Original Article

Bibliometric Analysis of the Worldwide Scientific Production on COVID-19 Infection and Cerebrovascular Disease

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ABSTRACT

Objective: To identify the worldwide bibliometric characteristics of research on SARS-CoV-2 infection and cerebrovascular disease.

Methods: A retrospective, descriptive, and bibliometric study was performed. We analyzed 1834 publications about COVID-19 and cerebrovascular disease from the Scopus database considering the time since the beginning of the pandemic between 2019 and 2020. Bibliometric indicators were evaluated such as number of citations, citations per publication by authors, countries, journals, and collaborations at national, international, institutional, and impact levels according to Cite Score Quartile and h-index metrics. All analysis was performed using SciVal software.

Results: The highest percentage of articles corresponded to universities in the United States, including Harvard and New York with 59 and 20 publications, respectively, and the University of Toronto in Canada with 22 publications. In relation to citation indicators, journals such as Stroke and Journal Stroke and Cerebrovascular diseases obtained 1971 and 561 citations, respectively. Regarding collaboration indicators, the national collaboration index was 39.4% and the institutional collaboration index was 31.1%. Finally, neurology, cardiovascular medicine, and cardiology and surgery were the subject areas with the highest research results, with 424, 217, and 128 studies, respectively.

Conclusion: It was observed that the United States was the country with the highest scientific production on COVID-19 and cerebrovascular disease in the year 2020 in the different health areas; however, more research is still needed worldwide for a better analysis of the bibliometric indicators on the subject.

Keywords: Bibliometric, cerebrovascular disease, COVID-19, scopus

INTRODUCTION

Currently, the pandemic due to the SARS-CoV-2 virus has had a great impact on the health area, bringing with it serious social, economic, and political consequences.[1] For this reason, there has been a continuous search for information on its adequate management using various studies and trials according to age groups.[2] It has been described that the Sars-Cov-2 virus has a protein in the form of a spike as a component, which, upon binding to the angiotensin-converting enzyme receptor, facilitates the entry of the virus into other cells.[3] Because this receptor is expressed in alveolar cells, myocytes, arterial muscle cells, gastrointestinal tract, kidney, liver, etc., it gives rise to a varied clinical picture with gastrointestinal,

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neurological, renal, and dermatological symptoms, among others.[4]

Considering that the average age of patients with cardiovascular disease (CVD) is between 62 and 65 years and the male/female ratio is 1.47,[5] a link has been observed between COVID-19 and high mortality rates in CVD patients. The range in patients with COVID-19 is from 3.7 to 5%.[6,7] To this end, it has been suggested that the current situation has not allowed adequate management of patients due to the fear of contagion in healthcare institutions, whether public or private.[8]

According to the literature, tomographic imaging tests have shown findings that correspond to cerebrovascular diseases among the most common of ischemic origin with a mortality rate of 50% in patients hospitalized for COVID-19.[9] In addition, it states that a history of stroke increases the probability of death due to SARS-CoV-2 infection.[8] However, a history of hypertension, dyslipidemia, and diabetes, which are the most frequent in our population, has been associated with inadequate regulation of the ACE-2 receptor, complicating the patient's condition due to virus infection. That being said, high production of angiotensin II increases endothelial damage and dysfunction that favors cerebrovascular disease.[3]

The scientific method implemented was a bibliometric analysis. This type of method is of great help to researchers when conducting a retrospective study of many publications.[10] The database selected for this project was Scopus, which has several scientific items for a more accurate search of articles related to the selected topic and is an outstanding database that has reliable and high-quality works.[11,12]

For this reason, the aim of this study was to identify the bibliometric characteristics of worldwide scientific research on COVID-19 infection and cerebrovascular diseases.

MATERIALS AND METHODS

Study design
A bibliometric, descriptive, and retrospective study about COVID-19 and cerebrovascular disease was performed with secondary data from Scopus whose search date was October 13, 2021, with an average of 1834 publications.

