ORIGINAL RESEARCH

Knowledge Mapping of Acupuncture for Fibromyalgia from 1990 to 2022: A Bibliometric Analysis

Peize Li[1,2], Huanchi Zheng[3], Yuanfang Chen[1], Zhaoxi Liu[4], Jun He[1,2]

[1]The First Clinical School of Medicine, The First Affiliated Hospital of Guangzhou University of Chinese Medicine, Guangzhou, People's Republic of China; [2]Guangdong Provincial Key Laboratory of Traditional Chinese Medicine and Acupuncture, Guangzhou, People's Republic of China; [3]Guangdong Second Traditional Chinese Medicine Hospital, Guangzhou, People's Republic of China; [4]Clinical Medical College of Acupuncture Moxibustion and Rehabilitation, Guangzhou University of Chinese Medicine, Guangzhou, People's Republic of China

Correspondence: Jun He, The First Affiliated Hospital of Guangzhou University of Chinese Medicine, The First Clinical School of Medicine, Guangzhou, 510405, People's Republic of China, Tel +86 13728020800, Email hejunzj@gzucm.edu.cn

Background: Fibromyalgia is a rheumatic disease with no specific laboratory markers and is insensitive to hormonal drugs and nonsteroidal anti-inflammatory drugs commonly used to treat rheumatism. Guidelines recommend that non-pharmacological therapy should be the first-line treatment for fibromyalgia. Since the publication of the first diagnostic criteria for fibromyalgia in 1990, studies on acupuncture for fibromyalgia have been reported periodically. This study aims to explore the intellectual landscape of acupuncture for fibromyalgia since 1990, and to identify research trends and fronts in this field.

Methods: The Web of Science Core Collection Database was searched for publications on acupuncture for fibromyalgia from 1990 to 2022. VOSviewer and CiteSpace were used to analyze the annual publication, countries, institutions, authors and cited authors, journals and cited journals, references and keywords.

Results: A total of 280 publications were retrieved, and the number of publications showed an overall upward trend. The United States was the most productive country. China Medical University was the institution with the most publications. Lin Yi-wen was the most prolific author, while Wolfe was the most cited author. *Evidence-Based Complementary and Alternative Medicine* was the journal in which most of the research was published, while *Pain* was the most cited journal. An article by Wolfe (1990) had the most citations, but an article by Crofford (2001) had the highest centrality. The four most frequently used keywords in the included articles were mechanism, spinal cord, activation and sensitivity.

Conclusion: Acupuncture can effectively relieve pain in patients with fibromyalgia and improve accompanying symptoms such as anxiety and depression. However, the design of clinical trials still needs to be optimized to better verify the efficacy of acupuncture on various clinical symptoms of fibromyalgia. Exploring the central analgesic mechanism of acupuncture on fibromyalgia is also the focus research direction now and future.

Keywords: acupuncture, fibromyalgia, bibliometric analysis, CiteSpace, VOSviewer

Introduction

Fibromyalgia is a disorder characterized by chronic generalized musculoskeletal pain, often accompanied by fatigue, sleep disturbance, anxiety, depression and balance disorder.[1,2] Its prevalence in the general population is 2–8%, and it is the third most common musculoskeletal-related disorder after lumbar pain and osteoarthritis.[3–6] Although the American College of Rheumatology (ACR) issued the first diagnostic criteria for fibromyalgia in 1990,[7] the clinical diagnosis and treatment of fibromyalgia still face enormous challenges. For example, fibromyalgia is mainly diagnosed based on clinical symptoms, with no specific laboratory indicators and imaging examinations, and prior to revision of the diagnostic criteria for fibromyalgia by the ACR in 2016,[8] fibromyalgia was mostly considered to be an exclusive diagnosis. Moreover, the accompanying symptoms of fibromyalgia, such as fatigue, sleep disturbance, anxiety and depression, are often misdiagnosed by clinicians as neurological and psychiatric disorders.[9] Difficulties in diagnosis may prevent patients with fibromyalgia from receiving timely and effective treatment. In addition, fibromyalgia is not sensitive to hormonal drugs and NSAIDs commonly used in rheumatism. The European League Against Rheumatism

(EULAR) suggested that non-pharmacological approaches should be first-line treatments for fibromyalgia.[10] Exercise is the only treatment modality with strong recommendations from the EULAR, but is a significant challenge for patients, who find exercise programs difficult to start and maintain, and are concerned that exercise will worsen their pain and fatigue.[10] Therefore, it is necessary to find effective complementary and alternative medicine therapies.

Studies have shown that fibromyalgia is one of the dominant diseases of acupuncture.[11] Acupuncture has a good analgesic effect on fibromyalgia, and can effectively relieve the accompanying symptoms such as fatigue, sleep disturbance, anxiety and depression in patients with fibromyalgia.[12,13] However, there is still a lack of bibliometric studies on the cooperation, development trends and research fronts in the field of acupuncture for fibromyalgia.

Bibliometrics is an interdisciplinary subject that applies mathematical and statistical methods to qualitative and quantitative analysis of publications.[14,15] Currently, the most commonly used bibliometric tools are CiteSpace and VOSviewer, since CiteSpace allows effective co-citation analysis, while VOSviewer is user-friendly and has a clear and concise map. The Web of Science Core Collection Database is the most commonly used database for bibliometric analysis, providing references that meet the formatting requirement of CiteSpace-specified reference co-citation analysis.

Therefore, the study used CiteSpace and VOSviewer to perform a visual analysis of publications on acupuncture for fibromyalgia in the Web of Science Core Collection Database, with the aim of understanding the collaboration between research institutions and researchers, and research trends in this field, and promoting future research and Clinical application.

Materials and Methods

Data Source and Search Strategy

We conducted a search of the Web of Science Core Collection Database for literature on acupuncture for fibromyalgia. The retrieval date was May 30, 2022, and included articles published between January 1, 1990 and May 30, 2022. The search strategy was as follows: topic= (acupuncture OR acupuncture points OR electroacupuncture) AND topic= (fibromyalgia OR fibromyalgia syndrome OR FMS). No restrictions were imposed on language or type of article. Although some article types may offer little information, this approach provides a more comprehensive representation of the range of sample data. Duplicate studies were removed, but no studies were removed for other reasons. All the information, including the number of paper and citation, title, authors, affiliations, countries, keywords, references, publication year and journal were collected for bibliometric analysis.

Statistical Analysis

Microsoft Office Excel (version 2019), VOSviewer (version 1.6.18) and CiteSpace (version 5.8.R3) were used to perform the bibliometric analysis.

Microsoft Office Excel (version 2019) was used to manage data and create a chart showing annual research output.

VOSviewer is a bibliometrics software developed by Van Eck and Waltman.[15,16] In this study, we used VOSviewer to visualize collaborations and time trends among countries, institutions and authors, as well as the journals in which the articles were published. The size of nodes in the map represents the number of publications, the thickness of lines represents the strength of the link and different colors of nodes represent different clusters or times. In order to build a clear visualization network, the number of visualization items in each research topic was limited according to the respective conditions. For example, in the visual network map of co-authored countries, only countries/regions with more than five publications were displayed.

CiteSpace is a bibliometric software developed by Professor Chen Chaomei.[14] In this study, we used CiteSpace for co-citation, cluster and co-occurrence analysis, dual map overlay of journals, and citation burst strength detection. Co-citation analysis of authors, journals, and references can provide an overview of the knowledge base in the field. Cluster analysis can categorize references and identify important research directions in the field of acupuncture for fibromyalgia. The Modular Q and mean silhouette S are two important evaluation indicators in cluster analysis. When Q>0.3, the clustering structure is sufficiently significant, and when S>0.5, the clustering results are credible. Keyword co-occurrence analysis and citation burst strength detection for keywords and references help to demonstrate the research priorities, research hotspots and future research trends in this field. In addition, centrality is a key parameter to measure the importance of a node, and nodes with high centrality are often regarded as turning points or key points in the field. Thus,

Table 1 Document Types for Documents on Acupuncture for Fibromyalgia

Ranking	Type	Counts	% of 280
1	Article	188	67.143
2	Review	57	20.357
3	Letter	13	4.643
4	Proceeding paper	8	2.857
5	Editorial material	8	2.857
6	Meeting abstract	6	2.143
7	News item	6	2.143
8	Book chapter	5	1.786

in this study, CiteSpace was also used to calculate the centrality of cited authors, cited references, and co-occurrence keywords. The parameters of CiteSpace were set as follows: link retaining factor (LRF=3), look back years (LBY=−1), e for top N (e=3), time span (1990–2022), years per slice (4), links (strength: cosine, scope: within slices), selection criteria: g-index (k=25) and pruning (minimum spanning tree).

Results
Analysis of Annual Publications

A total of 280 publications related to this study were retrieved from the database, including 188 articles, 57 reviews, 13 letters, eight proceeding papers, eight editorial materials, six meeting abstracts, six news items and five book chapters (Table 1). The number of publications published each year is shown in Figure 1. We arbitrarily divide the period from 1990 to 2022 into two
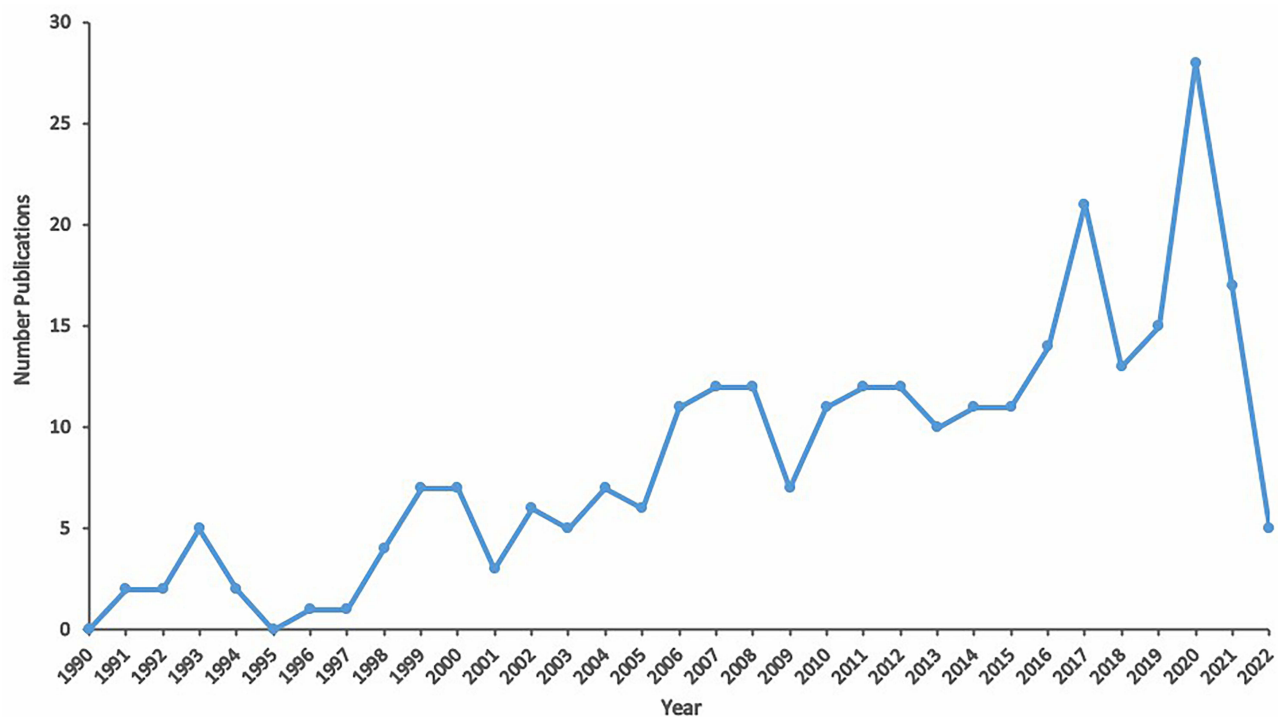

