JISTaP http://www.jistap.org
Journal of Information Science Theory and Practice

RESEARCH PAPER
J Inf Sci Theory Pract 10(2): 74-85, 2022

eISSN : 2287-4577 pISSN : 2287-9099

https://doi.org/10.1633/JISTaP.2022.10.2.5

Assessing Publication Productivity of the Top 10 Countries Across Medical Specialties: Prolific Versus Prestigious Journals

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ABSTRACT

This study aimed to investigate publication productivity in various medical specialties in the top 10 countries with the highest number of published journal articles, considering the distinction between prolific and prestigious journals. For this study, we selected 10 specialties from the Scientific Journal Rankings (SJR) and used journals listed in both SJR and PubMed. Bibliographic details of these journals' articles published from 2017 to 2019 were downloaded from PubMed. The results showed that various aspects of medical publication output were influenced by country characteristics such as specialty, journal type, population size, wealth, and healthcare expenditure. China showed the greatest variability in terms of specialty, as its publications in Oncology (ONCGY) were exceptionally high compared with the specialties of other countries. China's publications in ONCGY exceeded even those of the United States in ONCGY. Furthermore, the western countries, the United Kingdom, Canada, and the United States in particular published more articles in prestigious journals than the other top 10 countries, where the East Asian countries published more articles in prolific journals than in prestigious journals.

Keywords: prolific journals, prestigious journals, h-index, medical specialties, journal types, PubMed

Received: April 3, 2022
Revised: May 12, 2022
Accepted: May 19, 2022
Published: June 30, 2022

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1. INTRODUCTION

In the past two decades, there has been an enormous growth of research publications in large bibliographic databases such as PubMed (https://pubmed.ncbi.nlm.nih.gov). PubMed, provided by the National Institutes of Health (NIH), is considered a leading source of medical research publications (Williamson & Minter, 2019). In the past, numerous bibliometric studies have been conducted based on PubMed to assess the medical research outputs of certain countries and regions (Albarqouni et al., 2018; Song et al., 2014; Tadmouri et al., 2019; Tan & Sijbrands, 2020). The quantitative results of such studies may vary among medical specialties, as these are important divisions of medical research. Medical specialties will be referred to simply as "specialties" hereinafter.

Modern specialties emerged in the early nineteenth century as a form of knowledge production closely related to clinical practice (Weisz, 2003). Today, the number of specialties has increased as medical practices have become more complex (Dolan, 2021). The American Board of Medical Specialties (https://www.abms.org), a professional organization that certifies specialties in the United States, has certified more than 150 specialties to date. Many previous studies have focused on identifying characteristics of each specialty (Jamjoom & Jamjoom, 2016; Özen Çınar, 2020; Shamseddine et al., 2014).

Consequently, publication patterns within the specialties of particular countries need to be assessed more comprehensively, as superficial analyses can mislead researchers. Various factors, such as population size, wealth, and health care expenditure, must be taken into consideration when assessing countries' publication outputs. It is also useful to consider different types of journals because scientific journals are often considered as the basic unit for evaluating publication output (Schubert & Braun, 1986). First, we considered prolific journals, i.e., journals that publish a large number of articles in specific fields. Prolific journals are common in various fields of study (Konur, 2012; Zhao et al., 2018). We also considered prestigious journals, i.e., journals that have relatively high h-indexes in certain fields. A journal's h-index is considered a reasonable indicator of a journal's impact and prestige (Bornmann et al., 2009) and is a single numerical indicator that takes into account both the number of citations and the number of published documents (Braun et al., 2006).

In recent years, there has been considerable interest in examining the scientific productivity of leading countries (Elango & Oh, 2022). In light of this, it is possible to compare the research output of leading countries using the bibliographic data of journals with high h-indexes. However, there is a lack of studies that have examined specialties within specific countries using different journal types. Considering the distinction between prolific and prestigious journals, the publication patterns of specialties in the leading countries should be examined in terms of journal types in addition to various country characteristics, such as population size and the country's wealth and health expenditure.

The 10 countries that published the highest number of articles in medicine were the following: the United States, China, Japan, the United Kingdom, Germany, Italy, Canada, France, Australia, and South Korea. Moreover, the 10 specialties selected for this study were the following: Cardiology and Cardiovascular Medicine (CARGY); Infectious Diseases (INFEC); Neurology (NEURO); Oncology (ONCGY); Orthopedics and Sports Medicine (ORTHO); Pediatrics, Perinatology, and Child Health (PEDIA); Pharmacology (PHARM); Psychiatry and Mental Health (PSYCH); Radiology, Nuclear Medicine, and Imaging (RADGY); and Surgery (SURGY). These specialties had the highest numbers of journals indexed in the Scientific Journal Ranking (SJR).

Hence, the objective of this study was twofold:

a) to examine publication productivity in various medical specialties in the top 10 countries with the highest number of published journal articles
b) to compare the output of the specialties in the top 10 countries in terms of prestigious and prolific journals

2. METHODOLOGY

In this study, we examined the publication productivity of the previously mentioned 10 specialties and 10 countries. Publication productivity is commonly used to measure the performance of researchers, institutions, disciplines, and countries (Aboagye et al., 2021; Koljatic & Silva, 2001; Matthews, 2013). We refer to this term as a measurement of publication output efficiency in this study. To assess the research output of countries across specialties, we first used journals listed in both the 2020 SJR and PubMed. For the 10 medical specialties, the journal category of the 2020 SJR was used, and the bibliographic records of the journal articles of 10 medical specialties published from 2017 to 2019 were downloaded from the NIH website (http://nlm.nih.gov/databases/download/pubmed_medline.html).

