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ORIGINAL ARTICLE

Systematic review of bibliometric studies on SARS-CoV-2

Revisão sistemática dos estudos bibliométricos sobre SARS-CoV-2

Thainá Ferreira Silva[1,*], Amanda Alves de Melo[1], Dener Lucas Araújo dos Santos[2], Elisa Carvalho Vaz[1], Leonardo Carlos Jeronimo Corvalan[1], Marcela de Lacerda Ribeiro[1], Flávia Melo Rodrigues[3,4]

[1]*Biological Sciences Institute, Federal University of Goiás, Goiânia, Goiás, Brazil.*
[2]*Tropical Pathologhy and Public Health Institute, Federal University of Goiás, Goiânia, Goiás, Brazil.*
[3]*School of Agricultural and Biological Sciences, Pontifícal Catholic University of Goiás, Goiânia, Goiás, Brazil.*
[4]*Health Sciences and Biological Academic Institute, Goiás State University, Anápolis, Goiás, Brazil.*

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KEYWORDS
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ABSTRACT

Objective: To perform a systematic review of articles that evaluated the scientific production on SARS-CoV-2 through bibliometric analyzes.
Methods: Scopus, Web of Science and Google Scholar databases were used. After applying the pre-established inclusion criteria, 30 articles were included.
Results. The total number of articles found in the bibliometric studies on SARS-CoV-2 varied widely from 153 to 21,395 articles and an average equal to 4,279 (± 5,510). A total of 17 countries published within the scope of this study, but only six published more than one article, emphasizing authors from Chinese institutions (17%). Scopus was the most used database in bibliometric studies (50%, n = 15). The articles used 72 different keywords with emphasis on: COVID-19 (15%), SARS-CoV-2 (12%) and 2019-nCoV (9%).
Conclusion. We are facing an unprecedented scenario of information about SARS-CoV-2 and this has required a collective scientific effort reflected in the daily publication of hundreds of studies (articles, pre-prints, clinical guides, protocols). Bibliometric methods are being increasingly used by the scientific community to systematize this information. Therefore, the systematic review carried out in this study provided an overview of the bibliometric literature on the SARS-CoV-2 virus.

*Corresponding author:
Instituto de Ciências Biológicas, Programa de Pós-Graduação em Genética e Biologia Molecular, Universidade Federal de Goiás.
Av. Esperança, s/n - Chácaras de Recreio Samambaia. Goiânia, Goiás, Brasil | CEP 74690-900.
Phone: +55 62 3521-1203
E-mail: thaina.ferreira@discente.ufg.br (Silva TF)

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PALAVRAS-CHAVE
Bibliometria
COVID-19
Coronavirus
Epidemia por 2019-nCoV
Pesquisa

RESUMO

Objetivo: Realizar uma revisão sistemática de artigos que avaliaram a produção científica sobre SARS-CoV-2 por meio de análises bibliométricas.
Métodos: Foram utilizados os bancos de dados Scopus, Web of Science e Google Scholar. Após a aplicação dos critérios de inclusão pré-estabelecidos, 30 artigos foram incluídos.
Resultados. A quantidade total de artigos encontrados nos estudos bibliométricos sobre SARS-CoV-2 apresentou uma grande variação de 153 a 21.395 artigos e uma média igual a 4.279 (± 5.510). Um total de 17 países publicaram no escopo deste estudo, mas apenas seis publicaram mais de um artigo, com destaque para autores de instituições chinesas (17%). Scopus foi o banco de dados mais utilizado nos estudos bibliométricos (50%, n = 15). Os artigos usaram 72 palavras-chave diferentes com destaque para: COVID-19 (15%), SARS-CoV-2 (12%) e 2019-nCoV (9%).
Conclusão. Estamos diante de um cenário sem precedentes de informações acerca do SARS-CoV-2 e isso tem exigido um esforço científico coletivo que se reflete na publicação diária de centenas de estudos (artigos, pré-impressões, guias clínicos, protocolos). Os métodos bibliométricos são sendo cada vez mais utilizados pela comunidade científica para sistematizar essas informações. Assim sendo, a revisão sistemática realizada nesse estudo permitiu fornecer uma visão geral da literatura bibliométrica sobre o vírus SARS-CoV-2.