Figure 1 The number of annual publications on acupuncture for fibromyalgia indexed by the Web of Science Core Collection Database.
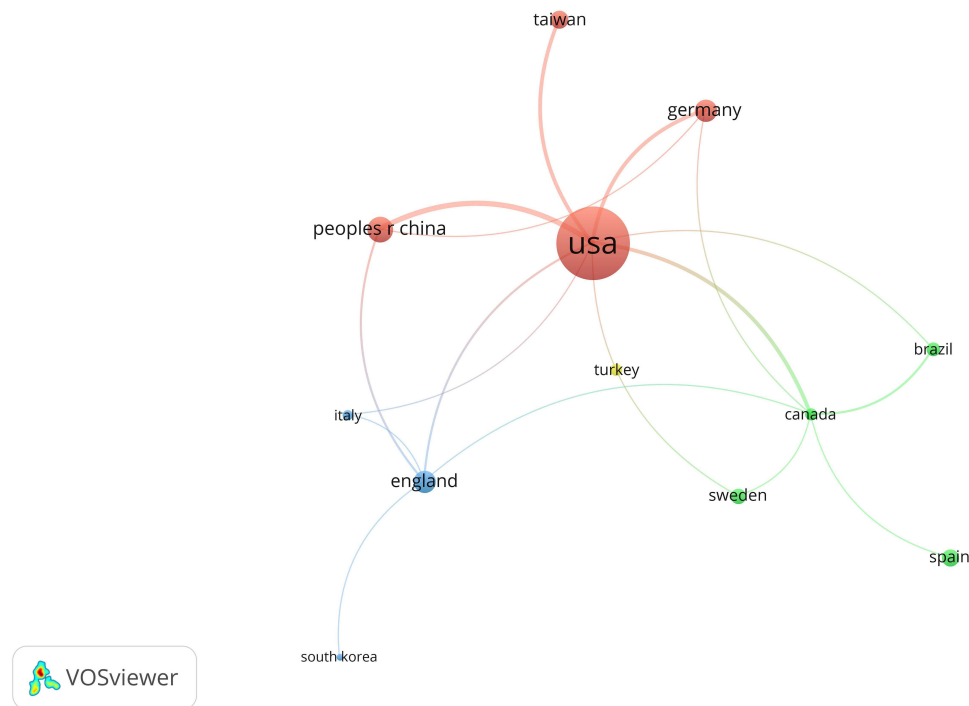
Figure 2 Map of active countries/regions on acupuncture for fibromyalgia.

stages according to the annual output. 1990 to 2005 may be seen as the first phase, in which the total number of publications was less than 10 per year. 2006 to 2022 may be seen as the second phase, in which the total number of publications was probably more than 10 per year, and reached a peak in 2020 (n=28), with more than the total number of articles published in the previous 10 years (1990–1999, n=24). In summary, the number of publications showed an overall upward trend.

Analysis of Countries/Regions

From 1990 to 2022, 30 countries published research articles on acupuncture for fibromyalgia. For better visualization, 12 countries or regions with more than five articles were selected via VOSviewer (Figure 2 and Table 2). The United States showed the highest output, publishing a total of 105 articles, followed by the People's Republic of China (28 articles), Germany (23 articles) and England (23 articles). The country with the most cited published articles was also the United States (cited 4815 times), followed by England (1071 times), and Germany (736 times). The visualized international collaboration network showed limited cooperation among countries in this area. Furthermore, as shown in Figure 3, Western developed countries such as the United States, England, Germany, Canada and Sweden started research in this field earlier, while the research on acupuncture for fibromyalgia in developing countries such as the People's Republic of China and Brazil began in the past 10 years.

Analysis of Institutions

A total of 414 research institutions were involved, and 17 institutions with more than five papers were chosen for visualization (Figure 4). The top 10 institutions with the highest output are shown in Table 3. The China Medical University (published 18 articles) was the leading institution in terms of output, followed by the University of Michigan (12 articles), the University of Exeter & Plymouth (10 articles) and China Medical University Hospital (10 articles). The citation frequency of the University of Michigan in the United States (cited 1487 times) was the highest, followed by the University of Maryland School of Medicine (1191 times) and David Geffen School of Medicine at the University of California Los Angeles (904 times). The visualized institutional collaboration network showed cooperation among institutions with distinct cluster characteristics, and the distance between each cluster was relatively long, which meant that the international cooperation among institutions were

Table 2 The Top 10 Productive Countries/Regions Concerning Acupuncture for Fibromyalgia

Ranking	Country/Region	Counts	% of 280	Citation
1	United States	105	37.500	4815
2	China	28	10.000	545
3	England	23	8.214	1071
4	Germany	23	8.214	743
5	Taiwan, China	18	6.426	127
6	Spain	17	6.071	176
7	Sweden	15	5.357	640
8	Brazil	13	4.643	261
9	Canada	11	3.929	296
10	Turkey	11	3.929	287

not close enough, and global cooperation has not yet formed. Figure 5 shows institutions' involvement in research in this field over time. The University of Maryland initiated relevant studies at an early stage, and from 2010 research on acupuncture for fibromyalgia was conducted by the China Medical University and China Medical University Hospital. In addition, the geographical focus of research in this field gradually shifted to the East, especially to Asia, after 2010.

Analysis of Authors and Co-Cited Authors

A total of 1012 authors published the included articles, and we selected 39 authors with more than three papers for visual analysis (Figure 6). The top 10 authors publishing articles in this field are listed in Table 4. Lin Yi-wen (published 12
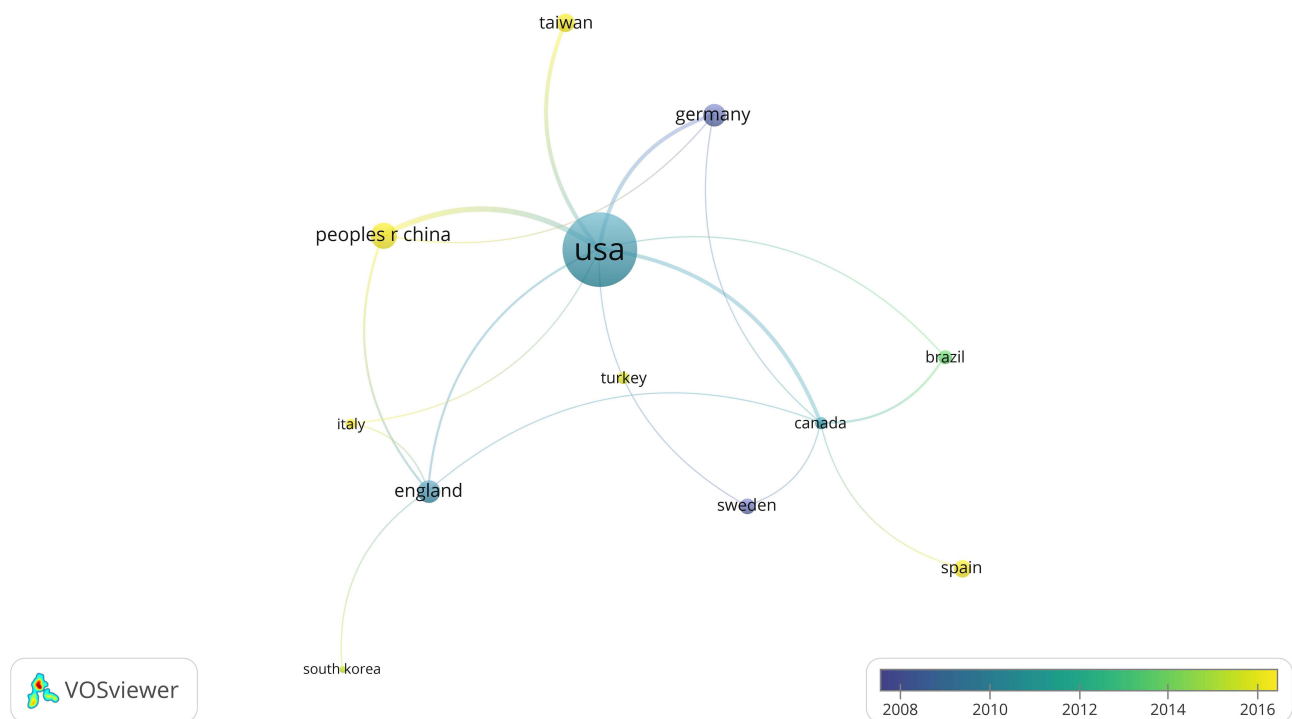
Figure 3 Map of active countries/regions on acupuncture for fibromyalgia in terms of time.
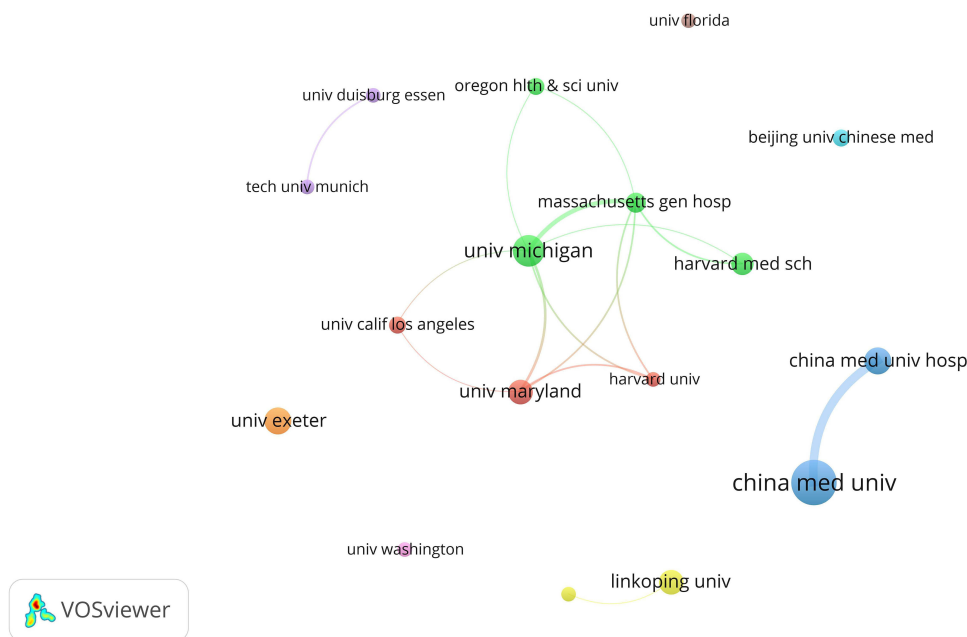
Figure 4 Map of institutions on acupuncture for fibromyalgia.

articles) was identified as the most active author in this field, followed by Langhorst (9 articles), Harris (8 articles) and Hauser (8 articles). However, it can be seen from the author cooperation network map that the degree of cooperation between authors in this field was not close enough, mainly within the same institution.

Co-citation refers to two or more articles being simultaneously cited in other article. The map of cited authors shows a total of 469 authors whose articles were cited in these 280 included articles (Figure 7). The top 10 co-cited authors in frequency and centrality are listed in Table 5. Wolfe had the most cited frequency (cited 114 times), mainly dedicated to standardizing the diagnostic criteria for fibromyalgia,[7,17,18] which has made significant contributions to the field of acupuncture for fibromyalgia. Deluze (cited 63 times) and Berman (50 times) had the next highest citation frequencies. Manheimer (0.21) had the highest centrality, and was mainly engaged in the research on acupuncture for knee osteoarthritis, low back pain and other rheumatic diseases,[19,20] followed by Appelbaum (0.15) and Berman (0.14). Among the top 10 authors by citation frequency and centrality, all were based in Europe and America except for Martin (South Africa).

