

# Characteristics and Trends of Published Adult Hip Research over the Last Decade

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**Purpose:** We designed this study to demonstrate recent trends in the proportion of adult hip research in orthopedics, to identify countries leading the adult hip research, and to evaluate the relationship between the economic power of the countries and their contributions. **Materials and Methods:** Studies published in seven select orthopedic journals were retrieved from PubMed. Among them, we determined the number of adult hip studies. The countries-of-origin of adult hip studies, and the economic power of the countries were investigated. **Results:** A total of 7218 orthopedic publications and 1993 (27.6%) addressed adult hip research were identified. Adult hip studies increased from 313 (23.7%) in 2000 to 555 (27.9%) in 2011. Twenty-five countries accounted for 97.6% of the total number of adult hip studies, and gross domestic product correlated with publication volume (Spearman's rho, 0.723;  $p=0.000$ ). **Conclusion:** Researchers from a limited number of developed countries have published their studies in the adult hip discipline.

**Key Words:** Hip, research, publishing, trends, PubMed

## INTRODUCTION

Research findings can help individual clinicians improve their medical knowledge and quality of patient management and drive medical advances. Research submitted to peer-reviewed journals and published is the most important and objective determinant by which research is rated and funding awarded.<sup>1-5</sup> The importance of clinical publications is growing as the importance of evidence-based medicine is increasingly recognized and acknowledged.<sup>5,6</sup>

The status of published adult hip research is unclear despite its importance, even though the publication status of other medical fields has frequently been investigated.<sup>1,3-5,7-10</sup> In particular, no investigation has characterized the geographic distribution of countries that generate published research in the adult hip discipline. Moreover, recent trends in adult hip research remain unclear. Several studies have addressed the relationship between the economic power of countries with research

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publication volume.<sup>5,8</sup> However, this association has not been explored in the adult hip discipline.

In this study, the publication volume in adult hip research of individual countries was scored in selected high-level orthopedic journals to identify those making the principal contributions to the development of adult hip research from 2000 to 2011. Our objective was to demonstrate recent trends in the proportion of adult hip research in orthopedics, to identify the countries generating knowledge and progress in adult hip research, and to evaluate the relationship between the economic power of the countries and their contributions.

Hence, we determined the volume and proportion of adult hip research published in high-level orthopedic journals, the geographic origin of the research, and the relationship between the economic power of the countries and their contribution to adult hip research.

## MATERIALS AND METHODS

We conducted a review of seven selected journals to retrieve articles using the PubMed database. Sixty-five journals are included in the orthopedics category from the Thompson Scientific Journal Citation Reports (JCR).<sup>11</sup> Of the 65 journals, 44 whose impact factor or 5-year impact factor in 2011 was <2.0 were excluded. The 5-year journal impact factor is the average number of times articles from the journal published in the past 5 years are cited in the JCR year. It is calculated by dividing the number of citations in the JCR year by the total number of articles published in the previous 5 years. It is less fluctuating than the impact factor.<sup>12</sup> Of the 21 remaining journals, 15 that did not cover all fields of clinical orthopedic surgery and basic research related to or-

thopedic surgery, such as *The Spine Journal* or *Arthroscopy*, were excluded. Even though *The Journal of Arthroplasty* (JOA) does not include all fields of orthopedics, it was included because many influential adult hip articles, mainly concerning hip arthroplasty, have been published in this journal. As a result, *Clinical Orthopaedics and Related Research* (CORR), *The Journal of Bone and Joint Surgery* (British volume) (JBJS-Br), *The Journal of Bone and Joint Surgery* (American volume) (JBJS-Am), *International Orthopaedics* (Int Orthop), *Acta Orthopaedica* (Acta Orthop), *Journal of Orthopaedic Research* (J Orthop Res), and JOA were chosen. All studies published in the above seven journals in 2000, 2005, 2009, and 2011 were retrieved from PubMed in September 2012 using the search terms “The Journal of Bone and Joint Surgery” British volume (Journal) AND [“2000/01/01(PDAT)” : “2000/12/31(PDAT)”]. Studies from the other six journals and those published for 3 years were also searched. Search results were downloaded in XML file format, which contained the following information: journal name, volume, issue, publication year and month, article title, authors’ names, authors’ affiliations, language, and article type.<sup>5</sup> This information was extracted, sorted, and rearranged using the database’s management software. Articles not classified as journal articles (e.g., news, editorial, commentary, letter, index, biography, congress, address, historical article, or introductory journal article) were excluded from analysis. Adult hip research publications were independently selected by three authors according to the inclusion and exclusion criteria summarized in Table 1. The coincidence rate of the three authors’ first selection was 96.2%. Questionable selections were resolved by consensus, and the final selections were a unanimous decision of the three authors.