INTRODUCTION

The new severe acute respiratory syndrome associated to a coronavirus, named by the World Health Organization (WHO) as Coronavirus Disease of 2019 (COVID-19), began in December 2019 in the Chinese town of Wuhan with confirmed cases of person to person transmission[1,2]. On February 11th, the *Coronaviridae* Study Group (CSG) from the International Committee on Taxonomy of Viruses (ICTV), responsible for classifying and establishing the nomenclature of viruses from the *Coronaviridae* family, evaluated the temporary name of the new virus as 2019-nCoV. Followed by new taxonomy and phylogeny studies, the 2019-nCoV was classified as a new strain of coronaviruses responsible for severe acute respiratory syndromes, and it was named SARS-CoV-2[3].

On March 11th, the WHO declared the state of contamination of this new virus as a pandemic. Immediately, strains of SARS-CoV-2 were isolated for research, which increased exponentially on the run, especially for virus genomic characterization[4], contributing to the development of vaccines, treatments, and data about its dispersal, transmission and origin[5]. According to the WHO, up until July 10th, 2020, there were 12,102,328 confirmed cases of COVID-19 worldwide, with 551,046 deaths. The Americas led the number of confirmed cases with 6,264,626, followed by Europe with 2,868,080, Eastern Mediterranean with 1,238,779, Southeast Asia with 1,065,093, Africa with 428,051 and Western Pacific with 236,958.

The rapid increase in the number of publications on SAR-COV-2 during the pandemic plays an essential role in informing the scientific community about the investigation status on this topic and providing significant insights about the future of research, contributing with COVID-19 information updates throughout the world. According to Zhang[6], there is a rapid response to publications regarding public health emergencies. Europe and North America develop collaborative research with the main countries and with the outbreak regions, as observed with Ebola in Africa. SARS research is commonly conducted by China and the USA, with European countries' contributions relatively low[6].

These data may reflect the progress of conveying information, which contributes to solving present and future public health emergencies, making intercommunication between countries necessary[7]. With the significant amount of data and information published, bibliometrics is considered an efficient way of evaluating scientific production progress, using journal articles, and covering the author's productivity and citation studies[8]. Therefore, the present work aimed to perform a systematic review of articles that evaluated the scientific production about SARS-CoV-2 through bibliometric analysis.

METHODS

This review was performed following PRISMA guidelines[9]. The search was done on June 10th, 2020, using three databases: Scopus, Web of Science and Google Scholar. The search terms and combination used were: (("covid-19" OR "SARS-CoV-2" OR "2019-nCoV" OR "Wuhan virus" OR "covid-19 virus") AND "bibliometri*). Only original articles, reviews and preprints published in 2020 were included.

The retrieved papers were manually checked, by all authors, for duplicates and for meeting the criteria of performing bibliometrics studies on SARS-CoV-2 (Figure 1). On a second filtering phase, the remaining papers were also manually checked to retain only publications about SARS-CoV-2 that explicitly and separately presented the bibliometrics results about this virus even if their research included other coronaviruses. After these two filtering phases, each of the remaining papers had some information extracted in order to perform further analysis: title, DOI, authors names, main author's country and institution, information on international collaborations, journal name and Impact Factor (IF), publication date, databases and keywords used, the period of search, main objective and total of papers retrieved after filtering. The IF of the journals whose analyzed articles were indexed was retrieved through the Journal Impact Factor (JIF).

For the quantitative data, statistical analysis was

performed (medium and standard deviation). The final number of articles retrieved per database and were made visually available on a Venn diagram using the 'VennDiagram' package in R. The number of studies using each retrieved database, countries of publication, the number of authors per paper, and the number of bibliometric papers published on SARS-CoV-2 throughout the months were plotted using 'ggplot2' in R. A word cloud was built with the retrieved keywords using the free online tool WordCloud.com (available at https://www.wordclouds.com).

RESULTS

It was found 95 documents on SARS-CoV-2, with 6, 12 and 77 retrieved from Web of Science (WoS), Scopus (Sc) and Google Scholar (GS) databases, respectively. Thirteen duplicates were excluded. In the first filtering phase, 40 articles were excluded for not meeting the study's main criteria. In the second phase, 12 other documents were not eligible for not presenting clear and distinct results on SARS-CoV-2 and, therefore, were also excluded. Therefore, 30 articles were included in the quantitative synthesis (Figure 1).

Two articles were exclusively found on Sc, one on WoS and 20 on GS (Figure 2). Seven papers were available in more than one database, with two found on all three (WoS, Sc and GS) and five found on Sc and GS (Table1, Figure 2). In this study, we verified that Google Scholar was the database that retrieved the highest number of documents (n = 77). However, it also had more documents excluded on the filtering phase (n = 36).

