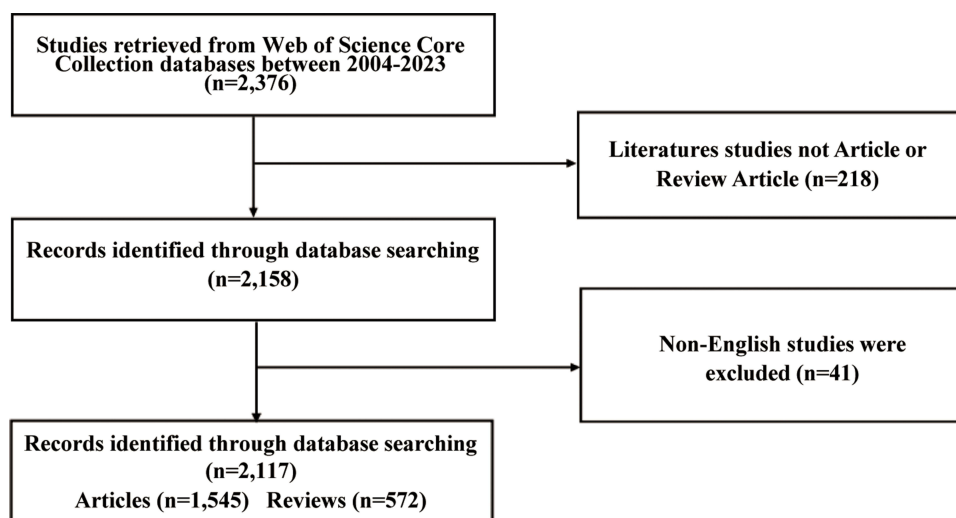
Figure 1 Search process of the literature flowchart.

CiteSpace software to identify highly cited literature and keywords that have experienced a significant increase in citation frequency over a defined period.

The visualization software VOSviewer(version 1.6.20) can perform co-authorship network analysis for countries, institutions, authors, as well as co-occurrence network and density analysis for keywords.VOSviewer's functionalities are based on its embedded clustering algorithm.[23,24] We used VOSviewer for co-citation and co-occurrence analysis. Node size represents the number of publications, line thickness indicates the strength of the relationships, and node color represents different clusters or periods.

Results

Annual Publications and Citations

A total of 2117 publications on acupuncture and oncology were retrieved between January 1, 2004, and September 30, 2024. Figure 2 illustrates the annual number and citation frequency of articles related to acupuncture and oncology. Since 2004, the yearly number of publications has shown a gradual increase. We categorized these 21 years of publications into three phases, as depicted in Figure 2: The number of papers published during 2004–2010 increased slowly, with fewer than 50 publications per year, suggesting that researchers initially overlooked the field. From 2011 to 2016, the number of publications gradually increased, indicating a growing interest among researchers. After 2017, the number of publications surged rapidly, reaching a peak in 2023, which signifies that the field has garnered widespread attention since 2011. The highest number of publications in 2023 was 224. This trend indicates that the topic of acupuncture and oncology has remained prominent in recent years. As our search was conducted only up to 30 September 2024, the annual number of publications for that year is incomplete. Consequently, it is not possible to accurately ascertain the trend in publications for 2024. Additionally, the number of annual citations is influenced by the volume of articles published yearly, with citations peaking in 2013. Supplementary material 1 has showed each country's contribution to the field of acupuncture for cancer over the past twenty years. The United States and China have made significant and noteworthy contributions to this field.

Analysis of Countries and Regions

Analysis of the number of articles published by each country shows that twenty countries/regions have published articles in the relevant field. The country/region with the highest output is China (n=822), followed by the United States (n=573), South Korea (n=153), the United Kingdom (n=89), and Germany (n=54) (Figure 3A).

To eliminate the influence of the number of publications on the number of citations, we standardized the citation numbers by the number of publications to infer each country's objective influence in the field of acupuncture for cancer. Although countries such as Canada and Italy do not have the highest number of publications, they exert a considerable influence. In
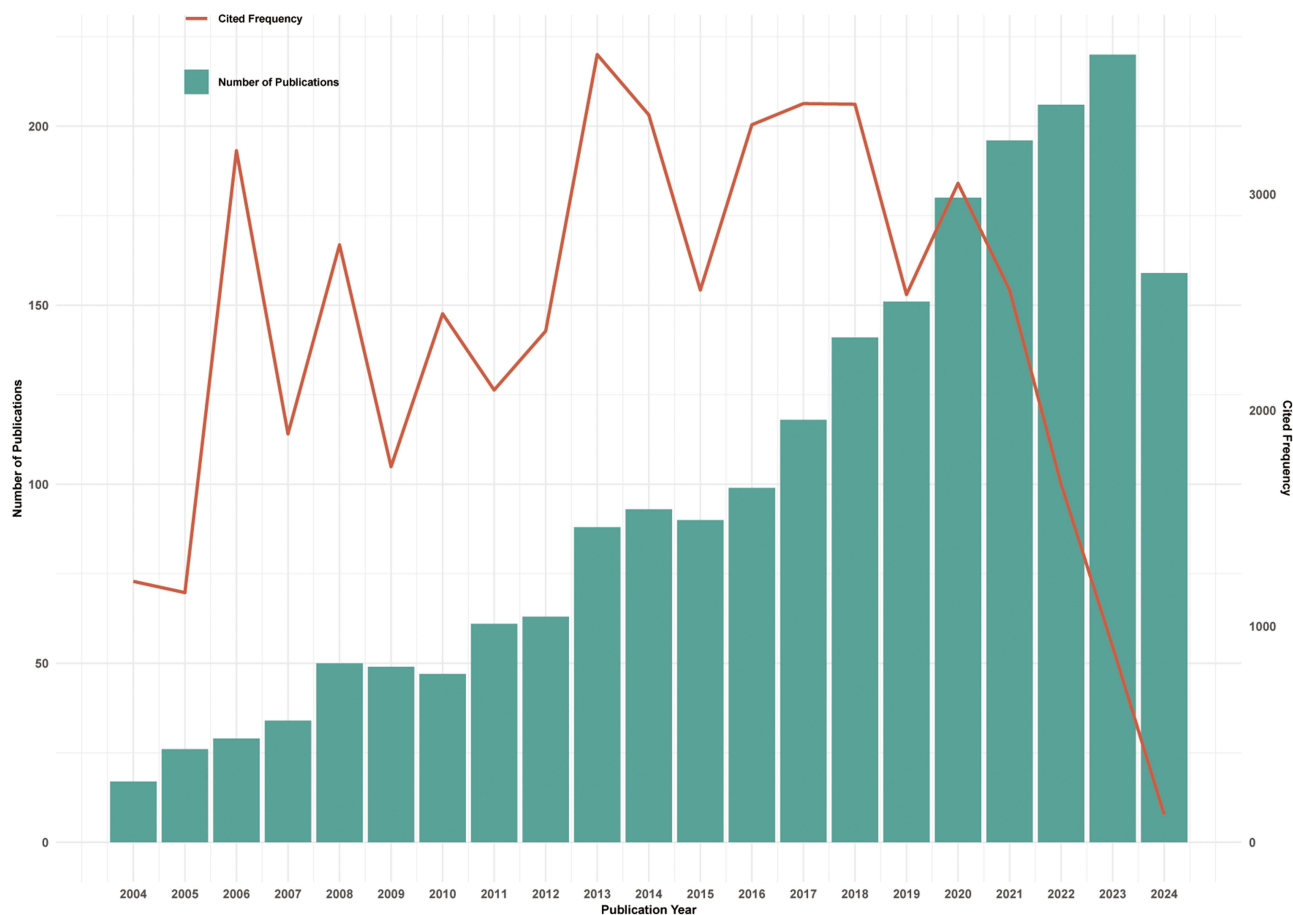
Figure 2 Research publications and citations of global trends in acupuncture for cancer from 2004 to 2024.

addition, China and the United States continue spearhead global oncology acupuncture research. (Figure 3B). Further results from citation density graphs show that the density curve for the United States exhibits a prominent peak, indicating that most academic citations are concentrated in relatively high ranges (Figure 3C). This suggests that the United States has a broad research base and higher citation frequency in this field. China's density curve is more comprehensive, indicating a wider distribution of citations. While its peak is not as prominent as that of the United States, it covers a more comprehensive range of citations, reflecting Chinese academic research's diversity and extensive impact. Other countries, such as the United Kingdom and Sweden, have flatter curves, reflecting the uniformity of their academic citations. Figure 3D illustrates the country collaboration network map, highlighting China's close partnerships with the United States, Australia, South Korea, Canada, England, Brazil and Japan. China emerged as a leading nation in this field, with a high volume of publications and significant citation frequency. As the birthplace of acupuncture, China stands out as the most active collaborator, demonstrating solid connections with other countries and underscoring its vital role in the field. In recent years, the publication output from countries such as the United States and South Korea has surged, likely due to their collaborations with China. To advance research and foster global cooperation in the field of acupuncture and moxibustion, particularly in oncological applications, it is imperative for other countries to enhance their collaborative efforts and exchanges.

