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Measuring Global Scientific Research On COVID-19: A Bibliometric Analysis

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Abstract

The COVID-19, become the critical health issues globally since its outbreak in China in December 2019, since, then the global research has spiked on this topic. The objective of the present study is to know the publications on COVID-19 by conducting a bibliometric analysis using available data on the Scopus database. The Selected documents related to COVID-19 extracted on 26th April 2020 from Scopus. The following analysis parameters used for this study are the pattern of authorship, international collaboration, document types, languages, published sources, affiliations, country-wise contributions, and citations. The present study analysed 3693 publications were available as on 26th April 2020 on Scopus from 116 countries. The highest number documents 51.16% published as articles, and the majority of them (94.40 %) are available in English. China has topped the list with 1053 (28.51%) publications with 5831 citations, while the USA (299) has the highest number of international collaboration. This study also found that Mahase, E. from the UK is the most prolific author with 31 publications, and Huazhong University of Science and Technology, China topes the affiliation list with 131, while *BMJ Clinical Research Ed* published the highest (125) articles.

Keywords: COVID-19; Novel coronavirus; Communicable diseases; Scientific Research; Bibliometric analysis; Scopus

Background

The unpredicted COVID-19 (Coronavirus Disease-2019), a disease caused by the coronavirus SARS-CoV-2 (Severe Acute Respiratory SyndromeCoronavirus-2) has been found in December 2019 in Wuhan, the capital of China's Hubei province.[1-2] The researchers sequenced the genome of the new virus and figured out 86.9% of the genome is the same as the SARS-CoV genome.[3] Since, then it has been outbreak to 215 countries across the globe with 3442234 confirmed cases, and 239740 deaths as on 04th May 2020, and WHO called it as Pandemic on 30th January 2020.[4] The common symptoms of the disease varied from mild self-limiting flu-

like illness to fulminant pneumonia, respiratory failure and death.[5] With a rapidly growing number of new cases across the globe, the research community is working hard for the vaccine; hence, it has allowed publishing their research works on COVID-19.

The bibliometric analysis is a crucial tool to evaluate the current research trends as well as scholarly networks in various research disciplines.[6] To know the research outputs on COVID-19, a bibliometric analysis performed to understand the research characteristics such as highly prolific authors, country-wise contribution, highly productive journals, research institutions, international collaboration, and citation habits. This analysis would give proper guidance to new and budding researchers.[7]

Materials and Methods

The present study uses the Scopus[8], an Elsevier's abstract and citation database for retrieving the data for the study. This study on COVID-19 had 3693 research outputs within six months due to global research on the topic. The data extracted and completed on 26th April 2020 by using the keyword "COVID-19" to avoid changes in the data due to daily updates in the database by Scopus. Besides, present study also used Journal Citation Reports (JCR)[9], an annual publication published by Clarivate Analytics available through Web of Science (WoS) and is accessed from the Web of Science-Core Collections and Altmetric[10] to analyse citation-based metrics for highly cited articles. VOSviewer[11] has been used to visualizing bibliometric networks of search results.

The present study analysis parameters include the year of publication, document types, research institutions, affiliations, journals, prolific authors, impact factor (IF), and citations. The statistical data retrieved from the database was put to the spreadsheet to analyse the same. The data has been calculated and represented in tables; quantitative and inferential methods have been used to analyse the same.

Review of Related Literature

The literature review helps the researchers "join the conversation" by providing context, methodology, identifying innovation, minimizing duplicative research, and ensuring that professional standards are met.[12] The failure of a quality literature review is associated with many problems such as repetition of the study, not grounded in theory, weak in methodologically, and fail to expand the research beyond a single setting.[13]

