

# Bibliometric Analysis: Research Trends and Performances of Stroke on Acupuncture

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**Purpose:** This study aimed to apply the bibliometric analysis to summarize acupuncture therapy for stroke, demonstrated and evaluated the trends, major research hotspots and frontier areas.

**Materials and Methods:** Articles on acupuncture for stroke were selected from the Web of Science Core Collection (WoSCC) from the inception of the database up until 2023. CiteSpace software was performed to conduct the collaborative analysis of networks of countries, institutions, authors and cited authors, journals and cited journals, cited references, keywords clustering and burstiness analysis.

**Results:** A total of 1141 articles were retrieved. China was the most productive country (851) and had the greatest centrality (0.43). Beijing Univ Chinese Med (86) contributed to the most publications. Chen LD (31) and Tao J (31) were the most prolific authors, of which all from Fujian Univ Tradit Chinese Med. Wu P (124) from Canadian College of Naturopathic Medicine, Canada, was the most cited author. Evidence-based Complementary and Alternative Medicine (89) was the most productive journal, while Stroke (744) was first cited journals. Stimulation, recovery, ischemic stroke, electroacupuncture, rehabilitation were the most high-frequency keywords. Future research in this area will pay more attention to the evaluation of the effectiveness of acupuncture therapeutics in treating stroke, conducting the clinical research on cognitive ability, quality of life and partial function of stroke patients, and basic research related to mechanisms.

**Conclusion:** The publications on acupuncture in stroke have shown major development, but the international cooperation for academic exchange among researchers and institutions remained to be strengthened to promote interdisciplinary and academic innovation. Furthermore, except for the molecular mechanism of acupuncture in treating functional rehabilitation of stroke, exploring the more high-quality clinical studies may become a key point based on the evidence-based medicine.

**Keywords:** acupuncture, stroke, bibliometric analysis, visualization, research trends

## Introduction

Stroke is characterized as a sudden, focused damage to the central nervous system (CNS) brought on by a vascular event, such as cerebral infarction, intracerebral hemorrhage, or subarachnoid hemorrhage. The two main types of stroke are ischemic (~80% of strokes) and hemorrhagic (~20% of strokes).<sup>1</sup> Motor dysfunction is one of the biggest issues with stroke patients' rehabilitation.<sup>2</sup> Most stroke survivors may experience a variety of secondary effects including imbalance, paralysis, spasticity, difficulty swallowing and muscle weakness. Over the years, many clinical studies and systematic reviews have supported the theory that acupuncture as a nondrug method was beneficial for stroke recovery motor function.<sup>3-7</sup> As one of the oldest Chinese medicine techniques, acupuncture has been extensively practiced over 3000 years, which is the most extensively researched methods in Chinese medicine, a process that entails inserting a tiny needle into the skin or deeper tissues at particular areas on the body (known as acupoints). This needling can be manipulated manually, electrically, or via heat.<sup>8</sup> The World Health Organization (WHO) has recommended acupuncture as an alternative and complementary technique for stroke therapy and for relieving pareses after a stroke.<sup>1</sup>

Literature is essential in scientific research, and published paper can reflect this fields' development trend and latest research achievements. Bibliometrics is a method of statistics used to examine a collection of literatures and its

bibliometric properties, evaluate the development of a specific topic, and forecast its future trends.<sup>9</sup> Now it is being gradually applied to the study of Chinese medicine, public health, infectious disease, etc., in various medical fields and predict its future development. CiteSpace, a Java-based information visualization application, was developed by Dr. Chaomei Chen (School of Information Science and Technology, Drexel University, United States).<sup>10</sup> This method has been widely utilized to investigate the knowledge structure, dynamic progress, and trending topics of acupuncture for stroke.<sup>9</sup> It does this by evaluating countries, institutions, journals, authors and keywords that contain information hidden in the literature,<sup>11</sup> to help scientists to establish further research directions.

According to a study that searched the WOCSS for literature on acupuncture, moxibustion, and acupoints, the field of comprehensive alternative medicine had the most publications (37.7%) in 2019, stroke was identified as the main hotspots.<sup>12</sup> Several of the most recent bibliometric studies on stroke have been published by researchers worldwide. Konark Malhotra analyzed the top 100 highest-cited articles in ischemic stroke and evaluate their characteristics,<sup>13</sup> Kjell Asplund conducted bibliometric analysis compared between countries of the development of stroke research over time,<sup>14</sup> Kun-Yang Chuang's study has collected stroke-related research articles published by Taiwan from the Science Citation Index from 1991 to 2005.<sup>15</sup> However, there was little studies that have gathered substantial global data on the application of bibliometric analysis for a considerable amount of time both in terms of study objects and the duration of literature contained in the database. As of right now, we conducted a bibliometric analysis of stroke literature in this study to identify the global research trend of acupuncture for stroke and to offer a reference for prospective research and practices.

## Materials and Methods

### Data Collection

All data were retrospectively collected in the Web of Science Core Collection (WoSCC). The search queries were: TS = (stroke or brain ischemia or intracranial hemorrhage) AND TS = (acupuncture), Indexes=SCI-EXPANDED, Time span = Inception to 2023–09-30. No restrictions on document types or languages. The search was performed on 5 October 2023. A total of 1141 papers were collected and exported, which included complete records and references in plain text format.

