



Global research trends of sham acupuncture: A bibliometric analysis

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ABSTRACT

Objective: Sham acupuncture has been used as a control in acupuncture efficacy trials. However, questions have been raised about whether it is a physiologically inert placebo. We aimed to understand global research trends and provide guidance for future research by conducting a bibliometric analysis of sham acupuncture studies.

Methods: Journal articles published to date related to sham acupuncture were retrieved from Web of Science on May 29, 2023. The publication year, country, keyword, author, and organization of the studies were analyzed using the available bibliometric information. Using VOSviewer software, the co-occurrence of keywords in sham acupuncture studies was visualized as a network map by cluster analysis and overlay analysis according to the publication year.

Results: A total of 3428 studies were included in the analysis. Studies on sham acupuncture have been steadily increasing since 1991, with most of the studies conducted in China (1514 studies, 44.17%), followed by the United States (789 studies, 23.02%) and South Korea (277 studies, 8.08%). The keywords of sham acupuncture research were classified into four clusters: evidence synthesis, pain clinical research, mechanism research, and acupressure research. Keyword analysis according to the publication year showed that evidence synthesis on sham acupuncture was recently focused on psychiatric conditions including depression and insomnia through systematic reviews, and clinical and mechanism studies on sham acupuncture were mostly conducted relatively in the past.

Conclusion: This bibliometric analysis provides a comprehensive overview of the development and global trends of sham acupuncture research to date, suggesting directions for future research.

1. Introduction

Sham acupuncture is frequently used as a control intervention in randomized controlled clinical trials to evaluate the efficacy of acupuncture. Two common forms of sham acupuncture, minimal needling and non-penetrating needling using sham devices (e.g., the Streitberger and Park sham devices), have been performed to mimic some technical aspects of acupuncture needling.^{1–3} However, their physiological inactivity has not been tested,⁴ and whether these sham acupuncture methods can be considered as placebo treatments has been

repeatedly questioned.^{1,5} In addition, every sham acupuncture method penetrates or touches the skin, and even touching the skin can create a specific effect, suggesting that sham acupuncture is never inert.^{6,7} Furthermore, acupuncture is a complex medical intervention with various factors that can induce therapeutic effects, including the acupuncture points themselves and the acupuncture manipulation procedure;⁸ therefore, sham acupuncture may not be a true placebo for acupuncture studies.^{9,10}

A sham acupuncture device has been reported to be more effective than an inert placebo pill,¹¹ and different types of sham acupuncture

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controls have shown different responses.¹² Therefore, inconsistent results have been reported in previous acupuncture efficacy trials that used sham acupuncture as a control group, leading to situations where acupuncture was conditionally or not recommended in clinical practice guidelines.^{13–15} To further investigate the appropriateness of sham acupuncture for evaluating the efficacy of acupuncture and to identify areas for future sham acupuncture studies, it would be helpful to review the trends in the literature thus far.

A bibliometric analysis summarizes the progress of a specific field by quantitatively analyzing a large amount of literature published in the field using mathematics and statistics.¹⁶ It plays an important role in understanding research hotspots by explaining global research trends in a particular field and identifying the contributions of various authors, institutions, and countries to the field.¹⁶ Recently, this research method has been used to identify acupuncture research trends including cancer pain,¹⁷ neck pain,¹⁸ depression,¹⁹ and cognitive impairment.²⁰

However, to the best of our knowledge, no bibliometric analysis has been conducted on the global research trends of sham acupuncture. A bibliometric analysis of studies on sham acupuncture can help identify gaps in studies in this field and set the direction for future studies. Therefore, we aimed to understand global research trends by analyzing and visualizing hot spots and development trends through a bibliometric analysis of sham acupuncture studies conducted thus far, which could help provide guidance for future research.

2. Methods

2.1. Data sources and search

The Science Citation Index-Expanded (SCI-E) of the Web of Science search engine (<https://www.webofknowledge.com>) was used as a data source. The search strategy was based on related systematic reviews and was set as follows after expert discussion: “TS= (acupuncture* OR acupoint* OR needl*) AND TS= (sham).” The database search was performed on May 29, 2023, and document types were limited to articles and review articles to target only peer-reviewed articles published in relevant journals. There were no other restrictions such as publication year or language. As a result of the search, a total of 3428 studies published up to the search date were included in the analysis.

2.2. Data preprocessing

The bibliometric data were downloaded as a text file. Data preprocessing was performed by checking for term duplication in the text file. To increase the accuracy of keyword analysis, plural forms of words were converted to singular forms (e.g., placebos → placebo). In addition, all keywords with “-” were deleted (e.g., clinical-trial → clinical trial), except for converting “metaanalysis” to the commonly used term “meta-analysis”. In addition, to avoid duplication, both the keywords “randomized trial” and “randomized clinical trial” were unified as “randomized controlled trial”, and “clinical trial” was converted to “trial”. To avoid duplication of the author’s organizational affiliation, when “university-affiliated hospital” and “university” were used as the institution, they were unified as “university”.

2.3. Data analysis

Frequency analysis was performed for bibliometric information such as publication year, country, keywords, author, and organization. Data were analyzed using Excel 2019 (Microsoft Corporation, Redmond, WA, United States) and visualized using VOSviewer (version 1.6.19; Leiden University, Leiden, Netherlands).