Considering different journal types, three types of datasets were created: a) *ALL* dataset, b) *30H* dataset, and c) *30P* dataset. The *ALL* dataset, which was created without the consideration of journal types, consisted of bibliographic records of articles published in all indexed journals across the 10 specialties. The top 30 journals from the 10 previously mentioned specialties were selected for the prolific and prestigious journal categories. The *30H* dataset included bibliographic records of articles published in the 30 journals with the highest h-index scores, whereas the *30P* dataset included bibliographic records of articles published in the 30 journals with the highest number of articles published. We defined and distinguished prestigious and prolific journals by creating the *30H* dataset for prestigious journals and the *30P* dataset for prolific journals.

In creating the datasets, some records were removed from the original downloaded data because the country names were not recognizable. Country codes were first extracted from the PubMed data (or the *ALL* dataset) based on author affiliation information. Approximately 5% of the records were removed due to missing or unrecognizable author affiliation information. In addition, country names were extracted using *libpostal*, an NLP tool for extracting international street addresses (Barrentine, 2018). The *libpostal* tool failed to correctly identify country names for approximately 4% of the datasets. Thus, approximately 9.6% of the total experimental data was excluded from the study. The research data were processed using Python and SQL, and the research results were analyzed using Excel and R.

The total number of journals and articles used in this study varied by specialty. Table 1 shows the descriptive statistics for the 10 selected specialties. On average, the *30P* dataset contained approximately one and a half times more journal articles than the *30H* dataset. The number of journals, the journal article records, and the average h-index of specialties across the three datasets varied widely. The average h-index of journals ranged from 50.7 (SURGY) to 65.9 (ONCGY) in the *ALL* dataset, from 130.8 (PEDIA) to 222.5 (ONCGY) in the *30H* dataset, and from 105.0 (PEDIA) to 171.5 (CARGY) in the *30P* dataset. Although the h-indexes in the *30H* dataset are higher than those in the *30P* dataset in each specialty, the difference among the specialties varied considerably. The varying h-indexes are indicative of the characteristics of journals in each specialty. The h-index of ONCGY is the highest (222.5) in the *30H* dataset, suggesting that there were more prestigious journals published in this specialty than in other specialties. In contrast, the h-index of PEDIA

Table 1. Descriptive statistics of three datasets

Specialties	*ALL* dataset			*30H* dataset			*30P* dataset		
	N Journals	Avg. h-index	N Articles	N Journals	Avg. h-index	N Articles	N Journals	Avg. h-index	N Articles
CARGY	278	59.0	91,745	30	202.1	28,161	30	171.5	34,042
INFEC	227	61.9	81,953	30	180.8	25,266	30	135.4	39,240
NEURO	299	63.5	103,421	30	197.4	24,734	30	148.2	39,693
ONCGY	292	65.9	141,306	30	222.5	26,070	30	154.0	61,836
ORTHO	196	51.5	59,941	30	150.2	25,848	30	137.3	28,404
PEDIA	210	53.9	63,649	30	130.8	19,960	30	105.0	27,244
PHARM	179	59.5	55,759	30	143.5	18,345	30	114.5	28,930
PSYCH	366	61.7	78,845	30	189.7	18,161	30	144.6	30,460
RADGY	248	51.3	78,173	30	152.4	25,384	30	126.5	29,721
SURGY	340	50.7	134,000	30	169.9	30,278	30	127.3	45,449
Average	263.5	57.9	88,879	30	173.9	24,121	30	136.4	36,502

CARGY, Cardiology and Cardiovascular Medicine; INFEC, Infectious Diseases; NEURO, Neurology; ONCGY, Oncology; ORTHO, Orthopedics and Sports Medicine; PEDIA, Pediatrics, Perinatology, and Child Health; PHARM, Pharmacology; PSYCH, Psychiatry and Mental Health; RADGY, Radiology, Nuclear Medicine, and Imaging; SURGY, Surgery.

(130.8) is the lowest in the *30H* dataset, suggesting that there were fewer prestigious journals published in this specialty than in other specialties. Some journals listed in the *30H* dataset are also included in the *30P* dataset, indicating that some journals are both prestigious and prolific.

The total number of journal articles used in this study is shown in Fig. 1. In addition, we used a fractional counting method in which co-authors are counted equally regardless of the author sequence (e.g., first author, second author, etc.). Fractional counting is usually preferred over whole counting in processing bibliometric data (Gauffriau, et al., 2008; Perianes-Rodriguez et al., 2016; Pritychenko, 2016). The author's country was counted proportionally to the number of co-authors, and only a fraction of the country was credited to the authors of the article.

