Chapter 10
A Detailed Scientometric Review of Coronavirus Research

A. K. Srivastava, Sarika Verma, Medha Mili, Samarendra Maji, Arfat Anis, S. A. R. Hashmi, and Kunal Pal

1 Introduction

In late December 2019, an emergence (COVID-19) was first diagnosed in Wuhan, China, occurring due to a novel coronavirus [1]. The coronavirus has now been rapidly spread to almost all parts of the world [2]. The global outbreak of the novel coronavirus disease or COVID-19 has been declared as a pandemic like Ebola, Zika, and Nipah by the World Health Organization (WHO) on March 12, 2020 [2]. This is now considered to be of major international concern toward public health. The coronavirus disease (COVID-19) is triggered by 2019-nCoV or most commonly known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), belonging to the β-coronavirus cluster [3].

Earlier, the world has witnessed an endemic situation in Guangdong, China (2002), due to a severe acute respiratory syndrome (SARS) outbreak that was caused by SARS-CoV [4]. After a decade in the year 2012, an endemic occurred in the Middle Eastern countries that were caused by Middle East respiratory syndrome

A. K. Srivastava · S. Verma (✉) · M. Mili · S. A. R. Hashmi
Council of Scientific and Industrial Research-Advanced Materials and Processes Research Institute (AMPRI), Hoshangabad Road, Bhopal, M.P 462026, India
e-mail: sarika.verma@ampri.res.in

S. Maji
Department of Chemistry, SRM Institute of Science and Technology, Kanchipuram, Tamil Nadu 603203, India

A. Anis
Department of Chemical Engineering, SABIC Polymer Research Center, King Saud University, Riyadh, Saudi Arabia

K. Pal (✉)
Department of Biotechnology and Medical Engineering, National Institute of Technology, Rourkela 769008, India
e-mail: palk@nitrkl.ac.in

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coronavirus (MERS-CoV) [5]. Both the SARS-CoV and MERS-CoV belong to the β-coronavirus subgroup.

According to the report of the World Health Organization (WHO), the COVID-19 epidemic has already affected millions of people across the globe. The data itself is alarming, and the entire humanity is battling this era's most gut-wrenching war. However, till date, in the absence of specific therapeutic drugs or clinically approved vaccines for COVID-19, intensive research is urgently needed on the newly emerged SARS-CoV-2 to identify potential drug targets and for the eradication of the pathogenic mechanisms and epidemiological characteristics for the development of effective strategies for its prevention and treatment.

Coronaviruses (CoVs) consist of a single-stranded positive-sense RNA genome encapsulated within a membrane envelope [6, 7]. The coronaviruses consist of glycoprotein spikes on its outer surface, which are responsible for the attachment and entry of the virus to the host cells [8]. The receptor-binding domain (RBD) is loosely attached among the virus, which allows the virus to infect multiple hosts [9]. Their genomes contain 29,891 nucleotides that encode for 9860 amino acids [10]. CoVs are classified into four genera: Alphacoronavirus (alphaCoV), Betacoronavirus (betaCoV), Deltacoronavirus (deltaCoV), and Gammacoronavirus (gammaCoV) [11]. The SARS-CoV-2 belongs to the betaCoVs category and has a round, elliptic, or pleomorphic form, which has a diameter of 60–140 nm (approx.) [12, 13]. Similar to the other CoVs, they are sensitive to ultraviolet rays and heat. SARS-CoV-2 also possesses the typical coronavirus structure with spike protein [2]. This spike protein consists of a 3-D structure in the RBD region, which interacts with the host cells through the Van der Waals forces.

As reported in the literature, the SARS-CoV-2 also uses the same angiotensin-converting enzyme 2 (ACE2) cell receptor and the mechanism, which was previously used by the SARS-CoV for its entry into the host cell [7, 14]. SARS-CoV-2, similar to SARS-CoV and MERS-CoV, also attacks the lower respiratory system that causes viral pneumonia. Further, the virus also affects the gastrointestinal system, liver, kidney, heart, and central nervous system that lead to multiple organ failure [15].

According to recent information, SARS-CoV-2 is more transmissible/more contagious than SARS-CoV [7, 16]. A published report has revealed that the binding affinity of SARS-CoV-2 S protein to ACE2 is about 10−20 times higher than that of SARS-CoV S protein, which is speculated to be the reason behind the high transmissibility and contagiousness of SARS-CoV-2 as compared to SARS-CoV [7]. At the onset of the COVID-19, the main symptoms include fever, dry cough, fatigue, headache, and sore throat [17].

In severe cases, the patients may suffer from dyspnea and/or hypoxemia one week after the onset of the disease. But sometimes patients with even no obvious fever, mild fatigue, and no pneumonia, known as asymptomatic cases, can also spread SARS-CoV-2 between humans. The spread of the deadly virus from human-to-human is known to be transmitted via droplets or direct contact. Thus, there has been an urgent need for coronavirus-based research for detailed analysis in recent years. This will help in the availability of analyzed data under one common

umbrella and thus will be helpful in future research work related to coronavirus. Unfortunately, there is no such scientometric review of the coronavirus-based research till now. A considerable amount of knowledge can be gained in a specific domain by having a systematic literature review in a relatively short time [18]. One of the quickest methods is the bibliometric analysis to perform literature review of a specific area for a large number of publications [18]. The bibliometric analysis supports us by providing the current trends in research of a specific field along with detailed understanding of the various relationship of author citation and author cooperation etc.

In view of the above discussions, we propose to introduce the bibliometric analysis of research based on coronavirus so as to gain an insight of the influential authors, institutions, and countries involved in the said research field, the most cited research articles and journals, and lastly, the recent trends in the field of the study. For the bibliometric analysis, the records of publications were retrieved from the database of Web of Science.

2 Methodology

2.1 Data Source

Publication information was obtained using the search engine of Web of Science (WOS) database, SCI-Expanded, which was deemed as the optimal database, was analyzed via bibliometric analysis.

2.2 Search Strategy

All the publication information was extracted from the Web of Science, and the database was collected on April 16, 2020. In our study, the research terms used for searching the articles were as follows: The database search was conducted using the parameters: TS = ((coronavirus) OR (coronavirus)). There was no restriction on the timespan, which resulted in the fetching of the documents from the year 2000 to 2020.

2.3 Data Collection

The total number of documents obtained was 11,925. From the obtained pool of publications, the document type was restricted to “Article,” which reduced the count of publications to 9450. Further, the articles in “English” language were

segregated. This process brought down the total number of documents to 9257. Then, the "full records with references" data of these publications were downloaded as.txt files with the Tab-delimited (Win, UTF-8) file format. The information on citations, bibliography, abstract and keywords, funding details, and all other information was exported as CSV files from the analyzed results of the Web of Science search engine.

2.4 Bibliometric and Visualized Analysis

The bibliometric analysis was performed using the VOS viewer software, developed by Van Eck and Waltman [19]. The intrinsic function of Web of Science was used to describe the essential features of the eligible desired publications network. These networks commonly include global researchers, journals, or individual publications and can be developed based on various factors like bibliographic couplings, citations, co-citations, authorship or co-authorship relationships, funding agencies, publication source, etc. The VOS viewer software creates a graphical representation of the bibliometric data [19]. The distances between the nodes within the graphical representation are related with the closeness between the nodes. Different bibliometric maps were generated and analyzed [18, 19].