### Data Analysis

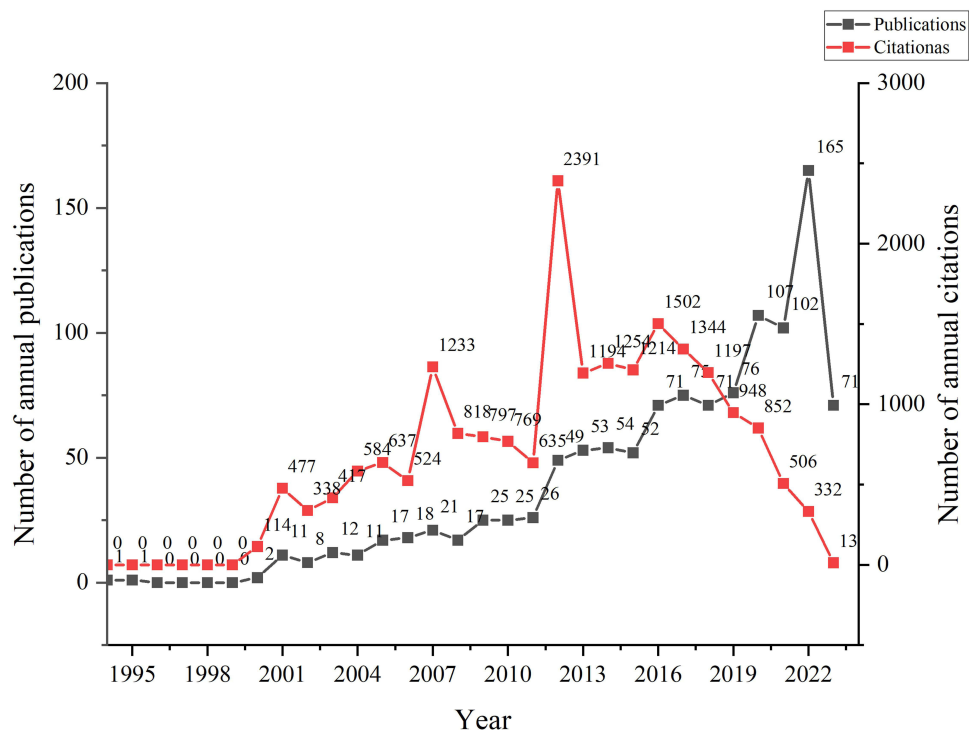
To perform the bibliometric analysis, all valid data were imported into Microsoft Excel 2019 and CiteSpace 6.1.R3 (School of Computer and Information Science, Drexel University, United States). Microsoft Excel 2019 was utilized to conduct the descriptive statistical analysis and the trend of annual publication volume analysis. CiteSpace 6.1.R3 was used to conduct collaborative analysis of networks of countries, institutions, authors and cited authors, journals and cited journals, cited references, keywords clustering and burstiness analysis. The following was the set of CiteSpace parameters: Time slicing: 1994–2023, because the article in this field appeared for the first time in 1994, Slice Length = 4, Section Criteria: g-index (k = 20).

CiteSpace is a software for bibliometric visualization analysis that is being developed under the background of metrology and data visualization. It focuses on the potential knowledge that exists within the research society. Since the structure, principles and distribution of scientific knowledge are illustrated by means of visualization, the visual graphs obtained by using these methods are also known as “scientific knowledge graphs”.<sup>16</sup> Betweenness centrality is a crucial metric for assessing nodes in the network, and a centrality higher than 0.1 is regarded as significant.<sup>17</sup> The relationships between two nodes in terms of collaboration, co-occurrence, and co-citation are represented by the linkages. Nodes with a larger size indicate a higher frequency of occurrence or citation. The occurrence or citation years are indicated by the color of the nodes. Burst is used to identify events such as topics, publications, authors, and journal citations, etc., which are expanding or changing quickly.<sup>18</sup>

## Results

### Analysis of Annual Publications

Figure 1 showed the number of publications and citations for each year among the 1141 papers. The first article was published in 1994, with a slow increasing trend for the next six years. Between 2001 and 2011, the number of relevant

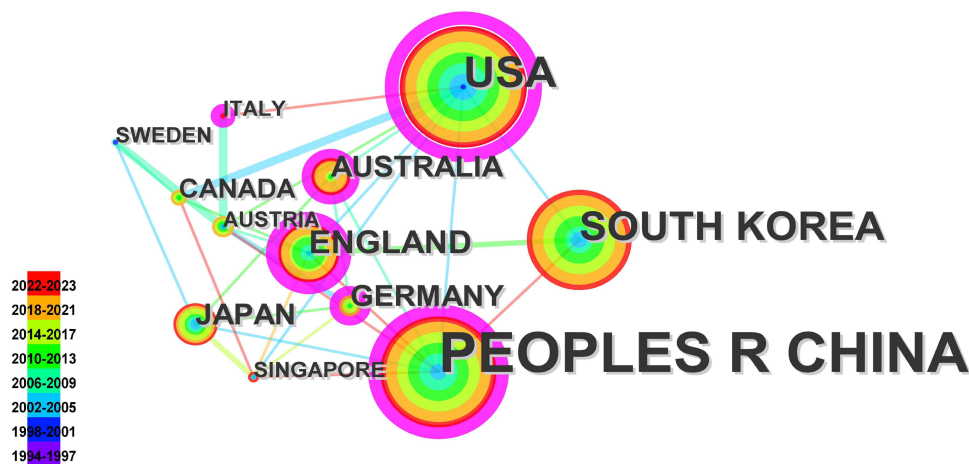


**Figure 1** The number of acupuncture for stroke from 1994–2023.

research papers reached up to more than ten, then grew yearly to 26 in 2011. From 2012 to 2019, more scholars conducted the research in acupuncture treatment for stroke, there was a rapid growth trend and reached a peak of 165 in 2022. The average citation times of each article were 17.60 times, showing a fluctuating growth trend from 0 citation to 2391 citations in 2012, followed by a rapidly decreasing in later years. That implied that the influence and quality of the papers published in the past decade on acupuncture for stroke treatment need to be improved. In 2023, the number of papers from January to July was counted only, so it was not compared with other years.

### Analysis of Countries

A total of 57 countries contributed to 1141 articles on acupuncture treatment for stroke. **Figure 2** presents the collaboration network of countries with published exceeding 10 papers selected for visualization, consisting of 57 nodes and 128 links. It can be seen from **Table 1** that the top 5 nations with the greatest amount of papers were China



**Figure 2** Collaboration network of countries on acupuncture for stroke.

**Table 1** Top 5 Countries Performed Research on Acupuncture for Stroke

Rank	Country	Count (%)	Centrality
1	China	851 (74.6)	0.43
2	USA	137 (12.0)	0.39
3	South Korea	102 (8.9)	0
4	England	37 (3.2)	0.21
5	Australia	25 (2.2)	0.18

(851), United States (137), South Korea (102), England (37), and Australia (25). The China (0.43), United States (0.39), England (0.21) and Australia (0.18) were top 4 nations having a centrality value higher than 0.10. This indicates that these countries played an important role in the field of acupuncture for stroke research through their own worldwide networks of collaboration.

