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ORIGINAL RESEARCH

Scientific Knowledge Graph of Acupuncture for Migraine: A Bibliometric Analysis from 2000 to 2019

Yanqing Zhao[1,*]
Li Huang[2,*]
Meijuan Liu[1]
Han Gao[1]
Wentao Li[1,3]

[1]Internal Medicine of Traditional Chinese Medicine, Shanghai Municipal Hospital of Traditional Chinese Medicine, Shanghai, People's Republic of China; [2]Internal Medicine of Traditional Chinese Medicine, Putuo Hospital, Shanghai University of Traditional Chinese Medicine, Shanghai, People's Republic of China; [3]Encephalopathy Department, Shanghai Municipal Hospital of Traditional Chinese Medicine, Shanghai University of Traditional Chinese Medicine, Shanghai, People's Republic of China

*These authors contributed equally to this work

Objective: This study aims to explore the trend and knowledge mapping of acupuncture for migraine through bibliometrics.

Methods: It retrieved the literature on acupuncture for migraine in the Web of Science database from 2000 to 2019, and then resorted to CiteSpace to conduct bibliometric analysis to attain the knowledge mapping.

Results: The total number of publications each year has increased year by year, and the average annual growth rate from 2000 to 2009 was 15.57%, while from 2010 to 2019 was 6.35%, with a faster growth rate from 2000 to 2009. According to the cluster analysis of institutions, authors, cited references, and keywords, 10, 7, 12, and 10 categories were gained from 2000 to 2019. The most productive countries, institutions, and authors are the USA and China, Technical University of Munich and Beijing University of Chinese Medicine, Linde K and Liang FR from 2000 to 2019, whose frequency is 119/103, 28/24, and 28/24, respectively. However, the most important of them are Canada, Sichuan University, and Witt CM. Owing to their highest centrality, they are 0.86, 0.54, and 0.27 separately. Moreover, cited references that contributed to the most co-citations are Linde K (2005), yet, the most vital cited reference is Karst M (2001). Keywords such as migraine, acupuncture, headache, pain, and randomized controlled trial are the most frequently used. However, needle acupuncture is the crucial keyword. In the cluster analysis of institutions, authors, cited references, and keywords from 2000 to 2019, the largest cluster categories are #0 migraine prophylaxis, #1 randomized controlled trial, #0 episodic migraine, and #0 topiramate treatment. Then, randomized controlled trials of acupuncture prevention and treatment of migraine are the most important research content in this field.

Conclusion: Through the bibliometric analysis of the research on acupuncture for migraine in the Web of Science database in the past 20 years, the trends and the Knowledge Graph of the country, institution, author, cited reference, and the keyword are acquired, which have an important guiding significance for quickly and accurately positioning the key information in the field.

Keywords: acupuncture, migraine, scientific knowledge graph, CiteSpace, bibliometric analysis

Introduction

Migraine is a group of recurrent headache diseases, showing unilateral or bilateral pain, often accompanied by nausea and vomiting. A few typical cases have visual, sensory, and motor disorders and other auras before the attack,[1] and may have a family history.[2] According to a study of 2016 global burden of disease study, 1.04 billion people worldwide suffer from migraines, with an overall prevalence rate of 14.4%.[3]

Correspondence: Wentao Li
Encephalopathy Department, Shanghai Municipal Hospital of Traditional Chinese Medicine, 274 Zhijiang Middle Road, Jingan District, Shanghai, 200071, People's Republic of China
Tel +86 133 31882730
Email lwt1132@163.com

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Migraine affects women three times as much as men,[4] the prevalence of migraine in children increases with age.[5] And the annual prevalence of migraines in the elderly is about 10%.[6] Migraine is the main cause of disability in the world, the number of years of disability-adjusted life lost caused by migraine has reached one third.[7] With the increase of headache days, the disease burden (disability, medical care utilization, and direct cost) of migraine patients also increases.[8] The high incidence rate, high disability rate, and the increase of treatment expenditure have brought serious economic costs and brought various burdens to society. It is vital to quickly and accurately grasp the research trends of migraines. And the drug treatment of migraine includes acute drug therapy and intermittent preventive drug therapy. Presently, the treatment in the acute phase mainly utilizes non-steroidal anti-inflammatory drugs, barbiturates, opioids, and triptans.[9] Although the above-mentioned drugs have achieved positive effects in the treatment and prevention of migraines, long-term use has more side effects. Such as long-term use of NSAIDs may cause gastrointestinal reactions, bleeding risks, liver and kidney damage, and headaches caused by drug overuse; ergotamine long-term high-dose medication can see muscle pain, precordial pain, the sudden withdrawal of drugs can appear rebound headache, also easy to produce psychological dependence.[10,11] Given that migraines may be chronic and therefore, require long-term control, current research should explore treatment options that focus on high efficiency and minimal side effects.[12] This has led many clinicians and researchers to turn to other forms of treatment, such as acupuncture, as an alternative source of pain management and healing for patients with refractory migraines with standard medications.[13] Traditional Chinese medicine treatment (including acupuncture) has the characteristics of "overall regulation", which has advantages in reducing the attack frequency of migraine, relieving headache symptoms, and improving the quality of life.[14]

Bibliometrics is an interdisciplinary science that uses mathematical and statistical methods to quantitatively analyze all knowledge carriers. It uses statistical indicators to measure the contribution to a research field,[15] including different countries, institutions, journals, or authors and predicts trends or hotspots in a field.[16] The research methods involved include co-word analysis and cluster analysis. Co-word analysis is an important method of bibliometrics.[17] It can be used to identify trends and hotspots. The number of occurrences in the group of literature, this number of co-occurrences to measure the close relationship between them. Cluster analysis utilizes a weighting algorithm, log-likelihood algorithm, and mutual information algorithm with "title entries", "index entries", and "abstract entries" to extract common information to interpret research mainstreams and research characteristics.[18] Researchers rely on relevant analysis software for visual analysis (including Citespace,[19] VOSviewer,[20] Histcite,[21] etc.).

Up to now, there has been no comprehensive article of studies on acupuncture for migraine using bibliometric methods. Therefore, in this study, to analyze the global status and trend of acupuncture for migraine in the past 20 years, the researchers utilized the bibliometric software CiteSpace to not only analyze the growth of publications in this field from 2000 to 2019 of the Web of Science Database (SCI-E) but also construct the knowledge maps of countries, institutions, authors, cited references and keywords from 2000 to 2019, which is of great significance to accurately grasp the research trends and hotspots.