3 Results and Discussions

3.1 Yearly Distribution and Trend of Growth

Altogether, a total 9257 number of articles were published on the topic related to coronavirus. This depicts that researchers and scientists had a great attraction and interest in this research field. The total count of publications that are published on year-on-year basis shows a good projection of the strength of research in a specific field. The analysis of the trends in the number of publications per year may divulge information on the research interest in the near future. A plot of the number of publications versus cumulative publications on a year-on-year basis was used to analyze the trend of research in the area of coronavirus in the past years (Fig. 1a). The analysis of the plot suggested that the research in the related field could be dated back to the year 2000. The highest number of publications (613 documents) was published in the year 2004. But in the year 2020, until now, i.e., 16 April 2020, 381 articles already had been published. The year 2002 has witnessed a very less number of publications (130 documents). Post-2002, there was an increase in the publications, which reached the maximum in the year 2004. This can be accounted for the fact that in late 2002, there was this SARS epidemic. Hence, there was a sudden increase in the field of coronavirus. However, post-2004, there was a

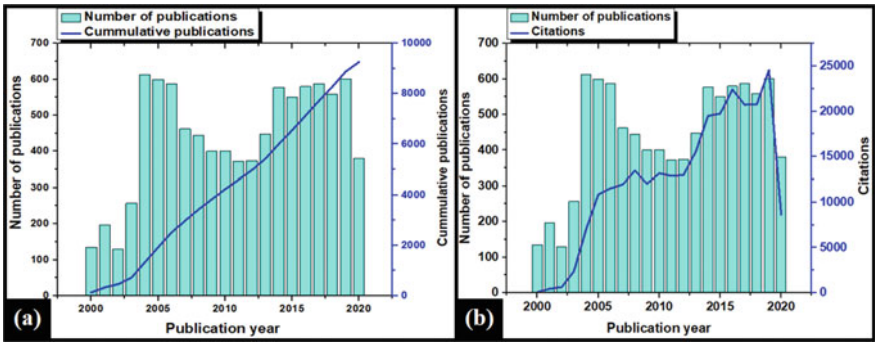

Fig. 1 Year-on-year publication information. **a** The number of publications and cumulative publications and **b** the number of publications and citations

decrease in the annual publications of articles until the year 2012. In late 2012, there was an outbreak of the Middle East respiratory syndrome (MERS). As a result of that, there was again an increase in the research in the field of coronavirus. Since the year 2014, the annual publications of the articles until the last year (2019) were similar. From the previous trends, it is quite expected that the number of publications is bound to increase in the year 2020. As a matter of fact, within the first three and a half months of the year 2020, nearly 400 articles on coronavirus have already been published. For the analysis of the graph of cumulative publications, the time period could be broadly divided into three main zones. The first zone of the period is between the years 2000 and 2004, wherein the research on coronavirus was increasing at a slow pace. Subsequently, during the period of 2004 to 2012, the momentum on the coronavirus research initially picked up. However, post-2006, the momentum was lost. In the third phase (2013–till date), there is a linear increase in coronavirus research. It is expected that the year 2020 will bring another turning point in coronavirus research across the globe.

The variation in the citations received by the publications during the 2000–2020 time periods has been summarized in Fig. 1b. During the period 2000 and 2002, the citations of the publications on coronavirus received very fewer citations. Since the year 2003, the number of citations had increased unexpectedly, and the increasing trend continued until 2008. This was quite expected because the researchers across the globe had started working on the coronavirus that was instigated by the SARS outbreak. Thereafter, until the year 2012, there was a plateau phase in terms of citations received by the publications on coronavirus. This suggested that the research on

coronavirus reached a stagnant phase. Since 2013, the number of citations per year showed an increasing trend even though the number of publications has remained fairly constant. This observation can be explained by the fact that the researchers were trying to gain insight on the coronavirus from the previously published publications. The average citation per year is 12,437. Although the year

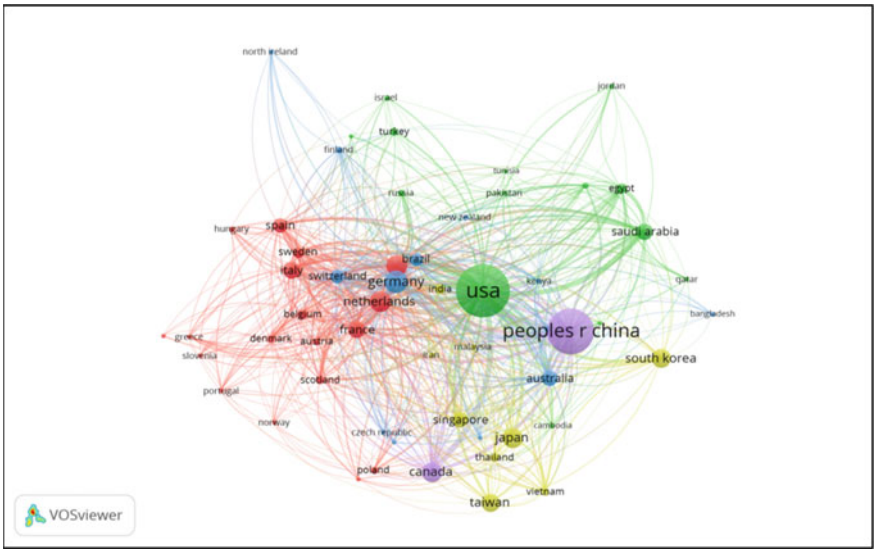

Fig. 2 Country cooperation network on coronavirus (N.B: (1) Countries that published at least more than ten documents were considered)

2020 has witnessed only just over 8500 citations, it is important to note that we are just within the first three and a half months of the year.

3.2 Country-Level Distribution of Publications

The 9257 number of documents was published from 126 countries, as tabulated in Table 1. The highest number of publications (3197 documents, 34.53% of the total documents) was reported from the United States of America (USA), followed by 2386 publications (25.77%) from Peoples R. China. Germany, the third rank holder, published 602 publications (6.50%). England and Netherlands were in fourth and fifth positions with 510 publications (5.50%) and 504 publications (5.44%), respectively. Further, the trend was followed by Japan, Canada, and South Korea. These countries had publications in the range of 406–470. Afterward, three countries that published documents were in the range of 329–366. Thereafter, five countries that published documents were in the range of 212–298, followed by another five countries that have published 115–189 documents. The analysis confirms the synergistic as well as a simultaneous approach between different countries in the area of coronavirus research. In total, 34 countries in the past had already published at least a hundred documents in the area of coronavirus. The statistics view of these countries is provided in Table 1. From the table, it is quite evident that 19 countries out of 56 countries had a nominal GDP rank below 20 indicating that

Table 1 Top countries that published more than ten documents

#	Country	Documents	% of 9257	Citations	Average citations per documents	Nominal GDP rank[a]	Total link strength
1	USA	3184	34.536	110,117	34.58	1	1941
2	Peoples R China	2382	25.775	65,472	27.49	2	1123
3	Germany	598	6.503	28,688	47.97	4	799
4	Netherlands	504	5.509	30,408	60.33	17	626
5	England	500	5.445	17,734	35.47	7	697
6	Japan	470	5.088	8794	18.71	3	196
7	Canada	461	5.002	17,417	37.78	10	407
8	South Korea	406	4.407	6934	17.08	12	152
9	Taiwan	366	3.954	9715	26.54	22	111
10	France	352	3.824	11,987	34.05	6	534
11	Italy	329	3.554	7234	21.99	8	276
12	Saudi Arabia	298	3.219	11,100	37.25	19	413
13	Singapore	277	3.003	10,557	38.11	38	229
14	Australia	274	2.982	9820	35.84	14	324
15	Spain	234	2.528	6979	29.82	13	226
16	Switzerland	212	2.301	9697	45.74	20	411
17	Brazil	189	2.042	1917	10.14	9	89
18	Sweden	133	1.437	4555	34.25	24	206
19	Belgium	122	1.329	2858	23.43	25	129
20	Egypt	117	1.264	2149	18.37	40	230
21	India	115	1.264	1637	14.23	5	84
22	Scotland	87	0.961	3710	42.64	–	166
23	Thailand	86	0.929	4016	46.70	23	90
24	Turkey	78	0.843	977	12.53	18	38
25	Poland	67	0.724	785	11.72	21	63
26	Austria	59	0.648	2550	43.22	28	96
27	Denmark	59	0.637	1408	23.86	39	107
28	Vietnam	59	0.637	2863	48.53	44	123
29	United Arab Emirates	54	0.583	1257	23.28	31	85
30	Finland	49	0.529	2626	53.59	45	55
31	South Africa	48	0.519	1279	26.65	37	70
32	Russia	47	0.508	1381	29.38	11	74
33	Iran	42	0.465	278	6.62	27	15

