

Bibliometric analysis of integrated complementary medicine research articles included in Science Citation Index

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More and more new concepts and methods are surfacing thanks to integrated complementary medicine research. As many laws and new discoveries have been covered in the sea of existing literature, understanding research progress and following its direction has become difficult for researchers. This study investigates the global development of integrated complementary medicine research over the past ten years through bibliometric analysis to provide reference to researchers for future work. Searched and selected were articles in 22 integrated complementary medicine journals published globally in the Web of Science database. Analysis of the articles was based on changes of publication years, geographical distribution, research institutes, research fields and so on with multiple bibliometric analysis methods. Generally, the total amount of integrated complementary medicine research articles has increased. However, there was a slight decrease in the last two years. Research in China, US and South Korea has taken the dominant position. Integrated complementary medicine is the inevitable trend of the development of Chinese medicine and even world medicine. Traditional Chinese medicine should take in achievements of modern technology to make breakthroughs. Although research in the last two years declined compared with the peak time of 2013, integrated complementary medicine research will still flourish. There will be more and more research institutes and researchers involved in the near future.

Keywords: Integrated complementary medicine; Science Citation Index (SCI); Development; Bibliometrics

INTRODUCTION

Integrated complementary medicine is a recently developed medical discipline with Chinese characteristics. It combines the essence of traditional Chinese medicine (TCM) and modern medicine in an attempt to develop medical science by applying modern science, including modern medical theories and methods, to studying the fundamental theories and clinical practice of TCM [1]. At present, it has become an indispensable part of the Chinese medical and health system. In recent years, with the rapid development and infiltration of molecular biology and computer science, integrated complementary medicine research has been greatly improved. The discovery of new concepts and methods has promoted this research, and the amount of related articles and reports has been increasing [2]. The features of the development of medical literature rapidly increase, including duplication, scattered contents, and quick updates. All these features create difficulties for researchers in immediate, correct and comprehensive understanding of literature. Therefore, it is necessary to analyze and study

literature with scientific methods. Bibliometrics, which is applied in medical literature research, has provided an effective method. [3]

Bibliometrics is a cross-discipline quantitative analysis of information repositories. It has been widely used in medical research including HIV [4], tuberculosis [5], Parkinson's [6], Alzheimer's diseases [7], TCM [8] and acupuncture [9]. This study statistically analyzed articles from 22 Science Citation Index (SCI) journals related with 'general medicine and complementary medicine' in the area of Chinese Academy of Sciences in 2013. The changes in publication years, geographical distribution, research institutes, research highlights and keywords were studied to understand the current situation and the trends of development to provide reference for future research.

MATERIALS AND METHODS

The literature data we analyzed were collected from the Web of Science database by the Information Sciences Institute (ISI). Search terms included 22 general medicine and complementary medicine SCI journal names selected according to 2012 Journal Citation Reports (JCR), 2013 JCR Journal Categories Index by China Academy of Sciences (*Alternative Medicine Review*, *Phytomedicine*, *Journal of Ethnopharmacology*, *Integrative Cancer Therapies*, *American Journal of*

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Chinese Medicine, Complementary Therapies in Medicine, BMC Complementary and Alternative Medicine, Evidence-based Complementary and Alternative Medicine, Journal of Manipulative and Physiological Therapeutics, Journal of Alternative and Complementary Medicine, Alternative Therapies in Health and Medicine, Chinese Journal of Integrative Medicine, Acupuncture in Medicine, Explore-the journal of Science and Healing, Homeopathy, Acupuncture & Electro-Therapeutic Research, Journal of Traditional Chinese Medicine, European Journal of Integrative Medicine, African Journal of Traditional, Complementary and Alternative Medicines, Holistic Nursing Practice, Journal of the Australian Traditional-Medicine Society Chinese Medicine) and ‘integrative complementary medicine’. As the earliest literature accessed was in 2004, the years in our study were limited from 2004 to 2016. All literature sources searched were downloaded and imported to EndNote with ‘Full Record’. The information regarding title, abstract, keywords, publication year, authors, and research institutes was statistically analyzed with Excel 2010. RefViz software was used to study the keywords and research highlights. The search of the literature was completed on September 6th, 2017. Final data were included in the database on the day.