Methods

Source of Literature

To prevent the omission of searching the literature, we obtained the synonyms for "migraine" and "acupuncture" through the MeSH Database in PubMed, and then amalgamate the final data. Foremost, we input the Web of Science database with English Topic= "migraine", and TS= "acupuncture" OR "Acupuncture Therapy" OR "Acupuncture, Ear" OR "Acupuncture Points" OR "Acupuncture Analgesia" separately.[22] Next is the parameter setting when retrieving the database, kinds of literature were retrieved online through the Science Citation Index-Expanded of the Web of Science Core Collection on March 1, 2021[23], and the language of the literature is not limited.The time range of searching is from 2000 to 2019, which is the basis of data analysis. After literature retrieval, a total of 749 kinds of literature were acquired, and 438 records were utilized for bibliometric analysis after Citespace removed duplication. Data removal is done in the form of a combination of manual verification and CiteSpace software. And the searched Web of science database stems from the Tsing Hua University Library database in China.

Analysis Software

The version of visual software is Citespace 5.2.R1, which was invented by Professor Chen Chaomei from the

Computer and Information Science of Drexel University in the United States, and can be used to analyze the structure, laws, and distribution of scientific knowledge.[24]

Parameter Setting

Time slicing (from 2000 to 2019, years per slice: 5), node type (check one at a time, including Author, Institution, Country, Keyword, Cited Reference), pruning select Pathfinder, Pruning sliced networks, and Pruning the merged network.

Statistical methods

Bibliometric analysis was implemented on all acupuncture for migraine literature. Frequency was the main metric used to identify the core countries/territories, institutions, authors, cited references, and keywords. Centrality means betweenness centrality, which is an indicator to measure the importance of nodes in the network. Citespace uses this indicator to discover and measure the significance of kinds of literature and utilizes purple circles to highlight such literature. Pieces of literature with high betweenness centrality are usually the key hub connecting two different fields. It is also called a turning point in Citespace. This method of calculating the importance of nodes is proposed by Freeman in 1977. Betweenness centrality Calculated as follows:

$$BC_i = \sum_{s \neq i \neq t} \frac{n_{st}^i}{g_{st}}$$

In the formula, g_{st} is the number of shortest paths from node s to node t, and n_{st}^i is the number of shortest paths through node i among g_{st} shortest paths from node s to node t. From the perspective of information transmission, the higher the betweenness centrality, the greater the importance of the node. The result of clustering analysis is a keyword co-occurrence network. The cluster view emerges the distribution of fields from a different point of view. The timeline view primarily reveals solicitude for delineating the relationship between clustering results and concentrates on the historical span of literature in a clustering result. CiteSpace offers the module value (called Q value) and the silhouette value (called S value) to judge the effect of map drawing. The Q value is generally in the interval [0,1], and Q>0.3 implies that the allocated community structure is conspicuous. When the S>0.7, the clustering is the most reliable; if S>0.5, clustering is generally rational.[25]

Research Ethics

These data are downloaded from the Web of Science database; these are secondary data and do not involve interactions with animals or humans.

Results and Discussion

Analysis of the Total Number of Publications

In order to find the development trend of the total number of publications accurately, researchers divided it into two periods (2000–2009 and 2010–2019)[26] for comparative analysis, In Figure 1, we found an interesting phenomenon: Comparing the average total number of publications of the two-time nodes, it is found that the number of publications in 2000–2009 is 15.9 and that in 2010–2019 is 28.0. The number of outputs in the second period is higher than that in the first period. However, the growth rate of the two periods is reckoned by using the growth rate calculation formula ($growthrate = \left(\frac{present}{past}\right)^{\frac{1}{n}} - 1$, n is the number of years), which is 15.57% in 2000–2009 (The total number of publications in 2000 was 8, and that in 2009 was 34) and 6.35% in 2010–2019 (The total number of publications in 2010 was 20, and that in 2009 was 37). It can also be further confirmed that there is a smooth transition period from 2013 to 2016, and the total number of publications fluctuates a little. Therefore, we can think that the growth rate of publications in 2000–2009 is greater than in 2010–2019, and the overall trend is to increase year by year (the total growth rate is 16.55%).

Analysis of Countries/Territories/Institutions

A network map with 24 nodes and 19 links of countries/territories was created (Figure 2), and a cluster map (Modularity Q = 0.8278, Silhouette = 0.6373) with 130 nodes and 158 links of institutions was engendered, along with a timeline view. The countries/territories/institutions that published papers on acupuncture for migraine in 2000–2019 are revealed in Tables 1 and 2. The top 5 countries/territories are the USA, Peoples R China, Germany, England, and Italy, and the most prolific institutions were Tech Univ Munich, followed by Beijing Univ Chinese Med, Chengdu Univ Tradit Chinese Med, Capital Med Univ, and Mem Sloan Kettering Canc Ctr. However, the value of centrality reflects the importance of countries/territories/institutions in the node of the cooperative relationship network, so the most important countries/

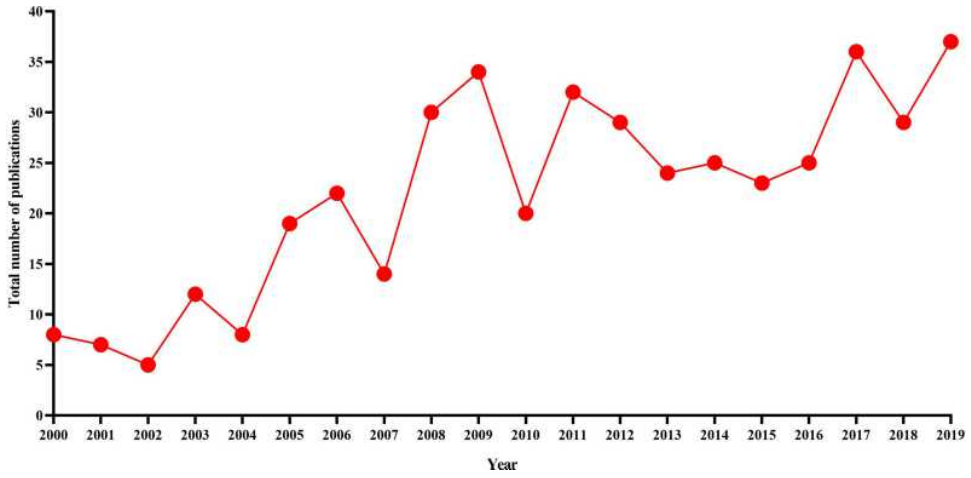

Figure 1 Line Chart of Yearly Output on acupuncture for Migraine. The abscissa in the figure represents the year and the ordinate represents the total number of publications.

