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Original Contributions

SCIENTIFIC PUBLICATION PRODUCTIVITY OF EMERGENCY PHYSICIANS: A BIBLIOMETRIC ANALYSIS OF THE LAST DECADE

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☐ **Abstract—Background: A significant increase has been observed in scientific research in emergency medicine in the past 10 years. However, the contribution of emergency physicians (EPs) to the emergency medicine literature is not known. Objective: The aim of this study was to analyze the contribution of EPs to the emergency medicine literature and their scientific publication productivity during a recent 10-year period. Methods: Manuscripts published by EPs in emergency medicine journals in the Science Citation Index Expanded database during a recent 10-year period (2008–2017) were included in the study. The number of articles published by EPs, the distribution of the manuscripts by country and year, the impact factors, the citations per article, and the Hirsch (H) index were determined. Results: A total of 15,281 original articles were published in a total of 24 journals by all EPs worldwide between 2008 and 2017. EPs from the United States published the highest number of articles (54.4% of all articles), followed by Canada (7.2%), Australia (6.2%), Turkey (4.3%), and the UK (4.1%). The countries with the highest H index were the United States (80), Canada (43), and the UK (40), respectively. South Korea had the highest increase in scientific production during the 10-year period (average annual growth rate of 17.89%). Conclusions: The number of articles increased from 2008 to 2017 in the whole world and in the United States. EPs from the United States were the most productive, both qualitatively and quantitatively.** © **2019 Elsevier Inc. All rights reserved.**

☐ **Keywords—bibliometrics; emergency medicine; emergency physician; research; publication productivity**

Ethics Committee Approval: This study protocol was approved by the local ethics committee and conducted in accordance with the Declaration of Helsinki and Good Clinical Practices.

INTRODUCTION

Together with developments in science and technology, a significant increase has been observed in scientific research in all fields of medicine, including emergency medicine (EM). The production of new knowledge occurs through contributions from various countries, institutions, and researchers. One of the most important indicators of the contribution to new knowledge production is the number of original articles published by a country or institution (1). There is a gradually increasing interest in measuring and comparing the scientific productivity of different fields of specialization or different countries in all sciences, including medicine. EM, which has existed for about 50 years, is among the youngest branches and cannot be excluded from this interest. Therefore, some studies have been carried out to analyze the literature regarding EM (1–5). Some of these studies have investigated scientific publications in the EM literature published by all physicians (e.g., cardiologists,

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orthopedic surgeons, emergency physicians) and the distribution of these publications according to country (1,2). Other studies have investigated the scientific productivity of Spanish or Korean emergency physicians (EPs) and their contribution to the EM literature (3–5).

The EM literature is contributed to by two groups of researchers; the first is EPs, and the second is all researchers except EPs (e.g., neurologists, cardiologists, medical students, graduate students, doctors in nonmedical fields [PhDs]). No studies are available in the literature that comprehensively investigate the productivity and contribution of EPs to the EM literature. The aim of this descriptive bibliometric study was to analyze the scientific publication productivity of EPs and investigate the contribution of EPs on a country basis.

MATERIALS AND METHODS

Journal Selection

The journals indexed in the Web of Science (Clarivate Analytics, Beijing, China) database are categorized according to their content. In our study, we used the Web of Science's Science Citation Index Expanded database to find journals in the EM field (6). A total of 27 journals were found in the EM category of the Science Citation Index Expanded journal list, and 24 were included in the study (Table 1). *Emergency Medicine International*, *Burns & Trauma*, and *Prehospital and Disaster Medicine* were not included in the study as they had been indexed only since 2017 or did not have actual impact factors.