Table 3 The Top 10 Institutions Concerning Acupuncture for Fibromyalgia

| Ranking	Institution	Abbreviation	Country	Counts	Citation
1	China medical University	China Med Univ	China	18	125
2	University of Michigan	Univ Michigan	United States	12	1487
3	University of Exeter & Plymouth	Univ Exeter	England	10	528
4	China medical University Hospital	China Med Univ Hosp	China	10	91
5	University of Maryland School of Medicine	Univ Maryland	United States	9	1191
6	Linkoping University	Linkoping Univ	Sweden	9	385
7	Harvard Medical Hospital	Harvard Med Sch	United States	8	79
8	Massachusetts General Hospital	Massachusetts Gen Hosp	United States	7	553
9	David Geffen School of Medicine at UCLA	Univ calif Los Angeles	United States	6	904
10	Beijing University of Chinese Medicine	Beijing Univ Chinese Med	China	6	154
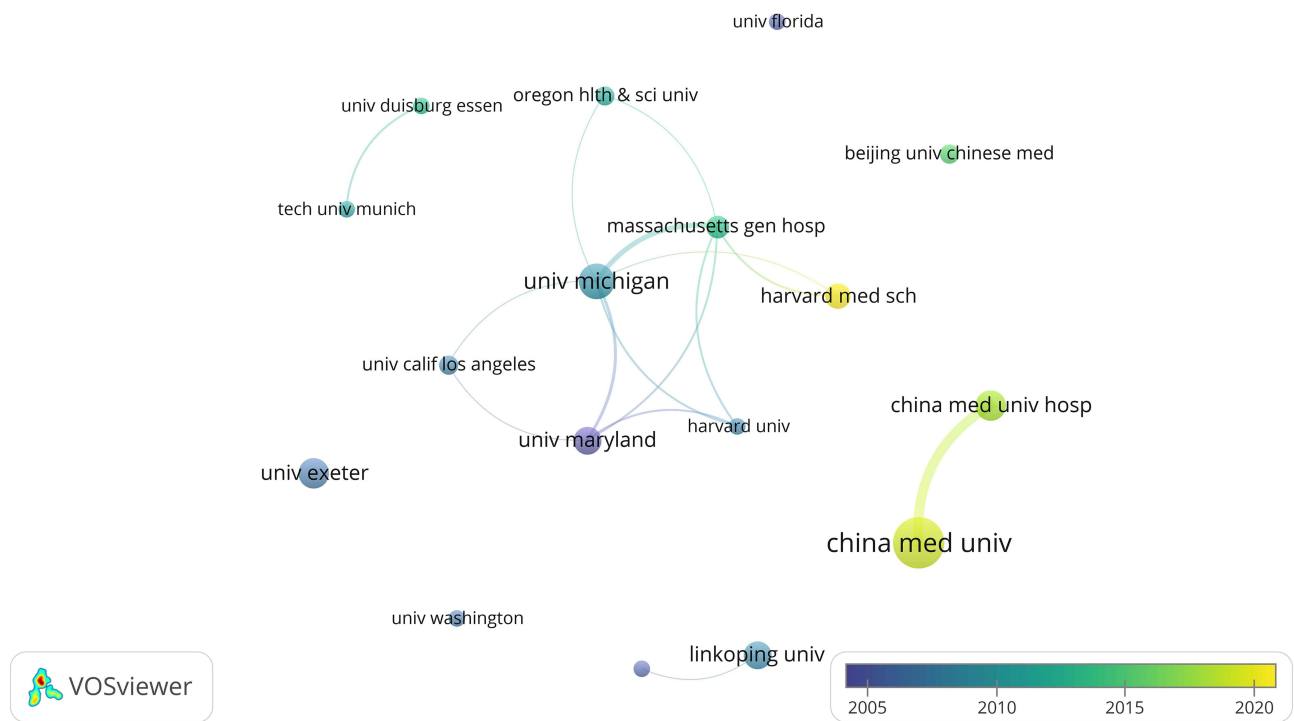
Figure 5 Map of institutions on acupuncture for fibromyalgia in terms of time.
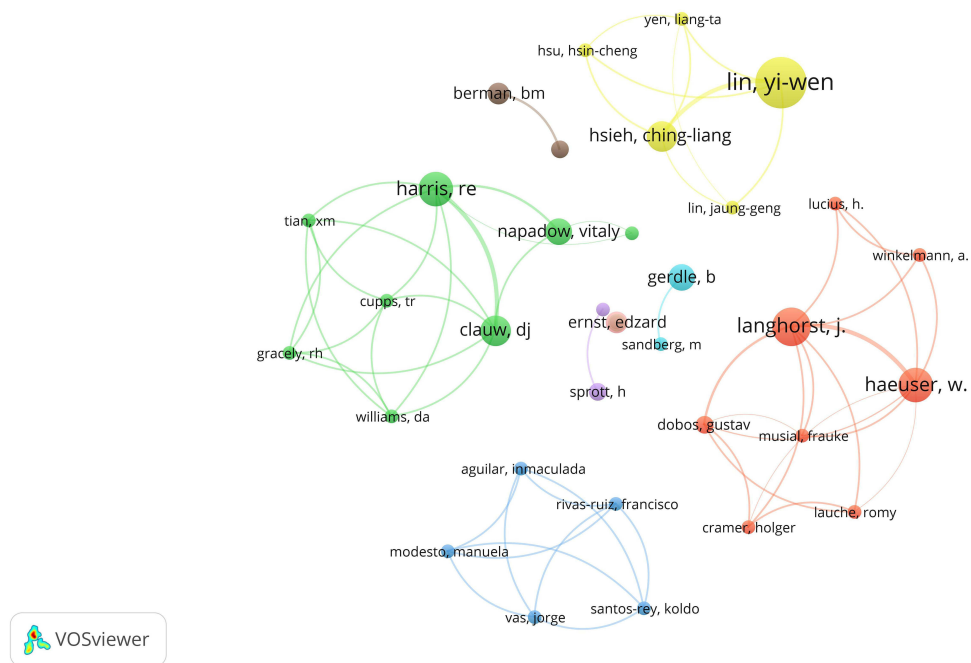

Figure 6 Map of authors who study acupuncture for fibromyalgia.

Analysis of Journal and Co-Cited Journal

All of the included articles on acupuncture for fibromyalgia were published in 136 journals. For better visualization, we selected 36 journals producing more than three papers (Figure 8). The top 10 journals with the highest productivity are shown in Table 6, and about 29% of articles in this field were published in these 10 journals. Evidence-Based

Table 4 The Top 10 Authors Who Study Acupuncture for Fibromyalgia

Ranking	Author	Country	Counts (Type)	% of 280
I	Lin Yi-wen	Taiwan, China	12 (12 animal experiments)	4.296
2	Langhorst J	Germany	9 (7 reviews, 2 clinical trials)	3.214
3	Harris RE	England	8 (6 clinical trials, 2 meeting abstracts)	2.857
4	Hauser W	Germany	8 (7 reviews, I letter)	2.857
5	Clauw DJ	United States	7 (5 clinical trials, 2 meeting abstracts)	2.500
6	Hsieh Ching-liang	Taiwan, China	7 (7 animal experiments)	2.500
7	Napadow V	United States	6 (4 clinical trials, I proceeding paper, I editorial material)	2.143
8	Gerdle B	Sweden	6 (6 clinical trials)	2.143
9	Berman BM	United States	5 (5 reviews)	1.786
10	Ernst E	England	5 (4 reviews, I letter)	1.786

Complementary and Alternative Medicine was the most productive journals (published 16 papers), followed by Journal of Alternative and Complementary Medicine (15 papers) and Acupuncture in Medicine (9 papers). According to the Journal Citation Reports (2020), the average impact factor (IF) of these top 10 journals was 3.926, indicating that it remains challenging to publish research in this field in high-impact journals. The journal Rheumatology had the highest IF at 7.580 and is a professional journal in this field.

A cited journal map was generated for 427 journals (Figure 9). The top 10 co-cited journals are shown in Table 7. The journal Pain was most cited, followed by Arthritis & Rheumatology and Journal of Alternative and Complementary Medicine. The cited journals were mainly in the field of neurosciences, rheumatology and integrative and complementary medicine.

The dual-map overlay (Figure 10) shows that the majority of journals that published articles in this field include three subjects: medicine/medical clinical, neurology/sports/ophthalmology and molecular/biology/immunology. Within these fields, the circles representing the medical/medical clinical fields were larger, indicating a relatively large number of co-authors and published publications. Most of the cited articles came from journals in the fields of molecular/biology/genetics, health/nursing/medicine, sports/rehabilitation and psychology/education/social. The lines in the figure represent the links between citing publications and cited references. The fields molecular/biology/genetics and health/nursing/medicine were cited more frequently by publications in other fields, indicating that these two fields had an important position in the cited references of acupuncture for fibromyalgia research.

Analysis of Co-Cited References

A total of 491 references (Figure 11) were generated from 280 papers. A cluster analysis (Figure 12) was performed on the visual network of co-cited references, and was combined with the context of the literature content to provide a total of nine main clusters (Table 8). The modularity Q was 0.8081, and the weighted mean silhouette S was 0.9436, indicating that the clustering results are credible. The results show that most of the research in these fields was conducted after 1990. Early research directions are Cluster 5 "non-pharmacological intervention", Cluster 3 "prevalence of alternative medicine" and Cluster 7 "pharmacological intervention" with most published before 2000. There are followed by Cluster 1 "efficacy of alternative medicine", Cluster 8 "muscle" and Cluster 6 "acupuncture analgesia", mostly representing research conducted between 2000 and 2010. Cluster 0 "randomized controlled trial (RCT)" and Cluster 2 "acupuncture and fibromyalgia" are long standing research topics in this field. Finally, Cluster 4 "mechanism of acupuncture analgesia" is the focus of the most recent publications. More specific information about each cluster is shown below.
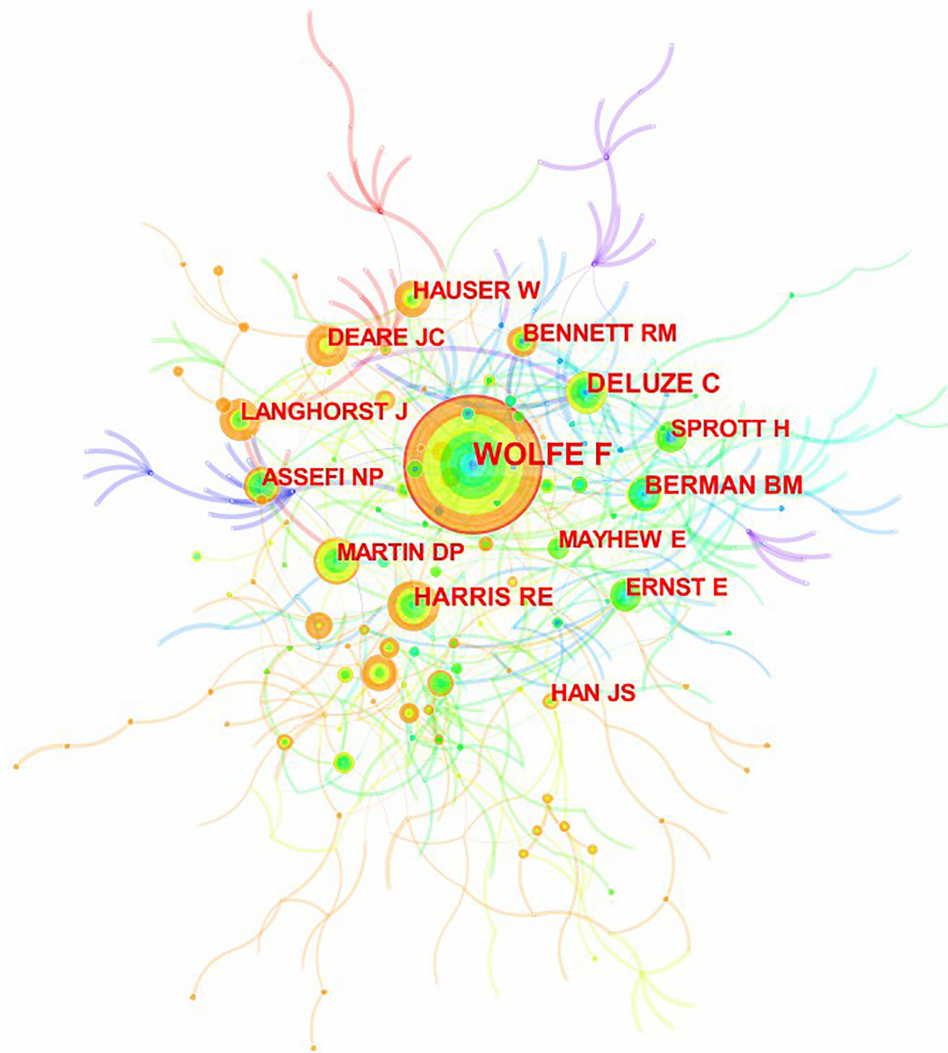
Figure 7 Map of cited authors related to acupuncture for fibromyalgia.

