Worldwide research productivity in the field of back pain

A bibliometric analysis

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Abstract

Background: This study aimed to show the world research productivity in the field of back pain and to help researchers follow the scientific development and promote the cooperation in this field.

Methods: Web of Science (WoS) database was searched from 1995 to 2016 without other restrictions. The keywords were as follows: “lumbar NEAR pain,” “back pain,” “dorsalgia,” “backache,” “lumbago,” “back NEAR disorder,” and “discitis.” The following information of retrieved articles was analyzed: countries/territories, journals, publication year, authors, citation reports, and institutions. Publication activity was further adjusted for countries by gross domestic product (GDP) and population size.

Results: A total of 50,970 articles were retrieved in WoS database from 1995 to 2016. The United States published the biggest number of articles (16,818, 33.00%), followed by England (4,582, 8.99%), Germany (3,871, 7.60%), Canada (3,613, 7.09%), and Australia (3,063, 6.01%). Sweden ranked the first after adjusted for publication, and Netherlands ranked the first after adjusted for GDP. Besides, there was positive correlation between total number of publications and GDP for each country (P < .05). Harvard University was the most productive institution (917, 1.80%), Maher CG was the most productive author (229, 0.45%) and Spine was the most popular journal (3605, 7.07%) in the field of back pain research. Moreover, the article titled “Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale” in Pain had the highest citations (1749).

Conclusion: There was a significant increase in annual publications concerning back pain research worldwide. The total number of publications was positively associated with GDP in main productive countries. The United States was the most productive country, Harvard University was the most productive institution, Maher CG was the most productive author and Spine was the most popular journal in the field of back pain.

Abbreviations: GDP = gross domestic product, WoS = Web of Science.

Keywords: back pain, bibliometric analysis, correlation analysis, worldwide research productivity

1. Introduction

Back pain is a common and global symptom that heavily affects the quality of the people’s life and even results in work disability.[1,2] Global Burden of Disease Study declared that low back pain was the top cause of years lived with disability in most countries.[3] In view of the high prevalence of the back pain, increasing researchers paid attention to back pain research.[4] As a result, a large number of studies have been conducted annually to explore the etiology, prevention, risk factors, and treatments of back pain.[9–12] which make it difficult to get the crucial scientific development in the field of back pain.

As important indicators, the number of published articles and citation reports have been acknowledged and frequently used to assess worldwide research productivity.[13–16] Bibliometric analysis was an important tool to measure scientific outputs of an individual, institution or country using relevant parameters including the number of published articles and citation of published articles.[17,18] Besides, bibliometric analyses could roughly investigate the trend of one specific topic and were frequently used in biomedical fields.[19–21] However, to our knowledge, there was no bibliometric analysis to assess the worldwide research productivity in the field of back pain. Therefore, the aim of this bibliometric analysis was to evaluate the worldwide research productivity, follow the scientific development and promote the cooperation in the field of back pain.

2. Materials and methods

Ethical approval was not necessary for this study because no patient was involved in this study.

2.1. Literature search

Similar to previous bibliometric analyses,[16–18,21] literature search was conducted in the database of Web of Science (WoS) (Thomson Reuters, New York) on November 15th, 2016. The keywords were “lumbar NEAR pain,” “back pain,” “dorsalgia,” “backache,” “lumbago,” “back NEAR disorder,” and “discitis.” The published time was limited from 1995 to 2016, without other restrictions.
2.2. Bibliometrics analysis

Worldwide research productivity was assessed based on a mature methodology used in other bibliometric studies. The following information was extracted: total publications, countries, published years, journals, citations, institutions, and authors. The population size and gross domestic product (GDP) of each country were obtained from the World Bank. The top productive countries (the country produced at least 1% of total articles) were classified into high-income, upper-middle-income, lower-middle-income, and low-income countries like previous studies. The publications from top productive countries were further analyzed with respect to GDP and population. Additionally, top 10 productive institutions, top 10 productive authors, top 10 cited articles, and top 5 popular journals were analyzed.

2.3. Statistical analysis

All statistical analyses were performed using SPSS software version 20.0 (SPSS Inc., Chicago, IL). The sum and average were used to analyze total publications, countries' contribution, years' contribution, journals, citations, top productive institutions, top productive authors, and top cited articles. The correlations among number of publications, GDP and population size were detected by Spearman’s test as previous studies. 

