

Bibliometric Analysis of Research Trends on Acupuncture for Neck Pain Treatment Over the Past 20 Years

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Abstract: A bibliometric approach using network analytical methods was applied to explore the research trends on acupuncture for neck pain treatment. Publications related to acupuncture for neck pain treatment from 2000 to 2020 were retrieved from the Web of Science database. The extracted records were analyzed in terms of publication year, research area, journal title, country, organization, authors, and keywords. The research trends on acupuncture for neck pain treatment were visualized using the VOSviewer program. Analyses of 325 articles revealed that the total number of publications has continually increased over the last 20 years. The most represented research area was integrative complementary medicine. The country producing the most articles was the US, followed by China, England, and the Republic of Korea. By assessing the total link strength of organizations and authors, we identified influential organizations and authors who have contributed to research on acupuncture for neck pain treatment. A network analysis based on the cooccurrence of keywords revealed the following two major study designs: clinical study and research methodology. This study examined the research trends on acupuncture for neck pain treatment using bibliometric methods. Our findings provide useful guidelines for researchers in searching for relevant topics.

Keywords: acupuncture, bibliometric analysis, cervical pain, neck pain, network analysis

Introduction

Neck pain, which is caused by neck damage, stiff neck, or cervical disease, refers to pain and movement disorders in the neck area. It can be induced by trauma, invasion of external pathogens (eg, wind-cold dampness), weakness, or multiple causes. Consequently, neck pain can cause tension, movement disorders, stiffness, radiating pain, and other forms of pain.¹ It is a common musculoskeletal disease, and according to the 2017 statistics on the leading cause of global years lived with disability, it ranked 9th in women and 11th in men.² Almost half of adults experience neck pain at least once in their lifetime,³ and more than 50% of acute neck pain cases last longer than 1 year from onset.⁴ Although neck pain does not adversely influence an individual's life itself, it affects the quality of life.⁵

Conventional treatments, including drugs, injections, and surgeries, are known to reduce neck pain;^{6,7} however, these interventions can also induce adverse events, such as gastrointestinal, cardiovascular, and renal complications; nerve damage; hemorrhage; and readmission.^{8–10} Thus, an increasing number of patients seek complementary and alternative medicine (CAM) for effective and safe treatment of neck pain.

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Acupuncture therapy, which originated from ancient China,¹¹ is one of the most popular CAM therapies in the world and widely used to effectively manage neck pain.¹² Numerous studies have shown the benefits of acupuncture on neck pain, including pain relief,^{13–17} improved quality of life,¹⁸ reduced rate of cervical surgery,¹⁹ and cost-effectiveness.²⁰ One of the reasons patients seek acupuncture therapy is because of its safety and effectiveness. However, notwithstanding the popularity in clinics and research areas, no studies have yet analyzed the publication trends on acupuncture for neck pain treatment via visual analyses.

Bibliometric methods are quantitative methods that analyze large volumes of literature in a specific field using mathematical and statistical tools. By measuring the cooccurrence of information—authors, organizations, countries, keywords, and number of citations—in the literature, we can possibly understand various network relationships.²¹ This analytical method has been applied in many areas with large numbers of studies accumulated, including those on CAM. Jeon et al,²² Park et al,²³ Moon et al,²⁴ and Chen et al²⁵ employed a bibliometric method to explore the general prescription of acupuncture, moxibustion, bee venom, and traditional Chinese medicine formula. In addition, Lee et al²⁶ analyzed articles on acupuncture for pain treatment. Liang et al²⁷ also evaluated the research trends on acupuncture for low back pain, while Li et al²⁸ reviewed acupuncture therapy for knee osteoarthritis.

In this study, we aimed to (a) analyze a large number of studies on acupuncture for neck pain treatment from a macroscopic perspective using a bibliometric method, (b) understand the characteristics of network data among the studies, and (c) discuss future research directions and specific tasks that may be undertaken in related research areas.

Materials and Methods

Data Sources, Search Strategies, and Coding

A systematic literature search was conducted using the Web of Science database to identify relevant papers. The following search string was used to generate the initial search results: “(acupuncture OR electroacupuncture) AND (cervical pain OR neck pain).” This yielded 658 papers, which were further analyzed using the following inclusion criteria: (a) published from January 1, 2000 to December 4, 2020, (b) classified as an “article” or “review,” (c) written in English, and (d) had an abstract. The papers were manually selected on the basis of their titles and abstracts. Specifically, studies

on acupuncture with needle insertion, ear acupuncture, and electroacupuncture were included, whereas those on pharmacopuncture, injection, acupressure, laser acupuncture, and transcutaneous electrical nerve stimulation were excluded. Using these systematic criteria, we finally included 325 articles. The authors were processed on the basis of their full names.

Data Analysis

The papers were coded in terms of publication year, research area, journal, country, organization, authors, and keywords. The results were analyzed and visualized using VOSviewer (v1.6.15; The Center for Science and Technology Studies, Leiden University, Leiden, The Netherlands), a program that maps bibliometric network data.²⁹

In the visualization using the VOSviewer program, the attraction/repulsion values in the layout items were set differently to yield clear representations of each of the organization, author, and keyword items (organization: attraction, 4/repulsion, −2; author: attraction, 5/repulsion, −4; keywords: attraction, 3/repulsion, −1).

Results

Distribution by Year

The frequency of publication gradually increased from 5 publications in 2000 to 25 in 2018. Throughout the steady increase observed every year, 44 papers were published in 2019, which was the highest recorded number of publications in a year (Figure 1).

Distribution by Research Area

In terms of research area, the area of integrative and complementary medicine (38.2%) yielded the most papers, followed by the areas of neuroscience and neurology (21.2%), general and internal medicine (15.7%), rehabilitation (13.2%), and anesthesiology (10.8%) (Table 1).

Distribution by Journal Title

In terms of journals, *Evidence-based Complementary and Alternative Medicine* (5.8%) was the most frequently publishing journal, followed by the *Journal of Alternative and Complementary Medicine* (5.2%), *Acupuncture in Medicine* (3.7%), *Complementary Therapies in Medicine* (3.7%), and *Pain* (3.4%) (Table 2).