Table 1. Journals Included in the Study

Rank	Journal	2017 IF
1	*Annals of Emergency Medicine*	5.4
2	*Resuscitation*	5.2
3	*Emergencias*	3.0
4	*Academic Emergency Medicine*	2.9
5	*Prehospital Emergency Care*	2.7
6	*World Journal of Emergency Surgery*	2.3
7	*Scandinavian Journal of Trauma & Emergency Medicine*	2.0
8	*European Journal of Emergency Medicine*	2.0
9	*Injury*	1.9
10	*Emergency Medicine Journal*	1.9
11	*American Journal of Emergency Medicine*	1.5
12	*Emergency Medicine Australasia*	1.5
13	*Emergency Medicine Clinics of North America*	1.4
14	*Canadian Journal of Emergency Medicine*	1.3
15	*Journal of Emergency Medicine*	1.2
16	*Pediatric Emergency Care*	1.0
17	*European Journal of Trauma and Emergency Surgery*	0.9
18	*Journal of Emergency Nursing*	0.8
19	*Notfall & Rettungsmedizin*	0.5
20	*Turkish Journal of Trauma & Emergency Surgery*	0.5
21	*Unfallchirurg*	0.5
22	*Notarzt*	0.3
23	*Signa Vitae*	0.1
24	*Hong Kong Journal of Emergency Medicine*	0.1

IF = Impact factor.

Search Strategy

Electronic literature screening was performed on May 1, 2018, using the Web of Science online application (version 5.29) in the Web of Science database (7). The addresses of the authors were listed in the inferior part of the pages of the manuscripts indexed in the Web of Science database. We used the institutional addresses of the authors to identify scientific publications produced by EPs. The Web of Science database lists the addresses of the authors in English or in the local language. The only exception is that the Web of Science lists the names of the authors' countries in English at all times. "Emergency department" (ED) or "emergency room" may be expressed differently in the local languages of different countries. For example, "Department of Emergency Medicine" or "Dept Emergency Med" was written in the address section in a study published by an EP from a country whose language was English (i.e., the United States). However, "Service des urgences" or "Urgences Med" was written in the address section in a study published by an EP from a country whose local language was not English (i.e., France). We also identified the words used to mean "emergency department" in different languages and designed a relevant search string (Supplementary Table 1). Using this search string, we identified articles published by EPs in 24 EM journals in the Web of Science database. A recent 10-year period (2008–2017) was selected as the time interval. We used the "Article" filter in the "Document type" field to include only original articles in our study. Article types such as editorial material, corrections, letters, reviews, meeting abstracts, and retractions were excluded from the study. Only papers for which the first author or corresponding author was an EP were included in the study. In this study, we defined EPs as follows: physicians who had been educated in the EM field, who had completed their residency training, who had been approved by board certification in the EM field, who could immediately diagnose acute illnesses or injuries and perform emergency intervention, and who worked in the ED.

Our primary purpose was to detect the number of original articles produced by EPs in each country and the production trend according to year. The countries were listed according to academic productivity. To evaluate the

contributions of different countries, we analyzed the publications of the main productive countries (which had produced at least 1% of the overall publications). We used six bibliometric markers when performing these analyses: one was the indicator of production (number of overall articles), and the remaining five were indicators of the scientific impact (total impact factor [IF], average IF, total citations, average citations per article, and Hirsch [H] index). Data such as the number of articles, distribution of the articles according to country, year of publication, total citations, average citations per article, and H index were obtained through the Web of Science application. The total and average IFs for each country were calculated using the IFs in the 2017 Journal Citation Reports (data for the 2017 Journal Citation Reports were published in 2017 based on data from 2016) (8).

We also comprehensively analyzed the publications of the nine most productive countries (the countries that had produced at least 3% of all publications). The average annual growth rate was used to reveal the change in the number of articles by all EPs worldwide and of the nine most productive countries during the recent 10 years. The average annual growth rate was calculated using the following formula:

Average annual growth rate = (number of publications in 2017/number of publications in 2008)$^{1/n}$ *− 1*, where n = number of time periods (in our study, n = 2017–2008 = 9).

Finally, we used the above-mentioned search string to identify the scientific publications of EPs in high-impact journals (Supplementary Table 1). In addition, we determined the total number of citations for these scientific publications and the average number of citations per article. As high-impact journals, we included the following four journals: *The New England Journal of Medicine* (*NEJM*), *The Lancet*, *The Journal of the American Medical Association* (*JAMA*), and *PLoS Medicine* (*PLoS Med*).

Statistical Analysis

The primary purpose of the present study was to define and reveal the scientific productivity of EPs worldwide. Another purpose was to define countrywide scientific contributions and publication trends. Therefore, no hypothesis was tested with statistical tests; only simple descriptive statistics (e.g., the number of articles, rate, total, percent, and mean) were used. Ethics committee approval for this study was received from the local Clinical Research Ethics Committee.

