

# Global performance of traditional Chinese medicine over three decades

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**Abstract** Traditional Chinese medicine (TCM), which is divided into three subfields, including Chinese medicine, Chinese herb and acupuncture, attracts increasing attentions due to its challenging and significant medical values. This study employs bibliometric analysis to examine the profile of publication activity in TCM field as well as its subfields. The data are retrieved from the Science Citation Index Expanded database during 1980–2009, and 16,536 papers are identified for analysis. Generally speaking, proportions of papers in subfield of acupuncture decreased dramatically, while the proportions of papers of Chinese medicine and Chinese herb rose increasingly. This study finds that East Asia has the largest number of TCM papers, followed by North America and Europe. Furthermore, while China is ranked first in terms of the amount of TCM publications, USA gains the highest percentage of citations. As for regional specialty, mainly, scholars in East Asia publish intensively in Chinese medicine, while most of the scholars in North America and Europe probe into the study of acupuncture. In the latest two decades, China took the first place over Japan in subfields of both Chinese medicine and Chinese herb, while the US has always kept the largest share in acupuncture with a marked upward trend. Regarding the top-ranked TCM institution, Chinese Academy of Sciences located in China, is ranked first in the subfields of Chinese medicine and Chinese herb as well. As for Kyung Hee University, which is located in South Korea, is ranked first in the number of acupuncture papers and Harvard University is ranked first in number of acupuncture citations.

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## Introduction

Rooted in Chinese culture for more than 5000 years, Traditional Chinese Medicine (TCM) is a natural medicine that is practiced by experience and guidance of a holistic concept and the belief of treating the entire body and the spirit as a whole (Zuskin et al. 2008; Jiang 2005). Under the influence of the widespread western allopathic medicine, which developed rapidly after its initiation and had reached its fruitful outcome in the twentieth century, TCM is classified as complementary and alternative medicines (CAM) with other nonconventional medicines like Ayurvedic medicine and osteopathic manipulation (Food and Drug Administration 2006). However, with its great impact on people's lives, TCM still deserves attentions because of its significant role-playing in both traditional and modern period in China that almost accounts for 20% of global populations. On the other hand, TCM is also a prime basis of other oriental medicine like Japanese Kampo, which has been adapted to its indigenous culture after transmission (Yu et al. 2006).

TCM had eased almost 40% of the healthcare burden (Chan 2005), and China is the only country in the world where western medicine and TCM are practiced alongside at every level of the healthcare system (Hesketh and Zhu 1997), which has been written into the Constitution of the People's Republic of China (P.R. China) as an important issue (National People's Congress 2004). People raise more concerns about TCM, and there has been a steep rise in the demand for researches on it for various reasons.

Firstly, limitations of allopathic medicine, such as increased side effects, lack of curative treatment for several chronic diseases, high cost of new drugs, microbial resistance, and emerging diseases are driving scientists and companies to discover novel components and drugs from traditional medicine (Patwardhan et al. 2005). It is estimated that there are at least 25% of drugs in western medicines using natural products as major components, and a much higher proportion of drugs in TCM (Wang et al. 2008; Harvey 2008; Kong et al. 2009).

Secondly, rigorous scientific randomized placebo-controlled trials of TCM including herbs, compounds, and acupuncture have been carried out to further explore its effects and safety, and better elucidate potential mechanisms (Ernst 2006; Zhong et al. 2010; Yuan and Lin 2000). Experts in multidiscipline have made efforts to collaborate in a proper exploration to put TCM into popular utilization (Leung 2006).

Thirdly, some new methods based on TCM existing theories are developed, like laserneedle acupuncture that represents a new painless and noninvasive acupuncture method (Litscher 2009), which would enhance the integration between TCM and high-tech, and may enlarge the acceptance and utilizing community for health promotion.

Fourthly, concerns on adverse effects, drug interactions, and stable quality of TCM are gearing up over the past decades. Increasing studies try to analyze Chinese traditional medicine preparations by applying modern means like chromatographic and electrophoretic techniques (Drasar and Moravcova 2004). Advances of science and technology in both biomedical and instrumental analysis would help to obtain more information and enhance quality control over medications from natural sources (Chan 2003).

Furthermore, the identification of consistency and reliability of TCM diagnosis as well as treatment among TCM practitioners have always been one of the most perplexed issues in related scientific community (O'Brien and Birch 2009; Zhang et al. 2003). As the result,

a lot of research projects have been initiated, and publication number and proportion of TCM in Medline were increased steadily (Fu 2010).

According to the rising of modern partitioning method from 20th century, TCM has been divided into three subfields: Chinese medicine, Chinese herb and acupuncture. And the three subfields are identically corresponded with the current built-up TCM departments in education and hospital systems of P.R. China. The bibliometric method employs empiric data and quantitative analysis to trace the core production or citation. The content or quality of publications, and the motivations of researchers in the form of published literature proves to be a valid and reliable way to map external and internal features in scientific field (Estabrooks et al. 2004). A few researchers had tried to describe the trends in the publication activity of TCM after analyzing TCM related papers indexed in the Medline database (Fu 2010; Zhang 1994). However, the analysis of citation impact of TCM publications as well as the trends in TCM subfields has not been reported yet.