(continued)

Table 1 (continued)

#	Country	Documents	% of 9257	Citations	Average citations per documents	Nominal GDP rank[a]	Total link strength
34	Hungary	41	0.443	872	21.27	–	49
35	Israel	35	0.378	810	23.14	32	29
36	Mexico	32	0.346	1127	35.22	15	49
37	Kenya	31	0.335	1060	34.19	–	76
38	Malaysia	31	0.335	278	8.97	36	27
39	Norway	31	0.335	781	25.19	30	24
40	Greece	29	0.313	413	14.24	–	56
41	Portugal	24	0.259	377	15.71	49	41
42	Argentina	23	0.259	491	21.35	29	19
43	Qatar	23	0.248	732	31.83	–	36
44	Jordan	22	0.248	568	25.82	–	36
45	Czech Republic	18	0.216	628	34.89	–	29
46	Ireland	18	0.194	413	22.94	33	33
47	New Zealand	18	0.194	917	50.94	–	13
48	Pakistan	18	0.194	310	17.22	48	32
49	North Ireland	15	0.184	1085	72.33	–	29
50	Slovenia	15	0.162	297	19.80	–	21
51	Bangladesh	14	0.151	485	34.64	–	17
52	Tunisia	14	0.151	226	16.14	–	23
53	Ghana	13	0.14	608	46.77	–	33
54	Nigeria	13	0.14	418	32.15	26	34
55	Cambodia	12	0.13	210	17.50	–	45
56	Croatia	10	0.108	72	7.20	–	10

[a]Nominal GDP Rank as per the International Monetary Fund (2020 estimates), World Economic Outlook Database, February 2020

the economically developed countries are carrying out research on coronavirus. The USA has the most number of 110,117 citations from the 3184 documents, followed by Peoples R. China, Netherlands, Germany, and England. The publications from these countries had received 65,472, 30,408, 28,688, and 17,734 citations, respectively. Interestingly, the average citation per documents of North Ireland was in the first position (72.33) from 15 documents, followed by the Netherlands with an average citation of 60.33 from a total of 604 documents. Germany, England, Finland, and New Zealand, respectively, were subsequently in order of the countries that had an average citation of 50 or higher. It is important to note that India is ranked twenty-first, in terms of the published number of documents with an average citation per document of 14.23.

According to the VOS viewer manual, each and every link is assigned a strength, which is shown by a positive numerical value. The higher the value, the stronger is the link. In other words, the link and the assigned strength are directly proportional to each other. The TLS highlights the total number of publications with at least a common two keywords in the documents. The TLS also gives information related to the collaborative research in the common research area among different countries. The analysis of TLS, as shown in Table 1, suggested that USA, had TLS of 1941, was the most superior country by far in terms of collaborative research. USA was the major contributor in the area of coronavirus research and globally played a leading role. It was found that the USA had documents published in collaboration with many countries like Argentina, Cambodia, Egypt, Israel, Jordan, Nigeria, Pakistan, Qatar, Russia, Saudi Arabia, Tunisia, Turkey, and United Arab Emirates (Fig. 2). China was in the second position, with a TLS of 1123, followed by Germany in the third position with a TLS score of 799 in the collaborative research. The TLS score along with the cooperation network map suggests a strong research collaboration of many countries with USA and China. In the fourth and fifth positions were England and Netherlands, with a TLS of 626 and 697, respectively.

3.3 The Co-Authorship and Organizations Relationship

Further, the co-authorship and organization relationship was studied with a minimum number of documents of an organization and citations of an organization of being 10 and 1000 in number, respectively. Accordingly, the data of 150 organizations was obtained and is presented in Fig. 3 and Table 2. It shows that the University of Hong Kong was in the first position with 417 documents and 56.62 average citations. The TLS of the University of Hong Kong was 384. After the University of Hong Kong, the Chinese Academy of Science with 306 documents, 33.80 average citations, and 283 TLS was in the second position. The third position was occupied by the "Center for Disease Control and Prevention," which have 191 documents, 55.87 average citations per document, and TLS of 210. Univ Utrecht and Chinese Academy Gramsci have 184 and 162 documents with 45.80 and 17.41 average citations and 170 and 45 TLS with other organizations.

3.4 Relationship of Authors and Co-Authors

The author and co-authorship network visualization map was created on the basis of bibliographic data gathered from the core collection. The analysis helps in identifying the major groups across the globe that is working in a research field related to coronavirus. This is achieved easily by mapping the relationship of authors with the co-author, as depicted in Table S2 and Fig. 4, respectively. Easy and visual representation of the relationship is obtained using the mapping process, which makes

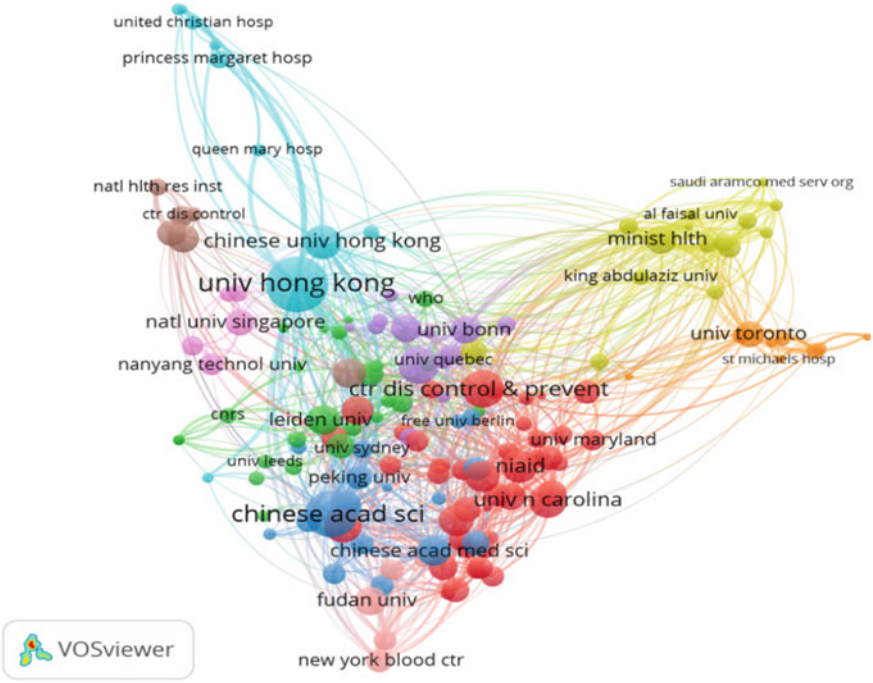

Fig. 3 Co-authorship—organizations of the researchers who are working in the area of coronavirus research. (N.B.: (1) Authors who have published at least ten documents were considered)

the study of both the individual activity of an author as well its interconnectivity with other research groups much easier. Figure 5 depicts five major groups (considering the presence of at least five authors in each group) that are working in the field of coronavirus. The research group of the author named Yuen Kwok-yung was the prominent group in the research field of coronavirus. Yuen Kwok-yung had the highest number of documents (number of documents = 120) among all other researchers, followed by Ralph S. Baric and Christian Drosten, with 111 and 109 total number of documents, respectively. The analysis of the TLS suggests that there is a significant research collaboration work among many of the researchers. However, some of the researchers are not involved in much research collaboration. It is of understanding that research collaboration improves critical information and knowledge flow among the different research groups all over the world. Extensive research collaboration among all the authors will definitely help in enhancing the improvement in the quality of the research on coronavirus. Further, Table 3 depicts the details of the count of published documents by the authors and their citation metrics, which helps to identify the most active researchers in this coronavirus research field. As already mentioned, the authors Kwok-Yung Yuen, Ralph S.Baric, and Christian Drosten had the highest number of published documents. However,