**Table 1. Inclusion and Exclusion Criteria for Hip Article Selection**

Inclusion criteria
Research covering adult hip and pelvis surgery and treatment (adult reconstruction of hip, hip arthroplasty, hip arthroscopy, and non-surgical management)
Research covering anatomical structure between the sacroiliac joint and the subtrochanteric area of the femur
Research covering tumors, trauma, and other disease occurred between the sacroiliac joint and the subtrochanteric area of the femur
Research covering arthroplasty of the hip joint with other joints
Research of biomaterials related with hip bearing surfaces or hip implant fixation
Exclusion criteria
Childhood or adolescent hip research such as developmental dysplasia of the hip, Legg-Perthes disease, or slipped femoral capital epiphysis
Biomaterial research not specific to the hip
Osteoporosis research not specific to the hip
Bone substitute research not specific to the hip

The total number of orthopedic articles published in 2000, 2005, 2009, and 2011 in the seven journals was counted. Publications categorized as adult hip research were evaluated according to the country of origin (the corresponding author's affiliation), and the proportions of hip publications during the study years were calculated.

Impact factor values from the JCR were assigned to each article based on the journal impact factor of the publishing journal in the given year of publication.<sup>11</sup> Although the use of journal impact factor remains controversial, it is strongly correlated with both the methodological strength of the article and the likely subsequent citations of that article.<sup>13,14</sup> An additional variable, aggregate impact (AI), was calculated as a measure of total research productivity.<sup>10</sup> AI is calculated by multiplying the number of journal articles by the mean journal impact factor of articles from a given country; it tends to account for both the volume of articles and the likely scientific significance of those articles. AI is useful to define any discrepancy between publication volumes and article quality. This variable was also used to decide ranks of countries when the publication volumes were the same.

The gross domestic product (GDP) and GDP per capita were used as an economic power indicator of the country. By comparing adult hip publications in 2011 to the GDP of 2010, the relationship between economic power and the outcomes of adult hip research was evaluated. GDP data was reported by the International Monetary Fund.<sup>15</sup>

The first primary outcome measure was the proportion of adult hip articles and changes in this proportion over time. Other measures included characteristics and trends in each journal. The second primary outcome measure was geographic distribution of adult hip publications by country. The final primary outcome measures were the adult hip articles publication volume and GDP of each publishing country.

Data were recorded using Microsoft Excel 2010 (Microsoft Corp, Redmond, WA, USA) and analyzed using SPSS software, v 17.0 for Windows (SPSS Inc., Chicago, IL, USA). Spearman's correlation analysis was used to evaluate the correlation between article volume and time or economic status. Spearman's correlation coefficient was calculated and the level of significance was set to  $p < 0.05$ .

## RESULTS

A total of 7218 articles were published in 2000, 2005, 2009, and 2011 in the seven journals. Of these, 1993 (27.6%) were adult hip studies. Adult hip studies increased from 313 articles (23.7%) in 2000 to 555 articles (27.9%) in 2011, but no increasing tendency was found statistically significant (Spearman's rho, 0.800;  $p = 0.200$ ) (Table 2). During the study years, 518 adult hip studies were published in JOA, 426 in CORR, 335 in JBJS-Br, 267 in JBJS-Am, 200 in Int Orthop, 165 in Acta Orthop, and 82 in J Orthop Res (Table 3).

At least one adult hip article was published from 43 countries. The articles came from 28, 30, 39, and 33 countries in 2000, 2005, 2009, and 2011, respectively. About 20–30 countries contributed to adult hip publications during the study years. JBJS-Br had the highest number of countries contributing hip articles (32 countries) and J Orthop Res had the lowest number (19 countries) (Table 4). The USA was the most productive country in JOA, JBJS-Am, CORR, and J Orthop Res, and the UK was the most productive in JBJS-Br, Germany in Int Orthop, and Sweden in Acta Orthop.

