

Acupuncture in the treatment of stroke: A bibliometric analysis based on Citespace

*¹Yajing Zhang, *²Yu Shen, ¹Xixi Dang, ¹Xiaomeng Chen, ²Yirong Yang, ²Ying Xiong, ²Daojun Hong

*YJ Zhang and Y Shen contributed equally to this work and are co-first author

¹Department of Neurology, People's Hospital of Tiantai County, Taizhou, Zhejiang; ²Department of Neurology, The First Affiliated Hospital of Nanchang University, Nanchang, Jiangxi, China

Abstract

Background & Objectives: Stroke is an acute cerebrovascular disease with high morbidity, high mortality and high disability rate. Acupuncture has been widely used in the treatment of stroke. However, bibliometrics on acupuncture for stroke are still lacking. This study aims to analyze the global research trend of acupuncture treatment for stroke in the past 20 years. **Methods:** A systematic search was conducted in Web of Science about acupuncture in the treatment of stroke. The databases were searched from inception to August 2022. Citespace is a service that researches the underlying knowledge in the scientific literature. We used it to analyze the relationship between publication year and country, institution, journal, author, bibliography, and keywords about acupuncture for stroke. **Results:** A total of 897 articles were included for analysis. Over the past 20 years, the results showed a steady increase in the number of articles about acupuncture treatment for stroke. The country with the largest number of publications is the People's Republic of China (670), and the institution with the largest number of publications is Beijing University of Traditional Chinese Medicine (66). Keyword analysis showed that acupuncture in the treatment of post-stroke conscious cognitive impairment is the research development trend and focus on this field.

Conclusion: This study provides a visual analysis method for the trends and frontiers of acupuncture treatment for stroke. Acupuncture is the research development trend for the treatment of post-stroke conscious cognitive impairment. Although most studies conclude that acupuncture has a positive effect on stroke, a large sample, randomized controlled trials are still needed to analyze the efficacy and physiological mechanisms of acupuncture in the treatment of stroke.

Keywords: Acupuncture; stroke; bibliometric analysis; Citespace; treatment

INTRODUCTION

Stroke is divided into ischemic and hemorrhagic; as an acute cerebrovascular disease, it is the main cause of death and disability in adults.¹⁻³ Study showed that there were 137 million more strokes worldwide in 2016. A statistical analysis of stroke patients in 2019 showed that there were 3.94 million new stroke cases in China.⁴⁻⁸ Stroke patients have clinical features such as unfavorable unilateral limb movement, dysphagia, unfavorable speech, cognitive impairment. Severe stroke often leaves sequelae, which brings great challenges to the patients' daily life, and also burden to the family and society.⁸

Acupuncture originated in China and is a

complementary and alternative therapy widely used in the treatment for various diseases.⁹⁻¹⁴ It has the advantages of safety, convenience and low cost. Acupuncture has been used for the treatment of stroke or post-stroke as early as thousands of years ago. Modern clinical studies have also shown that acupuncture can improve the symptoms of neurological deficits in patients after stroke, with no obvious adverse reactions.¹⁵⁻¹⁸ Mechanism study shows that acupuncture can achieve its purpose of by promoting nerve regeneration and cell proliferation in the central nervous system and regulating blood flow in the brain.¹⁹⁻²¹

Bibliometric analysis is a statistical analysis and quantitative tool for research publications. It has recently been used in many research fields

Address correspondence to: Ying Xiong, Department of neurology, the first affiliated hospital of Nanchang university, Yong Wai Zheng Street 17th, Nanchang, 330006, China. Email: yingxiong@ccmu.edu.cn; Daojun Hong, Department of neurology, the first affiliated hospital of Nanchang university, Yong Wai Zheng Street 17th, Nanchang, 330006, China. Email: hongdaojun@hotmail.com

Date of Submission: 23 December 2022; Date of Acceptance: 29 March 2023

<https://doi.org/10.54029/2023tie>

to assess countries, institutions, journals, authors, and keyword patterns associated with specific publication types.²²⁻²⁴ For example, Li X *et al.* conducted a global bibliometric analysis to assess the research trends of acupuncture in the treatment of Parkinson's disease.²⁵ Li P *et al.* conducted a study on the research trends and hotspots of acupuncture in the treatment of fibromyalgia. Articles of acupuncture in the treatment of stroke focused on retrospective analysis, literature review and meta-analysis.²⁶ So, there is still a lack of bibliometric analysis of acupuncture in the treatment of stroke to evaluate the current research trends and hotspots.

We performed a bibliometric analysis here to evaluate the current research trends and hotspots about acupuncture in the treatment of stroke. It aimed to clarify the time series changes of research hotspots and dynamic frontiers in this field, and to obtain quantitative data and key references.

METHODS

Data source and search strategy

The Web of Science database was searched from inception to August 2022. The search method was ((TS=(acupuncture)) OR TS=(Pharmacopuncture)) AND (((TS=(stroke*)) OR TS = (Brain Vascular Accident*)) OR TS= (Cerebrovascular Accident*)) OR TS=(Apoplexy)). The data were analyzed between August 2022 and September 2022.

Inclusion and exclusion criteria

Studies related to acupuncture for stroke selected included articles and reviews were read. Publications such as letters, reviews, and conference abstracts were excluded. The publication language was limited to English. A total of 897 publications (663 articles and 234 reviews) were identified for final analysis.

Analysis method

CiteSpace was used to analyze the research literature to illustrate the structure of scientific knowledge. The software uses Java to perform a visual analysis of scientific references. The software utilizes co-occurrence and co-citation analysis of a large number of reference data in a given research field to objectively and quantitatively analyze and predict research frontiers and development trends.^{27,28} CiteSpace 5.8.R3 software was used by us to retrieve studies,

with the "time slice" value set to 1 year.^{29,30} Node types were selected for co-occurrence analysis based on country, keyword and category, and co-citation analysis was performed for references and journals.

Interpretation of visual map recognition applications

Tree Ring History: It represents the citation history of a certain article. The overall size of the rings reflects the number of times the paper is cited, and the color of the citation ring represents the corresponding citation time. The thickness of a ring is proportional to the number of citations in the corresponding time zone.³¹

Nodes and connections: In the collaboration graph of authors, institutions, and countries/regions, the size of the nodes represents the number of papers published by authors, institutions, and countries/regions, and the connections between them represent the strength of the partnership; in the network graph of words and scientific categories, the size of the nodes represents their frequency, and the lines between them represent the co-occurrence strength; in the co-citation analysis, the size of the nodes reflects the number of citations, and the lines represent the co-citations.

Centrality is a key indicator of the importance of keywords. If the node with centrality exceeds 0.1, the node is a central node, which is more important and influential in the study, and is marked by purple circles. Nodes marked with purple circles have greater centrality (0.1), and nodes marked with red circles show greater burst intensity, which indicates a large number of references in a short time.²⁹

RESULTS

Analysis of post volume

A total of 897 articles were extracted by searching the Web of Science. Literature types include articles and reviews. The number of specific articles published each year is shown in Figure 1. Literature on acupuncture treatment for stroke appeared in the database in 2003. Since then, the publication number has increased year by year ($R^2=0.9319$), indicating that the number of published papers is in a linear growth mode. These results suggest that acupuncture is receiving increasing attention as a complementary and alternative treatment for stroke, and more research is ongoing.