Database
All data from the Scopus database were collected with the help of the SciVal tool to search for journals, articles, and/or publications of greater relevance for the present study; in addition, it was used for the analysis of bibliometric

indicators due to its capacity to instantly analyze many publications worldwide.[12]

Search strategy
The search strategy used in this study was the Emtree thesaurus of Embase and Mesh (PubMed). With the terms generated, an advanced search could be performed in the Scopus database. Publications such as articles, reviews, short surveys, systematic reviews, and clinical trials were included. In addition, documents corresponding to conference papers, letters, editorials, book chapters, notes, and errata on COVID-19 and cerebrovascular disease were excluded, resulting in a total of 1605 publications [Figure 1]. The advanced search strategy formula was as follows:

TITLE-ABS-KEY (2019*cov OR cov OR (((cov) W/2 (19 OR 2019 OR 2)) AND NOT ("Coefficient* of variation" OR "Torsion" OR cov*o*)) OR (*covid W/2 (19 OR 2019 OR 2)) OR covid**19 OR (*covid AND NOT tocovid) OR ((coronavirus OR "Coronavirus" OR cov) W/2 (disease OR infection) W/2 (2019 OR 19 OR 2)) OR ((sars OR "Severe acute respiratory syndrome*" OR sras) W/2 (cov OR coronavirus OR "Coronavirus" OR covid) W/2 ("2" OR 2019 OR 19)) OR "SARS-CoV2" OR sarscov2 OR "SRAS-CoV2" OR "Severe acute respiratory syndrome COV2" OR ((((novel OR wuhan OR china OR pandemi* OR outbreak OR "new human" OR crisis OR "new cases" OR "normalcy") W/2 (coronaviru* OR "coronaviru*" OR covid)) OR ("new corona*" AND NOT (coronar*)))) OR "Corona pandemic" OR (wuhan w/2 pneumonia) OR "Corona crisis" OR "Corona outbreak" OR "20I 501Y. V1" OR "20J501Y.V3" OR "CAL.20C" OR "20H501Y. V2" OR "mRNA 1273 vaccine" OR "Covishield" OR "AZD1222" OR "Ad26.COV2.S" OR "JNJ 78436735" OR "Ad26COVS" OR "BNT162 vaccine" OR "BNT162-01" OR "BNT162b1" OR "BNT162a1" OR "BNT162b2" OR "BNT162c2") AND (LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020)) AND TITLE-ABS-KEY ("Cerebrovascular Accident*" OR "Vascular Accident* Brain" OR "Brain Vascular Accident*" OR "Cerebrovascular Stroke*" OR "Stroke* Cerebrovascular" OR "Cerebral Stroke*" OR "Stroke* Cerebral" OR "Stroke* Acute" OR "Acute Stroke*" OR "Cerebrovascular Accident* Acute" OR "Acute Cerebrovascular Accident*"

Bibliometric indicators
Different bibliometric indicators were analyzed, such as the number of publications and citations according to the country, author, and journal that has been registered for a study published up to the cutoff date of our work on COVID-19 and cerebrovascular disease. In addition,

we considered the different collaborations at the national level, that is, studies carried out by different authors/researchers/institutions from the same country, at the international level by authors/researchers/institutions from different countries, and at the institutional level by authors/researchers from different countries. The impact at the institutional level by authors/researchers from the same institution or without collaboration (single authorship) for these publications, as well as the impact according to the CiteScore quartile found by the average number of citations made specifically in the year it is published or in relation to up to 3 years that it was published by a journal; H-index, an author-level metric that measures both the productivity and the citation impact of publications; normalized source impact per article (SNIP), a complex metric that compares each journal's citations by number with the citation potential in its domain, defined as the set of citations of publications from that journal; and field-weighted citation impact (FWCI), which is an indicator that compares the actual number of citations received by a document with the expected number of citations for documents of the same type.[13-17]

The data analyzed were obtained from the Scopus database, and then, the respective analysis was made in Scival with the different bibliometric indexes used in this study, and given that, Microsoft Excel was used to record them in tables, which are shown below in the results.

RESULTS

Top 10 most productive authors
Table 1 shows the authors who had the most scientific productions. Mocco, J, and Jabbour, P.M., from different affiliations. These two authors lead the list with the most citations, 1139 and 305, respectively. Mocco, J, and Jabbour, P. M., maintain their positions in the H-index with 59 and 50. The author with the most citations per publication is Fifi, Johanna T. with 160.4, followed by Mocco, J. with 113.9. Regarding the impact in publications, Mocco, J., leads the h-index table with a total of 59, followed by Jabbour

with an h-index of 50. The authors with the highest impact were Fifi, Johanna T. and Raz, Eytan, with 22, 28 and 20, 29, respectively.