At least one article was published every year from 25 countries. These steadily publishing countries published 1945 hip articles, representing 97.6% of all hip articles (Table 5). The top 10 countries accounted for 79.9% of adult hip studies, the first five countries (US, UK, Japan, Canada, and Germany) for 64.6% and the USA for 34.3%. The difference between the rank order by AI and that by a volume of publications was less than three (Table 5). Although the US was consistently the most productive country, their contribution decreased from 34.5% (108 articles) in 2000 to 31.4% (174 articles) in 2011.

Of 25 countries that had published persistently, 14 countries including Canada, South Korea, the Netherlands, China, France, Australia, Denmark, Italy, Norway, Greece, Ireland, Turkey, New Zealand, and Belgium (in descending order of total publications) contributed more in 2011 than in 2000. The contribution of these 14 countries to hip article publications increased from 18.2% (57 articles) in 2000 to 34.4% (191 articles) in 2011. The annual increase of publi-

**Table 2. Volume of Publications during the Study Years**

Year	2000	2005	2009	2011
Number of orthopedic papers	1318	1828	2086	1986
Number of adult hip papers	313	504	621	555
Percentage of adult hip papers (%)	23.7	27.6	29.8	27.9

**Table 3.** Volume of Publications in Each Journal

Journal		Number of articles				
		2000	2005	2009	2011	Total
J Arthroplasty	Orthopedic papers	168	215	257	302	942
	Adult hip papers	97	131	156	134	518
	Percentage of adult hip papers (%)	57.7	60.9	60.7	44.4	55.0
Clin Orthop Relat Res	Orthopedic papers	416	468	410	391	1685
	Adult hip papers	74	101	150	101	426
	Percentage of adult hip papers (%)	17.8	21.6	36.6	25.8	25.3
J Bone Joint Surg Br	Orthopedic papers	224	313	279	261	1077
	Adult hip papers	43	105	97	90	335
	Percentage of adult hip papers (%)	19.2	33.5	34.8	34.5	31.1
J Bone Joint Surg Am	Orthopedic papers	178	393	478	403	1452
	Adult hip papers	34	75	72	86	267
	Percentage of adult hip papers (%)	19.1	19.1	15.1	21.3	18.4
Int Orthop	Orthopedic papers	76	91	283	248	698
	Adult hip papers	22	21	75	82	200
	Percentage of adult hip papers (%)	28.9	23.1	26.5	33.1	28.7
Acta Orthop	Orthopedic papers	124	146	133	124	527
	Adult hip papers	32	45	47	41	165
	Percentage of adult hip papers (%)	25.8	30.8	35.3	33.1	31.3
J Orthop Res	Orthopedic papers	132	202	246	257	837
	Adult hip papers	11	26	24	21	82
	Percentage of adult hip papers (%)	8.3	12.9	9.8	8.2	9.8

**Table 4.** Geographic Distribution of Adult Hip Articles

Journal	Number of countries publishing adult hip papers				
	2000	2005	2009	2011	Sum of 4 yrs
J Arthroplasty	19	19	21	17	31
Clin Orthop Relat Res	14	17	22	15	30
J Bone Joint Surg Br	14	21	25	21	32
J Bone Joint Surg Am	7	14	14	15	22
Int Orthop	11	10	25	24	29
Acta Orthop	11	16	15	11	22
J Orthop Res	7	11	8	12	19

cation rate was 11.6%. Although the total volume of hip articles by the 14 countries during the study years was less than that of the USA, the number of publication in 2011 (191 articles) was larger than that of the US (174). In particular, China (from one to 22), South Korea (from four to 21), and Italy (from two to 13) contributed significantly more in 2011 than in 2000.

The publication volume of the 43 publishing countries in 2011 was analyzed to find any correlation with GDP and GDP per capita of 2010, respectively. GDP was positively correlated (Spearman's rho, 0.723;  $p=0.000$ ) with the volume of hip publication, whereas GDP per capita was not (Spearman's rho, 0.171;  $p=0.225$ ).