Analysis of Institutional Output and Collaboration

The analysis of the results of institutional communications indicates that a total of 1260 institutions are included. In Table 1, the Memorial Sloan Kettering Cancer Center has the highest H-index (H-index=48), with 168 publications and 6989 citations. Six of these ten institutions have published more than 100 papers, including seven from the United States, two from China, and one from Korea.
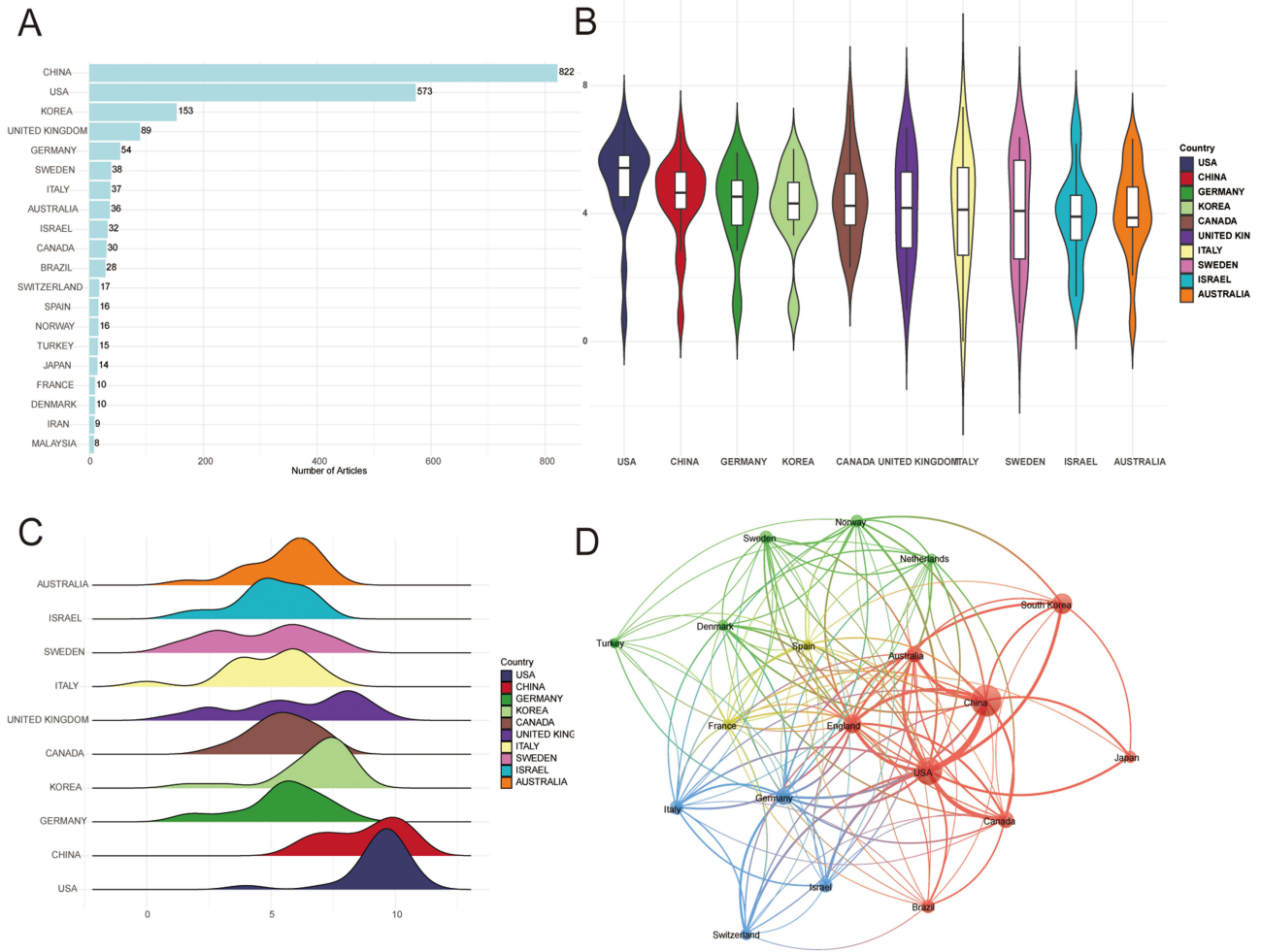
Figure 3 Analysis of inter-country/inter-regional cooperation.(**A**)The overall volume of publications in the top 20 countries/regions in this field. (**B**)Violin plot of standardized citation counts across countries in this field from 2004 to 2024. (**C**)Density plot of standardized citation counts across countries in this field from 2004 to 2024. (**D**)The co-occurrence map of countries or regions(The colour of the nodes represents clustering, the size of the nodes represents the number of articles, and the connectivity between the nodes represents the strength of collaboration).

Cooperation network analysis was conducted among universities or institutions, generating six clusters on the network map. Beijing University of Chinese Medicine (n = 72, Cluster 1), Memorial Sloan Kettering Cancer Center (n = 80, Cluster 2), Hong Kong Polytechnic University (n = 30, Cluster 3), Kyung Hee University (n = 65, Cluster 4), China Medical University (n = 46, Cluster 5), and Israel Institute of Technology (n = 27, Cluster 6) are the most prominent nodes in the six clusters. Notably, three of the six institutions are from China, while the remaining three are from the United States, South Korea, and Israel. Cluster 1 is the largest, with eight nodes representing different universities or institutions, while Clusters 5 and 6 are the smallest, with only two nodes each (Figure 4). Beijing University of Chinese Medicine has the most frequent exchanges with other institutions or universities, and its researchers have been very active in the field of acupuncture and oncology in recent years.

Analysis of Article Output and Impact of Journals

A total of 501 journals have published articles in the field of acupuncture in oncology. As shown in Table 2, the top 10 journals ranked by H-index, along with their publication volume, citation count, and country, are listed. Among these 10 journals, SUPPORTIVE CARE IN CANCER achieved the highest H-index, INTEGRATIVE CANCER THERAPIES ranked first with 120 articles in total publication. The JOURNAL OF CLINICAL ONCOLOGY was the most cited, with 2507 citations. Six publishers are from the US, and four are from the UK. Figure 5 illustrates the top 20 journals ranked

Table 1 Top 10 Institutions with the Highest H-Index About the Field of Acupuncture for Cancer

Institution	H-index	G-index	M-index	Citation	Publication	Country
Memorial Sloan Kettering Cancer Center	48	79	2.29	6989	168	USA
University Of Texas System	38	63	2.11	4513	124	USA
Utmd Anderson Cancer Center	38	62	2.38	4105	94	USA
Harvard University	36	61	1.89	3953	104	USA
University Of California System	36	55	1.80	3466	110	USA
University Of Pennsylvania	36	58	1.71	3826	96	USA
Kyung Hee University	34	45	1.62	3478	164	Korea
China Medical University Taiwan	33	47	1.94	3102	182	China
Fudan University	30	44	1.58	2099	64	China
Columbia University	23	41	1.15	3055	41	USA