3. Results

3.1. The general information

A total of 50,970 articles were retrieved in WoS database from 1995 to 2016. As presented in Table 1, a total of 163 countries contributed to the scientific development of back pain. The United States published the great number of articles (16,818, 33.00%), followed by England (45,82, 8.99%), Germany (3,871, 7.60%), Canada (3,613, 7.09%), and Australia (3,063, 6.01%). The world map of worldwide research productivity demonstrated that North America, West Europe and Australia were main productive regions (Fig. 1). An obvious increase was detected in the number of annual publications worldwide in the field of back pain (Fig. 2).

3.1.1. Main productive countries or regions. The top productive countries were further analyzed (Table 1). There were 23 top productive countries, which published most publications worldwide (92.20%). Furthermore, the results showed the number of publications was significantly correlated with GDP (P = .003 and R = 0.595). However, no obvious relationship was observed between the number of publications and population size (P = .308, R = 0.222).

3.1.2. Top 10 productive countries. The top 10 productive countries published 42,074 articles, which account for 82.55% of total publications (Table 1). The top 10 productive countries all were high-income countries except for China, which was an upper-middle-income country. Regarding the production per capita, Sweden had the greatest number of articles (1.73E–04), followed by the Netherlands (1.58E–04), Australia (1.29E–04), Canada (1.01E–04), the United States (5.23E–05), Germany (4.75E–05), France (2.36E–05), Japan (1.77E–05) and China (1.41E–06). Besides, Netherlands ranked the first after adjusted for GDP, which published 3.55991E–09 articles and followed by Sweden (3.43674E–09), Canada (2.33016E–09), Australia (2.28661E–09) and England (1.60842E–09). Among the top 5 countries, the citation report of the United States was unavailable for the limited function of WoS database. As for the other 4 countries, England had the greatest total citations (120,624), followed by Canada (98,440), Germany (69,403), and Australia (68,473) (Table 2). However, Canada had the highest average citations per article (27.25), followed by England

| Country or Region | Publication | GDP ($) | Population | Level | Publication/GDP($) | Publication/population | % of total publication |
|-------------------|-------------|---------|------------|-------|--------------------|------------------------|-----------------------|
| USA               | 16818       | 17,946,996,000,000 | 321,418,820 | H     | 9.37003E-10       | 5.23E–05               | 32.997%               |
| England           | 4582        | 2,848,755,449,421 | 65,138,232  | H     | 1.06042E–09       | 7.03E–05               | 8.990%                |
| Germany           | 3871        | 3,355,772,429,655 | 81,413,145  | H     | 1.15353E–09       | 4.75E–05               | 7.595%                |
| Canada            | 3613        | 1,550,536,520,142 | 35,861,774  | H     | 2.35076E–09       | 1.01E–04               | 7.089%                |
| Australia         | 3003        | 1,333,539,063,150 | 23,761,169  | H     | 2.2061E–09        | 1.29E–04               | 6.010%                |
| Netherlands       | 2679        | 7,524,541,410,447 | 16,936,520  | H     | 3.55991E–09       | 1.58E–05               | 5.256%                |
| Japan             | 2250        | 4,123,257,609,615 | 126,958,472 | H     | 5.45685E–10       | 1.77E–05               | 4.415%                |
| China             | 1927        | 10,866,443,998,394 | 1,371,220,000 | M    | 1.77335E–10       | 1.41E–06               | 3.781%                |
| Sweden            | 1693        | 492,618,068,569   | 9,798,871   | M     | 3.43674E–09       | 1.73E–04               | 3.322%                |
| France            | 1578        | 2,421,682,377,731 | 66,808,385  | H     | 6.51613E–10       | 2.35E–06               | 3.036%                |
| South Korea       | 1450        | 1,377,873,107,656 | 50,617,045  | H     | 1.05235E–09       | 2.38E–05               | 2.845%                |
| Turkey            | 1396        | 718,021,076,309   | 19,365,830  | H     | 1.94648E–09       | 1.78E–05               | 7.943%                |
| Italy             | 1364        | 1,814,762,858,046 | 60,802,085  | H     | 7.51613E–10       | 2.24E–05               | 2.676%                |
| Switzerland       | 1302        | 664,737,543,617   | 8,286,076   | H     | 1.96867E–09       | 1.57E–05               | 2.555%                |
| Spain             | 1184        | 1,199,057,336,143 | 46,418,269  | M     | 9.87442E–10       | 2.55E–05               | 2.323%                |
| Denmark           | 1085        | 295,164,313,329   | 5,676,002   | M     | 3.67502E–09       | 1.91E–04               | 2.129%                |
| Belgium           | 980         | 454,039,037,374   | 11,265,721  | H     | 2.13584E–09       | 8.68E–05               | 1.923%                |
| Norway            | 926         | 388,314,909,979   | 5,195,921   | H     | 2.38466E–09       | 1.78E–04               | 1.817%                |
| Brazil            | 858         | 1,774,924,819,000 | 207,847,528 | M     | 4.83465E–10       | 4.13E–06               | 7.683%                |
| Finland           | 854         | 229,810,358,212   | 5,482,013   | H     | 3.71611E–09       | 1.56E–04               | 1.676%                |
| Taiwan            | 657         | 1,022,000,000,000 | 23,359,928  | H     | 6.42837E–10       | 2.81E–05               | 1.289%                |
| India             | 614         | 2,073,542,978,209 | 1,311,050,527 | M    | 2.96112E–10       | 4.68E–07               | 1.205%                |
| Iran              | 533         | 425,326,088,423   | 79,109,272  | U     | 1.25316E–09       | 6.74E–06               | 1.046%                |