## DISCUSSION

The importance of clinical publications is growing, however, the state of published adult hip research remains unclear. We, therefore, determined; 1) the volume and proportion of adult hip studies in high-level orthopedic journals; 2) the geographic origin of adult hip research; and 3) the relationship between the economic power and adult hip research.

This study had some limitations. First, data from selected journals and the selected period were investigated. Numerous journals are available but it was not essential to investigate all adult hip articles in those journals. Lee, et al.<sup>5</sup> re-

**Table 5.** Characteristics of 25 Steadily Publishing Countries during the Study Years

Rank order	Countries	Number of articles (%)	Aggregate impact	GDP* (billion dollars)	GDP per capita* (dollars)
1	United States	683 (34.3)	1417.0	14527	47132
2	United Kingdom	284 (14.2)	573.7	2263	36298
3	Japan	119 (6.0)	224.9	5488	42325
4	Canada	107 (5.4)	250.4	1577	45888
5	Germany	95 (4.8)	181.9	3287	40512
6	South Korea	70 (3.5)	140.8	1015	20165
7	Sweden	65 (3.3)	109.4	462	47667
8	Netherlands	61 (3.1)	117.3	781	46418
9	China	56 (2.8)	116.1	5930	4283
10	France	53 (2.7)	104.1	2563	40591
11	Switzerland	50 (2.5)	96.2	528	67074
12	Australia	41 (2.1)	84.1	1245	54869
13	Denmark	38 (1.9)	73.4	312	55113
14	Italy	34 (1.7)	69.6	2061	33829
15	Norway	30 (1.5)	54.9	418	84543
16	Austria	27 (1.4)	47.9	380	43723
17	Spain	22 (1.1)	38.9	1395	29875
18	Taiwan	20 (1.0)	41.8	430	18304
19	Finland	20 (1.0)	33.2	239	43134
20	Greece	18 (0.9)	36.5	305	27265
21	Ireland	15 (0.8)	29.6	207	45642
22	Turkey	12 (0.6)	20.7	735	10207
23	New Zealand	11 (0.6)	22.4	141	31589
24	Belgium	7 (0.4)	16.4	470	42597
25	Slovenia	7 (0.4)	12.1	47	23009
Total		1945 (97.6)			

GDP, gross domestic product.

\*GDP and GDP per capita announced at 2010 by the International Monetary Fund.

ported that 2889 orthopedic articles were published in PubMed in 2000. In the present study, we identified 1318 orthopedic articles from seven journals in 2000. Even though all orthopedic journals were not investigated, we believe that these top orthopedic journals published a sufficient number of articles to demonstrate characteristics and trends for adult hip articles. Articles published in 2000, 2005, 2009, and 2011 were analyzed in this study. We initially included 2000, 2005, and 2009 as representatives of initial, middle, and end years of the last decade. We then included articles published in 2011 to add updated information. The proportion of adult hip articles in JOA was prominently high because hip and knee arthroplasty is the main topic of JOA. Therefore, it is noteworthy that JOA's data may affect the proportion of adult hip articles to total orthopedic articles in this study.

Second, the criteria for adult hip article selection may have been problematic. Although there was minimal dis-

crepancy between our selections, some articles could have been excluded although they were related to the adult hip. Third, article quality was not considered. This should probably be evaluated using impact factors.

The number of adult hip studies increased during the study period, but maintains their proportion to orthopedic articles because the volume of articles published in the journals also increased. The increase in the volume of articles was mostly due to increased publishing capacity of JOA, JBJS-Am, Int Orthop, and J Orthop Res (Table 3). The proportion of adult hip articles in these four journals was consistent.

The proportion of adult hip articles in J Orthop Res was prominently low (9.8%) (Table 3). Several reasons are suggested. First, the scope of J Orthop Res is broader than any other journal. It publishes spectrum of orthopedic research, including life sciences, engineering, translational, and clinical studies. Second, basic adult hip research may require



more resources: laboratory facility or long-term support, especially financial, is a realistic limitation for basic research in the hip field.<sup>16,17</sup>

Less than 30 countries published the adult hip articles in any study year in any journal (Table 4). Thus, a continental imbalance in adult hip research was observed. The USA was the most productive country. The same findings are evident for biomedical publications.<sup>8</sup> The origin of the journal, lingual factor, and economic factors might be related.