Chiu, Huang and Ho (2004)[14] had conducted a bibliometric study on Severe Acute Respiratory Syndrome (SARS), the authors used the Science Citation Index (SCI), the analysis parameters included language, document type, authorship, number of time cited, authorship, and patterns

of international collaboration. This study found that 32% of the total share published as news features, and the lowest as letters with 13%, and the remaining were biographic items, corrections, meeting abstracts, and reprints. The USA produced the highest number of publications which shared 30% of the total share, followed by Hong Kong with 24%. This study also found that 63% of papers published by the mainstream countries, and English and mainstream country domination in production. Zyoud (2016)[15] had studied a similar analysis on Middle East respiratory syndrome coronavirus (MERS-CoV) publications published between 2012 and 2015. The authors had found 883 MERS-CoV research publications during the period across the globe. The research publications on MERS-CoV originated from 92 countries/territories, the USA was the topmost significant contributor, with 319 articles published over four years with the highest *h*-index, while Netherland produced the most considerable proportion of publications with international research collaboration (72.7 %). This study also found that the USA, UK and KSA had a quality of articles according to the value of *h*-index. Chahrour et al. (2020)[16] have done a particular bibliographic study on COVID-19 by using the PubMed database and the World Health Organization (WHO) databases up to 18th March 2020. They have analysed 564 publications from 39 different countries, and 24% of the papers were from affected countries. As per the data analysis, China produced the highest number of publications with 377 publications (67%). Lou et al. (2020)[17] also used PubMed for the study; they found 183 publications between 14th January 2020 to 29th February 2020. All these publications published in 80 journals with the first corresponding authors from 20 different countries. The highest number of authors are from the hospital 78 (42.6%), followed by the university 64 (35%) and from research institutions 39 (21.3%) The most of these articles have been published in *Journal of Medical Virology* with 25 publications. China has made the highest contribution with 123 articles. Another study conducted by Danesh and GhaviDel (2020)[18] on global scientific production on Coronavirus from 1970 to 2019 by using Web of Science (WoS). There were 5128 Coronavirus subject area documents available during this period, the highest number of articles were published in 2005, while the most top citations marked in 2019. The researchers found that Enjuanes L. is the most proliferated author, and the USA has contributed the highest number of publications. The University of Hong Kong was the top organization in Coronavirus in the last half-century. The recent study conducted by Shri Ram (2020)[19] has also analysed a 50 years' bibliographic analysis like another study by Danesh and GhaviDel[18] on Coronavirus (a large family of viruses). This study also showed that the highest number of publications came from the USA (5646 articles, 31.67%), while the

University of Hong Kong was the productive institute with *The Journal of Virology* had published the highest number of articles on CoV.

Results

A total of 3693 COVID-19 related publications retrieved for the study, only 2 (0.06%) publications published in 2019, and the remaining 3691 (99.94%) published in 2020. Around 51.16% (1889) of the total share published as articles, 16.37% (604) as letters, 11.98% (442) as editorials, 9.28% (343) as notes, and the remaining being short survey, erratum, conference paper, and data paper. Among 3693 articles, the highest number of publications are available in English 3486 (94.40 %) followed by Chinses 169 (4.58 %), German 27 (0.74%), and 5 (0.13%) in French and Italian, and only 1 (0.2%) in Korean. The COVID-19 related research publications were contributed from 116 countries/territories, indicating the international spread of the research.

Productive Countries

Table-**1** shows the top 10 countries with the highest number of publications. Of 3693 publications in which 3252 (88.05%) contributed by the top 10 countries, China and USA have shared (54.85%) publications within top ten countries due to highest cases in the early stages. Unlike other two studies[16-17] China has topped the list with 1053 (28.51%) articles within six months with an average of 5.53 citations per article; this is followed by the United States 731 (19.79%), the United Kingdom 368 (9.96%), Italy 357 (9.66%), and India 147 (3.98%). The total number of citations for these publications have already reached 9852, with an average of 2.66 citations for each paper, out of 3252 from top ten countries, 1227 (37.73%) published with international collaborations. The USA tops the highest number of articles with the international collaborations shared 299 (40.90%) articles come from 731 publications collaborated with 47 countries. China again topped the list not only by the highest of publications, even with the highest in country-level *h*-index with 29. Hirsch[20] in 2005 has proposed the index *h*, he defined as "the number of papers with citation number ≥*h*, as a useful index to characterize the scientific output of a researcher", China is followed by USA (17), UK (13), and Italy (8), while Germany has ten *h*-index even though it has only 117 research outputs with 402 citations.