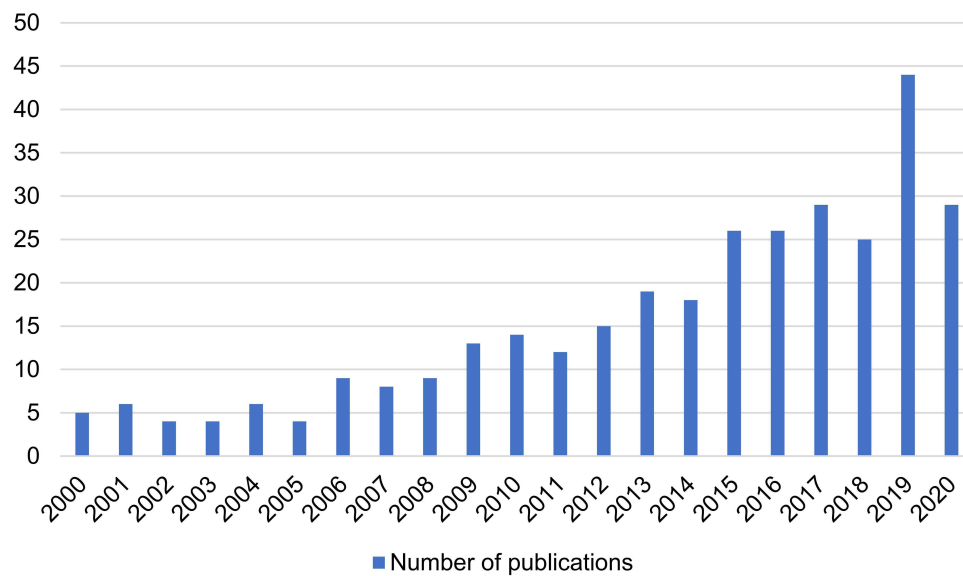


Figure 1 Distribution of publications by year.

Distribution by Country

In terms of publishing countries, the US (30.5%) had the most publications, followed by China (21.8%), England (12.0%), the Republic of Korea (10.2%), and Germany (7.4%) (Table 3).

Distribution by Organization

In terms of research organizations, the University of York, UK, (5.5%) and Kyung Hee University (4.3%) published the most papers, followed by Jaseng Hospital of Korean Medicine and Memorial Sloan Kettering Cancer Center,

Table 1 Distribution of the Publications by Research Area

	Research Area	Records (n)	% (of 325)
1	Integrative and complementary medicine	124	38.2
2	Neurosciences and neurology	69	21.2
3	General and internal medicine	51	15.7
4	Rehabilitation	43	13.2
5	Anesthesiology	35	10.8
6	Orthopedics	33	10.2
7	Sport sciences	15	4.6
8	Research and experimental medicine	12	3.7
9	Rheumatology	11	3.4
10	Health care sciences and services	8	2.5
	Science and technology - other topics	8	2.5
12	Oncology	4	1.2
13	Emergency medicine	3	0.9
14	Dentistry, oral surgery, and medicine	2	0.6
	Engineering	2	0.6
	Pharmacology and pharmacy	2	0.6
	Surgery	2	0.6
	Veterinary sciences	2	0.6

Table 2 Distribution of the Publications by Journal Title

	Journal Title	Records (n)	% (of 325)	IF*
1	<i>Evidence-based Complementary and Alternative Medicine</i>	19	5.8	1.813
2	<i>Journal of Alternative and Complementary Medicine</i>	17	5.2	2.256
3	<i>Acupuncture in Medicine</i>	12	3.7	2.129
	<i>Complementary Therapies in Medicine</i>	12	3.7	2.063
5	<i>Pain</i>	11	3.4	5.483
6	<i>Trials</i>	10	3.1	1.883
7	<i>Clinical Journal of Pain</i>	9	2.8	2.893
8	<i>European Spine Journal</i>	8	2.5	2.458
9	<i>BMJ Open</i>	7	2.2	2.496
	<i>Medicine</i>	7	2.2	1.552
	<i>PLoS One</i>	7	2.2	2.740
12	<i>American Journal of Chinese Medicine</i>	6	1.8	3.682
	<i>American Journal of Physical Medicine & Rehabilitation</i>	6	1.8	1.838
	<i>European Journal of Integrative Medicine</i>	6	1.8	0.974
	<i>European Journal of Pain</i>	6	1.8	3.492
	<i>Journal of Acupuncture and Tuina Science</i>	6	1.8	-

Note: *IF was reported according to 2019 journal citation reports.

Abbreviation: IF, impact factor.

with 11 articles (3.4%) each. The University of Southampton ranked fifth, with 10 papers (3.1%) published (Table 4).

The organizations were analyzed using VOSviewer. First, the organizations that published more than three papers were identified. Of 73 organizations, 59 were divided into six clusters (Figure 2A). Cluster 1 consisted of 15 organizations, including the University of Alberta, University of Toronto, and Canadian Memorial Chiropractic College. Cluster 2 consisted of 14 organizations, including the University of York, UK, Memorial Sloan Kettering Cancer Center, and the University of Southampton. Cluster 3 consisted of 10 organizations, including the China Academy of Chinese Medical Sciences, Harvard University, and Beijing University of Chinese Medicine. Cluster 4 consisted of nine organizations, including the University of California, Los Angeles; Karolinska Institute; and Stanford University. Cluster 5 consisted of seven organizations, including Kyung Hee University, Jaseng Hospital of Korean Medicine, and the Korea Institute of Oriental Medicine. Cluster 6 consisted of four organizations, including China Medical University Taiwan, China Medical University Hospital, Taiwan City Hospital, and Taipei City Hospital.

