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A Bibliometric Analysis of Early COVID-19 Research

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Abstract

COVID-19 breakout calls for immediate research explorations. Exploring early publications on Coronavirus renders the immediate reaction of scholars and journals to the extemporary shocks the scholarly community and the whole world has faced. The objective of this study is to perform a bibliometric analysis of all COVID-19-related publications in Science Citation Index Expanded (SCI-EXPANDED) in the early stage of the outbreak. The figures of early publications are collated to the total scholarship on Covid-19 to date. The assessment of early publications allows for more detailed examinations of the material characteristics and dynamics with respect to to-date publications. Analysis parameters include performances of authors, institutes, and countries as well as distributions of Web of Science categories, journals, languages, and types of publications. Results show that 32% of total papers were published as editorial materials and an overwhelming production from Chinese research institutes. An association of research indexes with the number of cases was also found.

Keywords: COVID-19, SARS-CoV-2, Coronavirus, Bibliometrics, Early publications, Outbreak,

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Pandemic, Web of Science Core Collection, WoS.

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1. INTRODUCTION

In 1968, virologists found a new group of viruses called coronaviruses (Almeida et al., 1968). Almeida et al. pointed out that solar corona, with negative staining, is shared by mouse hepatitis virus and several viruses and is recently recovered from humans. Infectious diseases have always been a threat and seriously affected to humans and the most vulnerable categories in human societies (Agovino et al., 2018). That is the case of the Ebola virus (Emond et al., 1977) in the 1980s (Breman et al., 1999), the severe acute respiratory syndrome (SARS) in 2003 (Ksiazek et al., 2003), the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in 2013 (Assiri et al., 2013), the Zika virus (Dick et al., 1952) in 2015 (Mlakar et al., 2016), and presently COVID-19 in 2019 (Zhu et al. 2020; Gatto et al., 2020; Huang et al., 2020).

The mentioned publications exploited diverse databases. These were: Science Citation Index (SCI); Scopus; Medline (using GoPubMed); Science Citation Index Expanded (Sci-Expanded); PubMed; Google Scholar; the World Intellectual Property Organization (WIPO) database; Brazilian Patent and Trademark Office (INPI); Questel Intellectual Property Business Intelligence (Orbit software); European Patent Office (EPO); PubMed database of the National Center for Biotechnology Information (NCBI); WHO database; and WHO database on COVID-19.

The 2019 novel coronavirus – a novel βcoronavirus – was first discovered in December 2019 in Wuhan, China named 2019-nCoV (Huang et al., 2020; Cohen, 2020). The World Health Organization (WHO) officially named the new disease as COVID-19 (Cohen and Kupferschmidt, 2020) on 11 February 2020. COVID-19 rapidly spread and seriously affected life in the world since its outbreak in Wuhan, undermining production and economic systems globally as well as people's lives.

Bibliometric studies of Ebola virus (Cruz-Calderon et al., 2015; Pouris and Ho, 2016; Garg and Kumar, 2017), severe acute respiratory syndrome (SARS) (Chiu et al., 2004; Bonilla-Aldana et al., 2020), Middle East Respiratory Syndrome Coronavirus (MERS-CoV) (Zyoud, 2016; Bonilla-Aldana et al., 2020), Zika virus (Martinez-Pulgarin et al., 2016; Albuquerque et al., 2017), and

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COVID-19 (Chahrour et al., 2020) were precedingly reported by different databases and views. In addition, publication patterns of the severe acute respiratory syndrome (SARS) research at the beginning of the outbreak (Chiu et al., 2004) were also presented.

The terms “novel coronavirus 2019”, “coronavirus 2019”, “COVID 2019”, and “COVID 19” were used to search publications in PubMed for bibliometric analysis of COVID-19 research activity (Chahrour et al., 2020). In ‘Coronavirus disease 2019: A bibliometric analysis and review’ (Lou et al., 2020), authors used pneumonia, 2019-nCoV, COVID-19, Corona Virus Disease 2019, Novel Coronavirus Pneumonia, NCP, 2019 novel coronavirus, SARS-CoV-2, 2019 Novel Coronavirus Diseases, and novel coronavirus as well as Wuhan as searching keywords.