Table-1: Top ten countries in COVID-19 research

SCR	Countries	TP	Citations	ACPP	*h* index	CC	ICP
1	China	1053 (28.51%)	5831	5.53	29	32	225 (21.36%)
2	United States	731 (19.79%)	1458	1.99	17	47	299 (40.90%)
3	United Kingdom	368 (9.96%)	634	1.72	13	37	181 (49.18%)
4	Italy	357 (9.66%)	372	1.04	8	36	140 (39.21%)
5	India	147 (3.98%)	93	0.63	5	34	51 (34.69%)
6	France	142 (3.84%)	140	0.98	7	28	52 (36.61%)
7	Canada	125 (3.38%)	249	1.99	8	25	75 (60%)
8	Germany	117 (3.16%)	402	3.43	10	36	68 (58.11%)
9	Australia	112 (3.03%)	421	3.75	5	30	76 (67.85%)
10	Switzerland	100 (2.70%)	236	2.36	8	27	60 (60%)

SCR: standard competition ranking; TP: total publications; ACPP: average citations per publication; CC: country collaboration; ICP: internationally collaborated papers

Figure-1: International Collaboration

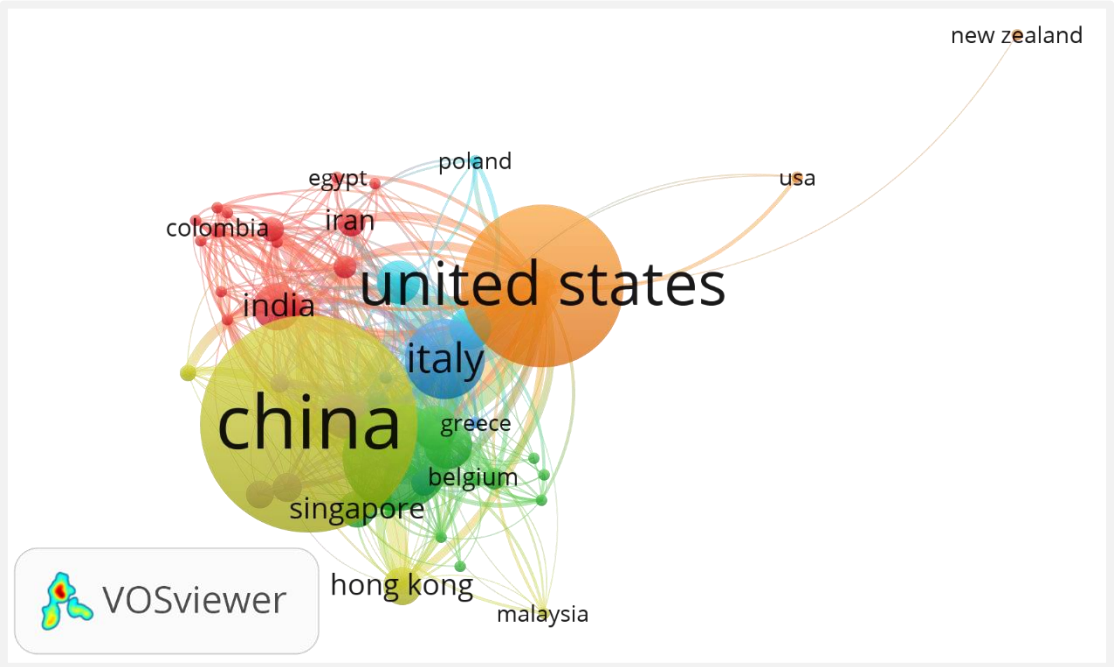


Figure-**1**: International collaboration visualization map shows a network of co-authorship among the authors from different countries. Any collaborating country with a minimum number of 5 documents considered for the visualization and a total of 47 countries met the threshold in 07 clusters. Countries with larger circle size or font had relatively more publications

Productive Journals

The COVID-19 publications (3693) published in 158 different journals, but most of the articles are published in *BMJ Clinical Research Ed* (125 of 3693 articles), followed by, *Journal of Medical Virology* (102), *The Lancet* (93) and *Clinical Infectious Diseases* (49) (**T**able-**2**). *New England Journal of Medicine* has the highest impact factor as per the 2018 JCR report with 70.670, and it is in 7th place with 38 articles published on COVID-19. *Lancet Infectious Diseases* and *Medicine and Infectious Disease* journals are shared 5th place in the table with 48 articles each in the journals with 23088 and 1576 citations respectively, while *Zhonghua Liu xing bing Xue za Zhi* a Chinese journal has achieved 14959 citations for 29 publications.