The statistics of core country/region publishing relative articles were determined with Bradford law. Journals were permuted in descending order with the amount of published articles under one theme. Consequently, journals were distinguished into a group with the highest rate of published articles and other groups with equal rate of published articles [10].

In 2005, J. E. Hirsch, physicist from US, published an article entitled ‘An Index to Quantify an Individual’s Scientific Research Output’ in *Proceedings of the National Academy of Sciences of the United States of America* [11]. Articles of one researcher in one database were permuted in descending order with cited frequency until the order number of one article was bigger than the cited frequency of this article. The h-index was generated by the order number of this article minus one. [11] This study attempted to analyze the features and impact factors of countries or regions and institutes by the h-indices of articles. The graph analyzing co-author networks between countries was constructed by Gephi software in this study [12].

Refviz is a tool of visualized text analysis and data mining [13]. It is able to do cluster analysis by title and abstract, and present the results in graphs to users. The graph can be altered according to the adjustments between major and minor topics made by users to achieve accurate results and results that meet the professional information requirements of users [14]. This study analyzed literature related to

integrated complementary medicine using Endnote and Refviz. The research highlights were concluded to provide reference for further research.

RESULTS

According to the selection methods 31 963 articles were included in the study. There were 14 categories of articles, in which ‘original article’ was the top with 26 175 results, followed by reviews (2439), editorial material (1773) and letters (693).

Article numbers in years

As shown in Table 1, the amount of integrated complementary medicine research articles has increased from 2004 to 2016. After 2012, there were more than 3000 articles every year. This indicated that the discipline has come to a mature period of development.

Table 1. Yearly amount of published articles related to integrated complementary medicine

No.	Year	Amount in the year	Amount accumulated by year
1	2004	989	989
2	2005	1329	2318
3	2006	1376	3694
4	2007	1744	5438
5	2008	1697	7135
6	2009	1955	9090
7	2010	1968	11058
8	2011	2971	14029
9	2012	3278	17307
10	2013	3885	21192
11	2014	3551	24743
12	2015	3673	28416
13	2016	3547	31963

Geographical distribution

Regions were determined by the geographical location of the organization or institute extracted from the literature. According to statistics, integrated complementary medicine research has already covered 148 countries. The top ten countries with most related research articles are China (8368), USA (5306), Southkorea (2583), India (1767), Taiwan (1682), Brazil (1525), Germany (1354), England (1306), Japan (1028), Australia (980).

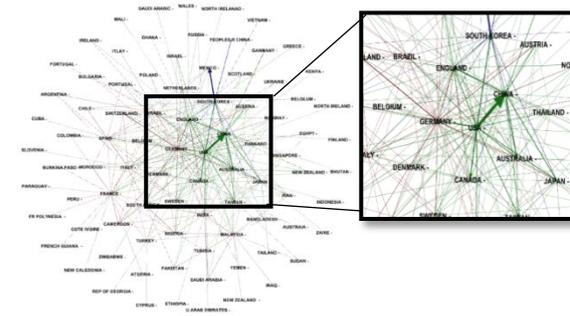


Fig. 1. Inter-country co-author networks graph

The co-authorship between countries is presented in Figure 1. Each node represented one country in the co-authorship while the connection between nodes represented the co-authorship between two countries.