This study proposes to map the global early research efforts related to COVID-19 pandemic put forward from the international research community. This work opted for a detailed analysis of those scientific contributions to provide a detailed mapping of publications determinants. **Table 1** sketches early vs to-date publications on Coronavirus. As one can easily see, the early publication response by authors and journals has been important. However, the publications’ figures on COVID-19 have sharply increased to date. As sketched in **Table 1**, it would have not been possible the same analyses performed in this paper for such a large array of publications. For this reason, this study aims to capture a specific moment of the outbreak to depict the efforts paid by the international scientific community on COVID-19 research, rendering a comprehensive mapping of the early publications time-frame. Further works analyzed the issue but did not take into account specific variables, signaling the research novelty of the present study. For this scope, this paper addresses existing research trends, investigating publication performances in the first four months of COVID-19 outbreak.

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Table 1 - Early publications figures vs publications to date

	Enquiry Date	Results
Early publications	April 30, 2020	1,660 publications
Publications to date	December 21, 2020	50,545 publications

Source: SCI-EXPANDED, 2020

The results presented in **Table 1** are insightful also in terms of validation of this study's results: the additional analysis manages to corroborate the underlying theoretical framework, methodological assumptions and decisions, working as a robustness test.

The paper is structured in this way: **section 1** examined the framework of COVID-19, describing the main features and exploring related literature and highlighting the importance of early publications mapping as compared to to-date publications on Coronavirus. **section 2** explains the methodology used in this piece of research – i.e. the bibliometrics and the specific parameters analyzed. Following, in **section 3**, the results achieved are explored, providing detailed information on the publications charcteristics. A discussion of the outputs of this study is provided. **Section 4** concludes.

2. METHODOLOGY

In terms of methodology and research design, the paper made use of bibliometrics, exploring the Clarivate Analytics Web of Science Core Collection. The utility of bibliometrics in capturing complex phenomena, outbreaks and broadly science mapping has been largely investigated in past scholarship (Gatto and Drago, 2020; Aria and Cuccurullo, 2017). Bibliometrics is deemed a worthy technique to disentangle scattered information and research and presents profitable opportunities for hot bottom issues such as the COVID-19 pandemic (Gatto et al., 2020).

The data used in this study were retrieved from the Clarivate Analytics Web of Science, the online

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version of the SCI-EXPANDED on April 30, 2020. The database was searched under the keywords included in **Table 2**.

Table 2. Searching keywords used.

Searching keywords
"COVID-19"
"COVID-2019"
"2019-nCoV"
"2019 novel coronavirus"
"COVID19"
"COVID2019"
"COVD-19"
"SARS CoV-2"
"corona virus disease 2019"
"coronavirus disease 2019"
"2019 novel coronavirus disease"
"novel coronavirus disease-19"
"severe acute respiratory syndrome coronavirus 2"
"novel coronavirus 2019"
"novel coronavirus infection" and (2019 or 2020)
("acute coronary syndromes" and "December" and "2019") not ("December 2004" or "2019 Elsevier Masson SAS" or "2019 published by Elsevier Ltd" or "2019 published by Elsevier B.V." or "2019 Elsevier Inc" or "2019 IMSS")
("acute coronary syndrome" and "December" and "2019") not ("December 31, 2010" or "2019 Elsevier B.V." or "2019 Elsevier Inc" or "2019 published by Elsevier B.V." or "2019 IMSS")
("coronavirus" and "December" and "2019") not ("December 2016" or "June 2019")

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("corona virus" and "December" and "2019")

("novel coronavirus" and 2019) not ("January of 2019" or "2019 published by Elsevier B.V.")

In terms of topics (title, abstract, author keywords, and *KeyWords Plus*), we investigated the database from January 1, 2019 until the update of April 30, 2020. In total, 1,660 documents were searched out. Then, we checked the search results to make sure that all entries were related to the COVID-19 topic. For this reason, documents such as 'Middle East respiratory syndrome' (Memish et al., 2020); 'Finding equipoise: CEPI revises its equitable access policy' (Huneycutt et al., 2020); 'Biochemical and structural insights into the mechanisms of SARS coronavirus RNA Ribose 2'-O-methylation by nsp16/nsp10 protein complex' (Chen et al., 2011); and 'SARS-CoV: 2. Modeling SARS epidemic' (Flahault, 2003) were excluded.

Lastly, 1,656 documents were selected as COVID-19 publications. These records were downloaded into spreadsheet software, and additional coding was manually performed using Microsoft Excel 2016 for calculation (Li and Ho, 2008; Ho and Fu, 2016). Affiliations originating from England, Scotland, Northern Ireland, and Wales were reclassified as from the UK (United Kingdom) (Chiu and Ho, 2005). It shall be noticed that, as precedingly evidenced, such a detailed level of information would not have been possible for to-date Covid publications mapping. The reader may recall **Table 1** for a comparison of the figures between early-stage against to-date publications on Coronavirus.