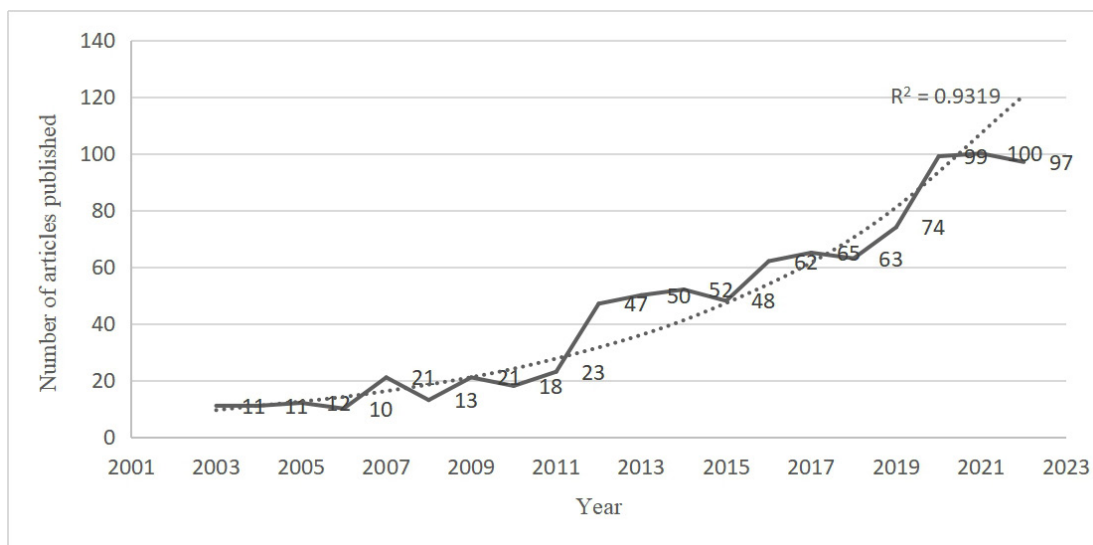


Figure 1. Number of articles published each year

Journal and cited journal analysis

Among the 897 studies published between 2003 and 2022, the journals with the most publications were *Journal of Alternative and Complementary Medicine* with 16, followed by *Acupuncture in Medicine*, *American Journal of Chinese Medicine*, *Evidence-based Complementary and Alternative Medicine*, *Neural Regeneration Research*. (Supplement Figure 1). Among the top 10 most cited journals, *Stroke* is the most cited journal with 616 citations; followed by *Evid-Based Compl Alt* with 361 citations; *J Altern Complem Med* with 327 citations (Table 1).

Burst analysis of cited journals reveals neuroscience journals with research hotspots (Figure 2). A journal co-citation analysis of 2003-2022 references cited by 897 studies published in 2003-2022 found that among the oldest journals *Acupuncture Electro*, *Neurology*, *J Neurol*, *JAMA-J Am Med Assoc*, *Chinese Med J-Peking*, *Neurosci Lett* has a hot spot in 2003, while *Chinese Med J-Peking* has the longest hot spot, that is, from 2003 to 2015. *Int J Mol Sci*, *Front Neurosci-Switz*, *Ann Phys Rehabil Med*, *Integr Med Res* have recent frontier hotspots.

The double image superimposition shows that the most popular citation journals are focused on the field of rehabilitation medicine and neuroscience, the double-graph superposition graph of 897 studies is shown in Supplement Figure 2. On the left side of the graph is the distribution of cited journals, on the right side is the distribution of cited journals. On the left side of the graph, the more papers published in

journals, the longer the longitudinal axis of the ellipse. The greater the number of authors, the longer the horizontal axis.²⁹ The citing journals of 897 studies were mainly from the fields of molecular immunology, neurology, kinesiology, medical science, facial medicine, diagnostics, psychology, and rehabilitation medicine. The cited journals are mainly from health, nursing, medicine, oral health, molecular biology, sports, rehabilitation medicine and other fields. Among them, rehabilitation medicine and molecular biology are the most concentrated in the cited journals (as shown in the center of the right circle), which is the hot spot of current research on acupuncture treatment for stroke.

The 897 included studies were from *Integrative & Complementary Medicine*, *Neurosciences & Neurology*, *General & Internal Medicine*, *Research & Experimental Medicine*, *Social Science Citation Index*, *Clinical Neurology*, *Cell Biology*, *Rehabilitation* and other fields (Supplement Figure 3).

Based on the references of 897 included studies, 19 types of cited references were used to generate a common reference cluster for the landscape displayed in the figure. The first 100 references with the most citations per year were selected to construct a co-citation network. When the annual network was synthesized, it was found that the network contained a total of 416 references and 734 nodes. The cluster studies were divided into 19 groups (# 0-18). Each cluster is labeled according to the title, keywords, and subject words in the citation reference abstracts that reference the cluster citation (Supplement Figure 4).²⁹

Table 1: Top journals with the most publications and the most citations

Rank	Journal	Count	IF	JCR	Rank	Co-cited Journal	Co-citations	IF	JCR
1	JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE	16	2.381	Q3	1	STROKE	616	10.170	Q1
2	ACUPUNCTURE IN MEDICINE	13	2.244	Q3	2	EVID-BASED COMPL ALT	361	2.650	Q3
3	AMERICAN JOURNAL OF CHINESE MEDICINE	13	6.005	Q1	3	J ALTERN COMPLEM MED	327	2.381	Q3
4	EVIDENCE-BASED COMPLEMENTARY AND ALTERNATIVE MEDICINE	13	2.650	Q3	4	ZHONGGUO ZHEN JIU	298	-	-
5	NEURAL REGENERATION RESEARCH	13	12.749	Q1	5	PLOS ONE	290	3.752	Q2
6	JOURNAL OF TRADITIONAL CHINESE MEDICINE	12	2.547	Q3	6	LANCET	290	202.731	Q1
7	COCHRANE DATABASE OF SYSTEMATIC REVIEWS	11	12.008	Q1	7	COCHRANE DB SYST REV	288	12.008	Q1
8	TRIALS	9	2.728	Q4	8	ACUPUNCT MED	261	1.976	Q3
9	BMC COMPLEMENTARY AND ALTERNATIVE MEDICINE	8	4.782	Q2	9	NEUROSCI LETT	244	3.197	Q3
10	COMPLEMENTARY THERAPIES IN MEDICINE	8	3.335	Q2	10	J TRADIT CHIN MED	240	2.547	Q3
11	MEDICINE	8	1.817	Q3	11	AM J CHINESE MED	225	6.005	Q1
12	PLOS ONE	8	3.752	Q2	12	NEUROLOGY	225	11.800	Q1