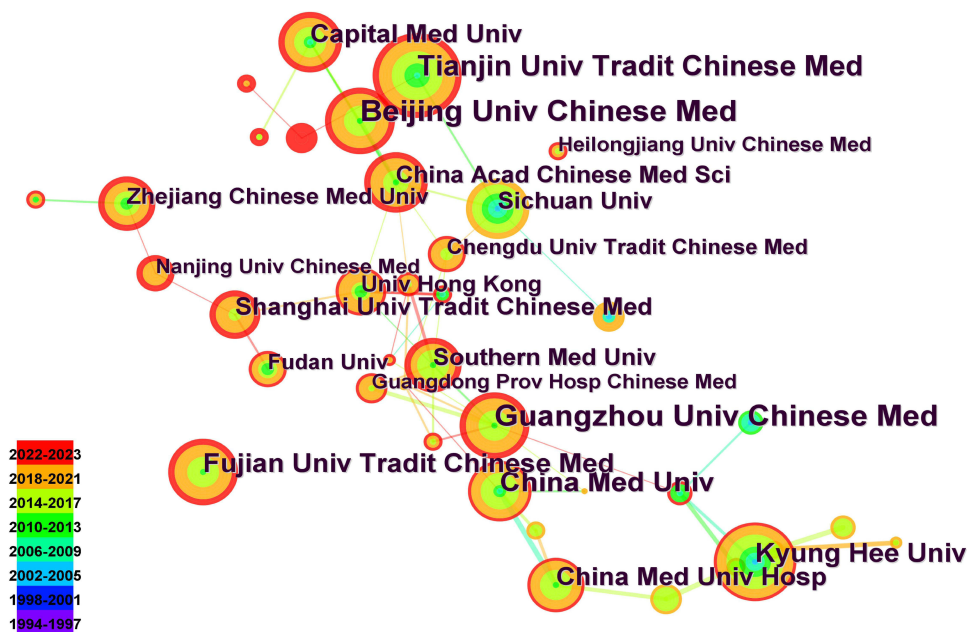
### Analysis of Institutions

A total of 3377 research institutions published related publications. As shown in Figure 3, institutions published more than 10 papers were selected for visualization with 337 nodes and 474 links. The 10 most productive institutions was listed in Table 2, nine out of ten of these institutions were located in China, and 1 institution was Kyung Hee Univ from South Korea. Beijing Univ Chinese Med had 87 published papers, which was the greatest amount of papers among all institutes, accounting for 7.5% of all publications in this area. Guangzhou Univ Chinese Med and Tianjin Univ Tradit Chinese Med ranked second and third, with 78 and 67 papers, respectively. Guangzhou Univ Chinese Med had the highest centrality of 0.19, followed by Tianjin Univ Tradit Chinese Med of 0.17 and China Med Univ of 0.16.

### Analysis of Authors and Cited Authors

#### Analysis of Authors

A total of 5279 authors participated in the publication of the papers. Table 3 displays a list of the top 10 authors. Chen LD and Tao J each had 31 published papers, of which all from Fujian Univ Tradit Chinese Med, and they were the top 2



**Figure 3** Collaboration network of institutions on acupuncture for stroke.

**Table 2** Top 10 Institutions Performed Research on Acupuncture for Stroke

Rank	Institution	Count (%)	Centrality
1	Beijing Univ Chinese Med	86 (7.5)	0.07
2	Guangzhou Univ Chinese Med	78 (6.8)	0.19
3	Tianjin Univ Tradit Chinese Med	67 (5.9)	0.17
4	China Med Univ	55 (4.8)	0.16
5	Kyung Hee Univ	51 (4.5)	0.13
6	Fujian Univ Tradit Chinese Med	47 (4.1)	0.09
7	Capital Med Univ	41 (3.6)	0.08
8	China Med Univ Hosp	40 (3.5)	0.05
9	Shanghai Univ Tradit Chinese Med	36 (3.2)	0.06
10	Sichuan Univ	33 (2.9)	0.08

**Table 3** Top 10 Authors Performed Research on Acupuncture for Stroke

Rank	Author	Country	Count	Centrality
1	Chen, LD	China	31	0.06
2	Tao, J	China	31	0.02
3	Huang, J	China	18	0.02
4	Zou, YH	China	18	0.08
5	Liu, WL	China	16	0.02
6	Lin, JG	China	15	0
7	Yang, SL	China	13	0.02
8	Park, SU	South Korea	12	0
9	Park, JM	South Korea	12	0
10	Jung, WS	South Korea	11	0

influential authors of publications. Among of 10 productive authors, 7 authors from China, and 3 authors from South Korea. The top 10 authors' centralities were all less than 0.1, indicating that the academic cooperation between authors was not close. [Figure 4](#) presents the cooperative relationship between authors who have published at least five papers, and several relatively independent small research cooperation teams could be found.

### Analysis of Cited Authors

The top 10 cited authors who conducted research on acupuncture for stroke were shown in [Table 4](#). The first 5 authors were: Wu P from Canadian College of Naturopathic Medicine, Canada; Zhang SH from Shanghai University of traditional Chinese Medicine, China; Park JM from Kyung Hee Univ, South Korea; Sze FKH from Shatin Hospital, Hong Kong; Feigin VL from University of Washington, USA. These academics have high influential in the field of stroke acupuncture treatment research. As shown in [Figure 5](#), cited authors published over 30 articles were selected for visualization with 560 nodes and 877 links.

### Analysis of Journals

Acupuncture for stroke-related papers have been published in 306 journals. [Table 5](#) displays that the top 10 productive journals published 438 papers, representing 38.4% of all publications. Complementary and alternative medicine, acupuncture, neurology and general medicine were the primary journal categories. The top 5 journals with the highest number of publications were: Evidence-based Complementary and Alternative Medicine (89), Medicine (80), Neural Regeneration Research (48), Acupuncture in Medicine (46) and Frontiers in Neurology (40). The Stroke was the journal with the highest IF of 10.170, while the average IF of these top 10 journals was 3.93. A total of 637 journals were cited,