For network visualization, co-occurrence analysis of keywords was performed, as well as collaboration pattern analysis of the author and organization (based on co-authorship). The size of a node in a network map indicates the number of related studies. The thickness of the

connection line between nodes demonstrates a relationship such as co-occurrence. In addition, nodes related to each other are expressed so that they are close, and nodes that are less related are far away. The connection strength between nodes was calculated as total link strength (TLS), and the higher the TLS, the higher the connection strength. The resolution of the network map was all set to a default value of 1. Full counting was used as the counting method, and to clearly visualize the network, the minimum number of occurrences was set differently (keywords: 40, author: 20, organization: 30).

All network maps are presented in the following two forms: (1) Cluster map with different colors between nodes indicating different clusters. Specifically, the names of the clusters in the keyword cluster map were given by the authors after analyzing the items with a high frequency in each cluster. To avoid subjectivity in this process, two researchers (BL and CYK) performed and discussed the clustering classification and naming. (2) Overlay map showing the temporal trend of overlay visualization and the average publication year through the node color. Specifically, using VOSviewer’s overlay visualization function, each node was displayed as a purple and yellow spectrum according to the publication year of the included documents. The closer the node color is to purple, the earlier the study was published, and the closer it is to yellow, the more recently the study was published.

3. Results

3.1. Publication year

The number of publications according to the year showed a tendency to increase, starting from 8 (0.23%) in 1991 – 105 (3.06%) on May 29, 2023 (the search date). In particular, more than 100 papers have been published annually since 2008, and in 2022, it reached 352 papers (10.27 %), which was the highest number of publications (Fig. 1).

3.2. Leading country

The included studies were published in a total of 68 countries, with the largest number of studies published in China (1514 studies, 44.17 %), followed by the United States (US) (789 studies, 23.02 %), South Korea (277 studies, 8.08 %), the United Kingdom (UK) (211 studies, 6.16 %), and Germany (181 studies, 5.28 %). Although publications were most likely to originate from China, in terms of citations and TLS, studies from the US were considered the most influential (citations: 33,550; TLS: 515). Within the top 5 and even the top 10 countries, Asian countries accounted for less than 50 % (Table 1).

3.3. Keywords

A total of 9733 keywords were identified, and the keyword that appeared the most in relation to sham acupuncture was ‘acupuncture’ (1650 articles, 48.13 %), followed by ‘electroacupuncture’ (781 articles, 22.78 %), ‘randomized controlled trial’ (491 articles, 14.35 %), and ‘pain’ (483 articles, 14.09 %). Excluding sham acupuncture, a total of 5 acupuncture-related techniques (i.e., manual acupuncture, laser acupuncture, electroacupuncture, acupressure, and auricular acupuncture) were included in the keywords (Table 2, Supplement 1).

A total of 111 keywords that appeared at least 40 times were classified into four clusters in co-occurrence analysis. The naming of each cluster was as follows: (1) Cluster 1: Evidence synthesis; (2) Cluster 2: Pain clinical research; (3) Cluster 3: Mechanism research; (4) Cluster 4: Acupressure research. Cluster 1 consisted of 37 keywords, including ‘acupuncture’ (1650 articles, 48.13 %), ‘management’ (330 articles, 9.63 %), ‘meta-analysis’ (292 articles, 8.52 %), ‘efficacy’ (240 articles, 7.00 %), and ‘systematic review’ (184 articles, 5.37 %). Cluster 2 consisted of 31 keywords, including ‘randomized controlled trial’ (492 articles, 14.35 %) and ‘pain’ (483 articles, 14.09 %). Cluster 3 consisted of 30 keywords, including ‘electroacupuncture’ (781 articles, 22.78 %),



Fig. 1. Number of publications according to the year on sham acupuncture research.

Table 1

Top 10 countries in the research area of sham acupuncture.

	Countries	Records (n)	% (of 3428)	Citations	Total link strength
1	China	1514	44.17	22,830	467
2	United States	789	23.02	33,550	515
3	South Korea	277	8.08	5947	131
4	United Kingdom	211	6.16	11,772	260
5	Germany	181	5.28	9513	174
6	Australia	173	5.05	4361	155
7	Taiwan	173	5.05	3594	52
8	Brazil	109	3.18	2104	38
9	Canada	101	2.95	5005	107
10	Japan	82	2.39	1501	38

Table 2

Top 10 keywords in the research area of sham acupuncture.

	Keywords	Records (n)	% (of 3428)	Total link strength
1	acupuncture	1650	48.13	6395
2	electroacupuncture	781	22.78	3120
3	randomized controlled trial	492	14.35	2364
4	pain	483	14.09	2086
5	stimulation	332	9.68	1362
6	trial	331	9.66	1479
7	management	330	9.63	1555
8	meta-analysis	292	8.52	1539
9	therapy	247	7.21	1069
10	efficacy	240	7.00	1236

‘stimulation’ (332 articles, 9.68 %), ‘mechanism’ (225 articles, 6.56 %), and ‘rat’ (174 articles, 5.08 %). Cluster 4 consisted of 13 keywords, including ‘acupressure’ (115 articles, 3.35 %), ‘surgery’ (70 articles, 2.04 %), ‘prevention’ (59 articles, 1.72 %), and ‘children’ (56 articles, 1.63 %) (Fig. 2(A), Supplement 1).

When overlay visualization of keywords was performed according to the publication year, studies related to Cluster 1 (Evidence synthesis) were conducted relatively recently, mainly on psychiatric symptoms including depression, and insomnia. However, more clinical trials and mechanism studies on sham acupuncture were conducted in the past (Fig. 2(B)).

