

Bibliometric analysis of complementary and alternative medicine research over three decades

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Abstract This study applies bibliometric analysis to investigate the quantity and citation impact of scientific papers in the field of complementary and alternative medicine (CAM). The data are collected from 19 CAM journals in the Science Citation Index Expanded (SCI-E) database during 1980–2009, and 17,002 papers are identified for analysis. The study analyzes the document types, geographical and institutional distribution of the authorship, including international scientific collaboration. This study suggests that the major type of document is original article. The CAM papers are mostly published by North America, East Asia, and European countries, of which publications authored in East Asia are cited most. Country-wise, major contributors of CAM papers are from USA, People's Republic of China, India, England and Germany. India has the highest CPP value, attracting high attentions in CAM community. This article also finds that international co-authorship in the CAM field has increased rapidly during this period. In addition, internationally collaborated publications generate higher citation impact than papers published by authors from single country. Finally, the research identifies productive institutions in CAM, and China Medical University located in Taiwan is the most productive organization.

Keywords Complementary medicine · Alternative medicine · CAM ·
Bibliometric analysis

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Introduction

Complementary and alternative medicine (CAM) is known as a relative term including various health-care methods, which are considered “other than” conventional medicine. Treatments like traditional Chinese medicine (TCM) and Ayurvedic medicine have been practiced for centuries, while electrotherapy has been created for just a few decades. National Center for Complementary and Alternative Medicine (NCCAM), which is under the National Institutes of Health (NIH) of USA, had made an effort to define CAM as a group of diverse medical and health care systems, practices, and products that are not presently considered as an integral part of conventional medicine (National Center for Complementary and Alternative Medicine 2004). It had classified CAM therapies into five categories: biologically based practices, energy medicine, manipulative and body-based practices, mind–body medicine and whole medical system (Food and Drug Administration 2006).

In spite of the ambiguity of definition as well as the variety of domain, the consumers and practices of CAM had risen dramatically in recent years in the western world like USA (Tindle et al. 2005) and Britain (Thomas and Coleman 2004). To some extent, it had even been officially accepted in the late 20th century, though the regulation of health insurance coverage for CAM varies greatly across various national health plans (Gray et al. 2002; Mills 2001). In so far as the usage in the developing world, TCM had eased almost half of the healthcare burden in China (Hesketh and Zhu 1997), and the utilization of Korean medicine had been estimated up to 70% in its health system in North Korea (Zhong and Jia 2006). Similar situation of traditional medicine had been identified in India (Sharma et al. 2007), Vietnam (Wahlberg 2006) and other under-industrialized nations.

But just as noted by the World Health Organization (WHO) in *WHO Traditional Medicine Strategy 2002–2005* that the general lack of research on the safety and efficacy of traditional medicines was of great concern (World Health Organization 2002). In need for better understanding of the effects and mechanisms of CAM treatments, and discussing and elucidating the possible integration between allopathy and CAM, many researches on CAM had been initiated (Eskinazi and Hoffman 1998). Without doubt, developing appropriate research methods and conducting rigorous scientific studies can provide patients with identified information and more accesses to rational, effective and efficient CAM intervention. At the same time, it will make for the establishment of common practices for the production, regulation, governance and legislation of CAM. Along with more and more ongoing research projects, the number and quality of CAM publications had increased rapidly (Barnes et al. 1999).

Bibliometric analysis is a quantitative analysis done to aid the evaluation of research performance (Van den Berghe et al. 1998). The publication output of a certain discipline or topic represents the current research trend, whether it is the present, previous, or future research (Garfield 1970). Citation analysis is also usually used in bibliometric methods, and the number of citations an article received after its publication reflects its impact on the scientific community (Gehanno et al. 2007). Furthermore, scientists had observed the upward trend in the publication activity of CAM after analyzing CAM papers, as well as journals indexed in the Medline database (Danell and Danell 2009; Schmidt et al. 2001). These outcomes prove that it would be a good method to perform bibliometric analyses to investigate the trends in CAM based on the quantity changes in continuous time.

The aim of this study is to investigate the regional distribution of the authorship as well as their international scientific collaboration. Citation data will be used as a bibliometric tool to indicate the intellectual impact of the research output published in the CAM field. Time trends of indicators will be investigated by analyzing data divided into three decades.

