Orthopedics research output from China, USA, UK, Japan, Germany and France: A 10-year survey of the literature

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ABSTRACT

Background: In the past decade, researchers have made great progress in the field of Orthopedics. However, the research status of different countries is unclear. To summarize the number of published articles, we assessed the cumulative impact factors in top orthopedic journals. The aims of the study were to measure: 1) the quality and quantity of publications in orthopedics-related journals from China and other five counties, 2) the trend of the number of publications in orthopedics-related journals.

Methods: The related journals were selected based on the 2014 scientific citation index (SCI) and articles were searched based on the PubMed database. To assess the quantity and quality of research output, the number of publications including clinical trials, randomized controlled trials, meta-analyses, case reports, reviews, citations, impact factors, number of articles in the top 10 journals and most popular journals were recorded.

Results: A total of 143,138 orthopedics articles were published from 2005 to 2014. The USA accounts for 24.0% (35,763/143,138) of the publications, followed by UK (7878/143,138 (5.5%)), Japan (7133/143,138 (5.0%)), Germany (5942/143,138 (4.2%)), China (4143/143,138 (2.9%)) and France (2748/143,138 (1.9%)). The ranking for accumulated impact factor as follows: USA, UK, Japan, Germany, France and China. The mean impact factor’s order is USA, China, Germany, Japan, France, UK, and interestingly the mean impact factors in Japan is similar to the Germany in 2005–2014. The USA had the highest percentage of articles in the top 10 journals, while China owns the least. The USA had the highest number of average citations, while Japan had lowest number of average citations.

Conclusions: According to this study, we can conclude that the USA has been leading the orthopedics research in the past 10 years. Although China still falls behind, it has made considerable progress in the orthopedics research, not only in quantity but also quality.

Level of evidence: IV.

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1. Introduction

Orthopedics diseases affect the health of people worldwide, including rachitic, fracture, rheumatism, protrusion of intervertebral disc, Avascular Necrosis of the Femoral Head/Osteneocrosis of the Femoral Head (ANFH/ONFH). In the past decades, the health status of the Chinese population has been significantly improved. Generally, the number of published scientific papers represents a country’s scientific strength [1]. Study of orthopedics has become a hot area nowadays and shows a promising future [2–4].

Orthopedics study in China has seen rapid development in recent years [5]. The number of articles in the specific field represents the level of concern in the field. Many articles analyzing the status in certain disciplines have been published [6,7]. But the scientific publications in orthopedics by Chinese authors have not been reported. We therefore intended to reveal the contribution of Chinese authors in the field of orthopedics compared with top five countries—the United States (USA), the United Kingdom (UK), Germany, France and Japan—to the research in the field of orthopedics. The aims of the study were to measure:

• the quality and quantity of publications in orthopedics-related journals from China and other five countries;
• the trend of the number of publications in orthopedics-related journals.

Abbreviations: USA, the United States; UK, the United Kingdom; JCR, Journal citation report; IF, Impact factor; RCT, randomized controlled trial; SCIE, Science citation index expanded.

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1877-0568/© 2016 Published by Elsevier Masson SAS.
2. Methods

2.1. Search strategy

Seventy-two orthopedics journals were selected from the orthopedics category of the Science Citation Index Expanded (SCIE) subject categories [8]. The 72 journals are all indexed by PubMed, a comprehensive database containing articles from high-quality medical journals [9], and the citations are all indexed by Web of Science. The ISSN (print) and publication date (print) were used to perform searches in the PubMed database. The search terms were provided in Appendix A.

2.2. Statistical analysis

SPSS (IBM SPSS Statistics 21) was used for statistical analysis. Regression analysis was used to determine if there are significant changes in time trend from 2005 to 2014. The differences among the three regions were detected with the Kruskal-Wallis test, and rank-sum test if necessary for differences between the two countries. The test for significance was two tailed and P value < 0.05 was considered significant.