The purpose of this present study is to investigate the profile of publication activity in TCM field as well as its subfields by analyzing related published papers. Citation data will be used as a bibliometric tool to indicate the intellectual impact of the research output. The time trends of indicators will be explored by analyzing data divided into three decades.

## Materials and methods

The analyzed data in this paper was retrieved from the Science Citation Index Expanded (SCI-E) database on Web of Science (WOS) during the period 1980–2009 on 24 April 2010. SCI-E, a multidisciplinary database produced by the Institute for Scientific Information (ISI), was chosen to conduct bibliometric research in this study due to its indexing of address information for almost all authors, and citation information for all items in its database.

In this study, TCM subfields relevant words and phrases set up by experts were used as the keywords to search as a part of the title, abstract or keyword, details is shown in Table 1. TCM related documents were obtained by gathering three parts of papers in three subfields of TCM. All 14 types of documents, including article, editorial material, letter, meeting abstract, note, review, proceedings paper, book review, news item, correction, reprint, biographical-item, correction and discussion, were used.

In this paper, the distribution of document types, TCM subfields, continents, countries, institutions as well as international collaboration are analyzed. The data are resolved to geographical representation of authorship using the following regional categories: North

**Table 1** Search terms in three TCM subfields

| Subfields        | Keywords  |
|------------------|---|
| Chinese medicine | “Chinese medic*”, “Chinese folk* medic* herb*”, “Chin* herb* medic*”, (TCM and (“herb* medic*)), (TCM and (“Chinese herb*)), “Chinese Materia* Medic*”, “TCM Biotech”, “TCM Therap*”, (TCM and (“alternative medic*)), “Tradition* Chinese herb* medic*”, “Tradition* TCM theory”, “China medicine”, “Chinese tradition* medic*”, “oriental traditional medic*”, ((“oriental medic*”) and (Chinese or China)) |
| Chinese herb     | “Chinese drug*”, “Chin* herb*”, ((“Chinese plant*”) and (extract*)), “Chinese medic* herb*”, “Chinese tradition* herb*”   |
| Acupuncture      | Acupuncture, Acupuncturist*, electroacupuncture   |

America, Latin America, East Asia, West Asia, Europe, Oceania, and Africa. Countries are assigned regions on a geographical basis. Papers with multiple authors or under different TCM subfields are counted more than once when the co-authorship is cross regional and inter institutional, or the paper belonged to two or three subfields. At the same time, time trends of TCM publications are analyzed over three decades in this research. 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 number of citations divided by the number of publications. CPP<sub>c</sub> is defined as the number of citations received by international collaboration publications, divided by the number of international collaboration publications. And CPP<sub>t</sub> is defined as the number of citations received by total publications, divided by the number of total publications.

$$CPP_c = \frac{C_c}{N_c}$$

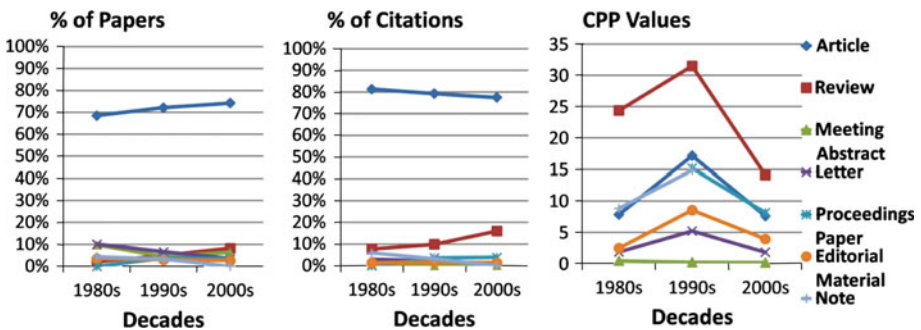
$$CPP_t = \frac{C_t}{N_t}$$

C<sub>c</sub> is the number of citations received by international collaboration publications, N<sub>c</sub> is the number of international collaboration publications, C<sub>t</sub> is the number of citations received by total publications, N<sub>t</sub> is the number of total publications.

### Results and discussion

#### Distribution of document types

The total 16,536 TCM papers were distributed into 14 document types, and the number of almost all types increasingly went up over the three decades except note, which disappeared entirely in 2000s. According to Fig. 1, the article, as the most popular document type, comprises over 70% of the total production. Its proportions remain a growing trend during the past 30 years, point out a large portion of the TCM research activities was original, and scientists who engaged in TCM researches paid more and more attention to it. Its percentage share of citations is 78.42%, which is higher than its share of total papers, though it increasingly decreased over three decades. Review was the second major document type, and its proportions of both papers and citations kept rising trends.