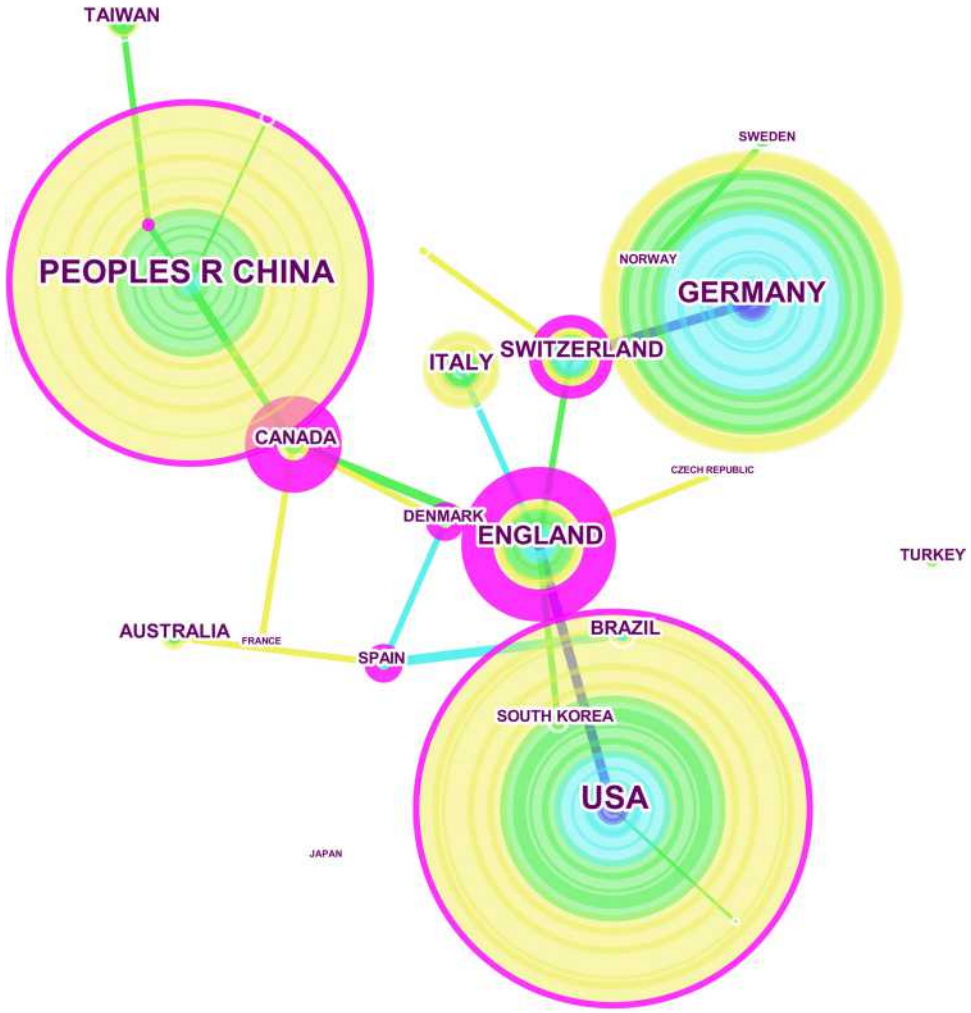

Figure 2 Network of countries/territories on acupuncture for Migraine. The purple node in the middle of the annual ring means the influence and the significance of a country/territory. The larger the node and the more purple it exhibits, the greater is the importance of the country/territory.

Table 1 Countries/ Territories Contributed to Publications on Acupuncture for Migraine from 2000 to 2019

Countries/ Territories	Frequency	Countries/ Territories	Centrality
USA	119	Canada	0.86
Peoples R China	103	England	0.82
Germany	90	Denmark	0.36
England	41	Switzerland	0.26
Italy	32	Spain	0.26
Switzerland	25	USA	0.13
Brazil	16	Peoples R China	0.13
Canada	15	Scotland	0.13
Australia	14	Germany	0.00
Taiwan (China)	14	Italy	0.00
Spain	11	Brazil	0.00
South Korea	10	Australia	0.00
Turkey	8	Taiwan (China)	0.00
Denmark	8	South Korea	0.00
Sweden	6	Turkey	0.00

Note: In this table, the other two identical columns represent different rankings. The left column of the table represents the Countries/ Territories that have published acupuncture for migraine. The frequency of contribution is sorted from high to low. The column on the right represents the sorting from high to low according to centrality.

institutions are Canada (0.86) and Sichuan Univ (centrality=0.54), followed by England (0.82), Denmark (0.36), Switzerland (0.26), and Spain (0.26), and the following institutions are Univ York (0.49), Chengdu Univ Tradit Chinese Med (0.44), Hunan Univ Tradit Chinese Med (0.36) and Mem Sloan Kettering Canc Ctr (0.34).

Through the above analysis, we found an interesting phenomenon: from the outputs of acupuncture for migraine, China ranks second, second only to the USA, but from the perspective of centrality, China's importance in this field is weaker than that of the Western developed countries and other developing countries have fewer outputs and the cooperation between countries is not close enough, which is also its limitation. Besides, we also discovered that most institutions engaged in acupuncture for migraine are from China, with the University of Traditional Chinese Medicine as the main body of research, there are two reasons for this phenomenon,

Table 2 Institutions Contributed to Publications on Acupuncture for Migraine from 2000 to 2019

Institution	Frequency	Institution	Centrality
Tech Univ Munich	28	Sichuan Univ	0.54
Beijing Univ Chinese Med	24	Univ York	0.49
Chengdu Univ Tradit Chinese Med	23	Chengdu Univ Tradit Chinese Med	0.44
Capital Med Univ	19	Hunan Univ Tradit Chinese Med	0.36
Mem Sloan Kettering Canc Ctr	15	Mem Sloan Kettering Canc Ctr	0.34
Univ Turin	12	Peking Univ	0.32
China Acad Chinese Med Sci	12	Shandong Univ Tradit Chinese Med	0.31
Univ York	11	Aalborg Univ	0.19
Sichuan Univ	11	Hunan Univ Chinese Med	0.17
Univ Maryland	11	Univ Maryland	0.15
Harvard Univ	10	Univ Oxford	0.15
Univ N Carolina	10	Univ Ottawa	0.15
Ruhr Univ Bochum	10	Oregon Coll Oriental Med	0.15
Xidian Univ	8	China Acad Chinese Med Sci	0.12
Charite	8	Massachusetts Gen Hosp	0.12

Note: In this table, the other two identical columns represent different rankings. The left column of the table represents the institutions that have published acupuncture for migraines. The frequency of contribution is sorted from high to low. The column on the right represents the sorting from high to low according to centrality.

Abbreviations: Tech Univ Munich, Technical University of Munich; Beijing Univ Chinese Med, Beijing University of Chinese Medicine; Chengdu Univ Tradit Chinese Med, Chengdu University of Traditional Chinese Medicine; Capital Med Univ, Capital medical university; Mem Sloan Kettering Canc Ctr,Memorial Sloan-Kettering Cancer Center; Univ Turin, University of Turin; China Acad Chinese Med Sci,China Academy of Chinese Medical Sciences; Univ York, University of York; Sichuan Univ, Sichuan University; Univ Maryland, University of Maryland; Harvard Univ, Harvard University; Univ N Carolina, University of North Carolina; Ruhr Univ Bochum, Ruhr University Bochum; Xidian Univ, Xidian University; Hunan Univ Tradit Chinese Med, Hunan University of Traditional Chinese Medicine; Peking Univ, Peking University; Shandong Univ Tradit Chinese Med, Shandong University of Traditional Chinese Medicine; Aalborg Univ, Aalborg University; Hunan Univ Chinese Med, Hunan University of Chinese Medicine; Univ Oxford, University of Oxford; Univ Ottawa, University of Ottawa; Oregon Coll Oriental Med,Oregon College of Oriental Medicine; Massachusetts Gen Hosp, Massachusetts General Hospital.

