



Geographic Origin of Publications in Major Spine Journals

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Aim of the present study was to assess the contribution of each country in the field of spine surgery. Three major spine journals were included in our study and the search conducted in PubMed for a 5-year period (2007-2012). Publications on spine surgery were assessed according to the country. A total of 6312 articles were identified and 5842 were included. Fifteen countries generated 86.9% of publications, with 31.7% by the United States, followed by Japan (9.6%), China (8.1%) and Canada (5.2%). After correction for population size Switzerland (19 studies per 10⁶ inhabitants), the Netherlands (10), Sweden (9), Canada (9) and Australia (6) ranked the top. The USA was placed 7th after correction for population size. Small European countries with modest research funding and non-native English speaking population are more productive in relation to their population size, despite the fact that the contribution of USA is the greatest in the field of the major peer-reviewed indexed spine surgery journals.

Keywords: bibliometrics ; spine research ; research productivity ; contribution ; publications by country ; population size.

INTRODUCTION

Monitoring of publication activity has served as an indicator of research productivity of individual scientists, institutions, or countries (1,2,5,7-9,14). Bibliometrics is a term describing the process of quantitatively measuring the scientific literature. This concept has served as a tool in several medical

disciplines, including orthopedic surgery (2), surgery (14), general surgery (8), vascular surgery (7), hand surgery (1) and neurosurgery (5).

The bibliometric study by Bosker *et al.* (2) in orthopedic surgery proved that the United States was the most productive country in terms of absolute number of publications in the 15 orthopedic journals with the highest impact factor. When corrected for population size, the smaller European countries with a high proficiency in the English language were most successful.

A bibliometric analysis of spine publications has not been undertaken to date. Primary aim of this study is to analyze the number of publications in the field of spine surgery, in relation to their geographic

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origin. Secondary aim of the study is to investigate the impact of the expenditure on research and the language proficiency, according to the population size and the number of physicians of each country, to the research output.

MATERIALS AND METHODS

Two reviewers (CK, SA) independently searched and assessed the studies for inclusion. We searched the leading journals in the field of spine surgery in the 2011 Journal Citation Reports issued by Thompson Reuters in the category Orthopedics (6). According to our protocol the three leading orthopedic spine journals were identified, with the highest impact factors. Namely *The Spine Journal* (IF 3.290), *Spine* (IF 2.078) and the *European Spine Journal* (IF 1.965). All three journals have an established influence within the field of spine surgery.

We conducted a MEDLINE Database (12) search for articles published between January 2008 and December 2012 in these journals (*Appendix*). The searches were conducted from 02/01/2013 to 05/01/2013. The retrieved titles and abstracts were scrutinized. Items were excluded if they belonged to the following categories: letters to the editor, editorials, awards or biographies. Case reports, technical notes, guidelines or other articles contributing to the “continuing surgical education” were included after agreement of both reviewers (CK, SA). The country of the corresponding author was considered and recorded as the country of origin of the article.

The mid-2012 world population data were extracted from the Geohive network (4). These data were used to calculate the research output after correction for population size of the countries by dividing the absolute number of publications by the number of inhabitants of each country.

The number of physicians was recorded according to the World Health Statistics 2011, published by the World Health Organization (16). In order to estimate the productivity of the physicians of each country, we divided the absolute number of publications (in spine journals) produced by the total number of physicians (irrespective of discipline) occupied within the borders of the country.

The percentage of the Gross Domestic Product Expenditure on Research and Development (% of GDP on R&D) for our study countries (10) and data on the performance of examinees with English as foreign language who took the TOEFL internet-based test between January and December 2011 (13) are also documented in order to investigate the potential interrelationship between

these two factors and the research output of the individual countries.

In order to investigate the relationship between publication output corrected for population size and standardized research funding of the top 15 countries, we used Pearson’s correlation equation. We transformed the standardized publication rate to a natural logarithmic scale, because the data distribution wasn’t normal. We conducted simple regression analysis with log-transformed standardized publication rate (dependent variable) and standardized research funding (independent variable). We conducted the same analysis with TOEFL scores as well (independent variable). Multiple regression analysis is also performed to determine the independency of the association of the expenditure on research and the English language proficiency with the publication productivity. Our tests were two-tailed and a value of $p < 0.05$ was considered significant.

The Yate’s chi-square test, corrected for continuity was used, in order to compare the proportions of published studies produced in the host country of each journal. A value of $p < 0.05$ was considered significant.

RESULTS

The literature search retrieved 6312 articles. After exclusion of the letters to the editor, editorials, awards or biographies, 5842 articles were included and allocated according to the country of origin.