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

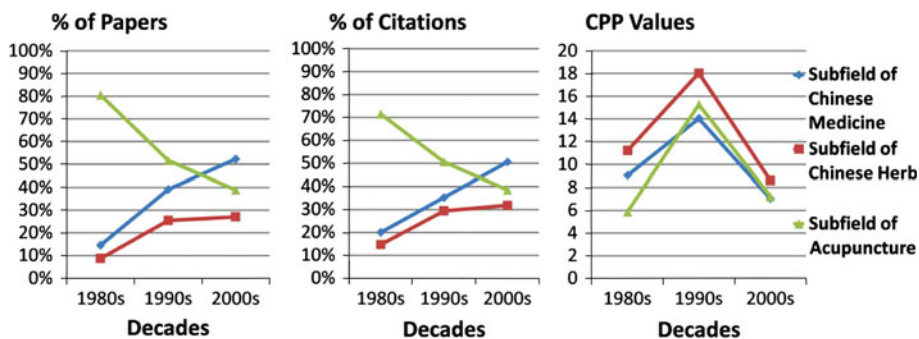
The ratio of citations to papers by types of documents was further considered. Review was ranked first with a CPP value of 16.80, meaning intensive, comprehensive, broad overviews, perspectives or comments made by senior scientists has cause wide concern in TCM society. Obviously, it could be observed that CPP values of all document types in 2000s were the lowest, and the ones in 1990s were the highest. The lack of papers of cumulative cited period published in the latest decade would illuminate the results partly, and it may also result from a lot of outstanding research emerged after the establishments of some important CAM and TCM administrations. For instance, National Center for Complementary and Alternative Medicine (NCCAM) in USA in 1990s, and State Administration of Traditional Chinese Medicine in P.R. China in 1988.

### Distribution of TCM subfields

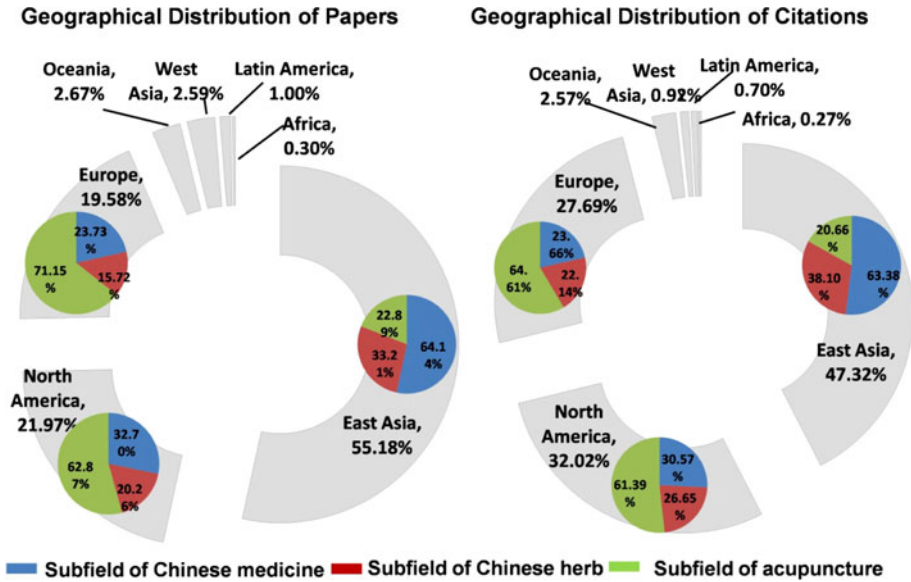
Figure 2 shows the distribution of publications of three TCM subfields during the period from 1980 to 2009. 80.51% of TCM papers were related to the research of acupuncture in 1980s, but its proportions dramatically dropped afterward, which reached to 38.92% in the latest 10 years. On the contrary, the proportions of Chinese medicine and Chinese herb increasingly rose; especially the Chinese medicine, which has become the top TCM subfield in 2000s due to the number of publications. The changes of percentage share of citations in three subfields show the similar trends as the ones in total papers. Chinese herb is ranked first with a CPP value of 10.55 though its figure of papers is small. In fact, acupuncture was the first cognized by people outside of China, rigorous scientific studies on acupuncture was undertaken to evaluate its effect and possible scientific basis for the mechanism like analgesia, directly resulted to high share in TCM papers in early stage. Afterward, other TCM conceptions and interventions were gradually introduced to foreign scientific community. On the other hand, because the acupuncture studies released by Chinese scientists are not a main force in the increase of TCM related publications, that's why the proportional changes have occurred.

### Geographical distribution

Figure 3 shows the geographical distribution of authorship for papers in TCM and its subfields publication between 1980 and 2009. East Asia, with 9,125 papers, has the largest amount of authored papers that account for 55.18% in all the documents, followed by North America and Europe with 3,633 and 3,237 papers respectively. TCM is the major



**Fig. 2** Percentages of papers and citations, and CPP values of Three TCM subfields over three decades



**Fig. 3** Geographical distribution of authorship and citation of publications in TCM and its subfields between 1980 and 2009

component and even the original source of Asian medicine like Japanese Kampo, Korean medicine, and Vietnam medicine. So it is not surprising that Asia contributes over half scientific papers in TCM field, 47.32% in total citation. 21.97% of TCM papers are written by the authors located in North America, which receives 32.02% of citations. Europe practices the similar way with 19.58% of papers and 27.69% of citations.