Publications of bibliometric studies on SARS-CoV-2 happened between March and June of 2020. We noticed a tendency of growth on the number of publications, with May being the month with the highest number of articles published (n = 14), followed by April (n = 9), March (n = 4), and June (n = 3), considering that our search was performed on the 10th day of this later month (Figure 3). One of the first studies published in March used the PubMed database solely, the search term "COVID-19," and found only 183 publications[15]. Of the 30 articles, 24 searched exclusively for SARS-CoV-2 publications, and only six had as main objectives to evaluate bibliometric aspects of the literature related to coronaviruses in general and other multiple outbreaks, including SARS-CoV-2 (Table 1). Almost half of the studies were preprints and were found in electronic repositories (47%, n = 14).

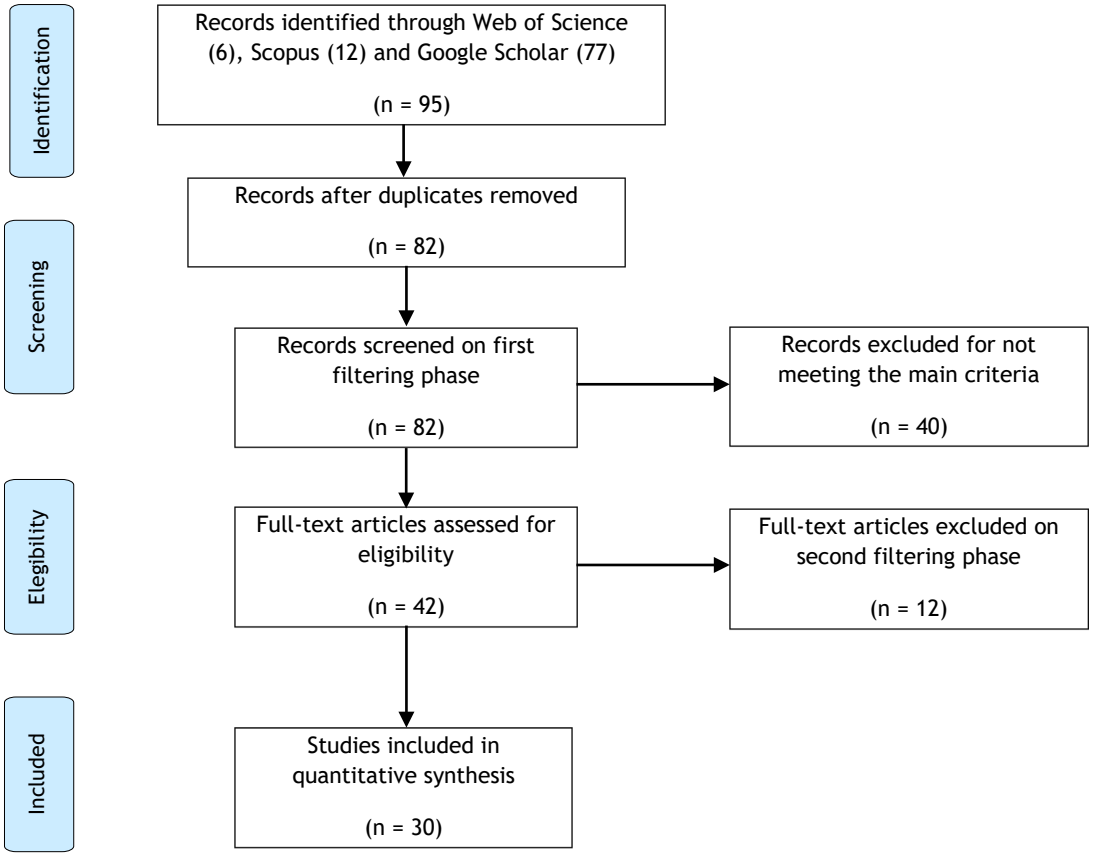

Figure 1 – PRISMA Flow diagram containing details on number of documents included and excluded on filtering phases.

Table 1 – Detailed information about the 30 selected and analyzed bibliometric studies on SARS CoV-2 and from which database it was retrieved, journal and its Impact Factor or repository which it is indexed.