The USA produced the greatest absolute number of publications ($n = 1853$, Fig. 1). Japan, China and Canada followed with 559 (10%), 476 (8%), 301 (5%) publications, respectively. Thirty-six percent of publications originated from North America, 29% from Europe, 26% from Asia, 3% from the Middle East, 3% from Australia and New Zealand, 1% from South America and 0.3% from Africa (Fig. 2).

After correction for population size many European countries turned to be more productive. The leading countries following adjustment were: Switzerland, the Netherlands and Sweden having published 19, 10 and 9 studies per 10^6 inhabitants, respectively. In contrast, the position of USA (7th place), Japan (8th) and China (15th) changed significantly (Fig. 3).

In the estimation of the productivity per physician, Switzerland and Canada topped the ranking with 0.47 and 0.45 publications in spine journals per

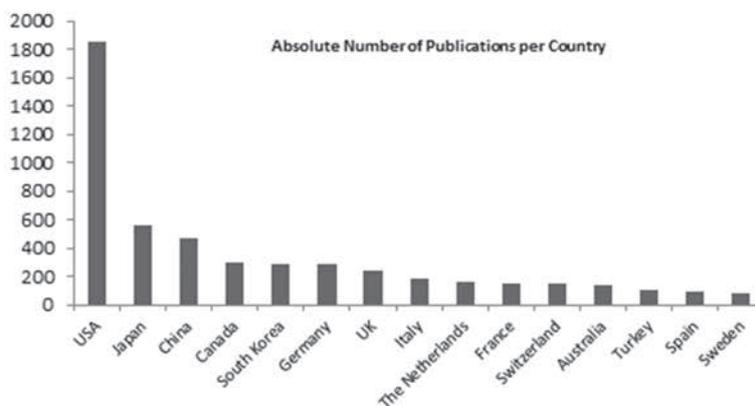


Fig. 1. — Absolute Number of Publications per Country

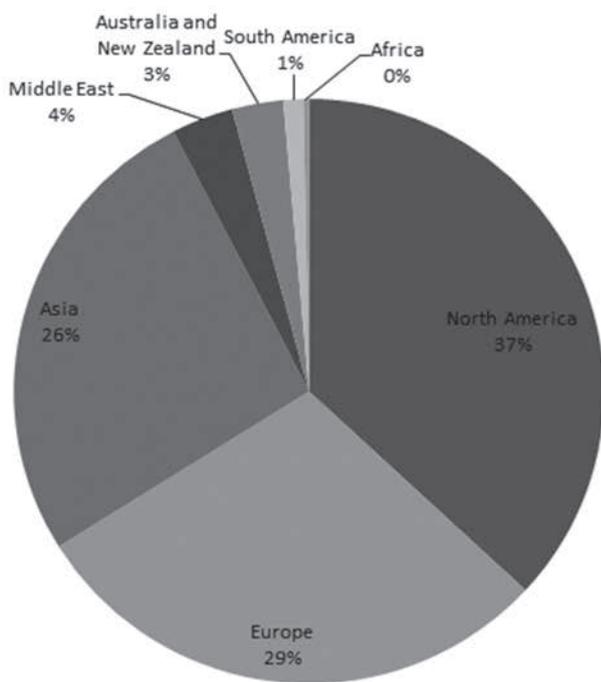


Fig. 2. — Publication Rate per Region

physician, whereas South Korea (0.30), Sweden (0.26) and the Netherlands (0.22) followed (Fig. 4).

The last two recorded parameters, which have a potential influence on research productivity, namely the Gross Domestic Product Expenditure on Research and Development (% of GDP on R&D) and the performance of examinees with English as foreign language who took the TOEFL internet-based test, are presented in accordance with the publica-

tion rate per inhabitant in Table I. The examinees of the countries, which topped the ranking, performed excellent in the TOEFL internet-based test (Switzerland : 97 points, The Netherlands : 100 points and Sweden : 92 points). Furthermore, the first 8 countries spent more than 1.8% of their GDP for research and development. Switzerland spent 3% of GDP on research and development, The Netherlands 1.8%, Sweden 3.4% and Canada 1.9%.