3. RESULTS AND DISCUSSION

The only paper published in 2019 was 'Coronaviruses: A paradigm of new emerging zoonotic diseases' (Salata et al., 2019) from the University of Padua in Italy. Nevertheless, it shall be remarked that this article was submitted on February 7, 2020 – hence, this is likely to be motivated by the fact that this was a late publication from this journal, that added up the publication in an

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earlier issue. It was reported that a novel type of coronavirus (2019-nCoV) infecting humans appeared in Wuhan, China, at the end of December 2019. Since the identification of the outbreak, the infection quickly spread. A total of 1,656 COVID-19 documents were published in SCI-EXPANDED in the first four beginning months after its breakout.

3.1. Document Types and Languages

The total 1,656 COVID-19 documents were found in SCI-EXPANDED within nine document types. **Table 3** shows that the most common paper category was editorial materials (32% of the 1,656 documents) followed by articles (30%) and early accesses (29%).[i] In total, 537 pieces of editorial material were published in 262 journals mainly in *BMJ-British Medical Journal* (59 editorial materials; 11% of 537 editorial materials) and *The Lancet* (51; 9.5%), whereas 499 articles were published in 222 journals mainly in *Journal of Medical Virology* (41 articles; 8.2% of 499 articles) and *Eurosurveillance* (30; 6.0%). It has been reported that a higher percentage of document type of editorial materials and a lower percentage of articles were published in the beginning stage of SARS breakout in 2003 (Chiu et al., 2004).

It should be noticed that documents could be classified in two document types in the Web of Science, for instance, document type of early accesses with 475 was also classified as articles (164), editorial materials (153), letters (117), reviews (37), and corrections (4) respectively; thus, the sum of percentages is higher than 100% (**Table 3**). Document type of data papers with one document had the highest number of authors per publication (*APP*) of 22 followed distantly by articles with *APP* of 8.6. The article entitled ‘First cases of coronavirus disease 2019 (COVID-19) in France: surveillance, investigations and control measures, January 2020’ (Stoecklin et al., 2020) was published by the maxima number of 67 authors from nine institutes in France.

Nine languages have been used for the examined publications. Intuitively, English, as the most popular language, comprised 98% of the 1,656 COVID-19 documents, distantly followed by German (20 documents; 1.2% of the 1,656 documents) and Hungarian (11; 0.66%). Other

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languages that were less used were Portuguese (3 documents), French (2), Spanish (2), and, respectively, one per each in Icelandic, Italian, and Polish (1 document per each).

3.2. Web of Science Category and Journal

Journal Citation Reports (JCR) indexed 9,258 journals with citation references across 178 Web of Science categories in SCI-EXPANDED in 2018. The 1,656 COVID-19 documents were published by 475 journals among the 99 Web of Science categories in SCI-EXPANDED. Three Web of Science categories published more than 100 COVID-19 documents such as general and internal medicine (478 documents; 29% of the 1,656 documents), infectious diseases (120; 7.2%), and virology (102; 6.2%).

The top 10 productive journals publishing more than 15 COVID-19 documents were listed in **Table 4** with the total number of publications and journal impact factor in 2018 (IF_{2018}). *BMJ-British Medical Journal* with IF_{2018} of 27.604 (214 publications; 13% of the 1,656 publications) published the vast majority of articles. Four of the top 10 journals were classified in the Web of Science category of general and internal medicine followed by infectious diseases with two journals. The journal with the highest IF_{2018} of 70.670 was *New England Journal of Medicine* with 21 publications followed by *The Lancet* (IF_{2018} = 59.102) with 111 publications, *Nature Reviews Drug Discovery* (IF_{2018} = 57.618) with one article, and *JAMA-Journal of the American Medical Association* (IF_{2018} = 51.273) with three publications. *New England Journal of Medicine*, *The Lancet*, and *JAMA-Journal of the American Medical Association* were the top three journals in the Web of Science category of general and internal medicine. More papers were also published in the top three journals in the beginning stage of the SARS breakout in 2003 (Chiu et al., 2004).