Table-2: The top 10 productive journals in COVID-19 research

SCR	Journals	TP	TCJ	IF 2019
1	BMJ Clinical Research Ed	125	112901	27.604
2	Journal of Medical Virology	102	8197	2.049
3	The Lancet	93	247292	59.102
4	Clinical Infectious Diseases	49	64031	9.055
5	Lancet Infectious Diseases	48	23088	27.516
5	Travel Medicine And Infectious Disease	48	1576	4.868
6	JAMA Journal Of The American Medical Association	47	156350	51.273
7	New England Journal of Medicine	38	344581	70.670
8	Journal Of Infection	35	6946	5.099
9	Infection Control And Hospital Epidemiology	33	9857	2.856
10	Zhonghua Liu xing bing Xue za Zhi	29	14959	0.491

SCR: standard competition ranking; TP: total publications; TCJ: total citations for journals; IF: impact factor

Highly Cited Publications

Table-**3** depicts the top 10 cited papers for COVID-19. The ten most frequently cited articles have been cited an average 31.70 times. The highest citations are received for Huang C. et al. article which is cited for 714 times which was published in 2020 in *The Lancet*, followed by Zhu, N. et al. with 459 citations which was published in the *New England Journal of Medicine* in 2020. Out of the top 10 highly cited articles, *The Lancet* and *New England Journal of Medicine* have shared four articles each, and rest two have appeared in *Nature* and *JAMA - Journal of the American Medical Association* respectively. Most of the top-cited publications published in high impact factor journals, the earlier studies have shown high IF journals will likely to get more citations[21-22]. The following article Clinical features of patients infected

with 2019 novel coronavirus in Wuhan, China written by Huang C. et al.[1] is topped in the Altmetrics ranking with 13886, followed by Wu Z. and McGoogan J.M. (11632), and Guan W. J. et al. with 9915.

Table-3: The top 10 highly cited publications in COVD-19 research

SCR	Authors*	Article Titles	Year	Language	Journal	Citations	IF $_{2019}$	Altmetrics
1	Huang C. et al. (28)	Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China	2020	English	The Lancet	714	59.102	13886
2	Zhu N. et al. (18)	A novel coronavirus from patients with pneumonia in China, 2019	2020	English	New England Journal of Medicine	459	70.670	4814
3	Chen N. et al. (13)	Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study	2020	English	The Lancet	402	59.102	4525
4	Chan J.F.W. et al. (20)	A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster	2020	English	The Lancet	298	59.102	4532
5	Zhou P. et al. (28)	A pneumonia outbreak associated with a new coronavirus of probable bat origin	2020	English	Nature	266	43.070	4369
6	Guan W. J. et al. (37)	Clinical Characteristics of Coronavirus Disease 2019 in China	2020	English	The New England Journal of Medicine	265	70.670	9915
7	Lu R. et al. (34)	Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding	2020	English	The Lancet	240	59.102	2315

8	Holshue M.L. et al. (24)	First case of 2019 novel coronavirus in the United States	2020	English	New England Journal of Medicine	190	70.670	9830
9	Wu Z. and McGoogan J.M.	Characteristics of and Important Lessons from the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72314 Cases from the Chinese Center for Disease Control and Prevention	2020	English	JAMA - Journal of the American Medical Association	184	51.273	11632
10	Rothe C. et al. (16)	Transmission of 2019-NCOV infection from an asymptomatic contact in Germany	2020	English	New England Journal of Medicine	152	70.670	9425

SCR: standard competition ranking; IF: impact factor
*Numbers mentioned in brackets against authors are the number of contributors for each article.

