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Scientific efforts on SARS-CoV-2 research: A global survey analysis

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Abstract

Introduction: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) outbreak has been a global pandemic. Researchers have made great efforts to investigate SARS-CoV-2. However, there are few studies analyzing the general situation of SARS-CoV-2 research at global level. This study aimed to characterize global scientific efforts based on SARS-CoV-2 publications.

Methodology: SARS-CoV-2 -related publications were retrieved using Web of Science. The number of publications, citation, country, journal, study topic, total confirmed cases, and total deaths were analyzed.

Results: A total of 441 publications were identified. China contributed the largest number of publications (198, 44.90%), followed by USA (51, 11.56%), Italy (28, 6.35%), Germany (19, 4.31%), and South Korea (13, 2.95%). Upper-middle-income economies (51.70%) produced the most SARS-CoV-2 publications, followed by high-income (45.12%), lower-middle-income (2.95%), and low-income economies (0.23%). The research output had a significant correlations with total confirmed cases ($r = 0.666$, $p = 0.000$) and total deaths ($r = 0.610$, $p = 0.000$). China had the highest total citations (1947), followed by USA (204), and Germany (54). China also had the highest average citations (9.83), followed by Netherlands (5.80), and Canada (5.43). The most popular journals were *Journal of Medical Virology, Eurosurveillance,* and *Emerging Microbes & Infections*. The most discussed topic was the epidemiology of SARS-CoV-2.

Conclusions: Scientific research on SARS-CoV-2 is from worldwide researchers' efforts, with some countries and journals having special contributions. The countries with more total confirmed cases and total deaths tend to have more research output in the field of SARS-CoV-2. China was the most prolific country, and had the highest quality of publications on SARS-CoV-2.

Key words: SARS-CoV-2; web of science; publication; citation; country.

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Introduction

Since December 2019, a cluster of patients with unexplainable pneumonia were reported in Wuhan city in China [1,2]. It has been confirmed to be an acute respiratory infection caused by a novel coronavirus, which was named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the International Committee on Taxonomy of Viruses [3-5]. The sudden outbreak of SARS-CoV-2 has rapidly grown into a global pandemic [2].

The SARS-CoV-2 infection is more likely to affect older individuals with comorbidities, and can result in severe and even fatal respiratory diseases [1]. According to a survey conducted by Chinese Centers for Disease Control and Prevention on 72314 cases, the majority (53.54%) of confirmed cases are aged ≥ 50 years-old [4]. The median age was 59 years, and about 56% of the patients were men [5]. Among the 1,023 deaths, the majority (81.04%) were among patients of ≥ 60 years of age, with the ≥ 80 age group had the highest case fatality rate (14.8%) of all age groups [4]. Numerous specialties and researchers make great efforts to investigate SARS-CoV-2 due to this emerging coronavirus has caused a global threat [1-5]. However, as far as we know, few studies have been conducted to analysis the current situation of scientific efforts on SARS-CoV-2 research at global level.

Publication as a critical method of knowledge sharing is a central part of scientific activity [6,7]. The research patterns, indexed by the quantity and quality of publications, have been widely analyzed to describe the worldwide researchers' efforts in multiple fields [6-12]. However, to the best of our knowledge, such global survey analysis has been seldom reported in the field of

SARS-CoV-2. The objective of this study was to analyze global SARS-CoV-2 -realted publications, and to provide a general view of current status of scientific efforts in the field of SARS-CoV-2.

Methodology

This study does not contain any studies with human participants or animals performed by any of the authors. Ethical approval was not needed. The database of Web of Science was selected in this study, because Web of Science was considered as the leading reliable database for academic assessment [9-11]. It had been widely accepted in similar studies [6-12]. A comprehensive literature search was performed in the database of Web of Science in April 20, 2020. A topic search was conducted to retrieve the SARS-CoV-2 research. The keywords included "SARS-CoV-2", "2019-nCoV", "COVID-19", "COVID19", "Corona Virus Disease-19", "Corona Virus Disease-2019", "2019 novel coronavirus", "Wuhan coronavirus", and "Wuhan seafood market pneumonia virus". The original articles and reviews were included in this study [6-12]. The affiliated country of the corresponding author was considered as the origin of the publication [6-12].