The related research of its distribution in TCM subfields conducting by three major continents are presented too. Researchers in East Asia have concentrated on subfield of Chinese medicine, occupied 64.14% in all of Asian TCM papers, followed by Chinese herb with 33.21% and acupuncture with 22.89% respectively. However, acupuncture is the most interesting topic for North American and European scientific community, the figure are 62.87 and 71.15% of their papers respectively.

Distribution of countries/regions

Figure 4 shows top eight countries and regions according to the amount of authors in TCM papers. P.R. China, with 5,842 papers, has the largest number of publications. It is followed by USA with 3,285 papers. Japan, Taiwan, and England have similar number of publication between 1,000 and 1,500 papers. However, USA-authored papers are most frequently cited with 42,714 citations, 29.34% of all citations, about 10% higher than its percentage of all the papers. It is followed by P.R. China, which occupies 27.43% of all citations and 35.33% of all papers. Scientists has pointed out that the exponential increase in publication output by China over the last few years was astonishing. However, in terms of visibility, i.e. citation rates, China could not catch up with those countries with more advanced scientific development. Therefore, its scientific performance remains below the world average (Haustein et al. 2011), which was in conformity with the results in this study. Among the top eight prodigious producers of TCM papers, England has the highest

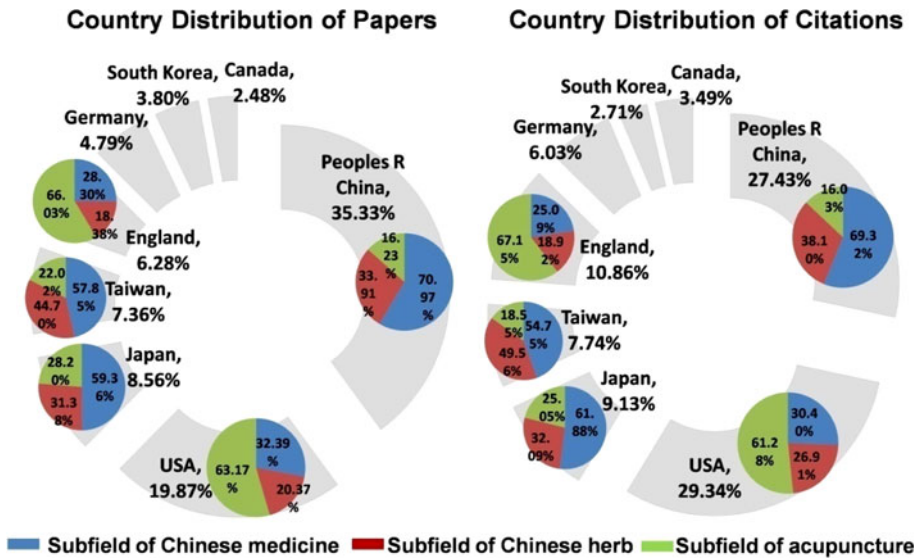


Fig. 4 Distribution of papers and citations of TCM and its subfields by countries/regions between 1980 and 2009

CPP, value of 15.22, indicating research conducted by Britain scientists have drawn great attention to TCM field.

As to the distributions of papers in three TCM subfields, being consistent with anterior results of geographical distribution, Asian countries and regions pay more attentions to Chinese medicine. Especially in P.R. China, who owns 70.97% of papers. Acupuncture still is the prevalent subject in USA and England, with 63.17 and 66.03% of papers respectively.

The time trends for the top eight countries/regions due to the TCM publications and citations were presented in Table 2. It demonstrates that P.R. China replaces USA and owns the first place in the number of papers, with the highest percentage share of citations in 2000s. The share of all papers is 8% higher than the figure of citations. England, Germany, and South Korea have kept a comparably stable performance according to their ranks from aspects of the number in both of publications and citations over three decades. Other notable rises in rankings are found in Taiwan. However, opposite trends of changes are also found in other countries. For instance, Japan and Canada.

Figure 5 shows the distribution of TCM papers in three subfields by countries/regions over three decades. P.R. China is ranked in the first place with over 50% of papers in subfields of Chinese medicine and Chinese herb in the latest two decades. P.R. China has exceeded Japan since the percentage of shares of Japan sharply decreased in all subfields during the past 30 years. Taiwan shows a similar tendency as P.R. China, including the stable share in the subfield of acupuncture. USA has always remained the largest share of total publication in acupuncture with a notable upward trend, which also could be shown in England.