Table 3 Distribution of the Publications by Country

	Country	Records (n)	% (of 325)
1	US	99	30.5
2	China	71	21.8
3	England	39	12.0
4	Republic of Korea	33	10.2
5	Germany	24	7.4
6	Australia	22	6.8
	Canada	22	6.8
8	Taiwan	13	4.0
9	Brazil	12	3.7
10	Iran	9	2.8
	Japan	9	2.8
12	Spain	8	2.5
	Sweden	8	2.5
	Switzerland	8	2.5
15	Italy	6	1.8

Second, the results were classified according to the average publication year by organization (Figure 2B). The yellow color in Figure 2B indicates that the

Table 4 Distribution of the Publications by Organization

	Organization	Records (n)	% (of 325)
1	University of York, UK	18	5.5
2	Kyung Hee University	14	4.3
3	Jaseng Hospital of Korean Medicine Memorial Sloan Kettering Cancer Center	11 11	3.4 3.4
5	University of Southampton	10	3.1
6	China Academy of Chinese Medical Sciences Harvard University University of Alberta	9 9 9	2.8 2.8 2.8
9	China Medical University Taiwan Korea Institute of Oriental Medicine University of Toronto	8 8 8	2.5 2.5 2.5
12	Canadian Mem Chiropract Coll Institute for Work & Health McMaster University	7 7 7	2.2 2.2 2.2
15	Beijing University of Chinese Medicine Chengdu University of Traditional Chinese Medicine New York University Pusan National University Technical University of Munich University of California, Los Angeles University of Exeter University System of Maryland	6 6 6 6 6 6 6 6	1.8 1.8 1.8 1.8 1.8 1.8 1.8 1.8

organizations had published papers in recent years, and the blue color indicates otherwise. The University of Munich in Germany had the oldest average publication year (2007.0). The Icahn School of Medicine at Mount Sinai and Oregon Health & Science University in the US had the most recent average publication year (2019.0).

Third, the publications from every organization were classified according to their average number of citations (Figure 2C). The yellow color in Figure 2C indicates more citations, and the blue color indicates otherwise. The network map of the average number of citations revealed that Keele University in England had the highest average number of citations (238.0), while Daejeon University had the lowest average number of citations (1.7).

Distribution by Author

In terms of authors, Hugh MacPherson of the University of York, UK, (5.5%) had published the most papers, followed by Claudia Witt of the University Hospital Zurich (4.0%), In-Hyuk Ha of Jaseng Hospital of Korean Medicine (3.4%), Andrew Vickers of Memorial Sloan Kettering

Cancer Center (3.1%), and Pierre Cote of Ontario Tech University (2.8%) (Table 5).

The authors were analyzed using the VOSviewer program. First, 60 of the 81 authors who had published more than three papers were classified into six clusters (Figure 3A). Cluster 1 consisted of 13 authors, including Kristi Randhawa, Yu Hainan, and Carlo Ammendolia. Cluster 2 consisted of 13 authors, including Hugh MacPherson, Kathleen Ballard, and Julia Woodman. Cluster 3 consisted of 12 authors, including Claudia Witt, Andrew Vickers, and Dominik Irnich. Cluster 4 consisted of 11 authors, including Pierre Cote, Margareta Nordin, and Linda Carroll. Cluster 5 consisted of seven authors, including In-Hyuk Ha, Me-riong Kim, and Yoon Jae Lee. Cluster 6 consisted of four authors, including Cesar Amorim, Daniela Aparecida Biasotto-Gonzalez, and Nivea Cristina De Melo.

Second, the author results were analyzed according to the average publication year (Figure 3B). The yellow color indicates the authors who had published in recent years, and the blue color indicates otherwise. According to the

B by year

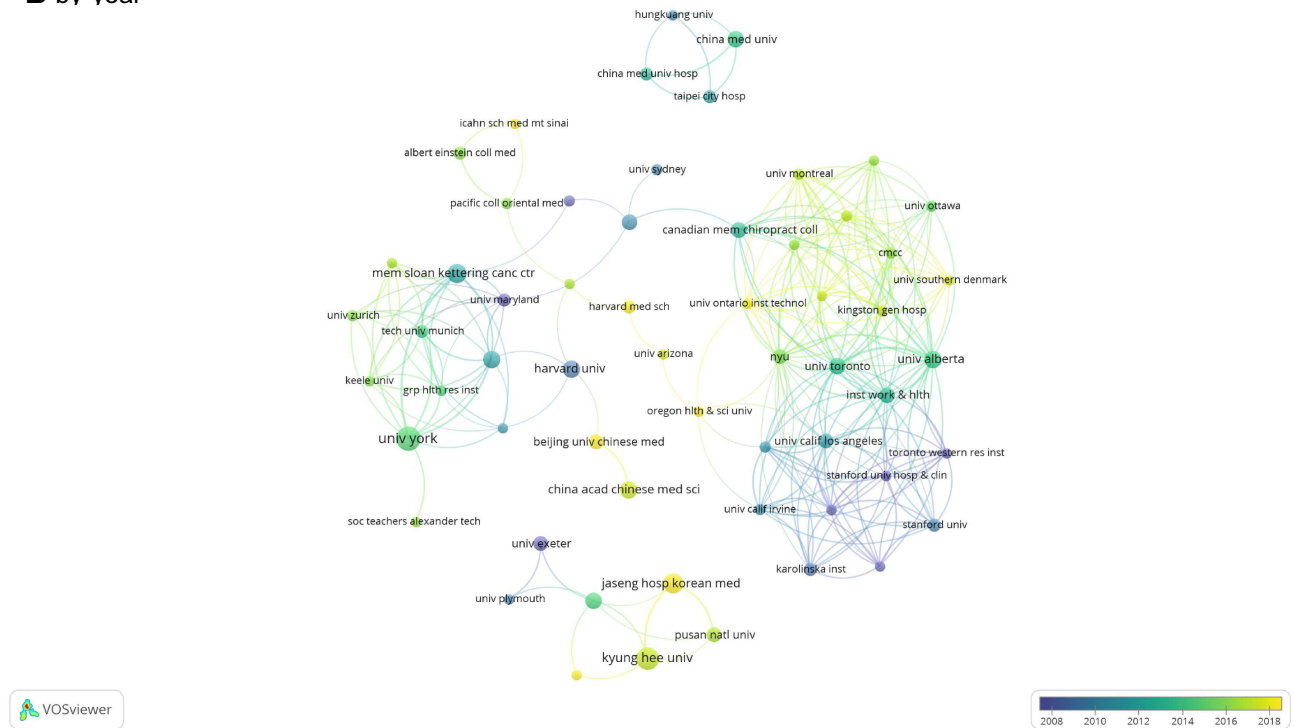


Figure 2 Continue.