Research institutes

The research institutes (different departments, renamed or merged organizations were regarded as the same one) was determined based on the organizations extracted from literature. According to statistics, 31 963 articles were from 5058 research institutes. Top ten institutes with most publishing articles were China Academy of Chinese Medical Sciences (865), Kyung Hee

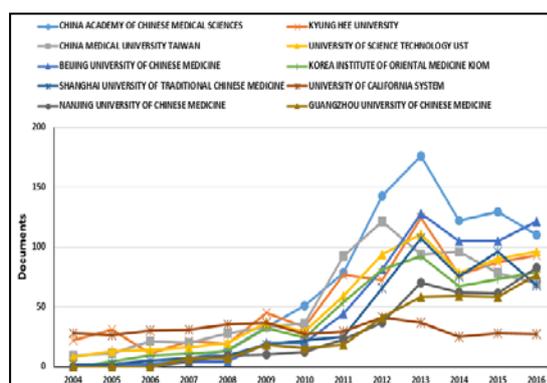


Fig. 2. Top ten institutes with the most published articles by year

University (712), China Medical University Taiwan (708), University of Science Technology (665), Beijing University of Chinese Medicine (636), Korea Institute of Oriental Medicine Kiom (539), Shanghai University of Traditional Chinese Medicine (500), University of California System (401), Nanjing University of Chinese Medicine (371), Guangzhou University of Chinese Medicine (351).

The total amount of published articles from these institutes was 5432, making up 16.99% of the general amount. The increasing trends by year of the top ten institutes are shown in Figure 2. The numbers increased gradually before reaching a peak in 2013. The numbers decreased slightly after 2013, but the number of articles published by some institutes presents an increasing trend after 2015.

Inter-organization co-author networks are shown in Figure 3. As demonstrated, cooperation between the main organizations and others is divided into several categories (differentiated by color), which also indicates that there are several big research groups. The local picture describes the main research institutes cooperating with Beijing University of Chinese Medicine (BUCM). The institutes that have closer cooperation with BUCM were China Academy of Chinese Medical Sciences,

China-Japan Friendship Hospital, Peking University, Hong Kong Baptism University, Tianjin University of TCM, Shandong University of Traditional Chinese Medicine, and Peking Union Medical College Hospital.

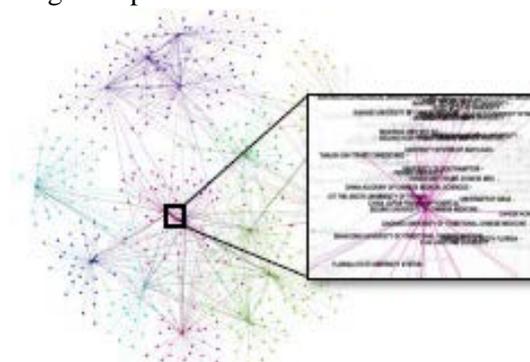


Fig. 3. Inter-organization co-author networks graph and main institutes cooperating with Beijing University of Chinese Medicine

KEYWORDS ANALYZED

Keywords analyzed by time period

Keywords in scientific essays refer to words or phrases selected from the title, abstract and main body, which reflect the topic of the article. Chiu and Ho [15] were the first to use keywords in bibliometrics to track the direction and breakthrough points of scientific development. The distribution of keywords revealed current common research themes and methods.

We divided major topics mined by Revviz from 2004 to 2016 into two periods (2004-2010 and 2011-2016) to compare. Key words such as db, mutans, venom, etc. were found to be frequently seen by comparing the frequency of key words in these two periods, which indicates that problems with these words were the research focus in recent ten years. However, some words were only popular in a certain period, for instance, cancer, needling, polysaccharide, etc. These words were frequently seen in the first period. But they were not as frequently seen in the second one. It indicated that problems presented by these words were no more a research focus in the second period as some of problems were better resolved in the first period or the words were changed in the latter period. Research questions with the keywords of massage, resveratrol, emodin, etc. were the focuses in recent years.

Keywords cluster analysis

Figure 4 is the keywords dendrogram of integrated complementary medicine literature from 2004 to 2016 created using Refviz. Icons represent a group of literature. The size of the icons demonstrates the number of works in the group while the space between the icons shows the

correlation of each work. In other words, the bigger the icon, the greater is the number of articles in the group. The closer the icons are together, the stronger is the correlation. We numbered each icon and extracted the keywords and related literature represented by the icon. We divided them into two concentrated areas according to the space between icons.