Articles included in Cluster 5 "non-pharmacological intervention", described the efficacy of non-pharmacological interventions for fibromyalgia, including biofeedback training, psychological interventions, aerobic exercise and stress management therapy; those in Cluster 3 "prevalence of alternative medicine", focused on the prevalence and frequency of use of alternative medicine among patients, as well as the per capita cost of alternative medicine. The researchers found that the use of alternative medicine and spending as a share of total health care expenditures has increased since 1990, largely attributable to an increase in the proportion of the population seeking alternative treatments rather than an increase in the number of visits per patient; research in Cluster 7 "pharmacological intervention", primarily evaluated the efficacy of pharmacological interventions for fibromyalgia, including opioids, nonsteroidal anti-inflammatory drugs (NSAIDs) and norepinephrine reuptake inhibitors, through double-blind randomized controlled trials; articles in Cluster 1 "efficacy of alternative medicine" include, mixed reviews of the effectiveness of acupuncture for fibromyalgia, but generally favor positive outcomes; in Cluster 8 "muscle", research demonstrated through clinical trials that acupuncture can have an effect on blood flow to the skin and muscles of patients with fibromyalgia. Both subcutaneous acupuncture and deep muscle acupuncture increase the blood flow to the trapezius, tibialis anterior muscle and the skin of this area, with similar efficacy. In addition, the researchers found that blood flow to the deep muscles

Table 5 The Top 10 Frequency and Centrality of Cited Authors Related to Acupuncture for Fibromyalgia

Ranking	Author	Country	Counts	Author	Country	Centrality
1	Wolfe F	United States	114	Manheimer E	Germany	0.21
2	Deluze C	Switzerland	63	Appelbaum Ka	United States	0.15
3	Berman BM	United States	50	Berman BM	United States	0.14
4	Harris RE	England	45	Eisenberg Dm	United States	0.14
5	Langhorst J	Germany	44	Hauser W	Germany	0.13
6	Assefi NP	United States	44	Wolfe F	United States	0.11
7	Martin DP	South Africa	43	Russell Ij	United States	0.11
8	Bennett RM	United States	41	Goldenberg Dl	United States	0.11
9	Sprott H	Switzerland	41	Clauw DJ	United States	0.11
10	Ernst E	England	41	Witt C	Germany	0.11

was positively correlated with muscle pressure pain thresholds; studies in Cluster 6 "acupuncture analgesia" were focused on the analgesic effect of acupuncture on low back pain, knee osteoarthritis and other rheumatic diseases. However, most of the literature in this cluster was not highly correlated with fibromyalgia; in Cluster 0 "randomized controlled trial", investigated the efficacy of various acupuncture treatments, such as electroacupuncture, formula acupuncture, manual acupuncture, and sham acupuncture for fibromyalgia. Findings were mixed, but skewed toward positive results. Researchers found that acupuncture not only improved pain, but may also have beneficial effects on anxiety, fatigue, and insomnia; article in Cluster 2 "acupuncture and
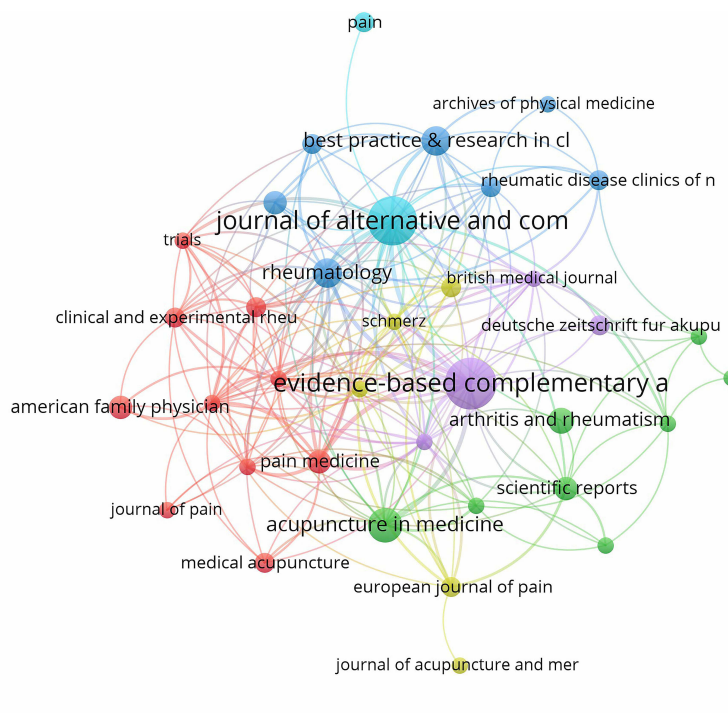

Figure 8 Map of journals producing publications about acupuncture for fibromyalgia.

Table 6 The Top 10 Journals on Acupuncture for Fibromyalgia

Ranking	Journal	IF (2020)	Counts	% of 280
1	Evidence-Based Complementary and Alternative Medicine	2.630	16	5.714
2	Journal of Alternative and Complementary Medicine	2.582	15	5.357
3	Acupuncture in Medicine	2.267	9	3.214
4	Rheumatology	7.580	7	2.500
5	Best Practice & Research in Clinical Rheumatology	4.098	7	2.500
6	Arthritis and Rheumatism	7.379	6	2.143
7	Pain Medicine	3.750	5	1.786
8	Scientific Reports	4.380	5	1.786
9	Alternative Therapies in Health and Medicine	1.305	5	1.786
10	American Family Physician	3.292	5	1.786

Abbreviation: IF, impact factor.

fibromyalgia" were cited primarily by RCTs on acupuncture for fibromyalgia, covering topics such as expert consensus on acupuncture treatment, development and validation of a fibromyalgia-related assessment questionnaire, and systematic reviews of acupuncture for fibromyalgia; Cluster 4 "mechanism of acupuncture analgesia" includes mainly studies on the mechanism of acupuncture analgesia. These studies found through animal experiments that electroacupuncture at a specific frequency can promote the release of specific neuropeptides in the central nervous system, and may interfere with the metabolism of adenosine and inhibit the activation of related signaling pathways in the central nervous system to relieve pain.

Table 9 shows the top 10 references by citation frequency and centrality. Among the top 10 most cited references, six were clinical trials and four were systematic reviews. Seven of these 10 focused on the clinical efficacy of acupuncture for fibromyalgia, two were on the diagnostic criteria for fibromyalgia, and one study investigated the effects of different acupuncture sites, stimulation intensity, and acupuncture frequency on fibromyalgia. Among the top 10 cited references for centrality, six were clinical studies, three were systematic reviews and one was questionnaires based. Four of the 10 focused on the clinical efficacy of acupuncture for fibromyalgia, one was on the diagnostic criteria for fibromyalgia; one on its pathogenesis, one on complementary and alternative treatments for fibromyalgia, one investigated the effects of different acupuncture sites, stimulation intensity, and acupuncture frequency on fibromyalgia; one was on the mechanisms by which acupuncture and sham acupuncture relieve fibromyalgia, and one was on the prevalence and per capita cost of alternative therapy in the United States. Therefore, the clinical efficacy of acupuncture for fibromyalgia has always been the focus of research in this field.

Figure 13 shows the top 15 references with citation burst, aside from the newly revised diagnostic criteria for fibromyalgia published by the ACR in 2010.[18] The article with the highest-cited outbreak was Berman (1999),[21] a systematic review which showed that acupuncture was more effective than sham acupuncture for pain relief in patients with fibromyalgia, increasing pain threshold, and reducing morning stiffness, but the duration of sustained benefit after acupuncture was unclear. Since 2018, two articles with high citation bursts, Vas (2016)[22] and Karatay (2018)[23] both demonstrated through RCTs that acupuncture, but not sham acupuncture, was effective in relieving fibromyalgia. In addition, Vas (2016) found through follow-up that the pain relief effect of acupuncture can persist for 1 year, while Karatay (2018) proposed that changes in the level of serum pain neuromediators may be one of the mechanisms by which acupuncture affects fibromyalgia. The surge in citations for these two studies also suggests that investigating the duration

Figure 9 Map of co-cited journals producing publications about acupuncture for fibromyalgia.

of benefit after acupuncture and the effects of acupuncture on pain neuromediator levels in patients with fibromyalgia are potential leading research directions in this field.

Analysis of Keywords

We extracted a total of 282 co-occurrence keywords from the data for visual analysis (Figure 14). Table 10 shows the top 10 co-occurrence keywords by frequency and centrality. The highest frequency keyword was fibromyalgia (71 times), followed by acupuncture (66 times) and pain (52 times). This suggests that verifying whether acupuncture can relieve pain symptoms in patients with fibromyalgia remains a research focus in this field. The highest centrality keyword was chronic pain (0.21), followed by management (0.19) and back pain (0.15). Fibromyalgia has been defined as a chronic systemic musculoskeletal pain disorder in which the back is one of the main pain sites. The management of fibromyalgia has always been an important part of guidelines related to fibromyalgia, and non-pharmacological therapies, including acupuncture, are the first-line clinical treatment recommended by the guidelines. For patients with poor response to non-pharmacological therapy, supplementary drug therapy, such as antidepressants, muscle relaxants and others are recommended. We subsequently performed a keyword citation burst detection analysis and extracted a total of 20 keywords (Figure 15). The result showed that the keyword "criteria" had the largest burst intensity in the field. This was closely related to the development of the diagnostic criteria for fibromyalgia. In 2010, the ACR revised the diagnostic criteria for

Table 7 The Top 10 Co-Cited Journals on Acupuncture for Fibromyalgia

Ranking	Journal	Abbreviations	IF (2020)	Counts
1	Pain	Pain	6.961	159
2	Arthritis & Rheumatology	Arthritis Rheum-Us	10.995	113
3	Journal of Alternative and Complementary Medicine	J Altern Complem Med	2.582	107
4	Journal of Rheumatology	J Rheumatol	4.666	102
5	Jama-Journal of the American Medical Association	Jama-J Am Med Assoc	56.274	101
6	Annals of Internal Medicine	Ann Intern Med	25.391	100
7	Rheumatology	Rheumatology	7.580	100
8	Clinical Journal of Pain	Clin J Pain	3.442	98
9	Cochrane Database of Systematic Reviews	Cochrane Db Syst Rev	9.289	94
10	BMJ-British Medical Journal	Brit Med J	39.890	89