Materials and methods

The information analyzed was retrieved from *Science Citation Index Expanded* (SCI-E) database on web of science (WOS) during the period from 1980 through 2009 on 24 April 2010. SCI-E is a multidisciplinary database produced by the Institute for Scientific Information (ISI), which indexes over 6,650 of the world's leading scientific and technical journals across 150 disciplines (Thomson Reuters 2010), and is considered to be the solid bases for bibliometric analysis.

The source journals for the papers examined were selected with the intention of representing the worldwide scientific production in the field of CAM. According to scope notes of SCI, category "Integrative & Complementary Medicine" is used to describe those covers resources on the practical use of allopathic, alternative and/or complementary medicine and therapies in preventing and treating disease, healing illness, and promoting health. The category is concerned with resources on alternative systems of practice that provide for an overall rational and comprehensive approach to healthcare. Topics such as bioelectromagnetics applications, herbal medicine, diet, nutrition and lifestyle changes, manual healing methods, mind/body interventions, and pharmacological and biological treatment as well as any other unconventional health care practices are included in this category (available on the website: http://science.thomsonreuters.com/mjl/scope/scope_sci/). It appears that this category is mostly consistent with the common cognizance of CAM, and choosing the journals under such category could create the profile of the publications of CAM and satisfy our research aims. Seventeen journals covered in the 2009 *Journal Citation Reports* (JCR) specific category "Integrative & Complementary Medicine" as well as two other journals included in the same category of SCI were chosen in this study. It seems that papers published in these 19 journals represent the majority of researches as well as its trend in CAM field even though there are certainly other CAM papers published in other journals. As shown in Table 1, all 19 journals specializing in CAM are listed. Totally 17,002 published documents were found in the SCI-E database, and citations per paper of journals range from 11.9 to 0.04.

In this paper, the distribution of document types of papers in the 19 CAM journals is first analyzed. Also, the data are resolved to geographical representation of authorship using the following regional categories: North America, Latin America, East Asia, West Asia, Europe, Oceania, and Africa. Countries are assigned regions on a geographical basis. Institutional distribution is investigated as well. Papers with multiple authors are counted more than once when authorship crossed regional and institutional boundaries. The bibliometric impact of publications is assessed in terms of the number of citations received. The average number of citations per paper (CPP) is defined as the total number of citations over the total number of publications. At the same time, time trends of CAM publications are analyzed over three decades in this research.

Results and discussion

Distribution of document types

The total 17,002 papers were distributed into 14 document types in the 19 CAM journals, and the number of almost all types increasingly went up over the three decades. Seventy percent of all documents were original articles, indicating that a large portion of the CAM research activities was original. As Fig. 1 shows, the proportion of articles decreases over three decades; however, its percentage share of citations remained stable to around 85%.

Table 1 Number of papers published and citations per paper in 19 CAM journals

Journal	Impact factor (2009)	No. Publication	No. Citation	Citations per paper (CPP)
J Ethnopharmacol	2.32	5,365	63,980	11.925
Complement Ther Med	1.95	447	2,574	5.758
Evid-Based Compl Alt	2.06	412	2,298	5.578
Am J Chinese Med	1.42	1,488	7,576	5.091
J Altern Complem Med	1.69	1,704	8,405	4.933
J Manip Physiol Ther	1.06	2,595	11,685	4.503
Acupuncture Electro	0.25	540	2,324	4.304
Altern Ther Health Med	–	945	3,854	4.078
Altern Med Rev	3.52	144	561	3.896
Integr Cancer Ther	1.51	160	491	3.069
Forsch Komplementmed	1.28	765	1,757	2.297
Altex-AlternTierexp	0.92	535	1,031	1.927
Homeopathy	1.13	227	331	1.458
BMC Compl Altern Med	–	115	142	1.235
Explore-J Sci Heal	0.74	581	353	0.608
Afr J Tradit Complem	0.32	194	103	0.531
Chin J Integr Med	0.42	238	71	0.298
J Aust Tradit-Med So	0.06	71	8	0.113
J Complement Med	0.06	476	19	0.04
Total	–	17,002	1,075,63	6.326

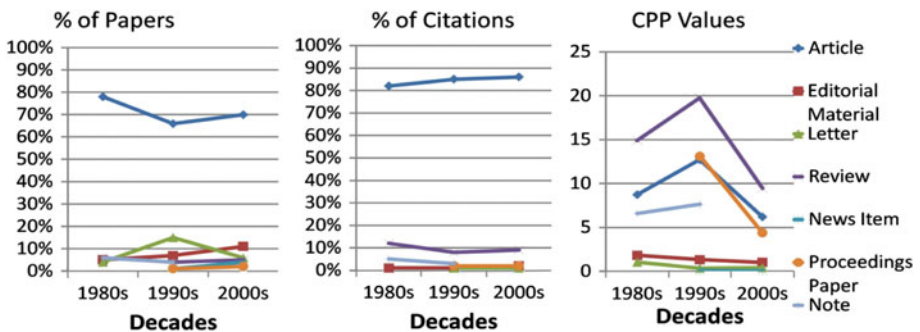


Fig. 1 Percentages of papers and citations, and CPP values of main seven document types over three decades

