

Global scientific production in the field of knee arthroplasty: A cross-sectional survey of research activities

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Abstract

Objective: To determine the quantity and quality of articles in the field of knee arthroplasty worldwide and elucidate the characteristics of global scientific production.

Methods: Web of Science was used to identify articles in the field of knee arthroplasty from 2011 to 2015. The total number of papers, number of papers per capita, total number of citations, and mean number of citations were collected.

Results: In total, 11,590 papers were identified. The number of publications significantly increased from 2011 to 2015. Most originated from North America, East Asia, and West Europe. Most (88.51%) were from high-income countries, 11.48% were from middle-income countries, and only 0.01% were from lower-income countries. The United States had the most articles and total citations. Sweden had the highest mean citations, followed by Denmark and Canada. However, when adjusted by population size, Denmark had the most articles per million population, followed by Switzerland and the Netherlands.

Conclusions: The number of knee arthroplasty publications has rapidly increased in recent years. The United States is the most prolific, but some European countries are more productive relative to their population.

Keywords

Knee arthroplasty, publication

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Introduction

Knee arthroplasty is a major surgery in the treatment of knee diseases.^{1–3} Many developments in knee arthroplasty have occurred during the past few decades.^{1–4}

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However, these contributions to the field of knee arthroplasty have been unequal among countries because of different healthcare systems, financial research sources, and scientific research programs.^{5,6}

The quantity and quality of articles are important indicators for scientific contributions and are usually used to analyze the importance of publications and describe trends in certain fields.⁷⁻¹⁰ Assessment of the global scientific production has recently been reported in many medical fields, including critical care medicine,⁷ the spine,⁸ hand and wrist surgery,⁹ endocrinology and metabolism,¹⁰ and arthroscopy.¹¹ To the best of our knowledge, however, the global scientific production in the field of knee arthroplasty has not been reported. Therefore, the present study was performed to assess the characteristics of the worldwide research output in knee arthroplasty.

Materials and methods

On 10 June 2016, a topic search using the terms “knee,” “replacement,” “arthroplasty,” and “prosthesis” was performed in Web of Science, with a year range of 2011 to 2015. Original articles and reviews were included, and letters, editorial material, and corrections were excluded. The country of the corresponding author’s institution was considered the source nation.^{8,9}

The number of articles and number of citations were used as the quantity and quality indicator, respectively, of scientific production. Countries were classified into high-, upper-middle-, lower-middle-, and low-income countries based on the categories set by World Bank.¹² The gross national income per capita was used to determine the income levels. An income of \$12,736 or more was classified as high income, \$4126 to \$12,735 as upper-middle income, \$1046 to \$4125 as lower-middle income, and \$1045 or less as low income.¹²

Countries with $\geq 1\%$ publications were considered the main prolific countries. The following data were collected: the total number of papers, the number of papers per capita, the total number of citations, and the mean number of citations. The Central Intelligence Agency was used to gather the populations of different countries.¹³ The number of articles published in the top five journals from the top five countries and the number of articles published from the top five countries in the top five journals were also collected.

SPSS (version 19.0; IBM Corp., Armonk, NY) was used for all statistical tests. A *P* value of < 0.05 was considered to indicate statistical significance. Significant changes in the number of articles over time were analyzed using regression analysis. Spearman’s test was used to analyze correlations.

Results

In total, 11,590 papers were identified from 2011 to 2015. The number of yearly publications significantly increased from 2011 to 2015 ($P = 0.010$) (Figure 1). A total of 76 countries contributed these publications worldwide. A world map of global production is shown in Figure 2. It indicates that North America, East Asia, and West Europe were the most prolific regions. High-income countries had 10,258 publications (88.51%), upper-middle-income countries had 1170 articles (10.09%), lower-middle-income countries had 161 publications (1.39%), and low-income countries had only 1 article (0.01%).

Eighteen main prolific countries published 90.41% (10,478/11,590) of the papers (Table 1). Most of these were high-income countries ($n = 15$); the 4th and 15th countries (China and Turkey, respectively) were upper-middle-income countries, and the 17th country (India) was one of the