C by citation

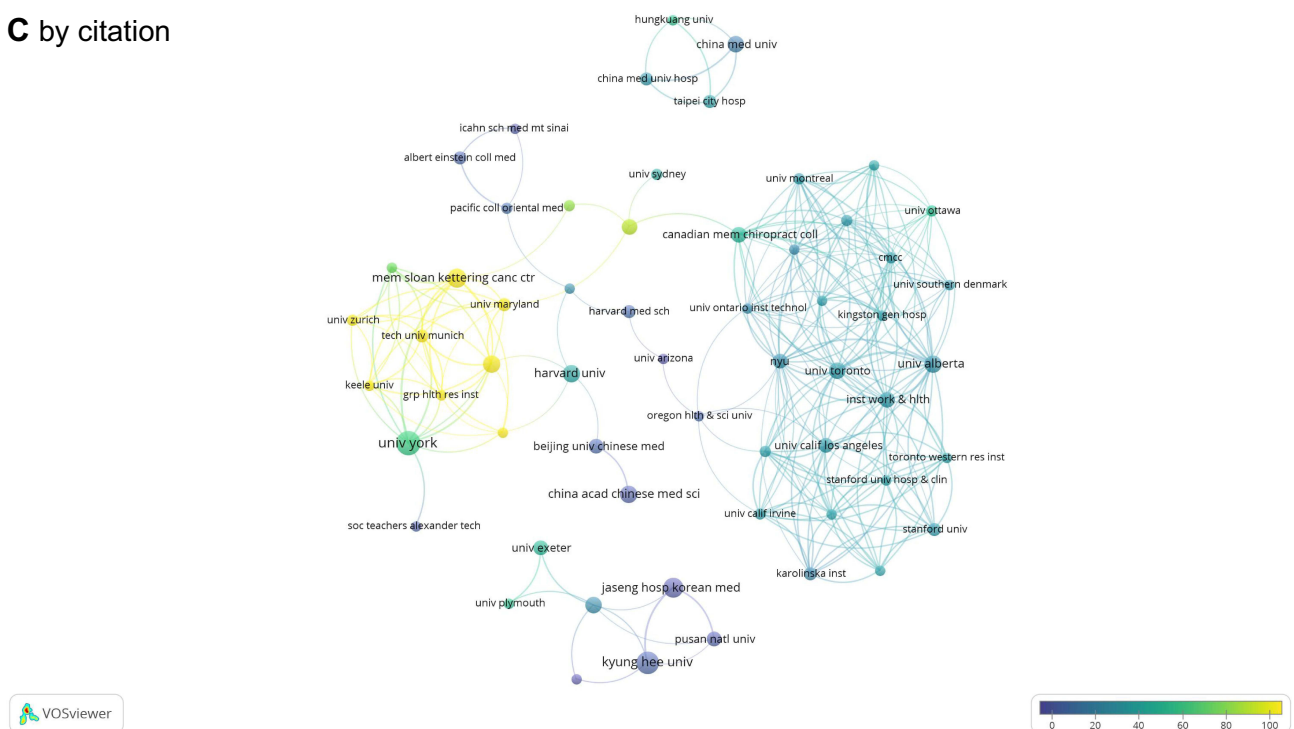


Figure 2 (A) Network map of the six clusters of organizations. (B) Network map of the organizations according to the average publication year. (C) A network map of organizations according to the average citations.

Table 5 Distribution of the Publications by Author

	Author	Records (n)	% (of 325)
1	Hugh MacPherson (University of York, UK)	18	5.5
2	Claudia Witt (University Hospital Zurich, Switzerland)	13	4.0
3	In-Hyuk Ha (Jaseng Hospital of Korean Medicine, Republic of Korea)	11	3.4
4	Andrew Vickers (Memorial Sloan Kettering Cancer Center, US)	10	3.1
5	Pierre Cote (Ontario Tech University, Canada)	9	2.8
6	Me-riong Kim (Jaseng Hospital of Korean Medicine, Republic of Korea)	8	2.5
	Yoon Jae Lee (Jaseng Hospital of Korean Medicine, Republic of Korea)	8	2.5
	Margareta Nordin (New York University, US)	8	2.5
9	Linda Carroll (University of Alberta, Canada)	7	2.2
	Dominik Irnich (University of Munich, Germany)	7	2.2
	Jinho Lee (Jaseng Hospital of Korean Medicine, Republic of Korea)	7	2.2
	Lewith George (University of Southampton, England)	7	2.2
	Karen Sherman (Kaiser Permanente Washington Health Research Institute, US)	7	2.2
	Gabrielle van der Velde (Toronto Health Economics and Technology Assessment THETA Collaborative, Canada)	7	2.2
	Stefan Willich (Charite Medical University of Berlin, Germany)	7	2.2

Discussion

The main finding of this study with a total of 325 selected papers is that we were able to identify the research trends on acupuncture for neck pain treatment using visual methods, including tables and figures. The number of research studies on this treatment method has gradually increased over the last two decades, indicating that acupuncture is becoming more popular among researchers, clinicians, and patients.

The area of the top publishing journal was integrated and complementary medicine. This indicates that papers on acupuncture for neck pain treatment are more favored in CAM journals that are focused on the intervention of traditional Chinese medicine than in other department-specific medical journals. Researchers need to broaden their choice of journal to journals of other areas to better disseminate information on the excellence of acupuncture among medical professionals who only have a keen interest in Western medicine.

In terms of publishing countries, the US, China, England, the Republic of Korea, and Germany were the top five countries researching on this topic. If the database was not limited to the English-based Web of Science database, Asian countries would have more published records because acupuncture is widely accepted in East Asian countries.

In terms of authors, Hugh MacPherson, Claudia Witt, and In-Hyuk Ha were the top three authors with the highest number of published papers. Cluster 1 mainly included Canadian authors from Ontario Tech University, while Cluster 2 had the most English authors from the University of York, UK. European authors were primarily included in Cluster 3, with authors from Charite Medical University of Berlin forming the largest group of researchers. The highest average number of citations in Cluster 3 was 113.2. Nadine Foster of England, who had the highest average number of citations, was also included in Cluster 3. The average publication year was 2011.4, which was the second oldest. The authors in Cluster 4 were from different organizations, but with most of them hailing from the US and Canada. The average publication year was 2010.6, which was the oldest. Cluster 5 included researchers from the Republic of Korea, specifically Jaseng Hospital of Korean Medicine, Kyung Hee University, and Pusan National University. The average publication year was 2017.7, which was the most recent among the clusters. Among the authors in Cluster 5, Yoon Jae Lee had an average publication year of 2018.5, which indicates that he had published several articles in recent years. In Cluster 6, there were numerous authors from Universidade Nove de Julho, all of whom were from