3.3. Publication Performances: Countries

In order to compare publication performance of countries and institutions, five publication indicators such as the total number of publications (*TP*), independent publications (*IP*),

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collaborative publications (*CP*), first-author publications (*FP*), and corresponding-author publications (*RP*) were proposed following Chuang et al. (2011). It was generally accepted that the first author and the corresponding author are the two principal authors in a publication (Riesenberg and Lundberg, 1990). At the institutional level, the determined institution of the corresponding author might be a home base of the study or origin of the paper (Ho, 2012). Of 1,342 documents (81% of the 1,656 documents) with author affiliations from 80 countries, 998 (74% of the 1,342 documents) were single-country documents from 48 countries, and 334 (26%) were internationally collaborative documents from 77 countries.

Figure 1 shows the distribution of the number of COVID-19 cases in worldwide countries. The map has been produced on May 3, 2020 and is related to the US case. Please refer to WHO analyses: https://covid19.who.int/table. The USA had the most cases followed by Spain and Italy. Africa and Oceania had fewer cases. The top 20 productive countries are listed in **Table 3** with the five publication indicators. Eight Asian countries, eight European countries, three American countries, and one Oceania country were ranked on the top 20 of publications. There was no African country in the top 20. The most productive African country was South Africa publishing 13 papers and ranked 24th.

China was ranked top in the four publication indicators with *TP* of 544 publications (41% of 1,342 publications), *IP* of 388 publications (39% of 998 country independent publications), *FP* of 489 publications (36% of 1,342 first-author publications), and *RP* of 468 publications (35% of 1,342 corresponding author publications). However, China had the largest number of SARS cases but limited publications in the starting four months of SARS breakout in 2003 (Chiu et al., 2004). Domination in coronavirus publications by China was not surprising since COVID-19 broke out from China (Huang et al., 2020; Cohen, 2020). It is clear that China focused more on coronavirus research after SARS in 2003.

The USA was the most popular collaborative country with *CP* of 163 publications (47% of 344 internationally collaborative publications). The USA had the largest number of collaborations,

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publishing with authors affiliated to 59 countries. The USA was followed by the UK with 53 collaboration, Germany with 47, China with 44, Italy with 43, and Canada with 40. The USA was the most popular partner with ten of the top 20 countries including China (76 collaborative publications with the USA), UK (40), Italy (34), Australia (19), Switzerland (12), Saudi Arabia (11), France (10), Netherlands (9), South Korea (8), and Iran (5).

Table 5 shows the distribution of COVID-19 articles in all countries. Collating **Figure 1** with **Figure 2**, one can notice that China published the most COVID-19 articles with fewer cases while Spain had more COVID-19 cases with less published articles. The top eight countries with 100,000 or more COVID-19 cases including USA, Spain, Italy, the UK, France, Germany, Russia, and Turkey published 613 documents (that is 46% of 1,342 documents with country information in SCI-EXPANDED).

3.4. Publication Performances: Institutions

A total of 449 COVID-19 publications (33% of the 1,342 publications) were single institution publications (*SP*) and 893 (67%) were inter-institutionally collaborative publications (*CP*). **Table 6** shows the top 20 most productive institutions. Amongst these 20 institutions, 15 were located in China, three in the UK, and one in Canada and the USA. The top 13 institutes were all located in China. Huazhong University of Science and Technology in China ranked top in all publication indicators with *TP* of 59 publications (4.4% of the 1,342 publications), *IP* of 23 publications (5.1% of 449 institute independent publications), *CP* of 36 publications (4.0% of 893 inter-institutionally collaborative publications), *FP* of 39 publications (2.9% of 1,342 first-author publications), and *RP* of 33 publications (2.5% of 1,342 corresponding author publications).

3.5. Publication Performances: Authors

A total of 55 publications were anonymous. In total 1,601 COVID-19 publications with author information in SCI-EXPANDED were published by 6,153 authors. **Table 7** shows the top 10

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productive authors with four publication indicators such as the total number of publications (*TP*), first-author publications (*FP*), corresponding-author publications (*RP*), and single-author publications (*SP*) (Ho, 2012).

Elisabeth Mahase, a clinical news reporter at the *BMJ-British Medical Journal*, published the most 32 publications which are all single-author news items in *BMJ-British Medical Journal*. Following, Gareth Iacobucci, senior reporter at the *BMJ-British Medical Journal*, published 23 single author news items in *BMJ-British Medical Journal*. Next, Abi Rimmer, the deputy editor at the *BMJ-British Medical Journal* careers, published 18 single author news items and two editorial materials including one collaborative editorial material in *BMJ-British Medical Journal*.