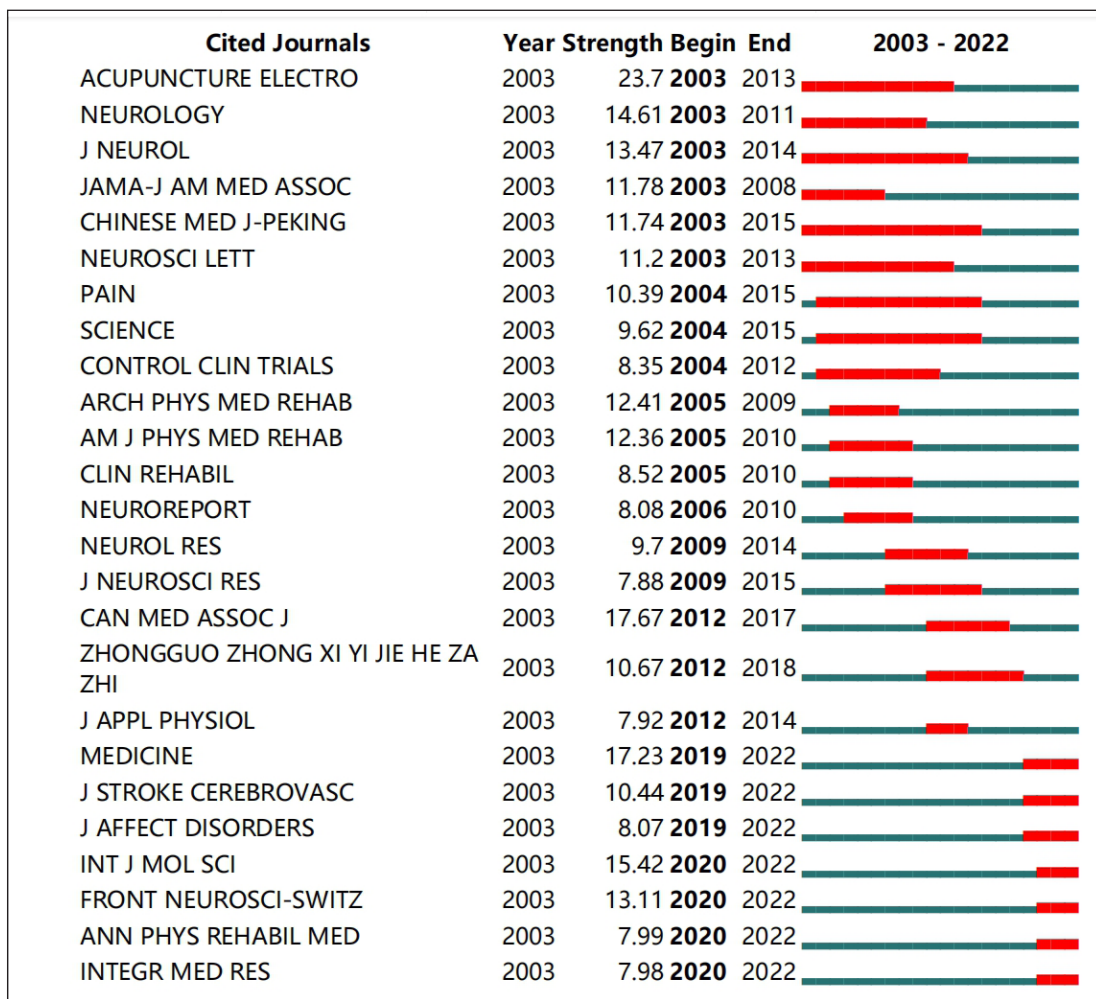


Figure 2. TOP 25 cited journals with the strongest citation

Time plot of the 897 cited references

Supplement Figure 5 shows the characteristics of the time span reference information for the nineteen cluster domains. The areas represented by the #0 electroacupuncture cluster at the top of the figure are given for the period from 1998 to 2020. In addition, between 2009 and 2016 there have been a number of important landmark results. For example: (1) Wang *et al.* found that electroacupuncture could increase the production of endocannabinoid 2-arachidonic acid glycerol and n-arachidonic acid ethanolamine-anandamide in a rat model of cerebral ischemia, thereby inducing a protective effect on transient cerebral ischemia through CB1 receptors (the paper was cited 12 times).³² (2) Wu *et al.* found that acupuncture may be effective for rehabilitation after stroke through systematic review, but large-scale, high-quality randomized controlled trials

are still needed to verify this result (the paper was cited 42 times).³³ (3) Shen *et al.* conducted a clinical randomized controlled trial and found that the recurrence rate of stroke in patients receiving acupuncture was clinically reduced, and acupuncture could also improve the quality of life of patients (the paper was cited 18 times).³⁴ (4) Kim *et al.* found that electroacupuncture could significantly improve neurological function and vestibular motor function in rats with cerebral ischemia (the paper was cited 18 times).³⁵ (5) Zhang *et al.* found through systematic review that acupuncture may be effective in treating neurological injury and dysfunction (such as dysphagia) after stroke, but the existing evidence does not clearly show that acupuncture can help prevent death or disability after stroke or improve motor dysfunction after stroke (the paper was cited 27 times).³⁶ (6) In Liu *et al.*, statistical findings show that acupuncture can improve the

clinical symptoms of convalescent stroke patients (the paper was cited 10 times).³⁷ (7) In Chavez *et al.*, studies have shown that acupuncture exerts beneficial effects on ischemic stroke by regulating different mechanisms originating from the central nervous system (the paper has been cited 45 times).²¹ (8) In Chang *et al.*, the use of appropriate electroacupuncture parameters after ischemic stroke can produce neuroprotective and neuroregenerative effects (the paper was cited 18 times).¹⁸ (9) In Hung *et al.*, acupuncture can improve cognitive function and depression in patients after stroke without significant serious adverse events (the paper was cited 8 times).³⁸

Analysis of 897 representative cited references

Content and perspective analysis: Reference information for the 897 cited references included in the study is summarized in Table 2. In Chavez *et al.*, it was found that acupuncture can help in the rehabilitation of ischemic stroke, reduce the infarct volume after stroke and neurological deficits through five different main mechanisms: (1) Promote the proliferation of resident cells in the central nervous system; (2) Regulation of cerebral blood flow through angiogenesis and vasoactive mediators; (3) Anti-apoptosis through direct intervention of intrinsic and extrinsic pathways or related pathways; (4) Regulation of neurochemicals involved in the ischemic cascade; (5) Enhancement and recovery of hippocampal memory and learning processes. The paper is frequently cited.²¹ Wu *et al.* found that acupuncture can promote the recovery of stroke patients in a systematic review, but the included literature still has shortcomings such as poor research quality and publication bias. Large-scale, transparent and well-conducted randomized clinical trials are still needed to further support this conclusion.³³ Zhang *et al.*, in a systematic review, found that acupuncture is safe and effective in the treatment of patients with subacute stroke. There was no significant reduction in stroke mortality, but neurological deficits improved more in the acupuncture group as a whole.³⁹ Kong *et al.* found that acupuncture does not show its advantages in the acute, subacute and sequelae stages after stroke.⁴⁰ Zhang *et al.* in a systematic review, found that acupuncture may be effective in the treatment of neurological injury and dysfunction after stroke (such as dysphagia), but the existing evidence does not clearly show that acupuncture can help prevent death after stroke or motor dysfunction after stroke.³⁶ Therefore, investigators should

focus on the potential use of acupuncture in the treatment of nerve damage and dysfunction after stroke and develop more precise tools to assess the degree of improvement in stroke symptoms after treatment.

Key words analysis

The keyword co-occurrence graph consists of 230 nodes and 343 lines (Supplement Figure 6). The five most commonly used keywords are “stroke”, “acupuncture”, “stimulation”, “recovery” and “electroacupuncture”. The top five key words of centrality are electroacupuncture, activation, RAT, and functional recovery. We plot the top 30 keywords from 2011 to 2020 (Figure 3). “Emergent words” are keywords that are often used within a certain period of time. As shown, the keywords associated with citation outbreaks first appeared in 2007. The first five breaking keywords are “trial”, “guideline”, “quality of life”, “management”, “clinical trial” and “improve”.

Three stages of keyword mutation

Figure 3 shows the beginning and end years of the popular keywords. The analysis of the year the keyword started suggests to two important points: (1) In the first stage, brain (2003-2011) is the first popular keyword, which mainly describes the influence of acupuncture on brain in stroke patients. (2) In the second stage, quality of life (2005-2012), acupuncture treatment (2008-2012), focal cerebral ischemia (2009-2015), arterial occlusion (2009-2014), functional magnetic resonance imaging (2014-2015) were the hot keywords. These papers mainly describe the effects of acupuncture on the quality of life of stroke patients and the effects of acupuncture on the brain magnetic resonance imaging manifestations of stroke patients. (3) In the third stage, cerebral ischemia (2016-2022) and cognitive impairment (2019-2022) are the hot words, which reflect that acupuncture treatment can improve the cognitive impairment of patients after stroke.

Centrality is the key criterion for measuring the presence of a node in a graph in a network. Through the calculation of the research keywords central (>0.1), 20 high heart keywords (Table 3) represent the current acupuncture treatment of stroke research field of high attention, influential hot issues mainly focus on the clinical effect of electroacupuncture treatment in patients with ischemic stroke, the main research method for randomized controlled experiment and systematic evaluation and the experimental mechanism of

Table 2: Five representative studies on acupuncture for stroke in the citations of the included 897 studies

Study	Citation counts	Design or type of articles	Sample size	Intervention	Outcomes	Highlights
Chavez LM	45	Review	40 studies	review	-	acupuncture has shown beneficial effects on ischemic stroke rehabilitation in animal studies through five different main mechanisms.
Wu P	42	Meta-analysis	56 studies (5,650 patients)	-	physical assessment, disability and motor assessments, and any other validated scales for stroke assessment	acupuncture can promote the recovery of stroke patients, but the included literature still has shortcomings such as poor research quality and publication bias. Large-scale, transparent and well-conducted randomized clinical trials are still needed.
Zhang SH	31	Randomized Controlled Trial	862 patients	862 patients received AM plus standard therapy or standard therapy alone.	(1) death/disability according to Barthel index and (2) death/institutional care at 6 months.	acupuncture seemed to be safe in the subacute phase of ischemic stroke. If the potential benefits observed are confirmed in future larger study, the health gain from wider use of the treatment could be substantial.
Kong JC	30	Meta-analysis	10 studies (711 patients)	-	activities of daily living, motor recovery and quality of life	acupuncture was not shown to have a positive effect on functional recovery after stroke.
Zhang JH	27	Meta-analysis	24 studies (30,790 patients)	-	death or dependency/disability at the end of treatment/follow-up	Current evidence suggests that acupuncture is ineffective for death or dependence/disability. However, acupuncture can improve dysphagia after stroke.