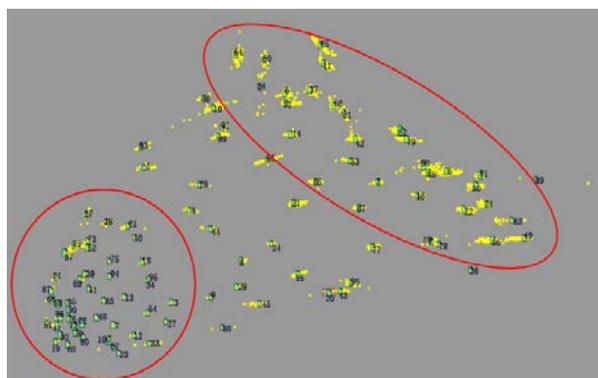


Fig. 4. Keywords dendrogram from 2004 to 2016

CONCLUSION

By studying integrated complementary medicine articles from 22 journals, we found a general increase in the number of articles and established core research area, core research institutes and core research highlights in this field.

From the amount of published articles every year, the development of research and application related to integrated complementary medicine can be divided into three periods. The first period is 2004 – 2010, which is the period of stable increase. The second one is 2010 – 2013, which is the period of rapid increase. In the third period, 2014 – 2015, the number of articles has slightly decreased.

In the analysis of geographical distribution, we found that Asia was the area that published the most papers while the region with the lowest amount of papers published was Oceania. From the statistics of countries participating in publication in every continent, although North America had fewer countries involved in co-author work, the general amount of articles was similar to that of Europe. China had the most published articles followed by the US, Korea and India.

From the study of the institutes that published more than 200 articles, half of the research was from institutes in Mainland China with high h-indices. This revealed that China has taken the leading position in this field in quantity and quality. As integrated complementary medicine has become a new discipline, more and more organizations and universities have become involved in research work, such as California University, Kyung Hee University, Seoul National University, Zhejiang University, Fudan University, National Taiwan University, and

Hong Kong University.

With the keywords extracted from the literature we found that research in this field is mainly focused on recovery, oncology, healthcare, nursing, acupuncture and neurosciences. Modern technology, such as multi-discipline and multi-indices, is applied in research methods to do in-depth study in subjects including *zheng hou*, five phases theory and four diagnostic methods. Research on chemical analysis of Chinese medicines has made great progress. Besides, there are some specific studies drawing international attention, for example, acupuncture anesthesia, integrated complementary treatment in leukemia, viral hepatitis, etc.

In the keywords cluster analysis, combined with the code and keywords, the highlights were as follows:

a. *Pharmacomolecular research*: Keywords scattered in Area 1 showed research on *materia medica*, especially focused on the pharmacomolecular research. The research on active ingredients in Chinese herbs is an important part of modernization of *materia medica*. In the treatment of cancer, active ingredients in Chinese herbs extractives such as curcumin, sophocarpidine, and tea polyphenol have achieved good effects on treating malignant tumors by inducing apoptosis of cancer cells and antioxidants. Therefore, it has become a research highlight in recent years.

b. *Acupuncture research*: Acupuncture is one of many unique diagnostic and treatment methods in TCM. It has been used in the treatment and prevention of diseases. As visible from the dendrogram, modern research on acupuncture has increased in the ten years surveyed. Research on the mechanism and molecular material basis of acupuncture for treating diseases has also become a highlight. People are increasingly willing to understand these mechanisms to find better solutions for patients.