Author(s) (Month. year)	Country	Journal (IF)	Study only focused on SARS-CoV-2	Total of documents retrieved	Database
Chahrou et al. (Mar 2020)[10]	Lebanon	Cureus (NA)	Yes	564	WoS
Hamidah, Sriyono, Hudha (May 2020)[11]	Indonesia	Indonesian Journal of Science & Technology (NA)	Yes	3,553	Sc
de Melo et al. (Apr 2020)[12]	Brazil	Interamerican Journal of Medicine and Health (NA)	Yes	1,841	GS
Kumar (May 2020)[13]	India	Sri Venkateswara Veterinary University (0.19)	Yes	2,168	GS
Dehghanbanadaki et al. (May 2020)[14]	Iran	Medical Journal of The Islamic Republic of Iran (0.73)	Yes	923	WoS, Sc, GS
Lou et al. (Mar. 2020)[15]	China	European Review for Medical and Pharmalogical Sciences (3.024)	Yes	183	GS
Belli et al. (May 2020)[16]	Spain	Research Square (Preprint)	No	917	GS
Liu et al. (May 2020)[17]	Singapore	MedRxiv (Preprint)	Yes	550	GS
Haghani, Bliemer (Jun 2020)[18]	Australia	Computer Science (Preprint)	No	11,859	GS
Pathak (Jun. 2020)[19]	India	Indian Journal of Biochemistry & Biophysics (0.537)	Yes	742	GS
Kousha, Thelwall (May 2020)[20]	England	The MIT Journal (NA)	Yes	21,395	GS
Fiesco-Sepúlveda, Serrano-Bermúdez (Jun. 2020)[21]	Colombia	PeerJournal (2.379)	Yes	153	GS
Hossain (May 2020)[22]	Bangladesh	F1000 Research (Preprint)	Yes	422	GS
Torres-Salinas (Apr 2020)[23]	Spain	El Profesional de la Información (1.505)	Yes	11,721	GS
Kirchhoff, Mertens, Scheufen (May 2020)[24]	Germany	Institut der deutschen Wirtschaft (0.07)	Yes	15,552	GS
Hu et al. (May 2020)[25]	China	Research Square (Preprint)	No	996	Sc
Helliwell et al. (May 2020)[26]	United Kingdom	MedRxiv (Preprint)	Yes	398	Sc, GS
Zhang et al. (May 2020)[6]	China	Scientometrics (2.867)	No	3,069	GS
Latif et al. (Apr 2020)[27]	Australia	TechRxiv (Preprint)	Yes	5,755	GS
O´Brien et al. (Apr 2020)[28]	Chile	Revista Chilena de Anestesia (0.05)	Yes	547	GS

Table 1 *– Cont.*

Author(s) (Month. year)	Country	Journal (IF)	Study only focused on SARS-CoV-2	Total of documents retrieved	Database
Torres-Salinas, Robinson-Garcia, Castillo-Valdivieso (Apr 2020)[29]	Spain	BioRxiv (Preprint)	Yes	11,686	Sc, GS
Tran et al. (May 2020)[30]	Vietnam	MedRxiv (Preprint)	Yes	5,780	GS
Zhou, Chen (Apr 2020)[31]	China	International Journal of Environmental Research and Public Health (2.849)	No	9,043	WoS, Sc, GS
Haghani et al. (May 2020)[32]	Australia	Safety Science (4.105)	No	1,239	Sc, GS
Aguado-Cortés, Castaño (Mar 2020)[33]	Mexico	Computer Science (Preprint)	Yes	547	GS
Gori, Boett, Fantini (Mar 2020)[34]	Italy	MedRxiv (Preprint)	Yes	234	GS
Golinelli et al. (Apr 2020)[35]	Italy	MedRxiv (Preprint)	Yes	239	GS
Kambhampati, Vaishya, Vaish (May 2020)[36]	India	Journal of Clinical Orthopaedics and Trauma (0.469)	Yes	6,831	Sc, GS
Bhattacharya, Singh (Apr 2020)[37]	India	Computer Science (Preprint)	Yes	9,146	GS
Zhang et al. (Apr 2020)[38]	China	Journal of Biomedical Engineering (0.590)	Yes	301	Sc, GS

GS: Google Scholar; Sc: Scopus; WoS: Web of Science; IF: Impact Factor; NA: Not Available