3. Results

3.1. Total number and share of articles

A total of 143,138 articles were published (Fig. 1) between 2005 and 2014 in the 72 orthopedics-related journals. The USA accounted for the largest proportion (35,763/143,138 [24.9%]), followed by UK (7878/143,138 [5.5%]), Japan (7133/143,138 [5.0%]), Germany (5942/143,138 [4.2%]), Mainland China (4143/143,138 [2.9%]), and France (2748/143,138 [1.9%]). The changes in the annual number from each country were shown in the Fig. 2. As shown in Fig. 2, there is a significant increase of articles from 2005 to 2014 in China (from 42 to 973, \(R^2 = 0.983, P < 0.001\)), the number of papers published from China surpassed that published from France in 2010 for the first time, and in 2013 surpassed that from Germany and approached that from UK. The number of papers from France is

![Fig. 1. Flow of information through the different phases of a systematic review.](image1)

![Fig. 2. Number of articles published in orthopedics journals from the six countries (2005–2014) (two scales are provided to distinguish trend after USA was excluded).](image2)
ranked last between 2010 and 2014, and the number of papers published from USA is always the first from 2005 to 2014. The number of papers from UK surpassed that from the Japan in 2010 and ranked second after the USA.

3.2. Clinical trials, randomized controlled trials, case reports, meta-analyses and reviews

The number of different types of articles from the six countries is shown in Fig. 3. The USA ranked the first in the number of clinical trials, randomized controlled trials, case reports, and reviews. Interestingly, the number of meta-analyses published by China ranked the first (189 meta-analyses).

3.3. Impact factor (IF)

Based on JCR 2014, we calculated the cumulated and mean IFs for each geographic region (Table 1). Cumulative IFs can reflect the quantity of articles and mean IFs can reflect the quality of articles. The ranking of the cumulative IFs in six countries was the USA (63,614.100), Japan (10,468.200), UK (9042.920), Germany (8884.810), China (6501.028) and France (4677.360) from 2005 to 2014. There is a significant increase of cumulative IFs from 2005 to 2014 in China (from 53 to 1688, \( R^2 = 0.971, P < 0.001 \)). China ranked the fifth with respect to the cumulative IFs in 2005 and ranked the second in 2014.

3.4. Citation reports

The rank of total citations-to-published articles between 2005 and 2014 was as follows (Table 2): USA (461,501 citations), France (157,775 citations), UK (101,633 citations), Germany (70,159 citations), Japan (51,110 citations), China (19,368 citations). USA had the highest average citation (12.618). Interestingly, in 2005, China ranked the first with respect to the average citation and usually ranked the third between 2005 and 2014.

3.5. Top 10 orthopedics journals

The number of articles from each country of the journals which ranked in the top 10 according to the JCR 2014 was shown in

![Graph showing number of articles by publication type from 2005-2014](image)

**Fig. 3.** Number of articles of different publication types from the six countries (2005–2014).

**Table 1** Cumulative and median impact factor (IF) of articles from each region.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cumulative IFs</th>
<th>Median IFs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>USA</td>
<td>Germany</td>
</tr>
<tr>
<td>2005</td>
<td>4389.484</td>
<td>419.707</td>
</tr>
<tr>
<td>2006</td>
<td>5465.525</td>
<td>571.321</td>
</tr>
<tr>
<td>2007</td>
<td>5328.572</td>
<td>595.347</td>
</tr>
<tr>
<td>2009</td>
<td>6556.258</td>
<td>773.754</td>
</tr>
<tr>
<td>2010</td>
<td>7152.415</td>
<td>954.718</td>
</tr>
<tr>
<td>2011</td>
<td>7853.335</td>
<td>975.624</td>
</tr>
<tr>
<td>2013</td>
<td>7591.286</td>
<td>1276.128</td>
</tr>
<tr>
<td>2014</td>
<td>5141.429</td>
<td>1533.474</td>
</tr>
<tr>
<td>Total</td>
<td>6,3614.100</td>
<td>8884.810</td>
</tr>
</tbody>
</table>
Among the six countries, USA accounted for the overwhelming majority of the number of articles (7597/11,716 [64.8%]). While the number of articles contributed by authors from China was relatively small (426/1,1716 [3.6%]). When comparing the data from 2010-2014 (Table 4), the percentage of articles in the top 10 from China increased slightly from (426/11,713 [3.6%]) to (333/5909 [5.6%]). But the contributions to the top 10 journals from six countries is slightly changed, it’s ranked USA, Japan, UK, Germany, France, China. And China surpassed France at 2010–2014. Interestingly, the Journal of Physiotherapy has a high impact factor journal, but France published only one article at the journal. And UK was more inclined to publish articles at the Journal of Bone And Joint Surgery-British Edition. From 2005 to 2014 the percentage of UK published articles at this journal was 67.8% (934). It ranked the first in the five countries.