3. RESULTS

3.1. Total Publication Outputs of 10 Specialties

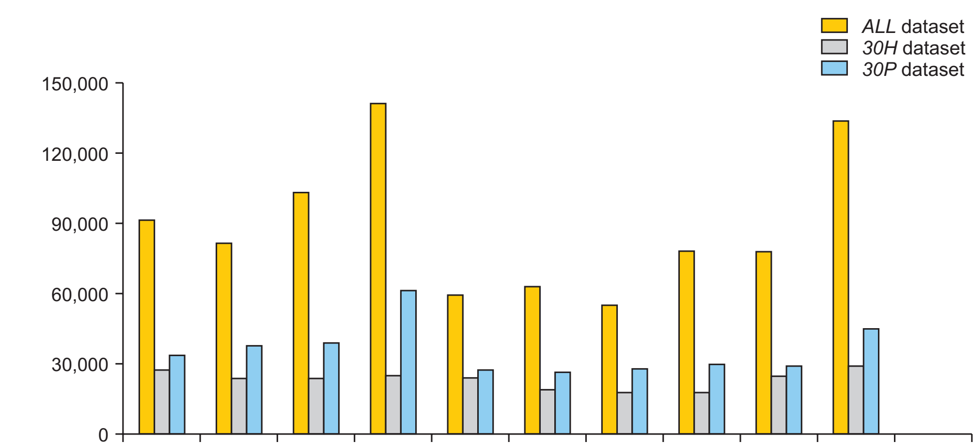
Fig. 1 illustrates differences in the total publication outputs of 10 specialties across the three datasets. The number of articles published in the *30H* dataset was considerably lower than in the other datasets across the specialties. The higher number in *30P* was not surprising, as *30P* represents prolific journals. As shown, the number of publications varied across specialties and datasets. In both the *ALL* dataset and the *30P* dataset, the number of published articles was highest in ONCGY. In contrast, the number of articles published in the *30H* dataset was highest in SURGY (30,278 articles, 12.6%). In the *ALL* dataset, the lowest number of articles was published in PHARM (55,759 articles, 6.3%), whereas the lowest number of articles in the *30H* dataset was published in PSYCH (18,161 articles, 7.5%).

3.2. Total Publication Output of the Top 10 Countries

Table 2 shows the publication output of the top 10 countries across the datasets. Except for China, the result shows that global medical research is mostly led by only a handful of developed countries, while many developing countries strive to build their medical research capacity (Rahman et al., 2020). The research output of the corresponding countries is also presented in the *30H* and *30P* datasets. As expected, the United States is the largest producer of medical research publications in all three datasets. There is a considerable gap between the total production of journal articles in the United States and other countries in the *ALL* dataset. Compared to China, the United States published approximately two and a half times more articles, six times more in the *30H* dataset, and two times more in the *30P* dataset. Compared to South Korea (ranked 10th), the United States published approximately nine times more articles in the *ALL* dataset, 15 times more in the *30H* dataset, and 10 times more in the *30P* dataset.

3.3. Relationship between the Number of Articles and Country Related Indicators

Using 2018 data from the World Health Organization (WHO), we investigated the relationships between the



Dataset type	CARGY	INFEC	NEURO	ONCGY	ORTHO	PEDIA	PHARM	PSYCH	RADGY	SURGY	All
ALL dataset	91,745 (10.3%)	81,953 (9.2%)	103,421 (11.6%)	141,306 (15.9%)	59,941 (6.7%)	63,649 (7.2%)	55,759 (6.3%)	78,845 (8.9%)	78,173 (8.8%)	134,000 (15.1%)	888,792 (100%)
30H dataset	28,161 (11.7%)	24,690 (10.3%)	24,734 (10.3%)	26,070 (10.8%)	24,848 (10.3%)	19,960 (8.3%)	18,345 (7.6%)	18,161 (7.5%)	25,384 (10.5%)	30,278 (12.6%)	240,631 (100%)
30P dataset	34,042 (9.3%)	38,431 (10.6%)	39,693 (10.9%)	61,836 (17%)	28,404 (7.8%)	27,244 (7.5%)	28,930 (7.9%)	30,460 (8.4%)	29,721 (8.2%)	45,449 (12.5%)	364,210 (100%)

Fig. 1. Total publications by specialty. CARGY, Cardiology and Cardiovascular Medicine; INFEC, Infectious Diseases; NEURO, Neurology; ONCGY, Oncology; ORTHO, Orthopedics and Sports Medicine; PEDIA, Pediatrics, Perinatology, and Child Health; PHARM, Pharmacology; PSYCH, Psychiatry and Mental Health; RADGY, Radiology, Nuclear Medicine, and Imaging; SURGY, Surgery.

Table 2. Total publications of top 10 countries

Rank (*ALL* dataset)	Country	Type of datasets		
		ALL (%)	*30H* (%)	*30P* (%)
1	United States	230,160 (38.7)	81,547 (48.4)	97,461 (38.0)
2	China	97,189 (16.3)	14,355 (8.5)	54,602 (21.3)
3	Japan	46,968 (7.9)	9,669 (5.7)	18,467 (7.2)
4	United Kingdom	41,673 (7.0)	14,755 (8.8)	16,409 (6.4)
5	Germany	40,266 (6.8)	10,531 (6.2)	14,708 (5.7)
6	Italy	35,203 (5.9)	7,478 (4.4)	13,075 (5.1)
7	Canada	28,035 (4.7)	9,745 (5.8)	11,281 (4.4)
8	France	26,191 (4.4)	7,546 (4.5)	9,973 (3.9)
9	Australia	24,913 (4.2)	7,621 (4.5)	10,574 (4.1)
10	South Korea	24,595 (4.1)	5,305 (3.1)	9,852 (3.8)
		595,193 (100)	168,551 (100)	256,402 (100)