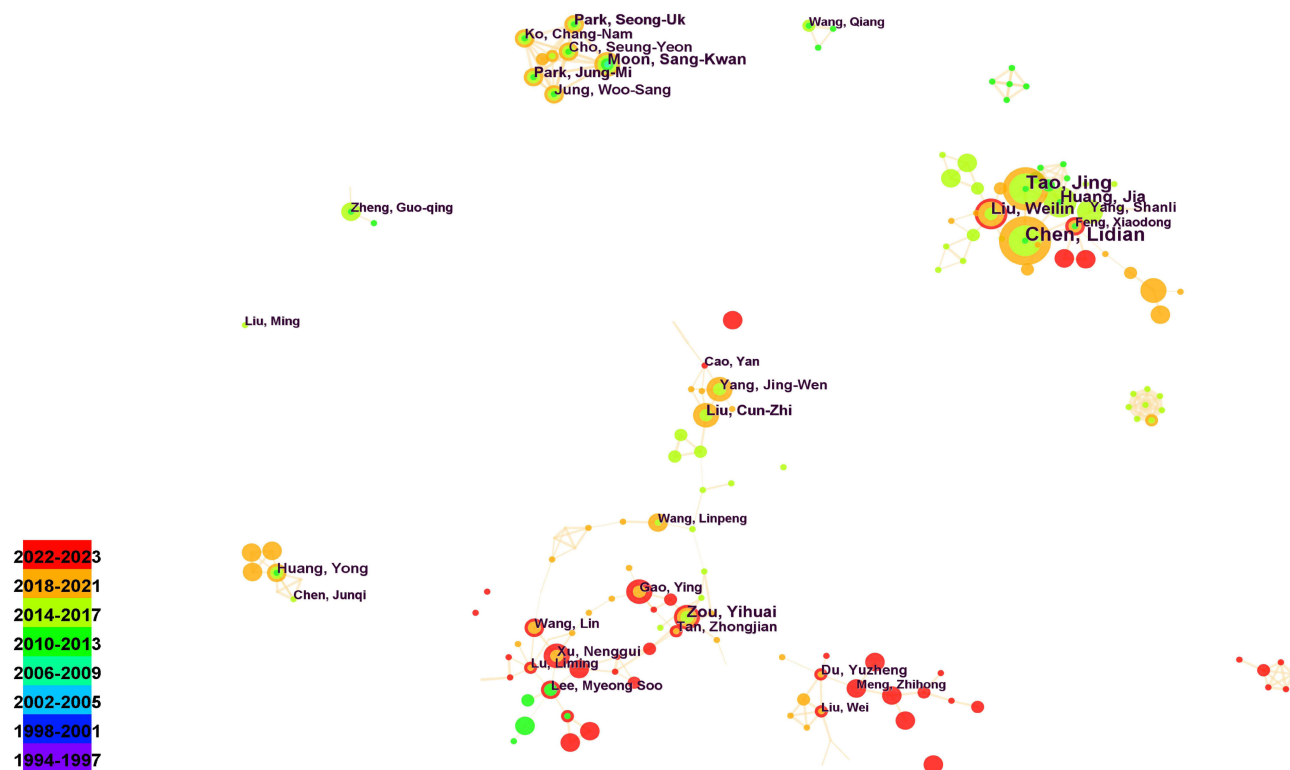


Figure 4 Collaboration network of authors on acupuncture for stroke.

of which 52 journals gaining more than 100 citations were included in the co-citation map (Figure 6), that had uncovered the interdependence and cross-relationship between journals. The top 5 cited journals were: Stroke (744), Evidence-based Complementary and Alternative Medicine (444), Journal of Alternative and Complementary Medicine (374), PLoS One (352), Cochrane Database of Systematic Reviews (344).

### Analysis of Keywords

Researchers are able to identify the areas of frontiers in the field of acupuncture for stroke by conducting a keyword analysis. In this study, 323 keywords were examined in total. Figure 7 shows the co-occurrence of 38 keywords with frequency which was equal or greater than 30, presented as 323 nodes and 1002 linkages. Table 6 demonstrates that the

Table 4 Top 10 Cited Authors Performed Research on Acupuncture for Stroke

Cited Author	Country	Year	Count	Centrality
Wu P	Canada	2010	124	0.04
Zhang SH	China	2006	123	0.06
Park JM	South Korea	2002	110	0.03
Sze FKH	Hong Kong	2002	102	0.03
Feigin VL	USA	2007	93	0.02
Longa EZ	USA	2004	86	0.05
Wang Y	China	2007	80	0.07
Macpherson H	USA	2006	75	0.05
Chavez LM	China	2018	67	0.01
Ramsay DJ	Canada	2001	65	0.15

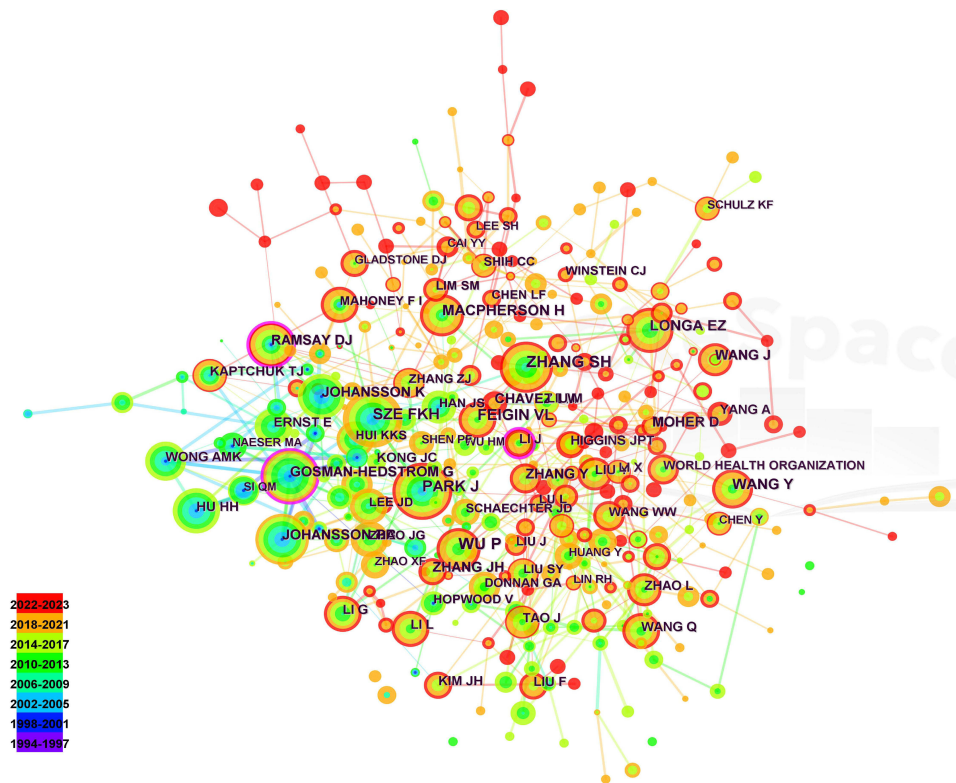


Figure 5 Collaboration network of cited authors on acupuncture for stroke.

top 10 high-frequency keywords on this theme included acupuncture, stoke, stimulation, recovery, ischemic stroke, electroacupuncture, and rehabilitation.