Table 2 Co-authorship and organizations relationship

Id	Organization	Documents	Citations	Average citations per document	TLS
1	Univ Hong Kong	417	23,612	56.62	384
2	Chinese Acad Sci	306	10,342	33.80	283
3	Ctr Dis Control and Prevent	191	10,672	55.87	210
4	Univ Utrecht	184	8427	45.80	170
5	Chinese Acad Agr Sci	162	2821	17.41	45
6	Chinese Univ Hong Kong	162	5209	32.15	124
7	Univ N Carolina	155	6759	43.61	153
8	Niaid	149	7380	49.53	181
9	Univ Iowa	140	4257	30.41	98
10	Univ Penn	132	4395	33.30	100
11	Leiden Univ	124	7179	57.90	119
12	Natl Inst Infect Dis	124	2413	19.46	21
13	Chinese Acad Med Sci	121	3760	31.07	212
14	Minist Hlth	115	5307	46.15	285
15	Natl Taiwan Univ	114	2698	23.67	86
16	Fudan Univ	109	2858	26.22	193
17	Seoul Natl Univ	109	2451	22.49	11
18	Univ Bonn	104	6108	58.73	165
19	Erasmus Mc	101	7146	70.75	105
20	Univ Calif Davis	100	2749	27.49	59
21	Ohio State Univ	98	2665	27.19	46
22	Univ Toronto	98	4641	47.36	208
23	Acad Sinica	97	2799	28.86	102
24	Natl Univ Singapore	92	3695	40.16	63
25	Vanderbilt Univ	92	4215	45.82	89
26	Univ Georgia	88	1895	21.53	51
27	Univ Minnesota	88	2343	26.63	101
28	Csic	87	2862	32.90	28
29	Peking Union Med Coll	85	2646	31.13	176
30	Univ Washington	83	3699	44.57	111
31	Peking Univ	81	2087	25.77	53
32	Cornell Univ	78	2430	31.15	51
33	Inst Pasteur	78	4386	56.23	111
34	Scripps Res Inst	78	3007	38.55	81
35	Johns Hopkins Univ	76	2374	31.24	58
36	Sun Yat Sen Univ	76	1286	16.92	61
37	Harvard Univ	75	5997	79.96	88
38	New York Blood Ctr	74	2591	35.01	155
39	Univ Oxford	74	2484	33.57	147

(continued)

Table 2 (continued)

Id	Organization	Documents	Citations	Average citations per document	TLS
40	Nanyang Technol Univ	71	1553	21.87	51
41	Wuhan Univ	69	1821	26.39	58
42	Univ Illinois	67	1700	25.37	57
43	Chinese Ctr Dis Control and Prevent	66	1815	27.50	99
44	Univ Colorado	65	2109	32.45	50
45	Univ Maryland	65	2074	31.91	53
46	Univ Texas Med Branch	65	1702	26.18	86
47	Natl Yang Ming Univ	63	1336	21.21	40
48	Purdue Univ	62	1478	23.84	42
49	Univ So Calif	62	2329	37.56	25
50	Zhejiang Univ	62	1680	27.10	61
51	King Saud Univ	60	1233	20.55	114
52	Tsinghua Univ	59	1641	27.81	55
53	Acad Mil Med Sci	58	1116	19.24	55
54	Beijing Inst Microbiol and Epidemiol	58	1768	30.48	122
55	Univ Tennessee	58	1311	22.60	31
56	Loyola Univ	56	2755	49.20	63
57	Univ Amsterdam	54	2398	44.41	43
58	Univ Zurich	54	2793	51.72	68
59	Inst Mol and Cell Biol	53	1493	28.17	40
60	Texas A & M Univ	53	1336	25.21	18
61	Univ Calif Irvine	51	1736	34.04	38
62	Iowa State Univ	50	1739	34.78	36
63	Univ Sydney	50	1322	26.44	41
64	Washington Univ	49	3176	64.82	68
65	Columbia Univ	48	2235	46.56	61
66	Nih	48	2922	60.88	92
67	Princess Margaret Hosp	48	3164	65.92	70
68	Alfaisal Univ	47	1516	32.26	163
69	Kansas State Univ	47	1010	21.49	42
70	Univ Calif San Francisco	46	5977	129.93	56
71	Shanghai Jiao Tong Univ	45	1261	28.02	49
72	Univ Florida	45	1087	24.16	55
73	Univ Texas	45	2472	54.93	22
74	Univ Wurzburg	44	4309	97.93	50
75	Univ Manitoba	42	2348	55.90	38
76	Singapore Gen Hosp	41	3392	82.73	50
77	Univ Bristol	41	1396	34.05	60

(continued)

Table 2 (continued)

Id	Organization	Documents	Citations	Average citations per document	TLS
78	Univ Quebec	41	1242	30.29	15
79	Emory Univ	40	1677	41.93	73
80	King Faisal Specialist Hosp and Res Ctr	40	1548	38.70	105
81	Natl Hlth Res Inst	40	1167	29.18	46
82	Ucl	40	3497	87.43	131
83	Univ Edinburgh	40	2271	56.78	78
84	Who	40	3173	79.33	77
85	Natl Vet Inst	39	1390	35.64	17
86	Cnrs	36	1759	48.86	68
87	Colorado State Univ	36	1301	36.14	42
88	King Abdulaziz Univ	36	1531	42.53	70
89	Mt Sinai Hosp	36	2380	66.11	89
90	Univ British Columbia	36	3556	98.78	38
91	Ecohlth Alliance	34	1637	48.15	56
92	Indiana Univ Sch Med	34	1623	47.74	108
93	New York State Dept Hlth	34	1940	57.06	26
94	Tan Tock Seng Hosp	34	1127	33.15	42
95	Nci	33	1292	39.15	34
96	Robert Koch Inst	33	1563	47.36	47
97	Univ Med Ctr Utrecht	33	1686	51.09	35
98	Univ Reading	33	1292	39.15	41
99	Cleveland Clin	32	1420	44.38	47
100	Ctr Dis Control	32	4192	131.00	44
101	Univ Virginia	32	1099	34.34	92
102	Mcmaster Univ	31	1330	42.90	49
103	Bernhard Nocht Inst Trop Med	30	5148	171.60	54
104	United Christian Hosp	30	2829	94.30	56
105	Univ Giessen	30	1389	46.30	41
106	Univ Leeds	30	1059	35.30	15
107	Univ London Imperial Coll Sci Technol and Med	30	1556	51.87	40
108	Univ Helsinki	29	1099	37.90	23
109	Free Univ Berlin	28	1048	37.43	28
110	Inst Anim Hlth	28	1404	50.14	8
111	Karolinska Inst	28	1996	71.29	50
112	Yale Univ	28	1071	38.25	17
113	Usda Ars	27	1230	45.56	19
114	Queen Mary Hosp	26	3273	125.88	46

(continued)

Table 2 (continued)