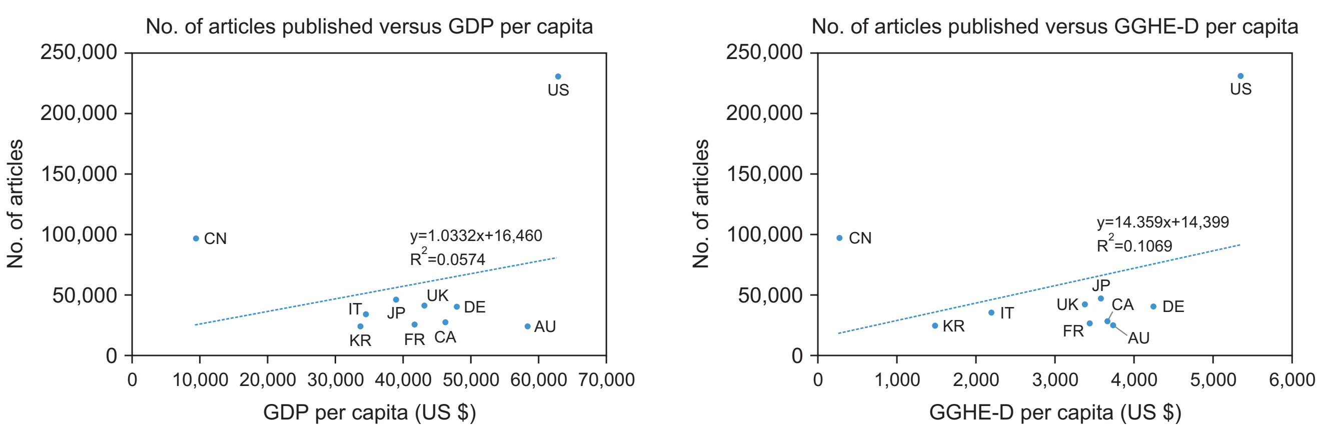


Fig. 2. Number of articles published vs. country's wealth and health expenditure. AU, Australia; CA, Canada; CN, China; DE, Germany; FR, France, IT, Italy; KR, South Korea; UK, United Kingdom; US, United States; GDP, gross domestic product; GGHE-D, total government health expenditure.

number of articles published and gross domestic product (GDP) per capita, as well as the number of articles published and total government health expenditure (GGHE-D) per capita. We found that the number of published articles increased with GGHE-D per capita. However, the R-squared values for both graphs shown in Fig. 2 indicate that there is a large variability in the trend line. In terms of number of articles and GDP per capita, the R-squared value shows that only about 5.7% of the variance can be explained by the linear regression model.

Similarly, in terms of number of articles and GGHE-D per capita, the R-squared value shows that approximately 10.7% of the variance in producing articles can be explained by the linear regression model. The United States has the highest GDP per capita and GGHE-D per capita, and it also has the highest number of articles published in medicine. In contrast, China has published the second-highest number of articles but has the lowest GDP per capita and GGHE-D per capita. As shown, the linear regression line can be used to assess a country's publication productivity in relation to other countries. When the country's wealth and health care expenditures are consid-

 https://doi.org/10.1633/JISTaP.2022.10.2.5

ered, the countries above the regression line are more productive in producing journal articles than the countries below the trend line; thus, the United States and China are more productive than most other countries.

Using the *ALL* dataset, the publication productivity of the top 10 countries was calculated relative to their population size. Similar to GDP per capita, we defined *Articles per T-Capita* as the articles produced per thousand populations and calculated the top 10 countries' *Articles per T-Capita* using the 2018 population data from the WHO (World Health Organization, 2020). *Articles per T-Capita* represent a country's publication productivity regarding medical journal articles. As shown in Table 3, *Articles per T-Capita* were the highest in Australia (1.00), whereas

Table 3. *Articles per T-Capita* across top 10 countries

Rank	Country	Articles per T-Capita	No. of articles (*ALL* dataset)	Population (1,000 head)
1	Australia	1.00	24,913	24,898
2	Canada	0.76	28,035	37,075
3	United States	0.70	230,160	327,096
4	Germany	0.67	40,266	60,484
5	United Kingdom	0.63	41,673	66,274
6	Japan	0.57	46,968	82,792
7	Italy	0.53	35,203	66,919
8	South Korea	0.48	24,595	51,172
9	France	0.21	26,191	127,202
10	China	0.07	97,189	1,427,648