### 3.6. Most published journals

The journals in which articles from the six countries were published more frequently were listed in Tables 5 and 6. Articles from China were most often published in Spine (Phila Pa 1976) and those from USA, Germany and France were mostly published in the Clin Orthop Relat Res, Arch Orthpa Trauma Surg and Orthpa Traumatol Surg Res, respectively. These four journals were not amongst the top 10 journals (Tables 5 and 6). When comparing the results between 2005-2014 and 2010-2014, there was no significant difference (Tables 5 and 6).

### 4. Discussion

To the best of our knowledge, this is the first study that compared the quality and quantity of publications in orthopedics-related journals from China and the USA, UK, Germany, France and Japan. Publications from the six countries were extracted based on the PubMed database. The IF of each journal was calculated using the JCR 2014, which quantified the influence of research and impact on the journal or category level. There is a significant increase of articles from 2005 to 2014 in China, it is from 42 to 973. And the accumulated IF is from 52.57 to 1688.21 between 2005 and 2014. France also have a significant increase of articles, it is from 119 to 575.

There are several limitations in the present study. Even though the journal list was generated based on the orthopedics category in SCIE subject categories, there may be excellent orthopedics journals
Table 5
Ten most published orthopedics journals in each region (2005–2014).

<table>
<thead>
<tr>
<th>Rank</th>
<th>N</th>
<th>Germany</th>
<th>UK</th>
<th>Japan</th>
<th>China</th>
<th>France</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1657</td>
<td>Int Orthop</td>
<td>Hip Int</td>
<td>Arch Orthop Trauma Surg</td>
<td>Injury</td>
<td>Knee Surg Sports Traumatol Arthrosc</td>
</tr>
</tbody>
</table>

not included in SCIE. Second, the publications of some international collaborative studies may have only listed one address for all authors. Therefore, when included in this study, the contributions of other countries were ignored. Third, there are some orthopedics-related articles published in general medical journals, which affected our results.

With the tremendous socioeconomic progress, significant development has been observed in Chinese science and medicine [10]. China exhibited a sustained trend in growth with respect to the number of publications in orthopedics-related journals. The USA showed an increasing trend in the number of orthopedics articles published between 2005 and 2012, but the trend was reversed in

Table 6
Ten most published orthopedics journals in each region (2010–2014).

<table>
<thead>
<tr>
<th>Rank</th>
<th>N</th>
<th>Germany</th>
<th>UK</th>
<th>Japan</th>
<th>China</th>
<th>France</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>861</td>
<td>Int Orthop</td>
<td>BMC Musculoskelet Disord Bone Joint J</td>
<td>Eur Spine J</td>
<td>Int Orthop</td>
<td>Int Orthop</td>
</tr>
<tr>
<td>5</td>
<td>756</td>
<td>Injury</td>
<td>165</td>
<td>J Spinal Disord Tech</td>
<td>Spinal Disord Tech</td>
<td>Spinal Disord Tech</td>
</tr>
<tr>
<td>6</td>
<td>742</td>
<td>BMC Musculoskelet Disord J Orthop Res</td>
<td>Eur Spine J</td>
<td>Arch Orthop Trauma Surg Orthopedics</td>
<td>Spinal Disord Tech</td>
<td>Spinal Disord Tech</td>
</tr>
</tbody>
</table>