by the number of publications over the past 20 years. The journal with the highest number of publications is INTEGRATIVE CANCER THERAPIES, with 120 publications (5.67%). It is followed by EVIDENCE-BASED COMPLEMENTARY AND ALTERNATIVE MEDICINE (110 publications, 5.20%), MEDICINE (87 publications,
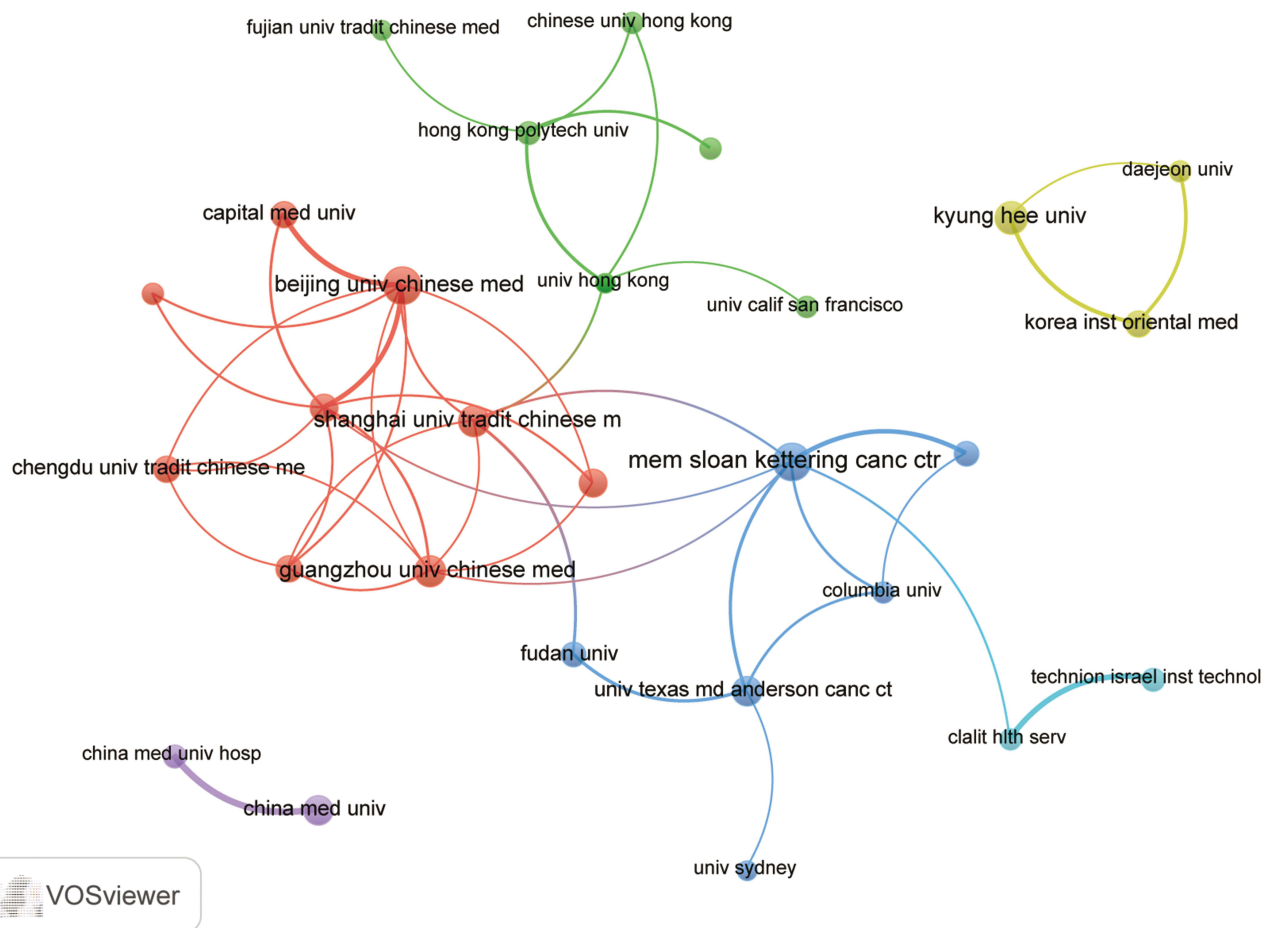

Figure 4 The co-occurrence map of institutions.(The size of the nodes represents the frequency of occurrence, and the thickness of the lines between the nodes represents the degree of cooperation between the links, and different colours represent different clusters).

Table 2 Top 10 Journals with the Highest H-Index About the Field of Acupuncture for Cancer

Journal	H-index	Publication	Citation	Country	IF
Supportive Care In Cancer	24	74	1872	USA	2.8
Integrative Cancer Therapies	23	120	1539	USA	2.9
Evidence-Based Complementary And Alternative Medicine	22	110	1813	UK	2.6
Journal Of Alternative And Complementary Medicine	19	61	1232	USA	2.3
Journal Of Clinical Oncology	19	19	2507	USA	42.1
Acupuncture In Medicine	18	59	950	UK	2.4
Journal Of Pain And Symptom Management	17	27	729	USA	3.2
Bmc Complementary And Alternative Medicine	16	29	699	UK	4.8
Cancer	16	20	767	USA	6.1
Cochrane Database Of Systematic Reviews	16	19	1214	UK	8.8

4.11%), SUPPORTIVE CARE IN CANCER (74 publications, 3.50%), and JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE (61 publications, 2.89%).

Analysis of Contributions of Authors

A total of 8078 authors participated in acupuncture and oncology-related research. In Table 3, the author with the highest H-index ranking is Mao J J, who has contributed to the publication of 61 papers with an H-index of 23. ZHANG Y ranks second (33 papers, H-index=17), and COHEN L ranks third (24 papers, H-index=16). The high publication and citation rates of Mao J J indicate their significant contribution to this field. Figure 6A shows the collaboration among researchers. Forty-three authors with eight or more articles are divided into 4 clusters. Cluster 1, with the most significant
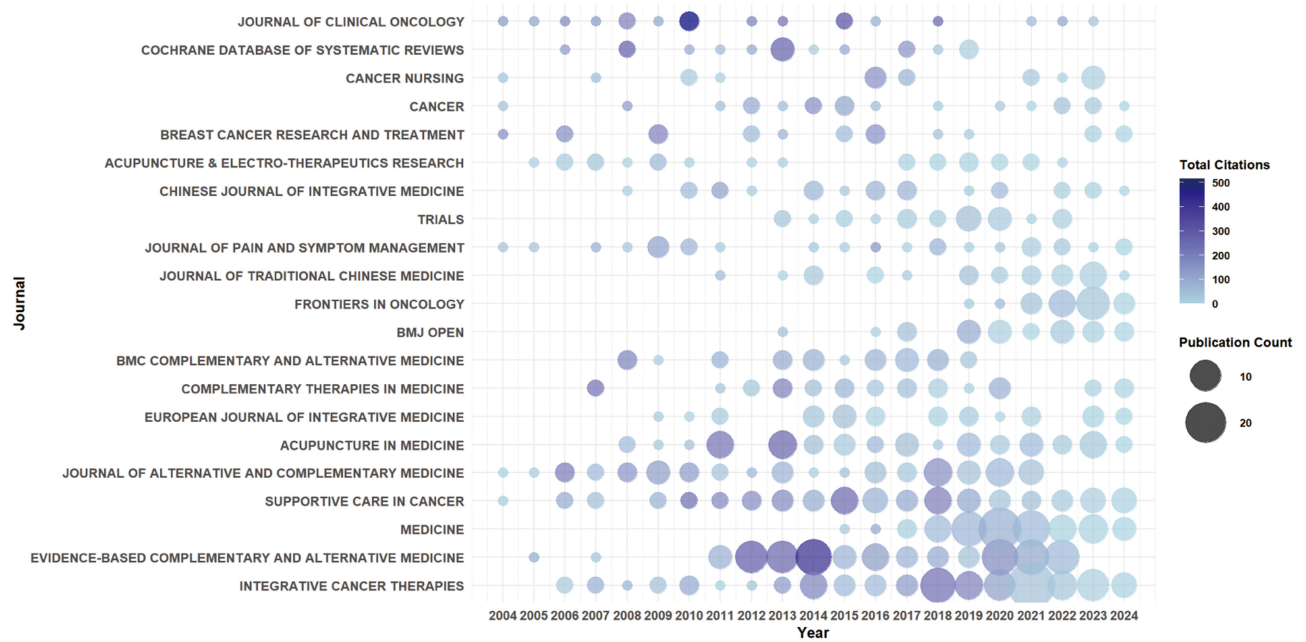

Figure 5 The total number of publications and citations in the top 20 journals(The size of the bubbles is positively correlated with the number of articles sent, and the colour depth of the bubbles is positively correlated with the frequency of citations).

Table 3 Top 10 Authors with the Highest H-Index About the Field of Acupuncture for Cancer

Author	H-index	Citation	Publication
MAO JJ	23	1971	61
ZHANG Y	17	925	33
COHEN L	16	1181	24
BAO T	15	1103	25
MOLASSIOTIS A	14	1099	22
LEE MS	14	581	21
GARCIA MK	13	643	16
CASSILETH BR	13	991	15
BEN-ARYE E	12	405	32
DENG G	12	1208	16

number of people, consists of 7 authors, with Mao J J having the most comprehensive number of publications and being the most active in collaborating with other authors. In Figure 6B, we generated a three-field plot (TFP) to illustrate the relationships among authors (left), keywords (center), and countries (right). The size of each rectangle corresponds to the number of published articles, while the connecting lines represent the correlations between academic strengths, with more connections indicating more research. Among authors, Mao J J has the widest research scope, significantly associated with keywords such as acupuncture, cancer, and electroacupuncture. Regarding countries, Chinese authors have published a large number of papers, exploring various aspects of the field and making significant contributions.