Id	Organization	Documents	Citations	Average citations per document	TLS
115	Univ Queensland	26	1499	57.65	24
116	Beijing Inst Radiat Med	25	1240	49.60	22
117	Natl Inst Publ Hlth and Environm	25	1539	61.56	35
118	Univ Hlth Network	23	1529	66.48	55
119	Univ Marburg	23	2934	127.57	27
120	Univ Massachusetts	23	1928	83.83	29
121	Pamela Youde Nethersole Eastern Hosp	22	2468	112.18	30
122	Tsing Hua Univ	22	1014	46.09	24
123	Univ Hosp	22	1110	50.45	11
124	Al Faisal Univ	21	2377	113.19	77
125	Kantonal Hosp St Gallen	21	1730	82.38	51
126	King Abdul Aziz Med City	20	1006	50.30	60
127	Csiro Livestock Ind	19	1544	81.26	13
128	Gordon Life Sci Inst	19	1484	78.11	18
129	Prince Sultan Mil Med City	19	1406	74.00	97
130	Univ Freiburg	19	1638	86.21	36
131	Guangzhou Ctr Dis Control and Prevent	18	1700	94.44	24
132	USA	18	1504	83.56	29
133	Dept Hlth	16	3069	191.81	36
134	Hosp Sick Children	16	1630	101.88	44
135	Univ Aix Marseille 1	16	1044	65.25	43
136	Univ Aix Marseille 2	16	1044	65.25	43
137	Goethe Univ Frankfurt	15	2999	199.93	18
138	Mt Sinai Sch Med	14	1383	98.79	20
139	Tufts Univ	14	1272	90.86	9
140	Hlth Protect Agcy	13	1096	84.31	20
141	Saudi Aramco Med Serv Org	13	1804	138.77	60
142	St Michaels Hosp	13	1510	116.15	42
143	Karolinska Univ Hosp	12	1629	135.75	19
144	Queen Elizabeth Hosp	12	2285	190.42	27
145	Erasmus Univ	11	3557	323.36	15
146	Royal Childrens Hosp	11	1255	114.09	13
147	Wellcome Trust Sanger Inst	11	1300	118.18	50
148	Austrian Acad Sci	10	1228	122.80	23
149	Erasmus Med Ctr	10	1952	195.20	16
150	Toronto Med Labs	10	1118	111.80	33

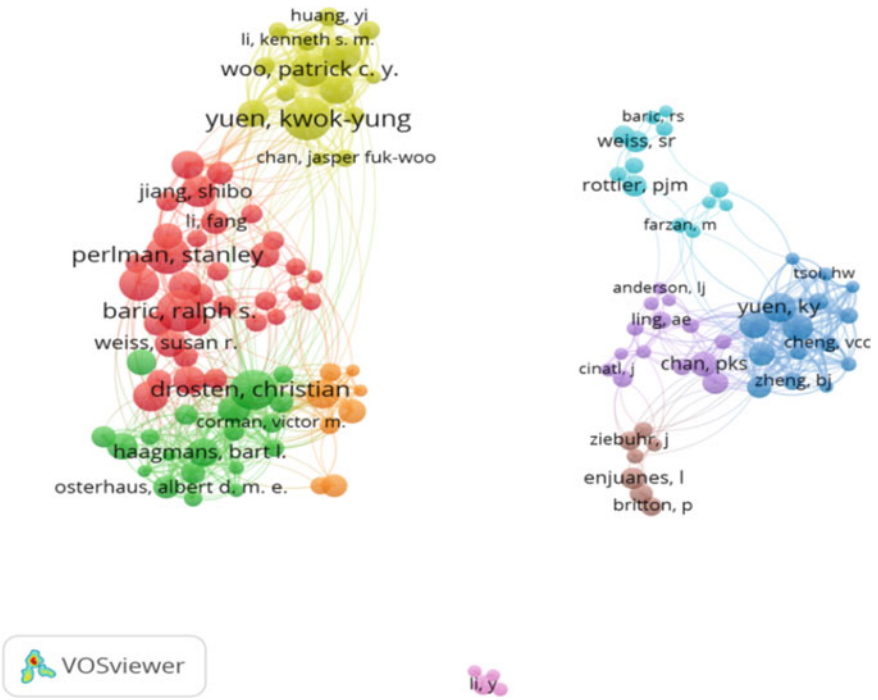

Fig. 4 Authors and co-authors relationship of the researchers who are working in the area of coronavirus research (N.B.: (1) Authors who have published at least twenty-five documents were considered)

the highest number of citations is of Ky Yuen, followed by Khandyuen Chan and Kwok-Yung Yuen, respectively, which indicated that these three authors are the most cited researchers on coronavirus across the globe. However, the information about the most impactful researchers can be provided by the average citations per document. In other words, a good quality paper can be identified by calculating average citations per document. It was found that W. Lim (documents: 14 citations: 411) followed by Lj Anderson (documents: 10 citations: 396), Adme Osterhaus (documents: 16 citations: 344), Ron A. M. Fouchier (documents: 11, citations: 245) and Theo M. Bestebroer (documents: 10, citations: 233) had the highest average citations per document. This is suggestive of the fact that the documents of W. Lim, Lj Anderson, Adme Osterhaus, Lj, Ron A. M. Fouchier and Theo M.Bestebroer were more impactful as compared to the others.

Table 3 Top authors who published more than twenty-five documents

Id	Author	Documents	Citations	Average citations per document	TLS
1	Yuen, Kwok-Yung	120	6176	51.47	420
2	Baric, Ralph S	111	3843	34.62	86
3	Drosten, Christian	104	5614	53.98	250
4	Perlman, Stanley	99	2790	28.18	86
5	Enjuanes, Luis	77	2251	29.23	51
6	Woo, Patrick C. Y	74	3935	53.18	325
7	Lau, Susanna K. P	72	3714	51.58	324
8	Jiang, Shibo	63	2002	31.78	125
9	Snijder, Eric J	63	3131	49.70	42
10	Memish, Ziad A	58	4198	72.38	118
11	Chan, Kwok-Hung	56	4269	76.23	253
12	Yuen, Ky	56	8074	144.18	255
13	Mueller, Marcel A	53	3297	62.21	160
14	Denison, Mark R	51	1663	32.61	36
15	Du, Lanying	51	1787	35.04	126
16	Thiel, Volker	51	2740	53.73	70
17	Haagmans, Bart L	50	3287	65.74	152
18	Chan, Kh	49	7149	145.90	242
19	Weiss, Susan R	49	1141	23.29	11
20	Peiris, Jsm	48	7789	162.27	200
21	Rottier, Peter J. M	47	2128	45.28	63
22	Zheng, Bo-Jian	45	2548	56.62	149
23	Saif, Linda J	41	1077	26.27	2
24	Wang, Lin-Fa	41	1499	36.56	18
25	Zhao, Jincun	41	1332	32.49	48
26	Baker, Susan C	40	1656	41.40	11
27	Chan, Pks	40	2208	55.20	51
28	Li, Fang	38	1136	29.89	49
29	Al-Tawfiq, Jaffar A	37	2516	68.00	72
30	Osterhaus, Albert D. M. E	35	3788	108.23	92
31	Zhou, Yusen	35	1046	29.89	100
32	Gerber, Susan I	34	1049	30.85	11
33	Guan, Y	34	7414	218.06	152
34	Sung, Jjy	33	1561	47.30	45
35	Frieman, Matthew B	32	1306	40.81	17
36	Rottier, Pjm	32	2350	73.44	25
37	Graham, Rachel L	31	1130	36.45	43
38	De Haan, Cornelis A. M	30	1052	35.07	35

(continued)

Table 3 (continued)

Id	Author	Documents	Citations	Average citations per document	TLS
39	Drexler, Jan Felix	30	1399	46.63	64
40	Gorbalenya, Alexander E	30	1535	51.17	34
41	Poon, Llm	30	6923	230.77	138
42	Weiss, Sr	30	1040	34.67	14
43	Ziebuhr, John	30	1004	33.47	19
44	Enjuanes, L	29	1601	55.21	2
45	Raj, V. Stalin	29	2700	93.10	117
46	Bosch, Berend-Jan	28	1485	53.04	65
47	Dijkman, Ronald	28	1290	46.07	52
48	Tseng, Chien-Te K	27	1147	42.48	41
49	Cavanagh, D	26	1357	52.19	25
50	Katze, Michael G	26	1198	46.08	32
51	Dediego, Marta L	25	1034	41.36	37
52	Gao, George F	25	1320	52.80	11
53	Li, Y	25	2633	105.32	19