It has been reported that the national affiliation of published articles is not necessarily proportional to that of the journals.<sup>5</sup> However, the origin of the journals seemed to be highly related to the nationality of the articles published in adult hip discipline. Of the seven journals, four are published in the US (JBJS-Am, CORR, JOA, and J Orthop Res), two in the UK (JBJS-Br and Acta Orthop), and one in Germany (Int Orthop). Researchers in the USA published most articles in JBJS-Am, CORR, JOA, and J Orthop Res, while German researchers were the most prolific in Int Orthop and UK researchers were in JBJS-Br. The only exception was Acta Orthop; this journal is published in the UK, but the host organization is the Nordic Orthopedic Federation, which is composed of the national orthopedic societies of Denmark, Estonia, Finland, Iceland, the Netherlands, Norway, and Sweden. Researchers from Sweden, Norway, and Denmark published more articles in Acta Orthop than those by UK researchers. The language used in the journals seemed to affect adult hip publications. Six of the seven journals publish exclusively in English with the remaining journal (Int Orthop) publishing articles in English or French. Notably, 71.8% of all adult hip research articles were produced in 14 countries where English is fluent (US, UK, Canada, Sweden, the Netherlands, Switzerland, Australia, Denmark, Norway, Finland, Greece, Ireland, New Zealand, and Belgium). It is conceivable that our findings are a reflection of both the authors' intention to write manuscript in English and the preference of editorial boards to select manuscripts written in proper English.

Economic status influences biomedical publications.<sup>8</sup> In the present study, economic status was found to be positively associated with the volume of adult hip articles in terms of GDP but not in terms of GDP per capita. Although GDP was found to have a positive correlation with adult hip publications, it is not always an absolute index. For example, Russia (11th in GDP in 2010) did not publish during the study period. While the reasons are unclear, lingual factors or the national status of orthopedic surgery could be the

reasons. GDP per capita, which is an important quality of life index, does not suggest academic achievement. Population and other factors may be related and more research is needed to explore this finding.

Fourteen countries increased the proportion of published articles. This might reflect changing economic power of the nations involved. For example, publications from China increased from one article in 2000 to 22 articles in 2011. During the same period, their GDP rank rose from sixth to the second. However, not all the countries that increased their publication volume proportionally raised their GDP rank. The proportion of research investment to total GDP, orthopedic surgeon's interest in research, and funding for medicine could have been influential, although the necessary detailed analysis was not possible in this study.<sup>7</sup> More investment and support are required for these countries to contribute to the increasing tendency of orthopedic publications and growth of orthopedic knowledge.

AI is used to evaluate the volume and quality of publications.<sup>10</sup> If the impact factors of the different journals are sufficiently different, the AI of a less prolific publishing country could be higher than that of a more prolific country. In this study, however, no remarkable difference was observed between the rank of publication volume and AI. Journals selected in this study had impact factors of 2.025–3.272 in 2011. In fact, these variations are not remarkable and contrasting to those of journals in internal medicine (2.0–53.298). Orthopedic surgery is a very specialized medical field, and a limited number of orthopedic surgeons are interested in this endeavour. This may have affected the relatively low impact factor of orthopedic journals.

We found that the number of adult hip publications increased from 313 articles (23.7%) in 2000 to 555 articles (27.9%) in 2011 in the seven selected orthopedic journals, even though no increasing tendency in total orthopedic publications was evident. The US was the most productive country in terms of adult hip research in the selected journals. About 20–30 countries contributed to adult hip publications, and publications were apparently led by a small number of countries. The economic power of a country indicated by the GDP showed a positive correlation with the volume of adult hip publications. Some factors other than GDP might affect adult hip publication; the population of each country, the number of doctors, and research fund condition may be related. More studies are needed to unravel which factors are related, giving an appropriate support to researchers who have difficulties in their research.

In conclusion, it is apparent that the researchers in selected countries have published their studies in the adult hip discipline. Academic oligopoly led by several developed countries may be a hurdle to generalize knowledge. Diversification of the countries that publish on adult hip research could generalize the knowledge and contribute to the development of adult hip orthopedics.

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