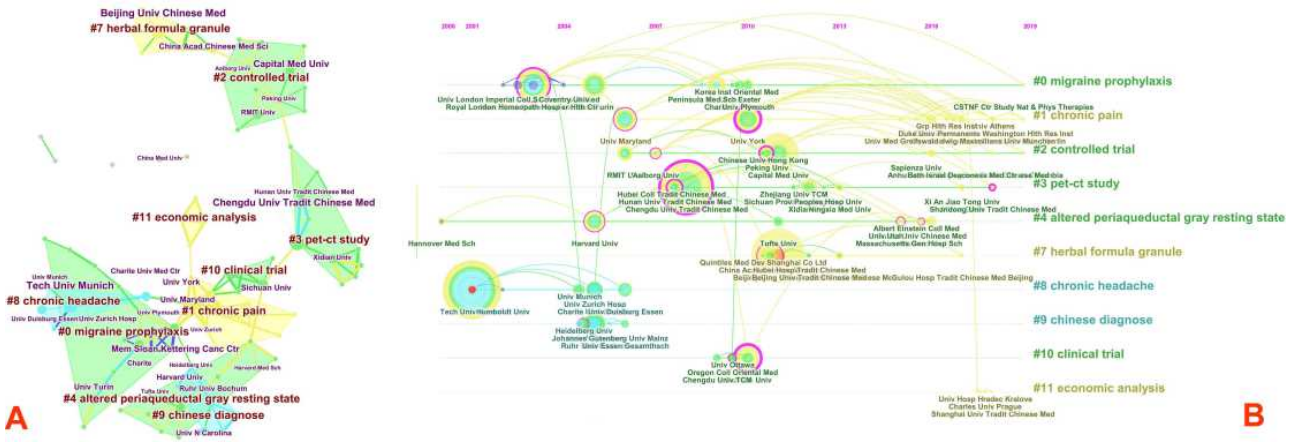

Figure 3 (**A**) Cluster map of institutions based on label clusters with title terms. The combination of symbols and numbers delegates the institutions' study of similar categories. (**B**) Timeline zone of institutions on acupuncture for Migraine The purple node in the middle of the annual ring means the influence and the significance of the institution. Institutions with the homologous research category are on the same time horizon.

First, acupuncture originated in China; Second, China's government policies support higher education institutions more than other social institutions.

By means of cluster analysis of institutions (Figure 3A and Table 3), researchers can locate the same research category that different institutions are participated in. Figure 3B is the timeline view of the co-citation analysis of institutions with the top 10 clusters, When the cluster view cannot estimate which institutions be absorbed in the same research in detail, it will make use of the cluster timeline view Figure 3B to analyze. The whole modularity Q= 0.8278 > 0.3 corresponds to a significant community structure. And the largest cluster were #0 migraine prophylaxis (S value=0.954> 0.7, Contains 14 institutions), #1 chronic pain (S value=0.865>0.7, Contains 13 institutions), #2 controlled trial (S value=0.954>0.7, Contains 12 institutions), #3 pet-ct study (S value=0.848>0.7, Contains 11 institutions). The relationship network in the category of migraine prophylaxis (#0) is a cooperative network between Royal London Homeopath Hosp, Mem Sloan Kettering Canc Ctr, Univ Plymouth, and Univ Exeter. Furthermore, the earliest research in this direction can be traced back to Royal London Homeopath Hosp in 2002; The research direction is the relationship network of

Table 3 Institutions Engaged in Acupuncture for Migraine That Details of Knowledge Clusters

Cluster ID	Size	Silhouette	Mean (Year)	Label (LLR)	Label (MI)
0	14	0.954	2007	Migraine prophylaxis	Placebo effect
1	13	0.865	2015	Chronic pain	Placebo effect
2	12	0.954	2012	Controlled trial	Placebo effect
3	11	0.848	2012	Pet-ct study	Placebo effect
4	10	0.936	2012	Altered periaqueductal gray resting state	Clinical trial
7	7	0.976	2012	Herbal formula granule	Clinical trial
8	6	0.919	2004	Chronic headache	Clinical trial
9	6	0.979	2005	Chinese diagnose	Clinical trial
10	5	0.920	2009	Clinical trial	Placebo effect
11	4	0.983	2018	Economic analysis	Clinical trial

Note: The cluster analysis results mainly include cluster ID, mean year, size, silhouette, label (LLR), and label (MI). Cluster ID is the number after clustering, and Size represents the number of members contained in the cluster. The larger the Size is, the smaller the number. Mean Year represents the average year of the literature in the cluster, which can be used to judge the distance of the cited literature in the cluster. The larger the log-likelihood ratio (LLR) is, the more representative the cluster category; mutual information (MI) is mainly used to represent the relationship between terms and categories in text mining, and it does not consider the frequency of feature words.

Table 4 Authors Contributed to Publications on Acupuncture for Migraine from 2000 to 2019

No.	Author	Frequency	Author	Centrality
1	Linde K	28	Witt CM	0.27
2	Liang FR	24	Huang WJ	0.23
3	Li Y	18	Willich SN	0.19
4	Zheng H	15	Sun GJ	0.17
5	Allais G	15	Lan L	0.12
6	Diener HC	15	Allais G	0.11
7	Witt CM	14	Melchart D	0.11
8	Melchart D	14	Brinkhaus B	0.11
9	Wang LP	11	Li Y	0.08
10	Weidenhammer W	11	Vickers AJ	0.07
11	Brinkhaus B	11	Zhao L	0.07
12	MacPherson H	10	MacPherson H	0.06
13	Willich SN	9	Zhang FW	0.06
14	Liu CZ	9	Hammes M	0.05
15	Vickers AJ	9	Liu JX	0.04

Note: In this table, the other two identical columns represent different rankings. The left column of the table represents the authors that have published acupuncture for migraine. The frequency of contribution is sorted from high to low. The column on the right represents the sorting from high to low according to centrality.

chronic pain (#1) that the cooperation network between Univ York, Univ Maryland, Nanjing Univ Chinese Med, Univ Southampton. In addition, the earliest research in this direction originated from Univ Maryland in 2006; The research direction of the institutional cooperation network of Capital Med Univ, Peking Univ, RMIT Univ, Anhui Univ Chinese Med, and Beijing Inst Tradit Chinese Med is controlled trial (#2), of which the earliest research on this aspect appeared from RMIT Univ in 2006; The research orientation of the institutional cooperation network of Chengdu Univ Tradit Chinese Med, Hunan Univ Tradit Chinese Med, Zhejiang Univ TCM, Shandong Univ Tradit Chinese Med, Xidian Univ, Xi An Jiao Tong Univ is pet-ct study (#3), and the earliest research on this aspect comes from Chengdu Univ Tradit Chinese Med in 2008.