Seven of the top ten authors had no first- or corresponding-author publications. Furthermore, first- and corresponding-authors are the most important authors in a paper. in this framework, the first author is the author who contributed most to the work and writing of the paper (Gaeta, 1999). Corresponding authors contributed the most to the initial idea and supervision (Wren et al., 2007).

Xingguang Li from Hubei Engineering Research Center of Viral Vector, Wuhan University of Bioengineering in China, published the most three first-author COVID-19 articles including 'Potential of large "first generation" human-to-human transmission of 2019-nCoV' (Li et al., 2020a), 'Transmission dynamics and evolutionary history of 2019-nCoV' (Li et al., 2020b), and 'Evolutionary history, potential intermediate animal host, and cross-species analyses of SARS-CoV-2' (Li et al., 2020c) in *Journal of Medical Virology*. Similarly, Silvia Angeletti from University of Campus Biomed Rome in Italy published the largest number of corresponding-author COVID-19 articles (five). It was pointed out that bias would appear in the analysis of authors who use the same name and those who use different names in their publications (Chiu and Ho, 2007).

4. CONCLUSION

The Coronavirus pandemic that is hitting the world for over a year has shown the vulnerability risks to major adverse events that our society constantly faces (Gatto and Busato, 2020). This is

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particularly evident for public health shocks, that imply socio-economic and environmental concatenated emergencies. This fact calls for prompt holistic outlooks and pluralistic perspectives, that need to be translated into sound resilience policies striving for sustainable attitudes making use of adequate metrics (Gatto, 2020; Gatto et al., 2020).

Investigating early publication of health policy, medical science, social sciences and further scientific results is of primary importance to communicate scientific results, to spread information and provide detailed data and explorations. Importantly, this aspect has a foremost social mandate. Some institutions, authors and journals have been putting forward special efforts in this regard, producing a paramount bulk of preliminary research in the beginning stage of the Coronavirus outbreak. The need for investigating publications dynamics on Covid-19 scholarship motivated this work. Despite a large number of early publications, this paper proposed a set of detailed analyses to disentangle defined parameters and examine important publications characteristics.During the first four months of the COVID-19 outbreak, a total of 1,656 documents have been published in 475 journals in the 99 Web of Science categories in SCI-EXPANDED. China dominates COVID-19 global publications and is followed by the USA. Nine document types were used in those publications. The top 12 productive institutions were all located in China. The top three authors published on *BMJ-British Medical Journal*. Researchers paid more attention to the Web of Science category of general and internal medicine. More than 60% of publications were in document types of editorial materials and articles. *BMJ-British Medical Journal* and *Journal of Medical Virology* predominantly published editorial materials and articles, respectively. Furthermore, the results from this study showed associations of research indexes with the number of COVID-19 cases.

The presented parameters provide specific pieces of information. The latter shall be quite innovative for this research, providing a new element of analysis in terms of empirical and theoretical publications and information science, bibliometrics, scientometrics and public health researchers. To the best knowledge of this work's authors, these factors have not been explored in further papers. Therefore, this shall be an added value with respect to existing scholarship. The sketched

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outputs are also a fairly interesting publication result in terms of theory advances and pave the way for future explorations.

Descriptive analyses are the most popular type of publications in this bibliometrics literature. However, after checking the 50,545 documents, no papers presented was detected to provide such informative results, focusing on early-stage publications. In this sense, this work produced a number of analyses concerning the characteristics of document type, the most productive journals, countries, institutes and authors. Additionally, the number of Coronavirus national cases was spatially collated to the number of worldwide domestic publications. This appraisal was conducted with the support of world heat maps. Tables 1, 3, 5, 6 and 7 are brand-new pieces of information. This allowed for deep analyses.

When it comes to research limitations, bibliometrics makes no exception (Haustein and Lariviere, 2015). A possible limitation is that bibliometrics only processes data from bibliographic databases. This study scrutinised the Web Of Science database records, a notable strength (Archambault et al., 2006). That is why the study could not include seminal, conference, policy and working papers, namely white literature. Future research may want to examine alternative aspects or perform different tests on these data, such as correlation analysis, a concentration (e.g. Gini, Herfindahl index) or other techniques.