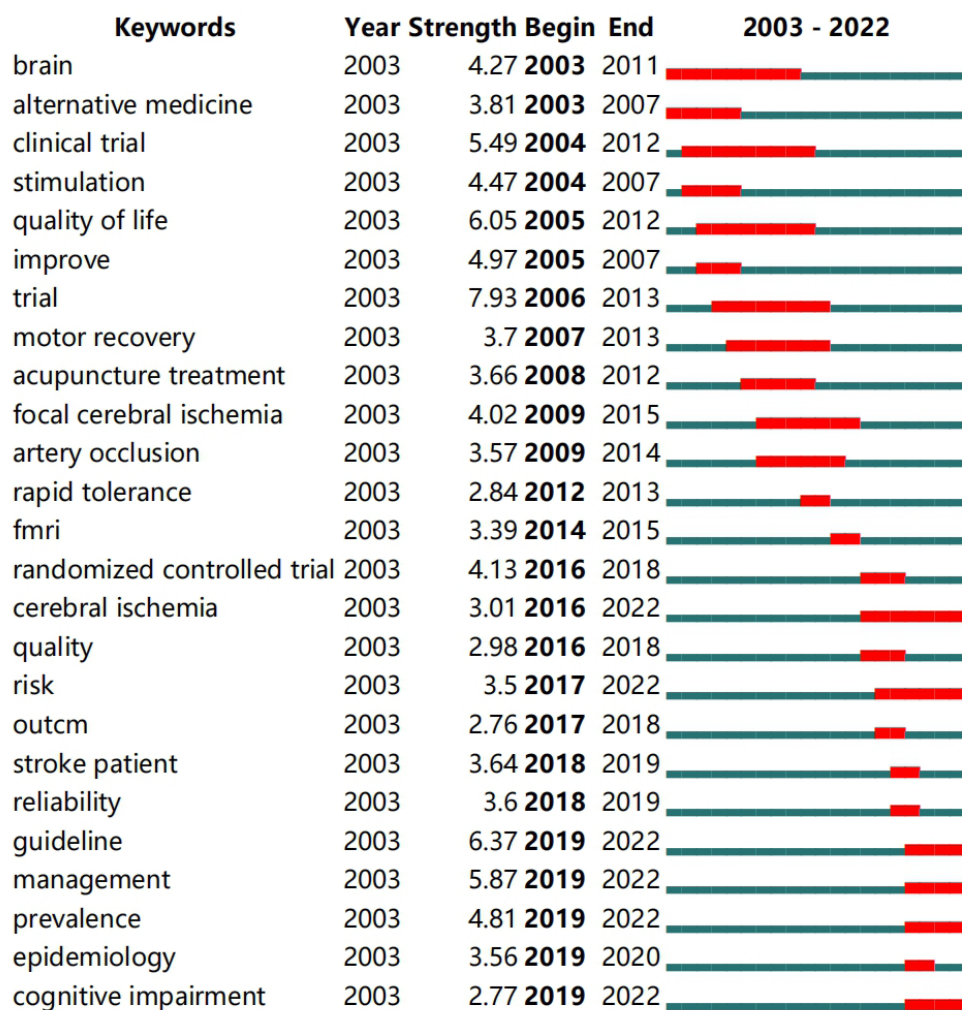


Figure 3. The top 25 most-cited keywords

acupuncture treatment for stroke.

Keywords cluster analysis

In order to further obtain the knowledge network structure of the research on acupuncture treatment for stroke and the combination categories of different keywords, this study selected LLR clustering method to cluster the included keyword maps and form 8 different categories (Supplement Figure 7, Table 4). Modularity Q value is 0.7243 (>0.3 indicates that the community structure of clustering is significant, and the average contour value S is 0.8982 (>0.7) indicates that the clustering results are convincing. Each color block represents a cluster, and the nodes in the color block belong to the cluster range. In the evaluation index of keyword clustering visualization atlas, $Q > 0.3$, it can be considered that the clustering structure of the network is significant. The Q value

of the key cluster visualization atlas in this study was 0.7243. The keyword cluster analysis formed 9 cluster results. Clustering labels represent the distribution of main research contents in this field.

Analysis of authoritative authors, institutions and countries

The author analysis

By analyzing the authors, we can understand the research trend, main researchers and team cooperation and other relevant data in this field. Through the analysis of 897 literatures, 287 nodes and 335 lines were obtained, and the network connection density was 0.0082 (Supplement Figure 8). The author co-occurrence chart shows the most prolific authors and co-authors and their connections. The connection between nodes in the figure can illustrate the joint publication between

Table 3: The centrality of the key words

Rank	Centrality	Frequency	Keywords
1	0.34	242	electroacupuncture
2	0.34	201	activation
3	0.24	111	acupuncture
4	0.23	109	rat
5	0.22	90	functional recovery
6	0.20	86	rehabilitation
7	0.20	68	meta-analysis
8	0.19	60	controlled trial
9	0.18	57	focal cerebral ischemia
10	0.18	56	alternative medicine
11	0.17	52	clinical trial
12	0.15	51	ischemia
13	0.15	51	acupuncture treatment
14	0.15	39	outcome
15	0.15	33	burden
16	0.14	32	stroke
17	0.14	32	ischemic stroke
18	0.14	30	double blind
19	0.13	29	acupuncture stimulation
20	0.12	28	Alzheimer's disease

Table 4: Keywords clustering table

Clustering number	S	Clustering tags
#0	0.945	therapy (14.68, 0.001); improve (13.73, 0.001); meta-analysis (12.73, 0.001); stimulation (10.71, 0.005); meridian (6.86, 0.01)
#1	0.917	acupuncture therapy (16.91, 1.0E-4); range of motion (12.07, 0.001); bias (12.07, 0.001); care (12.07, 0.001); muscle spasticity (6.73, 0.01)
#2	0.914	rehabilitation (13.04, 0.001); eeg (9.79, 0.005); ischemic stroke (6.7, 0.01); cerebral infarction (6.37, 0.05); Alzheimer's disease (6.37, 0.05)
#3	0.881	expression (17.15, 1.0E-4); double blind (12.67, 0.001); lipid peroxidation (10.61, 0.005); ischemic stroke (10.21, 0.005); rehabilitation (7.72, 0.01)
#4	0.902	deglutition disorders (11.74, 0.001); deglutition (8.04, 0.005); activities of daily living (8.04, 0.005); speech therapy (5.86, 0.05); music (5.86, 0.05)
#5	0.914	system (9.04, 0.005); caspase-3 (9.04, 0.005); baihui (du20) (9.04, 0.005); rat (7.47, 0.01); intrastriatal hemorrhage (5.44, 0.05)
#6	0.873	rapid tolerance (11.5, 0.001); focal cerebral ischemia (11.18, 0.001); neuronal specificity (10.55, 0.005); neurorestorative (5.27, 0.05); reactive astrocytes (5.27, 0.05)
#7	0.888	brain (16.91, 1.0E-4); injury (11.05, 0.001); cerebral artery occlusion (9.41, 0.005); positron emission tomography (9.33, 0.005); middle cerebral artery occlusion (9.33, 0.005)
#8	0.943	akt (11.99, 0.001); model (10.31, 0.005); vascular dementia (9.99, 0.005); hippocampus (9.99, 0.005); spectral analysis (5.99, 0.05)

authors. Among them, Li-Dian Chen is the most prolific author with 29 publications. According to Price's law, the number of papers published by the least productive author among core authors is equal to 0.749 times of the number of papers published by the most prolific author, and the specific formula is as follows:

$$M \approx 0.749 \sqrt{n_{\max}}$$

Among the core authors, M is the number of papers published by the least productive authors, and n_{\max} is the number of papers published by the most productive authors. From 2003 to 2022, the number of core authors in the field of acupuncture treatment for stroke was at least 4, with a total of 45 core authors (Table 5), accounting for 15.68% of the total number of authors, and 328 articles were published, accounting for 44.7% of the total number of papers. The number of core authors did not reach 50% of the total number of published papers, so the core author team has not yet been formed.