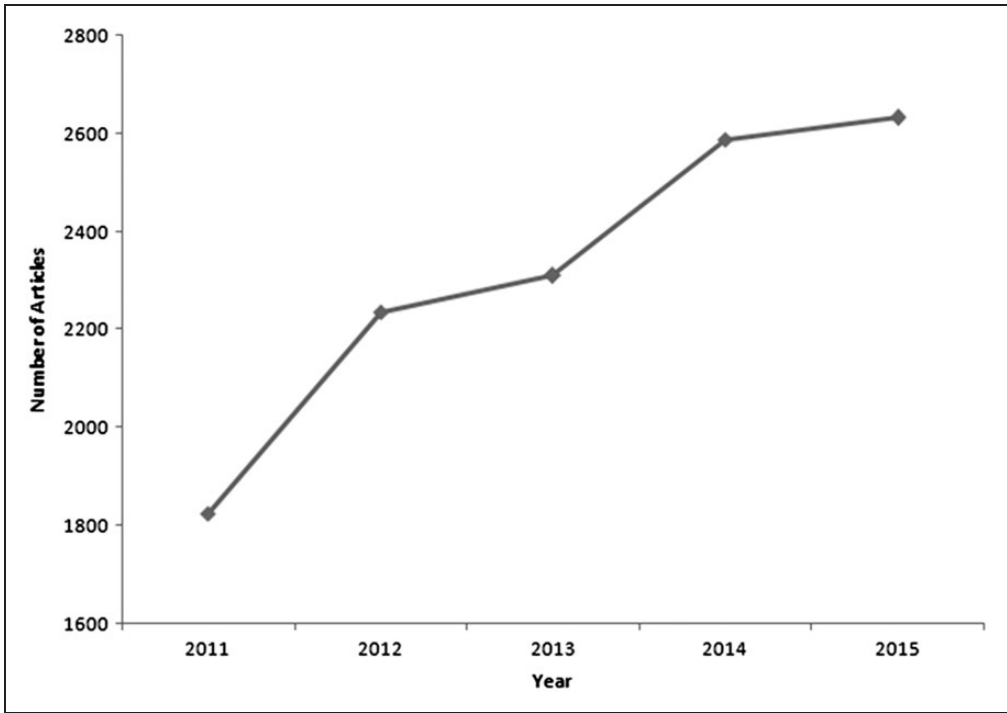


Figure 1. Trend of global scientific publications from 2011 to 2015.



Figure 2. World map of scientific production from 2011 to 2015.

lower-middle-income countries. The top five countries were the United States (3664/11,590; 31.61%), the United Kingdom (1072/11,590; 9.25%), Germany (876/11,590;

7.56%), China (724/11,590; 6.25%), and Canada (593/11,590; 5.12%) (Table 2). The United States ranked first in the total number of citations (27,166), followed by

Table 1. Publications in the most productive countries.

Country	Articles (n)	Articles (%)	Articles per million population (n)	Total citations (n)	Mean citations (n)
United States	3664	31.61	11.40	27,166	7.41
United Kingdom	1072	9.25	16.73	7710	7.19
Germany	876	7.56	10.83	3889	4.44
China	724	6.25	0.53	2678	3.70
Canada	593	5.12	16.89	5281	8.91
Japan	517	4.46	4.07	2054	3.97
South Korea	385	3.32	7.84	1644	4.27
Australia	383	3.30	16.83	2863	7.48
Italy	359	3.10	5.80	1715	4.78
France	341	2.94	5.12	1995	5.85
Netherlands	324	2.80	19.12	2457	7.58
Spain	240	2.07	4.98	1313	5.47
Switzerland	214	1.85	26.35	1509	7.05
Denmark	199	1.72	35.65	1924	9.67
Turkey	181	1.56	2.28	296	1.64
Belgium	154	1.33	13.60	1020	6.62
India	131	1.13	0.10	684	5.22
Sweden	121	1.04	12.34	1386	11.45

Table 2. Top five journals in top five countries.

Rank	United States	United Kingdom	Germany	China	Canada
1	JA (703)	<i>Knee</i> (119)	<i>Der Orthopäde</i> (92)	JA (61)	JA (75)
2	CORR (333)	BJJ (82)	KSSTA (60)	KSSTA (46)	CORR (31)
3	JBJS Am (183)	JBJS Br (53)	ZOU (59)	CMJ (33)	OC (18)
4	<i>Orthopedics</i> (132)	JA (50)	IO (56)	<i>Orthopedics</i> (30)	BJJ (15)
5	JKS (107)	KSSTA (47)	AOTS (45)	JOSR (26)	CJS (14)

The number of articles in each journal is shown in parentheses.

JA, *Journal of Arthroplasty*; KSSTA, *Knee Surgery, Sports Traumatology, Arthroscopy*; CORR, *Clinical Orthopaedics and Related Research*; IO, *International Orthopaedics*; JBJS Am, *Journal of Bone and Joint Surgery, American Volume*; JBJS Br, *Journal of Bone and Joint Surgery, British Volume*; BJJ, *Bone & Joint Journal*; CMJ, *Chinese Medical Journal*; OC, *Osteoarthritis and Cartilage*; ZOU, *Zeitschrift für Orthopädie und Unfallchirurgie*; JKS, *Journal of Knee Surgery*; AOTS, *Archives of Orthopaedic and Trauma Surgery*; JOSR, *Journal of Orthopaedic Surgery*; CJS, *Canadian Journal of Surgery*.

the United Kingdom (7710) and Canada (5281). Sweden ranked first in the mean number of citations (11.45), followed by Denmark (9.67) and Canada (8.91). Denmark had the most papers per capita (35.65), followed by Switzerland (26.35) and the Netherlands (19.12).