It is beneficial for discovering similar researches between institutions and exploring potential cooperation relationships between them. However, the cooperation between institutions is mainly based on domestic universities in China, or the cooperation between international institutions is dominated, and the cooperation between international institutions is also mainly in developed countries. This has certain limitations for the development of acupuncture for migraines and we should try to overcome this disadvantage, enabling acupuncture to benefit people from all over the world.

Analysis of Authors

Considering the volume of published documents and centrality, the top 15 authors publishing articles were listed in Table 4. Linde K(Frequency=28) was identified as the most active author in the field, followed by Liang FR, Li Y, Zheng H, and Allais G, and the authors with high centrality are Witt CM (0.27), Huang WJ, Willich SN, Sun GJ, and Lan L, therefore, they are considered to be the most important researcher in the Author's network relationship. Generating a cited author map resulted in 203 nodes and 398 links with a mean Silhouette, S = 0.6361 and Modularity Q, Q = 0.8845 (Figure 4A). In this map, the modularity Q score was greater than 0.7, which means the network was reasonably divided into loosely coupled clusters. Detailed information regarding the top 7 clusters and their timelines has been presented in Table 5 and Figure 4B. Mainly include #1 randomized controlled trial (S value=0.876>0.7, embodies 18 authors),

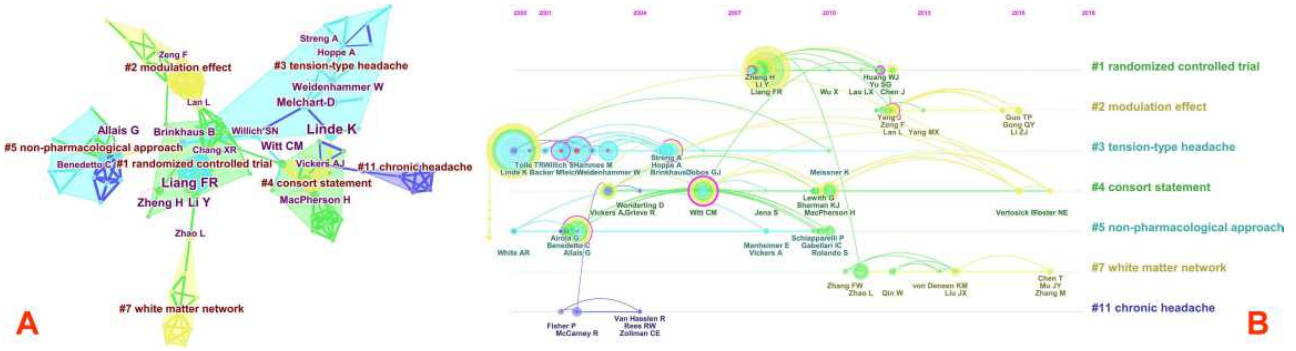

Figure 4 (**A**) Cluster map of authors based on label clusters with title terms. The combination of symbols and numbers delegates the authors' study of similar categories. (**B**) Timeline zone of authors on acupuncture for Migraine.

#2 modulation effect (S value=0.974>0.7, embodies 18 authors), #4 consort statement (S value=0.958>0.7, embodies 16 authors), #5 non-pharmacological approach (S value=0.995>0.7, embodies 14 authors), #7 white matter network (S value=0.921>0.7, embodies 9 authors), #11 chronic headache (S value=0.928>0.7, embodies 6 authors). Then the following categories are the specific analysis of the same category of the authors. ①Liang FR, Li Y, Sun GJ, and other authors' research on acupuncture for migraine can be classified into the same category, namely: randomized controlled trial (#1). And Li Y is the representative researcher in this category. Li Y et al[27,28] observed the effect of acupuncture for migraines through a multicenter randomized controlled trial. 480 migraine patients were randomly divided into 4 groups (Shaoyang-specific acupuncture, Shaoyang-nonspecific acupuncture, Yangming-specific acupuncture, or sham acupuncture control). Each group adopted a different treatment plan. It was found that acupuncture was more effective than sham acupuncture for almost all secondary results, and there was little correlation between acupuncture methods and results. Shaoyang specific acupuncture points did not produce better results than other acupuncture points, indicating that the role of specific acupuncture points plays a small role in the overall effect, and non-specific effects (such as expected and patient-doctor interaction) may be more prominent, so the research results may not be extended to Western populations. And it provides a direction for follow-up researchers to study acupuncture for migraines from the non-specific effects of acupuncture as an entry point. ②The authors engaged in #2 modulation effect mainly include Li ZJ, Lan L, Yang J, etc. Authors such as Li Z[29] used a randomized controlled trial to compare the resting-state functional connection of midbrain periaqueductal gray (PAG) between patients with migraine without aura and healthy controls and observe how acupuncture treatment affects the resting-state functional connectivity of migraine patients without aura.

Table 5 Authors Engaged in Acupuncture for Migraine That Details of Knowledge Clusters

Cluster ID	Size	Silhouette	Mean (Year)	Label (LLR)	Label (MI)
1	18	0.876	2009	Randomized controlled trial	Economic analysis
2	17	0.974	2014	Modulation effect	Economic analysis
3	17	0.883	2004	Tension-type headache	Economic analysis
4	16	0.958	2009	Consort statement	Economic analysis
5	14	0.995	2005	Non-pharmacological approach	Economic analysis
7	9	0.921	2014	White matter network	Economic analysis
11	6	0.928	2003	Chronic headache	Clinical trial

Note: The cluster analysis results mainly include cluster ID, mean year, size, silhouette, label (LLR), and label (MI). Cluster ID is the number after clustering, and Size represents the number of members contained in the cluster. The larger the Size is, the smaller the number. Mean Year represents the average year of the literature in the cluster, which can be used to judge the distance of the cited literature in the cluster. The larger the log-likelihood ratio (LLR) is, the more representative the cluster category; mutual information (MI) is mainly used to represent the relationship between terms and categories in text mining, and it does not consider the frequency of feature words.

