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Bibliometric Analysis of Global Scientific Research on COVID-19

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Abstract Since the outbreak of coronavirus disease 2019 (COVID-19), a large number of COVID-19-related reports have been published in journals or submitted to preprint platforms. In this study, we searched the COVID-19-related literature that has officially been published and included in the Web of Science (WOS) database or submitted to the four preprint platforms: bioRxiv, medRxiv, Preprints, and SSRN. Through using descriptive statistics data on the number of reports, author institution, country, and research categories, we analyze global trends in COVID-19 scientific research, including institution distribution and research hotspots. The results show that a large number of COVID-19-related reports have been produced; the United States has contributed the most published literature, followed by China. The United States has also published the most reports included in the WOS in the categories of non-pharmaceutical interventions, treatment, and vaccine-related reports, while China has published the most literature in the categories of clinical features and complications, virology and immunology, epidemiology, and detection and diagnosis. The publication countries are concentrated in Asia, North America, and Europe, while South America and Africa have less literature. In conclusion, many scientific research issues related to COVID-19 need to be further clarified, and COVID-19 research urgently needs global cooperation.

Keywords COVID-19; Bibliometric; Web of Science; Preprint

Introduction Since early in the 21st century, humans have suffered SARS (Severe Acute Respiratory Syndrome) and MERS—Middle East Respiratory Syndrome (MERS)—two epidemics caused by members of the coronavirus group. After each outbreak, a large number of related studies have been carried out by countries that are greatly affected. Some strong research as well as countries with a strong research tradition such as the United States, at the end of December 2019, a new coronavirus disease (COVID-19) broke out and spread rapidly around the world globally. On March 11, 2020, the World Health Organization announced that COVID-19 had caused a global pandemic. The...
outbreak of the COVID-19 pandemic has posed a huge challenge to global public health and has a profound impact on the economic and social operations of countries. Currently, the COVID-19 epidemic has caused more than 44 million infections in 218 countries worldwide, and more than 1,110,000 people have been killed. Since the outbreak of the COVID-19 pandemic, researchers around the world have carried out relevant research from many aspects such as virology and immunology, disease transmission and clinical processes, disease diagnosis and management, experimental therapy, and vaccine development.

Bibliometric analysis is an objective evaluation of the scientific research situation, which can quantitatively present the research hotspots, development trends, and key research institutions of relevant scientific research activities, and clarify research ideas for scientific researchers, and provide a reference for scientific research cooperation. The measurement of COVID-19-related literature as a whole is of great reference significance for understanding the current research status. This study comprehensively analyzes the literature published since the outbreak of COVID-19 based on the Web of Science (WOS) database and the four preprint platforms: bioRxiv (https://www.biorxiv.org/), medRxiv (https://www.medRxiv.org/), Preprints (https://www.preprints.org/), and SSRN (https://www.ssrn.org/). In particular, we examine in terms of the number of reports, institution, country distribution, and research categories to provide a reference for COVID-19-related scientific researchers and decision-makers.

Methods

Data Sources
A COVID-19-related literature search was conducted on October 14, 2020. The source of the literature was selected as the Science Citation Index Expanded database of the WOS (which is selected as the source for literature papers that has been officially published in journals) and four preprint platforms: bioRxiv, medRxiv, Preprints, and SSRN. The WOS literature data were retrieved by setting the corresponding subject terms, the literature type was limited to “article,” the search field was the title, and the specific search formula was: (TI = COVID-19 OR TI = “Coronavirus disease 2019” OR TI = COVID-19 OR TI = 2019-nCoV OR TI = nCov-2019 OR TI = “Severe acute respiratory syndrome coronavirus 2” OR TI = "Novel Coronavirus") AND "Article"[Publication Type]. The bioRxiv, medRxiv, Preprints, and SSRN
platform literature data were obtained through COVID-19-related reports published on the respective websites.

Within the literature included in the WOS, 20 reports that were not related to the subject (mainly the literature related to the search term “Novel Coronavirus” before 2020) and 353 duplicated reports were excluded, finally yielding 12,021 reports; from the literature obtained from the bioRxiv platform, we excluded four reports that were irrelevant to the COVID-19 pandemic, and finally, 2040 reports were obtained; from the literature obtained from the medRxiv platform, we excluded six reports that were not unrelated to the COVID-19 pandemic, and finally, 7555 reports were obtained; 1046 reports were obtained from the Preprints platform; and 2028 reports were obtained from the SSRN.