RESULTS

A total of 29,140 original articles were published from 2008 to 2017 in the EM journals included in this study; 15,281 (52.4%) of these articles were published by EPs, and 13,859 (47.6%) were published by researchers other than EPs. In 2008, 1124 articles were published by EPs around the world; in 2017, this number increased to 1650. Figure 1A demonstrates that the number of articles constantly increased during the 10-year period, except for declines in 2014 and 2017. We determined that although EPs from the United States had published 59.2% of all articles in 2008, this rate declined to 52.4% in 2017 (Figure 1B).

Nineteen countries produced at least 1% of the total articles during the 10 years (Table 2). Most of the articles were published in the United States (8314/15,281, or 54.4%), followed by Canada, Australia, Turkey, and the UK. The United States had the highest total IF (19,192.1), followed by Canada (2506.4), Australia (1888.6), the UK (1444.3), and Spain (1360.2).

Although the United States, Canada, and the UK had the highest total citations among all countries (84,605, 11,329, and 8583, respectively), Norway, which produced 1% of all publications, had the highest average citations per article (21.7). Among the first 10 most productive countries, the UK was the leading country for average citations per article (13.8), and China had the lowest rate (4.6). The H index was 80 for EPs from the United States, followed by Canada (n = 43), England (n = 40), Australia (n = 36), and Germany (n = 31).

Nine countries produced at least 3% of all articles. The productivities of all countries except for the UK increased within the recent 10 years. Although the number of articles published by British EPs was 71 in 2008, this declined to 45 in 2017. Although the trends in the number of articles published within the 10-year period showed increases and decreases, all countries except the UK showed an upward trend (Figures 1B and 2).

South Korea was found to be the most rapidly growing country among the nine most productive countries (average annual growth rate: 17.9%), followed by Turkey (8.2%), Spain (6.5%), Germany (6.2%), and Canada (5.8%; Figure 3). Whereas EPs from South Korea published 20 articles in 2008, this number increased to 88 in 2017.

In high-impact journals during the same period (2008–2017), we found out that 82 original articles were published by EPs. Forty-four of 82 (52.7%) of these articles were published by American EPs, and 25/82 (30.5%) were published by South Korean EPs (Table 3).

DISCUSSION

In this bibliometric analysis, we determined that the scientific publication productivity of EPs tended to increase from 2008–2017. Scientific productivity increased in all of the most productive countries, except the UK, in that