3.4. Author

A total of 15773 authors were included in the analysis, of whom those with the most publications were Lixing Lao of Virginia University of Integrative Medicine (56 articles, 1.63 %), followed by Fanrong Liang of Chengdu University of Traditional Chinese Medicine (52 articles, 1.52 %) and Myeong Soo Lee of Korea Institute of Oriental Medicine (43 articles, 1.25 %). The most influential authors were Klaus Linde of Technical University Munich in terms of citations (citations: 3115) and Cun-Zhi Liu of Beijing University of Chinese Medicine in terms of TLS (TLS: 123) (Table 3, Supplement 2).

A total of 27 authors who published 20 or more articles were classified into six clusters in network analysis based on co-authorship as follows: Cluster 1: 6 authors from China and Virginia University of Integrative Medicine, including Lixing Lao (56 articles, 1.63 %) and Zhishun Liu (42 articles, 1.23 %); Cluster 2: 5 authors from South Korea and the UK, including Myeong Soo Lee (43 articles, 1.25 %) and Edzard Ernst (29 articles, 0.85 %); Cluster 3: 5 authors from Beijing University of Chinese Medicine, including Cun-Zhi Liu (35 articles, 1.02 %); Cluster 4: 5 authors from the US and Europe, including Jian Kong (28 articles, 0.82 %); Cluster 5: 4 authors from Chengdu University of Traditional Chinese Medicine, including Fanrong Liang (52 articles, 1.52 %); Cluster 6: 2 authors from Guangzhou, including Yong Huang (24 articles, 0.70 %) (Fig. 3(A), Supplement 2).

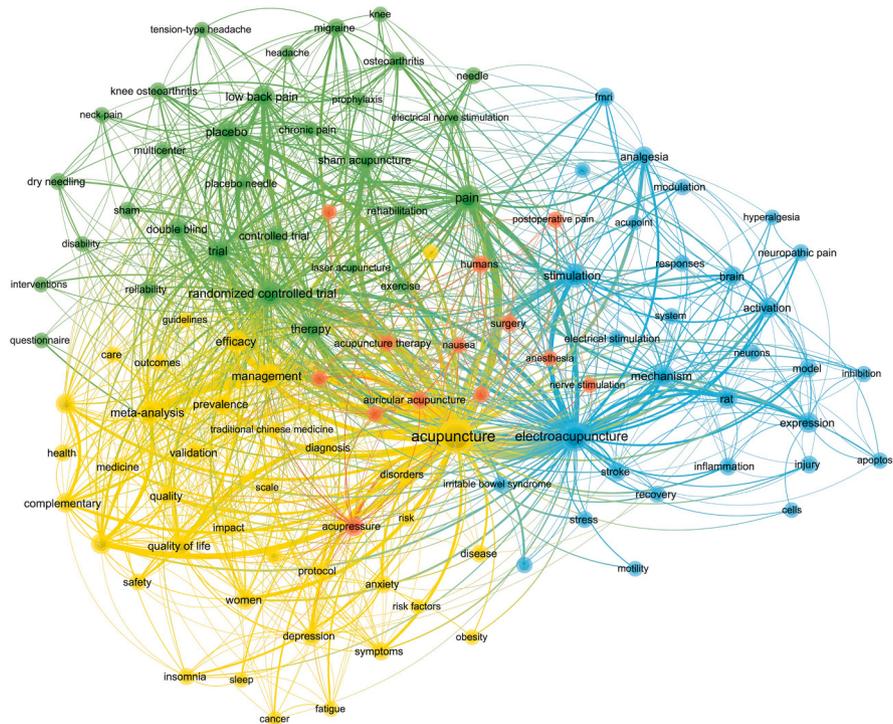
Based on overlay visualization of authors according to the publication year, authors from China in Clusters 1, 3, and 5 recently conducted related research, and authors from South Korea, the US, and Europe conducted more related research in the past (Fig. 3(B)).

3.5. Organizational affiliation

A total of 3218 organizations published related studies, with Beijing University of Chinese Medicine publishing the most studies (173 articles, 5.05 %), followed by Shanghai University of Traditional Chinese Medicine (149 articles, 4.35 %). The most influential organizations were University of Maryland in terms of citations (citations: 6224) and Beijing University of Chinese Medicine in terms of TLS (TLS: 221) (Table 4, Supplement 3).

A total of 39 organizations that published 30 or more studies were classified into six clusters in network analysis based on co-authorship as follows: Cluster 1: 10 organizations including Beijing University of Chinese Medicine (173 articles, 5.05 %) and Guangzhou Medical University (134 articles, 3.91 %); Cluster 2: 8 organizations including Shanghai University of Traditional Chinese Medicine (149 articles, 4.35