3.5 Relationship of Distribution and Co-Citation

The relationship between sources and citations helps in concluding the interest of authors in which journals they prefer to publish their research results. The research articles that had published related to coronavirus in the important journals in the last twenty years are depicted in Table 4 and Fig. 5, respectively. From Table 4, it can be concluded that the most preferred and accepted choice is the "Journal of Virology" of many authors to publish their coronavirus-related research work. In the journal, till date 886 numbers of documents have been published with gathering 39,407 citations for the journal. The Journal "Virology" occupied the second position where 285 numbers of documents have been published with 7759 citations followed by the journal "PlOS One," in the third position where 341 publications were published and had received 4488 citations for these articles. The aforesaid three journals had a good TLS, suggesting that these journals were highly cited. This observation can also be confirmed from the source-citation relationship map. The average citations per document provide an indication of the impactful publications that are published in the journals. Taking into account the average citations per documents, the top journals were The New England Journal of Medicine and Science with 15 documents, each with 530.27 and 419.90 average citations per document. Nature Medicine has 13 documents with 178.15 average citations per document. Also, the journals proceedings of the National Academy of Sciences of the United States of America have 111 documents but have105 average citations per document. Similarly, The Lancet Infectious Diseases has only 36 and

Table 4 Top Journals where more than ten documents were published

Id	Source	Documents	Citations	Average Citations Per Document	TLS
1	Journal Of Virology	886	39,407	44.48	21,327
2	Virology	285	7759	27.22	7231
3	Plos One	241	4488	18.62	3795
4	Emerging Infectious Diseases	203	9300	45.81	4559
5	Journal Of General Virology	188	5877	31.26	4567
6	Virus Research	175	3251	18.58	4782
7	Archives Of Virology	159	2693	16.94	2395
8	Journal Of Virological Methods	149	2783	18.68	1867
9	Veterinary Microbiology	146	2706	18.53	2145
10	Journal Of Medical Virology	131	4159	31.75	1754
11	Viruses-Basel	115	916	7.97	2357
12	Journal Of Clinical Microbiology	112	5542	49.48	1947
13	Proceedings Of The National Academy Of Sciences Of The United States Of America	111	11,439	103.05	5364
14	Vaccine	99	2190	22.12	1926
15	Virology Journal	97	1611	16.61	1638
16	Antiviral Research	96	1709	17.80	1634
17	Journal Of Clinical Virology	93	2760	29.68	1357
18	Journal Of Infectious Diseases	93	4012	43.14	2185
19	Avian Diseases	92	1993	21.66	1016
20	Biochemical And Biophysical Research Communications	92	3366	36.59	2089
21	Virus Genes	92	1849	20.10	1576
22	Nidoviruses: Toward Control Of Sars And Other Nidovirus Diseases	89	369	4.15	889
23	Plos Pathogens	85	4610	54.24	2742
24	Scientific Reports	81	876	10.81	1377
25	Journal Of Biological Chemistry	79	4255	53.86	2520
26	Eurosurveillance	68	1975	29.04	1071
27	Clinical Infectious Diseases	64	4566	71.34	1235
28	Nidoviruses (Coronaviruses And Arteriviruses)	63	282	4.48	200
29	Journal Of Feline Medicine And Surgery	61	1018	16.69	584
30	Journal Of Veterinary Diagnostic Investigation	60	1436	23.93	642

(continued)

Table 4 (continued)

Id	Source	Documents	Citations	Average Citations Per Document	TLS
31	Mbio	57	2709	47.53	2104
32	Avian Pathology	56	1588	28.36	1109
33	BMC Infectious Diseases	56	1067	19.05	638
34	Journal Of Veterinary Medical Science	56	525	9.38	448
35	Infection Genetics And Evolution	55	847	15.40	1136
36	Journal Of Immunology	55	2526	45.93	1095
37	Emerging Microbes and Infections	46	372	8.09	1027
38	Transboundary And Emerging Diseases	45	541	12.02	646
39	BMC Veterinary Research	41	410	10.00	459
40	Pediatric Infectious Disease Journal	41	1413	34.46	459
41	Febs Letters	40	1100	27.50	898
42	Journal Of Wildlife Diseases	39	654	16.77	108
43	Current Opinion In Virology	37	855	23.11	970
44	Influenza And Other Respiratory Viruses	36	489	13.58	295
45	Lancet	36	8666	240.72	3005
46	Viral Immunology	35	360	10.29	444
47	International Journal Of Infectious Diseases	34	877	25.79	501
48	Nucleic Acids Research	34	1360	40.00	403
49	Veterinary Record	32	711	22.22	288
50	Chinese Medical Journal	31	218	7.03	324
51	Research In Veterinary Science	31	312	10.06	326
52	Bioorganic and Medicinal Chemistry	30	574	19.13	450
53	Bioorganic and Medicinal Chemistry Letters	30	677	22.57	347
54	Veterinary Immunology And Immunopathology	30	595	19.83	319
55	Journal Of Medicinal Chemistry	29	1061	36.59	566
56	Journal Of Molecular Biology	29	1651	56.93	1229
57	Veterinary Journal	28	568	20.29	274
58	Biochemistry	27	794	29.41	744
59	Clinical And Vaccine Immunology	27	287	10.63	345

(continued)

Table 4 (continued)

Id	Source	Documents	Citations	Average Citations Per Document	TLS
60	Epidemiology And Infection	27	199	7.37	255
61	Veterinary Research	26	264	10.15	433
62	Clinical And Diagnostic Laboratory Immunology	25	528	21.12	443
63	Poultry Science	25	252	10.08	252
64	American Journal Of Infection Control	23	210	9.13	156
65	Japanese Journal Of Infectious Diseases	23	160	6.96	222
66	Preventive Veterinary Medicine	22	436	19.82	190
67	Journal Of Infection And Public Health	21	128	6.10	203
68	Microbes And Infection	21	270	12.86	404
69	Acta Crystallographica Section F-Structural Biology Communications	20	65	3.25	219
70	Antiviral Therapy	20	417	20.85	249
71	Intervirology	19	130	6.84	270
72	Journal Of Infection	19	615	32.37	276
73	Journal Of Infection In Developing Countries	19	94	4.95	180
74	Journal Of Korean Medical Science	19	158	8.32	117
75	Nature	19	4823	253.84	1729
76	Pediatrics	19	1040	54.74	246
77	Zoonoses And Public Health	19	242	12.74	249
78	Frontiers In Microbiology	18	100	5.56	296
79	Journal Of Veterinary Internal Medicine	18	303	16.83	151
80	Acta Veterinaria Hungarica	17	78	4.59	79
81	Antimicrobial Agents And Chemotherapy	17	637	37.47	347
82	Chest	17	748	44.00	155
83	Clinical Microbiology And Infection	17	493	29.00	218
84	Journal Of Comparative Pathology	17	272	16.00	179
85	Acta Virologica	16	98	6.13	155
86	American Journal Of Pathology	16	629	39.31	314
87	American Journal Of Veterinary Research	16	287	17.94	175

(continued)

Table 4 (continued)

Id	Source	Documents	Citations	Average Citations Per Document	TLS
88	Journal Of Hospital Infection	16	333	20.81	189
89	Journal Of Neurovirology	16	206	12.88	144
90	Journal Of Theoretical Biology	16	676	42.25	80
91	Lancet Infectious Diseases	16	1897	118.56	934
92	Veterinary Pathology	16	304	19.00	215
93	Canadian Journal Of Veterinary Research-Revue Canadienne De Recherche Veterinaire	15	246	16.40	105
94	Chinese Science Bulletin	15	127	8.47	129
95	European Journal Of Clinical Microbiology and Infectious Diseases	15	166	11.07	167
96	European Journal Of Medicinal Chemistry	15	334	22.27	134
97	Journal Of Neuroimmunology	15	141	9.40	106
98	Nature Communications	15	464	30.93	446
99	New England Journal Of Medicine	15	7954	530.27	3591
100	Respirology	15	351	23.40	145
101	Science	15	6294	419.60	2992
102	Journal Of Microbiology And Biotechnology	14	65	4.64	132
103	Virologica Sinica	14	107	7.64	276
104	Acta Crystallographica Section D-Structural Biology	13	117	9.00	250
105	Diagnostic Microbiology And Infectious Disease	13	177	13.62	146
106	Infection Control And Hospital Epidemiology	13	165	12.69	83
107	Nature Medicine	13	2316	178.15	904
108	Australian Veterinary Journal	12	219	18.25	153
109	BMC Bioinformatics	12	256	21.33	100
110	BMC Genomics	12	238	19.83	140
111	Clinical Chemistry	12	472	39.33	261
112	DNA And Cell Biology	12	157	13.08	171
113	Immunology	12	283	23.58	132
114	Journal Of Biomedical Science	12	171	14.25	253
115	Microbiology And Immunology	12	79	6.58	233
116	Molecular And Cellular Probes	12	166	13.83	99