There were 10 clusters for high-frequency keywords formed and visualized in Figures 8 and 9. The name of clusters is refined from the nominal terms retrieved from the articles' keywordlist, with a logarithmic likelihood ratio (LLR)

Table 5 Top 10 Journals Performed Research on Acupuncture for Stroke

Rank	Journal	Count	IF (2022) <sup>a</sup>	Cited Journal	Count	IF (2022)
1	Evidence-based Complementary and Alternative Medicine	89	2.65	Stroke	744	10.170
2	Medicine	80	1.817	Evidence-based Complementary and Alternative Medicine	444	2.65
3	Neural Regeneration Research	48	6.058	Journal of Alternative and Complementary Medicine	374	2.381
4	Acupuncture in Medicine	46	2.129	PLoS One	352	3.7
5	Frontiers in Neurology	40	4.003	Cochrane Database of Systematic Reviews	344	12.008
6	Trials	32	2.728	Lancet	339	202.731
7	Journal of Alternative and Complementary Medicine	29	2.381	Acupuncture in Medicine	320	2.129
8	Stroke	29	10.170	Journal of Traditional Chinese Medicine	301	2.547
9	Journal of Traditional Chinese Medicine	26	2.547	Neuroscience Letters	281	3.197
10	BMC Complementary And Alternative Medicine	19	4.782	Neurology	272	9.9

Note: IF(2022)<sup>a</sup> in category according to the Journal Citation Reports 2022.  
Abbreviation: IF, Impact factor.

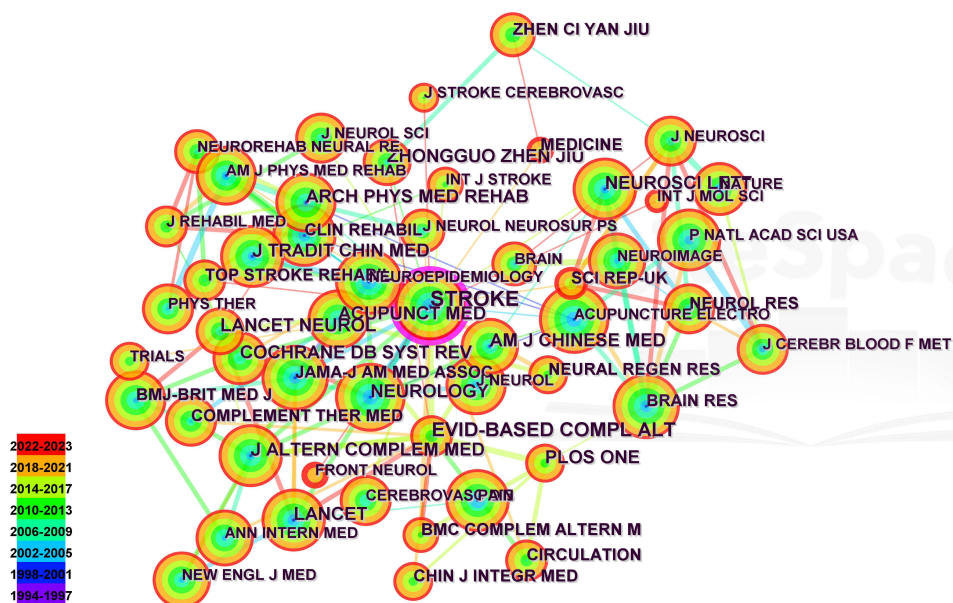


Figure 6 Collaboration network of cited journals on acupuncture for stroke.

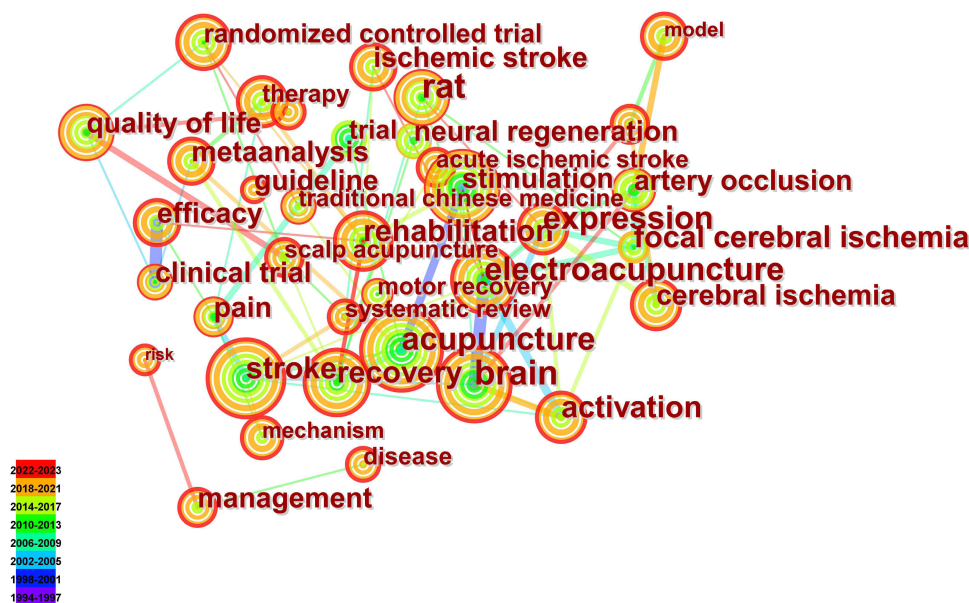


Figure 7 Collaboration network of keywords on acupuncture for stroke.