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Appendix A

Table 3. Characteristics of document type

Document type	*TP*	%	*TP**	*AU*	*APP*
Editorial material	537	32	503	1,624	3.2
Article	499	30	495	4,260	8.6
Early access	475	29	471	2,594	5.5
Letter	316	19	314	1,501	4.8
News item	169	10	160	165	1.0
Review	111	6.7	110	597	5.4
Correction	23	1.4	18	56	3.1
Data paper	1	0.060	1	22	22
Reprint	1	0.060	1	2	2.0

TP: number of publications; *TP**: number of publications with author information; *AU*: number of authors; *APP* (*AU*/*TP**): number of authors (*AU*) per publication (*TP*).

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Table 4. Top 11 productive journals (TP > 15)

Journal	*TP* (%)	IF_{2018}	Web of Science category
BMJ-British Medical Journal	214 (13)	27.604	general and internal medicine
Lancet	111 (6.7)	59.102	general and internal medicine
Journal of Medical Virology	77 (4.6)	2.049	virology
Eurosurveillance	37 (2.2)	7.421	infectious diseases
Intensive Care Medicine	21 (1.3)	18.967	critical care medicine
New England Journal of Medicine	21 (1.3)	70.67	general and internal medicine
Journal of Korean Medical Science	20 (1.2)	1.716	general and internal medicine
Science	19 (1.1)	41.063	multidisciplinary sciences
Lancet Infectious Diseases	18 (1.1)	27.516	infectious diseases
Emerging Microbes & Infections	17 (1.0)	6.212	immunology microbiology

TP: total number of publications; IF_{2018}: journal impact factor in 2018.

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Table 5. Top 20 most productive countries for COVID-19 in SCI-EXPANDED.

Country	*TP*	*TPR* (%)	*IPR* (%)	*CPR* (%)	*FPR* (%)	*RPR* (%)	No *CC*	MCC (CP)
China	544	1 (41)	1 (39)	2 (45)	1 (36)	1 (35)	44	USA (76)
USA	308	2 (23)	2 (15)	1 (47)	2 (15)	2 (15)	59	China (76)
UK	172	3 (13)	4 (7.5)	3 (28)	4 (7.2)	4 (7.5)	53	USA (40)
Italy	143	4 (11)	3 (8.6)	4 (17)	3 (8.2)	3 (8.0)	43	USA (34)
Germany	77	5 (5.7)	5 (3.4)	7 (13)	5 (3.6)	5 (3.6)	47	UK (19)
Australia	59	6 (4.4)	12 (1.3)	5 (13)	10 (1.8)	8 (2.1)	28	USA (19)
Canada	58	7 (4.3)	13 (1.2)	5 (13)	8 (1.9)	8 (2.1)	40	China (18)
Switzerland	58	7 (4.3)	7 (2.6)	9 (9.3)	6 (2.5)	6 (2.8)	36	USA, Italy (12)
India	47	9 (3.5)	13 (1.2)	8 (10)	12 (1.6)	12 (1.6)	36	China (18)
South Korea	40	10 (3.0)	6 (3.0)	22 (2.9)	7 (2.4)	7 (2.4)	28	USA (8)
France	38	11 (2.8)	10 (1.8)	11 (5.8)	12 (1.6)	13 (1.6)	33	USA (10)
Singapore	37	12 (2.8)	9 (1.9)	14 (5.2)	8 (1.9)	10 (1.9)	21	UK (10)
Iran	33	13 (2.5)	8 (2.3)	22 (2.9)	10 (1.8)	10 (1.9)	21	USA (5)
Brazil	28	14 (2.1)	17 (0.90)	13 (5.5)	16 (1.0)	18 (0.89)	36	Italy (11)
Japan	26	15 (1.9)	11 (1.5)	20 (3.2)	15 (1.3)	15 (1.3)	17	China, USA (5)

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Thailand	24	16 (1.8)	24 (0.30)	10 (6.1)	14 (1.4)	14 (1.4)	18	India (17)
Sweden	22	17 (1.6)	18 (0.80)	18 (4.1)	17 (1.0)	16 (1.0)	31	UK (9)
Netherlands	21	18 (1.6)	21 (0.40)	15 (4.9)	22 (0.52)	22 (0.52)	27	USA (9)
Saudi Arabia	20	19 (1.5)	N/A	11 (5.8)	21 (0.60)	21 (0.60)	25	USA (11)
Spain	18	20 (1.3)	33 (0.1)	15 (4.9)	30 (0.22)	36 (0.15)	26	Italy (11)

TP: total number of publications; *TPR* (%): rank of total number of publications and percentage; S*PR* (%): rank of single country publications and percentage in all single institute publications; *CPR* (%): rank of internationally collaborative publications and percentage in all internationally collaborative publications; *FPR* (%): rank of first-author publications and percentage in all first-author publications; *RPR* (%): rank of corresponding-author publications and percentage in all corresponding-author publications; No *CC*: number of collaborated countries; *MCC*: most collaborative country; *CP*: number of internationally collaborative publications; N/A: not available.