Cited author of the 897 cited references

Among all cited authors, the most cited author was Wu P (112 times), followed by Zhang SH (105 times) and Park J (90 times). All three authors are leading experts in their fields (Supplement Table 1).

Country and institutional analysis

A national distribution map was generated. A total of 48 countries were involved in acupuncture treatment for stroke (Supplement Figure 9), among which the total number of articles published by Peoples Republic of China (670) accounted for more than half of the total number of articles published. The United States (114), South Korea (88), England (33) and Australia (20) all published more than 20 articles, indicating that they all made significant contributions to the research results.

A total of 274 nodes and 517 lines were generated in the distribution map of institutions, and a total of 274 institutions participated in the related research of acupuncture treatment

Table 5: Core author rank table

Rank	Author	Count	Rank	Author	Count
1	LIDIAN CHEN	29	24	LIMING LU	5
2	JING TAO	24	25	JIANQIAO FANG	5
3	JAUNGGENG LIN	17	26	LIFANG CHEN	5
4	CUNZHI LIU	16	27	SEUNGYEON CHO	5
5	JIA HUANG	13	28	ZHIHONG MENG	5
6	SHANLI YANG	12	29	WOOSANG JUNG	5
7	NENGGUI XU	10	30	TALIANG CHEN	4
8	JINGWEN YANG	9	31	SANGKWAN MOON	4
9	GUOQING ZHENG	9	32	LUWEN ZHU	4
10	SEONGUK PARK	8	33	CHUNCHIEH YEH	4
11	CHANGNAM KO	8	34	YONG HUANG	4
12	YUZHENG DU	8	35	HSINLONG LANE	4
13	CHUNCHUAN SHIH	8	36	FENG ZHANG	4
14	JUNGMI PARK	8	37	SEUNGWON KWON	4
15	GUANGXIA SHI	7	38	QIANG WANG	4
16	HONG ZHANG	7	39	JAEYOUNG HAN	4
17	WEILIN LIU	7	40	KIHO CHO	4
18	BYUNGCHEUL SHIN	6	41	HAIBO YU	4
19	CHIENCHANG LIAO	6	42	QIANG TANG	4
20	CHUNZHI TANG	6	43	SUNG MIN LIM	4
21	LINPENG WANG	6	44	LIN WANG	4
22	BOXUAN LI	5	45	CHAO ZHANG	4
23	HUNKUK PARK	5			

for stroke (Supplement Figure 10). The top five institutions are Beijing University of Chinese Medicine, Guangzhou University of Chinese Medicine, China Medical University, Tianjin University of Traditional Chinese Medicine and Fujian University of Traditional Chinese Medicine (Supplement Table 2). The top 10 institutions in terms of centrality are Guangzhou University of Chinese Medicine, Hong Kong Baptist University, China Medical University, Tianjin University of Traditional Chinese Medicine and Shanghai University of Traditional Chinese Medicine, University of Hong Kong, Chengdu University of Traditional Chinese Medicine, Korea Institute of Oriental Medicine, Fujian University of Traditional Chinese Medicine, Capital Medical University. Among them, Southern Medical University has the highest centrality, indicating that it is an important institution to study acupuncture treatment for stroke. From the perspective of the number of publications and centrality, relevant institutions in China, the United States, South Korea and other countries have made great contributions to the research of acupuncture treatment for stroke.

DISCUSSION

To the best of our knowledge, this is the first bibliometric analysis of acupuncture for stroke. We obtained 897 published papers through Web of Science and analyzed them with Citespace to show the research hotspots of acupuncture in the field of stroke from 2003 to 2022. We believe that this study is a comprehensive analysis of the relevant fields, for the study of this field of scholars to provide a reference. Annual publication volume is an important indicator to identify the most influential countries/regions, institutions, authors and journals in the bibliometric analysis of general information. The frequency of publication has gradually increased from 11 in 2003 to 97 on September 2022 (and will continue to grow). Over the past 20 years, the total number of publications on acupuncture for stroke has been on the rise, indicating that acupuncture for stroke is still a hot topic.

In terms of journal distribution, the most published papers were Journal of Alternative and Complementary Medicine (16). Among the top 12 journals, Q3 accounted for 47%, Q2 23.5%, Q1 11.3% AND Q4 6.8%. Journals with high IFS, such as the Lancet and Nature, have yet to publish articles on the subject. It indicates that the quality of related research literature on

acupuncture for stroke still needs to be further strengthened. We think that acupuncture may be in the process of being accepted by mainstream international medicine. There will be high-quality research published in such journals in the future.

From the aspect of the author, most identified Li-Dian Chen, Jing Tao are from Fujian university of traditional Chinese medicine in recent years, Professor Chen found at the best, Electroacupuncture can activate the 5-HT1A receptor-mediated PKA, kinases, and NMDA receptors in the hippocampus, thereby improving learning and memory in a rat model of ischemic stroke.¹⁹ This provides favorable evidence for treating cognitive impairment secondary to ischemic stroke. From the perspective of centrality, there is little cooperation and communication among the authors. In the future, team cooperation should be strengthened to further promote the research and development in this field.

By country and institution analysis, China, the United States and South Korea are at the top in terms of the number of publications and citations. And the literature from China accounts for almost half of the total. In addition, the institutions with the largest number of publications are Beijing University of Chinese Medicine and Guangzhou University of Chinese Medicine, which are both from China, indicating that China is the largest contributor and world leader in the study of acupuncture for stroke treatment. The country with the highest centrality is Australia, indicating that acupuncture treatment for stroke has been paid more and more attention in Australia. But in general, cooperation and exchanges between countries are relatively small. Therefore, international cooperation between organizations in different countries needs to be strengthened to promote the global development of acupuncture. The top five institutions with the largest number of publications are all from China, and four of the top five institutions with the highest centrality are from China, indicating that China maintains a high degree of cooperation and communication with other countries and institutions researching acupuncture for stroke, which is conducive to information sharing and plays a very important role in the development of this field.

In terms of keywords, the most commonly used five keywords are “stroke”, “acupuncture”, “stimulation”, “recovery”, “electroacupuncture”. The five key words in terms of centrality are “electroacupuncture”, “activation”, “acupuncture”, “rat” and “functional recovery”, indicating that acupuncture treatment for stroke mainly focuses

on electroacupuncture intervention at present. It mainly focuses on improving the functional rehabilitation of patients after stroke. In addition, the mechanism of acupuncture in the treatment of stroke has also become a hot topic. From the perspective of keyword emergence, in recent years, more and more scholars have begun to focus on the improvement of acupuncture for cognitive impairment in stroke patients, and acupuncture to promote wakefulness has become a hot topic at present and in the future.