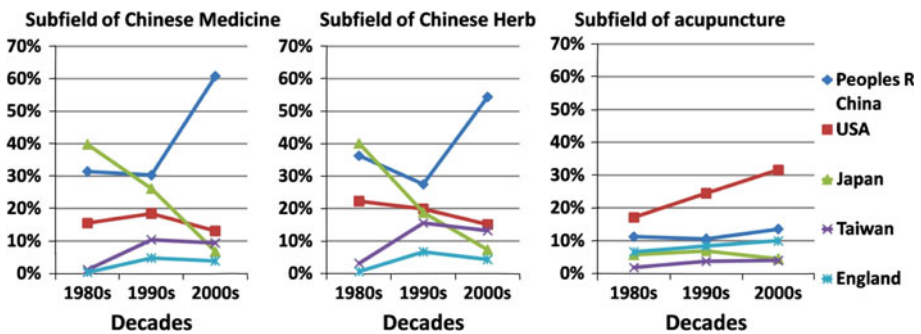
### International collaboration

Increasing globalization will probably lead to the increase of international collaboration in science and technology. However, there are substantial differences between countries in



**Table 2** Rank of top eight countries/regions by number of TCM papers and citation over three decades

| Countries/<br>regions | Percentage of papers (rank) |               |               |               | Percentage of citations (rank) |               |               |               |
|-----------------------|-----------------------------|---------------|---------------|---------------|--------------------------------|---------------|---------------|---------------|
|                       | 1980s                       | 1990s         | 2000s         | Total         | 1980s                          | 1990s         | 2000s         | Total         |
| P.R. China            | 15.34%<br>(2)               | 20.39%<br>(2) | 42.52%<br>(1) | 35.33%<br>(1) | 22.91%<br>(1)                  | 16.47%<br>(2) | 34.47%<br>(1) | 27.43%<br>(2) |
| USA                   | 16.78%<br>(1)               | 20.90%<br>(1) | 20.07%<br>(2) | 19.87%<br>(2) | 21.64%<br>(2)                  | 31.74%<br>(1) | 29.03%<br>(2) | 29.34%<br>(1) |
| Japan                 | 12.90%<br>(3)               | 15.41%<br>(3) | 6.01%<br>(5)  | 8.56%<br>(3)  | 20.14%<br>(3)                  | 11.84%<br>(4) | 5.98%<br>(6)  | 9.12%<br>(4)  |
| Taiwan                | 1.88%<br>(6)                | 8.34%<br>(4)  | 7.95%<br>(3)  | 7.40%<br>(4)  | 1.66%<br>(6)                   | 9.10%<br>(5)  | 7.80%<br>(4)  | 7.74%<br>(5)  |
| England               | 5.48%<br>(4)                | 7.29%<br>(5)  | 6.13%<br>(4)  | 6.28%<br>(5)  | 15.50%<br>(4)                  | 13.35%<br>(3) | 8.75%<br>(3)  | 10.86%<br>(3) |
| Germany               | 2.77%<br>(5)                | 3.96%<br>(6)  | 5.33%<br>(6)  | 4.79%<br>(6)  | 1.42%<br>(7)                   | 4.61%<br>(7)  | 7.51%<br>(5)  | 6.03%<br>(6)  |
| South<br>Korea        | 0.28%<br>(8)                | 0.70%<br>(8)  | 5.20%<br>(7)  | 3.80%<br>(7)  | 0.07%<br>(8)                   | 1.09%<br>(8)  | 4.04%<br>(7)  | 2.71%<br>(8)  |
| Canada                | 1.88%<br>(6)                | 2.85%<br>(7)  | 2.47%<br>(8)  | 2.48%<br>(8)  | 2.96%<br>(5)                   | 4.68%<br>(6)  | 2.87%<br>(8)  | 3.49%<br>(7)  |



**Fig. 5** Distribution of papers in three TCM subfields by countries/regions over three decades

their outlook, need, and respect for collaboration. The motivation for collaboration could be increased in the developed countries with higher intellect. With particular ways for increasing the efficiency and interaction in interdisciplinary and intercultural collaboration may be developed (Katsouyanni 2008). Owing to the specialization of research activities of each nation, international collaboration could be effective in promoting the creation, transmission, in sharing of knowledge, and in posing a serious obstacle to the diverse types of collective, exchangeable, and integrated in knowledge (Yarime et al. 2010).

Table 3 shows that indeed collaborative TCM researches among nations are rising, in some countries with impressive rates between 1980 and 2009. P.R. China produces the most international collaborated documents by releasing 1,021 papers in terms of its largest amount of publications. There are diverse patterns of the percentage share of international collaboration in different countries and regions. The table shows the highest percentage share of international collaboration in countries, including Canada and Germany, in 44.88 and 33.59% of the papers collaborated with other countries, respectively. On the second