The ratio of citations to papers by types of documents was further considered. Reviews ranked first with a CPP value of 11.84, although the cumulative number of reviews was small. This may due to the omnibus and recapitulated comments posted in reviews on the

history, situation, challenge, and perspective regarding CAM attracting a great deal of attention. CPP value of articles, which reached to 12.71 in 1990s, had decreased to 6.2 in 2000s, even lower than 1980s. Furthermore, CPP values in the latest decade were the lowest one for nearly all types. It may result from the shorter cumulative cited period of time for papers published in 2000s, or it may be a consequence of poor quality of quite a number of papers published in the last 10 years, which was inevitable while CAM related publications more than doubled over this decade. However, it is no doubt that a lot of excellent researches on CAM had conducted during 1990s that led to many high quality publications. It could be found later that almost all CPP values changed in a similar way no matter how they were viewed. Therefore, repeated analysis will not be presented.

Geographical distribution

Figure 2 shows the geographical distribution of authorship for CAM papers published in the 19 CAM journals between 1980 and 2009. North America, with 4,581 papers, has the largest number of authored papers that account for 26.94% of all the documents, followed by East Asia and Europe with 4,486 and 3,766 papers respectively. These may reflect the CAM research focused areas.

Furthermore, investigating citations attracted by papers in the light of continental distribution, publications authored in East Asia are cited most with 32,953 citations, which contribute 26.39% of publications but receive 30.64% of citations. Europe practices the similar way as East Asia.

Distribution of countries

There were countries and regions participating CAM publication activities in the 19 CAM journals. Figure 3 shows top ten countries and regions according to the number of CAM papers authored. The USA, with 4,117 papers, owns the largest number of authored papers. It is distantly followed by People's Republic of China with 1,243 papers and India with 1,026 papers. England and Germany have similar number of publication close to 1,000 papers.

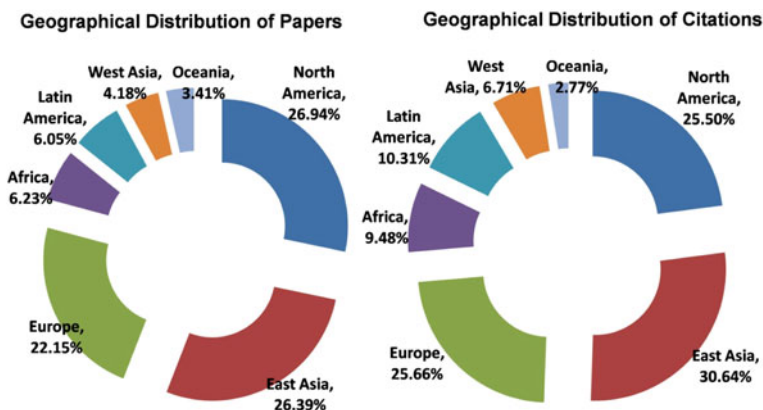


Fig. 2 Geographical distribution of authorship and citation of publications in the 19 CAM journals

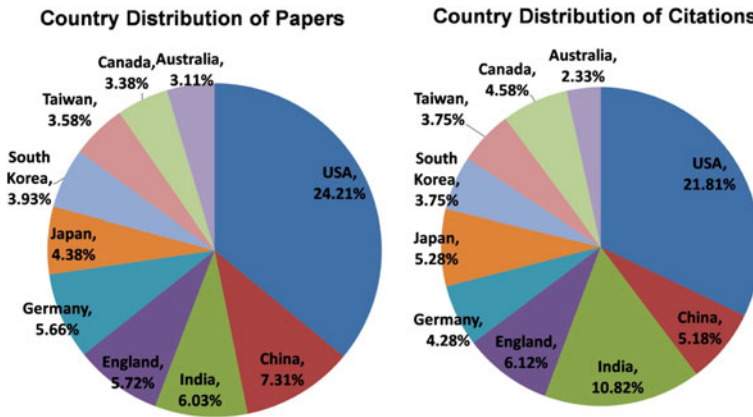


Fig. 3 Distribution of papers and citations by countries in the 19 CAM journals

At the same time, USA-authored papers are cited most with 23,463 citations, accounting for 21.81% of all citations, about 3% lower than its percentage of all the papers. India is the second highest with 11,642 citations, which contribute 6.03% of total publications but receive 10.82% of total citations. And India has the highest CPP value with 11.35 among the ten most prodigious producers of CAM papers, indicating achievements released by Indian scientists have attracted most attentions in CAM field. And People’s Republic of China is in the opposite way, receiving 5.18% of citations with 7.31% of papers.