Abbreviation: IF, impact factor.

fibromyalgia, bringing about changes in the entire field of fibromyalgia research.[18] In addition, mechanism, spinal cord, activation and sensitivity have relatively high burst strengths in recent years. These four keywords are closely related to the mechanism of acupuncture for fibromyalgia. Studies have shown that in a rat model of fibromyalgia, neurons in the spinal cord were hyperactivated, exhibiting higher background firing and increased mechanical responses, as well as increased excitatory synaptic input and decreased inhibitory synaptic input, resulting in nociceptive hypersensitivity reactions.[24] Acupuncture can down-regulate the phosphorylation levels of two subtypes of N-methyl-aspartate receptors (NMDARs), NR1 and NR2, and down-regulate the expression levels of transient receptor potential vanilloid 1 (TRPV1) and TRPV4 in the spinal cord to alleviate pain in mice with fibromyalgia.[25–27] In addition, acupuncture can exert
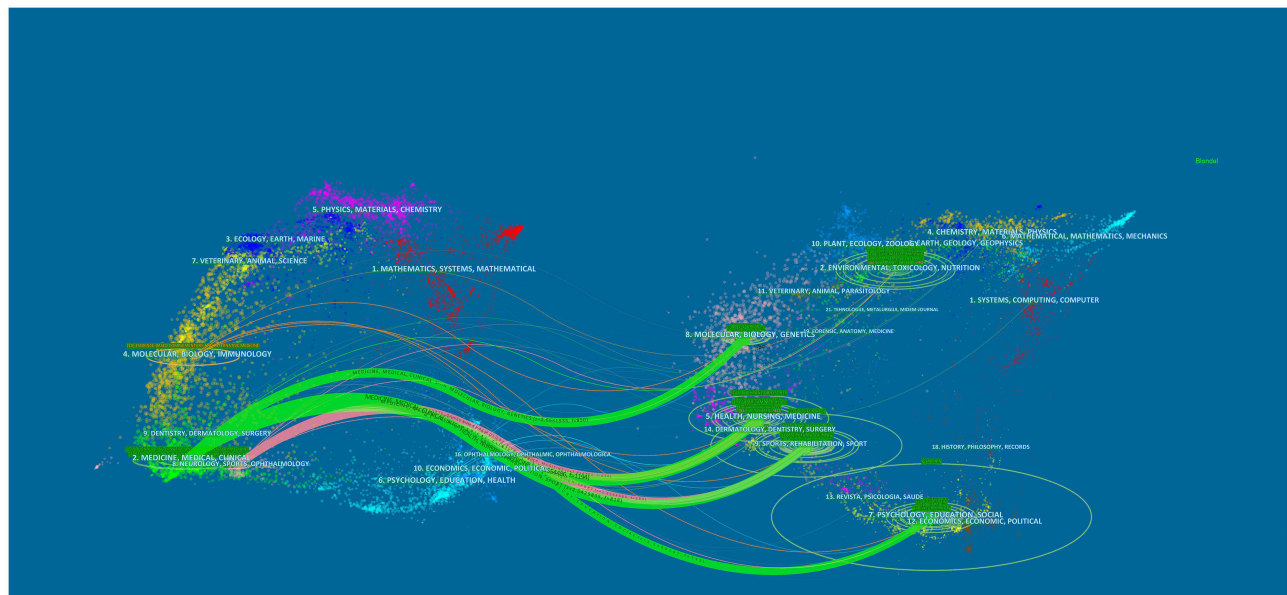

Figure 10 The dual-map overlay of citing journals and cited journals on articles related to acupuncture for fibromyalgia. (The left side were the citing journal, the right side were the cited journal, and the line path represents the citation relationship).
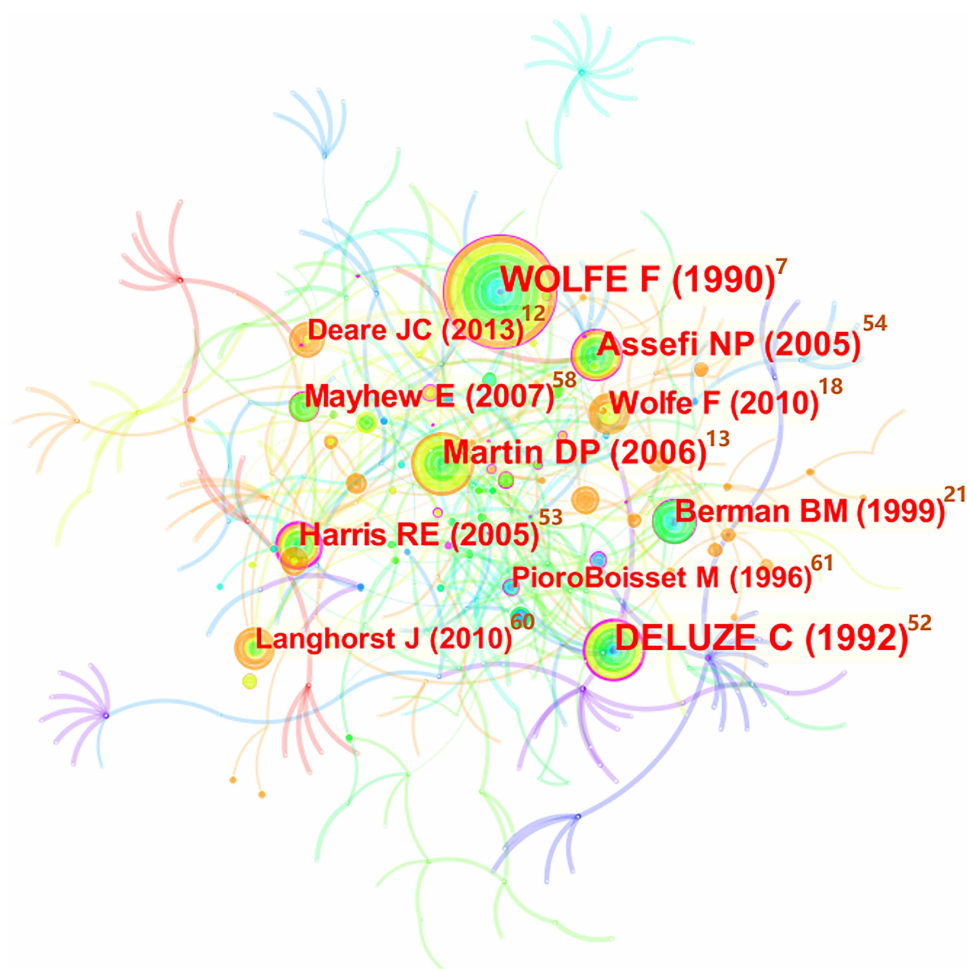
Figure 11 Map of co-cited references related to acupuncture for fibromyalgia.

analgesic effect by increasing the pain threshold and reducing pain sensitivity in patients with fibromyalgia.[28] Finally, since 2018, the keyword "meta-analysis" also has high burst strength. As research on acupuncture for fibromyalgia increases, timely meta-analysis and systematic reviews of new findings are warranted.

Discussion

In this study, we used a bibliometric approach to analyze trends and directions of research on acupuncture for fibromyalgia between 1990 and 2022. By combining collaboration network, co-citation network, co-occurrence network and burst analyses, we found low cooperation between countries and institutions, indicating that international cooperation should be further promoted, and direct cooperation between hospitals and scientific research institutions should be encouraged. Because there is currently no cure for fibromyalgia, long-term acupuncture treatment may be necessary for symptomatic relief. Through cooperation between hospitals and scientific research institutions, sharing data resources and improving the long-term follow-up observation of fibromyalgia patients, to clarify the reasonable setting of acupuncture courses, the interval between courses, the medical cost required to maintain such a treatment plan, and optimize current guidelines for alternative medicine treatment of fibromyalgia. In addition, in terms of research trends, the field has developed from studies on the clinical efficacy of acupuncture for fibromyalgia to exploring the mechanism of acupuncture for fibromyalgia. With regard to future research in this field, three points deserve further exploration.

Firstly, previous clinical studies have reached different conclusions on the difference between efficacy of acupuncture and sham acupuncture for fibromyalgia. This may reflect differences in the design of RCTs, including the inclusion criteria, the design of the sham acupuncture, the selection of acupuncture points in the acupuncture group, and the follow-
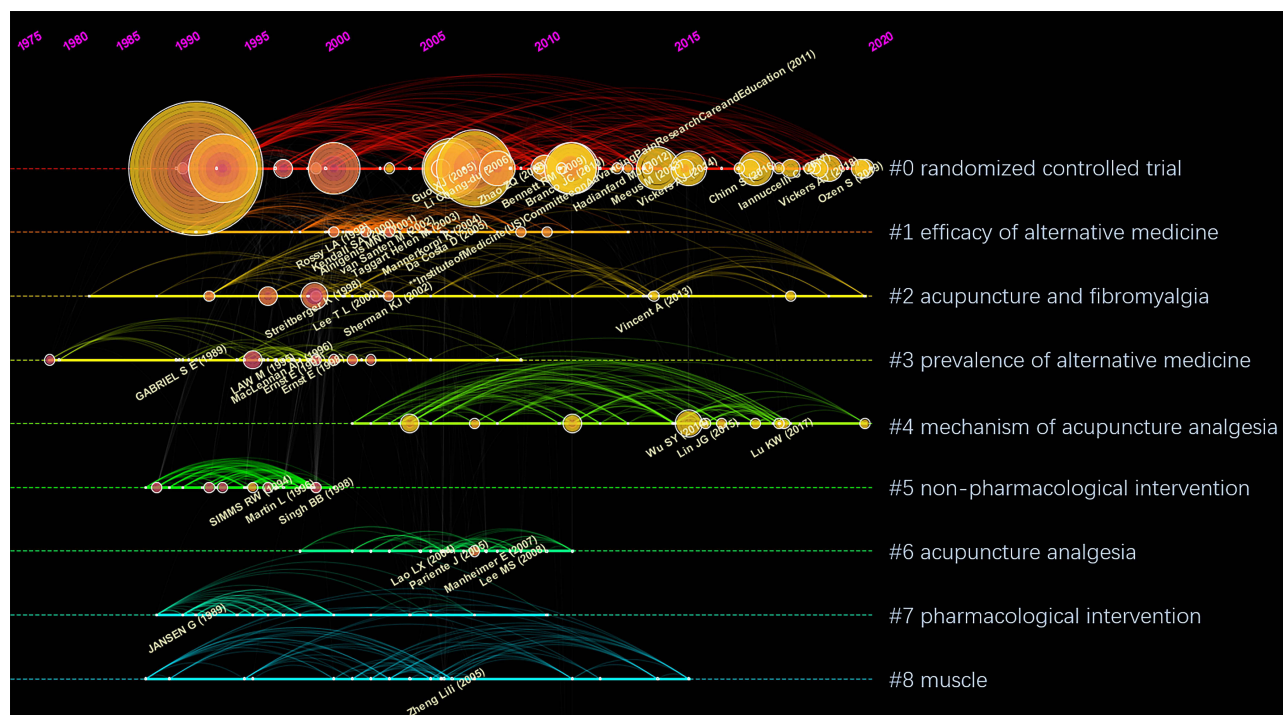
2418

Journal of Pain Research 2022:15

Figure 12 Cluster map of cited references based on label clusters with title terms.