GDP = gross domestic product, H = high-income, M = middle-income, U = upper middle-income.
With respect to Hi-index, England ranked the first (137), followed by Canada (131), Australia (110), and Germany (102).

3.1.3. Top 10 productive institutions. The top 10 productive institutions were presented in Table 3. Harvard University was the most productive institution (917), followed by the University of Washington (896), University of Sydney (714), University of Toronto (641), and Vrije University of Amsterdam (550). Among the top 10 productive institutions, 4 were located in the United States, 2 in Canada, 2 in Australia and 1 in Sweden as well as 1 in Netherlands.

3.1.4. Top 10 productive authors. Regarding the top 10 productive authors (Table 4), Maher CG ranked the first and published the largest number of publications, with a total of 229 publications (0.45%), followed by Deyo RA (192, 0.38%), Koes BW (186, 0.37%), Manchikanti L (178, 0.35%), and Lee SH (168, 0.33%). Besides, 3 authors were from the United States, 2 from the Netherlands, 1 from Australia, 1 from Japan, and 1 from South Korea.

3.1.5. Top 10 cited articles. With respect to the top 10 cited articles (Table 5), Farrar, JT study entitled “Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale” published in Pain had the highest citations (1749), followed by Beaton. DE study (1689), Vlaeyen. JWS study (1553), Lawrence. RC study (1530), and Astin. JA study (1496).

3.2. Top 5 popular journals

The top 5 productive countries in the top 5 popular journals were listed in Table 6. Spine was the most popular journal with 3605 articles (7.07%), followed by European Spine Journal (1280, 2.51%), Pain (1085, 2.13%), Journal of Manipulative and...
Physiological Therapeutics (699, 1.37%), and Spine Journal (689, 1.35%). The United States was the most productive country in all top 5 popular journals. England and Canada both appeared in the top 5 productive countries in 4 popular journals. The results about top 5 popular journals in top 5 productive countries were showed in Table 7. Spine remained the most popular journal in the United States, England, Canada, and Australia, while Schmerz was the most popular journal in Germany. In additions, Pain appeared in all top 5 productive countries.