Table 6 Cited Reference Contributed to Co-Citations on Acupuncture for Migraine from 2000 to 2019

No.	Cited Reference	Frequency	Cited Reference	Centrality
1	Linde K (2005)[32]	104	Karst M (2001)[45]	0.80
2	Diener HC (2006)[33]	95	Carlsson C (2002)[46]	0.71
3	Linde K (2009)[34]	53	Xue CCL (2004)[47]	0.71
4	Li Y (2012)[28]	45	Coeytaux RR (2005)[48]	0.68
5	Melchart D (2005)[35]	41	Manias P (2000)[49]	0.61
6	Silberstein SD (2004)[36]	40	Wallasch TM (2012)[50]	0.58
7	Wang LP (2011)[37]	38	Alecrim-andrade J (2008)[51]	0.50
8	Witt C (2005)[38]	34	Endres HG (2007)[52]	0.49
9	Vickers AJ (2012)[39]	34	Yang CP (2011)[53]	0.42
10	Scharf HP (2006)[40]	33	Ramsay DJ (1998)[54]	0.38
11	Bes A (2013)[41]	31	Wang LP (2011)[37]	0.30
12	Vickers AJ (2004)[31]	31	Linde K (2006)[55]	0.29
13	Brinkhaus B (2006)[42]	28	Kaptchuk TJ (2006)[56]	0.26
14	Allais G (2002)[43]	28	Melchart D (1999)[44]	0.24
15	Melchart D (1999)[44]	27	Streng A (2006)[57]	0.22

Note: In this table, the other two identical columns represent different rankings. The left column of the table represents the Cited References that have published acupuncture for migraine. The frequency of contribution is sorted from high to low. The column on the right represents the sorting from high to low according to centrality.

Studies have shown that damage to the descending pain modulatory system of migraine patients can return to normal after effective acupuncture treatment. This supplies a basis for us to study acupuncture treatment of migraine with the help of functional magnetic resonance imaging technology. ③Zhang M, Tian J, Liu JX, and other authors concentrated on acupuncture for migraine can be classified into #7 white matter network. The most critical researcher in this direction is Liu JX. Liu JX[30] studied the topology of the white matter network in patients with migraines without aura and healthy controls through a double-blind randomized controlled trial. Then, patients with simple paroxysmal migraines without aura were randomly divided into a traditional acupuncture group and sham acupuncture group, focusing on the results of the sham acupuncture group to study the placebo response of migraine patients. The results show that the placebo response can be identified a priori in migraine patients and that the specific topological properties of the brain structure network are the basis of the clinical placebo effect. ④The following authors are included in the #11 chronic headache: Vickers AJ, Zollman CE, McCarney R. Among them, the most prominent research is Vickers AJ. Vickers AJ[31] used a randomized controlled trial to explore the impact of the "use acupuncture" policy on headaches, health status, sick leave days, and resource utilization of chronic headache patients. Acupuncture not only reduced the number of headache days for migraine patients but also decreased the rate of drug use, the number of general practitioners, and the time spent on sick leave. It shows that acupuncture has sustained and clinically relevant benefits for primary care of chronic headaches, especially migraines.

Analysis of Cited Reference

The top 15 references in frequency and centrality are listed in Table 6. Among them, the top 5 references with the highest co-citations are Linde K (2005)[32] (Frequency=104), Diener HC (2006),[33] Linde K (2009),[34] Li Y (2012),[28] and Melchart D (2005),[35] and the highest centrality is Karst M (2001)[36,45] (Centrality=0.80) and is considered as the most important reference in the field, followed by Carlsson C (2002)[37,46], Xue CCL (2004)[38,47], Coeytaux RR (2005)[39,48] and Manias P (2000).[40,49] The co-citation map of references

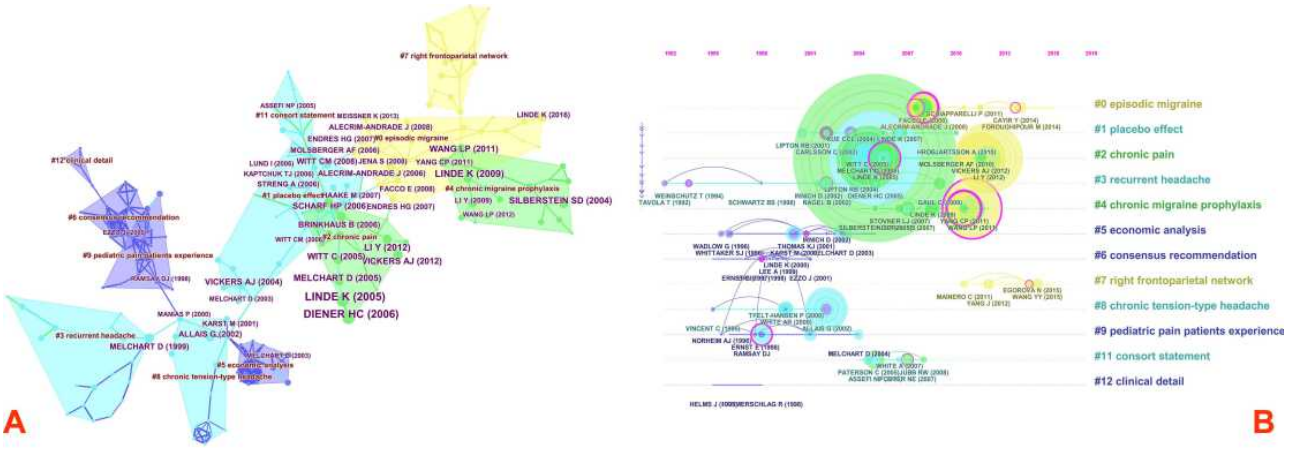

Figure 5 (**A**) Cluster map of Cited Reference based on label clusters with title terms. The combination of symbols and numbers delegates the Cited References' study of similar categories. (**B**) Timeline zone of Cited Reference on acupuncture for Migraine.

suggests the scientific relevance of the publications (Figure 5A). Here, the Modularity Q (0.8462) was higher than 0.7, which indicates that the network was reasonable. All clusters were labeled with index terms extracted from the references. The timeline view for all clusters, which stated clearly the time span and research progress in the development and evolution of each cluster sub-domain is presented in Figure 5B. In the cluster map, the 12 largest clusters (Table 7) (small clusters were automatically filtered), included #0 episodic migraine (Silhouette=0.939>0.7, Contains 27 references), #1 placebo effect, #2 chronic pain, #3 recurrent headache, #4 chronic migraine prophylaxis, #5 economic analysis, #6 consensus recommendation, #7 right frontoparietal network, #8 chronic tension-type headache, #9 pediatric pain patients experience, #11 consort statement, #12 clinical detail. Among them, the research categories closely related to acupuncture for migraine are as follows: ① #0 episodic migraine: Linde K et al[58] conducted a systematic review on the treatment of paroxysmal migraine with

Table 7 Cited Reference Concerned with Acupuncture for Migraine That Details of Knowledge Clusters

Cluster ID	Size	Silhouette	Mean (Year)	Label (LLR)	Label (MI)
0	27	0.939	2011	Episodic migraine	Prospective observational study
1	24	0.916	2005	Placebo effect	Prospective observational study
2	23	0.895	2007	Chronic pain	Prospective observational study
3	21	0.967	1999	Recurrent headache	Prospective observational study
4	21	0.951	2008	Chronic migraine prophylaxis	Prospective observational study
5	20	0.991	2000	Economic analysis	Prospective observational study
6	18	0.864	1998	Consensus recommendation	Prospective observational study
7	17	0.973	2013	Right frontoparietal network	Prospective observational study
8	14	0.921	1999	Chronic tension-type headache	Prospective observational study
9	14	0.893	1998	Pediatric pain patients experience	Chronic pain
11	9	0.971	2006	Consort statement	Prospective observational study
12	4	0.944	1996	Clinical detail	Chronic pain