(A) Keyword network cluster map



(B) Keyword network overlay map

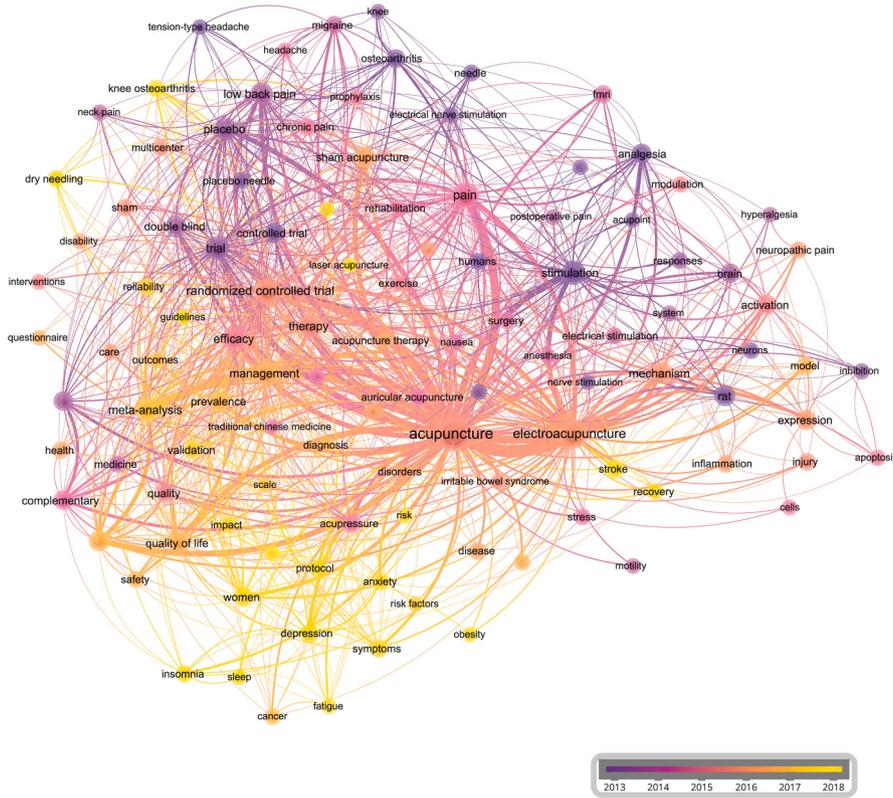


Fig. 2. Keyword network map in sham acupuncture research. (A) Cluster map: cluster 1 (Evidence synthesis), yellow color; cluster 2 (Pain clinical research), green color; cluster 3 (Mechanism research), blue color; and cluster 4 (Acupressure research), red color. (B) Overlay map: The closer the node color is to purple, the earlier the study was published, and the closer it is to yellow, the more recently the study was published.

Table 3
Top 10 authors in the research area of sham acupuncture.

	Authors	Records (n)	% (of 3428)	Citations	Total link strength
1	Lao, Lixing (Virginia University of Integrative Medicine, US)	56	1.63	1686	100
2	Liang, Fanrong (Chengdu University of Traditional Chinese Medicine, China)	52	1.52	1523	118
3	Lee, Myeong Soo (Korea Institute of Oriental Medicine, South Korea)	43	1.25	1126	78
4	Liu, Zhishun (China Academy of Chinese Medical Sciences, China)	42	1.23	548	79
5	Zhao, Ling (Chengdu University of Traditional Chinese Medicine, China)	39	1.14	677	78
6	Liu, Cun-Zhi (Beijing University of Chinese Medicine, China)	35	1.02	534	123
7	Li, Ying (Chengdu University of Traditional Chinese Medicine, China)	30	0.88	818	73
8	Chen, Jiande D. Z. (University of Michigan, US)	29	0.85	472	20
9	Ernst, Edzard (University of Exeter, UK)	29	0.85	1675	34
10	Kong, Jian (Harvard Medical School, US)	28	0.82	1686	42

%) and China Medical University (98 articles, 2.86 %); Cluster 3: 6 organizations including Chengdu University of Traditional Chinese Medicine (138 articles, 4.03 %) and Harvard University (112 articles, 3.27 %); Cluster 4: 6 organizations including Nanjing University of Chinese Medicine (84 articles, 2.45 %) and Huazhong University of Science and Technology (53 articles, 1.55 %); Cluster 5: 5 organizations including Kyung Hee University (148 articles, 4.32 %) and Korea Institute of Oriental Medicine (92 articles, 2.68 %); Cluster 6: 4 organizations including University of Maryland (72 articles, 2.10 %) and Charite University of Medicine Berlin (36 articles, 1.05 %) (Fig. 4(A), Supplement 3).

Based on overlay visualization according to the publication year, organizations located in China had published studies relatively recently, and organizations located in the US and Europe had published more studies in the past (Fig. 4(B)).

4. Discussion

Bibliometric analyses of the worldwide research trends of acupuncture have been performed with a focus on various conditions such as pain,^{17,18} depression,¹⁹ and cognitive impairment.²⁰ However, the current status of research on sham acupuncture, which has been used as a control group to evaluate the efficacy of acupuncture, has not been analyzed. Therefore, considering the current situation where questions about the appropriateness of sham acupuncture as a placebo are repeatedly raised,^{1,5} we conducted a bibliometric analysis to clarify the global research trends of sham acupuncture to date and to suggest future research areas for sham acupuncture.