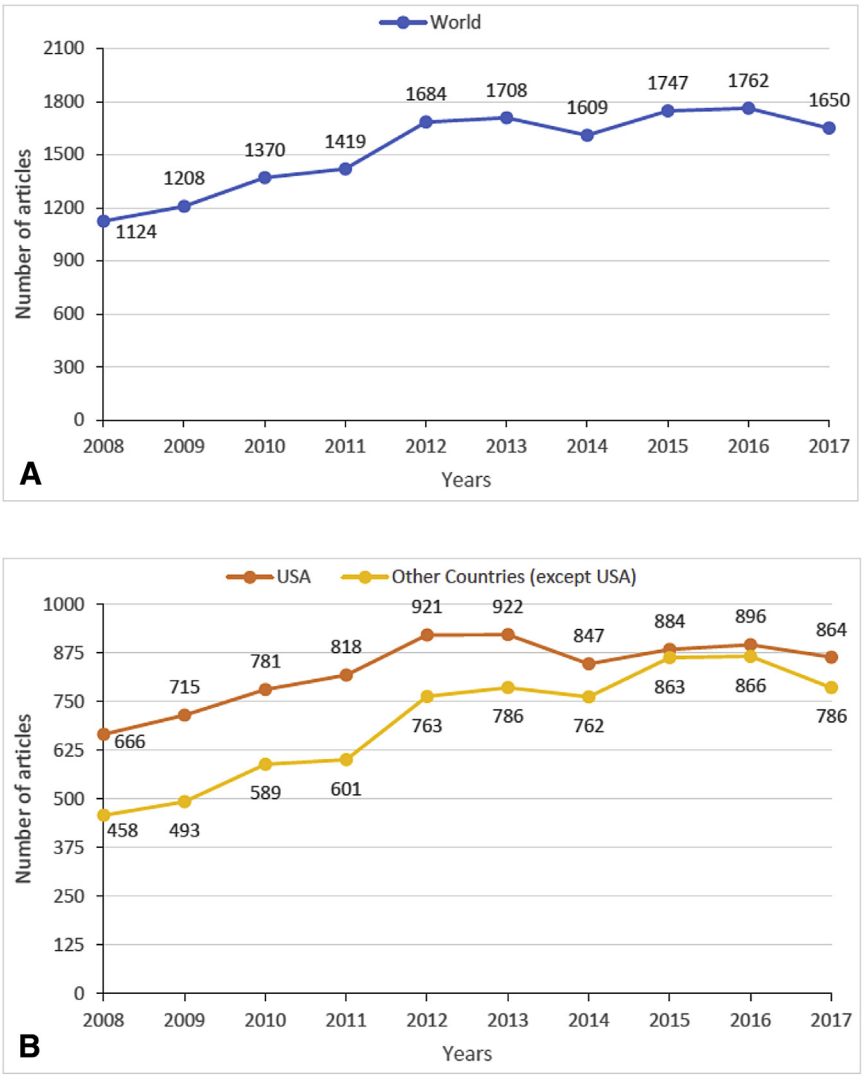

Figure 1. The annual change in the scientific publication productivity of all emergency physicians worldwide (A) and emergency physicians in the United States (B) between 2008 and 2017.

period. We also determined that EPs in the United States published many more articles than EPs in other countries. This result was not surprising for us, because the United States is the leader in all medical research categories (mainly orthopedics, psychiatry, endocrinology, and radiology) (9–12). However, considering the scientific productivity of only EPs in the recent 10-year period, the United States had an overwhelming advantage in addition to its leading position, because more than half of the articles published in both EM journals and high-impact journals were published by American EPs. American EPs had the highest total IF (19,192.1) and total citations (84,605), in addition to the highest article production. More importantly, the United States was the leading country among 19 with regard to the H index (80), at almost twofold that of Canada (43), which was the second leading country. These results reveal that the United States was the leading country with regard to not only quantitative data, but also qualitative data in scientific production.

The rates of scientific productivity were 59.2% and 40.8%, respectively, in the United States and the remaining countries in the world in 2008, whereas the rate of articles published in the United States regressed to 52.4%, it increased to 47.6% in the remaining parts of the world in 2017. This resulted not from a decrease in the productivity of the United States, but from an increase in the number of articles from the remaining parts of the world. Whereas the average annual growth rate was 4.4% for all EPs in the world, the growth rate in the United States remained at 2.9% in the recent 10-year period.

A study by Wilson and Itagaki examined 14,605 articles published by EPs between 1996 and 2005, and reported that 58.5% of the articles had been published by

Table 2. Scientific Publications of EPs According to Countries Between 2008 and 2017

Country	Articles n (%)	Total IF	Average IF	Total Citations	Average Citation per Article	H Index
United States	8314 (54.4)	19,192.1	2.3	84,605	10.2	80
Canada	1097 (7.2)	2506.4	2.3	11,329	10.3	43
Australia	943 (6.2)	1888.6	2.0	8314	8.8	36
Turkey	656 (4.3)	768.0	1.2	3179	4.9	23
UK	621 (4.1)	1444.3	2.3	8583	13.8	40
South Korea	598 (3.9)	1341.4	2.2	4480	7.5	29
Spain	493 (3.2)	1360.2	2.8	4265	8.7	27
Germany	487 (3.2)	658.4	1.4	4621	9.5	31
China	481 (3.1)	667.6	1.4	2234	4.6	19
Taiwan	439 (2.9)	779.4	1.8	3072	7.0	25
Japan	354 (2.3)	923.7	2.6	2929	8.3	28
France	325 (2.1)	803.4	2.5	3602	11.1	28
Italy	260 (1.7)	562.1	2.2	4133	15.9	28
Austria	184 (1.2)	597.3	3.3	3074	16.7	26
Switzerland	177 (1.2)	413.2	2.3	2246	12.7	24
Netherlands	176 (1.2)	428.1	2.4	3182	18.1	24
Denmark	169 (1.1)	561.5	3.3	1884	11.2	23
Norway	160 (1.0)	525.8	3.3	3465	21.7	29
Singapore	160 (1.0)	368.3	2.3	1537	9.6	22

EP = emergency physician; H = Hirsch index; IF = impact factor; UK = United Kingdom.