Note: The cluster analysis results mainly include cluster ID, mean year, size, silhouette, label (LLR), and label (MI). Cluster ID is the number after clustering, and Size represents the number of members contained in the cluster. The larger the Size is, the smaller the number. Mean Year represents the average year of the literature in the cluster, which can be used to judge the distance of the cited literature in the cluster. The larger the log-likelihood ratio (LLR) is, the more representative the cluster category; mutual information (MI) is mainly used to represent the relationship between terms and categories in text mining, and it does not consider the frequency of feature words.

acupuncture and found that it is beneficial to add acupuncture in the treatment of acute migraine attacks or routine care; compared with fake acupuncture, compared with sham acupuncture, real acupuncture intervention is related to small and statistically significant effect after treatment and follow-up; paralleled with drug prevention, acupuncture has an advantage when treatment is completed. A series of randomized controlled trials subsequently demonstrated the above conclusions. Cayir Y[59] analyzed the potential mechanism of acupuncture to relieve migraine from the perspective of the microscopic composition of blood, and found that it may be related to the reduction of matrix metalloproteinase-2 activity; Nevertheless, the focus of Enrico Facco 's study[60] is to analyze the effectiveness of real acupuncture treatment in migraine without aura. The results demonstrate that compared with only using rizatriptan, real acupuncture is the only treatment that can provide a stable therapeutic effect. These studies are of great significance to acupuncture for migraine.② #2 chronic pain: Vickers AJ's meta-analysis[39] of individualized patient data through acupuncture treatment of chronic pain (back and neck pain, osteoarthritis, chronic headaches, and shoulder pain) found that acupuncture is effective in treating chronic pain, not just a placebo, and the conclusion of this analysis is somewhat different from some previous randomized controlled trials, which show that the treatment of migraine is not distinguished between patients who receive sham acupuncture, acupuncture or standard therapies; therefore, this suggests that follow-up researchers need to do more Large-sample, multi-center randomized controlled trials to further verify the effectiveness of acupuncture in the treatment of migraine and further clarify its treatment mechanism. ③#3 recurrent headache: Melchart D[44] used a systematic review to evaluate the effectiveness of acupuncture in the treatment of recurrent headaches. The existing evidence shows that acupuncture has a role in the treatment of recurrent headaches. However, the quality and quantity of evidence are not entirely convincing. Thus, large-scale clinical research is needed to evaluate the effectiveness and efficiency of acupuncture under real-life conditions. ④#7 right frontoparietal network: Li K[61] analyzed the related effects of standard acupuncture on the right frontal-parietal network of migraine patients based on functional magnetic resonance imaging technology. The results exhibited that acupuncture for migraine patients without aura is associated with the reduction of the inherent functional connection to the right frontal-parietal neural network. This provides new insights into the treatment-related neurological responses of patients with migraine without aura, and also offer a potential functional approach for treatment evaluation.

Analysis of Keywords

Table 8 shows keywords contributed to publications on acupuncture for migraine, the five most frequently used keywords were migraine (Frequency=234), acupuncture (228), headache (103), pain (81), and randomized controlled trial (78). And the most considerable keyword is needle acupuncture (centrality=0.99), followed by tension type headache (0.98), aura (0.84), prophylactic treatment (0.71), and quality of life (0.57). Ten clusters were obtained, with a Modularity Q of 0.7905. Mean Silhouette was 0.7733 >0.7. The 10 largest clusters are presented in Table 9. The timeline view shows that new keywords appeared almost every year (Figure 6B), and Figure 6A shows the Keyword-term cluster view, contained #0 topiramate treatment (Silhouette=0.972>0.7, Contains 17 keywords), #1 consort statement, #2 sham acupuncture intervention, #3 further research, #4 sham acupuncture intervention, #5 episodic migraine, #6 3-year follow-up study, #7 prophylactic treatment, #8 alternative therapy, #9 new era. Among them, the research categories closely related to acupuncture for migraine are as follows: ⑴ #0 topiramate treatment: Yang CP[53,62] compared the efficacy and tolerability of acupuncture and topiramate in the prevention of chronic migraine through a randomized controlled trial. The results showed that acupuncture is better than topiramate in the treatment of chronic migraine patients, mainly in the number of days of moderate/severe headache per month, the number of headache days per month, headache disability, several quality of life indicators reported by patients, and psychological stress. Hence, acupuncture should be considered as a treatment option for chronic migraine patients who are willing to receive this preventive treatment. ⑵ #2 sham acupuncture intervention: Foroughipour M[63] evaluated the effect of acupuncture in routine migraine prevention measures through a randomized controlled trial. Migraine patients were divided into an acupuncture group and a sham acupuncture group. The results showed that the monthly frequency of migraine patients in the true acupuncture group ranged from 5.1 to 3.4, and the monthly seizure frequency of the sham acupuncture group decreased from 5.0 to 4.4. The difference was significant,

Table 8 Keyword Contributed to Publications on Acupuncture for Migraine from 2000 to 2019

No.	Keyword	Frequency	Keyword	Centrality
1	Migraine	234	Needle acupuncture	0.99
2	Acupuncture	228	Tension type headache	0.98
3	Headache	103	Aura	0.84
4	Pain	81	Prophylactic treatment	0.71
5	Randomized controlled trial	78	Quality of life	0.57
6	Efficacy	75	Therapy	0.54
7	Prophylaxi	67	Disability	0.53
8	Placebo	65	Placebo	0.50
9	Tension type headache	62	Double blind	0.39
10	Double blind	60	Complementary medicine	0.38
11	Low back pain	46	Electrical nerve stimulation	0.30
12	Prevalence	44	Low back pain	0.26
13	Multicenter	41	Primary care	0.25
14	Clinical trial	39	Impact	0.22
15	Electroacupuncture	31	Electroacupuncture	0.21
16	Trial	31	Prevention	0.21
17	Osteoarthriti	30	Topiramate	0.21
18	Management	25	Reliability	0.20
19	Migraine prophylaxi	24	Onabotulinumtoxina	0.18
20	Knee	24	Migraine	0.17

Note: In this table, the other two identical columns represent different rankings. The left column of the table represents keywords that have published acupuncture for migraine. The frequency of contribution is sorted from high to low. The column on the right represents the sorting from high to low according to centrality.