At present, more and more studies have shown that acupuncture can improve the clinical symptoms of stroke patients and improve their quality of life. We summarize the underlying mechanisms: (1) Some scholars have found that electroacupuncture could promote adenosine 5'-monophosphate (AMP)-activated protein kinase phosphorylation of the caudate putamen, motor cortex and somatosensory cortex regions can enhance neural activity and motor functional recovery after ischemic stroke.⁴¹ It is suggested that acupuncture can promote nerve regeneration, which is of great significance to the recovery of life function in patients with stroke sequelae. (2) Scalp acupuncture can alleviate neurological deficits in rats with hemorrhagic stroke by inhibiting the expression of TNF- α and NF- κ B. TNF- α and NF- κ B are classical inflammatory pathway substances, suggesting that acupuncture has inhibiting inflammation effect.⁴² (3) acupuncture Baihui and Zusanli could improve limb sensorimotor function by promoting the expression of vascular endothelial growth factor(VEGF) and HIF-1 α and promoting vascular regeneration.⁴³ Scalp acupuncture can activate Wnt/ β -catenin signaling pathway to promote the expression of angiogenic factors and restore blood perfusion in ischemic areas.⁴⁴ These results suggest that acupuncture has a complex regulatory effect on vascular activity, which can promote the formation of new blood vessels and improve stroke symptoms. (4) Some studies also suggest that acupuncture can increase the concentration of lactic acid in the ischemic brain for the use of injured neurons, inhibit the activities of CASPASE-3, CASPASE-8 and CASPASE-9, and exert the effects of anaerobic metabolism and anti-apoptosis.⁴⁵ The specific mechanism still needs rigorous basic experimental design and clinical research to prove. However, we have also found that a large number of clinical studies have concluded that acupuncture can effectively treat stroke.^{6,13,46-49}

Electroacupuncture has been paid more and

more attention in the treatment of cerebral apoplexy. The frequency of 2 Hz can reduce the number of penumbra area Ki67 immune reaction cells and can increase the number of glial fibrillary acidic protein (GFAP) immunoreactive cells. However, the frequency of 15 Hz did not alter the immunoreactivity of rats with ischemia-reperfusion injury.⁵⁰ Current study does not indicate which electroacupuncture frequency is more effective. Future studies should be designed to observe the effect of different electroacupuncture frequency on the clinical outcome of stroke.

The advantages of our study are obvious, which provides a comprehensive and accurate bibliometric reference for scholars in this field and provides a hot topic. However, there are some limitations to this study. We only analyzed data from Web of Science, which may lead to language and publication bias. In addition, all the studies on acupuncture treatment of stroke lack of large-scale randomized controlled studies. All of these factors may affect the results. We also need to highlight the natural disadvantages of CiteSpace, for example: CiteSpace was unable to evaluate the quality of the included literature like meta-analysis and unable to identify publication bias. Multicenter, large-sample studies that use consistent methods are still needed to analyze the efficacy and physiological mechanisms of acupuncture in the treatment of stroke. We expect acupuncture to become a more popular and globally accepted way in the treatment for stroke.

In conclusion, this study provides useful data for potential collaboration between researchers and institutions and identifies hot topics and trends in acupuncture for stroke research. Acupuncture may be effective in treating stroke, but more evidence is needed.

DISCLOSURE

Financial support: The work was supported by the National Natural Science Foundation of China (No.81460199 and 82160252), Natural Science Foundation of Jiangxi province (20202BAB206029), Science and technology project of Jiangxi Health Commission(202110028), and Double thousand talents program of Jiangxi province (jxsq2019101021).

Conflict of interest: None

Data availability: The datasets used and/or analyzed during the current study are available

from the corresponding author on reasonable request.

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Supplement Table 1

Top10 authoritative authors in cited reference.

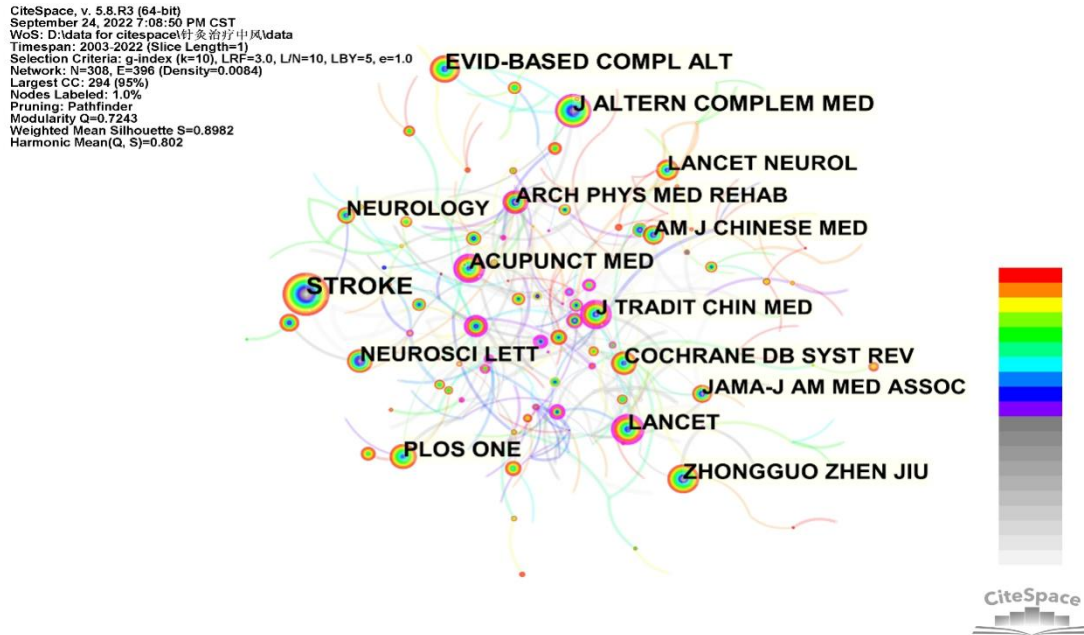
Rank	Count	Centrality	Year	Author
1	112	0.13	2011	WU P
2	105	0.03	2006	ZHANG SH
3	90	0.07	2003	PARK J
4	85	0.15	2007	WANG Y
5	82	0.06	2003	SZE FKH
6	70	0.09	2012	FEIGIN VL
7	68	0.01	2008	MACPHERSON H
8	62	0.04	2011	LONGA EZ
9	56	0.03	2015	ZHANG Y
10	46	0	2019	CHAVEZ LM

Supplement Table 2

Top 5 countries and institutions.

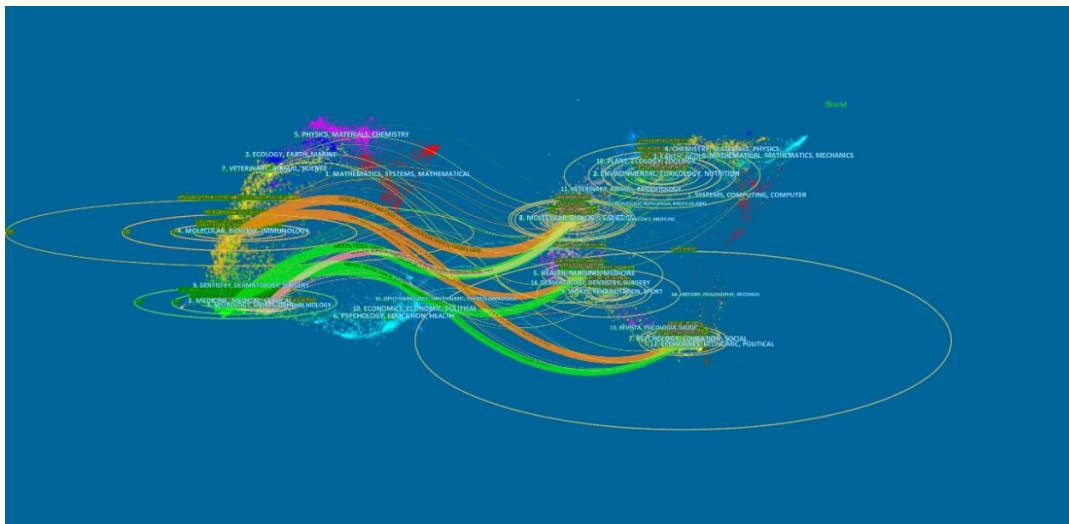
Rank	Country	Pub Publication	Centrality	Institutions	Pub Publication	Centrality
1	PEOPLES R CHINA	670	0.28	Beijing Univ Chinese Med	66	0.03
2	USA	114	0.27	Guangzhou Univ Chinese Med	58	0.14
3	SOUTH KOREA	88	0.00	China Med Univ	50	0.02
4	ENGLAND	33	0.27	Tianjin Univ Tradit Chinese Med	49	0.08
5	AUSTRALIA	20	0.65	Fujian Univ Tradit Chinese Med	41	0.04