(continued)

Table 4 (continued)

Id	Source	Documents	Citations	Average Citations Per Document	TLS
117	Msphere	12	55	4.58	131
118	Protein Science	12	248	20.67	274
119	Proteomics	12	348	29.00	200
120	Tropical Animal Health And Production	12	91	7.58	89
121	Vector-Borne And Zoonotic Diseases	12	163	13.58	138
122	Acta Veterinaria Scandinavica	11	164	14.91	76
123	Applied Microbiology And Biotechnology	11	105	9.55	111
124	Brazilian Journal Of Microbiology	11	26	2.36	57
125	Cell Research	11	542	49.27	392
126	Cellular Microbiology	11	367	33.36	212
127	Comparative Medicine	11	137	12.45	41
128	Febs Journal	11	210	19.09	180
129	Infectious Disease Clinics Of North America	11	158	14.36	294
130	Journal Of The Formosan Medical Association	11	124	11.27	67
131	Journal Of Veterinary Medicine Series B-Infectious Diseases And Veterinary Public Health	11	516	46.91	92
132	Journal Of Veterinary Science	11	80	7.27	114
133	Journal Of Zoo And Wildlife Medicine	11	150	13.64	33
134	Molecular Immunology	11	142	12.91	184
135	Revue Scientifique Et Technique-Office International Des Epizooties	11	44	4.00	155
136	Structure	11	738	67.09	282
137	Travel Medicine And Infectious Disease	11	134	12.18	143
138	American Journal Of Respiratory And Critical Care Medicine	10	641	64.10	155
139	Biochemical Journal	10	244	24.40	158
140	Bioinformatics	10	183	18.30	43
141	Biomedical And Environmental Sciences	10	90	9.00	76

(continued)

Table 4 (continued)

Id	Source	Documents	Citations	Average Citations Per Document	TLS
142	Cell Host and Microbe	10	754	75.40	333
143	Ecohealth	10	167	16.70	106
144	Frontiers In Immunology	10	119	11.90	116
145	Human Vaccines and Immunotherapeutics	10	95	9.50	198
146	Journal Of Dairy Science	10	282	28.20	51
147	Protein Expression And Purification	10	124	12.40	110
148	Scandinavian Journal Of Infectious Diseases	10	146	14.60	97
149	Thorax	10	610	61.00	146

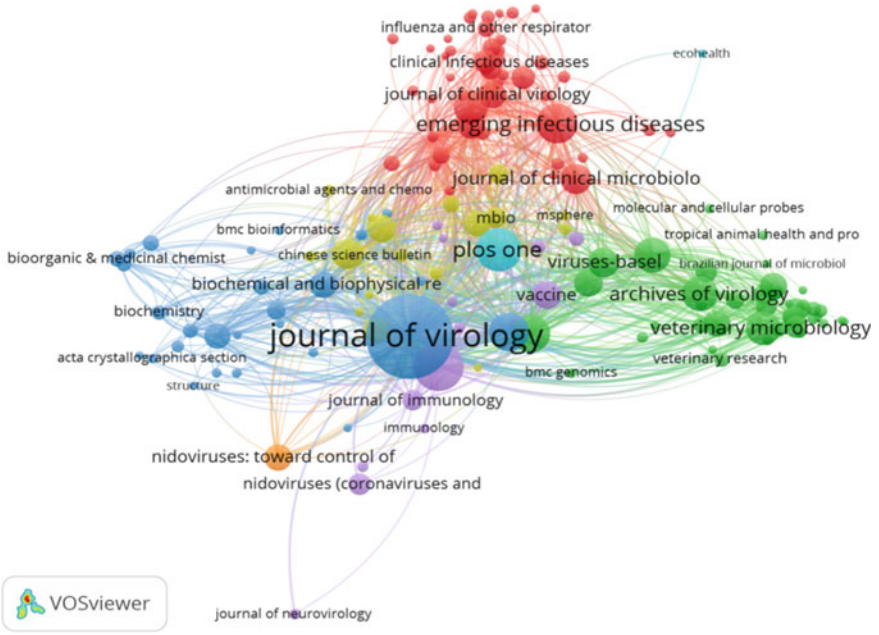

Fig. 5 Source and citations relationship of the sources that published documents on coronavirus research (N.B.: (1) Sources that have published at least ten documents were considered)

Table 5 Top documents that have been cited for at least 300 times

Id	Document	Citations	Links	References
1	Ksiazek (2003)	1891	23	[21]
2	Drosten (2003)	1802	18	[22]
3	Rota (2003)	1507	22	[23]
4	Peiris (2003a)	1472	18	[24]
5	Zaki (2012)	1353	13	[25]
6	Marra (2003)	1298	17	[26]
7	Allander (2005)	1037	5	[20]
8	Li (2003)	1009	11	[27]
9	Guan (2003)	918	10	[28]
10	Li (2005a)	877	9	[29]
11	Peiris (2003b)	852	7	[30]
12	Van Der Hoek (2004)	768	17	[31]
13	Snijder (2003)	686	15	[32]
14	Poutanen (2003)	678	9	[33]
15	Lau (2005)	658	15	[34]
16	Woo (2005)	658	15	[35]
17	Assiri (2013a)	562	7	[36]
18	Chen (2013)	549	2	[37]
19	Kuiken (2003)	499	8	[38]
20	Gaynor (2007)	496	5	[39]
21	Raj (2013)	492	8	[40]
22	Anand (2003)	473	6	[41]
23	Ruuskanen (2011)	461	1	[42]
24	Nicholls (2003)	412	3	[43]
25	Allander (2007)	397	4	[44]
26	Imai (2005)	390	5	[45]
27	Traggiai (2004)	389	4	[46]
28	Thiel (2003)	388	9	[47]
29	Chou (2015)	385	2	[48]
30	Bosch (2003)	380	5	[49]
31	Assiri (2013b)	378	2	[50]
32	Daffis (2010)	377	1	[51]
33	Fraser (2004)	377	2	[52]
34	Van Boheemen (2012)	371	12	[53]
35	Cinatl (2003)	362	1	[54]
36	Meyers (2005)	357	5	[55]
37	Reusken (2013)	353	3	[56]
38	Hota (2004)	349	0	[57]
39	Woo (2012)	338	10	[58]
40	Fouchier (2004)	338	16	[59]
41	Stevenson (2013)	336	1	[60]

(continued)

Table 5 (continued)

Id	Document	Citations	Links	References
42	Song (2012)	335	2	[61]
43	Yang (2003)	335	5	[62]
44	Chou (2003)	329	1	[63]
45	Zuest (2011)	323	2	[64]
46	Yang (2004)	322	6	[65]
47	Li (2005b)	313	7	[66]
48	Van Elden (2001)	309	0	[67]
49	Wang (2003)	308	4	[68]
50	Ge (2013)	306	6	[69]
51	Simmons (2005)	306	3	[70]
52	Azhar (2014)	305	4	[71]
53	Knoops (2008)	303	2	[72]