4.1. Worldwide sham acupuncture studies

A total of 3428 studies on sham acupuncture published until May 29, 2023 were analyzed, which revealed that studies on sham acupuncture

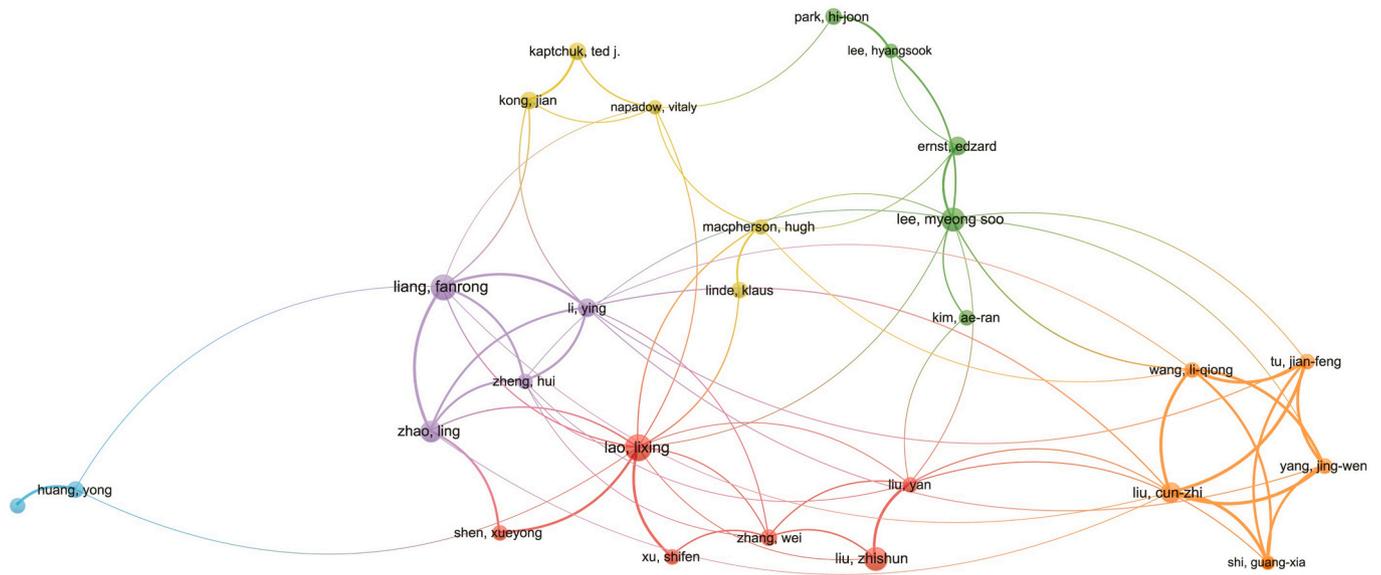
have been steadily increasing from 1991 to the present. In addition, although almost half of the studies were conducted in China, a considerable number of studies were also conducted in the US, South Korea, the UK, and Germany. In other words, despite the emergence of acupuncture from traditional East Asian medicine (TEAM), sham acupuncture is being studied worldwide and not limited to Asian countries. However, an analysis with overlay visualization found that research activity according to the country was different over time. A possible explanation for this observation could be the different timing of progress in acupuncture research. Specifically, according to a bibliometric analysis of acupuncture studies from 1995 to 2014, high-quality acupuncture studies (i.e., randomized controlled trials) were mainly conducted in the US and UK in the first 10 years; however, studies were mainly conducted in China (yearly growth rate: 56.2%) in the following 10 years.²¹ The Chinese government's research funding to promote the traditional Chinese medicine industry appears to have accelerated this trend.²²

The observed trends of sham acupuncture research may also be attributed to differences in the cultural interpretation of acupuncture. The difference between the East and West in medicine has been pointed out previously.²³ However, this does not imply a simple black-and-white distinction but acknowledges that the academic foundations of the East and West are different. In East Asian countries, the mechanisms underlying the therapeutic effects of acupuncture have been described according to the theories of TEAM; however, in other countries, TEAM-based treatments including acupuncture need to be explained in terms of evidence-based medicine (EBM).²⁴ For example, in Asian countries, some TEAM theories (e.g., Yin/Yang Theory and Meridian Theory) have been used to understand the therapeutic mechanism of acupuncture;^{25,26} instead, efforts are focused on demonstrating the efficacy of verum acupuncture compared with sham acupuncture. However, in Western countries where the theories of TEAM are less familiar, it may be necessary to compare sham acupuncture and verum acupuncture with the aim of explaining the therapeutic mechanism of acupuncture.²⁷ Adrian White, who defined Western medical acupuncture as "an adaptation of Chinese acupuncture using current knowledge of anatomy, physiology, and pathology and the principles of EBM", has differentiated Western medical acupuncture from Chinese acupuncture.²⁷ Importantly, he pointed out that Western medical acupuncture no longer adheres to concepts such as Yin/Yang and circulation of qi.²⁷ Accordingly, different approaches to acupuncture may have created different research environments that encourage the study of sham acupuncture, with more focus on evaluating the mechanisms of acupuncture in Western countries. This may explain our findings showing that some studies on sham acupuncture from Western countries have the strongest influence in terms of citations and TLS. Nevertheless, possibly due to these research efforts, acupuncture has been increasingly included in clinical practice guidelines worldwide.²⁸

4.2. Lack of research on the completeness of sham acupuncture

In the keyword co-occurrence network, the nodes were classified into four clusters. According to the analysis of the keywords included in Cluster 1 (Evidence synthesis), systematic review and/or meta-analysis studies on the efficacy, management, and safety of acupuncture compared with sham acupuncture have been conducted relatively recently. In addition, these studies were conducted by mainly focusing on psychiatric symptoms and diseases such as insomnia, depression, and anxiety. These studies attempted to elucidate the clinical efficacy and safety of verum acupuncture, one of the objectives of sham acupuncture studies.²⁹ According to the analysis of Cluster 2 (Pain clinical research), clinical studies on sham acupuncture were mainly conducted in the form of randomized controlled trials, which focused on conditions related to pain such as low back pain or knee osteoarthritis. According to Cluster 3 (Mechanism research), mechanism studies on sham acupuncture were conducted mainly on electroacupuncture for stroke and neuropathic