up period. Studies have shown that the pain pressure threshold of subjects can affect the effect of acupuncture and sham acupuncture. Patients with higher pain pressure threshold showed better analgesic effect of acupuncture, while those with lower pain pressure threshold showed better analgesic effect after sham acupuncture.[29] The rational design of sham acupuncture has also been controversial in the academic circles. The common sham acupuncture designs in the past include conventional acupuncture at non-acupoints, acupuncture at acupoints but only lightly piercing the skin, or simulated acupuncture at acupoints without penetrating the skin. Some researchers believe that it may be unreasonable to simply select points far away from acupoints for sham acupuncture.[30] These points may puncture other meridians or acupoints, and it is difficult to find truly ineffective acupoints.[30] In addition, the width of the meridians is unclear.[30] Other studies have found that subcutaneous acupuncture can cause changes in local blood flow.[31,32] On the selection of

Table 8 Cited Reference Concerned with Acupuncture for Fibromyalgia That Details of Knowledge Clusters

| Cluster ID	Size	Silhouette	Mean (Year)	Label
0	81	0.857	2009	Randomized controlled trial
1	57	0.906	2002	Efficacy of alternative medicine
2	37	0.904	2005	Acupuncture and fibromyalgia
3	35	0.889	1995	Prevalence of alternative medicine
4	32	0.981	2011	Mechanism of acupuncture analgesia
5	30	0.891	1993	Non-pharmacological intervention
6	27	0.950	2005	Acupuncture analgesia
7	19	0.958	1996	Pharmacological intervention
8	19	0.929	2002	Muscle

Table 9 The Top 10 Frequency and Centrality of Cited References Related to Acupuncture for Fibromyalgia

Ranking	Cited Reference	Counts	Cited Reference	Centrality
1	Wolfe F (1990)[7]	72	Crofford LJ (2001)[51]	0.26
2	Deluze C (1992)[52]	59	Deluze C (1992)[52]	0.22
3	Martin DP (2006)[13]	43	Harris RE (2005)[53]	0.21
4	Assefi NP (2005)[54]	42	Eisenberg DM (1998)[55]	0.18
5	Berman BM (1999)[21]	36	Targino RA (2008)[56]	0.17
6	Harris RE (2005)[53]	35	Harris RE (2009)[57]	0.16
7	Mayhew E (2007)[58]	35	Russell IJ (1994)[59]	0.16
8	Wolfe F (2010)[18]	34	Wolfe F (1990)[7]	0.15
9	Langhorst J (2010)[60]	28	Mayhew E (2007)[58]	0.15
10	Deare JC (2013)[12]	26	Berman BM (1999)[21]	0.14

acupoints in the acupuncture group, there is currently no generally recognized dominant acupoint group, so it is impossible to determine whether the acupoints selected in the trial have superior curative effects.[30] Regarding follow-up periods, studies have found that both acupuncture and sham acupuncture can relieve fibromyalgia, but the effect may persist for 3 months in the acupuncture group but not the sham group.[23] In conclusion, standardized, reasonable and rigorous RCTs design may be the key to further clarify the difference in clinical efficacy between acupuncture and sham acupuncture on fibromyalgia.

Secondly, an important future research focus may be to further explore whether acupuncture can effectively improve the accompanying symptoms of fibromyalgia of different severities, and reduce the risk of comorbidities in patients with fibromyalgia. Previous research has found that acupuncture can effectively improve fatigue and sleep quality in patients with high-severity fibromyalgia that is refractory to conventional pharmacological therapy. Unfortunately, most of the patients in that research were also receiving drug treatment, and there was no corresponding control group, which made it difficult to evaluate the true efficacy of acupuncture.[33] Therefore, follow-up studies are needed to further explore the efficacy of acupuncture on fibromyalgia of different severities, especially the benefit in patients with fibromyalgia who are refractory to

Top 15 References with the Strongest Citation Bursts
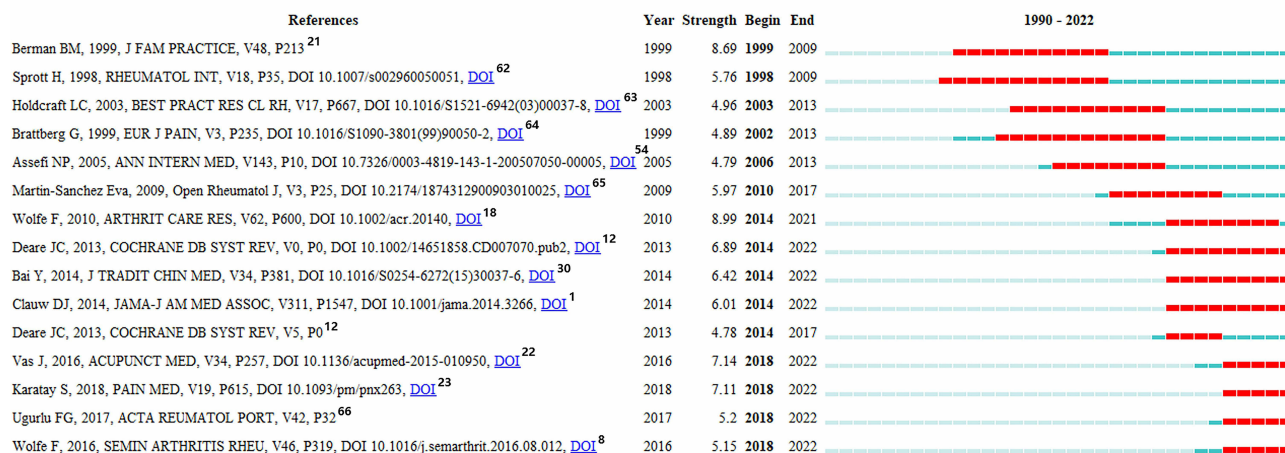
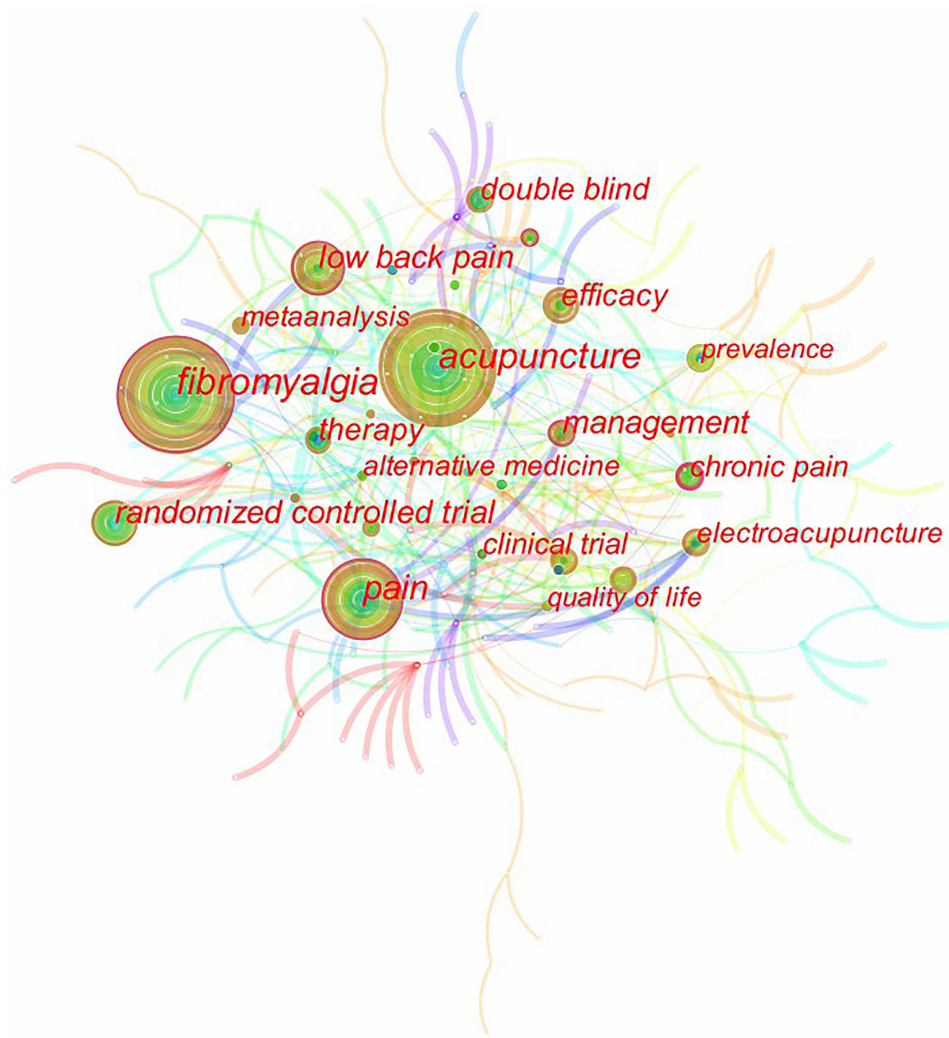Figure 13 Top 15 references with the strongest citation bursts.

Figure 14 Map of co-occurrence keywords related to acupuncture for fibromyalgia.

conventional medical therapy. In addition, the accompanying symptoms of fibromyalgia include fatigue, sleep disturbance, anxiety, depression, balance disturbance and others. Previous studies have focused on the effects of acupuncture on fatigue, sleep disturbance, anxiety and depression.[12,13] With the increasing number of studies on balance disorders in fibromyalgia patients in recent years,[2,34] researchers in this field have also begun to pay attention to the effects of acupuncture on balance disorders in fibromyalgia. Research has shown that acupuncture improves dynamic equilibrium and postural control in women with fibromyalgia, with effects sustained for 5 weeks.[35] However, research on the efficacy of acupuncture on balance disorders in fibromyalgia is still at an early stage, and more clinical studies with large samples, multi-center and rigorous trial designs are needed for further verification. The comorbidities of fibromyalgia, including diabetes, high blood pressure, heart disease, irritable bowel syndrome, migraines and others, also represent a significant health care concern. Retrospective studies showed that acupuncture reduces the risk of coronary heart disease and stroke in Taiwanese patients with fibromyalgia.[36,37] It is well known that acupuncture is a non-pharmacological therapy that works through multiple targets. Therefore, it is important to explore whether acupuncture can reduce the risk of other comorbidities in patients with fibromyalgia through retrospective studies, prospective RCTs and basic scientific research.

Finally, research on the central analgesic mechanism of acupuncture on fibromyalgia is a relatively new research direction. Fibromyalgia is generally believed to be systemic pain caused by central nervous system dysfunction.[38,39] In recent years, researchers in this field have begun to further explore the central analgesic mechanism of acupuncture on

Table 10 The Top 10 Frequency and Centrality of Co-Occurrence Keywords Related to Acupuncture for Fibromyalgia

Ranking	Keyword	Counts	Keyword	Centrality
1	Fibromyalgia	71	Chronic pain	0.21
2	Acupuncture	66	Management	0.19
3	Pain	52	Back pain	0.15
4	Low back pain	42	Physical therapy	0.14
5	Randomized controlled trial	38	Pain	0.13
6	Management	35	Low back pain	0.12
7	Double blind	33	Clinical trial	0.12
8	Therapy	29	Trigger point	0.12
9	Efficacy	29	Osteoarthritis	0.12
10	Clinical trial	25	Beta endorphin	0.12

fibromyalgia through animal experiments and neuroimaging techniques. Bibliometric analysis found 11 studies in this field that use animal experiments to investigate the central analgesic mechanism of acupuncture, and all experimental animal models were induced by acidic saline and intermittent cold stress.[26,27,40–48] However, although acidic saline-induced, reserpine-induced, and intermittent cold stress-induced experimental animal models were the three most common animal models of fibromyalgia.[49] The reserpine-induced models can develop spontaneous nociception and only respond to recommended fibromyalgia medications, not to opioids and NSAIDs.[49] In contrast, experimental animal models induced by acidic saline and intermittent cold stress are free of spontaneous nociception and respond to recommended fibromyalgia medications, opioids, and NSAIDs.[49] Therefore, the reserpine model may be the closest animal model to the clinical manifestations of fibromyalgia.[49] Of course, since the clinical manifestations of fibromyalgia are complex and diverse, and the pathogenesis is unknown, there is no animal model that can completely model the clinical symptoms of fibromyalgia, so the selection of model must be based on the symptoms or mechanisms to be studied. In addition, one study using neuroimaging techniques found that electroacupuncture increased the connection between the trunk sensory cortex and the anterior and posterior insula in patients with fibromyalgia, which in turn led to increased GABA levels in the anterior insula and relieved pain symptoms.[50] At present, there are few studies in this area. Future research should continue to use neuroimaging techniques to study the role of the central nervous system or related neurotransmitters in acupuncture for fibromyalgia.