Keyword Occurrence and Co-Occurrence Analysis

Keywords are fundamental to an article, and keyword co-occurrence analysis is valuable for identifying active research areas. From a total of 3504 published records, keywords with a minimum of 25 occurrences were extracted, forming four clusters in the web map (Figure 7A). Each cluster comprises 17, 13, 8 and 3 keywords, respectively. The first cluster is
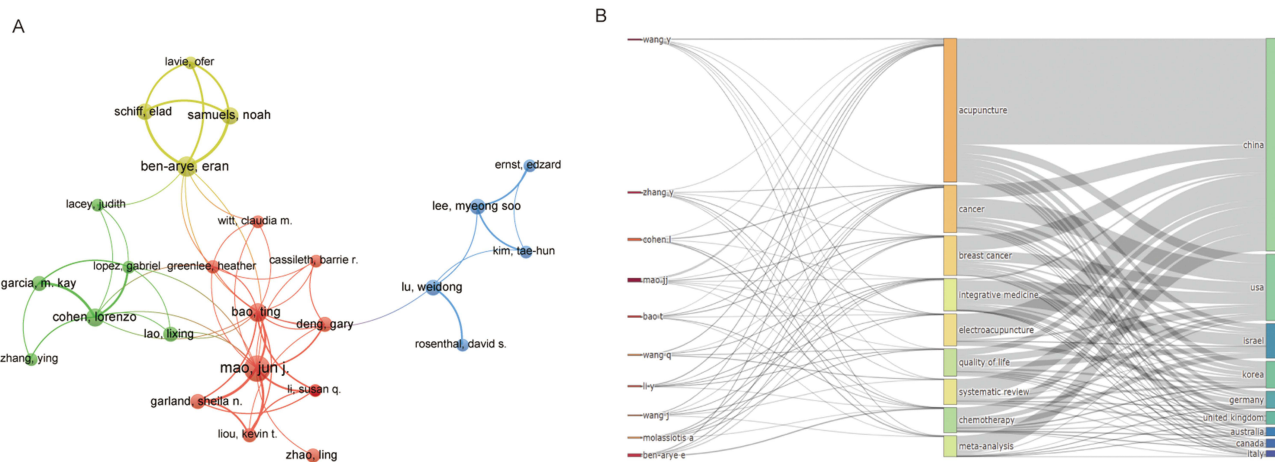

Figure 6 Distribution of authors. (**A**)) The co-occurrence map of authors(The colour of the nodes represents clustering, the size of the nodes represents the number of articles, and the connectivity between the nodes represents the strength of collaboration). (**B**)Three-field plot of the analysis on the field of acupuncture for cancer (Left field: authors; Middle field: keywords; Right field: countries).
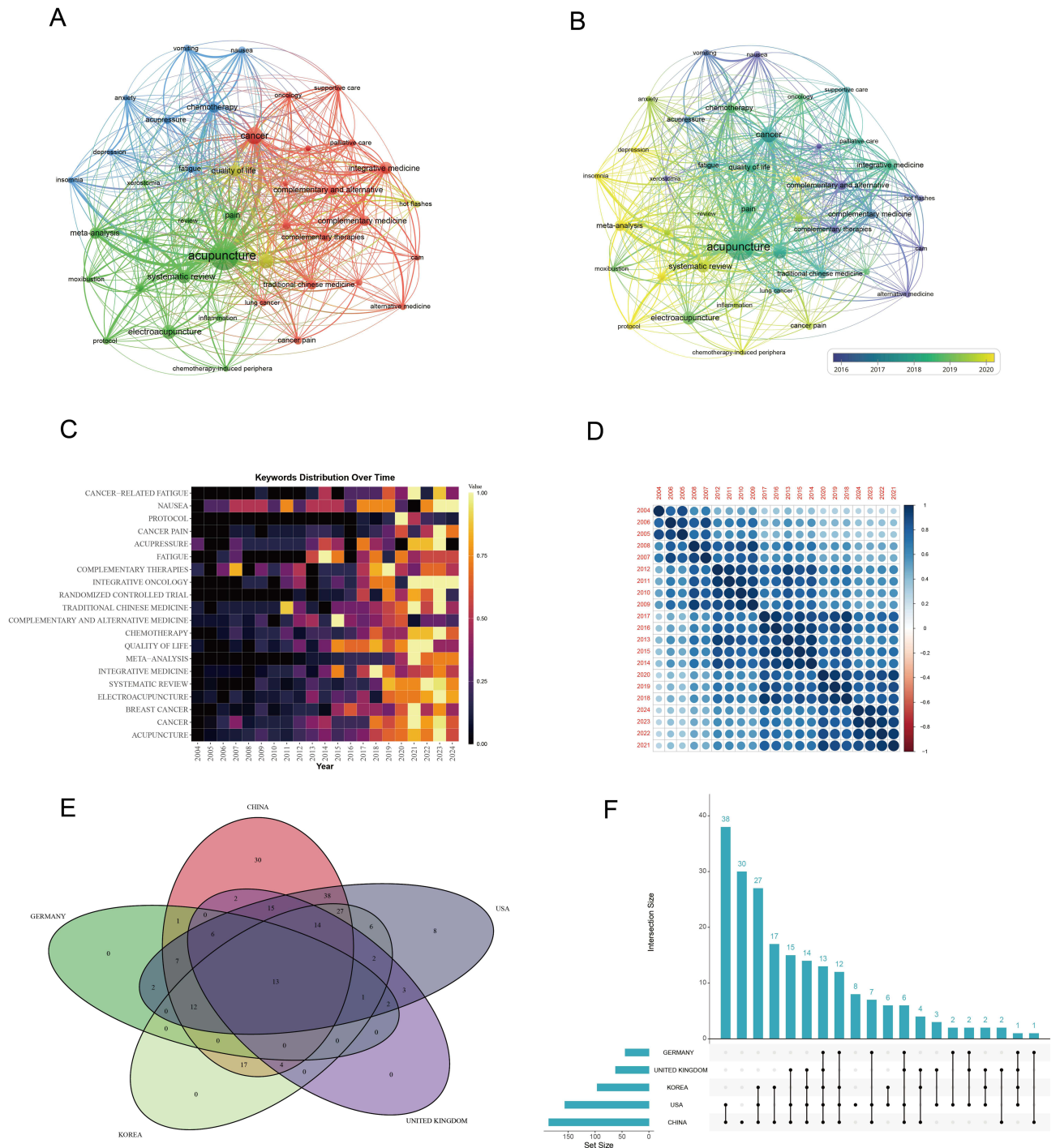
Figure 7 Research hotspots on the field of acupuncture for cancer. (**A**)Keyword co-occurrence network. (**B**)Time-overlapping co-occurrence analysis network of keywords. (**C**)Keyword distribution from 2004 to 2023. (**D**)Keyword correlation analysis. (**E**)Keyword-overlapping for the top 5 countries. (**F**)Upset chart of keyword-overlapping for the top 10 countries.