Productive Institutes

Among the ten highest contributed institutions (**T**able-**4**), China has topped with six institutions with 487 publications. The Huazhong University of Science and Technology, China has the maximum contribution with 131 articles with 1256 citations an average of 9.56% citations per article, followed by the Tongji Medical College, China (130 articles) and Chinese Academy of Medical Sciences & Peking Union Medical College, China (64 articles). Among the top ten institutions Zhongnan Hospital of Wuhan University, China has 16.98% highest average citations with 968 citations for 57 publications.

Table-4: The top 10 productive and influential institutions in COVID-19 research

SCR	Affiliation	COVID 19 Publications	Citations	ACPP	*h* index
1	Huazhong University of Science and Technology	131	1256	9.59	12
2	Tongji Medical College	130	1463	11.25	12
3	Chinese Academy of Medical Sciences & Peking Union Medical College	64	967	15.11	9
4	Zhongnan Hospital of Wuhan University	57	968	16.98	5

5	Fudan University	55	365	6.64	10
6	The University of Hong Kong	51	643	12.61	7
7	UCL	50	137	2.74	4
8	Wuhan University	50	325	6.50	8
9	Harvard Medical School	48	59	1.23	4
9	University of Toronto	48	152	3.17	8
10	Università Degli Studi di Roma La Sapienza	46	10	0.22	1

SCR: standard competition ranking; ACPP: average citations per publication

Discussion

This study showed a sudden increase in research activities related to COVID-19 within the past six months. China is the most productive country on COVID-19 publications with 1053 (28.51%) articles; it is because of the disease first found in the country. After, China, the other three countries have contributed more are United States (731), United Kingdom (368), and Italy (357) where the virus was affected more after China. The highest number of articles contributed in English 3486 (94.40 %) because it is extensively being used in the research activities to share their research, as well as most of the journals indexed in Scopus are available in the same language, a small proportion of the publications are also available in Chinses 169 (4.58 %) as China has contributed the highest number of publications on COVID-19.

The study found that the article was written by Huang C. et al. (28)[1] on Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China is one of the highly cited articles with 714 citations as on 26th April 2020, this article was published in *The Lancet* in 2020 within a stipulated time it becomes a highly influenced article on COVID-19.

This study also reveals that each article is having on an average 22 authors for each publications as this is the collaborative research on the disease because collaborative research activities help to find appropriate solutions as well as effective medications for the treatment of the illness[23-24]. The study also finds Mahase, E. from *BMJ* is the highly prolific author with 31 articles with 18 citations, followed by Wiwanitkit, V (20), and Iacobucci, G. with (17) articles. Out of 166 publications from top authors, 61 articles are contributed by three authors who are affiliated with *BMJ* journal, which shares 36.74% total publications. At the same time, Hsueh, P.R. is a highly cited author in the top ten list with 84 citations for 14 articles with 72 *h* index (**T**able-**5**). Since, the Medicine is the broader subject, hence the most of the articles are under Medicine which shared 62.4%, followed by Immunology and Microbiology (7.8%), and Biochemistry, Genetics and Molecular Biology (6.4%) (**F**igure-**2**).

Funding will play an essential role in the research[25-26]. There are 159 funding agencies have been made for the research on COVID-19, the National Natural Science Foundation of China has funded for the highest publications (126), followed by National Institutes of Health, USA (26), National Basic Research Program of China (24). Keywords are essentials and play an important role in retrieving the relevant articles[27]. **F**igure-**3** shows the keyword trends assigned by the authors. There are 1763 keywords are available on Novel Corona (COVID-19), in which 82 keywords have appeared a minimum five times. These 82 terms categorised and grouped under nine research topic clusters with nine different colours. COVID-19 in blue colour specifies that it has appeared early among all the keywords.