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Table 6. Top 20 productive institutes for COVID-19 in SCI-EXPANDED

Institute	*TP*	*TP* rank (%)	*IP* rank (%)	*CP* rank (%)	*FP* rank (%)	*RP* rank (%)
Huazhong University of Science and Technology, China	59	1 (4.4)	1 (5.1)	1 (4)	1 (2.9)	1 (2.5)
Wuhan University, China	44	2 (3.3)	2 (2.4)	3 (3.7)	2 (1.9)	2 (1.8)
Fudan University, China	37	3 (2.8)	6 (1.3)	4 (3.5)	3 (1.6)	3 (1.3)
University of Hong Kong, China	36	4 (2.7)	4 (2.2)	7 (2.9)	5 (1.0)	5 (1.0)
Capital Medical University, China	35	5 (2.6)	65 (0.22)	2 (3.8)	20 (0.52)	21 (0.45)
Zhejiang University, China	30	6 (2.2)	2 (2.4)	9 (2.1)	4 (1.2)	4 (1.2)
Chinese Academy of Medical Sciences, China	28	7 (2.1)	N/A	5 (3.1)	17 (0.6)	13 (0.67)
Chinese Academy of Sciences, China	28	7 (2.1)	N/A	5 (3.1)	9 (0.89)	13 (0.67)
Shanghai Jiao Tong University, China	22	9 (1.6)	10 (0.89)	12 (2.0)	5 (1.0)	6 (1.0)
Peking University, China	21	10 (1.6)	35 (0.45)	9 (2.1)	10 (0.82)	8 (0.82)
Sun Yat Sen University, China	21	10 (1.6)	10 (0.89)	13 (1.9)	16 (0.67)	8 (0.82)
Chinese University of Hong Kong, China	20	12 (1.5)	15 (0.67)	13 (1.9)	7 (1.0)	8 (0.82)
Harvard Medical School, USA	20	12 (1.5)	N/A	8 (2.2)	23 (0.37)	52 (0.22)
University of Oxford, UK	20	12 (1.5)	8 (1.1)	15 (1.7)	13 (0.75)	8 (0.82)
London School of Hygiene & Tropical Medicine, UK	19	15 (1.4)	10 (0.89)	15 (1.7)	23 (0.37)	36 (0.30)

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University College London, UK	19	15 (1.4)	N/A	9 (2.1)	37 (0.3)	101 (0.15)
Chongqing Medical University, China	18	17 (1.3)	6 (1.3)	27 (1.3)	10 (0.82)	16 (0.60)
Guangzhou Medical University, China	18	17 (1.3)	15 (0.67)	15 (1.7)	13 (0.75)	16 (0.60)
Sichuan University, China	17	19 (1.3)	5 (1.8)	42 (1.0)	10 (0.82)	12 (0.74)
University of Toronto, Canada	17	19 (1.3)	35 (0.45)	15 (1.7)	23 (0.37)	101 (0.15)

TP: total number of publications; *TPR* (%): rank of total number of publications and percentage; S*PR* (%): rank of single institute publications and percentage in all single institute publications; *CPR* (%): rank of inter-institutionally collaborative publications and percentage in all inter-institutionally collaborative publications; *FPR* (%): rank of first-author publications and percentage in all first-author publications; *RPR* (%): rank of corresponding-author publications and percentage in all corresponding-author publications; N/A: not available.

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Table 7 . Top 10 most productive authors with TP ≥ 13.

Authors	Rank (*TP*)	Rank (*FP*)	Rank (*RP*)	Rank (*SP*)
E. Mahase	1 (32)	1 (32)	1 (32)	1 (32)
G. Iacobucci	2 (23)	2 (23)	2 (23)	2 (23)
A. Rimmer	3 (20)	3 (20)	3 (19)	3 (19)
Y. Wang	3 (20)	142 (1)	N/A	N/A
J. Li	5 (16)	17 (3)	N/A	N/A
V. Wiwanitkit	6 (15)	N/A	N/A	N/A
Y. Liu	7 (14)	17 (3)	N/A	N/A
Y. Yang	8 (13)	10 (4)	N/A	N/A
L. Zhang	8 (13)	142 (1)	N/A	N/A
J. Chen	8 (13)	142 (1)	N/A	N/A

TP: total number of publications; *FP*: number of first-author publications; *RP*: number of corresponding-author publications; *SP*: number of single-author publications; N/A: not available.