represented in red, involving acupuncture and integrative medicine for cancer care and symptom management, with keywords such as "alternative medicine", "complementary and medicine", "integrative medicine", and "pain management." The second cluster is represented in green, focusing on acupuncture for cancer-related fatigue, neuropathy, and pain management, with keywords including "acupuncture", "cancer-related fatigue", "randomized controlled trial", and "meta-analysis." The third cluster is represented in blue, associating with acupressure for managing anxiety, depression, and insomnia in cancer patients, with keywords such as "acupressure", "chemotherapy", "depression", and "insomnia."
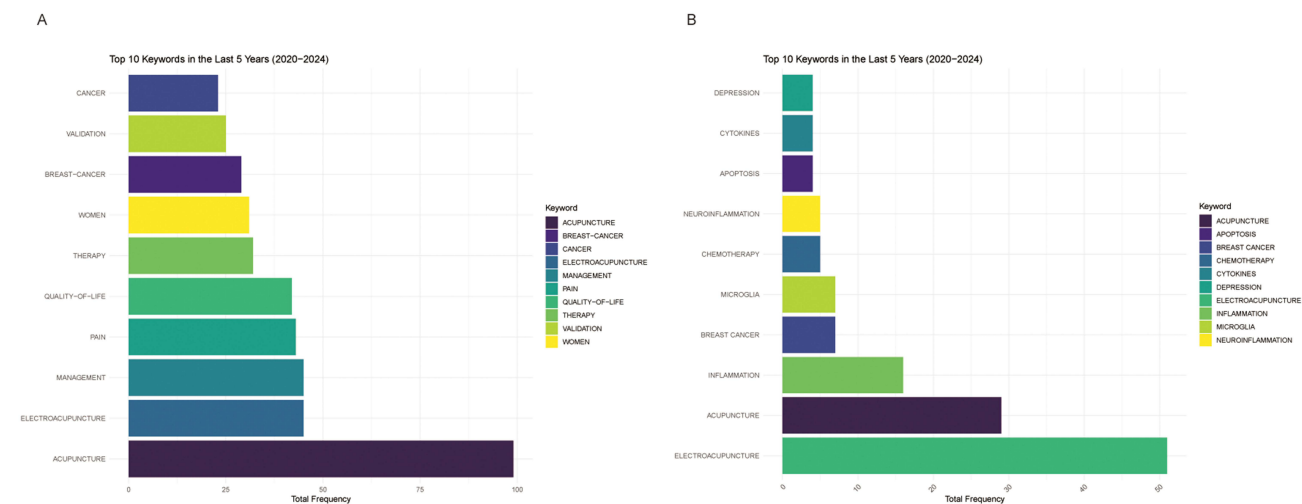
Figure 8 Keyword frequency analysis of clinical and basic experimental studies in the last 5 years. (**A**)Keyword frequency analysis of clinical studies in the last 5 years. (**B**) Keyword frequency analysis of basic experimental studies in the last 5 years.

The fourth cluster is represented in yellow, concentrating on common issues and concerns in breast cancer treatment, with keywords including "breast cancer", "hot flashes", and "quality of life."

Figure 7B depicts the temporal overlap of keywords. Early-appearing keywords are shown in indigo, while recent ones are displayed in yellow. Early research primarily focused on "alternative medicine", "complementary medicine", "vomiting", and "nausea." Recent studies have concentrated on topics such as "randomized controlled trial", "meta-analysis", "protocol", and "systematic review." Figure 7C illustrates the temporal evolution of the top 20 keywords ranked by frequency. "Acupuncture" is the most frequently used keyword, followed by "cancer" and "breast cancer". Figure 7D divides the relevant keywords into three different periods: 2004–2008, 2009–2017, and 2018–2024. Supplementary material 2B-D correspond to word clouds for each period. From 2004 to 2008, the number of publications was relatively low, focusing mainly on the application of acupuncture in managing tumor-related symptoms, From 2009 to 2017, the number of studies and attention to this field increased significantly, the application of acupuncture expanded to encompass breast cancer-related fatigue and menopausal symptoms, with a heightened focus on quality of life. From 2018 to 2024, the number of studies further increased substantially, researches on the use of acupuncture in the treatment of cancer pain, inflammation, insomnia and neuropathy continues to increase. Figure 7E illustrates the overlap of keywords among the top 5 countries by H-index, excluding the contribution of keywords from other countries. China contributes 30 unique keywords related to this field, indicating broader research and unique insights from China in this area. Figure 7F quantifies the overlap of keywords among the top 10 countries by H-index, with China and the United States having the most overlapping keywords, indicating significant research overlap between the two countries in this field. We utilize time views and keyword bursts to explore the evolution of research trends, predict emerging topics, and uncover potential research hotspots. Supplementary material 2A presents keyword bursts in the acupuncture and oncology field over the past two decades. The keyword "complementary and alternative medicine" (2015–2020) and "stimulation"(2014–2019) received the most sustained attention. However, recent usage of keywords such as "induced peripheral neuropathy" (2021–2024), "sleep" (2022–2024), "insomnia" (2021–2022), "recovery"(2021–2022),and "radiation induced xerostomia" (2021–2022) suggests future research will focus on these topics.

In the end, as shown in the Supplementary File, we classified 2117 articles and subsequently screened 649 clinical research articles and 320 basic experimental research articles. The number of basic experimental articles published was nearly half that of clinical research articles. Figure 8A and B illustrates the top 10 popular keywords in the clinical research and basic experimental research fields over the past five years, respectively. In the clinical research domain, the predominant keywords include "ELECTROACUPUNCTURE", "MANAGEMENT", "PAIN", and "QUALITY-OF-LIFE." Conversely, in basic experimental research, the key terms primarily consist of "ELECTROACUPUNCTURE", "INFLAMMATION", "BREAST CANCER", and "MICROGLIA."

Discussion

In this study, we conducted a thorough search in the WOSCC database and performed a comprehensive bibliometric analysis on the application of acupuncture in oncology over the past 20 years using the bibliometric R package, CiteSpace, and VOSviewer. We analyzed the contributions of countries, institutions, authors, journals, and keywords to this emerging field and predicted the hotspots and trends in the application of acupuncture in oncology.

Through histogram analysis of annual publication trends, we observed a continuous increase in articles published yearly since 2004. The highest publication volume was in 2023, accounting for about 10% of all studies included. This suggests that scholars increasingly value acupuncture for cancer, and it holds promising clinical application potential. We advocate for more high-quality, multicenter randomized controlled trials in the future, as they provide robust academic evidence.

In terms of country analysis, by standardizing the citation count by the number of publications, we found that China and the United States remain at the forefront of global research in acupuncture and oncology, reflecting the scientific prowess of these two countries and their recognition within the industry. As the birthplace of acupuncture, China ranks first in the number of published papers, with the number of publications increasing annually, indicating China's emphasis on the application of acupuncture in oncology. According to the citation density map, the United States has a broad research foundation and a high citation frequency in this field, whereas Chinese academic research is more diverse and has a wider impact by comparison. The top 10 countries by h-index are primarily European countries, and scholars from Asia and other continents should take note and work to enhance their recognition globally. European countries dominate the top 10 countries in terms of H-index, indicating the need for scholars from Asia and other continents to pay attention to this and strive to enhance their recognition on a global scale.

Regarding Institutions and authors, our analysis indicates that the Memorial Sloan-Kettering Cancer Centre in the United States had the highest H-index (H-index = 48), with 168 publications and 6989 citations. It is worth noting that the Beijing University of Chinese Medicine from China, whose researchers have been particularly active in the field of acupuncture in oncology in recent years, had the highest number of collaborative interactions with other institutions or universities. The author with the highest H-index ranking is Mao J J, who has contributed significantly to the field with 61 publications and an H-index of 23, demonstrating the researcher's outstanding contributions in this field.

Regarding journals, Cochrane Database Of Systematic Reviews from the United States ranks first in the H-index, indicating its high recognition in the field. Integrative Cancer Therapies ranks first with 120 publications, demonstrating a specific diversity and breadth of articles in this field. Additionally, our results indicate the presence of journals from various specialties, including nursing, alternative medicine, and oncology. Systematic analysis of journals can provide researchers with a reference point for the transformation of results and other critical elements of scientific research, which can be of significant value in guiding the direction of scientific inquiry.

In regard to keywords, we demonstrated the importance and inspiration of keywords in terms of keyword bursts, keyword analysis related to cancer, and the correlation between keywords.

Keyword Bursts as Indicators of Emerging Trends

Based on the keyword bursts in the field of acupuncture for cancer in the last two decades, we identified four emerging trends in the application of acupuncture for cancer treatment: Sleep and Insomnia, Radiation-induced xerostomia, Recovery, and Induced peripheral neuropathy. Below, we will elaborate on the insights and significance associated with these four keywords.

1. Sleep and Insomnia: Insomnia is a prevalent clinical condition primarily characterized by difficulty in initiating sleep, maintaining sleep, early awakening, poor sleep quality, and insufficient total sleep duration. It is often accompanied by daytime dysfunction, including fatigue, drowsiness, and memory impairment.[25] Insomnia can manifest independently as primary insomnia (PI), which is attributed to general psychophysiological overarousal.[26] Acupuncture has demonstrated positive effects on enhancing sleep quality and can also alleviate symptoms of anxiety and depression associated with sleep deprivation.[27,28] Numerous studies indicate that

acupuncture can effectively lower overall scores on sleep assessment scales and exhibits a specific pro-hypnotic effect.[29] Nevertheless, the underlying mechanisms remain to be elucidated.