A by cluster

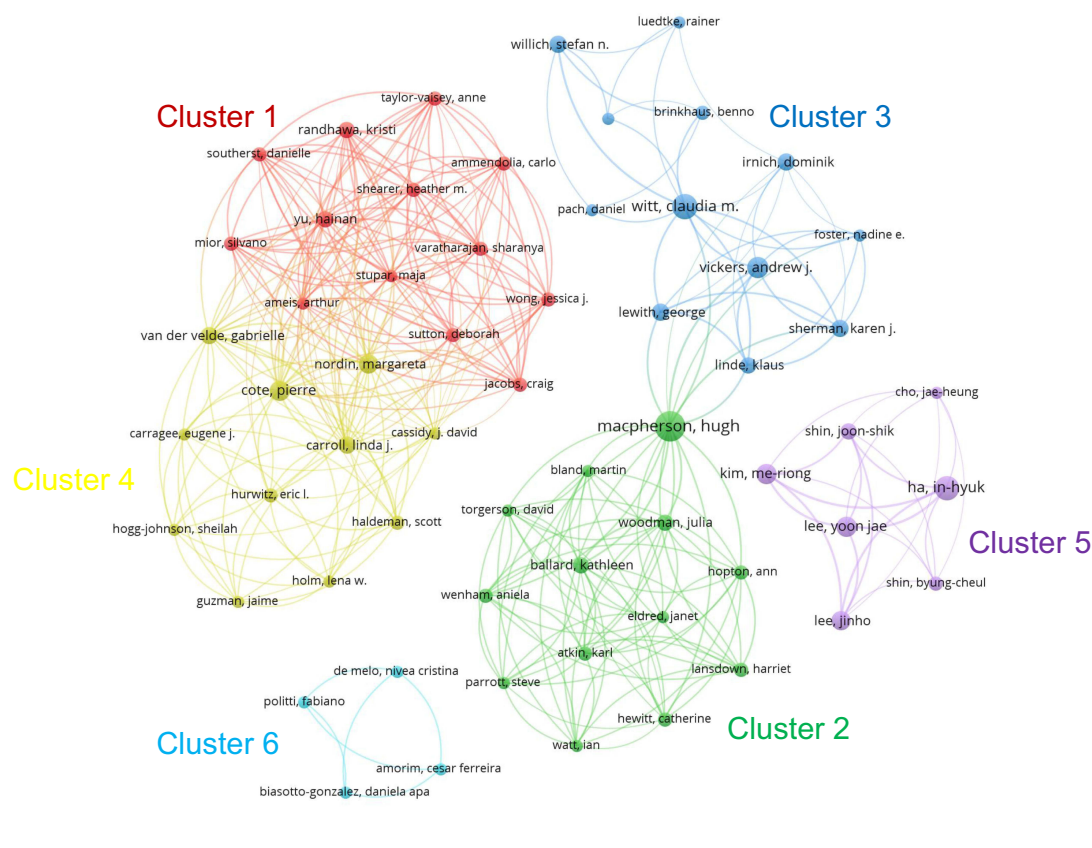


Figure 3 Continue.

Brazil. Our analysis revealed that the average number of citations of the papers published by European authors was generally high.

Organizations in the Republic of Korea had recently published a large number of research studies on acupuncture, ranking fourth in terms of the number of publications by country. It appears that organizations the Republic of Korea have made significant progress in a short period compared to older and more established organizations in Europe. However, the average number of citations of the publishing authors in the Republic of Korea (6.0) was the second lowest. The gap between the two types of ranking lists indicates that many studies are published but less cited in other studies; this finding needs to be pointed out to the researchers in the country.

The top ranking authors were also analyzed according to the contents of the studies. First, we determined that some authors, including Hugh MacPherson of Cluster 2 and Claudia Witt, Andrew Vickers, Dominik Irnich, George Lewith, Karen Sherman, Stefan Willich, and Nadine Foster of Cluster 3, were members of

Acupuncture Trialists. They studied chronic pain treated with acupuncture.^{30,31} This group disclosed that among several patient characteristics, the pain severity at baseline was related to the effect of acupuncture on chronic pain.³² However, the application of this criterion in clinical situations is limited because of lack of clinical applicability. Second, Pierre Cote, Margareta Nordin, Linda Carroll, and Gabrielle van der Velde of Cluster 4 are often involved in the same studies. They were included in the task force on neck pain and usually conducted studies according to clinical practice guidelines.³³ Among the authors from the Republic of Korea in Cluster 5, In-Hyuk Ha, Me-riong Kim, Yoon Jae Lee, and Jinho Lee from Jaseng Hospital of Korean Medicine co-authored several articles. This group usually conducted studies on the effect of acupuncture and electroacupuncture on neck pain.^{19,34}

In terms of keywords, those in Cluster 1 were commonly used terms in clinical trials, including “group,” “week,” “score,” “session,” and “acupuncture treatment.” The keywords in Cluster 2 were terms related to research methodology, including “therapy,” “evidence,” “data,”