American researchers (13). Li et al. reviewed articles published in 13 EM journals between 2006 and 2010, and reported that American researchers published 46.3% of all articles and that the most productive country was the United States (1). Again, in this study, the UK ranked second with a percentage of 12.7%, and Australia ranked third with 5.9% (1). The other countries in the top 10 were China, Canada, Germany, Turkey, France, the Netherlands, and South Korea, respectively (1). Our study analyzed articles published between 2008 and 2017, and the 10 most productive countries we identified were similar to the top 10 countries identified by Wilson and Itagaki, and Li et al. in their studies (1,13).

In Wilson and Itagaki's study, in terms of academic productivity, Turkish EPs ranked ninth among EPs in the world, and Spanish EPs ranked fifteenth (13). In our study, Turkey ranked fourth and Spain ranked seventh. This may be due to the higher increase in the annual average number of articles in these two countries than in other countries (Figure 3). In addition to these countries, South Korea has special importance because it is the country with the highest increase in the rate of publications among the most productive countries. We predict that South Korea will yield better outcomes with regard to the number of articles in future years.

Traditionally, the number of produced articles and the number of citations are used when evaluating

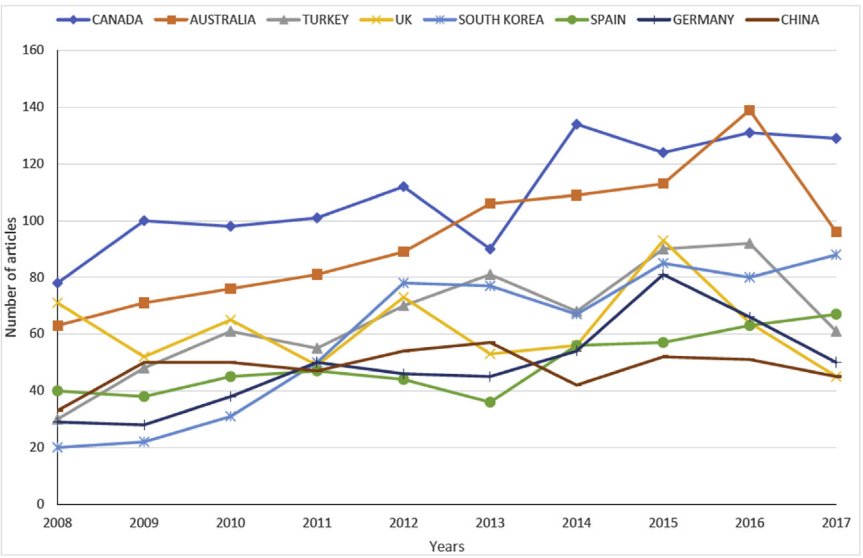

Figure 2. Productivity trends by year in the most productive countries other than the United States.