### 4. Discussion

Biomedical research publication has been frequently used as an index for assessing the worldwide scientific productivity in a specific field.\(^\{18,20,26\}\) Bibliometric analyses have been utilized to assess the worldwide scientific productivity in several biomedical fields.\(^\{13,19,25,27,28\}\) Recently, Huang et al. performed a citation analysis focusing on the back pain, which was published in Spine. However, Huang et al group only aimed to obtain the top 100 cited articles, and further analysis was also based on these 100 articles. Therefore, the results and conclusions were limited and not enough to assess worldwide scientific productivity in the field of back pain.\(^\{29\}\) Therefore, to the best of our knowledge, our study was the first to assess the worldwide research productivity in the field of back pain from 1995 to 2016. In our study, an obvious increase was observed in the number of annual publications worldwide in the field of back pain. The United States was the most productive country and made major contributions to the development of back pain research. Harvard University was the most productive institution, Maher CG was the most productive author as well as the study conducted by Farrar et al.\(^\{29\}\) was the most popular article and Spine was the most popular journal.

In the study, the United States published the greatest number of publications. Besides, 4 of top 10 productive institutions located in the United States, and 3 of top 10 productive authors were from the United States. Therefore, the United States was leading the back pain research worldwide. It was a pity that we failed to obtain the citation report of the publications from the United States because of the limited functions of WoS. However, we found the United States was the most popular country among the top 5 popular journals, including famous peer-reviewed journals (e.g., Spine, Spine Journal, and European Spine Journal). In slight of this situation, we could roughly think publications from the United States were with relatively higher quality. In addition to the United States, the European countries (e.g., Denmark) also contributed a lot to the development of back pain research. Among the top 10 productive countries, Sweden ranked the first after adjusted for population and the Netherlands was the most productive country after adjusted for GDP. Besides, 2 of top 10 productive institutions located in European countries and 3 of top 10 productive authors were from European countries. Therefore, to some extent, the articles published in the United States and European countries should be fully utilized to improve health policies and health care worldwide.\(^\{7,30\}\)

Similar to previous studies,\(^\{25,30\}\) we further explored the association among the number of publications, GDP and population size. Significant relationship was detected between the number of publications and GDP, which agreed with the previous studies.\(^\{25,30\}\) The positive relationship indicated the country’s economy affected a lot on the development of scientific research. Nonetheless, there was no obvious correlation between the number of publications and the population size, which

### Table 2

Citation report of articles in top 5 productive countries from 1995 to 2016.

| Country          | Publications | Total citations | Average citations | Hi-index |
|------------------|--------------|-----------------|-------------------|----------|
| USA              | 4582         | 120,624         | 19.93             | 137      |
| England          | 3871         | 69,403          | 17.93             | 102      |
| Germany          | 3612         | 98,440          | 27.25             | 131      |
| Canada           | 3063         | 68,473          | 22.35             | 110      |

### Table 3

Top 10 productive institutions from 1995 to 2016.

| Institution                  | Country        | Publications | % of total publications |
|------------------------------|----------------|--------------|-------------------------|
| Harvard University           | USA            | 917          | 1.80%                   |
| University of Washington     | USA            | 896          | 1.76%                   |
| University of Sydney         | Australia      | 714          | 1.40%                   |
| University of Toronto        | Canada         | 641          | 1.26%                   |
| Vrije University of Amsterdam| Netherlands    | 550          | 1.08%                   |
| University of Pittsburgh     | USA            | 515          | 1.01%                   |
| Karolinska Institute         | Sweden         | 495          | 0.97%                   |
| The University of Queensland | Australia      | 488          | 0.96%                   |
| University of Alberta        | Canada         | 487          | 0.96%                   |
| The University of California | USA            | 460          | 0.90%                   |