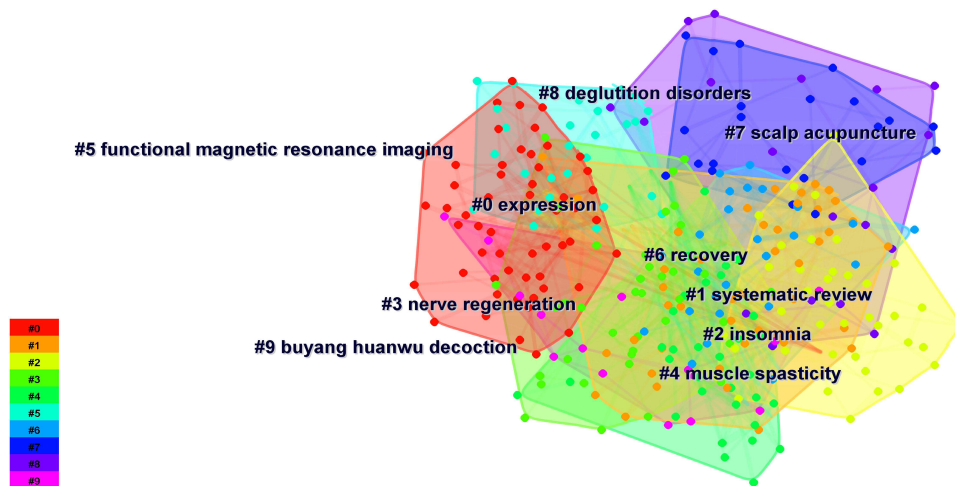
algorithm applied. Generally, clusters with Modularity  $Q > 0.3$  are considered as significant and clusters with Silhouette  $> 0.5$  are regarded as reasonable.<sup>19</sup> This study’s results were deemed convincing with S value of 0.7631 and Q value of 0.616. According to the cluster information for each, the current research focused on the following 4 directions in this study: 1) research on mechanism of acupuncture for stroke (#0 expression, #3 nerve regeneration); 2) systematic review (#1 systematic review); 3) verification of efficacy and safety on improvement of acupuncture for stroke patients’ functional rehabilitation (#2 insomnia, #4 muscle spasticity, #5 functional magnetic resonance imaging, #6 recovery, #7 scalp acupuncture, #8 deglutition disorders); 4) evaluation of clinical effect of Chinese medicine on stroke (#9 buyang huanwu decoction).



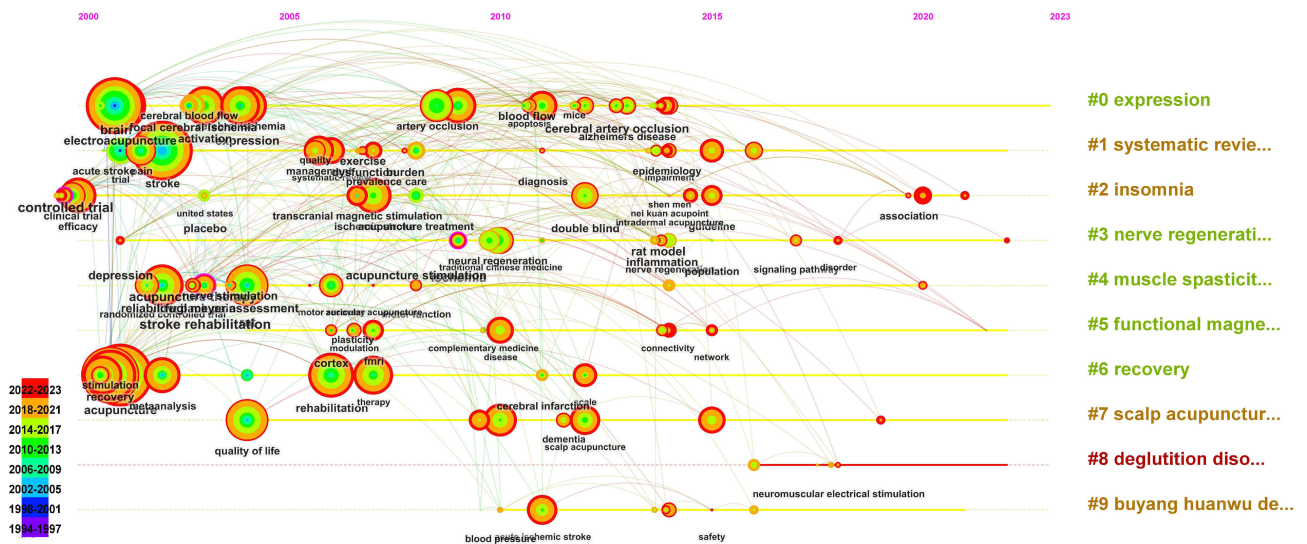
**Table 6** Top 10 Keywords in Term of Publications

Rank	Keywords	Count	Centrality
1	stroke	286	0.05
2	acupuncture	235	0.06
3	stimulation	125	0.03
4	recovery	125	0.05
5	ischemic stroke	119	0.02
6	electroacupuncture	108	0.06
7	rehabilitation	102	0.03
8	randomized controlled trial	96	0.01
9	systematic review	90	0.01
10	brain	83	0.08

“Burst keywords” are those that have been cited frequently over a period of time, suggesting potential research hotspots or future trends.<sup>18</sup> Figure 10 shows 20 burst keywords arranged by the “begin year”. The keyword “trial” was the earliest burst keyword, with the highest strength (11.04), and “focal cerebral ischemia” had the longest duration. There



**Figure 8** Clusters map of keywords on acupuncture for stroke.



**Figure 9** Collaboration network of timeline.

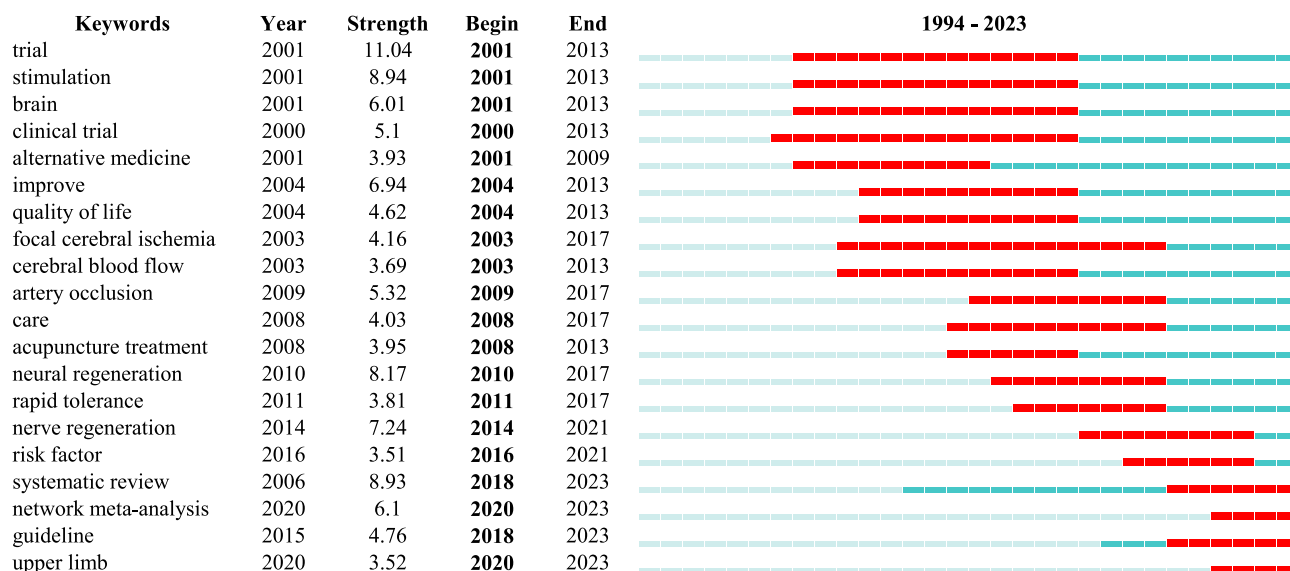


Figure 10 Top 20 keywords with the strongest citation bursts.