Supplement Figure 1. Co-occurrence map of cited journals

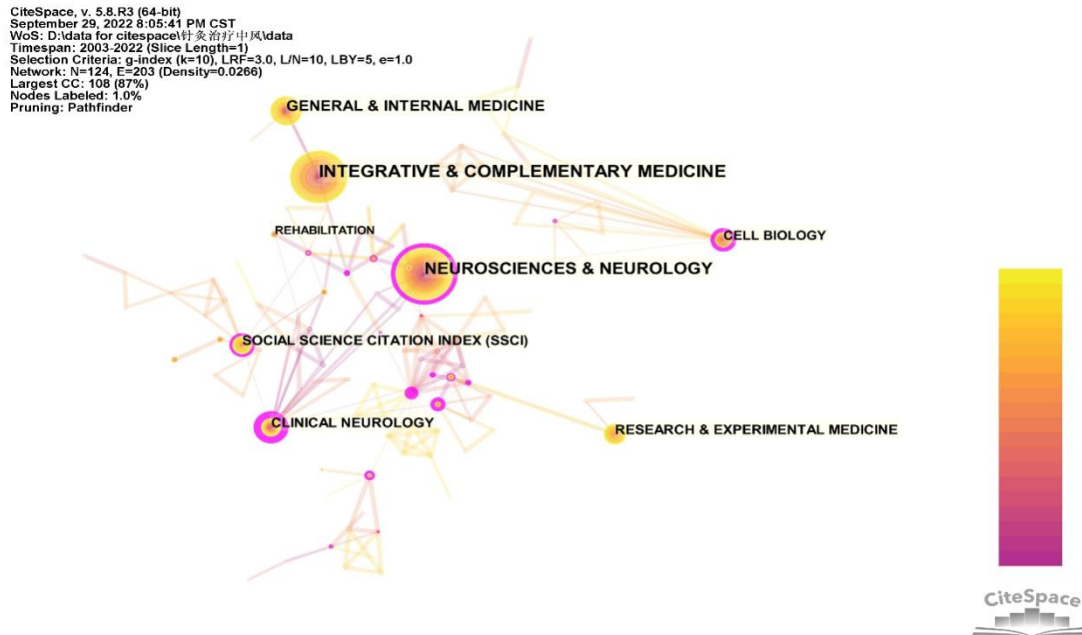


Supplement Figure 2. Double image superposition

Double image overlay visualization of citing and cited journals. The curve is the citation line, which starts from the 11 fields of citing journals on the left and points to the 14 fields of cited journals on the right, completely showing the origin and origin of citation.

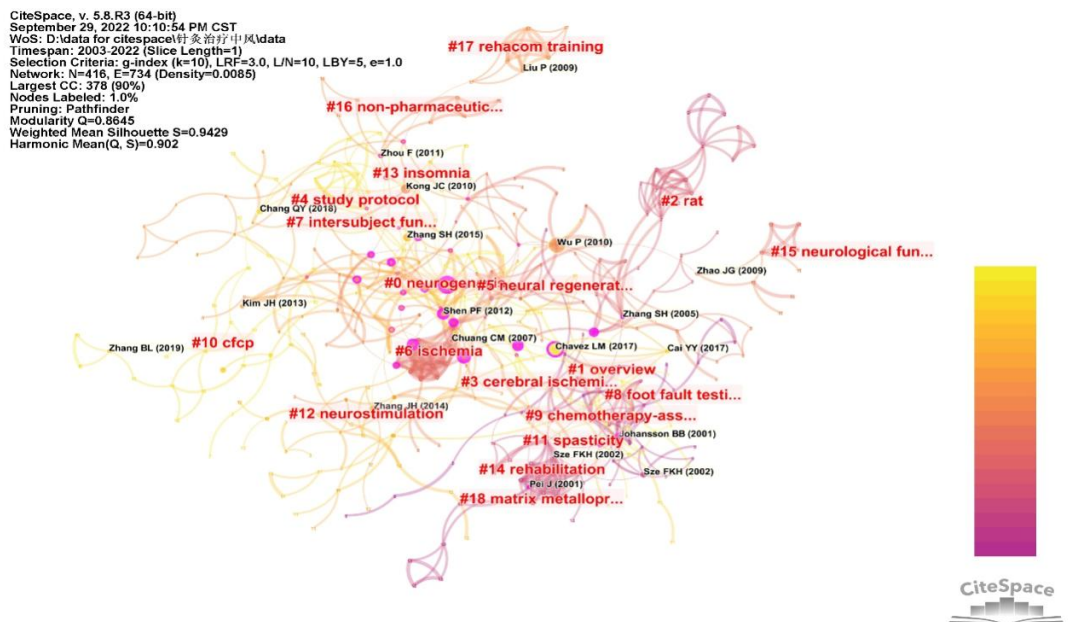


Supplement Figure 3. Journal source co-occurrence chart



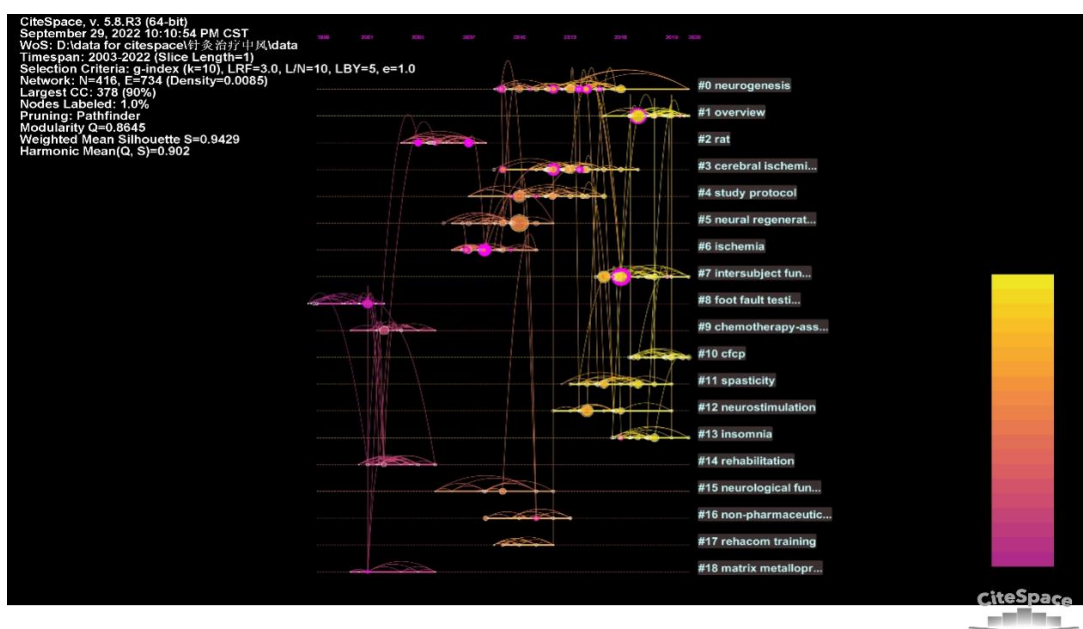
Supplement Figure 4. Analysis of cited references in keyword clustering.

The color of the cluster indicates the year when the co-citation relation first appears in the cluster. The blue block appears earlier than the green block, and the yellow block appears later than the green block. By analogy, the size of the node represents the number of references to a reference, journal, or author, and the color of the line represents the time of the first citation. The time color is 2003 to 2022, from left to right. There are 19 types of clusters (# 0-19).