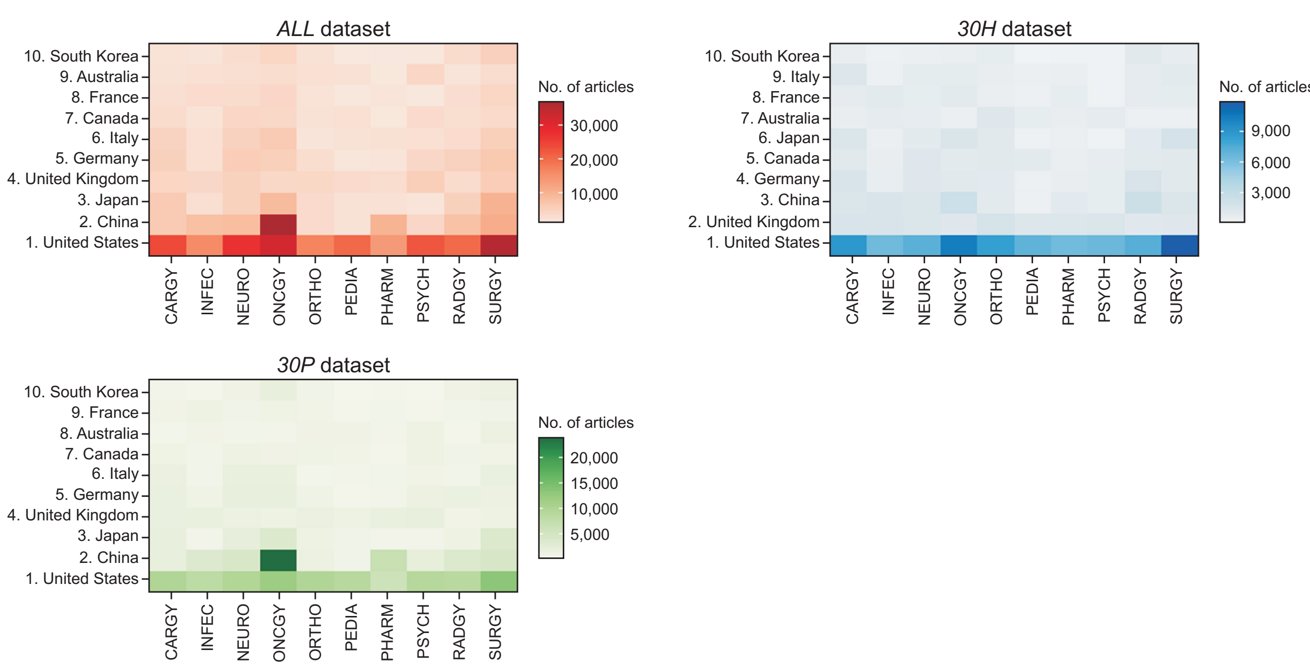


Fig. 3. Publication counts of top 10 countries' specialties. The numbers on the left side of each country name indicate the rank in producing journal articles. CARGY, Cardiology and Cardiovascular Medicine; INFEC, Infectious Diseases; NEURO, Neurology; ONCGY, Oncology; ORTHO, Orthopedics and Sports Medicine; PEDIA, Pediatrics, Perinatology, and Child Health; PHARM, Pharmacology; PSYCH, Psychiatry and Mental Health; RADGY, Radiology, Nuclear Medicine, and Imaging; SURGY, Surgery.

China published the lowest number of articles (0.07) according to this metric. Thus, when population size was taken into account, Australia was the most productive, and China was the least productive country in producing journal articles.

3.4. Number of Articles in Top Countries' Specialties

The number of published articles varied considerably across the specialties, countries, and datasets. Fig. 3 represents the raw publication counts of the top 10 countries' specialties in the *ALL*, *30H*, and *30P* datasets. China showed the most distinctive publishing pattern. Compared with other countries, China published the highest number of articles in ONCGY in the *ALL* dataset. In the *30P* dataset, the number of China's publications in ONCGY is greater than the number of publications produced in any other country's specialty. The dominance of the United States in medical research can also be noticed in this figure. Except for China in ONCGY, the United States published more articles than any other country in all specialties. The number of articles published by the United States in SURGY in the *ALL* dataset is the second highest across all specialties. In contrast to the publication patterns in the *30P* dataset, the United States consistently published more articles in the *30H* dataset than any other country in all specialties.

		Australia	Canada	China	France	Germany	Italy	Japan	South Korea	United Kingdom	United States	Average
ALL dataset	CARGY	8.0%	11.4%	6.4%	9.8%	12.6%	13.1%	13.2%	7.7%	10.2%	10.5%	10.1%
	INFEC	9.6%	6.4%	8.1%	12.0%	6.2%	7.0%	5.5%	7.0%	9.4%	7.0%	7.5%
	NEURO	10.9%	14.5%	8.5%	11.8%	14.4%	13.9%	10.5%	11.4%	11.9%	12.0%	11.6%
	ONCGY	11.2%	13.3%	38.1%	15.2%	13.1%	17.5%	18.4%	17.7%	9.1%	14.1%	18.2%
	ORTHO	10.1%	7.4%	3.6%	7.3%	7.4%	4.8%	7.4%	8.6%	9.2%	7.4%	6.9%
	PEDIA	9.2%	8.6%	2.1%	5.0%	3.7%	6.0%	4.5%	3.7%	7.9%	8.9%	6.5%
	PHARM	5.6%	4.9%	10.1%	6.6%	4.3%	6.3%	4.9%	4.5%	7.3%	5.9%	6.4%
	PSYCH	16.4%	11.7%	4.1%	5.1%	9.7%	7.2%	3.7%	5.2%	13.2%	9.8%	8.5%
	RADGY	7.1%	9.5%	7.9%	10.9%	12.4%	8.9%	10.8%	13.3%	7.9%	8.8%	9.2%
	SURGY	12.0%	12.1%	11.1%	16.3%	16.1%	15.3%	21.1%	20.9%	13.9%	15.7%	15.2%
	All	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
30H dataset	CARGY	8.3%	12.4%	10.7%	12.1%	15.7%	18.8%	15.2%	11.7%	11.2%	11.0%	11.9%
	INFEC	11.7%	6.5%	10.9%	13.9%	6.8%	6.4%	5.9%	6.0%	11.3%	8.1%	8.6%
	NEURO	11.2%	13.7%	10.3%	10.7%	12.6%	11.7%	9.6%	8.9%	10.4%	9.0%	10.1%
	ONCGY	7.4%	9.4%	17.6%	12.4%	10.5%	11.8%	15.7%	11.6%	8.4%	12.8%	12.3%
	ORTHO	17.6%	11.6%	7.1%	8.1%	9.4%	8.5%	12.1%	14.4%	12.4%	10.5%	10.7%
	PEDIA	10.6%	9.6%	2.9%	5.3%	4.7%	7.4%	3.3%	2.1%	9.4%	8.7%	7.4%
	PHARM	8.4%	6.3%	7.0%	10.7%	6.1%	7.7%	5.9%	5.2%	9.6%	7.9%	7.7%
	PSYCH	11.9%	8.7%	5.2%	3.2%	7.5%	3.5%	2.5%	3.4%	10.4%	8.2%	7.4%
	RADGY	6.3%	10.5%	17.5%	12.0%	16.4%	12.0%	10.3%	21.1%	7.7%	9.1%	10.8%
	SURGY	6.7%	11.4%	10.7%	11.7%	10.3%	12.3%	19.6%	15.7%	9.1%	14.7%	13.1%
	-	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
30P dataset	CARGY	6.6%	10.8%	3.8%	11.1%	12.5%	13.8%	11.8%	7.8%	11.3%	10.3%	9.2%
	INFEC	11.0%	7.9%	6.9%	13.9%	8.1%	6.8%	4.3%	5.8%	11.7%	8.7%	8.2%
	NEURO	8.9%	12.3%	7.8%	10.9%	14.7%	15.1%	12.7%	12.5%	9.9%	10.2%	10.5%
	ONCGY	8.2%	11.2%	43.9%	12.9%	14.4%	15.3%	20.8%	21.0%	8.6%	12.4%	19.9%
	ORTHO	12.0%	10.5%	3.1%	11.8%	8.1%	5.4%	8.0%	10.3%	10.9%	10.1%	8.3%
	PEDIA	11.7%	10.3%	1.8%	4.9%	3.8%	6.4%	5.9%	3.0%	8.4%	9.4%	6.7%
	PHARM	7.3%	5.8%	13.1%	9.4%	5.8%	7.3%	4.2%	5.1%	11.5%	6.3%	8.1%
	PSYCH	13.7%	11.6%	4.4%	5.6%	10.5%	8.9%	4.5%	4.5%	12.6%	9.6%	8.2%
	RADGY	4.5%	9.3%	7.0%	8.8%	11.6%	6.7%	7.2%	12.9%	6.9%	9.2%	8.4%
	SURGY	16.1%	10.4%	8.2%	10.8%	10.4%	14.2%	20.7%	17.2%	8.1%	13.8%	12.5%
	All	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Fig. 4. Publication share of specialties within countries. CARGY, Cardiology and Cardiovascular Medicine; INFEC, Infectious Diseases; NEURO, Neurology; ONCGY, Oncology; ORTHO, Orthopedics and Sports Medicine; PEDIA, Pediatrics, Perinatology, and Child Health; PHARM, Pharmacology; PSYCH, Psychiatry and Mental Health; RADGY, Radiology, Nuclear Medicine, and Imaging; SURGY, Surgery.