were 5 burst keywords (ie, focal cerebral ischemia, cerebral blood flow, artery occlusion, neural regeneration, rapid tolerance) described the mechanism of acupuncture treatment in stroke comprehensively. The current burst keywords (ie, alternative medicine, quality of life, care, risk factors) indicated that researchers were currently focusing more on how to integrate the traditional Chinese medicine with Western medicine for the improvement on prognosis and quality of life of ischemic stroke patients.

### Analysis of Cited Reference

Among the 1141 articles, 557 references were extracted and have been cited 4262 times in total. Table 7 demonstrates that the top 10 articles on acupuncture for stroke with the most citations could be considered as the most popular and extensive academic impact article in this field. According to the global citations, there were 6 systematic review articles on acupuncture for stroke treatment, 3 clinical studies were conducted to improve cognitive ability, quality of life and

Table 7 Top 10 Cited References Related to Acupuncture for Stroke

Rank	Cited Reference	Authors	Journal	Total Citations	Year
1	Acupuncture in poststroke rehabilitation: a systematic review and meta-analysis of randomized trials <sup>20</sup>	Wu P, Mills E, Moher D, et al	Stroke	78	2010
2	Mechanisms of Acupuncture Therapy in Ischemic Stroke Rehabilitation: A Literature Review of Basic Studies <sup>1</sup>	Chavez LM, Huang SS, MacDonald I, et al	Int J Mol Sci	67	2017
3	Acupuncture for stroke rehabilitation <sup>21</sup>	Yang A, Wu HM, Tang JL, et al	Int J Mol Sci	51	2016
4	Acupuncture efficacy on ischemic stroke recovery: multicenter randomized controlled trial in China <sup>22</sup>	Zhang SH, Wu B, Liu M, et al	Stroke	50	2015
5	Acupuncture for functional recovery after stroke: a systematic review of sham-controlled randomized clinical trials <sup>23</sup>	Kong JC, Lee SM, Shin CB, et al	Can Med Assoc J	45	2010
6	Overview of Systematic Reviews and Meta-Analyses of Acupuncture for Stroke <sup>24</sup>	Zhang JH, Wang D, Liu M	Neuroepidemiology	37	2014

(Continued)

**Table 7** (Continued).

Rank	Cited Reference	Authors	Journal	Total Citations	Year
7	Efficacy of Scalp Acupuncture with the Long-Stay Method on Motor Dysfunction in Patients with Acute Ischemic Stroke: A Randomized Controlled Trial <sup>25</sup>	Wang H, Guo J, Zhang YJ, et al	Neuropsychiatr Dis Treat	34	2023
8	Guidelines for Adult Stroke Rehabilitation and Recovery: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association <sup>26</sup>	Winstein JC, Stein J, Arena R, et al	Stroke	32	2016
9	Acupuncture and transcutaneous nerve stimulation in stroke rehabilitation: a randomized, controlled trial <sup>27</sup>	Johansson BB, Haker E, Arbin M, et al	Stroke	30	2001
10	Acupuncture for neurogenesis in experimental ischemic stroke: a systematic review and meta-analysis <sup>28</sup>	Lu L, Zhang X, Zhong LD, et al	Sci Rep	30	2016

partial functions of stroke patients, and 1 article was an American Heart Association handbook for adult stroke rehabilitation and recovery.

## Discussion

In this study, we used bibliometric methods to study the research themes, hotspots and new frontier of the application of acupuncture treatment for stroke. According to the findings, 1141 articles were obtained from the WoSCC, from inception to 30 July 2023. The article related to acupuncture for stroke was published in 1994 for the first time, which has demonstrated that how patients with severe left or right side hemiparesis could improve their recovery from postural function with acupuncture therapy.<sup>29</sup> But few studies were published in subsequent years, and the number of publications has begun to rapidly grow trend from 2012 to 2022. Considering the acupuncture was widely used and recognized in the world, articles in the field of acupuncture were more and more published in international journals in recent years. From the perspective of counties, the global scientific cooperation has been formed and was relatively close, especially for China, and USA has the most and thick links with other countries.

Authors and institutions are the primary aspects of the research cooperative collaboration. The leading academic universities or scientific research institutions for Chinese medicine and western medicine in China and South Korea were located in Beijing, Guangzhou, Tianjin and Seoul respectively. Despite having the highest number of publications in this field, there was a lack of close cooperation among these institutions. For Chinese and South Korea institutions, the cooperative relationship between them was mostly limited in Guangzhou Univ Chinese Med, Tianjin Univ Tradit Chinese Med, China Med Univ and Kyung Hee Univ. The acupuncture education was one of famous major in academy of Korean Medicine in Kyung Hee University. The research team led by Sabina Lim initially revealed the remarkable effect and underlying mechanism of acupuncture in the treatment of encephalitis, which was common in Parkinson's disease in 2007. These findings were published in Brain Research.<sup>30</sup> Later, scholar Lim continued to further study the acupuncture for stroke, cerebral palsy and rheumatoid arthritis, etc., and some corresponding research results were produced. Regarding the author collaboration network, there presented approximately eight cooperation teams with some degree of collaboration between them, especially from the same institutions. However, the geographical location of institutions and variety of disciplinary directions may be contributed to the loose relationship among the cooperative teams. The top 10 cited authors with 925 co-citations have significantly advanced in the field of acupuncture for stroke. As with the high number of publications, Park JM was one of the highest co-citation authors. His primary focus was on assessing the evaluation of effectiveness and mechanism of acupuncture in treating stroke patients. According to his research, acupuncture treatment can reduce cerebral vasospasm after subarachnoid hemorrhage (SAH) by adjusting the levels of plasma nitric oxide (NO) and endothelin-1 levels.<sup>31</sup>

The majority of journals that published papers on acupuncture for stroke were those related to complementary alternative medicine and neurology. Specialized journals made up the majority of active journals in the field of acupuncture. Of the 10 most published journals, the Stroke got the greatest IF 10.170, while others had IF between 1.817 and 6.058. Even though there were difficulties in publishing high IF papers in this area, we believed that in the process of acupuncture papers being gradually recognized globally, rigorously designed trials and high-quality papers on acupuncture for stroke were growing.