B by year

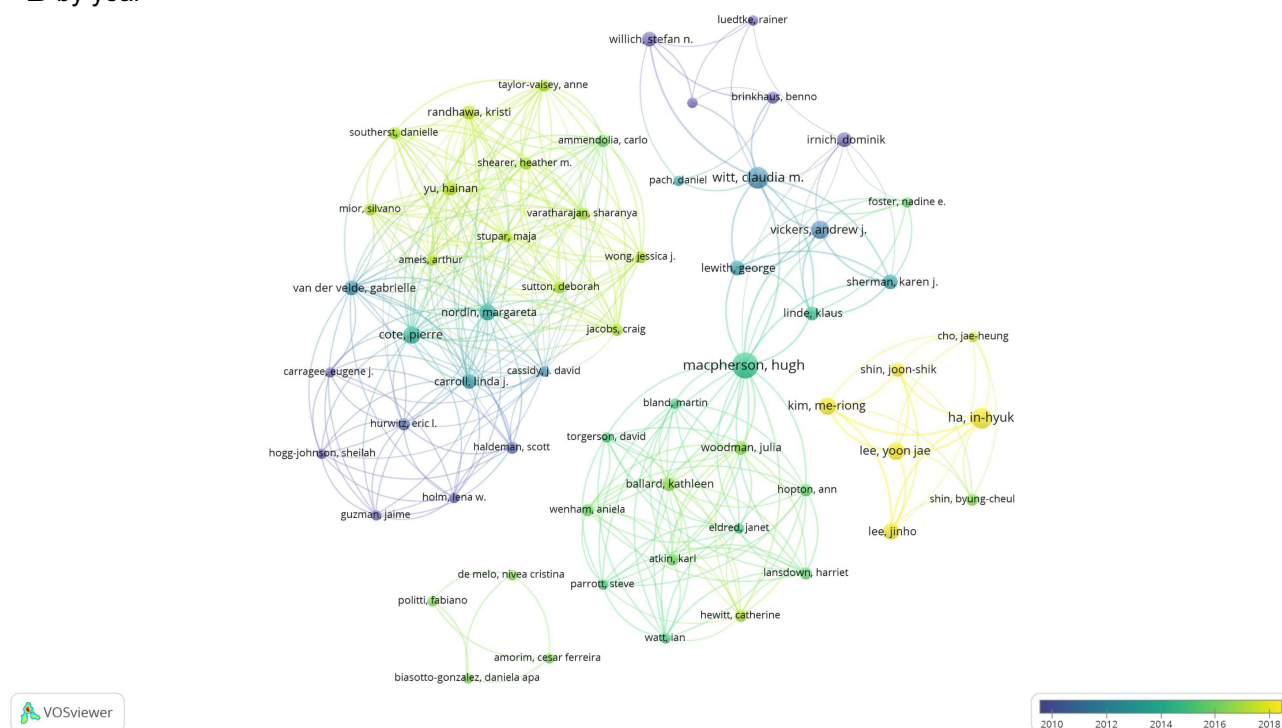


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C by citation

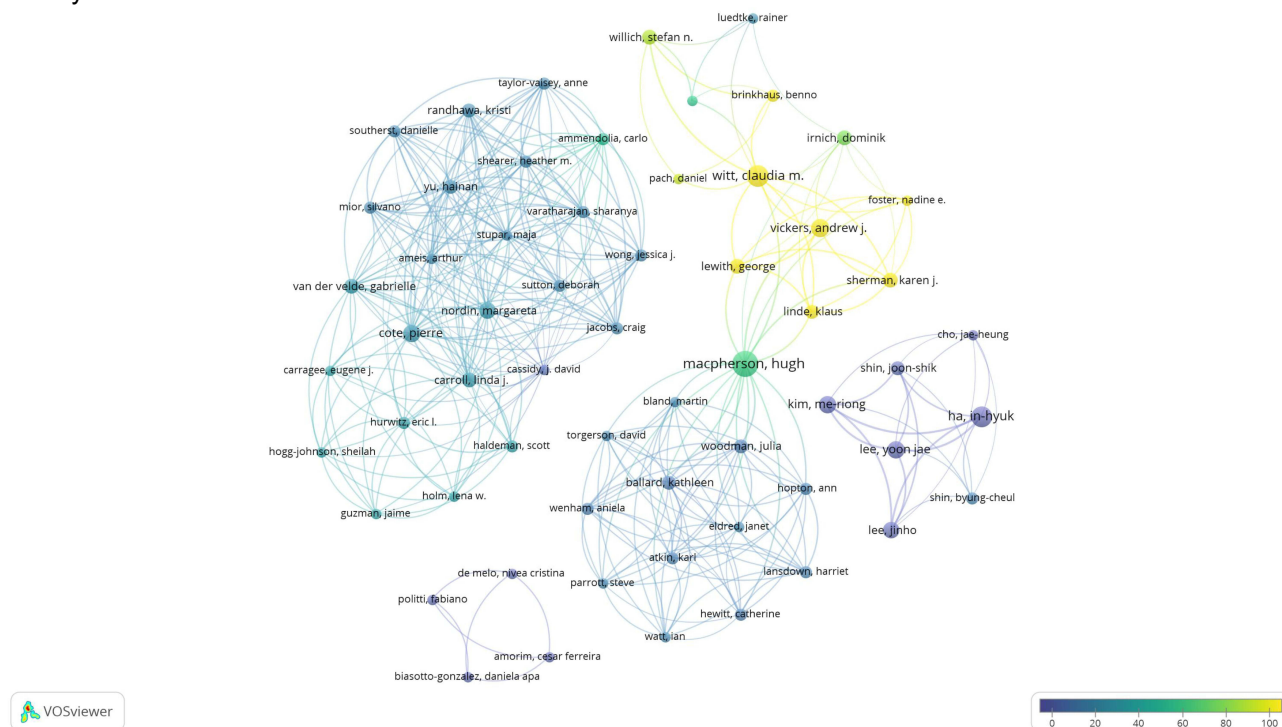


Figure 3 (A) Network map of the six clusters of authors. (B) Network map of the authors according to the average publication year. (C) Network map of the authors according to the average number of citations.