2. Recovery: With advancements in surgical technology, the field of surgery has progressively transitioned from open procedures to minimally invasive laparoscopic techniques. However, patients often require an extended recovery period following surgery. Consequently, the quality of life of patients postoperatively, along with associated complications, has become a growing concern for clinical researchers. Postoperative ileus (POI) is typically defined as a transient delay in the coordinated intestinal motility recovery, occurring 2–6 days after surgical intervention due to non-mechanical reasons.[30–32] Even with the adoption of laparoscopic surgical techniques, POI is still commonly regarded as an inevitable complication following abdominal surgery, seriously hindering the patient's postoperative recovery process.[33] Acupuncture has been widely used clinically for various functional gastrointestinal disorders. Studies have indicated that acupuncture treatment for POI in colorectal cancer can improve gastrointestinal function.[34] Additionally, a systematic review suggested that electroacupuncture contributes to the recovery of intestinal function and may serve as a potential therapeutic option for POI after laparoscopic surgery.[35] These findings suggest promising prospects for acupuncture in the treatment of postoperative ileus.

3. Radiation-induced xerostomia: Radiation-induced xerostomia is a common chronic side effect in patients with head and neck cancer following radiation therapy.[36,37] Damage to the salivary and submandibular glands caused by radiation alters saliva secretion volume, viscosity, and pH, leading to chronic symptoms such as dry mouth.[38] A considerable proportion of patients develop salivary gland dysfunction after radiotherapy for head and neck cancer, with limited treatment options available. A review article summarized recent research on acupuncture treatment for radiation-induced xerostomia. Their findings suggest that the clinical efficacy of acupuncture for xerostomia has not yet been confirmed, indicating the need for further active exploration and discovery in this field.[39]

4. Induced peripheral neuropathy: Chemotherapy-induced peripheral neuropathy (CIPN) is a prevalent complication of anti-cancer therapy.[40] The symptoms primarily manifest as sensory disturbances, including numbness and tingling in the hands and feet, as well as pain. The pathogenesis of CIPN may be associated with inflammatory responses, alterations in cytokine levels, and a reduction in nerve growth factors within peripheral nerves.[41] Unfortunately, there are currently no effective pharmacological strategies for preventing or alleviating CIPN, which can result in reduced chemotherapy doses, delayed treatment, or even discontinuation of chemotherapy. Some studies have investigated the use of acupuncture in conjunction with other complementary and alternative medicine therapies to assess their impact on CIPN in patients. The findings indicate that acupuncture significantly improves CIPN-related issues, particularly numbness, tingling, and discomfort in the limbs, as well as overall physical function.[42] Additionally, some research suggests that the preventive application of acupuncture in patients at risk for CIPN may offer a neuroprotective effect, thereby preventing or mitigating the symptoms of CIPN.[43]

Acupuncture Application in Different Types of Cancer

In the keyword analysis, cancer-related keywords led by breast cancer appeared. We categorized the cancers, as shown in Supplementary Material 3. We extracted all cancer types related to acupuncture and calculated the frequency of occurrence for each cancer type. From 2004 to 2024, the tumors with a frequency of occurrence greater than 20 times are as follows: breast cancer, lung cancer, colorectal cancer, prostate cancer, gastric cancer and liver cancer. Breast cancer appeared a total of 374 times, ranking first. Notably, breast cancer also appeared in the top 10 keyword frequencies, indicating that breast cancer is likely to remain a significant focus in the fields of acupuncture and oncology in the future. Previous research indicates that acupuncture has some therapeutic effects on various symptoms caused by breast cancer. Acupuncture can reduce cancer pain associated with breast cancer, decrease the use of painkillers, significantly relieve cancer-related fatigue, and effectively reduce lymphoedema related to post-treatment in breast cancer patients.[44–46] On the other hand, in the field of gastric and colorectal cancer, acupuncture can help post-operative patients pass gas and stools, avoiding bloating, nausea, and vomiting.[47] Its potential mechanisms may

include regulating the function and quantity of interstitial cells of Cajal,[48] increasing the thickness of intestinal smooth muscle,[49] reducing the production of inflammatory cytokines,[50] improving gut microbiota,[51] and promoting nerve regeneration and repair.[52] On the contrary, endometrial cancer, sarcoma, and kidney cancer appeared with very low frequency, suggesting that acupuncture research on these types of tumors is inadequate and needs further exploration and development.

Correlation of Theme Keywords in Different Time Periods

As shown in Supplementary Material 2, the theme keyword correlation heat map is mainly divided into three parts: 2004–2008, 2009–2017, and 2018–2024. Each part represents a specific correlation among the theme keywords within that period. Therefore, we further generated three corresponding word cloud maps for each part.

From 2004 to 2008, the predominant theme was the application of acupuncture in managing tumor-related symptoms, including relief from nausea, vomiting, and pain. The research methods employed were grounded in complementary and alternative medicine (CAM), primarily consisting of observational studies that encompassed a broader spectrum of traditional Chinese medicine. The keywords during this period were diverse, concentrating on symptom management, such as pain, nausea, and vomiting, while integrating various alternative therapies. From 2009 to 2017, there was a significant increase in attention within this field. During this time, the application of acupuncture expanded to encompass breast cancer-related fatigue and menopausal symptoms, with a heightened focus on quality of life. Research methodologies gradually incorporated systematic reviews, randomized controlled trials (RCTs), and integrative medicine approaches. The key terms from this period included breast cancer, fatigue, and hot flashes, indicating a trend towards standardized research that emphasizes efficacy evaluation. A notable example is the third edition of the American College of Chest Physicians Evidence-Based Clinical Practice Guidelines, which for the first time acknowledged the use of acupuncture.[53] The guidelines suggest that acupuncture may be beneficial for managing nausea and vomiting following chemotherapy or radiotherapy, as well as for alleviating cancer-related pain and peripheral neuropathy. Patients with lesions may receive adjunctive treatment with acupuncture. From 2018 to 2024, research on the application of acupuncture in managing cancer pain, inflammation, insomnia, and neuropathy is anticipated to increase, with a focus on exploring mechanisms and verifying efficacy. Systematic reviews and meta-analyses are being widely adopted to enhance the quality and forward-looking nature of research. Prominent keywords during this period include cancer pain, inflammation, and depression, as research increasingly aligns with molecular mechanisms and cancer pain management.

Over time, acupuncture research has evolved to become more detailed and systematic, progressing from initial focuses on symptom relief to later explorations of underlying mechanisms. Methodologically, there has been a shift from observational studies to randomized controlled trials (RCTs), systematic reviews, and meta-analyses, enhancing the scientific rigor of the field. Additionally, contemporary research has expanded discussions on related mechanisms, including inflammation, neuropathy, and depression, advancing acupuncture studies to the molecular level and laying the groundwork for precise treatment.

Difference Analysis of Keywords for Clinical Research and Basic Experimental Research

In clinical research, the top 10 most frequent keywords from the past five years are illustrated in Figure 8A. These keywords primarily reflect the research focus in the fields of cancer treatment, particularly breast cancer, pain management, and the application of electroacupuncture. Recent literature indicates that a team conducted a randomized controlled trial comparing breast cancer patients who received highly emetogenic chemotherapy and standard triple antiemetic treatment, with and without electroacupuncture. The results demonstrated that electroacupuncture significantly alleviated nausea and vomiting in breast cancer patients post-chemotherapy, providing a new feasible approach to managing these symptoms in clinical chemotherapy settings.[54] Additionally, a study involving patients experiencing hot flashes while undergoing endocrine therapy for breast cancer was conducted across three centers in China, the United

States, and South Korea. The findings revealed that acupuncture effectively reduced hot flash symptoms and enhanced patients' quality of life.[55]

In basic research, the top 10 most frequent keywords from the past five years are presented in Figure 8B. These keywords primarily focus on neuroinflammation and immune responses in cancer, particularly concerning microglia and cytokines, as well as mental health issues, such as depression, in cancer patients. Recent studies have demonstrated that electroacupuncture can prevent depressive-like behaviors in experimental mice subjected to chronic stress. At the cellular and molecular levels, electroacupuncture can mitigate astrocyte morphological atrophy and the down-regulation of ezrin, thereby alleviating depression.[56] Furthermore, acupuncture has been shown to regulate central neurotransmitters, inhibit the overactivity of the hypothalamic-pituitary-adrenal (HPA) axis, increase the expression of brain-derived neurotrophic factor (BDNF), enhance neuroplasticity, suppress neuroinflammatory responses, mediate the inhibition of the lateral habenula (LHb), affect mitogen-activated protein kinase (MAPK)-related cell signaling pathways, and regulate epigenetic mechanisms, thus influencing the 'Brain + X axis'.[57–59]

The analysis of the keywords associated with clinical and basic research over the past five years reveals a distinct focus within each field. Clinical research has emphasized the exploration of treatment methods and efficacy evaluations, particularly in cancer treatment and symptom management. In contrast, basic research has concentrated on the discovery of tumor biological mechanisms, immune responses, and the development of new therapies. Moving forward, collaborative innovation between clinical and basic research is likely to facilitate the advancement of more effective treatments and precision medicine, thereby offering more personalized and effective options for cancer treatment.