3.5. Publication Share of Specialties within Countries

We compared the publication share of the top 10 countries' specialties across all of these countries and across datasets. As shown in Fig. 4, the sum of all publication shares of the specialties in each country is 100%. China showed the most distinctive pattern of publication in terms of the publication share of individual specialties. In the *ALL* dataset, the number of articles published by China was the highest in ONCGY (38.1%). In the *30P* dataset, China's publication share in ONCGY (43.9%) was greater than that of any other country across all specialties. Furthermore, China also had the lowest publication share across all three datasets in PEDIA (2.1%) within the *ALL* dataset.

The average publication share of specialties, which is shown on the right side of Fig. 4, was calculated by taking the average share across all countries. An equal average percentage share of publications would be 10% because there are ten specialties. However, the actual average publication share varied widely, and the highest average publication share was found in the *30P* dataset in ONCGY. In the *ALL* dataset, the high average publication share of ONCGY (18.2%) was partly due to China's exceptionally high number of publications in this specialty. In the same dataset, the lowest publication share was that of PHARM (6.4%).

3.6. Comparing Proportions of Publications Using Ratios

Publication output can vary widely between two journal types — prestigious and prolific. Considering this distinction, we developed the *30H-All Ratio* and the *30P-All Ratio* to compare publication proportions within a dataset and between two datasets. The *30H-All Ratio* measures the relative proportion of articles published in prestigious journals within a specialty or country. Because the *30H* dataset consists of the top 30 journals by h-index scores, the *30H-All Ratio* is defined as follows:

$$\textit{30H-All Ratio} = \frac{\textit{Publications of Country's Specialty in the 30H Dataset}}{\textit{Publications of Country's Specialty in the ALL Dataset}}$$

The *30P-All Ratio* measures the relative proportion of articles published in prolific journals within a specialty or country. Because the *30P* dataset consists of the top 30 journals that published the highest number of articles, it is defined as follows:

$$\textit{30P-All Ratio} = \frac{\textit{Publications of Country's Specialty in the 30P Dataset}}{\textit{Publications of Country's Specialty in the ALL Dataset}}$$

Fig. 5 shows the empirical results of applying the *30H-All Ratio* and *30P-All Ratio* to the top 10 countries' specialties. The highest *30H-All Ratio* is found in ORTHO