c. *Diseases and mechanism*: According to the results of data mining, research on molecular mechanism of diseases has become a research highlight in recent years as well. For example, in the study of diabetes, people found one-third of diabetes patients deteriorate to diabetic nephropathy. [16] During the process, albuminuria is the main clinical symptom. The occurrence of albuminuria is closely related with sertoli cells. Advanced glycation end products (AGEs) are important products in the patient's body. The combination of AGEs and receptors can reduce the expression of sertoli cells connecting protein and induce the damage of sertoli cells to affect the occurrence of albuminuria. [17]

d. *Others*: The tongue as a place of manifestation of changes in disease and body constitution effects on diseases have become highlights in integrated complementary medicine. As syndrome

differentiation is the essence of TCM diagnosis and treatment, tongue manifestation and body constitution reflect this idea well. Correct syndrome differentiation is the premise of guaranteeing the effect of TCM.

Considering the results of data mining, keyword cluster analysis has provided a new path for us to study integrated complementary medicine. It helps us to understand the current clinical application and research situation of this discipline. However, we also found some limitations during our research. For instance, there were some keywords analyzed that were not in accordance with integrated complementary medicine. It may be because the keywords in the original articles could not appropriately reflect the contents of the articles. As a result, we should use the logical combination of keywords to present the ideas and contents of articles to access required literature rapidly, correctly and comprehensively.

In short, an increase in research on integrated complementary medicine is the inevitable trajectory of medical development. Traditional Chinese medicine should combine with modern technology to become more powerful. The direction of the development of integrated complementary medicine should be an open, dynamic, sustainably developed scientific system [18]. Although research in recent two years has slightly decreased compared with the peak in 2013, it can be foreseen that research in this field will be flourishing in certain time. There will be more domestic and overseas institutes and research dedicated to this topic. Integrated complementary medicine research will develop in multi-discipline, multi-level and comprehensive directions. New medical achievements will further promote the combination of theory and practice.

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REFERENCES

1. Ci Hai Editorial Board, Shanghai Ci Hai Press, Shanghai, 2227, 2002.
2. S.K. Chen, *Chin. J. Pract. Chin. with Modern Med.*, 13, bottom cover (2000).
3. J.G. Lu, Guangzhou University of Chinese Medicine, Guangzhou, 2007.
4. C.A. Macias-Chapula, *Bull. Med. Libr. Assoc.*, **88**, 56 (2000).
5. J.M. Ramos, S. Ramos, M. Masiá, F. Gutierrez, *Int. J. Tuberc. Lung. Dis.*, **12**, 1461 (2008).
6. T. Li, Y.S. Ho, C.Y. Li, *Neurosci. Lett.*, **441**, 248 (2008).
7. A.A. Sorensen, *J. Alzheimers. Dis.*, **16**, 451–465 2009.
8. S. Leung, K. Chan, L. Song, *Cat. Health Info. Libr. J.*, **23**, 13 (2006).
9. J.S. Han, Y.S. Ho, *Neurosci. Biobehav. Rev.*, **35**, 680 (2011).
10. J.P. Jing, F.C. Ma, X.X. Zhang, *Intelligence Science Theory*, Science Press, Beijing, 56, 2009.
11. J.E. Hirsch, *Proc. Natl. Acad. Sci. U S A*, **102**, 16569 (2005).
12. D.J. Price, D.D. Beaver, *Am. Psychol.*, **21**, 1011 (1966).
13. Y. Wang, W.H. Rong, *Chin. J. Med. Lib. Info. Sci.*, **15**, 61 (2006).
14. D. Li, J. Wu, *Application of medical literature analysis and management software*, People's military medical press, Beijing, 62, 2007.
15. W.T. Chiu, Y.S. Ho, *Scientometrics*, **73**, 3 (2007).
16. Y.M. Farag, J.S. Al Wakeel, *Clin. Pract.*, **119**, c317 (2011).
17. C.L. Cheng, Z.D. Zheng, C.G. Shi, Z.C. Ye, X. Liu, T.Q. Lou, *J. Third Military Med. Uni.*, 35, 1779 (2013).
18. S.K. Chen, K.J. Chen, *Forum For Advancement*, **3**, 29 (2003).