The primary outcome was the scientific output from different countries. The number of publications, citation, country, journal, study topic, and the correlations between the number of publications and total confirmed cases and total deaths were analyzed. The study topic included epidemiology, basic research, clinical characteristics, treatment, and so on. The data of total confirmed cases and total deaths on April 20, 2020 were collected from Coronavirus Disease 2019 Situation Report by World Health Organization (www.who.int). The number of publications was used as the indicator of the quantity of documents. The citation was used as the index of the quality of publications. The countries was classified into four categories in terms of Gross National Income per capita by the World Bank (www.worldbank.org), including

Figure 1. Worldwide distribution of SARS-CoV-2 publications.

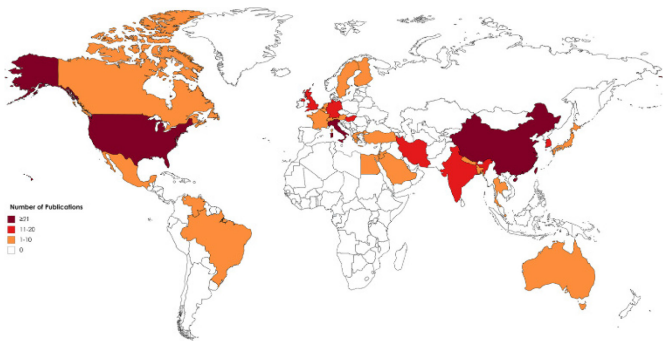
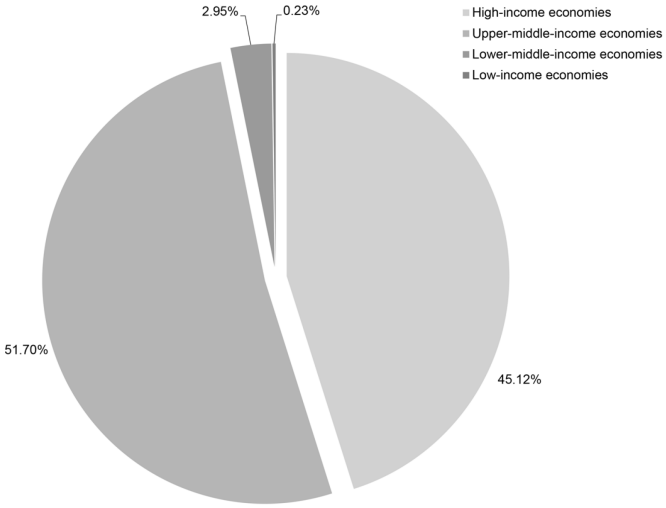


Figure 2. Scientific productivity on SARS-CoV-2 classified by economy status.



high-income, upper-middle-income, lower-middle-income, and low-income economies.

The countries contributing at least 1% of total publications worldwide were defined as the major prolific countries, and the journals publishing 1% or more of global publications were noted as the major popular journals. The three most prolific countries in the three most popular journals were extracted. The three most popular journals in the three most prolific countries were listed.

Statistical analyses were carried out for data analysis by SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). The Spearman's test was used to test the significance of the correlations between the variables. The $p < 0.05$ was considered to be statistically significant.

Results

A total of 441 publications on SARS-CoV-2 were identified. There were 34 countries producing these publications. The global scientific output on SARS-CoV-2 was illustrated in Figure 1, which indicated that East Asia, North America, and West Europe were the most active areas.

The contributions from different economies were depicted in Figure 2. The largest number of publications was from upper-middle-income economies producing for 51.70% of total publications, followed by high-income economies (45.12%), lower-middle-income economies (2.95%), and low-income economies (0.23%).

A total of 16 major prolific countries were listed in Table 1. These countries contributed 92.06% (406/441) of total publications.