A by cluster

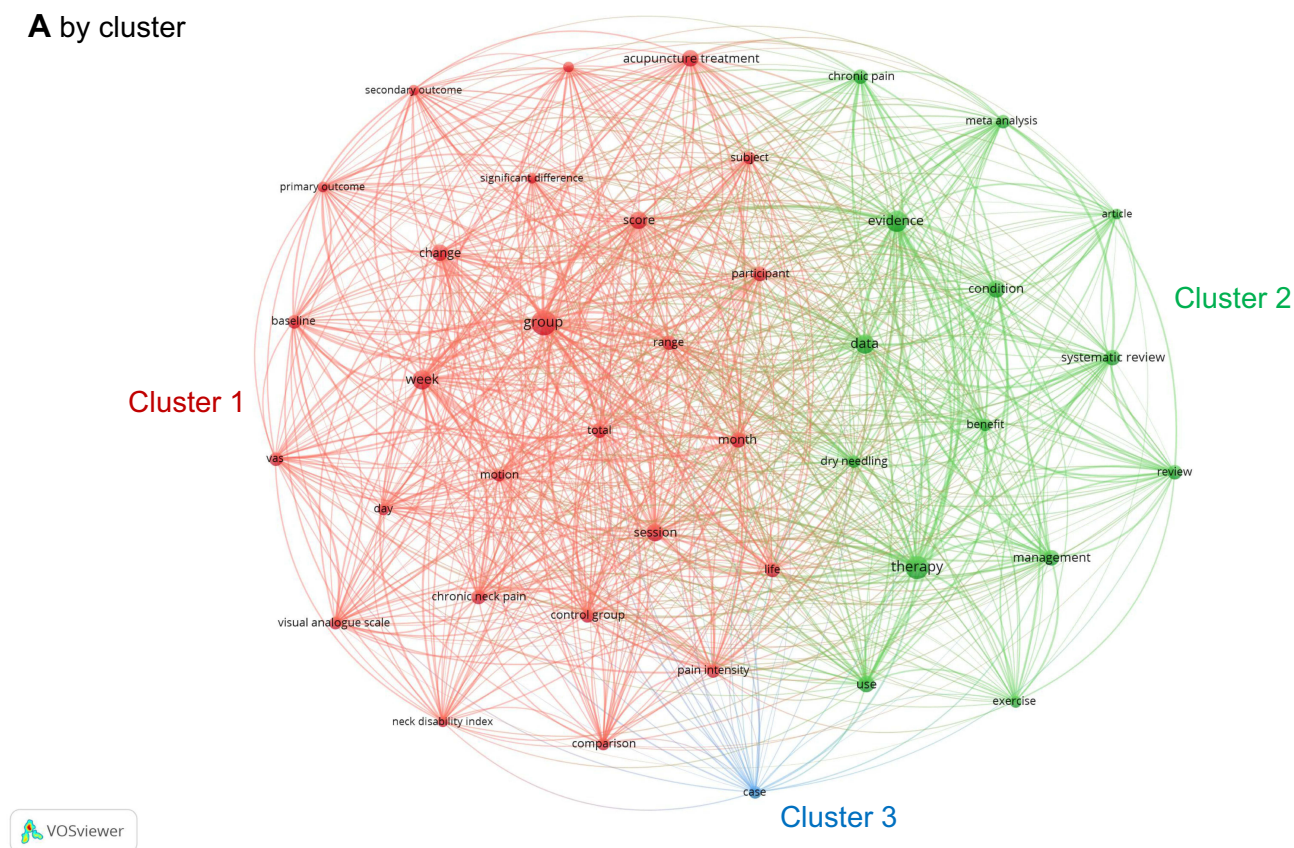


Figure 4 Continue.

“condition,” “systematic review,” and “meta-analysis”. The keywords in Cluster 3 were insufficient for analysis, as only one keyword (“case”) was retrieved. Cluster 2 had an earlier average publication year and a higher average number of citations than the other clusters. There appeared to be diverse opportunities for these papers to be cited, as they had the earliest average publication year.

This study has some limitations. Only papers written in English in the Web of Science database were retrieved in this study. Limiting the database to only one source can yield lopsided results but also has an advantage of providing information on clear and lucid research trends in a highly trusted database. Second, this study included various studies of different quality with the same emphasis on each article. Without relation to the type and the quality of studies, bibliometric analysis only explores on the distribution and the number of conducted studies. However, this is a characteristic of the analysis and it targets the quantitative research trend.

Our results suggest several important directions for further research on acupuncture for neck pain treatment. First, we suggest the construction of a more detailed and

precise search string that includes relevant keywords not only on neck pain but also on other diseases. The keywords used in this research were “acupuncture” and “neck pain” but these might not be enough to encompass all the diseases that can cause neck pain. Second, considering that this research was conducted on the basis of papers written only in English, further analyses of papers written in other languages would illustrate more accurate research trends on acupuncture for neck pain treatment. Third, as this study broadly reviewed different types of papers, focusing on clinical trials would better capture clinical research trends. Finally, the results of this study could contribute to future research on thoracic spine, pelvic girdle, and joint diseases.

Conclusion

This study analyzed 325 papers on acupuncture for neck pain treatment to analyze research trends over the last two decades using a bibliometric approach. First, our analysis showed that the number of publications increased from 2000 to 2020. Specifically, the number of studies had steadily increased since 2015, demonstrating that research had been actively conducted. Second, in terms of research area and journals,