**Table 3** International collaboration of top 10 countries/regions in TCM field over three decades

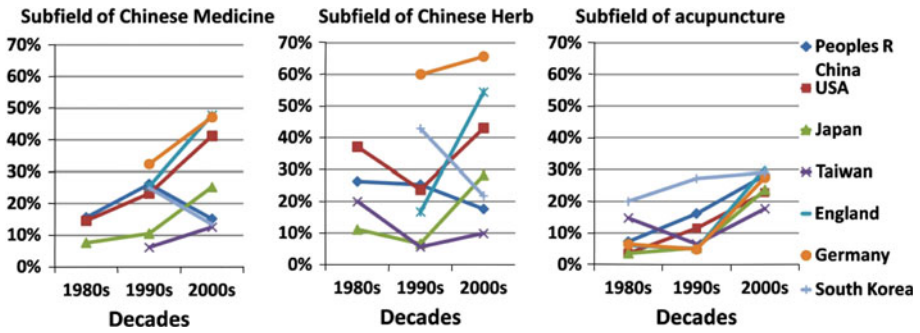
| Country     | International collaboration publication output (%*) |              |              |               | CPP values |       |
|-------------|---|--------------|--------------|---------------|------------|-------|
|             | 1980s   | 1990s        | 2000s        | Total         | CPPc       | CPPt  |
| P.R. China  | 36 (13.00%)   | 151 (23.48%) | 834 (16.94%) | 1021 (17.48%) | 9.97       | 6.83  |
| USA         | 24 (7.92%)  | 110 (16.69%) | 716 (30.82%) | 850 (25.88%)  | 13.58      | 13.00 |
| England     | 6 (6.06%)   | 26 (11.30%)  | 270 (38.03%) | 302 (29.07%)  | 9.38       | 9.39  |
| Germany     | 3 (6.00%)   | 29 (23.20%)  | 234 (37.93%) | 266 (33.59%)  | 8.74       | 9.25  |
| Japan       | 18 (7.73%)  | 45 (9.26%)   | 182 (26.15%) | 245 (17.31%)  | 14.20      | 15.22 |
| Canada      | 1 (2.94%)   | 30 (33.33%)  | 153 (53.50%) | 184 (44.88%)  | 20.28      | 11.08 |
| South Korea | 1 (20.00%)  | 7 (31.82%)   | 149 (24.75%) | 157 (24.96%)  | 8.89       | 6.28  |
| Taiwan      | 5 (14.71%)  | 16 (6.08%)   | 111 (12.07%) | 132 (10.85%)  | 13.11      | 12.39 |
| Australia   | 0 (0%)  | 8 (13.11%)   | 105 (35.84%) | 113 (29.66%)  | 6.79       | 8.48  |
| Sweden      | 4 (15.38%)  | 12 (13.19%)  | 35 (23.33%)  | 51 (19.10%)   | 22.47      | 16.22 |

\* Percentage of international collaboration publication output in the decade in the country/region

level, countries such as Australia, England, USA, Japan and South Korea collaborate with others in about 25–30% of their publications. On the third level, Sweden, P.R. China and Japan collaborate in 17–19% of their papers. Finally, the case of Taiwan shows a lowest percentage of international collaboration, with 10.85%. Most of the proportion figures of international collaborated papers have been moving in all countries and regions, except P.R. China and South Korea, have increased substantially over three decades and have indicated the importance of communication and information exchange in TCM field. Their efforts have made to conduct multi-location projects.

The citation per paper of international collaboration publication output (CPPc), as well as that of total publication output (CPPt) were also observed in this study. Being concordant with other scientists' results (Rojas-Sola et al. 2009), collaborative publications receive more citations than those based on national authorship. CPPc value was usually higher than CPPt value in the most of countries and regions; especially in Canada, its CPPc value is 1.8 times higher than the CPPt value, which means the research usually can attract more attention if it's conducted by the cross-border teams; it might be the factors that they have more frequent exchanges of ideas and their cultures leading the research to a higher level of quality. While the opposites for Australia, Japan and Germany are true, the figure of CPPc is almost equal to the figure of CPPt in USA and England. The size and international nature of collaborative projects and co-authors' past productivity have very significant impacts on the results and productivity; age, gender, and past productivity are also influential determinants in both of productivity and probability of promotion (Lissoni et al. 2011). In order to promote the accomplishment of a collaborative work, it will be interesting to know more influential factors, and understand more about advantages, disadvantages, experiences, and lessons learned from collaboration in TCM field.

Figure 6 shows the ratio trends of top seven countries/regions of international collaboration publication in total papers of TCM subfields over three decades. It reveals that scientists who engaged in TCM have the most frequent partners in Chinese herb subfield, followed by subfield of Chinese medicine. Germany is the most important host of collaborative research in the subfields of Chinese medicine and Chinese herb. Especially, in the latter period, the percentage share even reached to 65.69% in 2000s in Chinese herb. And the share of international outputs in acupuncture rises to the world's highest level with



**Fig. 6** Percent of international collaboration papers of three TCM subfields by countries/regions over three decades

27.59% in the latest 10 years. Furthermore, collaborative researches performed by England have risen with remarkable rates as its highest percentage share in subfields except Chinese herb.

**Institutional distribution**

The contribution of different institutes was assessed by the institute of the affiliation with at least one author in the published papers. The top 10 institutes were ranked by their published papers. According to Table 4, there are five universities are from the top 10 academic institutes in P.R. China. Chinese Academy of Sciences was ranked first all over the world, with 660 papers. There are 46 TCM universities and academies (State Administration of Traditional Chinese Medicine 2010a), and 3,130 TCM hospitals (State Administration of Traditional Chinese Medicine 2010b) from P.R. China. However, it is interesting to note that there’s no TCM-specialized institution or hospital but all comprehensive universities and academies have released their research achievements to the international community. On the other hand, the other four leading universities are located in Taiwan and Hong Kong. Kyung Hee University of South Korea is listed in the most productive organizations due to the large amount of papers related to acupuncture. The study indicates that the organizations from South Korea has developed and specialized at this field as a leading role over the past 30 years.