The use of both CiteSpace and VOSviewer to conduct the literature visualization analysis and provide a reference for researchers is a strength of the present study. However, the study also has some limitations. First, we retrieved data only from the Web of Science Core Collection database, not other large databases such as Embase and Scopus. This was because neither CiteSpace nor VOSviewer can analyze data from multiple databases simultaneously. Second, our search strategy may not have yielded all publications on acupuncture for fibromyalgia in the Web of Science Core Collection database. Finally, while some of the data were processed manually, most of the results of this study are based on machine algorithms, so the data used to support our results may be biased.

Conclusion

Acupuncture can effectively relieve pain in patients with fibromyalgia and improve accompanying symptoms such as anxiety and depression. However, this field is at an early stage of development. Further optimization of clinical trial design is needed to better verify the efficacy of acupuncture on various clinical symptoms of fibromyalgia, and exploration of the central analgesic mechanism of acupuncture for fibromyalgia is an important focus for current and future research in this field.

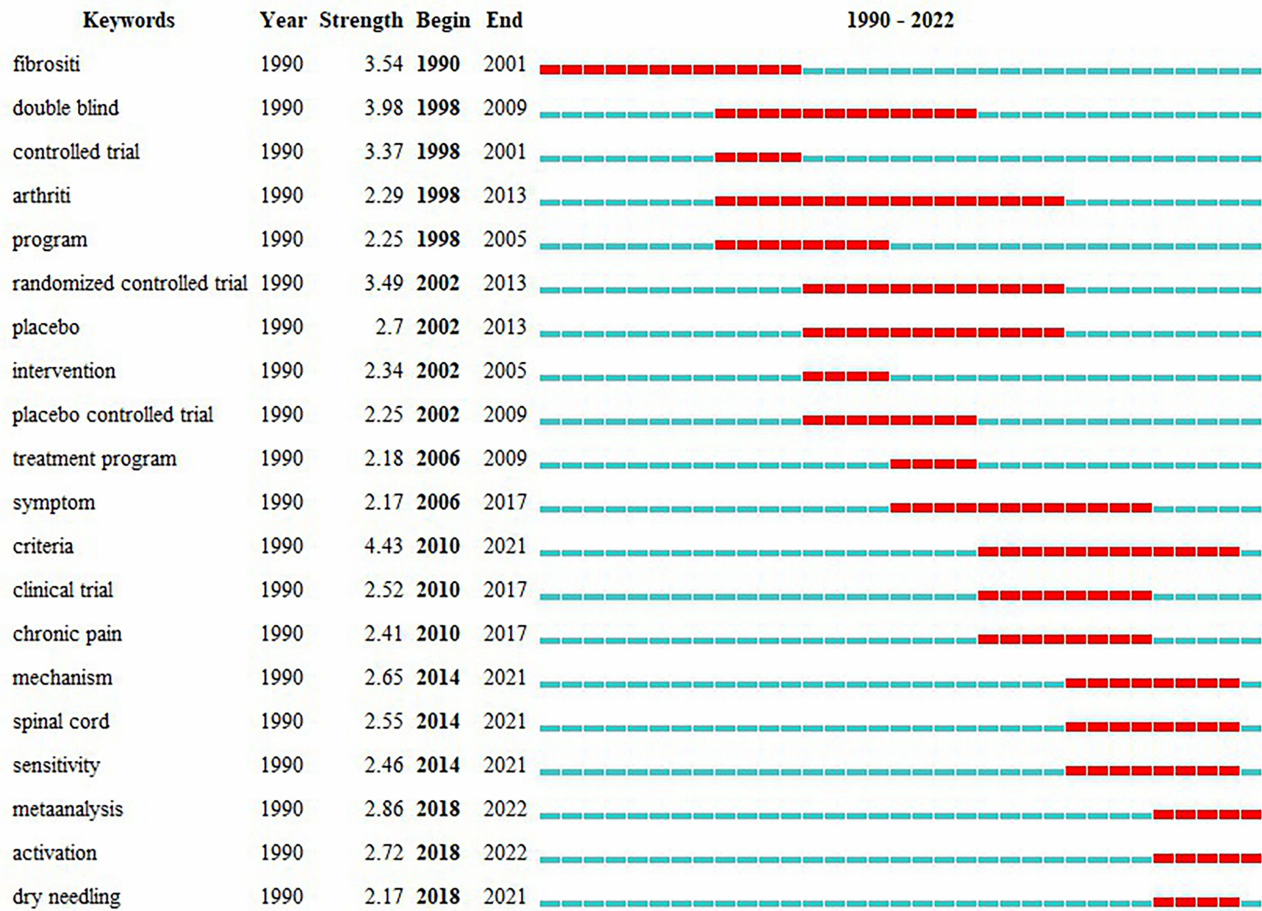## Top 20 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	1990 – 2022
fibrositi	1990	3.54	1990	2001	
double blind	1990	3.98	1998	2009	
controlled trial	1990	3.37	1998	2001	
arthriti	1990	2.29	1998	2013	
program	1990	2.25	1998	2005	
randomized controlled trial	1990	3.49	2002	2013	
placebo	1990	2.7	2002	2013	
intervention	1990	2.34	2002	2005	
placebo controlled trial	1990	2.25	2002	2009	
treatment program	1990	2.18	2006	2009	
symptom	1990	2.17	2006	2017	
criteria	1990	4.43	2010	2021	
clinical trial	1990	2.52	2010	2017	
chronic pain	1990	2.41	2010	2017	
mechanism	1990	2.65	2014	2021	
spinal cord	1990	2.55	2014	2021	
sensitivity	1990	2.46	2014	2021	
metaanalysis	1990	2.86	2018	2022	
activation	1990	2.72	2018	2022	
dry needling	1990	2.17	2018	2021	

Figure 15 Top 20 keywords with the strongest citation bursts.

Acknowledgments

Author Contributions

All authors made a significant contribution to this work, whether that was in the conception, study design, execution, acquisition of data, analysis and interpretation; took part in drafting or critically reviewing the article; agreed to submit to this journal; gave final approval of the version to be published and agree to be responsible for all aspects of the work.

Funding

Disclosure

The authors declare that they have no conflicts of interest for this work.

References

1. Clauw DJ. Fibromyalgia: a clinical review. *JAMA*. 2014;311(15):1547–1555. doi:10.1001/jama.2014.3266
2. Del-Moral-García M, Obrero-Gaitán E, Rodríguez-Almagro D, Rodríguez-Huguet M, Osuna-Pérez MC, Lomas-Vega R. Effectiveness of active therapy-based training to improve the balance in patients with fibromyalgia: a systematic review with meta-analysis. *J Clin Med*. 2020;9(11):3771. doi:10.3390/jcm9113771
3. McBeth J, Jones K. Epidemiology of chronic musculoskeletal pain. *Best Pract Res Clin Rheumatol*. 2007;21(3):403–425. doi:10.1016/j.berh.2007.03.003
4. Queiroz LP. Worldwide epidemiology of fibromyalgia. *Curr Pain Headache Rep*. 2013;17(8):356. doi:10.1007/s11916-013-0356-5
5. Vincent A, Lahr BD, Wolfe F, et al. Prevalence of fibromyalgia: a population-based study in Olmsted county, Minnesota, utilizing the Rochester epidemiology project. *Arthritis Care Res*. 2013;65(5):786–792. doi:10.1002/acr.21896
6. Wolfe F, Ross K, Anderson J, Russell IJ, Hebert L. The prevalence and characteristics of fibromyalgia in the general population. *Arthritis Rheum*. 1995;38(1):19–28. doi:10.1002/art.1780380104
7. Wolfe F, Smythe HA, Yunus MB, et al. The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. report of the multicenter criteria committee. *Arthritis Rheum*. 1990;33(2):160–172. doi:10.1002/art.1780330203
8. Wolfe F, Clauw DJ, Fitzcharles MA, et al. 2016 Revisions to the 2010/2011 fibromyalgia diagnostic criteria. *Semin Arthritis Rheum*. 2016;46 (3):319–329. doi:10.1016/j.semarthrit.2016.08.012
9. Fitzcharles MA, Perrot S, Häuser W. Comorbid fibromyalgia: a qualitative review of prevalence and importance. *Eur J Pain*. 2018;22 (9):1565–1576. doi:10.1002/ejp.1252
10. Macfarlane GJ, Kronisch C, Dean LE, et al. EULAR revised recommendations for the management of fibromyalgia. *Ann Rheum Dis*. 2017;76 (2):318–328. doi:10.1136/annrheumdis-2016-209724
11. Lu L, Zhang Y, Tang X, et al. Evidence on acupuncture therapies is underused in clinical practice and health policy. *BMJ*. 2022;376:e067475. doi:10.1136/bmj-2021-067475
12. Deare JC, Zheng Z, Xue CC, et al. Acupuncture for treating fibromyalgia. *Cochrane Database Syst. Rev*. 2013;2013(5):Cd007070.
13. Martin DP, Sletten CD, Williams BA, Berger IH. Improvement in fibromyalgia symptoms with acupuncture: results of a randomized controlled trial. *Mayo Clin Proc*. 2006;81(6):749–757. doi:10.4065/81.6.749
14. Chen C. Searching for intellectual turning points: progressive knowledge domain visualization. *Proc Natl Acad Sci USA*. 2004;101 ((Suppl 1)):5303–5310. doi:10.1073/pnas.0307513100
15. 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
16. Li J, Goerlandt F, Reniers G, Zhang B. Sam Mannan and his scientific publications: a life in process safety research. *J Loss Prev Process Ind*. 2020;66:104140.
17. Wolfe F. New American College of Rheumatology criteria for fibromyalgia: a twenty-year journey. *Arthritis Care Res*. 2010;62(5):583–584. doi:10.1002/acr.20156
18. Wolfe F, Clauw DJ, Fitzcharles MA, et al. The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. *Arthritis Care Res*. 2010;62(5):600–610. doi:10.1002/acr.20140
19. Manheimer E, Linde K, Lao L, Bouter LM, Berman BM. Meta-analysis: acupuncture for osteoarthritis of the knee. *Ann Intern Med*. 2007;146 (12):868–877. doi:10.7326/0003-4819-146-12-200706190-00008
20. Manheimer E, White A, Berman B, Forys K, Ernst E. Meta-analysis: acupuncture for low back pain. *Ann Intern Med*. 2005;142(8):651–663. doi:10.7326/0003-4819-142-8-200504190-00014
21. Berman BM, Ezzo J, Hadhazy V, Swyers JP. Is acupuncture effective in the treatment of fibromyalgia? *J Fam Pract*. 1999;48(3):213–218.
22. Vas J, Santos-Rey K, Navarro-Pablo R, et al. Acupuncture for fibromyalgia in primary care: a randomised controlled trial. *Acupunct Med*. 2016;34 (4):257–266. doi:10.1136/acupmed-2015-010950
23. Karatay S, Okur SC, Uzkeser H, Yildirim K, Akcay F. Effects of acupuncture treatment on fibromyalgia symptoms, serotonin, and substance P levels: a randomized sham and placebo-controlled clinical trial. *Pain Med*. 2018;19(3):615–628. doi:10.1093/pm/pnx263
24. Ejiri Y, Uta D, Ota H, Mizumura K, Taguchi T. Nociceptive chemical hypersensitivity in the spinal cord of a rat reserpine-induced fibromyalgia model. *Neurosci Res*. 2022;181:87–94. doi:10.1016/j.neures.2022.03.005
25. Jung TG, Lee JH, Lee IS, Choi BT. Involvement of intracellular calcium on the phosphorylation of spinal N-methyl-D-aspartate receptor following electroacupuncture stimulation in rats. *Acta Histochem*. 2010;112(2):127–132. doi:10.1016/j.acthis.2008.09.009
26. Lin JG, Hsieh CL, Lin YW. Analgesic effect of electroacupuncture in a mouse fibromyalgia model: roles of TRPV1, TRPV4, and pERK. *PLoS One*. 2015;10(6):e0128037. doi:10.1371/journal.pone.0128037
27. Lu KW, Hsieh CL, Yang J, Lin YW. Effects of electroacupuncture in a mouse model of fibromyalgia: role of N-methyl-D-aspartate receptors and related mechanisms. *Acupunct Med*. 2017;35(1):59–68. doi:10.1136/acupmed-2015-010986
28. Bastos JL, Pires ED, Silva ML, de Araújo FL, Silva JR. Effect of acupuncture at tender points for the management of fibromyalgia syndrome: a case series. *J Acupunct Meridian Stud*. 2013;6(3):163–168. doi:10.1016/j.jams.2013.02.001
29. Zucker NA, Tsodikov A, Mist SD, Cina S, Napadow V, Harris RE. Evoked pressure pain sensitivity is associated with differential analgesic response to verum and sham acupuncture in fibromyalgia. *Pain Med*. 2017;18(8):1582–1592. doi:10.1093/pm/pnx001
30. Yang B, Yi G, Hong W, et al. Efficacy of acupuncture on fibromyalgia syndrome: a meta-analysis. *J Tradit Chin Med*. 2014;34(4):381–391. doi:10.1016/S0254-6272(15)30037-6
31. Sandberg M, Larsson B, Lindberg LG, Gerdle B. Different patterns of blood flow response in the trapezius muscle following needle stimulation (acupuncture) between healthy subjects and patients with fibromyalgia and work-related trapezius myalgia. *Eur J Pain*. 2005;9(5):497–510. doi:10.1016/j.ejpain.2004.11.002