(A) Author network cluster map



(B) Author network overlay map

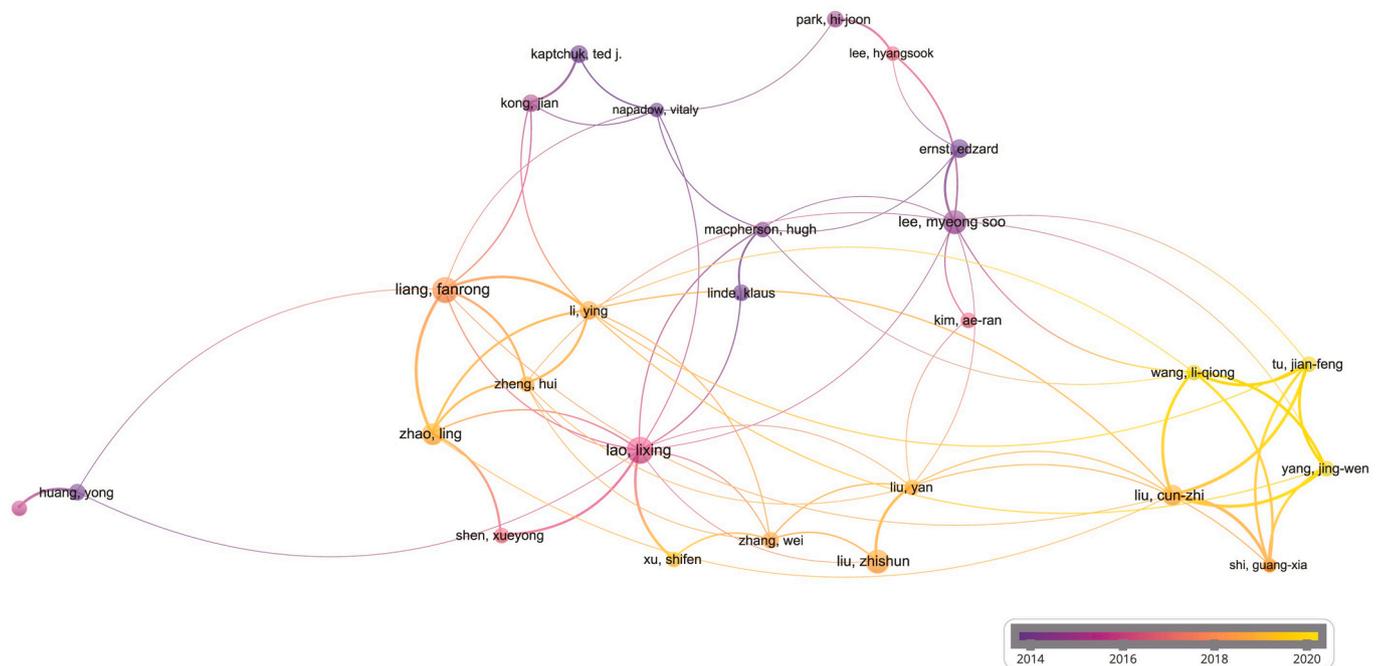


Fig. 3. Author network map in sham acupuncture research. (A) Cluster map: cluster 1 (6 authors from China and Virginia University of Integrative Medicine), red color; cluster 2 (5 authors from South Korea and the UK), green color; cluster 3 (5 authors from Beijing University of Chinese Medicine), orange color; cluster 4 (5 authors from the US and Europe), yellow color; cluster 5 (4 authors from Chengdu University of Traditional Chinese Medicine), purple color; and cluster 6 (2 authors from Guangzhou), blue color. (B) Overlay map: The closer the node color is to purple, the earlier the study was published, and the closer it is to yellow, the more recently the study was published.

pain and were mostly conducted in the past based on overlay analysis. Analysis of Cluster 4 (Acupressure research) revealed that sham acupressure studies were conducted mainly for the purpose of preventing postoperative pain and nausea in children who may be afraid of needles.

Among the four clusters, Cluster 3 was the most relevant to the completeness of sham acupuncture. As demonstrated above, research on this topic appears to be relatively outdated given the controversial status of the completeness of sham acupuncture as a placebo.^{1,5} On the other hand, sham acupuncture studies aimed at demonstrating the clinical

Table 4
Top 10 organizations in the research area of sham acupuncture.

	Organizations	Records (n)	% (of 3428)	Citations	Total link strength
1	Beijing University of Chinese Medicine	173	5.05	3118	221
2	Shanghai University of Traditional Chinese Medicine	149	4.35	2027	139
3	Kyung Hee University	148	4.32	3510	125
4	Chengdu University of Traditional Chinese Medicine	138	4.03	2180	154
5	Guangzhou Medical University	134	3.91	1129	105
6	China Academy of China Medical Sciences	119	3.47	1838	156
7	Harvard University	112	3.27	5461	111
8	China Medical University	98	2.86	1445	25
9	Capital Medical University	97	2.83	1552	122
10	Korea Institute of Oriental Medicine	92	2.68	1865	139

efficacy of the acupuncture (i.e., Cluster 1) are relatively new. This observed gap in research suggests that funds for future acupuncture research should be channeled to efforts to investigate the completeness of sham acupuncture as a placebo rather than its clinical efficacy. In addition, according to Cluster 1, the efficacy of acupuncture appeared to be recently investigated with a focus on mental disorders. Studies using placebo controls for psychiatric disorders should consider not only the completeness of sham acupuncture but also important aspects related to placebo use in psychiatric research, such as placebo literacy.³⁰