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Figure 1. Distribution of COVID-19 cases.

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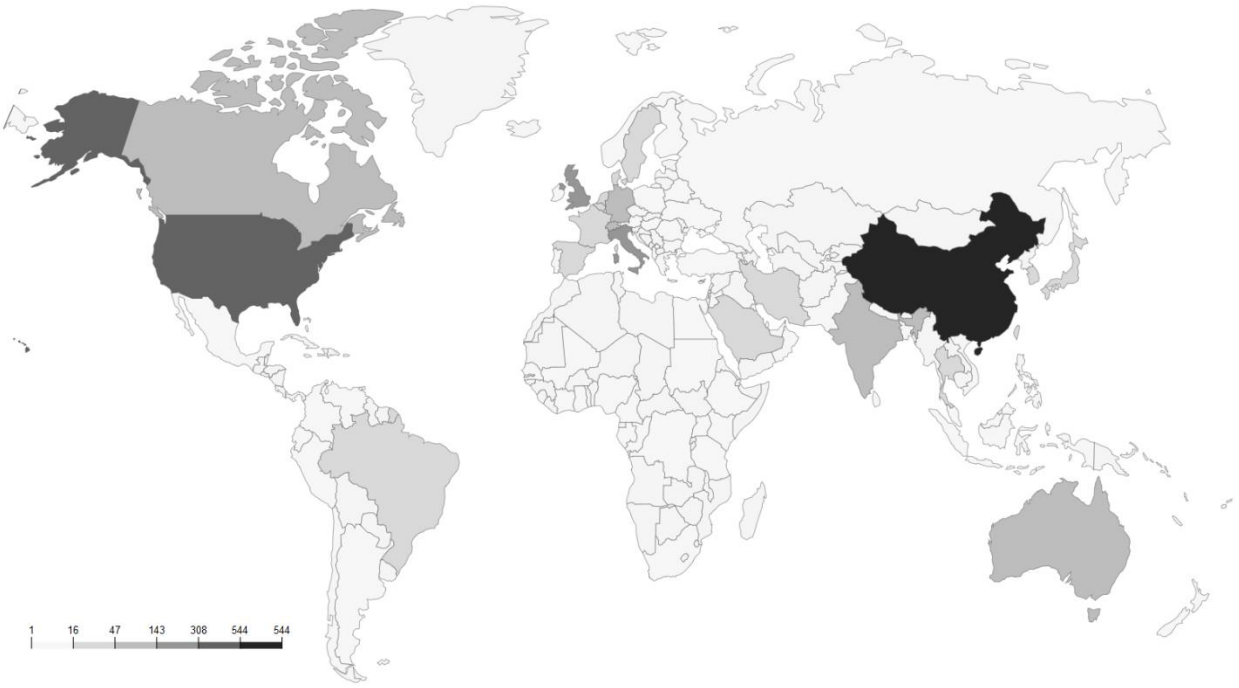
Figure 2. Distribution of articles published.



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Appendix B

SCI-EXPANDED data has been exploited for this study. “Early access” is a document type (Web of Science Core Collection only): https://images.webofknowledge.com/images/help/WOS/hs_document_type.html#:~:text=When%20you%20limit%20a%20search,you%20selected%20from%20the%20list.. Web of Science Core Collection includes the items compiled in **Table 8**.

Table 8 – Web of Science Core Collection: Citation Indexes

(1) Science Citation Index Expanded (SCI-EXPANDED)
(2) Social Sciences Citation Index (SSCI)
(3) Arts & Humanities Citation Index (A&HCI)
(4) Conference Proceedings Citation Index - Science (CPCI-S)
(5) Conference Proceedings Citation Index - Social Science & Humanities (CPCI-SSH)
(6) Book Citation Index - Science (BKCI-S)
(7) Book Citation Index - Social Sciences & Humanities (BKCI-SSH)
(8) Emerging Sources Citation Index (ESCI)
Web of Science Core Collection: Chemical Indexes
(1) Current Chemical Reactions (CCR-EXPANDED)
(2) Index Chemicus (IC).

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[i] A comprehensive categorization of SCI-EXPANDED categories can be found in Appendix B.