When papers were inspected in terms of three TCM subfields, Peking University based in P.R. China and China Medical University based in Taiwan are the only two institutes on the top 10 ranking in all three subfields, implying their balanced developments and remarkable contributions in each subfield of TCM.

Top 10 institutes in subfields of both of Chinese medicine and Chinese herb are all located in P.R. China, Hong Kong and Taiwan, which have similar traditional Chinese culture and social background. Chinese Academy of Sciences is also ranked in the first place of those two subfields.

Referring to the subfield of acupuncture, it has been highly cognized and globalized, the condition is entirely different. Among the top 10 institutes, three of them are derived from the USA, followed by P.R. China and UK, each of them has two institutes on the top 10 ranking. Each of Sweden, Taiwan, and South Korea has one institution. Kyung Hee University, located in South Korea, is ranked number one in the amount of acupuncture publications.

**Table 4** Top 10 productive organizations in TCM and its subfields between 1980 and 2009

| Organization (country/region)                   | TCM  |        | Subfield of Chinese medicine |        | Subfield of Chinese herb |        | Subfield of acupuncture |        |
|---|------|--------|------------------------------|--------|--------------------------|--------|-------------------------|--------|
|   | Rank | Papers | Rank                         | Papers | Rank                     | Papers | Rank                    | Papers |
| Chinese Academy of Sciences (P.R. China)        | 1    | 660    | 1                            | 497    | 1                        | 255    | –                       | –      |
| The Chinese University of Hong Kong (Hong Kong) | 2    | 424    | 2                            | 353    | 2                        | 192    | –                       | –      |
| Peking University (P.R. China)                  | 3    | 380    | 3                            | 206    | 3                        | 126    | 5                       | 122    |
| Fudan University (P.R. China)                   | 4    | 312    | –                            | –      | –                        | –      | 2                       | 161    |
| China Medical University (Taiwan)               | 5    | 280    | 7                            | 155    | 5                        | 93     | 9                       | 88     |
| Tsinghua University (P.R. China)                | 6    | 242    | 4                            | 205    | 7                        | 92     | –                       | –      |
| Kyung Hee University (South Korea)              | 6    | 242    | –                            | –      | –                        | –      | 1                       | 201    |
| Zhejiang University (P.R. China)                | 8    | 233    | 5                            | 194    | –                        | –      | –                       | –      |
| The University of Hong Kong (Hong Kong)         | 9    | 232    | 6                            | 167    | 9                        | 75     | –                       | –      |
| National Yang Ming University (Taiwan)          | 10   | 218    | 9                            | 127    | 4                        | 109    | –                       | –      |
| Sichuan University (P.R. China)                 | –    | –      | 8                            | 152    | –                        | –      | –                       | –      |
| Hong Kong Baptist University (Hong Kong)        | –    | –      | 10                           | 125    | 10                       | 73     | –                       | –      |
| National Taiwan University (Taiwan)             | –    | –      | –                            | –      | 5                        | 93     | –                       | –      |
| Taipei Medical University (Taiwan)              | –    | –      | –                            | –      | 8                        | 83     | –                       | –      |
| The University of Exeter (UK)                   | –    | –      | –                            | –      | –                        | –      | 3                       | 158    |
| Harvard University (USA)                        | –    | –      | –                            | –      | –                        | –      | 4                       | 156    |
| University of California—Los Angeles (USA)      | –    | –      | –                            | –      | –                        | –      | 6                       | 96     |
| University of Plymouth (UK)                     | –    | –      | –                            | –      | –                        | –      | 6                       | 96     |
| Karolinska Institute (Sweden)                   | –    | –      | –                            | –      | –                        | –      | 6                       | 96     |
| University of Maryland—Baltimore (USA)          | –    | –      | –                            | –      | –                        | –      | 9                       | 88     |

Citations attracted by TCM papers were further investigated in the light of institutional distribution, as is shown in Table 5, Chinese Academy of Sciences still occupies the largest part of all the top institutes. Comparing to the top 10 institutions based on the amount of publications, Harvard University located in USA, University of Exeter located in UK, and National Taiwan University as well as Taipei Veterans General Hospital located in Taiwan, are newly listed on the top 10 high-citation organizations with comparably smaller number of publications. Their research outcomes might have brought more new ideas, insights and funds to TCM community and have grabbed more attention.

With the emphasis to the ranks based on the number of citations in TCM subfields, this study lists the top 10 prodigious units in all of three fields. Peking University is the only one listed on the top 10 high-citation institutions in worldwide, indicating its productive, excellent, and well-rounded TCM researches.