4.3. Implications for future studies

According to our findings, research on sham acupuncture is steadily increasing. The current research trend is focused on synthesizing evidence from existing clinical studies, and most clinical trials and mechanism studies on sham acupuncture have been conducted in the relatively past. Sham acupuncture was developed and used in acupuncture efficacy trials without testing for its physiological inactivity prior to the debate about methodological requirements for a placebo control.⁴ Accordingly, questions have been raised on the appropriateness of using a physiologically inert placebo to evaluate the efficacy of acupuncture.^{1,5,8} This may have resulted in the relatively small number of clinical studies recently conducted on sham acupuncture. Furthermore, pragmatic acupuncture clinical trials have been conducted using standard care as the control intervention to assess the effectiveness of acupuncture.^{31,32} In particular, in the development of clinical and insurance guidelines for acupuncture, evidence of its effectiveness compared with the usual care, which is closer to real-life routine practice, is becoming more important than evidence of its efficacy compared with sham acupuncture.^{33,34}

In the field of evidence synthesis for sham acupuncture, in addition to systematic summaries of the efficacy and safety of acupuncture compared with sham acupuncture, review studies comparing the effects of verum and sham acupuncture according to various factors involved in inducing the effects of acupuncture have been conducted. For example, in randomized controlled clinical trials using a sham acupuncture device for the control group, the sham device uses a base unit that is also used in the verum acupuncture group for successful blinding. However, this base unit can affect acupuncture procedures such as needle depth and manipulation and thus would not properly reflect the effectiveness of acupuncture in actual clinical settings. In a network meta-analysis of hot flashes in menopausal women and knee osteoarthritis,^{35,36} the efficacy of verum acupuncture in sham-controlled trials with base units was

significantly lower than that of verum acupuncture in sham-controlled trials without base units. In addition, a review study observed significant differences in the effectiveness of sham acupuncture between needling at acupuncture points and non-acupuncture points.³⁷ Furthermore, acupuncture studies that used verum and sham locations on highly or lowly overlapping dermatomes reported almost identical and significantly different efficacy, respectively.³⁸

Based on the existing review studies, some of the sham needles that have been used in acupuncture clinical trials are not appropriate as a control for efficacy evaluation. However, studies using sham acupuncture as a control are ongoing.^{39,40} The use of sham acupuncture in a clinical trial may underestimate the effectiveness of acupuncture.^{35-38,41} In addition, a recent review highlighted the lack of information for evaluating the appropriateness of sham controls in clinical trials on acupuncture.^{38,42} Therefore, researchers should disclose all relevant information on sham needles used in clinical trials to allow a proper evaluation.^{38,43,44} With organized efforts to assess sham needles used in acupuncture research, the appropriateness of sham acupuncture as a placebo control can be determined.

Through our bibliometric analysis, we found that research on the mechanism of sham acupuncture, which was actively conducted in the past, has not shown considerable progress in recent years. Although studies on the mechanism of sham needles demonstrated the potential influence of tactile, interpersonal, psychological, and visual factors on the overall placebo effect, quantitative measurements of their influence have not been performed.^{45,46} Therefore, further mechanism studies on the physiological inertness of sham needles should be conducted to assess the extent of the influence of the above factors on the placebo effect. Sham acupuncture trials should be discontinued while investigations of the mechanism of sham acupuncture techniques are ongoing until conclusive findings are obtained. Studies on sham acupuncture mechanisms may help identify specific mechanisms underlying the effects of acupuncture.^{47,48} Systematic reviews and meta-analyses of acupuncture that included sham acupuncture trials may need to re-evaluate their findings in light of the problems of underestimation that have been identified.

4.4. Limitations and strengths

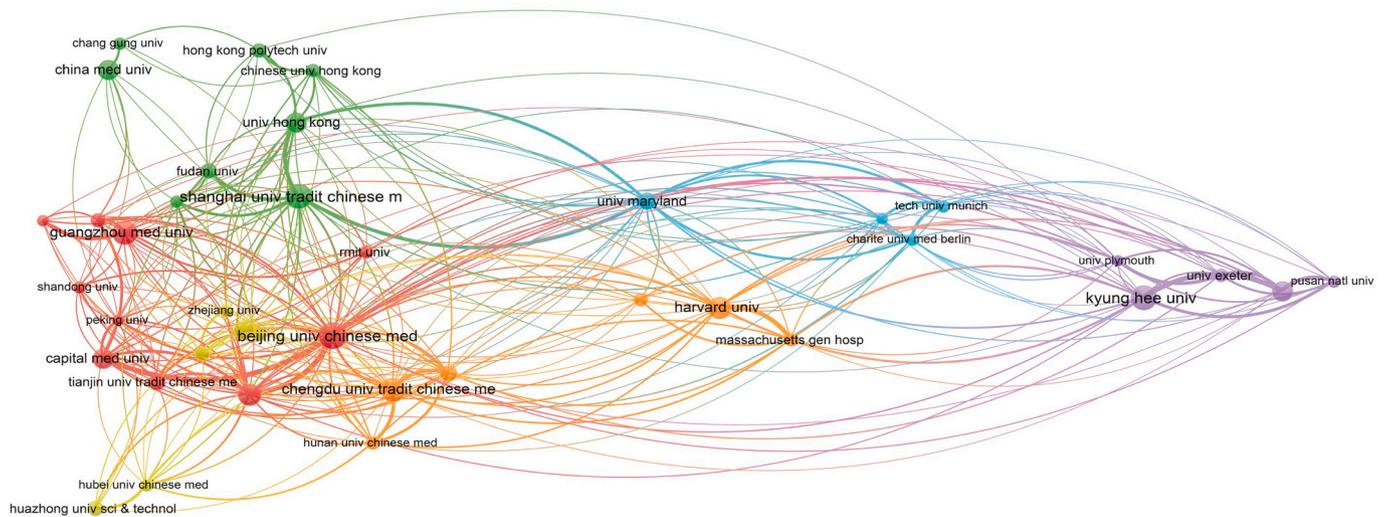
Our analysis has some limitations. Due to the inherent nature of bibliometric analysis using VOSviewer software, the researcher's subjective judgment may have affected cluster formation through various software options (e.g., resolution and minimum number of occurrences) even though a default value of 1 was used for the resolution and different occurrence criteria were each for each variable for a clear visualization of the network map. In addition, because we did not conduct a full-text analysis of the included studies, we could not examine changes in the characteristics of sham acupuncture used in the studies, such as the types of needles, needling points, and procedures. Furthermore, due to the nature of bibliometric analysis, most of the discussion was derived from previous research and the authors' opinions.