		Australia	Canada	China	France	Germany	Italy	Japan	South Korea	United Kingdom	United States	Average
30H dataset	CARGY	0.32	0.38	0.25	0.35	0.33	0.30	0.24	0.33	0.39	0.37	0.33
	INFEC	0.37	0.35	0.20	0.33	0.29	0.19	0.22	0.18	0.42	0.41	0.33
	NEURO	0.31	0.33	0.18	0.26	0.23	0.18	0.19	0.17	0.31	0.27	0.25
	ONCGY	0.20	0.25	0.07	0.23	0.21	0.14	0.17	0.14	0.33	0.32	0.19
	ORTHO	0.54	0.54	0.29	0.32	0.33	0.37	0.33	0.36	0.48	0.50	0.44
	PEDIA	0.35	0.39	0.21	0.30	0.33	0.26	0.15	0.12	0.42	0.35	0.33
	PHARM	0.46	0.44	0.10	0.47	0.36	0.26	0.25	0.25	0.47	0.48	0.34
	PSYCH	0.22	0.26	0.19	0.18	0.20	0.10	0.14	0.14	0.28	0.30	0.25
	RADGY	0.27	0.38	0.33	0.32	0.35	0.29	0.20	0.34	0.35	0.37	0.33
	SURGY	0.17	0.33	0.14	0.21	0.17	0.17	0.19	0.16	0.23	0.33	0.24
	Average	0.31	0.35	0.15	0.29	0.26	0.21	0.21	0.22	0.35	0.35	0.28
30P dataset	CARGY	0.35	0.38	0.34	0.43	0.36	0.39	0.35	0.40	0.44	0.41	0.39
	INFEC	0.49	0.49	0.48	0.44	0.48	0.36	0.31	0.33	0.49	0.53	0.47
	NEURO	0.35	0.34	0.51	0.35	0.37	0.40	0.48	0.44	0.33	0.36	0.39
	ONCGY	0.31	0.34	0.65	0.32	0.40	0.33	0.44	0.47	0.37	0.37	0.47
	ORTHO	0.50	0.57	0.49	0.61	0.40	0.42	0.42	0.48	0.47	0.58	0.52
	PEDIA	0.54	0.48	0.49	0.37	0.37	0.39	0.52	0.33	0.42	0.45	0.45
	PHARM	0.56	0.47	0.73	0.54	0.48	0.43	0.33	0.45	0.62	0.46	0.54
	PSYCH	0.35	0.40	0.60	0.41	0.39	0.46	0.47	0.35	0.38	0.41	0.42
	RADGY	0.27	0.39	0.50	0.31	0.34	0.28	0.26	0.39	0.35	0.44	0.39
	SURGY	0.57	0.34	0.42	0.25	0.24	0.34	0.39	0.33	0.23	0.37	0.36
	Average	0.42	0.40	0.56	0.38	0.37	0.37	0.39	0.40	0.39	0.42	0.43

Fig. 5. *30H-All Ratio* and *30P-All Ratio* of top 10 countries' specialties. Blue indicates a low ratio, whereas red indicates a high ratio. The intensity of the color indicates the degree of the ratio. CARGY, Cardiology and Cardiovascular Medicine; INFEC, Infectious Diseases; NEURO, Neurology; ONCGY, Oncology; ORTHO, Orthopedics and Sports Medicine; PEDIA, Pediatrics, Perinatology, and Child Health; PHARM, Pharmacology; PSYCH, Psychiatry and Mental Health; RADGY, Radiology, Nuclear Medicine, and Imaging; SURGY, Surgery.

Table 4. Frequency counts of the greater-than-average *30H Ratios* and *30P Ratios*

Ratio type	Grand average	Frequency count									
		Australia	Canada	China	France	Germany	Italy	Japan	South Korea	United Kingdom	United States
30H-ALL	0.30	7	9	1	6	5	2	1	3	9	9
30P-ALL	0.44	5	4	9	2	2	1	4	4	3	5

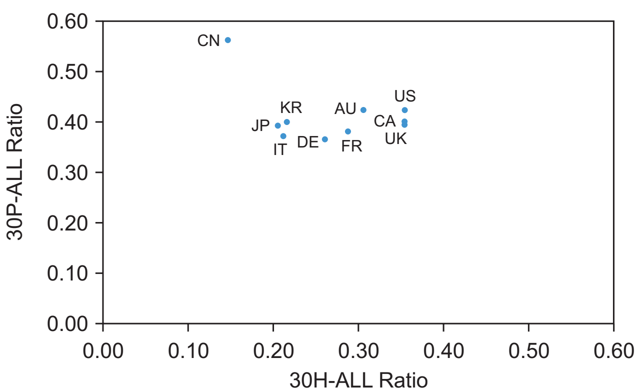


Fig. 6. *30P-All Ratios* and *30H-All Ratios* by country. AU, Australia; CA, Canada; CN, China; DE, Germany; FR, France, IT, Italy; KR, South Korea; UK, United Kingdom; US, United States.

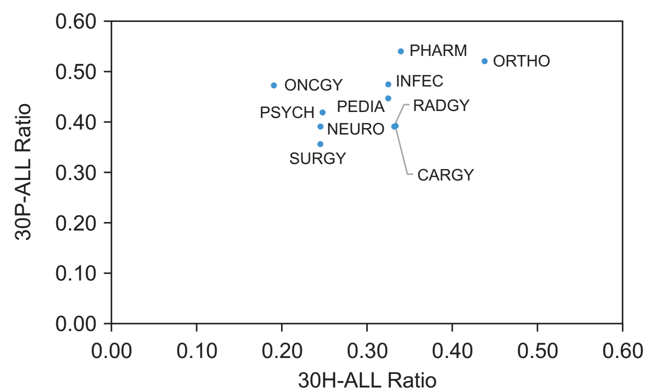


Fig. 7. *30P-All Ratios* and *30H-All Ratios* of specialties. CARGY, Cardiology and Cardiovascular Medicine; INFEC, Infectious Diseases; NEURO, Neurology; ONCGY, Oncology; ORTHO, Orthopedics and Sports Medicine; PEDIA, Pediatrics, Perinatology, and Child Health; PHARM, Pharmacology; PSYCH, Psychiatry and Mental Health; RADGY, Radiology, Nuclear Medicine, and Imaging; SURGY, Surgery.

of Australia (0.54) and ORTHO of Canada (0.54), shown in red. The lowest *30H-All Ratio* is found in ONCGY of China (0.07). Looking at the *30H-All* Ratio, China is mostly shown in blue, indicating that publication in most specialties was not the result of publishing in prestigious journals. On the other hand, the highest *30P-All Ratio* is found in PHARM from China (0.73). The lowest *30P-All Ratio* is found in SURGY of the United Kingdom (0.23), which indicates that this specialty within this country had the lowest proportion of publications published in prolific journals. The *30P-All Ratio* of the countries' specialties is mostly shown in red, indicating that considerably more publications were published in prolific journals than in prestigious journals.