Statistical Analysis

According to the search results, statistical analysis was performed in terms of the number of reports, author institution, country, and research category.

The author’s institution and country were selected as the institution and country information from the first author (where the first author had multiple institutions, we selected the first). As in the literature included in the WOS database, the Chinese literature contains the literature of Hong Kong and Macao, while it does not contain that of Taiwan of China, and the literature from the United Kingdom is divided into the literature of England, Scotland, and Wales. In the literature submitted on the preprint platforms, the UK literature includes the literature of England, Scotland, and Wales, while the Chinese literature does not include that of Hong Kong and Macao. Hence, in this study, for the convenience of unified comparison purposes, the Chinese literature includes the literature of Hong Kong and Macao but excludes that of Taiwan of China, while the UK literature includes the literature of England, Scotland, and Wales.

The publication time of WOS reports was selected as the official publication time, and the time for the reports on the preprint platforms was selected as the time when the preprint version was published. Journal impact factors were queried from the 2020 InCites Journal Citation Reports.

In order to further understand the current hotspots and trends of COVID-19 research, we referred to the classification from the WHO database of COVID-19 literature and divided all the literature into the following 10 categories according to the research content: epidemiology (research on...
COVID-19 epidemiological characteristics and development of predictive models), non-pharmaceutical interventions (research on COVID-19 epidemic prevention and nosocomial infection control), treatment (research on COVID-19 drug development and clinical treatment plans, etc.), vaccines (COVID-19 research related to vaccine development), clinical characteristics and complications (research on COVID-19 clinical and imaging manifestations and complications), detection and diagnosis (COVID-19 detection markers and clinical diagnosis, etc.), virology and immunology (SARS-CoV-2 virology and immunology basic research and virus traceability research), transmission (research on COVID-19 transmission route), psychology (COVID-19 related psychology-related research in the COVID-19 field), and other research (COVID-19 disease review, case reports, social impact, and social science research, etc.).

Results

Number of COVID-19 reports

As of October 15, 2020, the WOS database included a total of 12,021 reports related to COVID-19. For preprints, 2040 reports had been submitted to the bioRxiv platform, the first of which was submitted by Xiamen University on January 19, 2020; 7555 reports had been submitted to the medRxiv platform, the first of which was submitted by Lancaster University on January 23, 2020; 1046 reports had been submitted to the Preprints platform, the first of which was submitted by Shenzhen University on January 30, 2020; and 2028 reports had been submitted to the SSRN platform, the first of which was submitted by Boston Children’s Hospital on January 24, 2020. In the first five months (2020-01 through 2020-05), the total number of papers submitted to the four preprint platforms monthly is more than the number of reports included in the WOS monthly. Starting from June 2020, the number of papers submitted to the four preprint platforms continues to exceed the amount submitted to the WOS or submitted to these preprint platforms tends to be flat (Fig. 1; Supplementary Table 1).
Fig. 1  Monthly publications on COVID-19.

*As the data on publications in October include only the period from October 1 to October 14, this figure does not present literature included in the WOS or submitted as preprints in October.

Country and institution distribution of COVID-19 literature

According to the first author information of the relevant literature, more than 5000 institutions in 173 countries or regions have invested in COVID-19 research. The leading countries in the literature included in the WOS include the United States (2561 reports, 21.3%), China (2483 reports, 20.7%), Italy (1138 reports, 9.5%), the United Kingdom (596 reports, 5.0%), and India (484 reports, 4.0%). The leading countries in the literature submitted to bioRxiv include the United States (732 reports, 35.9%), China (294 reports, 14.4%), India (141 reports, 6.9%), the United Kingdom (106 reports, 5.2%), and Germany (95 reports, 4.7%). The leading countries in the literature submitted to medRxiv include the United States (2007 reports, 26.6%), China (986 reports, 13.1%), the United Kingdom (862 reports, 11.4%), India (430 reports, 5.7%), and Germany (259 reports, 3.4%). The leading countries in the literature submitted to Preprints include the United States (156 reports, 14.9%), India (143 reports, 13.7%), China (89 reports, 8.5%), Italy (67 reports, 6.4%), and the United Kingdom (48 reports, 4.6%). The leading countries in the literature submitted to the SSRN include China (649 reports, 32.0%), the United States (362 reports, 17.9%), India (148 reports, 7.3%), the United Kingdom (137 reports, 6.8%), and Italy.
The country that has published the most reports included by in the WOS monthly within the first six months (2020-01-01 through 2020-06-30) of 2020 is China. Since July 2020, the U.S. monthly literature included by in the WOS has surpassed that of China’s. At present, the monthly literature from the above five countries included by in the WOS shows a slow downward trend (Fig. 2; Supplementary Table 2).