The *Journal of Arthroplasty* was the most prevalent journal in three of the top five countries (United States, China, and Canada); *Knee* was the most prevalent journal in the United Kingdom; and *Der Orthopäde* was the most prevalent journal in Germany (Table 2). The top five journals

Table 3. Top five countries in top five journals.

Rank	JA	KSSTA	CORR	Knee	IO
1	United States (703)	Japan (63)	United States (333)	United Kingdom (119)	Germany (56)
2	Canada (75)	Germany (60)	Canada (31)	United States (57)	United States (34)
3	Japan (69)	Italy (53)	South Korea (26)	Japan (29)	Japan (28)
4	China (61)	South Korea (47)	Japan (13)	China (25)	France (27)
5	South Korea (56)	United Kingdom (47)	United Kingdom (12)	South Korea (23)	Italy (26)

The number of articles from each country is shown in parentheses.

JA, *Journal of Arthroplasty*; KSSTA, *Knee Surgery, Sports Traumatology, Arthroscopy*; CORR, *Clinical Orthopaedics and Related Research*; IO, *International Orthopaedics*.

were the *Journal of Arthroplasty*; *Knee Surgery, Sports Traumatology, Arthroscopy*; *Clinical Orthopaedics and Related Research*; *Knee*; and *International Orthopaedics*. The five most prolific countries in the top five journals are shown in Table 3. The United States was the most prolific country in two of the top five journals (*Journal of Arthroplasty* and *Clinical Orthopaedics and Related Research*); the United Kingdom was the most prolific country in *Knee*; Japan was the most prolific country in *Knee Surgery, Sports Traumatology, Arthroscopy*; and Germany was the most productive country in *International Orthopaedics*.

Discussion

Due to worldwide contributions, the field of knee arthroplasty has shown great improvements in recent years.²⁻⁴ The present study proved that the United States had far more knee arthroplasty publications than other countries. Generally speaking, the United States has been the most prolific country in multiple medical fields for many decades.⁷⁻¹¹ Moreover, the United States had the highest overall number of citations and highest mean number of citations in the present study. This suggests that the United States not only published a large quantity of articles in knee arthroplasty, but also high-quality publications in this field. Even with

its high population, the United States remains one of the top countries with respect to the number of publications per capita. Therefore, the United States was the most prolific country in knee arthroplasty research worldwide.

In terms of the countries' contributions, a "10/90" divide has been reported when describing the ratio of non-high-income versus high-income countries¹⁴; this has been proven in multiple fields.⁷⁻¹¹ A similar result was found in the present study. China, Turkey, and India, three of the main prolific countries, have played increasingly important roles in scientific production worldwide.⁷⁻¹¹ This may reflect their rapid economic growth.^{15,16} However, only one article was published among the low-income countries, indicating the lack of knee arthroplasty research in these countries. Insufficient financial support, a lack of experienced researchers, and low-level medical care may be responsible for this phenomenon.^{14,16}

When adjusted by population, some European countries, including Denmark, Switzerland, and the Netherlands, ranked higher. Moreover, some European countries, such as Sweden and Denmark, were also the top countries according to the mean number of citations. These results may indicate that some smaller European countries not only have a relatively high output of publications in knee arthroplasty research

but also publish relatively high-quality articles. Although China, Turkey, and India were three of the most prolific countries, their per-capita numbers of publications were rather small. This may indicate that their outputs are relatively low, and further improvement should be encouraged.

The United States was the most prolific country in the *Journal of Arthroplasty* and *Clinical Orthopaedics and Related Research*, and these were also the two most prevalent journals in the United States. In fact, they are issued in the United States. More articles may be submitted by authors in the United States than by authors in other countries. Similar findings were also demonstrated in the other three top journals in the present study.

This study had some limitations. First, only Web of Science was used to identify reports on knee arthroplasty. Papers from journals outside Web of Science were excluded despite their contributions to global scientific production. Second, with respect to the mean number of citations, it is more reasonable to normalize the citations by the number of researchers instead of the overall population. In fact, it may be impossible to obtain the number of knee arthroplasty researchers in each country. Third, this was a cross-sectional survey at one time point. The number of articles from each country may have been different if the study had been conducted at another time point. Fourth, it was difficult to distinguish articles focusing on knee arthroplasty from those that only mentioned or tangentially addressed it. Nevertheless, this study still provides a comprehensive survey of knee arthroplasty research and may therefore be used to track overall trends.

Conclusion

A significant increase in knee arthroplasty publications was observed from 2011 to 2015. The United States was the most prolific

country in knee arthroplasty. When population size was considered, some European countries may have been more prolific.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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