Figure 3. Scatter plots indicating correlation of scientific productivity with total confirmed cases from different countries.

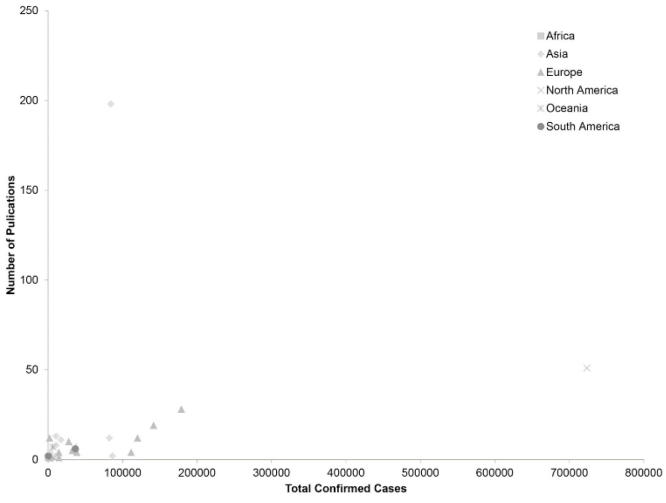


Figure 4. Scatter plots indicating correlation of scientific productivity with total deaths from different countries.

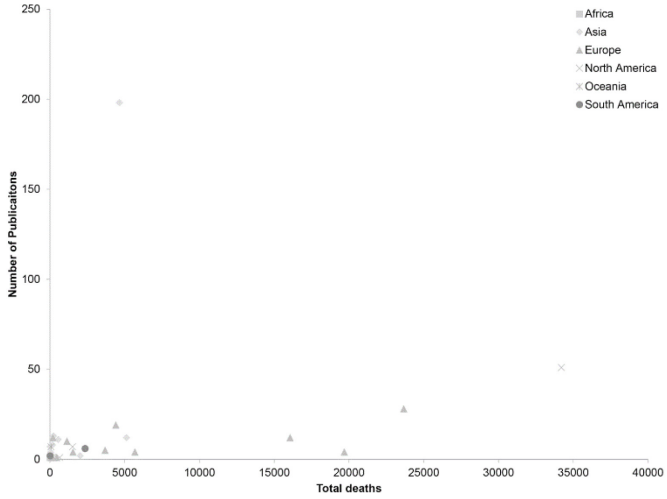


Table 1. The major prolific countries in the field of SARS-CoV-2.

Country	Number of publications	Percentage	Total confirmed cases	Total deaths	Number of total citations	Number of average citations
China	198	44.90%	84,237	4,642	1,947	9.83
USA	51	11.56%	723,605	34,203	204	4.00
Italy	28	6.35%	178,972	23,660	24	0.86
Germany	19	4.31%	141,672	4,404	54	2.84
South Korea	13	2.95%	10,674	236	40	3.08
Hungary	12	2.72%	1,984	199	2	0.17
Iran	12	2.72%	82,211	5,118	0	0.00
UK	12	2.72%	120,071	16,060	25	2.08
India	11	2.49%	17,265	543	7	0.64
Switzerland	10	2.27%	27,658	1,134	26	2.60
Japan	8	1.81%	10,751	171	11	1.38
Australia	7	1.59%	6,612	70	5	0.71
Canada	7	1.59%	33,909	1,506	38	5.43
Singapore	7	1.59%	6,588	11	11	1.57
Brazil	6	1.36%	36,599	2,347	2	0.33
Netherlands	5	1.13%	32,655	3,684	29	5.80

Table 2. The most popular journals in the field of SARS-CoV-2.