| Authors                  | Publication | % of 50968 | Affiliation                                                      |
|--------------------------|------------|------------|-----------------------------------------------------------------|
| Maher CG                 | 229        | 0.45%      | Univ Sydney, Sydney Med Sch, George Inst Global Hlth, Sydney, NSW 2006, Australia |
| Deyo RA                  | 192        | 0.38%      | Oregon Hlth & Sci Univ, Dept Family Med, Portland, OR 97239 USA  |
| Koes BW                  | 186        | 0.37%      | Erasmus MC, Dept Gen Practice, Rotterdam, Netherlands             |
| Manchikanti L            | 178        | 0.35%      | Pain Management Ctr Paduch, Paduch, KY USA; Univ Louisville, Louisville, KY 40292 |
| Lee SH                   | 168        | 0.33%      | Korea Univ, Coll Med, Dept Orthopaed Surg, Anam Hosp, 126-1 Anandong 5ga, Seoul 136705, South Korea |
| Takahashi K              | 162        | 0.32%      | Chiba Univ, Grad Sch Med, Dept Orthopaed Surg, Chiba 2608670, Japan |
| Vlaeyen JWS              | 150        | 0.29%      | Univ Leuven, KU Leuven, Fac Psychol & Educ Sci, Res Grp Hlth Psychol, Leuven, Belgium; Maastricht Univ, Dept Clin Psychol Sci, NL-6200 MD Maastricht, Netherlands |
| Van Tulder MW            | 139        | 0.27%      | Vrije Univ Amsterdam, Fac Earth & Life Sci, Dept Hlth Sci, Amsterdam, Netherlands |
| Hodges PW                | 135        | 0.27%      | Univ Queensland, Sch Hlth & Rehabil Sci, Brisbane, Qld, Australia |
| George SZ                | 134        | 0.26%      | Brooks PIHP Res Collaborat, Gainesville, FL 32610; Univ Florida, Dept Phys Therapy, Phys Therapy Program, Gainesville, FL 32611 |
The difference might be explained that the topic of the current study differed from the previous bibliometric analysis.\cite{25,26} This difference might be explained that the topic of the current study was a little broader or the distinctly uneven distribution of the publications concerning the back pain. Moreover, 18 of 23 main productive countries were high-income countries. Regarding the 5 middle-income countries, the rapid development of society and economy significantly promoted the advance of the research productivity. In view of their developing economy, we fully believed these middle-income countries would make greater contribution to back pain research in future. On the contrary, several identified factors contributed to the poor research productivity in some countries, such as inappropriate government policy, less fund and loss of outstanding researchers.\cite{25,31,32}

Given that these factors were difficult to change in a short period, these countries should make full use of the high-quality researches from high-income countries to improve health policies and health care in future.\cite{25,31,32}

China, the second largest economy and with over 1.3 billion people, contributes more and more to the development of worldwide scientific productivity.\cite{25,31} With the advancement of society and economy, China has increased the influence on back pain research. In this study, as the only one middle-income country, China ranked the eighth in the top 10 productive countries. Besides, China ranked the tenth after adjusted for GDP or population size. Nevertheless, China seldom appeared in top 5 popular journals, which meant that many publications from China were relatively with low quality. Therefore, China government should further increase the research fund and promote the enthusiasm of researchers to publish more high-quality publications concerning back pain in future.

We also discovered the United States was the most productive country in all top 5 popular journals. However, it should be noted that most of these journals were published in the United States. Besides, China and Canada both appeared in the top 5 productive countries. Furthermore, Spine was the most popular journal in 4 of top 5 productive countries, including the United States, England, Australia, and Canada. Spine was also the most popular journal in back pain research. Therefore, Spine made a great contribution to the development of back pain research. Given that Pain appeared in all top 5 productive countries, this journal was also essential for the
development of back pain research and might be a nice journal to
publish new work focusing on back pain.

There were some highlights of our study. First, it was the first
bibliometric analysis to evaluate worldwide research productivity
in the field of back pain over 20 years. Second, comprehensive
information was provided in current study, such as top
productive countries, authors, institutions, and journals. Never-
theless, our study was not without limitations. First, only articles
published in WoS was included into the analysis. However, lots of
articles were published in none WoS-cited journals. Second, it
was hard to ensure that all the identified articles indeed focused
on back pain research. Third, the citation report of the United
States was unavailable for the limited function of WoS; therefore,
we could not obtain the direct evidences to demonstrate that
publications from the United States were with relatively higher
quality. Therefore, more databases (e.g., Google Scholar) should
be used to evaluate the worldwide research productivity in the
field of back pain and provide more comprehensive information.
Besides, the characteristics of top cited articles should be further
analyzed to help new researchers design studies in future.

5. Conclusion
There was a significant increase in annual publications concern-
ing back pain research worldwide. The total number of
publications was positively associated with GDP in main
productive countries. The United States was the most productive
country, Harvard University was the most productive institution,
Maher CG was the most productive author and Spine was the
most popular journal in the field of back pain.

Author contributions
All authors have participated sufficiently in the study and
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