Top 10 universities with the highest scientific production
Universities played a large role in the publication of various scientific studies in times of pandemic. Universities located in the United States, Canada, and England had the highest number of published papers. Details are shown in Table 2. Harvard University (United States), University of Toronto (Canada), New York University (United States), and Johns Hopkins University (United States) were the four institutions with the highest scientific output. Harvard University (United States) has the most citations, followed by the University of London (England).

Top 10 scientific journals
According to the CiteScore percentile, 229 (54.5%) papers on polymyxin resistance were published in the top 10% of journals. Table 3 shows the top 10 journals with the highest number of publications on COVID-19 and cerebrovascular diseases. Stroke, Journal of Stroke and Cerebrovascular Diseases, and Frontiers in Neurology with 61, 43, and 27 publications, respectively. Stroke journal remains in the first place also in citations, having about 1971 citations, followed by the Journal of Stroke and Cerebrovascular Diseases with 561 citations. The journals Stroke, Journal of Stroke and Cerebrovascular Diseases, and Frontiers in Neurology have the highest number of authors, 501, 423, and 244, respectively. However, the journal Stroke showed twice the value of SNIP compared to the rest of the journals with 2.481.

Collaboration of scientific production
With respect to the papers used in the study, both national, international, and institutional collaboration, as well as those without any collaboration were observed in Table 4. Having as results of only national collaboration (n: 334, 39.4%), only institutional collaboration (n: 264, 31.1%), international collaboration (n: 174, 20.5%), and finally

Table 1: Top 10 most productive authors

Name	Scholarly Output	Most recent publication	Citations	Citations per Publication	Field-Weighted Citation Impact	H-index
Mocco, J.	10	2020	1139	113.9	16.91	59
Jabbour, P. M.	9	2020	305	33.9	13.36	50
Spiotta, Alejandro M.D.	8	2020	90	11.3	5.13	33
Biller, Josè A.	8	2020	233	29.1	10.85	37
Leslie-Mazwi, Thabele M.	7	2020	31	4.4	1.43	29
Borhani-Haghighi, Afshin	7	2020	74	10.6	3.81	27
Raz, Eytan	7	2020	421	60.1	20.29	26
Fifi, Johanna T.	7	2020	1123	160.4	22.28	20
Yaghi, Shadi R.	7	2020	312	44.6	14.9	26
Elkind, Mitchell S.V.	7	2020	166	23.7	8.2	77

Table 2: Top 10 universities

University	Country/ Region	Scholarly Output	Citations	Authors	Citations per Publication	FWCI
Harvard University		59	2725	127	46.2	9.65
University of Toronto		22	437	33	19.9	6.5
New York University		20	886	67	44.3	14.81
Johns Hopkins University		19	765	25	40.3	8.71
University of California		17	442	25	26	8.2
Columbia University		16	341	38	21.3	7.23
Yale University		16	702	45	43.9	12.18
University College London		14	1741	38	124.4	33.09
University of Calgary		14	287	12	20.5	6.26
University of Pennsylvania		14	581	40	41.5	18.12

Table 3: Top 10 scientific journals

Scopus Source	Publications	Citations	Authors	Citations per Publication	Source-Normalized Impact per Paper (SNIP)	SiteScore 2020	SCImago Journal Rank(SJR)
Stroke	61	1971	501	32.3	2.4	12.7	3.3
Journal of Stroke and Cerebrovascular Diseases	43	561	423	13	0.9	2.9	0.7
Frontiers in Neurology	27	259	244	9.6	1.2	4	1.2
American Journal of Neuroradiology	26	315	160	12.1	1.5	5.8	1.3
Neurological Sciences	17	272	142	16	1.0	4	0.7
World Neurosurgery	13	69	58	5.3	1.0	2.9	0.7
Journal of NeuroInterventional Surgery	13	228	119	17.5	2.0	8.2	2.6
European Journal of Neurology	10	184	90	18.4	1.7	7.4	1.8
Thrombosis Research	10	413	53	41.3	1.3	6.6	1.1
Journal of the Neurological Sciences	9	233	70	25.9	1.0	5.1	0.9

without collaboration (n: 76, 9.0%). Therefore, it was observed that national collaboration leads this list with the highest number of citations (n: 9212), and institutional collaboration comes close with a minimum difference in citations (n: 9205). However, citations by publication showed that both institutional collaborations followed by international collaboration with a percentage, respectively, of 34.9% and 33.4% was higher than national collaboration with 27.6%. In addition, it was evident that among the documents reviewed, there were very few without any collaboration.