Journal	Number of publications	Percentage	Impact factor	Number of total citations	Number of average citations
Journal of Medical Virology	28	6.35%	2.049	125	4.46
Eurosurveillance	28	6.35%	7.421	100	3.57
Emerging Microbes & Infections	12	2.72%	6.212	52	4.33
Archives of Iranian Medicine	11	2.49%	1.141	0	0.00
International Journal of Biological Sciences	11	2.49%	4.067	11	1.00
Journal of Korean Medical Science	11	2.49%	1.716	37	3.36
Lancet	11	2.49%	59.100	904	82.18
Orvosi Hetilap	11	2.49%	0.564	0	0.00
Journal of Clinical Medicine	9	2.04%	5.688	33	3.67
Swiss Medical Weekly	7	1.59%	1.821	6	0.86

Twelve countries were classified as high-income economies; China, Iran, and Brazil were upper-middle-income countries; and India was lower-middle-income economy. China (198, 44.90%) ranked first according to the number of total publications, followed by USA (51, 11.56%), Italy (28, 6.35%), Germany (19, 4.31%), and South Korea (13, 2.95%).

In addition, publications from China received the highest total citations (1947), followed by USA (204), and Germany (54) (Table 1). China also had the highest average citations (9.83), followed by Netherlands (5.80), and Canada (5.43). The number of publications from different countries had significant correlations with their total confirmed cases ($r = 0.666$, $p = 0.000$, Figure 3) and total deaths ($r = 0.610$, $p = 0.000$, Figure 4).

The major popular journals in the field of SARS-CoV-2 are presented in Table 2. The top three popular journals in terms of the number of publications on SARS-CoV-2 were *Journal of Medical Virology* (28), *Eurosurveillance* (28), and *Emerging Microbes & Infections* (12). *Lancet* (904) led the total citations list, followed by *Journal of Medical Virology* (125), and *Eurosurveillance* (100). *Lancet* received the highest average citations (82.18), followed by *Journal of Medical Virology* (4.46), and *Emerging Microbes & Infections* (4.33).

The three most prolific countries in the three most preferred journals are shown in Table 3. China ranked first in two journals including *Journal of Medical Virology* and *Emerging Microbes & Infections* according to the number of publications. Germany contributed the most in the journal *Eurosurveillance.* Table 4 shows the top 3 popular journals in top 3 prolific countries. *Journal of Medical Virology* ranked first in all the three most popular journals including in China, USA, and Italy.

SARS-CoV-2 research involved multiple topics which were listed in Table 5. The most discussed topic was epidemiology (130), followed by basic research (75), and treatment (64). The epidemiology topic had the highest total citations (948), followed by clinical characteristics (644), and basic research (563). The clinical characteristics topic had the highest average citations (10.92), followed by basic research (7.51), and epidemiology (7.29).

Discussion

There is a current global outbreak of SARS-CoV-2 infection due to its strong transmission ability [1, 2]. It has become a mounting threat to public health and worldwide economy [2-4]. Increasing efforts from different countries have been made to investigate this novel coronavirus [13-18]. Many global survey analyses have been published to present the characteristics of research production in multiple fields [6-12]. However, there were few studies describing the current patterns of scientific efforts in the field of SARS-CoV-2.

In this study, we analyzed worldwide scientific production in SARS-CoV-2. The result showed that China had the highest research productivity in terms of the number of SARS-CoV-2 -related publications. Our study proves the leadership of China in the field of SARS-CoV-2 research. In addition, China also has the highest total citations and average citations. These results indicate that China have the greatest influence in the quantity and quality of SARS-CoV-2 research, which do not match those observed in other fields [6-12]. In general, USA makes the greatest contributions

Table 3. The three most prolific countries in the three most popular journals.

Rank	*Eurosurveillance*	Number of publications	*Journal of Medical Virology*	Number of publications	*Emerging Microbes & Infections*	Number of publications
1	Germany	5	China	18	China	11
2	Italy	4	Italy	5	Australia	1
3	China	3	USA	2	NA	NA

Table 4. The three most popular journals in the three most prolific countries.