![Month in 2020 vs. Number of Publications](image)

**Fig. 2** Monthly publications on COVID-19 included by in the WOS by the main countries.

* The publications of China include Hong Kong and Macau but not Taiwan of China.

** The publications of the United Kingdom include England, Scotland, and Wales.

*** As the data on publications in October include only the period from October 1 to October 14, this figure does not present the literature included in the WOS or submitted as preprints in October.
| Ranking | Number of Publications |
|---------|-----------------------|
|         | WOS       | Percent | bioRxiv | Percent | medRxiv | Percent | Preprints | Percent | SSRN | Percent |
| 1       | United States (n = 2561) | 21.3% | United States (n = 732) | 35.9% | United States (n = 2007) | 26.6% | United States (n = 156) | 14.9% | China (n = 649) | 32.0% |
| 2       | China (n = 2483) | 20.7% | China (n = 294) | 14.4% | China (n = 986) | 13.1% | India (n = 143) | 13.7% | United States (n = 362) | 17.9% |
| 3       | Italy (n = 1138) | 9.5% | India (n = 141) | 6.9% | United Kingdom (n = 862) | 11.4% | China (n = 89) | 8.5% | India (n = 148) | 7.3% |
| 4       | United Kingdom (n = 596) | 5.0% | United Kingdom (n = 106) | 5.2% | India (n = 430) | 5.7% | Italy (n = 67) | 6.4% | United Kingdom (n = 137) | 6.8% |
| 5       | India (n = 484) | 4.0% | Germany (n = 95) | 4.7% | Germany (n = 259) | 3.4% | United Kingdom (n = 48) | 4.6% | Italy (n = 99) | 4.9% |
| 6       | Germany (n = 420) | 3.5% | France (n = 57) | 2.8% | Italy (n = 257) | 3.4% | Bangladesh (n = 41) | 3.9% | Germany (n = 50) | 2.5% |
| 7       | France (n = 399) | 3.3% | Canada (n = 56) | 2.7% | Brazil (n = 237) | 3.1% | Brazil (n = 40) | 3.8% | Spain (n = 45) | 2.2% |
| 8       | Spain (n = 369) | 3.1% | Italy (n = 55) | 2.7% | France (n = 226) | 3.0% | Iran (n = 24) | 2.3% | France (n = 44) | 2.2% |

Table 1  The top 10 countries of research on COVID-19.
|   | Canada (n = 250) | 2.1% | Japan (n = 42) | 2.1% | Spain (n = 204) | 2.7% | Spain (n = 22) | 2.1% | Canada (n = 39) | 1.9% |
|---|-----------------|------|---------------|------|----------------|------|---------------|------|----------------|------|
| 9 | Brazil (n = 249) | 2.1% | Brazil (n = 38) | 1.9% | Canada (n = 159) | 2.1% | Germany (n = 21) | 2.0% | Brazil (n = 37) | 1.8% |

* The publications of China include Hong Kong and Macau but not Taiwan of China.