Quantity and impact by quartile

Considering that our work is focused on pandemic times, we have been able to obtain data from the year 2020;

therefore, according to the Scopus database, we found those publications depending on the impact by Cite Score in Table 5. A total of 850 studies were extracted, from which, according to the degree of impact, 432 publications were found to belong to Q1 (top 25%), 262 to Q2 (top 26–50%), 106 to Q3 category (top 51–75%), and finally 50 to Q4 (top 76–100%). Therefore, it was shown that most of our reviewed studies were of Q1, being of higher relevance for many researchers and readers.

Top 5 thematic areas of scientific production

Within the thematic areas, the top 5 with the highest scientific production were found, including neurology, cardiovascular medicine and cardiology, surgery, general medicine, psychiatry, and mental health according to Table 6. Thus, the area of neurology has the most publications and citations (n: 424; n: 8665); however, general medicine has a minimal difference in terms of citations with 7939 compared to the other areas; however, cardiovascular medicine and surgery are superior in publications with 217 and 128, respectively. In terms of authors, it was observed that the area of neurology remained superior in relation to the other areas; however, in citations per publication, the majority was by general medicine with 74.9 and with a FWCI indicator of 9.52, followed by the area of psychiatry with 23.3 and 8.1, respectively.

DISCUSSION

Currently, the pandemic caused by the SARS-CoV-2 virus

Table 4: Collaboration of scientific production

Metric	%	Scholarly Output	Citations	Citations per Publication	FWCI
International collaboration	20.5	174	5803	33.4	8.15
Only national collaboration	39.4	334	9212	27.6	7.11
Only institutional collaboration	31.1	264	9205	34.9	7.32
Single authorship (no collaboration)	9.0	76	742	9.8	2.38

Table 5: Impact by Cite Score quartile

CiteScore quartile	2019	2020	Overall
Q1 (top 25%)	0	432	432
Q2 (top 26-50%)	0	262	262
Q3 (top 51-75%)	0	106	106
Q4 (top 76-100%)	0	50	50
Total	0	850	850

has greatly affected the population with a worldwide health crisis. Due to the mechanism of the virus, when it enters through the upper airways, it generates a respiratory clinical picture that makes its way to the digestive tract, thus affecting different organs. However, it has been described that the hypercoagulable state is more implicated with respect to cerebrovascular diseases due to a severe inflammatory response that causes tissue damage, raising the levels of D-dimer and fibrinogen.[18] There have been reports of different cases such as deep vein thrombosis, pulmonary embolism, myocarditis, etc., Also, it should be noted that the multi-organ damage caused by the condition complicates the patient's situation, leading to shock, possibly irreversible neurological deterioration, and even death.[19]

The scientific method to be used will be the biometric analysis. This biometric study aims to identify the scientific studies carried out on SARS-CoV-2 infection and cerebrovascular diseases. After an extensive review of the literature, recent publications on this point were found and those that have been done are mostly written in English. To this end, it is highlighted that there is another study that analyzed the biometry of both pathologies; however, it has a different database and search strategy. Therefore, this work will help professionals from different health fields such as neurology, internal medicine, etc., for their respective analysis of scientific publications on the subject.

The database used in this work is Scopus for its qualities mentioned above. A recent work by Francesca de Felice and Antonella Polimeni also used the database we worked with. Other important studies such as the one generated by Panpan Wang and Deqiao Tian had as a source the WOS Science Citation Index Expanded database, as did Hui Fang in his study on Recent trends in sedentary time: a systematic review of the literature. Erika Morganna Neves de Oliveira and colleagues used the same database as the previous study because it is considered a comprehensive database on scientific knowledge. However, a bibliometric study based on the African region by Fatima Hassan Geluid and colleagues used several sources, such as PubMed, African Journals Online, aRxiv, bioRxiv, Collabovid, and Google. Each study used COVID-19 in its keywords as did we. However, we had many different keywords as their study had another type of analysis of COVID-19.[20-23]
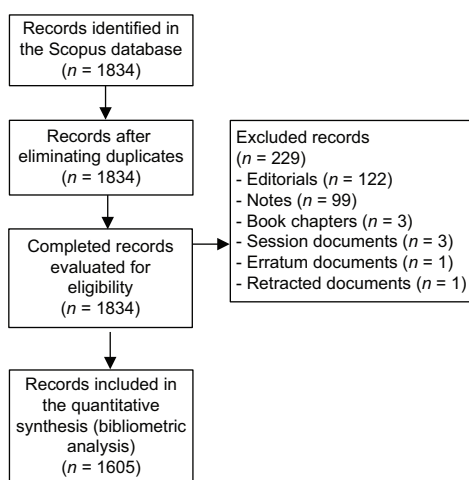
Table 6: Top 5 Thematic areas of scientific production