32. Sandberg M, Lindberg LG, Gerdle B. Peripheral effects of needle stimulation (acupuncture) on skin and muscle blood flow in fibromyalgia. *Eur J Pain*. 2004;8(2):163–171. doi:10.1016/S1090-3801(03)00090-9

33. Di Carlo M, Beci G, Salaffi F. Pain changes induced by acupuncture in single body areas in fibromyalgia syndrome: results from an open-label pragmatic study. *eCAM*. 2021;2021:9991144. doi:10.1155/2021/9991144

34. Núñez-Fuentes D, Obrero-Gaitán E, Zagalaz-Anula N, et al. Alteration of postural balance in patients with fibromyalgia syndrome-a systematic review and meta-analysis. *Diagnostics*. 2021;11(1):127. doi:10.3390/diagnostics11010127

35. Garrido-Ardila EM, González-López-Arza MV, Jiménez-Palomares M, García-Nogales A, Rodríguez-Mansilla J. Effectiveness of acupuncture vs. core stability training in balance and functional capacity of women with fibromyalgia: a randomized controlled trial. *Clin Rehabil*. 2020;34(5):630–645. doi:10.1177/0269215520911992

36. Wu MY, Huang MC, Chiang JH, Sun MF, Lee YC, Yen HR. Acupuncture decreased the risk of coronary heart disease in patients with fibromyalgia in Taiwan: a nationwide matched cohort study. *Arthritis Res Ther*. 2017;19(1):37. doi:10.1186/s13075-017-1239-7

37. Huang MC, Yen HR, Lin CL, Lee YC, Sun MF, Wu MY. Acupuncture decreased the risk of stroke among patients with fibromyalgia in Taiwan: a nationwide matched cohort study. *PLoS One*. 2020;15(10):e0239703. doi:10.1371/journal.pone.0239703

38. Kosek E, Cohen M, Baron R, et al. Do we need a third mechanistic descriptor for chronic pain states? *Pain*. 2016;157(7):1382–1386. doi:10.1097/j.pain.0000000000000507

39. Staud R. Biology and therapy of fibromyalgia: pain in fibromyalgia syndrome. *Arthritis Res Ther*. 2006;8(3):208. doi:10.1186/ar1950

40. Chen CT, Lin JG, Huang CP, Lin YW. Electroacupuncture attenuates chronic fibromyalgia pain through the phosphorylated phosphoinositide 3-kinase signaling pathway in the mouse brain. *Iran J Basic Med Sci*. 2019;22(9):1085–1090. doi:10.22038/ijbms.2019.35887.8547

41. Hsiao IH, Lin YW. Electroacupuncture reduces fibromyalgia pain by attenuating the HMGB1, S100B, and TRPV1 signalling pathways in the mouse brain. *eCAM*. 2022;2022:2242074. doi:10.1155/2022/2242074

42. Hsu HC, Hsieh CL, Lee KT, Lin YW. Electroacupuncture reduces fibromyalgia pain by downregulating the TRPV1-pERK signalling pathway in the mouse brain. *Acupunct Med*. 2020;38(2):101–108. doi:10.1136/acupmed-2017-011395

43. Liao HY, Lin YW. Electroacupuncture reduces cold stress-induced pain through microglial inactivation and transient receptor potential V1 in mice. *Chin Med*. 2021;16(1):43. doi:10.1186/s13020-021-00451-0

44. Maciel LY, da Cruz KM, de Araujo AM, et al. Electroacupuncture reduces hyperalgesia after injections of acidic saline in rats. *eCAM*. 2014;2014:485043. doi:10.1155/2014/485043

45. Yen CM, Hsieh CL, Lin YW. Electroacupuncture reduces chronic fibromyalgia pain through attenuation of transient receptor potential vanilloid 1 signaling pathway in mouse brains. *Iran J Basic Med Sci*. 2020;23(7):894–900. doi:10.22038/ijbms.2020.39708.9408

46. Yen LT, Hsieh CL, Hsu HC, Lin YW. Targeting ASIC3 for Relieving mice fibromyalgia pain: roles of electroacupuncture, opioid, and adenosine. *Sci Rep*. 2017;7:46663. doi:10.1038/srep46663

47. Yen LT, Hsieh CL, Hsu HC, Lin YW. Preventing the induction of acid saline-induced fibromyalgia pain in mice by electroacupuncture or APETx2 injection. *Acupunct Med*. 2020;38(3):188–193. doi:10.1136/acupmed-2017-011457

48. Yen LT, Hsu YC, Lin JG, Hsieh CL, Lin YW. Role of ASIC3, Nav1.7 and Nav1.8 in electroacupuncture-induced analgesia in a mouse model of fibromyalgia painRole of ASIC3, Nav1.7 and Nav1.8 in electroacupuncture-induced analgesia in a mouse model of fibromyalgia pain. *Acupuncture in MedicineAcupuncture in medicine*. 2018;36(22):110–116.

49. Brum ES, Becker G, Fialho MFP, Oliveira SM. Animal models of fibromyalgia: what is the best choice? *Pharmacol Ther*. 2022;230:107959. doi:10.1016/j.pharmthera.2021.107959

50. Mawla I, Ichesco E, Zöllner HJ, et al. Greater somatosensory afference with acupuncture increases primary somatosensory connectivity and alleviates fibromyalgia pain via insular γ-aminobutyric acid: a randomized neuroimaging trial. *Arthritis Rheumatol*. 2021;73(7):1318–1328. doi:10.1002/art.41620

51. Crofford LJ, Appleton BE. Complementary and alternative therapies for fibromyalgia. *Curr Rheumatol Rep*. 2001;3(2):147–156. doi:10.1007/s11926-001-0010-9

52. Deluze C, Bosia L, Zirbs A, Chantraine A, Vischer TL. Electroacupuncture in fibromyalgia: results of a controlled trial. *BMJ*. 1992;305(6864):1249–1252. doi:10.1136/bmj.305.6864.1249

53. Harris RE, Tian X, Williams DA, et al. Treatment of fibromyalgia with formula acupuncture: investigation of needle placement, needle stimulation, and treatment frequency. *J Altern Complement Med*. 2005;11(4):663–671. doi:10.1089/acm.2005.11.663

54. Assefi NP, Sherman KJ, Jacobsen C, Goldberg J, Smith WR, Buchwald D. A randomized clinical trial of acupuncture compared with sham acupuncture in fibromyalgia. *Ann Intern Med*. 2005;143(1):10–19. doi:10.7326/0003-4819-143-1-200507050-00005

55. Eisenberg DM, Davis RB, Ettner SL, et al. Trends in alternative medicine use in the United States, 1990–1997: results of a follow-up national survey. *JAMA*. 1998;280(18):1569–1575. doi:10.1001/jama.280.18.1569

56. Targino RA, Imamura M, Kaziyama HH, et al. A randomized controlled trial of acupuncture added to usual treatment for fibromyalgia. *J Rehabil Med*. 2008;40(7):582–588. doi:10.2340/16501977-0216

57. Harris RE, Sundgren PC, Craig AD, et al. Elevated insular glutamate in fibromyalgia is associated with experimental pain. *Arthritis Rheum*. 2009;60(10):3146–3152. doi:10.1002/art.24849

58. Mayhew E, Ernst E. Acupuncture for fibromyalgia–a systematic review of randomized clinical trials. *Rheumatology*. 2007;46(5):801–804. doi:10.1093/rheumatology/kel406

59. Russell IJ, Orr MD, Littman B, et al. Elevated cerebrospinal fluid levels of substance P in patients with the fibromyalgia syndrome. *Arthritis Rheum*. 1994;37(11):1593–1601. doi:10.1002/art.1780371106

60. Langhorst J, Klose P, Musial F, Irnich D, Häuser W. Efficacy of acupuncture in fibromyalgia syndrome–a systematic review with a meta-analysis of controlled clinical trials. *Rheumatology*. 2010;49(4):778–788. doi:10.1093/rheumatology/kep439

61. Pioro-Boisset M, Esdaile JM, Fitzcharles MA. Alternative medicine use in fibromyalgia syndrome. *Arthritis Care Res*. 1996;9(1):13–17. doi:10.1002/art.1790090105

62. Sprott H, Franke S, Kluge H, Hein G. Pain treatment of fibromyalgia by acupuncture. *Rheumatol Int*. 1998;18(1):35–36. doi:10.1007/s002960050051

63. Holdcraft LC, Assefi N, Buchwald D. Complementary and alternative medicine in fibromyalgia and related syndromes. *Best Pract Res Clin Rheumatol*. 2003;17(4):667–683. doi:10.1016/S1521-6942(03)00037-8

64. Brattberg G. Connective tissue massage in the treatment of fibromyalgia. *Eur J Pain*. 1999;3(3):235–244. doi:10.1016/S1090-3801(99)90050-2

65. Martin-Sanchez E, Torralba E, Díaz-Domínguez E, Barriga A, Martin JL. Efficacy of acupuncture for the treatment of fibromyalgia: systematic review and meta-analysis of randomized trials. *Open Rheumatol J*. 2009;3:25–29. doi:10.2174/1874312900903010025

66. Uğurlu FG, Sezer N, Aktekin L, Fidan F, Tok F, Akkuş S. The effects of acupuncture versus sham acupuncture in the treatment of fibromyalgia: a randomized controlled clinical trial. *Acta Reumatol Port*. 2017;42(1):32–37.