* The publications of the United Kingdom UK include England, Scotland, and Wales.
The main institutions from which published COVID-19 literature has been indexed by the WOS include Huazhong University of Science and Technology (n = 300), Wuhan University (n = 170), Fudan University (n = 80), Columbia University (n = 66), and Zhejiang University (n = 66); the main institutions that have submitted literature to the bioRxiv platform include the University of Oxford (n = 20), Chinese Academy of Medical Sciences (n = 18), Washington University (n = 18), Stanford University (n = 63), and Fudan University (n = 16); the main institutions that have submitted literature to the medRxiv platform include the University of Oxford (n = 83), Imperial College London (n = 72), Huazhong University of Science and Technology (n = 67), Stanford University (n = 63), and University College London (n = 62); the main institutions that have submitted literature to the Preprints platform include the University of Dhaka (n = 9), The Bhawanipur Education Society College (n = 6), the University of Sao Paulo (n = 6), the University of Catania (n = 6), and the All India Institutes of Medical Sciences (n = 5); and the main institutions that have submitted literature to the SSRN platform include Huazhong University of Science and Technology (n = 103), Wuhan University (n = 52), Shanghai Jiaotong University (n = 19), Fudan University (n = 18), and Fujian Medical University (n = 18) (Table 2).
| Ranking | Number of Publications | Ranking | Number of Publications |
|---------|------------------------|---------|------------------------|
| 1       | Huazhong Univ Sci & Technol 300 | 1       | Univ Oxford 20 |
|         | Wuhan Univ 170 | 2       | Chinese Acad Med Sci 18 |
|         | Fudan Univ 80 | 3       | Washington Univ 18 |
|         | Columbia Univ 66 | 4       | Stanford Univ 17 |
|         | Zhejiang Univ 66 | 5       | Fudan Univ 16 |
|         | US CDC 60 | 6       | Univ Calif San Diego 16 |
|         | Cent South Univ 59 | 7       | Yale Univ 16 |
|         | Icahn Sch Med Mt Sinai 59 | 8       | Columbia Univ 15 |
|         | Shanghai Jiao Tong Univ 57 | 9       | Chinese Acad Sci 14 |
|         | Univ Hong Kong 57 | 10      | Massachusetts Institute of Technology 14 |
|         | Huazhong Univ Sci & Technol 9 | 1       | Univ Dhaka 83 |
|         | Chinese Acad Med Sci 72 | 2       | Imperial Coll London |
|         | Stanford Univ 63 | 3       | Stanford Univ 62 |
|         | All India Inst Med Sci 58 | 4       | London Sch Hyg & Trop Med 58 |
|         | Huazhong Univ Sci & Technol 56 | 5       | Univ Bologna 56 |
|         | Columbia Univ 54 | 6       | Fudan Univ 54 |
|         | Icahn Sch Med Mt Sinai 51 | 7       | Amity Univ 4 |
|         | CSIR-Indian Institute of Chemical Biology 4 | 8       | Massachusetts Institute of Technology 4 |
|         | Massachusetts Institute of Technology 13 | 9       | Massachusetts Institute of Technology 13 |
|         | Massachusetts Institute of Technology 13 | 10      | Massachusetts Institute of Technology 13 |
The main journals of published COVID-19 literature

The 12,021 reports included in the WOS were published in 2076 journals. As shown in Table 3, the main journals of published COVID-19 literature include the *International Journal of Environmental Research and Public Health* (n = 283), *Journal of Medical Virology* (n = 261), *PLOS One* (n = 182), *International Journal of Infectious Diseases* (n = 154), and *Journal of Biomolecular Structure & Dynamics* (n = 142).

| Ranking | Journal                        | Number | Journal Impact Factor (2019) |
|---------|--------------------------------|--------|-----------------------------|
| 1       | Int J Env Res Pub He           | 283    | 2.8                         |
| 2       | J Med Virol                    | 261    | 2.0                         |
| 3       | PLOS One                       | 182    | 2.7                         |
| 4       | Int J Infect Dis               | 154    | 3.2                         |
| 5       | J Biomol Struct Dyn            | 142    | 3.3                         |
| 6       | Sci Total Environ              | 133    | 6.6                         |
| 7       | J Chem Educ                    | 89     | 1.4                         |
| 8       | Front Med-Lausanne             | 85     | 3.9                         |
| 9       | Mmwr-Morbid Mortal W           | 82     | 13.6                        |
| 10      | Head Neck-J Sci Spec           | 79     | 2.5                         |
| 11      | Front Public Health            | 78     | 2.5                         |
| 12      | Eurosurveillance               | 74     | 6.5                         |
| 13      | J Clin Virol                   | 73     | 2.8                         |
| 14      | Sustainability                 | 72     | 2.6                         |
| 15      | Epidemiol Infect               | 69     | 2.2                         |