Rank	China	Number of publications	USA	Number of publications	Italy	Number of publications
1	*Journal of Medical Virology*	18	*Journal of Medical Virology*	4	*Journal of Medical Virology*	5
2	*Emerging Microbes & Infections*	11	*Viruses-Basel*	4	*Eurosurveillance*	4
3	*International Journal of Biological Sciences*	11	*Proceedings of the National Academy of Sciences of The United States of America*	3	*Cancer Cytopathology*	2

Table 5. The topics on SARS-Cov-2.

Topics	Number of publications	Number of total citations	Number of average citations
Epidemiology	130	948	7.29
Basic research	75	563	7.51
Treatment	64	105	1.64
Clinical characteristics	59	644	10.92
General to SARS-Cov-2	30	87	2.90
Diagnosis	25	31	1.24
Radiology	24	66	2.75
Comorbidity	23	11	0.48
Others	11	4	0.36

in a large number of files [6-12]. However, USA ranks second in terms of the quantity of publications on SARS-CoV-2 research, which is far less than that from China.

There may be a number of explanations for these findings. First, our study demonstrated that there were positive correlations between the number of SARS-CoV-2 -related publications with the number of total confirmed cases and total deaths. That is to say, countries with more total confirmed cases and total deaths tend to product more SARS-CoV-2 - related publications. SARS-CoV-2 infection was originated from Wuhan in China. Therefore, Chinese researchers have the advantages in investigating the epidemiological, clinical characteristics and virology of this novel coronavirus pneumonia [1,2,4,5]. Second, China has increasing power in conducting basic and clinical research in recent years [6-12]. Chinese researchers have the capability to rapidly complete the SARS-CoV-2 -related research. Third, Chinese government has invest great efforts in controlling the pandemic and investigating the SARS-CoV-2 [2,4,5]. However, we should recognize that USA has the greatest power in science and technology, and the SARS-CoV-2 infection has rapidly developed in USA. Therefore, USA may exceed China in the quantity and quality of SARS-CoV-2 publications in the near future.

Our study showed that a total thirty-four countries produced all the publications on SARS-CoV-2. The first three countries including China, USA and Italy contributed more than 60% of total publications. These findings suggest that SARS-CoV-2 research is not widely distributed, and is centered in several countries. This may be associated with the distribution of SARS-CoV-2 cases.

The present study found that upper-middle-income economies produced the largest number of publications, which did not match those findings in other fields [6-12]. High-income economies usually rank first in scientific productivity due to the great research productivity [6-12]. However, it was not proved in the filed of SARS-CoV-2 research. The main possible explanation is that China, as an upper-middle-income economy, produced far more SARS-CoV-2 publications than other countries.

This study suggests that the researchers may have a tendency to submit their works to several journals. The most popular journals include *Eurosurveillance, Journal of Medical Virology,* and *Emerging Microbes & Infections*. This may demonstrate these journals have important influence in the field of SARS-CoV-2, and contribute great in the knowledge sharing of SARS-CoV-2 research. In addition, *Lancet* as one of the most popular journals has the highest total citations and average citations. This indicates that SARS-CoV-2 research published in *Lancet* not only have the large quantity, but also have the highest quality.

The present study has a number of limitations, which are similar to those identified form similar global surveys [6-12]. The database of Web of Science mainly includes English journals and high-impact journals with impact factors. Non-English journals and journals without impact factors may not be included in this study. However, in fact, no database could include all publications. The database of Web of Science is a reliable and large database for the academic analysis, and used in many similar publications [6-12]. This study is a survey of publications, so could not avoid the false positive and false negative results. Despite these limitations, this study still gives a worldwide insight of SARS-CoV-2 research.

Conclusions

Scientific efforts on SARS-CoV-2 are from worldwide researchers, with some countries having special contributions. China is the most prolific country on SARS-CoV-2 research, and has the highest quality of publications. The countries with large number of total confirmed cases and total deaths have a tendency to produce more publications in the field of SARS-CoV-2.

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ZJ and TW: study design, data analysis and interpretation, writing manuscript and coordination of entire study, ZJ, FD and YW: data collection and analysis, interpretation and revision of manuscript.

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