Limitations

Nevertheless, this study has some limitations. First, we only included data from WOSCC, which means our study should have considered other relatively less well-known journals. Secondly, we excluded articles in languages other than English, so we ignored the contributions of articles in different languages to this field. Moreover, the number and labels of clusters in network analysis may vary according to the clustering resolution and the authors' subjective views, making these results not immutable Finally, recently published high-quality studies might not have received due attention due to citation delays, requiring updates in future research. Despite these limitations, this study will assist relevant researchers in understanding the development, hotspots, trends, and frontiers of acupuncture in oncology, and in identifying areas requiring further research.

Conclusion

This bibliometric study illustrates the current status and emerging trends of acupuncture research in the field of oncology over the past two decades, providing future researchers with directions for investigation and opportunities for collaboration. The role of acupuncture for cancer treatment is gaining significant attention, and related research has reached an advanced stage. New areas of interest for future research include: 1. The application of acupuncture beyond breast cancer, where it has shown considerable potential for use in other cancer types. Given its successful implementation in breast cancer patients, acupuncture may offer substantial benefits to patients with various cancers. 2. Acupuncture is currently a popular direction in improving peripheral lesions caused by chemotherapy and other diseases, but the underlying mechanism is not clear. Therefore, further research is needed to explore the mechanisms 3. In clinical research, there is hope that acupuncture will evolve into a universal adjunctive tool for cancer treatment, enhancing the quality of life for cancer patients. This entails the integration of acupuncture into clinical guidelines and the development of personalized symptom management protocols. 4. In the realm of basic experimental research, additional targets of acupuncture related to immunomodulation and inflammation control have been identified. These findings can be combined with modern biological techniques to facilitate precision medicine applications. Looking ahead, we aspire for the application of acupuncture in oncology to gain global recognition and widespread acceptance.

Data Statement

The data in this study is accessible in the public domain. Therefore, this dataset is readily accessible and devoid of any confidential attributes. All the data employed in this study has been integrated into the article and Supplementary Materials.

Consent for Publication

Not applicable.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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.

Funding

Disclosure

Zhe Ji and Heyuan Niu are co-first authors for this study. The authors affirm that the research was conducted without any apparent commercial or financial affiliations that could be construed as potential conflicts of interest.

References

1. Bray F, Laversanne M, Sung H. et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2024;74(3):229–263. doi:10.3322/caac.21834
2. Hanahan D. Hallmarks of cancer: new dimensions. *Cancer Discov*. 2022;12(1):31–46. doi:10.1158/2159-8290.CD-21-1059
3. Chang QQ, Chen CY, Chen Z, Chang S. LncRNA PVT1 promotes proliferation and invasion through enhancing Smad3 expression by sponging miR-140-5p in cervical cancer. *Radiol Oncol*. 2019;53(4):443–452. doi:10.2478/raon-2019-0048
4. van Elk M, Murphy BP, Eufrasio-da-Silva T, et al. Nanomedicines for advanced cancer treatments: transitioning towards responsive systems. *Int J Pharm*. 2016;515(1–2):132–164. doi:10.1016/j.ijpharm.2016.10.013
5. Lu L, Zhang Y, Tang X, et al. Evidence on acupuncture therapies is underused in clinical practice and health policy. *BMJ*. 2022;e67475. doi:10.1136/bmj-2021-067475.
6. Maeda H, Khatami M. Analyses of repeated failures in cancer therapy for solid tumors: poor tumor-selective drug delivery, low therapeutic efficacy and unsustainable costs. *Clin Transl Med*. 2018;7(1):11. doi:10.1186/s40169-018-0185-6
7. Wei S, Sun T, Du J, Zhang B, Xiang D, Li W. Xanthohumol, a prenylated flavonoid from Hops, exerts anticancer effects against gastric cancer in vitro. *Oncol Rep*. 2018;40(6):3213–3222. doi:10.3892/or.2018.6723
8. Hu D, Shen W, Gong C, et al. Grain-sized moxibustion promotes NK cell antitumour immunity by inhibiting adrenergic signalling in non-small cell lung cancer. *J Cell Mol Med*. 2021;25(6):2900–2908. doi:10.1111/jcmm.16320
9. Huang Z, Hu Z, Ouyang J, Huang C. Electroacupuncture regulates the DREAM/NF-kappaB signalling pathway and ameliorates cyclophosphamide-induced immunosuppression in mice. *Acupunct Med*. 2019;37(5):292–300. doi:10.1136/acupmed-2017-011593
10. Wang B, Huang J, Li S, et al. The combinatorial effect of cisplatin and moxibustion on tumor growth inhibition with special reference to modulation of the immune microenvironment in Lewis lung cancer mice. *Evid-Based Complement Altern Med*. 2020;2020(1):3170803. doi:10.1155/2020/3170803
11. Paley CA, Johnson MI, Tashani OA, Bagnall AM. Acupuncture for cancer pain in adults. *Cochrane Database Syst Rev*. 2015;CD7753. doi:10.1002/14651858.CD007753.pub3
12. Ezzo JM, Richardson MA, Vickers A, et al. Acupuncture-point stimulation for chemotherapy-induced nausea or vomiting. *Cochrane Database Syst Rev*. 2006;CD2285. doi:10.1002/14651858.CD002285.pub2
13. Posadzki P, Moon TW, Choi TY, Park TY, Lee MS, Ernst E. Acupuncture for cancer-related fatigue: a systematic review of randomized clinical trials. *Support Care Cancer*. 2013;21(7):2067–2073. doi:10.1007/s00520-013-1765-z
14. Hicks D, Wouters P, Waltman L, de Rijcke S, Rafols I. Bibliometrics: the Leiden Manifesto for research metrics. *Nature*. 2015;520(7548):429–431. doi:10.1038/520429a
15. Jiang S, Liu Y, Zheng H, et al. Evolutionary patterns and research frontiers in neoadjuvant immunotherapy: a bibliometric analysis. *Int J Surg*. 2023;109(9):2774–2783. doi:10.1097/JS9.0000000000000492

16. Joost CFDW, Amir AZ, Dodou D. The expansion of Google scholar versus web of science: a longitudinal study. *Scientometrics*. 2014;1547–1565. doi:10.1007/s11192-013-1089-2

17. Team RC, Team R. *A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing; 2005.

18. van Eck NJ, Waltman L. Software survey: vOSviewer, a computer program for bibliometric mapping. *Scientometrics*. 2010;84(2):523–538. doi:10.1007/s11192-009-0146-3

19. Synnestvedt MB, Chen C, Holmes JH. CiteSpace II: visualization and knowledge discovery in bibliographic databases. *AMIA Annu Symp Proc*. 2005;2005:724–728.

20. Deng P, Wang S, Sun X, et al. Global trends in research of gouty arthritis over past decade: a bibliometric analysis. *Front Immunol*. 2022;13:910400. doi:10.3389/fimmu.2022.910400

21. Jiang ST, Liu YG, Zhang L, Sang XT, Xu YY, Lu X. Immune-related adverse events: a bibliometric analysis. *Front Immunol*. 2022;13:1096806. doi:10.3389/fimmu.2022.1096806

22. Chen C. Searching for intellectual turning points: progressive knowledge domain visualization. *Proc Natl Acad Sci U S A*. 2004;101 (suppl_1):5303–5310. doi:10.1073/pnas.0307513100

23. van Eck NJ, Waltman L. Citation-based clustering of publications using CitNetExplorer and VOSviewer. *Scientometrics*. 2017;111(2):1053–1070. doi:10.1007/s11192-017-2300-7

24. Ding Y, Rousseau R, Wolfram D. Measuring Scholarly Impact ‖. *Visualizing Bibliometric Networks*. 2014;285–320.

25. van der Zweerde T, Bisdounis L, Kyle SD, Lancee J, van Straten A. Cognitive behavioral therapy for insomnia: a meta-analysis of long-term effects in controlled studies. *Sleep Med Rev*. 2019;48:101208. doi:10.1016/j.smrv.2019.08.002

26. Lasch K, Joish VN, Zhu Y, Rosa K, Qiu C, Crawford B. Validation of the sleep impact scale in patients with major depressive disorder and insomnia. *Curr Med Res Opin*. 2009;25(7):1699–1710. doi:10.1185/03007990902973201