Subcategory	Scholarly Output	Citations	Authors	Citations per Publication	FWCI
Neurology (clinical)	424	8665	2682	20.4	6.97
Cardiology and Cardiovascular Medicine	217	4748	1895	21.9	7.1
Surgery	128	2046	923	16	7.23
General Medicine	106	7939	638	74.9	9.52
Psychiatry and Mental Health	58	1353	485	23.3	8.1

The most active authors who contributed with several works about COVID-19 and cerebrovascular disease are Mocco, J, and Jabbour, P.M. These authors have over 1139 and 305 citations, respectively. In a recent bibliometric study conducted in Southeast Asia that investigated trends in production on COVID-19, the leading author had a maximum of 461 citations. A bibliometric study that evaluated the 100 most cited articles on COVID-19 and type 2 diabetes mellitus was led by Awadesh Kumar Singh of GD Hospital and Diabetes Institute, Kolkata, India. The countries that had the most scientific support in the pandemic were first-world countries such as the USA, Canada, England, Italy, and China. Each country had a large representation by its universities. In this study, the most active universities were Harvard University with 2725 citations in the United States and the University of Toronto with 437 citations in Canada. In the bibliometric work carried out in Southeast Asia, the most productive university was the National University of Singapore located in Singapore with a total of 80 publications and 4107 citations. The bibliometric work that analyzed the trends between COVID-19 and diabetes mellitus is led by Columbia University. A bibliometric study on COVID-19 that had the World Health Organization (WHO) as its database has the All-India Institute of Medical Sciences as the most productive entity, and in second place is the Post Graduate Institute of Medical Education and Research (PGIMER), both entities being the most active in scientific production in India, making the first-world countries the most active in supporting COVID-19 research.

The journals have a great role in sponsoring studies. In our study, which is based on a neurological disease has journals for that field such as Stroke, which is the leading journal with 61 publications and 1971 citations, followed by the

Journal of Stroke and Cerebrovascular Diseases with a total of 61 publications and 661 citations, both being in the United States. The studies conducted in Southeast Asia had the main journal Frontiers in Public Health with a total of 10 publications, followed by Environmental Science. The bibliometric work studying diabetes with COVID-19 has Lancet and some related journals as the main journals, with a total of 24,221 visits. Another study found was carried out in India with the WHO database with the Indian Journal of Medical Research (IJMR) as the most active journal with 14 publications. Therefore, it has been seen that journals from the United States are the most influential and active with respect to SARS-CoV-2 infection.

Different areas of research are important because of the diverse viewpoints that each can provide. Our study as a neurological research-based work has as the most active research area the specialty of neurology, the fact that it is a disease of vascular origin has the specialty of cardiology as the second most active area. The Southeast Asian work, being based more on purely COVID-19 research, has clinical medicine as the most active area, followed by biochemistry, genetics, and molecular biology.[24-26]

This study presented some limitations to be developed. The main limitation was the scientific studies provided by Scopus. The need for researchers on this topic increased months after the arrival of the pandemic generated by COVID-19. Therefore, we only got to analyze studies that were published between 2020. In addition, our study was only based on the Scopus database; therefore, studies indexed in other databases were not considered. Therefore, other databases were not considered. Caution should be exercised when analyzing the results obtained from scientific publications on this topic. Finally, articles from non-indexed journals were excluded from this study. The last limitation of bibliometric design is that it cannot establish causality or clinical implications, but it does allow us to analyze the characteristics, impact, and quality of what is being published on a given topic.

The Scopus database is affiliated with outstanding research journals. This quality guarantees the elimination of gray literature and that the documents collected met demanding standards to be selected by this database. However, it is true that a large scientific production on COVID-19 and cerebrovascular disease has been noted in the Scopus database, evidencing exponential growth, and continuous research is encouraged worldwide to support the data provided in this study.

Figure 1: Flow diagram

CONCLUSIONS

The number of papers on COVID-19 and cerebrovascular disease started in 2020 because of the pandemic. A large percentage of papers were from English-speaking countries such as the United States and England. This, together with the high quality of the journals in which they were published, demonstrates the great importance of the topic.

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Conflicts of interest
There are no conflicts of interest.

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