last 2 years. In 2011, China followed Germany with respect to the number of orthopedics articles published. And in 2014 China surpassed the Japan, France and Germany and followed the UK in the number of orthopedics articles published. USA is the leader in this area of research and has a much stronger research influence than the other five countries. The same was demonstrated when the publication of different types of articles was analyzed. The USA is the leader in publishing clinical trials, randomized controlled trials, case reports and reviews, and China was the leader of meta-analyses articles. High-quality RCTs are important references for clinical practice and are often used to determine the effectiveness of various types of medical interventions [1]. RCTs are considered to be the most reliable scientific evidence in the hierarchy of evidence, and influence healthcare policy and practice [11]. The results herein demonstrated that USA has made the most contribution in orthopedics. In contrast, the number of meta-analyses published from China ranked the first, which can be explained by the rapid development of evidence-based medicine in China.

The optimal tool for assessing the quality of articles remains controversial, but the impact factors and popular journals have been widely used. The IF of an academic journal is a measurement which reflects the average number of citations of articles published in the journal. The IF is frequently used as a proxy for the relative importance of a journal within its field. Journals with higher IFs are deemed to be more influential than journals with lower IFs. Despite considerable criticism regarding the IF, the IF is universally accepted as the most convincing index for quality evaluation of journals. In the past decade, the cumulative IFs of articles published in the USA were several times higher than those of the other five countries. In 2014, the cumulative IFs of articles published in China ranked the second. It suggests that the USA published more high quality of orthopedics and it reflected the rapid development of Chinese scientific research.

For popular journals analysis, the Spine, Eur Spine J and Int Orthop were the top 3 popular orthopedic journals in China. There were 1992 articles from the Chinese authors, and 992 (49.8%) articles published in these three top journals. These results indicate that Chinese authors are more inclined to the three journals. And the Orthop Traumatol Surg Res, Eur Spine J and Int Orthop were the top 3 popular orthopedic journals in France. There were 1813 articles from the Chinese authors, and 1137 (62.7%) articles published in these three top journals. These results indicate that French authors are more favorite to the three journals.

When comparing the distribution of publications related to the IF, articles published from USA were mostly published in the top 10 journals and China ranked last. The published articles from China in top 10 journals were 426/11,716 (3.6%) between 2005 and 2014. These results indicate that the development of China in orthopedics field. And there was a greater increase in China than other countries as in some other fields, such as gastroenterology and hepatology [7], cardiology and cardiovasculature [5], spine [6]. These findings do not change significantly in 2010–2014.

There are several possible reasons for China increased contributions to the field of orthopedics. First, China’s GDP is second, behind the United States in the world [12]. In 2013, the amount of research spent in China was 11,846.6 hundred million Yuan, 2.08% of the GDP, which was increased from 1148.2 hundred million Yuan in 2012 [13]. And the percentage announced by the government may reach 2.5% in 2020 [14]. Various types of medical research-funded projects also increased considerably in the past decade. With the support of a variety of funds from government and corporations, more and more excellent Chinese scientists have taken part in this promising research field. So that fast and remarkable development has been achieved in the past decade [6,15]. Second, China has an advantage in recruitment of participants because of the large population and high prevalence of orthopedics disorders.

Our study proved that clinical study in orthopedics from China had comprehensively thrived over the last decade [16–18]. Third, China has the largest number of orthopedic surgeons, which facilitates large-scale multi-center studies [19]. All of those factors have greatly promoted Chinese research in the field of orthopedics.

Despite the rapid growth in the number of articles from China, the quality was not satisfactory. This could be associated with the current imperfect evaluation system on research performance in China, which enforced researchers to pay more attention to quantity rather than quality. The number of publications in the top 10 journals further supports the above conclusions. The USA has played the most important role in the field of orthopedics research in the past decade. Overall, the quality of publications in USA is better than China. We are delighted to see that China is narrowing the gap with the developed countries. With respect to future research, scientists from mainland China should take effective measures and strive to improve the quality of research.

Disclosure of interest

The authors declare that they have no competing interest.

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Appendix A

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