Research hotspots were the research topics that were deeply concerned and discussed by researchers, and keywords can summarize and generalize the topic and content of the literature, which was the core and essence of the paper. Among the top 10 cited papers listed in Tables 7 and 6 papers concentrated on assessing the rehabilitation and functional recovery of stroke patients after acupuncture treatment, such as cognitive ability, quality of life and motor functions were mentioned emphatically. As shown in Table 6, the most appeared keywords “stimulation”, “recovery”, “rehabilitation”, and “brain” were considered to be the representatives of hotspots in current research. “Stimulation”, “neural regeneration”, “improve”, and “artery occlusion” displayed in Figure 10, had strong citation bursts and relatively long duration, were the main research frontiers and indicated that the basic research results of acupuncture have been remarkable. Through analyzing these results, the future research on acupuncture therapeutics for stroke mainly will focus on the following three aspects: 1) in-depth study of the mechanism on acupuncture for stroke treatment, 2) conducting the high-level evidence from clinical trials to verify the efficacy of acupuncture, 3) formulation of clinical protocols and guidelines to integrate acupuncture and other potential therapeutics on stroke treatment.

According to the type of researches included, basic research occupied an absolute position. Researches have been done on a variety of topics on the mechanism underlying acupuncture treatment for stroke, such as inhibiting inflammatory injury, improving brain circulation and vascular regeneration, promoting nerve repair, blocking apoptosis and autophagy, and alleviating oxidative stress. It also demonstrated the features of acupuncture multi-target intervention in addition to demonstrating the efficacy of acupuncture treatment. In mechanistic studies, electroacupuncture can inhibit the excessive deposition of  $\beta$ -amyloid protein and alleviate cell damage caused by excessive deposition while promoting nerve regeneration.<sup>32</sup> Acupuncture treatment can suppress the ischemia-induced increment in the number of Fos-, TUNEL-, and caspase-3-positive cells, and these results suggested that acupuncture treatment alleviated ischemia-induced apoptosis and may aid in the recovery following ischemic cerebral injury.<sup>33</sup>

Clinical randomized controlled trials (RCTs) were the most researched methods of acupuncture and have long been considered the gold standard in strongest level of evidence. RCTs have emerged as the favored study design for acupuncture research in order to confirm its clinical effectiveness. In addition, researchers have designed a number of experimental animal models to simulate clinical stroke in many studies. These models could be helpful in our understanding of the pathogenesis of stroke and enable us to investigate preventive or therapeutic strategies, such as mouse, rat, rabbit, cat, pig and primate were the commonly used species.<sup>34</sup> In these clinical trials, electroacupuncture stimulation, fire acupuncture, and scalp acupuncture were widely used in rehabilitation treatment after stroke, and electroacupuncture has become the high-frequency keyword. Electroacupuncture was used to stimulate acupuncture points by connecting the pulse current of milliacupoints to enhance acupuncture sensation. The current intensity can be adjusted, and the stimulation method has a variety of optional parameters. Studies have shown that electroacupuncture can improve neurological deficits and reduced infarct volume<sup>35</sup> and regulate the activation of microglia and microglia-mediated inflammation.<sup>36</sup>

With the rapid development of evidence-based medicine, systematic review or meta-analysis has been widely concerned in this field. A systematic review showed that acupuncture for post-stroke patients could significantly decrease scores on the Hamilton Depression Rating scale.<sup>37</sup> Recent evidence published in 2021 suggested that optimal acupuncture intervention time-point for stroke was within 48 hours post-stroke, and it was better in improving Fugl-Meyer assessment (FMA) score and Barthel Index (BI).<sup>38</sup> Researchers found that acupuncture increased cerebral blood flow in the sensorimotor area and activated the somatosensory cortex in patients with stroke, providing evidence for the therapeutic effect of traditional medicine in stroke rehabilitation.<sup>39</sup>

Due to the multifactorial causes and varied conditions of stroke, the disease mechanism of acupuncture treatment for stroke sequelae was also complicated and difficult to confirm clearly. Researchers should investigate the internal relationships between distinct treatment mechanisms and enhance the theory within the mechanism framework since diverse injury

mechanisms in the pathogenesis of stroke frequently influenced each other rather than acting independently. Future studies should pay more attention to conducting large sample, multi-center, randomized controlled studies to verify the safety and efficacy of acupuncture, as well as clinical trial registration, results disclosure and data sharing, so as to promote the application of acupuncture in the treatment of stroke. In addition, it is also necessary to strengthen the training and education of TCM acupuncturists and improve the technical level of operators to ensure the stability and reliability of acupuncture treatment effects.

## Strengths and Limitations

In this study, the bibliometrics method was used for the first time to conduct a visual analysis of the literature relevant to acupuncture for stroke, based on 1141 scientific researches extracted from WoSCC. From the scientific visualization, we could analyze and summarize the research status and major areas of research on acupuncture for stroke and predict the research trend. Nonetheless, it is important to acknowledge the shortcomings of this study, and main performance in retrieval may not be comprehensive enough. We only analyzed the WoSCC, and other databases were not included. Besides, this study only retrieved English databases, which may have missed some studies in other language. Secondly, even though a complex search string was used to retrieve the input data, it is possible that some relevant publications with vague names were overlooked or that duplicate or irrelevant titles were included.<sup>40</sup> Despite these limitations, we believe that this study can still provide some insights into overall situation and emerging patterns in the area of acupuncture therapy for stroke on a global scale.

## Conclusion

This study has conducted bibliometric analysis to perform on the research of acupuncture for stroke. The current research hotspots mainly involved systematic review in this field, clinical research on cognitive ability, quality of life and partial function of stroke patients, and basic research related to mechanisms. Future research trends will concentrate on higher quality clinical evidence, and more strictly, RCTs trials should be conducted, and the process of execution should be standardized to verify the safety and efficacy of acupuncture therapy for stroke. It may help researchers understand the scope of these fields' study and guide for clinical practice.

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## Disclosure

The authors report no conflicts of interest in this work.

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