A total of 170 articles were published in the *Lancet*, the *New England Journal of Medicine*, *Nature*, *Science*, and *Cell*, including 32 in the *Lancet*, 23 in the *New England Journal of Medicine*, 37 in *Nature*, 47 in *Science*, and 31 in *Cell*. The most published country is the United States (n = 63), followed by China (n = 53) articles; other countries with articles in these journals include the United Kingdom (n = 14), Germany (n = 13), and France (n = 4). Institutions from the United States, China, the United Kingdom, Germany, and France have published 241 articles, accounting for 86.4% (Table 4).
Table 4  National distribution of publications on COVID-19 in The Lancet, the New England Journal of Medicine, Nature, Science, and Cell

| Country          | Number of Publications |
|------------------|------------------------|
|                  | Lancet | N Engl J Med | Nature | Science | Cell | Total |
| United States    | 6      | 16           | 11     | 18      | 12   | 63    |
| China*           | 12     | 4            | 13     | 12      | 12   | 53    |
| United Kingdom** | 4      | 3            | 7      |         |      | 14    |
| Germany          | 1      | 1            | 4      | 4       | 3    | 13    |
| France           | 1      | 2            | 1      | 1       |      | 4     |
| Italy            | 2      | 1            | 1      |         |      | 4     |
| Switzerland      | 2      | 2            |         |         |      | 4     |
| Netherlands      |         | 3            |         |         |      | 3     |
| Singapore        | 1      | 1            |         |         |      | 2     |
| Spain            | 2      | 1            | 1      | 1       | 3    | 8     |
| Others           | 2      | 1            | 1      | 1       |      | 5     |
| Total            | 32     | 23           | 37     | 47      | 31   | 170   |

* The publications of China include Hong Kong and Macau but not include Taiwan of China.

** The publications of the United Kingdom UK include England, Scotland, and Wales.

**Literature research category**

Literature based on clinical features and complications is the most commonly included in the WOS (n = 1889); literature based on virology and immunology is the most submitted to bioRxiv (n = 1243); literature based on epidemiology is the most submitted to medRxiv (n = 1956); literature based on virology and immunology is the most submitted to SSRN (n = 209); and literature based on epidemiology is the most submitted to SSRN (n = 456) (Table 5).

Table 5  Research categories of publications on COVID-19
As for the national distribution of research categories, the United States and China publish the most in each category of literature included in the WOS; the U.S. institutions publish the most in the categories of non-pharmaceutical interventions (n = 359), treatment (n = 239), and vaccine-related reports (n = 32); and whereas Chinese institutions publish the most in the categories of clinical features and complications (n = 638), virology and immunology (n = 263), epidemiology (n = 286), detection and diagnosis (n = 257), psychology (n = 138), and transmission (n = 101) (Figure 3, Supplementary Table 3).

*The publications of China include Hong Kong and Macau but not Taiwan of China.

Commented [A4]: In Fig. 3, I would prefer using the United States and the United Kingdom instead of USA and UK.
** The publications of the United Kingdom include England, Scotland, and Wales.

***In this figure, other research (COVID-19 disease review, case reports, social impact, and social science research, etc.) is not presented.

Discussion

This article study comprehensively analyzes the COVID-19-related literature based on the WOS database and four preprint platforms (bioRxiv, medRxiv, Preprints, and SSRN), which intuitively present the global COVID-19 research in terms of the number of reports, distribution of countries, institutions, and research topics.

A large number of COVID-19-related reports have been produced, with the U.S. and Chinese institutions having the highest literature output.

As of October 14, 2020, there were 12,021 COVID-19-related reports included in the WOS database, and 12,669 articles (some of which have been officially published and included in the WOS) were submitted to the bioRxiv, medRxiv, Preprints, and SSRN platforms. In January 2020, the reports included in the WOS or submitted to the above four preprint platforms each month numbered in the dozens; the reports each month in February exceeded 100, and by March there were nearly 1000 each month. After since June, the number of reports monthly was nearly 4000. From since August 2020, the total monthly number of reports included in the WOS and submitted to the four preprint platforms has been decreasing. However, with regard to the literature included in the WOS, the newly published studies may take some time to get included in the WOS, which may cause a statistical lag. Hence, the trend of literature publication needs to be further observed.

The U.S. and Chinese institutions have the highest literature output. In terms of the distribution of documents, institutions that publish literature are concentrated in countries such as the United States, China, the United Kingdom, and Italy. Institutions from China and the United States publish the most reports. In the early months of the outbreak, Chinese institutions maintained the world’s highest monthly publication rate. As the country was the most affected by the initial outbreak of the pandemic, institutions from China contributed many reports to the COVID-19 research effort and played an important role in the epidemic response. As of October 14, 2020, 20.7% of the reports submitted to the WOS were from China, and 32.0% of the reports
submitted to the SSRN platform were from China. Moreover, Huazhong University of Science and Technology contributed the most reports included in the WOS and submitted to the SSRN platform. Since July 2020, the monthly literature of U.S. institutions has surpassed that of China's. As of now, the proportion of reports included by U.S. institutions has reached 21.3%; the proportion of U.S. institutions published in leading journals such as *The Lancet* is up to 37.1%; and the majority of reports submitted to the bioRxiv platform come from U.S. institutions, accounting for 35.9%.