The time trends for rank of top ten countries based on the number of publications and citations are presented in Table 2, where it can be seen that, USA has always remained the first place over the three decades. People’s Republic of China rises remarkably in rankings from aspects of number of both publications and citations; the former was in the second place whereas the latter was only in the fourth place in the 2000s. India keeps a stably excellent performance according to its ranks, which always occupies the fourth place based on its published papers and second place based on its citations. Other notable rises in

Table 2 Rank of top 10 countries by number of papers and citation in the 19 CAM journals

Countries	Percentage of papers (rank)				Percentage of citations (rank)			
	1980s	1990s	2000s	Total	1980s	1990s	2000s	Total
USA	25.99 (1)	26.69 (1)	23.25 (1)	24.21 (1)	20.28 (1)	19.73 (1)	23.35 (1)	21.81 (1)
P.R. China	6.95 (3)	3.07 (9)	8.64 (2)	7.31 (2)	6.19 (5)	3.2 (7)	6.14 (4)	5.18 (5)
India	5.35 (4)	6.3 (3)	6.04 (4)	6.03 (3)	7.67 (3)	11.84 (2)	10.84 (2)	10.82 (2)
England	3.2 (6)	3.95 (6)	6.56 (3)	5.72 (4)	6.49 (4)	3.99 (6)	7.30 (3)	6.12 (3)
Germany	0.56 (9)	5.61 (4)	6.3 (5)	5.66 (5)	0.48 (9)	3.18 (8)	5.68 (5)	4.28 (7)
Japan	7.64 (2)	6.38 (2)	3.37 (8)	4.38 (6)	7.95 (2)	6.52 (3)	4.02 (7)	5.28 (4)
South Korea	0.35 (10)	1.41 (10)	5.13 (6)	3.93 (7)	0.08 (10)	1.75 (10)	5.66 (6)	3.75 (8)
Taiwan	2.15 (7)	4.17 (5)	3.58 (7)	3.58 (8)	2.19 (7)	4.82 (5)	3.44 (9)	3.75 (8)
Canada	4.31 (5)	3.4 (7)	3.26 (9)	3.38 (9)	4.31 (6)	6.43 (4)	3.55 (8)	4.58 (6)
Australia	1.88 (8)	3.18 (8)	3.23 (10)	3.11 (10)	1.23 (8)	2.48 (9)	2.46 (10)	2.33% (10)

rankings are found in countries such as England, Germany and South Korea. However, opposite trends of changes are found in other countries like Japan, Taiwan, Canada and Australia.

International collaboration

International collaboration in science and technology is both a reality and a necessity, and it is in the self-interest of all nations (Clegg and Boright 2009; He 2009). Table 3 shows that collaborative research endeavors between nations in CAM field have evolved rapidly over time. With respect to absolute production, in addition to its dominant publication, the USA also produces the most internationally collaborated documents by publishing 615 papers. There are various patterns of the percentage share of international collaboration in different countries and regions. The table shows the highest mean percentage share of international collaboration in countries including Canada, Germany and England, collaborating with others in 25–31% of the papers they generated. In addition, countries such as Japan, Australia and People's Republic of China collaborate with others in about 17–21% of their publications. The South Korea and USA collaborate in 14–16% of their papers. Finally, the cases of India and Taiwan show a lowest mean percentage of international collaboration, 10.33 and 7.55% respectively. Nearly all countries and regions except Taiwan increase efforts for widespread cooperation with other nations, which facilitates the increasingly rising percentage of international collaboration publication.

As to the citation per paper of international collaboration publication output (CPPc), compared with that of total publication output (CPPt), the former was notably higher than the latter in almost all countries and regions except South Korea. Specifically the CPPc was over 1.5 times higher than the CPPt in Germany and Japan. The result implied that research activities conducted by international collaborative programs usually had a higher citation impact. A related study found that the success of a collaborative work is associated with cultural similarity, strategic differences, and international experience (van Oudenhoven and van der Zee 2002). It remains unknown if those factors markedly influenced the success of the international collaboration, as well as the citation impact of publication outputs in CAM field.