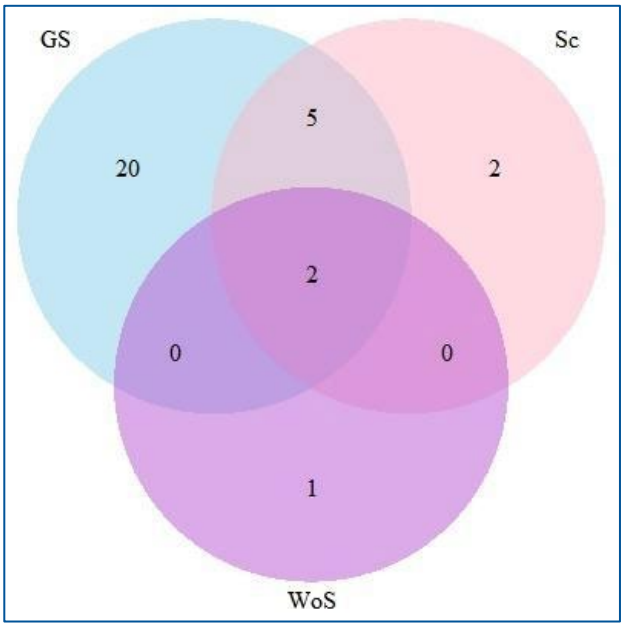

Figure 2 – Venn Diagram representing the number of articles found exclusively and in common on the three databases used in this study: Google Scholar (GS), Scopus (Sc) and Web of Science (WoS).

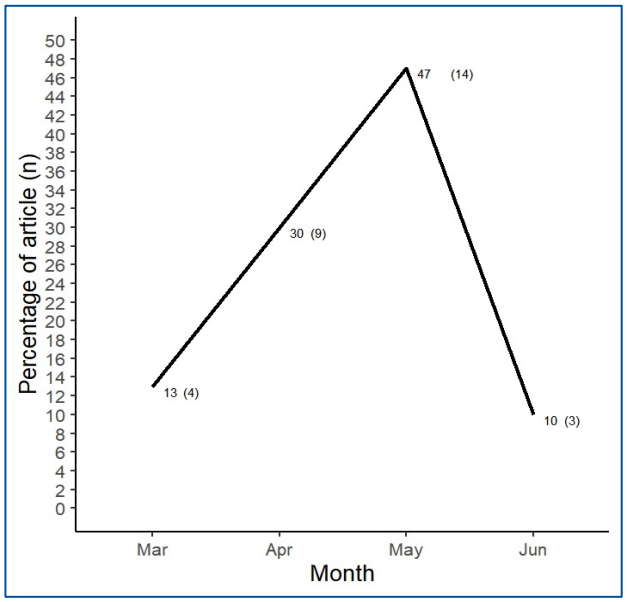

Figure 3 – Publication distribution of bibliometric studies on SARS-CoV-2 between the months of March and June shown as percentage. Numbers are shown in percentages and the number in parenthesis represent the absolute number of articles.

The retrieved documents on bibliometrics studies about SARS-CoV-2 showed a significant variation in their results, ranging from 153 to 21,395 articles with an average of 4,279 (± 5,510), although it was possible to observe some similarities. Golinelli[35] and Gori, Boetto and Fantini[34], aimed to measure what had been published in the first 30 days of the epidemic outbreak. Both studies used the PubMed platform and the same keywords combination as search terms, obtaining very similar results: 239 and 234 retrieved articles, respectively.

Two studies retrieved the same number of documents (n = 547) by using the same combination of search terms (COVID-19, 2019-nCoV, SARS-CoV-2), even using different databases. Aguado-Cortés and Castaño[33] obtained their data from MEDLINE, Web of Science and Scopus. On the other hand, O´Brien et al.[28], used only Scopus. In this case, the number and combination of keywords as search terms were more determinant for the obtained results than the chosen database.

Among the three studies published in June 2020, the first aimed to verify Latin American researchers' contribution to the comprehension of SARS-CoV-2, finding 153 publications with at least one Latin American researcher[21]. In the second study, Haghani and Bliemer[18] evaluated the scientometrics aspects of the literature on SARS-CoV-2, compared with two other main diseases caused by coronaviruses, SARS and MERS, retrieving 11,859 documents. Pathak[19], the third study, published in June 2020, studied the coverage of Indian publications about SARS-CoV-2 in different databases and found 742 papers in preprints repositories, being the leading platforms where Indian researchers made their work available.

Seventeen countries published on the scope of this study. However, only six countries published more than one article, highlighting authors of Chinese (17%), Indian (13%), Australian (10%) and Spanish (10%) institutions (Figure 4A). The most frequent number of authors per article were two or more than seven (20%, n = 6, each), followed by three or seven authors (17%, n = 5, each) (Figure 4B).