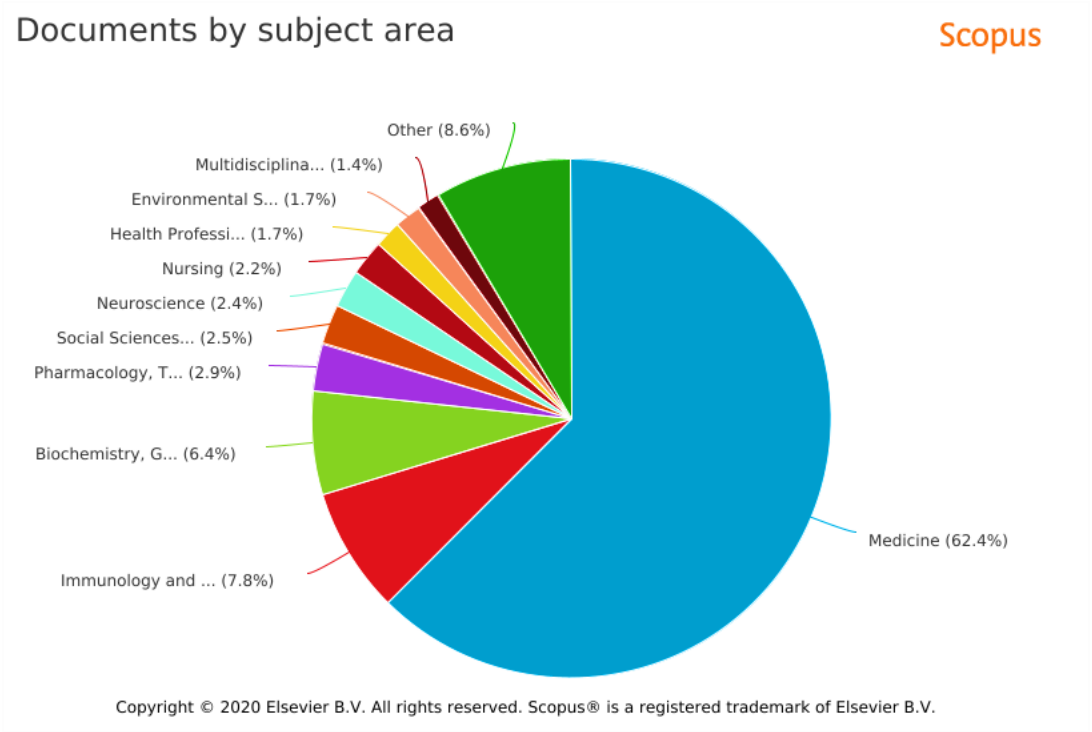
The critical limitation of the study is only Scopus database used to extract the data on COVID-19; hence, the publications listed on the other databases on the same subject are excluded from the study, and another possible limitation is that the data is taken till 26th April 2020, hence new publications, citations are not included after this date.

Table-5 The top 10 prolific authors

SCR	Authors	Affiliations	Country	COVID-19 Pub.	Citations	ACPP	Collaboration	CC	CACCP	TPAIS	TCAIS	*h* index
1	Mahase, E.	BMJ	UK	31	18	0.58	0	0	0	301	107	4
2	Wiwanitkit, V.	Hainan Medical University, Haikou	China	20	6	0.30	18	6	0.33	122	28	3
3	Iacobucci, G.	BMJ	UK	17	7	0.41	0	0	0	1052	648	8
4	Lippi, G.	University Hospital of Verona	Italy	16	33	2.06	9	15	1.67	1663	27180	66
5	Hsueh, P.R.	National Taiwan University	Taiwan	14	84	6.00	1	0	0	953	23707	72
6	Rimmer, A.	BMJ	UK	13	4	0.31	0	0	0	644	297	5
6	Rodriguez-Morales, A.J.	Universidad Tecnológica de Pereira	Colombia	13	41	3.15	12	36	3.00	434	3929	30
7	Joob, B.	Medical Academic Center	Thailand	12	5	0.42	12	5	0.42	626	336	6
8	The Lancet	The Lancet	UK	11	21	1.91	0	0	0	641	1197	14
9	Memish, Z.A.	Directorate, Ministry of Health, Riyadh	Saudi Arabia	10	27	2.70	10	27	2.70	641	60760	84
10	Baden, L.R.	Dana-Farber/Brigham and Women's Cancer Center	USA	9	19	2.11	0	0	0	217	9450	54

SCR: standard competition ranking; ACPP: average citations per publications; CC: collaboration citations; CACPP: collaboration average citations per publications; TPAIS: total publications by author indexed in Scopus; TCAIS: total citations by author indexed in Scopus