In both of Chinese medicine and Chinese herb, Chinese Academy of Sciences received the most citations in addition to its largest number of publication. Besides, top 10

**Table 5** Top 10 high-citation organizations in TCM and its subfields between 1980 and 2009

| Organization (country/region)                                  | TCM  |          | Subfield of Chinese medicine |          | Subfield of Chinese herb |          | Subfield of acupuncture |          |
|--|------|----------|------------------------------|----------|--------------------------|----------|-------------------------|----------|
|  | Rank | Citation | Rank                         | Citation | Rank                     | Citation | Rank                    | Citation |
| Chinese Academy of Sciences (P.R. China)                       | 1    | 5411     | 1                            | 4305     | 2                        | 2135     | –                       | –        |
| Harvard University (USA)                                       | 2    | 5355     | –                            | –        | –                        | –        | 1                       | 4698     |
| The Chinese University of Hong Kong (Hong Kong)                | 3    | 4919     | 2                            | 3885     | 1                        | 2896     | –                       | –        |
| Peking University (P.R. China)                                 | 4    | 4209     | 3                            | 1724     | 4                        | 1285     | 3                       | 1957     |
| The University of Exeter (UK)                                  | 5    | 3146     | –                            | –        | –                        | –        | 2                       | 2399     |
| National Yang Ming University (Taiwan)                         | 6    | 2611     | 7                            | 1210     | 3                        | 1354     | –                       | –        |
| The University of Hong Kong (Hong Kong)                        | 7    | 2329     | 4                            | 1700     | 7                        | 834      | –                       | –        |
| National Taiwan University (Taiwan)                            | 8    | 2246     | –                            | –        | 5                        | 1131     | –                       | –        |
| Fudan University (P.R. China)                                  | 9    | 2210     | 8                            | 1136     | –                        | –        | 8                       | 966      |
| Taipei Veterans General Hospital (Taiwan)                      | 10   | 1879     | –                            | –        | –                        | –        | –                       | –        |
| Tsinghua University (P.R. China)                               | –    | –        | 5                            | 1495     | 10                       | 513      | –                       | –        |
| Hong Kong Baptist University (Hong Kong)                       | –    | –        | 6                            | 1243     | 9                        | 677      | –                       | –        |
| The Hong Kong University of Science and Technology (Hong Kong) | –    | –        | 9                            | 1129     | –                        | –        | –                       | –        |
| National University of Singapore (Singapore)                   | –    | –        | 10                           | 1102     | –                        | –        | –                       | –        |
| Taipei Medical University (Taiwan)                             | –    | –        | –                            | –        | 6                        | 1003     | –                       | –        |
| China Medical University (Taiwan)                              | –    | –        | –                            | –        | 8                        | 795      | 10                      | 460      |
| Kyung Hee University (South Korea)                             | –    | –        | –                            | –        | –                        | –        | 6                       | 1442     |
| Karolinska Institute (Sweden)                                  | –    | –        | –                            | –        | –                        | –        | 4                       | 1854     |
| University of Maryland—Baltimore (USA)                         | –    | –        | –                            | –        | –                        | –        | 5                       | 1745     |
| University of California—Los Angeles (USA)                     | –    | –        | –                            | –        | –                        | –        | 7                       | 1192     |
| University of Plymouth (UK)                                    | –    | –        | –                            | –        | –                        | –        | 9                       | 855      |

high-citation institutes all belong to P.R. China, Hong Kong, Taiwan, and Singapore, implying the countries or regions with high impact in subfields.

The subfield of acupuncture was in a diverse situation. As it's demonstrated in Table 5, Harvard University ranks first, distantly followed by the University of Exeter, with its number related publications just ranked as the fourth. The number of citation of top 10 institutions and countries/regions are totally in conformity with the results based on the number of publication, which do not only located in East Asian regions as other two TCM subfields.

## Conclusions

TCM has caused extensive concern of governments, scientific community and the public due to its increasing clinic applications, potential values in new drugs development and many impending challenges. Nonetheless, the above factors all relate to the fast growing investment in researches and great rise of publications.

This study investigated TCM as well as its three subfields by conducting bibliometric methods. Some significant points of this study might be helpful to further studies for developing an approach to the scientific and clinical validation of TCM. The paper denoted that the total 16,536 of TCM papers were distributed into 14 types of document, and article was the most popular type. The proportions of subfields of acupuncture gradually decreased in the past three decades.

East Asia concentrated most of the efforts on Chinese medicine. It had the largest number of authored papers, followed by North America and Europe that paid more attention on acupuncture. P.R. China had the largest number of publications, followed by USA, whose percentage of citations were about 10% higher than the percentage of citations of all the papers. P.R. China was ranked first with over 50% of papers in Chinese medicine and Chinese herb in the latest two decades. USA had always kept the largest share of total publication in acupuncture with a notable upward trend. Collaborative TCM researches among nations were rising and usually received more citations, and P.R. China produced the most internationally collaborated documents. The subfield of Chinese herb that scientists engaged in had the most frequent international partners.

Top 10 productive units in TCM field, and both of the subfields in Chinese medicine and Chinese herb, were all located in East Asia, Chinese Academy of Sciences was ranked first. According to the top 10 high-citation institutes in TCM field, Harvard University and University of Exeter are the two institutes located outside of Asia. In subfield of acupuncture, among the top 10 institutes based on number of publications as well as citations, six were derived from USA, UK, and Sweden. Harvard University ranked first according to the number of citations, and Kyung Hee University released the most amounts in acupuncture related publications.

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