B by year

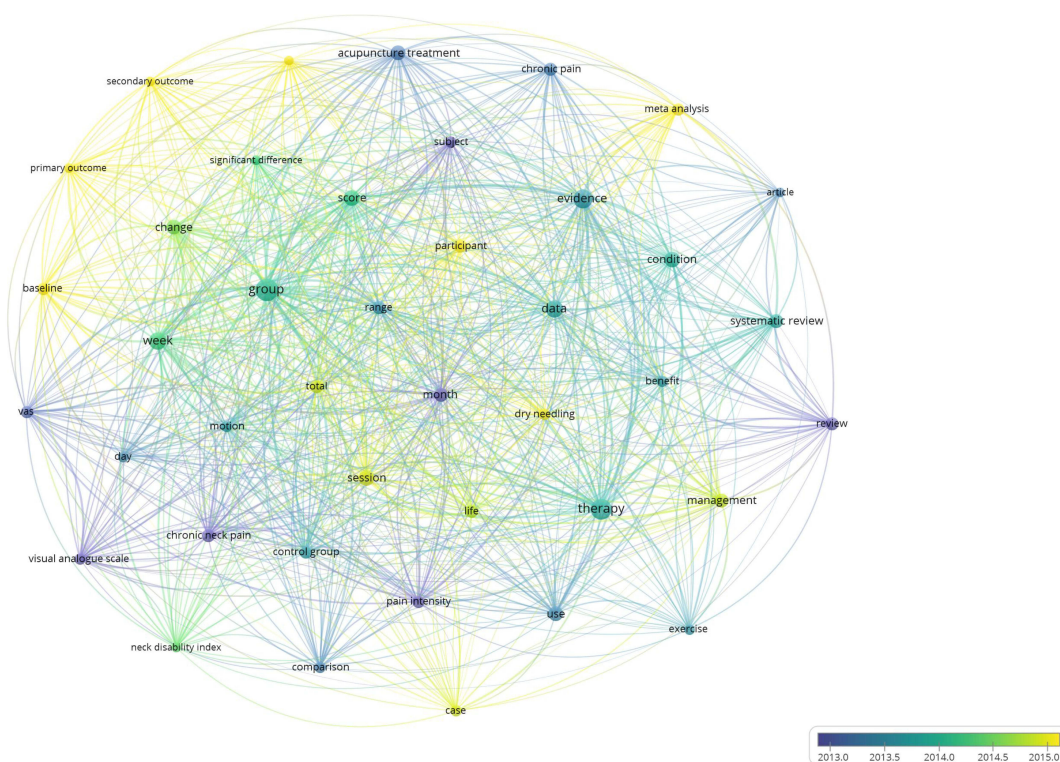


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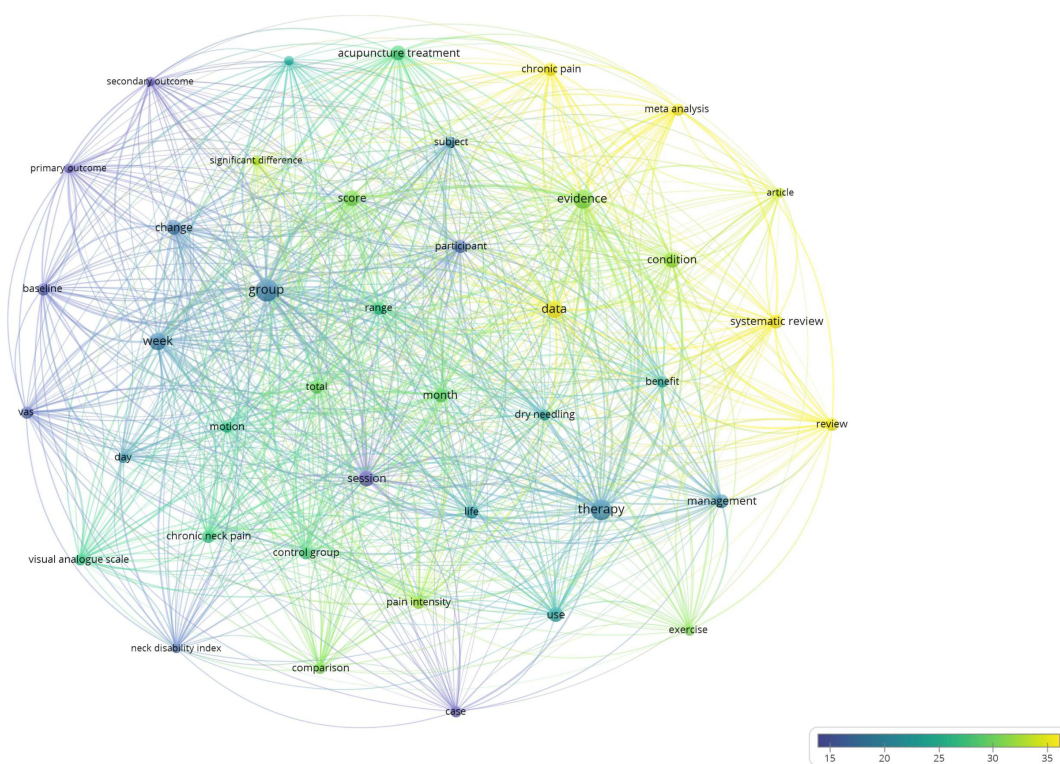


Figure 4 (A) Analysis of the three clusters of keywords. **(B)** Analysis of the keywords according to the average publication year. **(C)** Analysis of the keywords according to the average number of citations.

Table 6 Clusters of the Keywords by the Average Publication Year and Number of Citations

Cluster	Label	Occurrences	Publication Year (Average)	Number of Citations (Average)
1	Acupuncture treatment	65	2013.3	27.8
	Baseline	42	2015.4	15.9
	Change	62	2014.5	18.3
	Chronic neck pain	51	2012.9	27.0
	Comparison	36	2013.4	30.1
	Control group	44	2013.7	27.6
	Day	33	2013.4	20.2
	Group	149	2014.0	18.7
	Life	49	2014.7	21.2
	Month	57	2012.8	28.7
	Motion	39	2013.7	25.9
	Neck disability index	29	2014.4	17.1
	Pain intensity	45	2012.9	31.3
	Participant	53	2015.3	17.1
	Pressure pain threshold	28	2015.0	23.8
	Primary outcome	29	2016.4	11.3
	Range	50	2013.5	26.6
	Score	75	2014.1	30.0
	Secondary outcome	27	2016.4	10.7
	Session	75	2014.9	14.1
	Significant difference	28	2014.2	32.1
	Subject	40	2012.9	19.7
	Total	51	2014.8	29.2
	VAS	46	2013.2	16.3
	Visual analog scale	39	2012.3	26.3
	Week	87	2014.2	18.8
2	Article	30	2013.3	32.9
	Benefit	41	2013.7	23.4
	Chronic pain	49	2013.3	40.9
	Condition	70	2013.9	31.2
	Data	85	2013.8	36.9
	Dry needling	37	2015.5	22.2
	Evidence	109	2013.6	30.3
	Exercise	31	2013.6	30.2
	Management	57	2014.8	20.0
	Meta-analysis	43	2015.5	41.8
	Review	54	2012.9	34.6
	Systematic review	61	2013.8	43.8
	Therapy	123	2013.9	19.6
	Use	66	2013.4	22.7
3	Case	37	2014.8	11.7
	Cluster 1	51.1	2014.1	22.5
	Cluster 2	61.1	2013.9	30.8
	Cluster 3	37.0	2014.8	11.7

a number of papers had been published in the fields of CAM and pain. Third, in terms of countries, the largest number of papers had been published in the US and in Northeast Asian countries, such as China, Republic of Korea, Taiwan, and Japan. Fourth, in terms of organizations, the University of

York, UK, had published the most papers, followed by Kyung Hee University and Jaseng Hospital of Korean Medicine. Fifth, in terms of authors, the publishing authors from Europe had the highest average number of citations, while more authors from the Republic of Korea had recently

published more studies. In addition, the top three groups that published co-authored papers were also identified. Sixth, our analysis revealed two major topics: (a) topics used in clinical trials on acupuncture and (b) topics related to research methodology.

Data Sharing Statement

Data may be provided through the corresponding author's email.

Ethics Approval and Informed Consent

This study did not include any patient information. Thus, the requirement for ethics approval was waived.

Acknowledgments

This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF-2017R1A2B4011707).

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF-2017R1A2B4011707).

Disclosure

JP and HK are the co-first authors. The authors report no conflicts of interest related to this work.

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