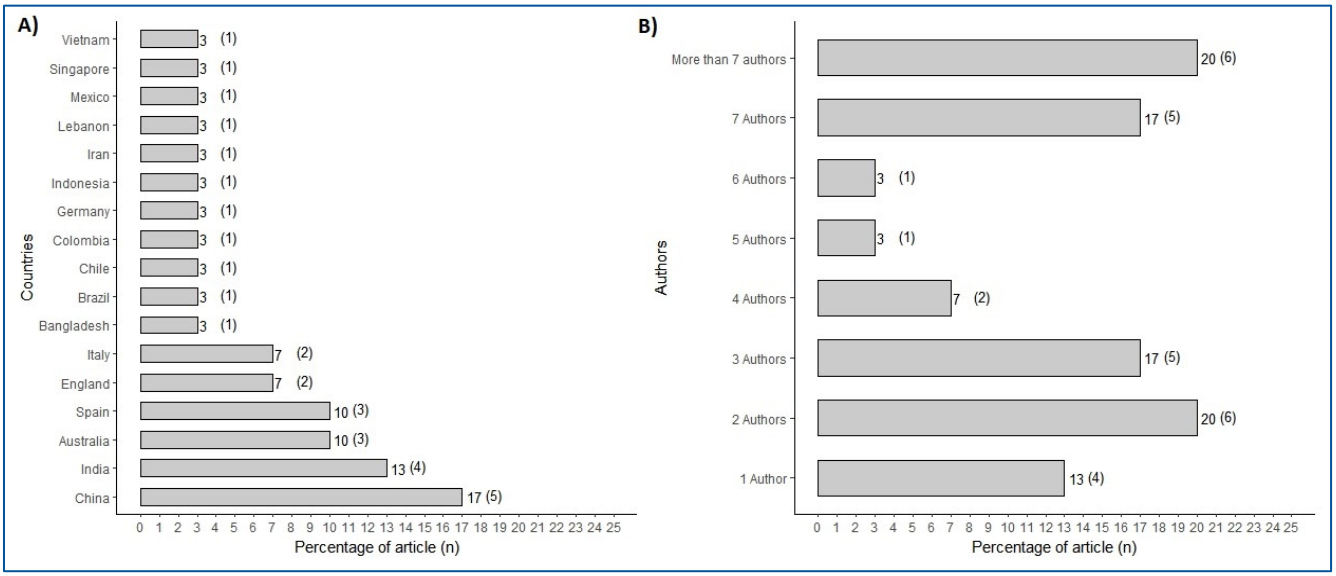

Figure 4 – **A**) Distribution of countries that published bibliometric studies about SARS-CoV-2; **B**) Distribution of the number of authors on bibliometric studies about SARS-CoV-2. Numbers are shown as percentage and numbers in parenthesis are the absolute number of articles.

Scopus was the database used in 50% (n = 15) of the bibliometric studies analyzed, followed by PubMed in 47% (n = 14) and Web of Science in 40% (n = 12) (Figure 5).

The studies used 72 different keywords as search terms 181 times. Considering that some words were used in more than one search term combination. The three most used ones were: COVID-19 (15%, 26x), SARS-CoV-2 (12%, 22x) and 2019-nCoV (9%, 16x) (Figure 6).

Fourteen studies could have the Impact Factor (IF) of their indexed journals accessed, two could not, and the other fourteen were preprints and were not indexed at all. Preprints do not have this index available since they are attached only in electronic repositories. The average value of the Impact Factor of the journals was 1.29 (± 1.28), ranging from 0.05 to 4.35. IF is calculated by the number of citations that the articles of a journal had in the last two years divided by the total number of published articles in the same period.

DISCUSSION

The difference in database coverage varies considerably according to scope and content. Therefore, it is a consensus that searches in systematic reviews be done in multiple databases[39,40]. For researches on the medical area, Scopus and Web of Science are considered good platforms for retrieving and analyzing quality Cresults[41]. Google Scholar is the