Nevertheless, this study is the first to shed light on the trends of sham acupuncture studies conducted so far through a bibliometric analysis without language restrictions. A network analysis of keywords was performed, which identified four major research topics on sham acupuncture as follows: evidence synthesis, pain clinical research, mechanism research, and acupressure research. In addition, collaboration pattern analysis of the author and organization was performed. Our study may provide a direction for future research on sham acupuncture by examining the hotspots of sham acupuncture research thus far.

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(A) Organization network cluster map



(B) Organization network overaly map

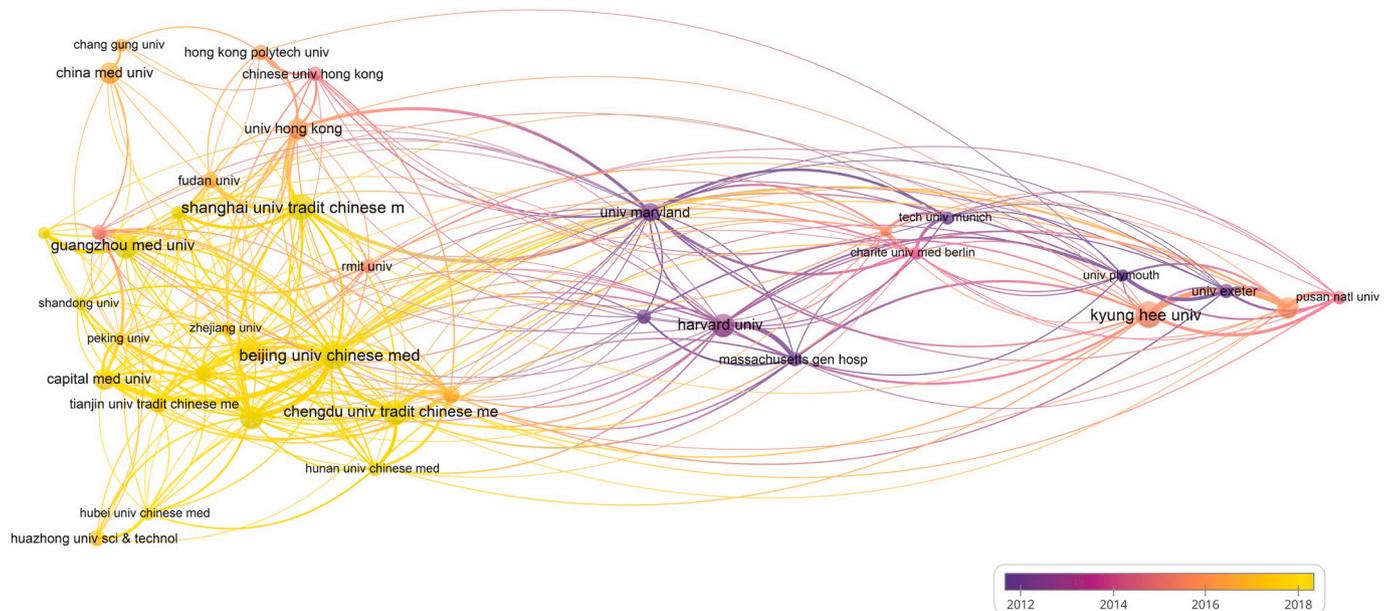


Fig. 4. Organization network map in sham acupuncture research. (A) Cluster map: cluster 1, red color; cluster 2, green color; cluster 3, orange color; cluster 4, yellow color; cluster 5, purple color; and cluster 6, blue color. (B) Overlay map: The closer the node color is to purple, the earlier the study was published, and the closer it is to yellow, the more recently the study was published.

CRediT authorship contribution statement

Boram Lee: Conceptualization, Methodology, Writing – original draft. **Chan-Young Kwon:** Methodology, Writing – original draft. **Ye-Seul Lee:** Writing – review & editing. **Terje Alraek:** Writing – review & editing. **Stephen Birch:** Writing – review & editing. **Hye Won Lee:** Writing – review & editing. **Lin Ang:** Writing – review & editing. **Myeong Soo Lee:** Methodology, Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

Data availability

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ctim.2023.103001.

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