Figure-2: Documents by subject areas



Source: Scopus database

Figure-3: Co-occurrence of Author Keywords

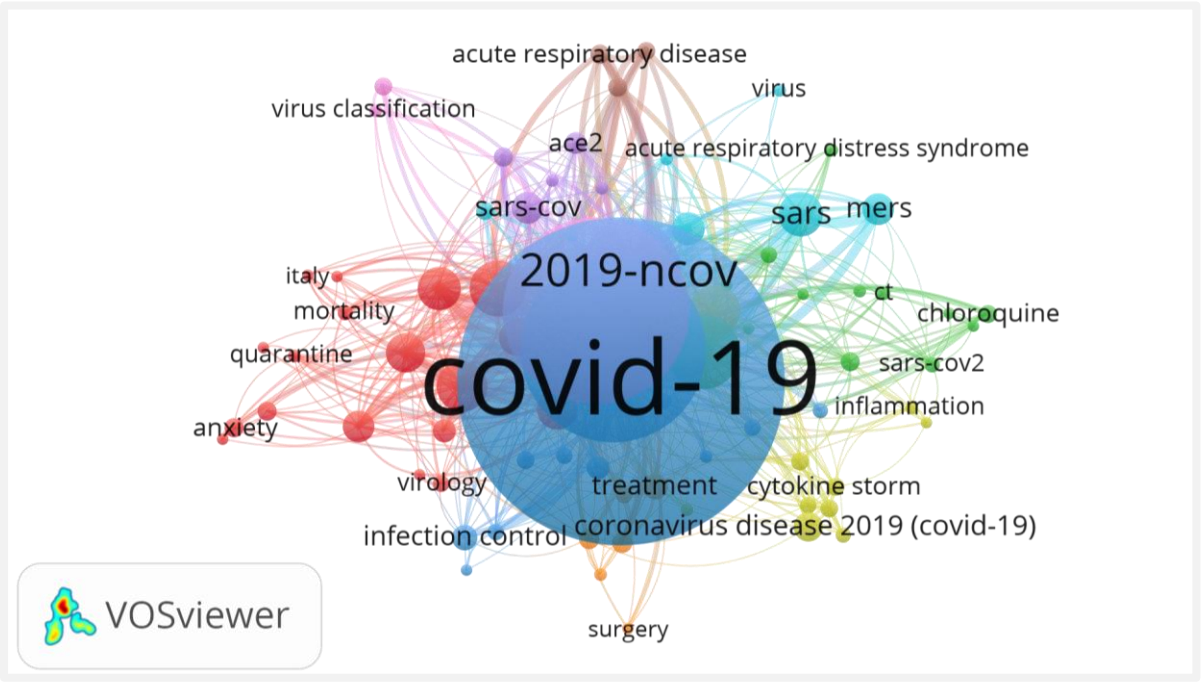


Figure-**3** Term visualization map of co-occurrence of author keywords with a minimum number of occurrences of a keyword with five. Among 1763 keywords 82 meet the threshold in nine clusters.

Conclusion

Based on the available data on the Scopus database for COVID-19, the characteristics of the research output on COVID-19 are analysed by applying bibliometric methods. The COVID-19 is a new study area as this virus was found at the end of 2019. Due, outbreak across the globe, this area is a rapidly increasing, within the six months, there are 3693 articles indexed on Scopus as on 26th April 2020, and the count is on. The highest number of publications are from China due to the first outbreak in the country, followed by the USA, UK, and Italy. This study finding shows the importance of the bibliometric method to give global research trends and outputs of COVID-19. Therefore, the present study provides a piece of useful information for medical practitioners, epidemiologists, policy makers, academicians, and researchers who are jointly working on COVID-19. As COVID-19 is the new disease and new research for many researchers, hence this study gives a snapshot on highly research areas, gaps in the publications, highly cited articles, prolific authors of the field for collaboration, funding agencies to help the researchers.

Data Availability

The data used to support the findings of the study are available from the corresponding authors upon request.

Conflicts of Interest

The authors declare that they have no conflict of interests.

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