To further examine the overall publication productivity of countries' specialties, we obtained the grand average by averaging the *30H-ALL Ratio* and *30P-ALL Ratio* across all specialties and countries. Then, we counted greater-than-grand average (GTGA) *30H-All Ratios* and GTGA *30P-All Ratios*. As shown in Table 4, the grand average of the *30P-All Ratio* (0.44) is much greater than the grand average of the *30H-All Ratio* (0.30), which suggests that greater proportions of articles are published in prolific rather than prestigious journals. In terms of countries, the United States (9), the United Kingdom (9), and Canada (9) show the highest greater-than-average *30H-All Ratios*, whereas China (9) shows the highest GTGA *30P-All Ratio*. Therefore, in most specialties, authors from the United States, the United Kingdom, and Canada tend to publish more in prestigious journals, whereas authors from China tend to publish in prolific journals.

The *30P-All Ratio* of countries was obtained by calculating the average *30P-All Ratios* of the countries' specialties. Similarly, the *30H-All Ratio* of countries was obtained by calculating the average *30H-All Ratios* of the countries' specialties. Fig. 6 shows a scatterplot of the *30P-All Ratios* and *30H-All Ratios* of the top 10 countries. China had the lowest *30H-All Ratio* (0.15) but the highest *30P-All Ratio* (0.56). This suggests that authors from China mainly published articles in prolific journals rather than in prestigious journals. The United Kingdom, Canada, and the United States had the highest *30H-All Ratios* (0.35). Authors from these Western countries published a greater proportion of their articles in prestigious journals and a smaller proportion of their articles in prolific journals.

Compared with Western countries, East Asian countries, namely China, South Korea, and Japan, had the lowest *30H-All Ratios*.

We also calculated the *30H-All Ratios* and the *30H-All Ratios* of specialties by averaging the *30H-All Ratios* andthe *30H-All Ratios* of all 10 leading countries. Fig. 7 illustrates a scatterplot of the *30H-All Ratios* and *30P-All Ratios*of specialties. ORTHO had the highest *30H-All Ratio* (0.44) with a relatively high *30P-All Ratio* (0.52). PHARM had the highest *30P-All Ratio* (0.54). This indicates that a substantial proportion of the articles in ORTHO and PHARM were published in both prolific and prestigious journals. Compared to other specialties, SURGY had a relatively low number of published articles in prolific or prestigious journals since SURGY had the lowest *30P-All Ratio* (0.36) and a relatively low *30H-All Ratio* (0.24).

4. DISCUSSION AND CONCLUSIONS

To our knowledge, this is the first study to examine the publication output of leading countries in regard to specific specialties using the large PubMed dataset. The top 10 countries we identified in terms of medical journal article production are similar to those of previous studies, such as Fontelo and Liu (2018) and Conte et al. (2017). While these studies used PubMed data, they used more specific document types (e.g., clinical studies) and a much smaller number of journals.

The results showed that publication productivity varied widely across countries and specialties and depended on several key factors. These were the country's population, its wealth and health expenditures, and the types of journals that authors tend to publish in. In terms of population size, Australia was the most productive, whereas China was the least productive. In terms of total publication output, it was not surprising to find that the United States was the most dominant in producing articles, accounting for 39% of all articles published by the top 10 countries in medicine. Compared with other top countries, the United States and China were more productive in producing articles considering their wealth and health expenditures. Both GDP per capita and GGHE-D per capita seem to have a positive correlation with the number of articles published by countries, which is consistent with the findings that GDP affects health care spending (Jakovljevic et al., 2020).The findings of this study support the study of Lin et al. (2018), as the number of articles published increased along with GDP per capita. In addition, the total research output of a country can be calculated by taking into account the wealth and health care expenditure of the country. Compared to most other countries, the United States and China were more productive when their wealth and health spending were considered.

To compare the output of the specialties across the top 10 countries in terms of prestigious and prolific journals, we formulated the *30H-All Ratio* and *30P-All Ratio*. In terms of specialties, the total research production in oncology was highest in ONCGY, partly due to the large volume of articles published by China. Overall, the highest number of articles were published in ONCGY, whereas the lowest number of articles were published in PHARM. China showed the greatest variability in terms of specialty, as its publications in ONCGY were exceptionally high compared with the specialties of other countries. China's publications in ONCGY exceeded even those of the United States in ONCGY. We believe *30H-All Ratio* and *30P-All Ratio* are effective in comparing publication proportions between specialties, a country's specialty, and the country as a whole.

China's high publication productivity was mostly due to publications in prolific rather than prestigious journals. Chinese authors in ONCGY also published a relatively low number of journal articles in more reputable journals. In general, authors from China in most specialties tended to publish in prolific journals, whereas authors from the United States, United Kingdom, and Canada in most specialties tended to publish in more prestigious journals. These countries also published a moderate number of journal articles in prolific journals. In contrast, East Asian countries (China, Japan, and South Korea) showed more distinct preferences in terms of journal type. Unlike the Western countries, these countries published more in prolific rather than prestigious journals. The strict editorial standards of journals pose a particular challenge for authors from non-Western countries (Oh et al., 2019). This may be one of the reasons why researchers from East Asian countries lag behind leading Western countries in publishing in more prestigious journals.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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