Our statistical analysis indicated a significant correlation of research spending with the standardized publication rate. In this case the correlation coefficient was 0.52 and $p = 0.05$. TOEFL scores were also significantly correlated with the standardized publication rate ($r = 0.56$, $p = 0.03$). These results indicate that countries which spent more on research and performed better in TOEFL test had better publication output. The multiple regression model explained 63.6% of the variation in the log-transformed publication rates and indicated the independency of the association of the expenditure on research and the English language proficiency with the publication productivity ($R = 0.80$, $p = 0.02$). An increase of 1% in research funding was associated with an increase in the publication rate by a factor of 1.8280 (95% CI : 0.0795-1.1270, $p = 0.05$). Furthermore, an increase of 10 units in TOEFL scores was associated with an increase in the publication rate by a factor of 1.8313 (95% CI : 0.0067-0.1143, $p = 0.05$).

Articles from the USA published in *The Spine Journal* accounted for 56.8% of all publications of

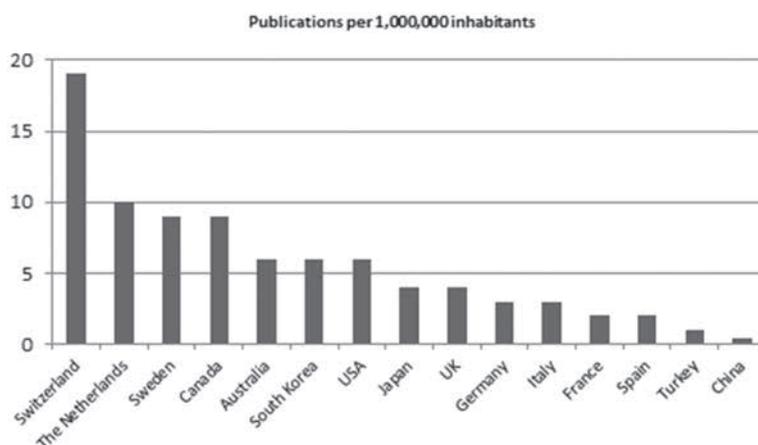


Fig. 3. — Publications per 1,000,000 inhabitants

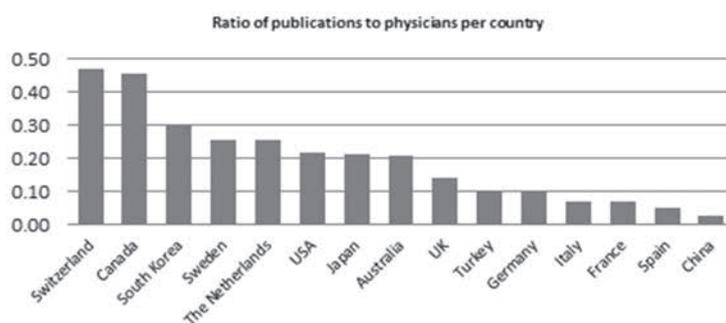


Fig. 4. — Ratio of publications to physicians per country

this journal, as compared to the *European Spine Journal* (7.8%, $p < 0.0001$). Similarly, articles from the USA were more commonly published in *Spine* (38.6%), as compared to the *European Spine Journal* (7.8%, $p < 0.0001$). Articles from the USA were more probably published in *The Spine Journal* (56.8%), as compared to the *Spine* (38.6%, $p < 0.0001$). The same fact was observed for articles originating from Canada, which were more frequently published in *The Spine Journal* (6.3%, $p < 0.0001$) or in *Spine* (6.3%, $p < 0.0001$), rather than in the *European Spine Journal* (2.5%). Finally, *European Spine Journal* published approximately half (43.1%) of their articles from the first 8 European countries, as compared to *Spine* (15.4%, $p < 0.0001$) and *The Spine Journal* (9.4%, $p < 0.0001$).

DISCUSSION

The USA has a prominent role, producing 31.7% of the total number of publications. After correction for population size, smaller European countries such as Switzerland (1.9), the Netherlands (1.0) and Sweden (0.9) were respectively more productive. These countries, which spend a remarkable proportion of their GDP on research and development in combination with good command of the English language from their population, manage to be more prolific than countries with native English speakers.

Studies originating from North America, Europe and Asia accounted for 92.4% of the total amount of publications. This fact may reflect the limited resources and the low level of penetration of novel techniques in developing countries, observed in the

Table I. — Publications per 1,000,000 inhabitants, research spending and TOEFL iBT per country

| Countries | Publications per 1,000,000 inhabitants | Research spending (% GDP) | TOEFL iBT |
|-----------------|--|---------------------------|-----------|
| Switzerland | 19 | 3 | 97 |
| The Netherlands | 10 | 1.8 | 100 |
| Sweden | 9 | 3.4 | 92 |
| Canada | 9 | 1.9 | |
| Australia | 6 | 2.2 | |
| South Korea | 6 | 3.7 | 82 |
| USA | 6 | 2.9 | |
| Japan | 4 | 3.4 | 69 |
| UK | 4 | 1.9 | |
| Germany | 3 | 2.8 | 96 |
| Italy | 3 | 1.3 | 90 |
| France | 2 | 2.3 | 88 |
| Spain | 2 | 1.4 | 88 |
| Turkey | 1 | 0.8 | 77 |
| China | 0.4 | 1.7 | 77 |

general surgical literature (8). This observation amplifies findings of similar studies in other medical disciplines (1,2,5,7).