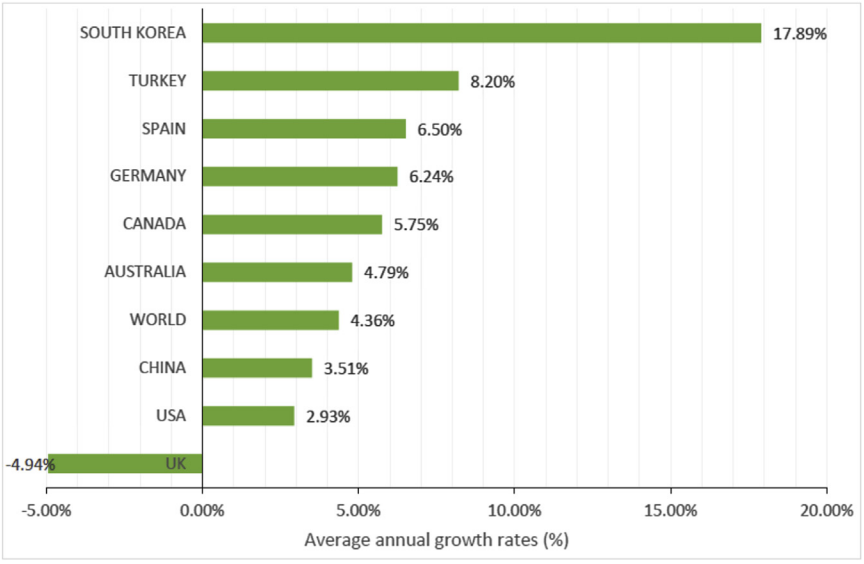

Figure 3. Annual growth rates of the top nine countries.

academic productivity. The H index is a relatively new bibliometric marker that can evaluate the number of produced articles and the number of citations simultaneously (14,15). The H index is defined as the highest number (n) of an author's papers that are cited n number of times. For example, an H index of 8 means that each of eight articles has been cited at least eight times (14). In a study analyzing the academic productivity of professors of EM in the United States and Canada, the average H index of 299 EM professors was reported to be 12.8 (16). Again, in this study, the highest H index was reported as 51 (16). In a study analyzing the academic productivity of EPs in South Korea, the highest H index was reported as 17 (5). The H indexes we obtained in our study were higher than in the aforementioned two studies because in our study, we calculated the cumulative H indexes of all the EPs of a country (5,16). Moreover, we think that the H indexes of countries have increased in this time period as time has passed since these studies (5,16).

Limitations

This study has some limitations. First, it included only 24 journals in the Web of Science database. Although these journals are in the EM category, manuscripts are also published by EPs in other journals in the Web of Science database (e.g., toxicology, critical care medicine, cardiology, and neurology journals). Manuscripts are also published by EPs in other databases (e.g., Emerging Sources Citation Index, Embase, PubMed). Not screening these databases may be a limitation. However, we consider that the scientific productivity of EPs is reflected in the 24 EM journals included in the study. We only included original articles in our study and compared bibliometric markers such as the citation number and the H index. However, today, new knowledge is spreading rapidly through free open access medical education sites, podcasts, and EM blogs, which also have a scientific impact. The citation of articles has traditionally been used to measure their scientific impact. In recent years, however, Altmetric (London, UK) scores have also

Table 3. Scientific Publications of Emergency Physicians in High-Impact Journals Between 2008 and 2017

Country	*NEJM*	*Lancet*	*JAMA*	*PLoS Med*	Total Citations	Average Citations per Article
United States	13	3	24	4	5624	127.8
Canada	2	–	1	–	350	116.7
UK	1	1	–	–	321	160.5
South Korea	1	–	–	24	292	11.7
France	1	1	1	–	528	176
Australia	–	1	–	–	31	31
Japan	–	–	2	–	66	33
Qatar	–	1	–	–	19	19
Italy	–	–	1	–	132	132

JAMA = Journal of the American Medicine Association; NEJM = New England Journal of Medicine; PLoS = Public Library of Science; UK = United Kingdom.

been used to measure the scientific impact of articles and the speed of sharing academic knowledge in a virtual environment (17,18). We did not include Altmetric scores in our study because we reviewed a great amount of data.

CONCLUSIONS

In summary, the scientific publication productivity of EPs steadily increased from 2008 to 2017. However, the number of publications by EPs in high-impact journals has remained limited. The United States is the country with the highest productivity, having published more than half of the total articles.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jemermed.2019.03.021.

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ARTICLE SUMMARY

1. Why is this topic important?

Scientific research in the field of emergency medicine is increasing day by day. However, the contribution of emergency physicians (EPs) to the emergency medicine literature is not known.

2. What does this study attempt to show?

The aim of this study was to analyze the contribution of EPs to the emergency medicine literature and their scientific publication productivity during 2008–2017.

3. What are the key findings?

The number of scientific articles published by EPs in the 10-year period increased significantly. In 2008, 1124 scientific articles were published by EPs, and in 2017, this. number increased to 1650. In this 10-year period, the highest number of articles was published by U.S. EPs.

4. How is patient care impacted?

As this is a bibliometric study, it has no effect on patient care.