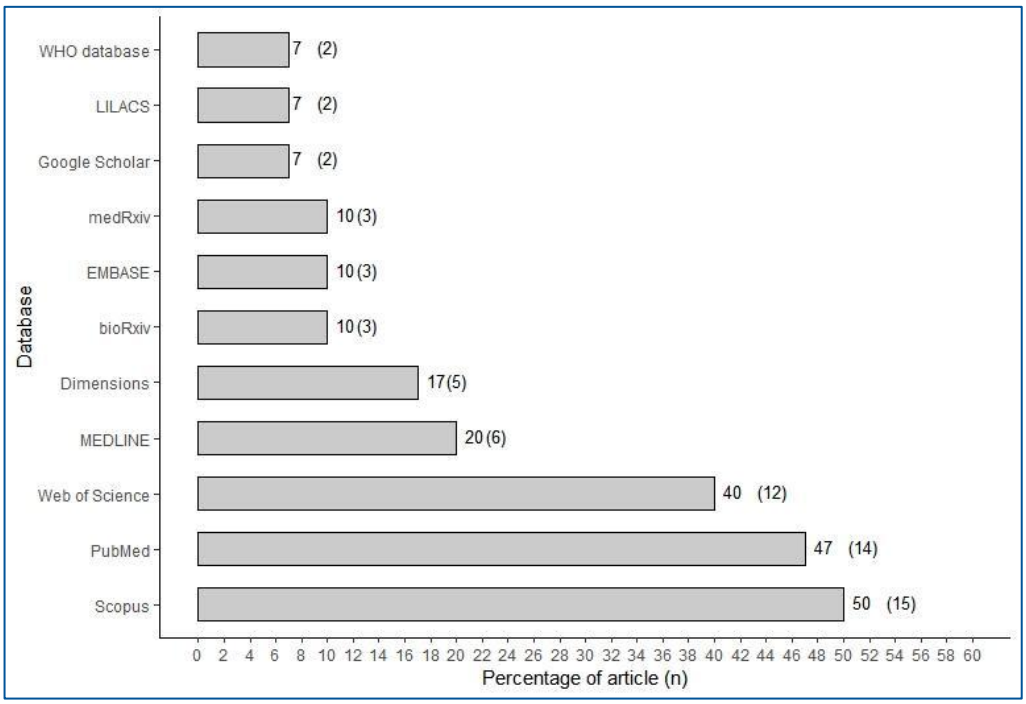

Figure 5 – Distribution of database used in more than one bibliometric article on SARS-CoV-2 analyzed by this study. Numbers are shown as percentage and the numbers in parentheses represent the absolute number of articles.

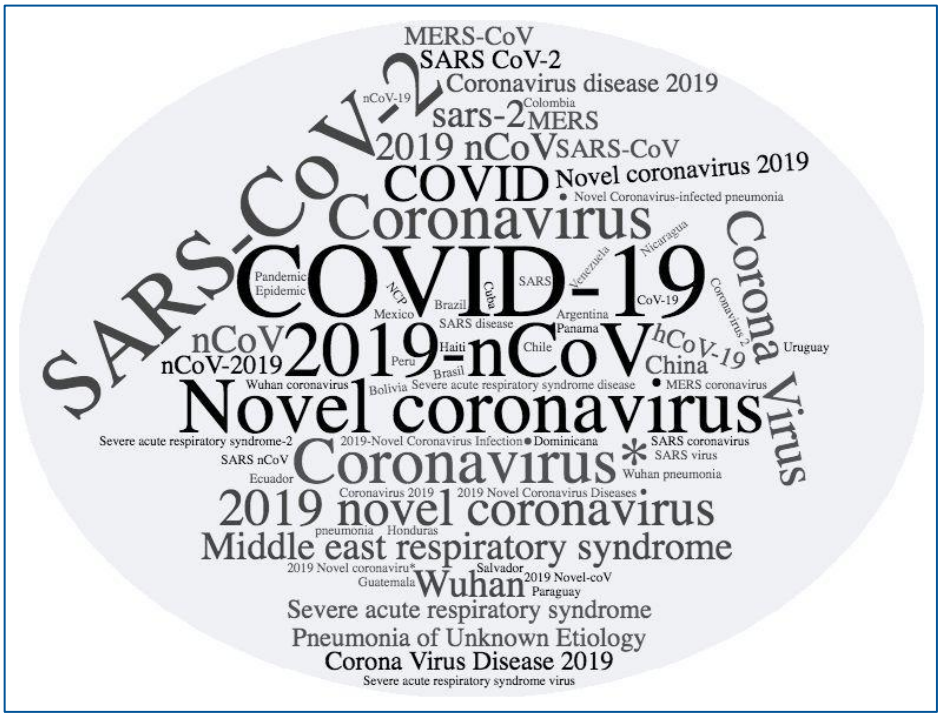

Figure 6 – Word cloud representing the frequency of the 72 different keywords used on SARS-CoV-2 bibliometrics studies. The bigger the size of the word, the more frequent it was used on search terms combinations.

biggest multidisciplinary platform; however, some specialists criticize its search approach due to the low specificity and difficulty finding relevant primary sources[42].