Diversified research categories and different focus on key countries. Since the outbreak of the COVID-19 epidemic, researchers worldwide have responded quickly and published many reports in a short period. So far, COVID-19-related research has involved non-pharmaceutical interventions, epidemiology, clinical characteristics, treatment, detection and diagnosis, virology and immunology, disease transmission, vaccines, and other categories. Additionally, there are some psychological studies related to science were published, which were devoted to studying the psychological status of the public and medical staff during the epidemic. In terms of the total number of articles, the leading categories are non-pharmaceutical interventions, treatment, and clinical features and complications. Currently, relatively few vaccine-related reports. Only 127 of the reports included in the WOS are vaccine-related, accounting for only 1%, which may be related to the relatively long time required for vaccine development. In terms of country distribution, some key countries have different focuses. Compared to other countries, U.S. has published more reports based on the non-pharmaceutical interventions, treatment, and vaccine-related report categories, whereas Chinese institutions are clinical features and complications, virology and immunology, epidemiology, detection and diagnosis, and psychology categories.

Preprint platforms have played an important role in COVID-19-related science research.

In terms of monthly publications, much of the literature has been submitted to the preprint platform in the previous period. Within five months of the publication of the first report, the total number of reports submitted to the four preprint platforms each month was greater than the literature included by.
in the WOS. In terms of the total number of articles, as of now, the number of reports submitted to the four preprint platforms continues to exceed the reports included in the WOS. In response to the Ebola and Zika outbreaks, the proportion of submitted fewer than 5% of articles were submitted to the preprint platforms, of the total number was less than 5%. In recent years, the preprint platforms have attracted increasing more and more attention from researchers because of their fast and free open-source release. Since the establishment of the first physics preprint platform arXiv in 1991, there have been dozens of preprint platforms involved in various fields, including the medRxiv and bioRxiv platforms in the biomedical field and the Chemrxiv platform in the chemical field. In 2017, Science ranked the preprint platform among the top 10 scientific and technological advances of that year. As it matures, the preprint platform is considered to have great potential for accelerating the spread of scientific discoveries, disseminating information in emergencies, and supporting infectious disease outbreak response; the preprint platform is also considered to be helpful for scientific and technological exchanges. However, recent studies have pointed out that in the COVID-19 epidemic response, the preprint platform has played an important role while also revealing its weaknesses; the articles submitted to preprint platforms have not been peer-reviewed by experts, and the paper quality of the article is worrying. For example, a paper from an Indian research team submitted to bioRxiv in February suggested that the new coronavirus may contain HIV inserts, and many people speculated that the new coronavirus may be a product of artificial modification based on it. The research team subsequently admitted that the research data were incorrect and retracted the article. Therefore, the prospects for preprints and how to effectively use preprint literature in scientific research and emergency response to infectious diseases are matters worth discussing.

Because many COVID-19-related scientific research issues remain unclear, the fight against the pandemic urgently requires the cooperation of scientific researchers all over the world. From a global perspective, COVID-19 has spread to 218 countries and regions across the world and brought unprecedented challenges to the global public health systems. Although the epidemic situation in Asia, such as China, Japan, and South Korea, has tended to be flattened by their effective prevention and control measures, the situations in Europe, North America, and other countries are still grim, and those in Africa and South America are not yet optimized. Many related scientific research issues such as the natural origin, capacity, and means of transmission,...
the vaccine for COVID-19, and effective treatment of COVID-19 remain unclear. There are also large differences in economic and social conditions, medical resource reserves, and the ability to respond to public health security incidents in various countries. There are great variables in where the COVID-19 epidemic will eventually go. Kissler et al. believed that the epidemic may not end in one or two years. Without effective treatment and vaccines, the strategy based on close contact tracking and effective isolation can reduce the incidence of SARS-CoV-2, but the long-term development of the epidemic would have a huge impact on the medical systems of various countries and the economies of various countries. To a certain extent, the publication of literature represents the corresponding scientific and technological level and reflects the global regional biomedical technology gap at the global and regional scale. As for the total number of reports, the United States, China, Italy, and the United Kingdom contribute nearly 60% of the reports included by the WOS and nearly 80% of the reports published in the top journals. There is relatively more literature from Asia, Europe, and North America, and few studies from Africa and South America. Therefore, in the context of global interconnection, there is an urgent need for the cooperation of governments and scientific researchers from all over the world to jointly fight the epidemic.