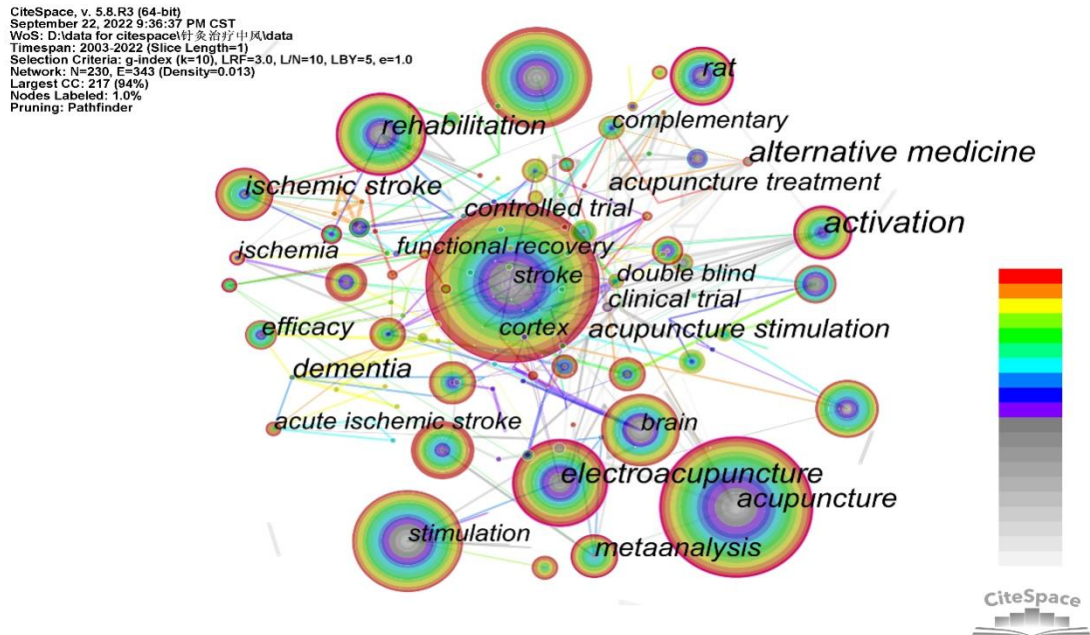


Supplement Figure 5. Timeline view of co-cited references

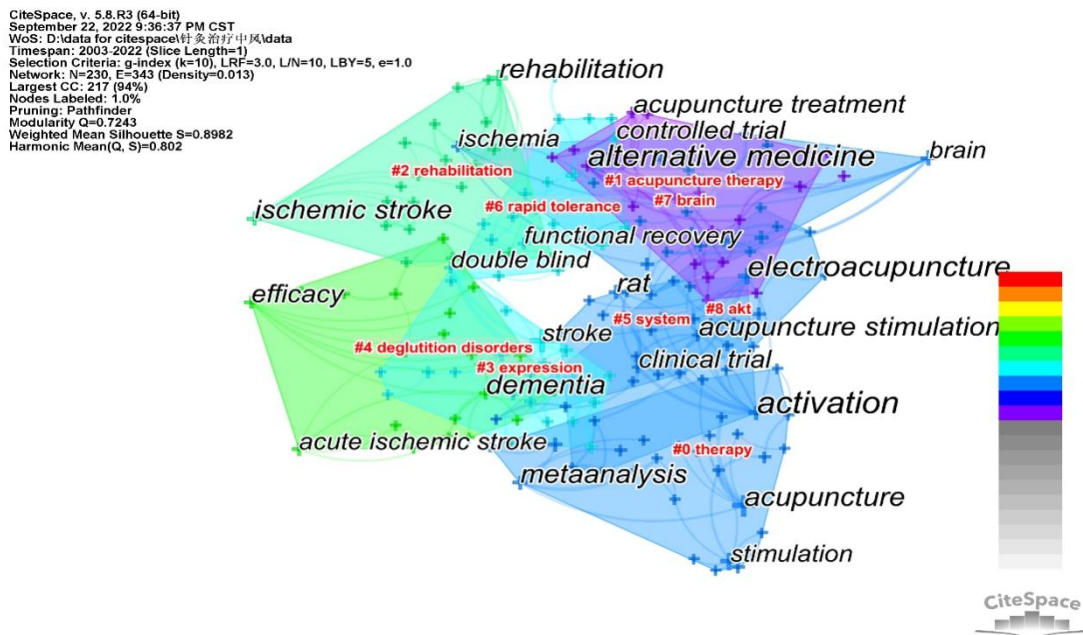
(1) the timeline view shows how references are co-referenced over time. (2) different years correspond to different colors, the longer the color line segment is, the larger the time span of reference is. (3) nodes represent references. The larger the node, the more frequently it is referenced. The lines indicate the connections between references. (4) the longer the color line segment is, the larger the time span of reference is. (5) the cluster labels on the right are the hot research categories. From 2003 to 2022, the clustering categories with the largest time span of reference citations were # 0 neurogenesis and # 3 cerebral ischemia. The most commonly cited cluster categories # 0 neurogenesis and # 3 cerebral ischemia. In recent years, the most cited clustering categories are # 10 CFCP, # 11 spasticity and # 13 insomnia.



Supplement Figure 6. Keywords co-occurrence diagram



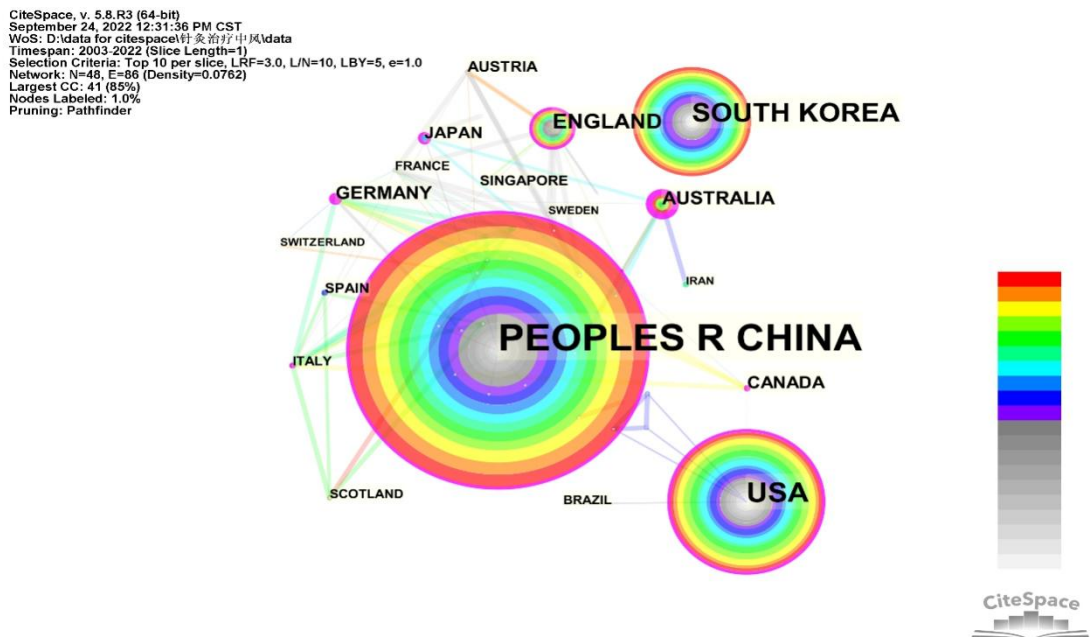
Supplement Figure 7. Keywords clustering graph



Supplement Figure 8. Author co-occurrence network diagram



Supplement Figure 9. Country co-occurrence network diagram



Supplement Figure 10. Institutional co-occurrence network diagram

CiteSpace, v. 5.8.R3 (64-bit)
September 25, 2022 10:22:34 AM CST
WoS: D:\data for citespace\行医精神中的数据
Timespan: 2003-2022 (Slice Length=1)
Selection Criteria: Top 10 per slice, LRF=3.0, L/N=10, LBY=5, e=1.0
Network: N=274, E=517 (Density=0.0138)
Largest CC: 157 (57%)
Nodes Labeled: 1.0%
Pruning: Pathfinder