Statistical analysis of the number of papers published by the host country of individual journals reveals a potential bias of paper allocation throughout the selected journals. *Spine* and *The Spine Journal* demonstrate a trend towards publishing a larger number of papers produced in the USA and Canada, as compared to *European Spine Journal*, which publishes more articles originating from the leading European countries. This fact may be explained through a preference of authors toward submitting their work in regional journals. Comparison of publication activity of *The Spine Journal* and *Spine* suggests a more “internationalized” concept for the latter. Collaborative efforts of European and American surgical associations have brought about common publications which attract articles from both continents, and enhance international and intercontinental exchange of information. This need seems to be more pronounced in the field of spine surgery.

Several limitations of the present study preclude generalization of results in the field of spine surgery. The conducted search considered spine journals, thus a number of relevant articles in miscellaneous

publications having been excluded. Publications in journals classified in the category of neurosciences by Thompson Reuters (e.g. *Journal of Neurosurgery Spine*, *Spinal Cord*, *Journal of Spinal cord Medicine*), publications in Journals with lower impact factors (e.g. *Journal of Spinal Disorders and Techniques*) and publications in non-English Journals with lower impact factors were not included in the present study. Thus, our findings should only be interpreted in the context of high-impact orthopedic spinal journals. Only three journals were selected for this analysis, with the objective to identify the most qualitative articles in the field. Although the journal impact factor is not necessarily indicative of the quality of published items, it may be considered as an indirect measure of methodological quality. Furthermore, the country of the corresponding author was considered as the country of origin of the article, thus underestimating the contribution of secondary participating countries. Analysis of the contributing countries imposed however significant difficulties in collection and analysis of data.

The distribution of countries of origin of publications in spine surgery seems to be multifactorial. Correlation between standardized publication rate and research spending or English proficiency does

not necessarily imply causation, taking into account the observational nature of our study. The research funding and the proficiency in the English language may play a significant role, such as in general medical journals (9). In accordance with the results of the present study, the study by Man *et al.* found also a significant correlation of research spending and TOEFL scores with the log-transformed publication output. The same countries (Switzerland, The Netherlands and Sweden) topped the ranking in the present study, according to the research output per inhabitant and the proficiency in English as a foreign language. These countries were among the top 12 countries in GDP Expenditure on Research and Development.

The authors have concerns about the global financial crisis and its impact on the research funding, which could have negative impact on the research output of the affected countries and Europe particularly. This fact may not be obvious, because shrinkage of the GDP with stable percentage of spending on research and development could conceal the nominal decrease in research and development spending (11). The result of the economic crisis might be a further widening of the gap between OECD Member states with high R&D intensities and some Member States with lower R&D intensities, the latter having more difficulty in avoiding cuts in R&D spending.

VINNOVA (Swedish Governmental Agency for Innovation Systems) suggested that public investments are called upon to compensate for fluctuations in private sector investments in R&I during the crisis (15).

Smart specialization might be the key to attracting more R&D. This could be managed from a nation by allowing the emergence of world centers of excellence. The agglomeration process, should also, be allowed to occur within an international integrated research space, in which mobility and competitive entry are the main characteristics. The countries, which target the same kind of specialization, should cooperate and coordinate in developing investment plans. Finally, the nations must have clear visions and strategies as to how they can develop distinctive, original and modern areas of specialization for the future (3).

Finally, small European countries are more productive in relation to their population size despite the fact that the contribution of USA is the greatest in the field of the major peer-reviewed indexed spine surgery journals. The positive role of proficiency in English language and the expenditures in R&D should be further investigated with experimental studies in national and international level. Bibliometric analysis is a useful tool for quantification of research contributions and opens further perspectives for research fund allocation and dissemination of spine surgery.

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Appendix. Combination of search terms

Search terms :

[any A] AND [B]

A.

1. "Spine"[Journal]
2. "The spine journal : official journal of the North American Spine Society"[Journal]
3. "European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society"[Journal].

B.

"2008/01/01"[Date - Publication] : "2012/12/31"[Date - Publication].