Table 3 International collaboration of top 10 countries/regions in the 19 CAM journals

Country	International collaboration publication output (% ^a)				CPP values	
	1980s	1990s	2000s	Total	CPPc	CPPt
USA	12 (3.21)	61 (6.31)	542 (19.52)	615 (14.94)	7.5	5.7
Germany	0 (0)	39 (19.21)	232 (30.85)	271 (28.14)	8.1	4.78
England	7 (15.22)	27 (18.88)	226 (28.86)	260 (26.75)	7.45	6.77
P.R. China	2 (2)	14 (12.61)	198 (19.19)	214 (17.22)	6.25	4.48
Canada	0 (0)	18 (14.63)	155 (39.85)	173 (30.14)	9.55	8.59
Japan	6 (5.45)	24 (10.39)	121 (30.02)	151 (20.3)	11.62	7.64
India	2 (2.6)	19 (8.33)	85 (11.79)	106 (10.33)	12.71	11.35
South Korea	0 (0)	5 (9.8)	100 (16.31)	105 (15.7)	5.3	6.03
Australia	1 (3.7)	7 (6.09)	95 (24.61)	103 (19.51)	5.27	4.75
Taiwan	4 (12.9)	6 (3.97)	36 (8.43)	46 (7.55)	8.74	6.63

^a Percentage of international collaboration publication output in the decade in the country/region

Table 4 Top 10 productive organizations contributing CAM publication in the 19 CAM journals

Rank	Organization (country/region)	No. publication	No. citation
1	China Medical University (Taiwan)	202	961
2	Kyung Hee University (South Korea)	174	803
3	University of California—Los Angeles (USA)	143	952
4	Harvard University (USA)	140	1,024
5	Chinese University of Hong Kong (Hong Kong)	121	895
6	University of Arizona (USA)	108	594
7	Fudan University (P.R. China)	102	728
8	Kaohsiung Medical University (Taiwan)	97	1,157
9	The University of Exeter (UK)	96	624
10	University of Calgary (Canada)	89	886

Institutional distribution

When the documents were inspected according to the affiliation of authors, China Medical University located in Taiwan was the most productive organization with 202 documents among all the paper producers in the 19 CAM journals, and Kaohsiung Medical University that also based in Taiwan ranked the eighth in addition, though the total number of publications authored by Taiwan researchers just ranked seventh all over the world, indicating small portion of organizations conducted most of the CAM researches with high concentration level in Taiwan. South Korea seemed to perform the similar way as Kyung Hee University ranked the second place based on a small national share of output. On the contrary, only Fudan University was listed in the top 10 organizations though P. R. China occupied the second place among all the countries/regions that released CAM publications, indicating CAM researches were scatteredly performed and no leading organization specializing in CAM developed yet in China. It was also significant to note that three universities among top ten research units were based in USA, implying its crucial position in CAM field, shows as Table 4.

Conclusions

The growing research funding and the increasing amount of scientific publication in CAM field could be regarded as the result of uncritical enthusiasm and uninformed skepticism, two distinct attitudes noted by WHO. However, continuous well-designed studies might be helpful to strengthen understanding of CAM better.

This study evaluated and analyzed CAM therapies by applying the bibliometric methods. Significant points suggested the changing situation of CAM over three decades. This paper denoted that the original article was the major type among 14 document types, and the number of almost all types increasingly went up over the three decades. Reviews ranked first with a CPP value of 11.84, but its cumulative number was small. Most of those CAM researches were done by North America, East Asia and European countries, and publications authored in East Asia were cited most. The USA, People's Republic of China, India, England and Germany were the major contributors of CAM papers and India had the highest CPP value, attracting high attentions in CAM community. USA remained the first

place in numbers of publications and citations, and conspicuous rises in rankings were found in countries such as People's Republic of China, England, Germany and South Korea.

Collaborative researches between nations and organizations in the CAM field increased rapidly over time, and the USA produced most of the internationally collaborated papers. Research activities conducted by international collaborative programs had a higher citation impact, except those by South Korea. China Medical University located in Taiwan was the most productive organization, and three universities among top ten research units were based in USA. For future studies, more topics could be discussed further including the most widely used TCM therapy and the most commonly targeted disorders to which patients resort to TCM.

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