With continuous changes in the epidemic situation in various countries, such as the expected release of more vaccine-related research results, the trend of literature data growth and the research priorities of various countries may change. A limitation is that the source of the literature data for this research may not cover local journals published in languages other than English in various countries, even though they have played an important role in the local outbreak response.

Conflict of Interest: The authors declare that they have no conflict of interest.
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## Supplementary Tables:

### Table 1 Monthly publications on COVID-19

| Month in 2020 | WOS  | BioRxiv | MedRxiv | Preprints | SSRN |
|--------------|------|---------|---------|-----------|------|
| Jan          | 14   | 30      | 7       | 1         | 4    |
| Feb          | 64   | 63      | 221     | 36        | 70   |
| Mar          | 190  | 146     | 571     | 96        | 232  |
| Apr          | 652  | 288     | 1182    | 231       | 253  |
| May          | 1434 | 336     | 1628    | 205       | 273  |
| Jun          | 2022 | 356     | 1126    | 136       | 327  |
| Jul          | 2492 | 280     | 943     | 120       | 330  |
| Aug          | 2512 | 243     | 727     | 106       | 227  |
| Sep          | 2220 | 209     | 840     | 97        | 153  |
| Oct*         | 421  | 89      | 310     | 18        | 159  |
| Total        | 12021| 2040    | 7555    | 1046      | 2028 |

* The publications in October include only from October 1st to October 14th.

### Table 2 Monthly publications on COVID-19 included in the WOS by the main countries.

| Month in 2020 | USA United States | China | Italy | United Kingdom | India | Others |
|--------------|-------------------|-------|-------|----------------|-------|--------|
| Jan          | 2                 | 3     | 1     | 1              | 1     | 8      |
| Feb          | 6                 | 30    | 5     | 3              | 1     | 19     |
| Mar          | 22                | 91    | 9     | 1              | 3     | 64     |
| Apr          | 112               | 211   | 67    | 21             | 21    | 220    |
| May          | 278               | 338   | 166   | 68             | 58    | 526    |
| Jun          | 387               | 439   | 203   | 82             | 74    | 837    |
| Jul          | 541               | 498   | 225   | 135            | 113   | 980    |
| Aug          | 552               | 434   | 249   | 131            | 105   | 1041   |
| Sep          | 569               | 365   | 176   | 125            | 88    | 897    |
| Oct*         | 92                | 74    | 37    | 30             | 21    | 167    |
| Total        | 2561              | 2483  | 1138  | 596            | 484   | 4759   |

* The publications in October include only from October 1st to October 14th.
Table 3: Research Categories on COVID-19 included in the WOS by the main countries

| Research Category                  | Number of Publications |
|-----------------------------------|------------------------|
|                                   | USA | China | Italy | UK | India | Others | Total |
| Clinical Features and Complications | 364 | 638   | 207   | 73 | 27    | 580    | 1889  |
| Non-pharmaceutical Interventions  | 359 | 255   | 141   | 128| 66    | 715    | 1664  |
| Treatment                         | 239 | 215   | 122   | 60 | 91    | 499    | 1226  |
| Virology and Immunology           | 240 | 263   | 96    | 31 | 82    | 430    | 1142  |
| Epidemiology                      | 184 | 286   | 98    | 47 | 32    | 416    | 1063  |
| Detection and Diagnosis           | 167 | 257   | 92    | 32 | 32    | 373    | 953   |
| Psychology                        | 66  | 138   | 39    | 15 | 18    | 225    | 501   |
| Transmission                      | 46  | 101   | 25    | 21 | 12    | 159    | 364   |
| Vaccine Related                   | 32  | 18    | 5     | 5  | 16    | 51     | 127   |
| Other Research                    | 864 | 312   | 313   | 184| 108   | 1311   | 3092  |
| Total                             | 2561| 2483  | 856   | 596| 484   | 4759   | 1202  |

Conflicts of interest
The authors declare no conflict of interest.

**Panpan Wang:** Data collection and analysis, Writing- Original draft preparation, Discussion

**Deqiao Tian:** Methodology, Writing- Reviewing and Editing,
Discussion