suggesting that acupuncture can be seen as an auxiliary method of preventive drug treatment for patients with migraines, and preventive drug treatment cannot reduce the number of migraine attacks. Then Yang Y[64] compared the efficacy of acupuncture and sham acupuncture for migraines through meta-analysis. Although current clinical evidence demonstrates that acupuncture is better than sham acupuncture in the treatment of migraines, it has a higher total effective rate and low recurrence rate. However, large-sample clinical randomized controlled trials are still needed for in-depth verification and analysis. ⑰ prophylactic treatment: This category mainly involves two aspects of conventional acupuncture and ear acupuncture. Wallasch TM et al[50] aims to use transcranial Doppler ultrasound to assess the effect of acupuncture on the cerebrovascular response of migraine patients. Conventional acupuncture is used. Acupuncture points include Hegu, Zusanli, Waiguan, Zulinqi, Houxi, Shenmai, Baihui, Fengchi, Taiyang, Taixi, Sizhukong, etc., and the results display that standardized acupuncture for migraine patients may have a positive effect on the dysfunction of the cerebrovascular autonomic nerve stimulation response, but it has no positive effect on the cerebrovascular tone at rest. It provides a methodological reference for us to study migraines from the autonomous cerebrovascular response. Next is the study of ear acupuncture to prevent chronic migraine, Allais G et al[65] reveals that ear acupuncture can not only treat acute migraine but also supplies potential evidence for migraine prevention. Also, the

Table 9 Keyword Related to Acupuncture for Migraine That Details of Knowledge Clusters

Cluster ID	Size	Silhouette	Mean (Year)	Label (LLR)	Label (MI)
0	17	0.972	2005	Topiramate treatment	Chronic daily headache
1	13	0.876	2005	Consort statement	Chronic daily headache
2	13	0.964	2004	Sham acupuncture intervention	Chronic daily headache
3	12	0.893	2007	Further research	Chronic daily headache
4	12	0.718	2005	Sham acupuncture intervention	Botulinum toxin type
5	12	0.870	2011	Episodic migraine	Controlled trial
6	10	0.954	2005	3-year follow-up study	Multicentre randomized controlled trial
7	10	0.646	2008	Prophylactic treatment	Controlled trial
8	8	0.797	2001	Alternative therapy	Controlled trial
9	8	0.816	2008	New era	Controlled trial

Note: The cluster analysis results mainly include Cluster ID, mean year, size, silhouette, label (LLR), and label (MI). Cluster ID is the number after clustering, and Size represents the number of members contained in the cluster. The larger the Size is, the smaller the number. Mean Year represents the average year of the literature in the cluster, which can be used to judge the distance of the cited literature in the cluster. The larger the log-likelihood ratio (LLR) is, the more representative the cluster category; mutual information (MI) is mainly used to represent the relationship between terms and categories in text mining, and it does not consider the frequency of feature words.

therapeutic effect is significant during the extended period of once every 3 weeks. This prompts that more closely scheduling treatment may be of greater benefit. However, the limitation of this study is the lack of a control group, and the observation case is female. And it offers a basis for acupuncture at special parts to prevent migraines.

By comparing the results of institution clustering, author clustering, reference clustering, and keyword clustering, we found that randomized controlled trials of acupuncture prevention and treatment of migraine are common content, so it can be regarded as the key research content in the field.

Conclusions

A new perspective on the trends of acupuncture for migraine is provided by this study. Although this study has certain limitations, it fully promulgates the global trend of acupuncture for migraine and presents it to readers in the form of a visual knowledge mapping.

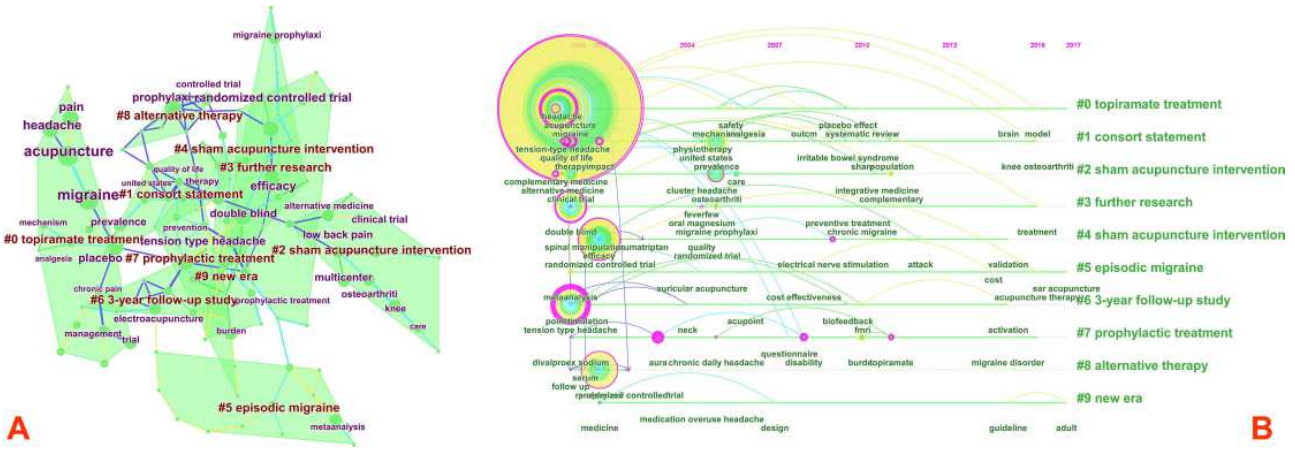

Figure 6 (**A**) Cluster map of Keyword based on label clusters with title terms. The combination of symbols and numbers delegates the Keywords' study of similar categories. (**B**) Timeline zone of Keyword on acupuncture for Migraine.

Most articles in this field were published in the USA and China, with the Technical University of Munich and Beijing University of Chinese Medicine contributing the most publications. The author who publishes the most papers is Linde K, and the most frequently co-cited literature is Linde K (2005). Most of the countries engaged in this field are in developed countries, and most of the momentous institutions are in China. However, the cooperation between different institutions and international cooperation is relatively weak. And the vital reference is Karst M published in 2001. Moreover, through knowledge mapping analysis, it is found that Randomized controlled trials of acupuncture in the prevention and treatment of migraine are the most important research content in this field. At last, the results of this research may offer researchers useful information, such as research frontiers, potential collaborators, Countries, and cooperative institutions.

Data Sharing Statement

The raw data supporting the conclusions of this article will be made available by Yanqing Zhao and Li Huang, without undue reservation.

Author Contributions

YZ designed this study. LH performed the search. YZ collected data. LH and WL rechecked data. YZ and LH performed analysis. HG and ML: critically revised the work. YZ and LH have contributed equally to this work and should be considered co-first authors. All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Research Limitations

There are several limitations of this study. Firstly, although the search strategy searches for synonyms of the MeSH subject words in PubMed, it may still cause some works of literature to be missed. Secondly, in our research, we only use the Science Citation Index-Expanded (SCIE) module in the Web of Science database. Although it contains most of the literature needed for research, it may still cause the loss of some literature. Thirdly, Citespace's function of removing duplication has certain limitations, which may bias the research results.

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Disclosure

The authors report no conflicts of interest in this work.

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