The variation in the number of retrieved articles can also be affected by the research's different objectives and the number of databases and keywords used. This explains the significant variation in the total amount of articles found in the bibliometric studies on SARS-CoV-2 included in this study. Kousha and

Thelwall[20] located the highest number of documents on SARS-CoV-2 (21,395), and it evaluated the potential of coverage of nine different academic databases. On the other hand, Fiesco-Sepúlveda and Serrano-Bermúdez[21] retrieved the fewest number of scientific articles (153). However, the main objective of these authors was restricted to evaluate only Latin American contributions to SARS-CoV-2 studies.

It was observed that almost half of the recovered articles were preprints. This format is a prior version of a complete manuscript before being formally peer-reviewed and published in scientific journals. These preprints are usually submitted simultaneously on scientific journals and open access electronic repositories and play an essential role in accelerating scientific progress as they democratize access to information for researchers worldwide[19,43]. In this sense, the higher and faster spread of research information about SARS-CoV-2 through preprints is necessary due to its large-scale distribution and lethality.

On the other hand, preprint versions are not eligible for IF metrics, have limited importance inside the scientific community, and have to be interpreted with caution as they may not depict the full spectrum of scientific activities in terms of social or economic impact[44]. Analyzing this metric can be questionable because some journals whose fields are rapidly renewed and publish more frequently have higher IFs than those that publish less often. Journals that publish regional research also tend to have fewer citations for approaching very specific topics[45], and therefore, some journals usually do not present this index.

This study observed an exponential increase in the bibliometrics publications since the discovery of the SARS-COV-2 outbreak. This increase was expected, as showed by Zhang et al.[6] when they compared the academy's response to five other outbreaks caused by viruses – Ebola, H1N1, Zika, SARS and SARS-CoV-2 – and showed that researchers usually respond fast to public health emergencies with an increase in the number of publications. These authors also observed that publications on SARS and SARS-CoV-2 were mainly conducted by the outbreaks's epicenter – China, in joint strength with the USA. There were also indications that Europeans and Americans pay more attention to aspects of public health of the outbreaks, while China emphasizes biochemistry and molecular biology, and Japan focuses on pharmacology.

For decades, the USA has been the top country in bibliometric analysis, as shown by Ellegaard and Wallin[46]. However, our findings showed that, regarding bibliometric studies on SARS-COV-2, China is leading. This is probably because it was where the outbreak started, and it has been ahead of the studies related to this virus since the beginning[6]. Multiple authors composed most of the publications, and this can be explained by the fact that areas of study are becoming more multidisciplinary and the knowledge combination generates studies with higher quality and impact[47].

Scopus was the most used database among the retrieved articles. This platform covers research in science, technology, social science, medicine, arts and humanities. Scopus belongs to Elsevier and it is considered the largest abstract and citation database of peer-reviewed literature, including scientific journals, conference proceedings and books[48]. The second most used database was PubMed, a National Center for Biotechnology Information (NCBI) database with more than 30 million citations and abstracts on biomedical and life science literature[49]. The third most used database on these bibliometrics studies was Web of Science, a Clarivate database and one of the most multidisciplinary platforms for regional, specialty, data and patent records[50].

All of the three most frequent keywords used were related to the virus or its respective disease. COVID-19 stands for "coronavirus disease of 2019", and it is the nomenclature used for the disease caused by the virus SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2), a second strain of coronavirus responsible for causing SARS3. When the virus and its symptoms were first discovered in 2019 in Wuhan, China, researchers recognized it was a new virus from the *Coronaviridae* family, but did not know the related strain yet, so the first studies used the terminology 2019-nCoV1.

This study's data survey provides an overview of 30 bibliometrics studies involving the new coronavirus (SARS-CoV-2) in the world. Bibliometric studies aim to measure the activity and growth of science in general. Here we summarize the currently available information about bibliometric studies on SARS-CoV-2 published to visualize this field's behavior regarding the massive amount of information generated during this pandemic.

CONCLUSION

The scientific community faces one of its biggest challenges to solve a global health issue, the COVID-19 pandemic, caused by SARS-CoV-2. An unprecedented outburst of information about the virus and its disease is being produced, and this has demanded a collective scientific effort reflected in the daily publication of hundreds of studies (articles, preprints, clinical guides and protocols). Bibliometric methods are being more frequently used by the scientific community to systematize this information. Researchers who access this kind of analysis become aware of the new scientific production tendencies and make their results available for the public policymakers, scientists, and other interested parties.

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