27. Zhang J, He Y, Huang X, Liu Y, Yu H. The effects of acupuncture versus sham/placebo acupuncture for insomnia: a systematic review and meta-analysis of randomized controlled trials. *Complement Ther Clin Pract*. 2020;41:101253. doi:10.1016/j.ctcp.2020.101253

28. Liu C, Zhao Y, Qin S, Wang X, Jiang Y, Wu W. Randomized controlled trial of acupuncture for anxiety and depression in patients with chronic insomnia. *Ann Transl Med*. 2021;9(18):1426. doi:10.21037/atm-21-3845

29. Wang YK, Li T, Ha LJ, et al. Effectiveness and cerebral responses of multi-points acupuncture for primary insomnia: a preliminary randomized clinical trial and fMRI study. *BMC Complement Med Ther*. 2020;20(1):254. doi:10.1186/s12906-020-02969-6

30. Harnsberger CR, Maykel JA, Alavi K. Postoperative Ileus. *Clin Colon Rectal Surg*. 2019;32(3):166–170. doi:10.1055/s-0038-1677003

31. Stakenborg N, Gomez-Pinilla PJ, Boeckxstaens GE. Postoperative ileus: pathophysiology, current therapeutic approaches. *Handb Exp Pharmacol*. 2017;39–57. doi:10.1007/164_2016_108

32. Venara A, Neunlist M, Slim K, et al. Postoperative ileus: pathophysiology, incidence, and prevention. *J Visc Surg*. 2016;153(6):439–446. doi:10.1016/j.jviscsurg.2016.08.010

33. Peters EG, Pattamatta M, Smeets BJJ, et al. The clinical and economical impact of postoperative ileus in patients undergoing colorectal surgery. *Neurogastroenterol Motil*. 2020;32(8):e13862. doi:10.1111/nmo.13862

34. Liu Y, May BH, Zhang AL, et al. Acupuncture and related therapies for treatment of postoperative ileus in colorectal cancer: a systematic review and meta-analysis of randomized controlled trials. *Evid-Based Complement Altern Med*. 2018;2018(1):3178472. doi:10.1155/2018/3178472

35. Chen KB, Huang Y, Jin XL, Chen GF. Electroacupuncture or transcutaneous electroacupuncture for postoperative ileus after abdominal surgery: a systematic review and meta-analysis. *Int J Surg*. 2019;70:93–101. doi:10.1016/j.ijsu.2019.08.034

36. Dirix P, Nuyts S, Van den Bogaert W. Radiation-induced xerostomia in patients with head and neck cancer: a literature review. *Cancer*. 2006;107 (11):2525–2534. doi:10.1002/cncr.22302

37. Li M, Zhang J, Zha Y, et al. A prediction model for xerostomia in locoregionally advanced nasopharyngeal carcinoma patients receiving radical radiotherapy. *BMC Oral Health*. 2022;22(1):239. doi:10.1186/s12903-022-02269-0

38. Bhide SA, Miah AB, Harrington KJ, Newbold KL, Nutting CM. Radiation-induced xerostomia: pathophysiology, prevention and treatment. *Clin Oncol*. 2009;21(10):737–744. doi:10.1016/j.clon.2009.09.002

39. Dorfler J, Freuding M, Zaiser C, et al. Umbrella review: summary of findings for acupuncture as treatment for radiation-induced xerostomia. *Head Neck*. 2023;45(4):1026–1044. doi:10.1002/hed.27297

40. Seretny M, Currie GL, Sena ES, et al. Incidence, prevalence, and predictors of chemotherapy-induced peripheral neuropathy: a systematic review and meta-analysis. *Pain*. 2014;155(12):2461–2470. doi:10.1016/j.pain.2014.09.020

41. Wang XM, Lehky TJ, Brell JM, Dorsey SG. Discovering cytokines as targets for chemotherapy-induced painful peripheral neuropathy. *Cytokine*. 2012;59(1):3–9. doi:10.1016/j.cyto.2012.03.027

42. Ben-Arye E, Hausner D, Samuels N, et al. Impact of acupuncture and integrative therapies on chemotherapy-induced peripheral neuropathy: a multicentered, randomized controlled trial. *Cancer*. 2022;128(20):3641–3652. doi:10.1002/cncr.34422

43. Huang MC, Chang SC, Liao WL, et al. Acupuncture may help to prevent chemotherapy-induced peripheral neuropathy: a randomized, sham-controlled, single-blind study. *Oncologist*. 2023;28(6):e436–e447. doi:10.1093/oncolo/oyad065

44. He Y, Guo X, May BH, et al. Clinical evidence for association of acupuncture and acupressure with improved cancer pain: a systematic review and meta-analysis. *JAMA Oncol*. 2020;6(2):271–278. doi:10.1001/jamaoncol.2019.5233

45. Zhang Y, Lin L, Li H, Hu Y, Tian L. Effects of acupuncture on cancer-related fatigue: a meta-analysis. *Support Care Cancer*. 2018;26(2):415–425. doi:10.1007/s00520-017-3955-6

46. Zhang X, Wang X, Zhang B, Yang S, Liu D. Effects of acupuncture on breast cancer-related lymphoedema: a systematic review and meta-analysis of randomised controlled trials. *Acupunct Med*. 2019;37(1):16–24. doi:10.1136/acupmed-2018-011668

47. Wang Y, Wang L, Ni X, Jiang M, Zhao L. Effect of acupuncture therapy for postoperative gastrointestinal dysfunction in gastric and colorectal cancers: an umbrella review. *Front Oncol*. 2024;14:1291524. doi:10.3389/fonc.2024.1291524

48. Fang J, Wang W, Shao X, Du J, Fang J, Liu Z. Effect and mechanism of electroacupuncture for postoperative ileus at perioperative stage. *Zhongguo Zhen Jiu*. 2017;37(3):291–296. doi:10.13703/j.0255-2930.2017.03.020

49. Wang X, Yin J. Complementary and alternative therapies for chronic constipation. *Evid-Based Complement Altern Med*. 2015;396396. doi:10.1155/2015/396396

50. Yang NN, Yang JW, Ye Y, et al. Electroacupuncture ameliorates intestinal inflammation by activating alpha7nAChR-mediated JAK2/STAT3 signaling pathway in postoperative ileus. *Theranostics*. 2021;11(9):4078–4089. doi:10.7150/thno.52574

51. Wang L, An J, Song S, et al. Electroacupuncture preserves intestinal barrier integrity through modulating the gut microbiota in DSS-induced chronic colitis. *Life Sci*. 2020;261:118473. doi:10.1016/j.lfs.2020.118473

52. Feng Y, Fang Y, Wang Y, Hao Y. Acupoint therapy on diabetes mellitus and its common chronic complications: a review of its mechanisms. *BioMed Res Int*. 2018;2018:3128378. doi:10.1155/2018/3128378

53. Deng GE, Rausch SM, Jones LW, et al. Complementary therapies and integrative medicine in lung cancer: diagnosis and management of lung cancer, 3rd ed: American college of chest physicians evidence-based clinical practice guidelines. *Chest*. 2013;143(5):e420S–e436S. doi:10.1378/chest.12-2364

54. Shen G, Ren D, Zhao F, et al. Effect of adding electroacupuncture to standard triple antiemetic therapy on chemotherapy-induced nausea and vomiting: a randomized controlled clinical trial. *J Clin Oncol*. 2024;42(34):4051–4059. doi:10.1200/JCO.24.00099

55. Lu W, Giobbie-Hurder A, Tanasijevic A, et al. Acupuncture for hot flashes in hormone receptor-positive breast cancer: a pooled analysis of individual patient data from parallel randomized trials. *Cancer*. 2024;130(18):3219–3228. doi:10.1002/cncr.35374

56. Lin SS, Zhou B, Chen J, et al. Electroacupuncture prevents astrocyte atrophy to alleviate depression. *Cell Death Dis*. 2023;14(5):343. doi:10.1038/s41419-023-05839-4

57. Liu S, Wang Z, Su Y, et al. A neuroanatomical basis for electroacupuncture to drive the vagal-adrenal axis. *Nature*. 2021;598(7882):641–645. doi:10.1038/s41586-021-04001-4

58. Ma Q. Somatotopic organization of autonomic reflexes by acupuncture. *Curr Opin Neurobiol*. 2022;76:102602. doi:10.1016/j.conb.2022.102602

59. Zhang B, Shi H, Cao S, et al. Revealing the magic of acupuncture based on biological mechanisms: a literature review. *Biosci Trends*. 2022;16(1):73–90. doi:10.5582/bst.2022.01039