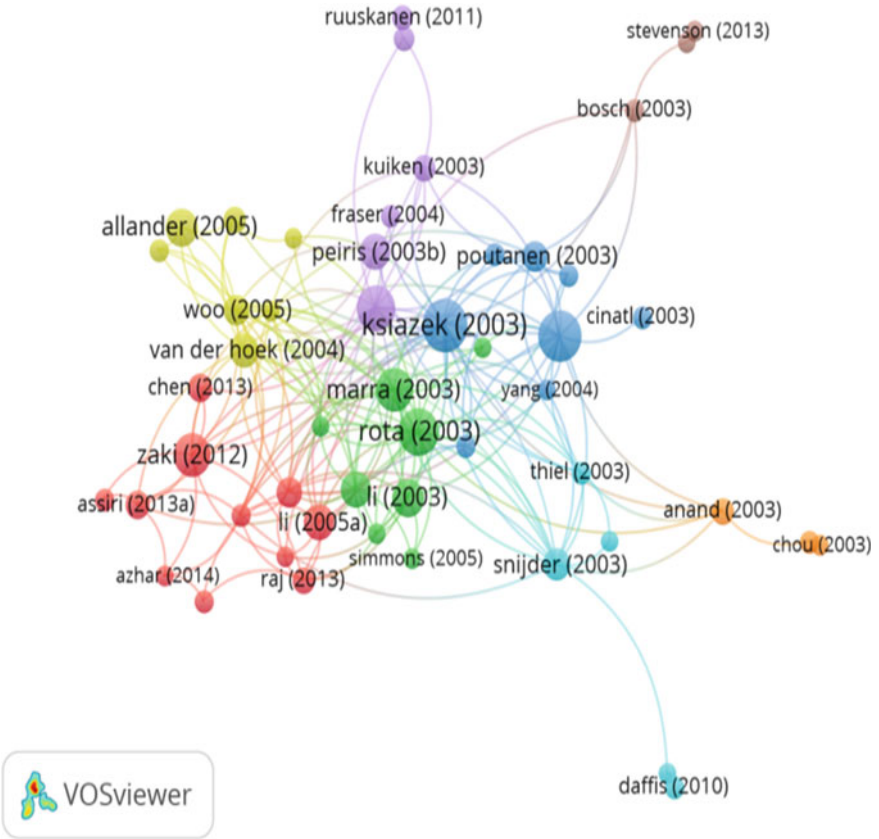

Fig. 6 Documents and citations relationship of the publications that have been cited for at least 300 times

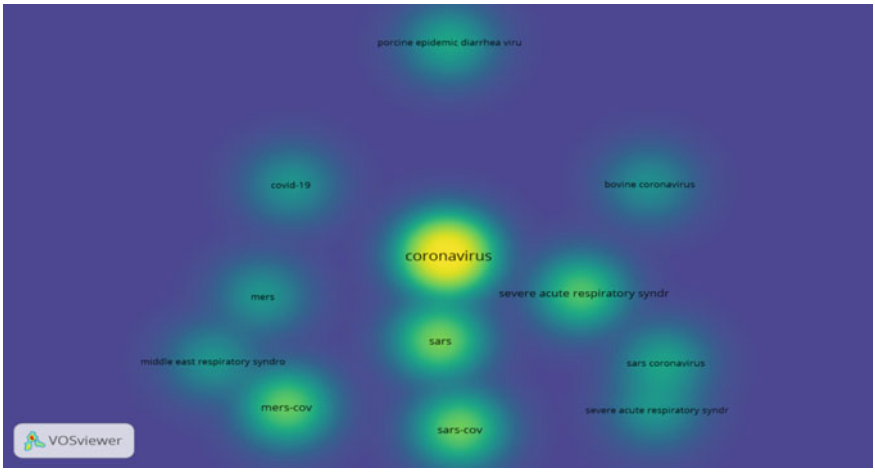

Fig. 7 Density visualization map of the coronavirus, major coronavirus-related infections and symptoms

16 documents but has 240.2 and 118.56 average citations per document. Also, Nature Medicine has 13 documents with 178.15 average citations per document. This indicates that these journals published high-quality research work irrespective of the number of published documents.

3.6 Document and Citations Relationship

The information about the quality of the documents published can be provided by studying the document and citation relationship. A higher quality of work is symbolized by a higher citation metric and thus has been cited by various researchers globally. As shown in Table 5 and Fig. 6, we have selected those documents having at least 300 times citations, which allowed us to narrow down the number of documents to 10 which in turn have been helpful in obtaining the highly cited documents related to coronavirus research. While fetching the collaboration map, the document by Allander et al. (2005) was not considered. The TLS of the publication was zero [20]. The top-cited document (1891 times) entitled "A novel coronavirus associated with severe acute respiratory syndrome" was reported by Ksiazek et al. [21]. The second most cited document described the "Identification of a novel coronavirus in patients with severe acute respiratory syndrome" by Drosten et al. in the same year, 2003 [22]. While the third most cited document was "Characterization of a novel coronavirus associated with severe acute respiratory syndrome" that was investigated by Rota et al. [23], and the fourth document also was reported in the year 2003 by Peiris et al. (2003) entitled "Coronavirus as a possible cause of the severe acute respiratory syndrome" [24]. Thereafter, the publication by Zaki Ali Moh [25] received a good

number of citations. The topic of the study was "Isolation of a Novel coronavirus from a man with pneumonia in Saudi Arabia." This means that these are the five documents that are followed by other high-quality documents in the research area of coronavirus.

Funding Agencies

Any funding agency plays a very important role by supporting and promoting research and development work in any specific area. Funding is among the most important pillars who is responsible for the growth of any subject area. Thus, we have extracted in total the top twenty global funding agencies who have supported funding in the area of coronavirus research as depicted in table S4. The United States Department of Health and Human Services (HSS) acquires the first position with the contribution of 17.58% of total research among 1628 documents related to the coronavirus research. It was followed by the National Institutes of Health (NIH), USA, being in the second position with 17.10% from 1583 documents. National Council for Scientific and Technological Development (CNPq) is being in the 20th position with 69 documents and 0.745%.

3.7 Identifying Coronavirus Infections and Health Condition by Density Visualization Map

The density visualization map was created by co-occurrence and analysis of the keywords (Fig. 7). Screenings of the keywords were done manually, such that only coronavirus and associated clinical symptoms or disease terms are selected for the density visualization map generation. The density visualization map analysis suggested that the coronavirus-related diseases are associated with severe acute respiratory syndrome. This is suggestive of the fact that even though there is a mutation in the coronavirus, which changes its characteristics, all of them precipitate severe acute respiratory syndrome.

4 Conclusion

In light of the results of the scientometric analysis of the research paper, in the area of the coronavirus, there was a significant increase in various aspects, which includes the number of author appearances, number of multi-authored articles, etc. In gist, the information on 9257 number of documents related to the above-mentioned research area was extracted from the Web of Science. The extracted information was then used to perform a detailed scientometric analysis. It was observed that the research in this field of study started as early at 2000, but the research in the said field started receiving much attention post-2000. Since then from 2000 till 2020, research articles

published reached a number of 9257. It was found that most of the economically developed countries were involved in the research related to the coronavirus. Also, the USA published the most number of documents followed by China. The USA had a TLS of 1941 indicating that the country was involved in extensive collaborative research. In terms of collaboration, China was in the second position. The University of Hong Kong was in the first position and was the most influential and impactful organization, having worked in the mentioned field of research with 417 documents with 56.62 average citations and TLS of 384, followed by Chinese Academy of Sciences with 306 documents, 33.80 citations, and 283 TLS. Other organizations like the Centers for Disease Control and Prevention, Utrecht University, Chinese Academy of Agricultural Sciences, The Chinese University of Hong Kong, and The University of North Carolina also received good attention from the researchers. The research groups of Yuen Kwok-Yung, followed by Ralph S. Baric and Christian Drosten, had the highest number of documents of 6176, 3843 and 5614, respectively. The scope for research collaboration across the globe is really very large, which, in turn, would definitely help in improving the overall research quality on coronavirus. The "Journal of Virology" has the highest number of 886 documents that have been published till date, and the documents were able to gain 39,407 citations for the journal. The journal "Virology" occupied the second spot by publishing 285 numbers of documents with 7759 citations. The top-cited document entitled "A novel coronavirus associated with severe acute respiratory syndrome" was reported by Ksiazek et al. (2003), which was found to be the most impactful documents in terms of average citations per documents. The document described as "Identification of a novel coronavirus in patients with severe acute respiratory syndrome" was cited as the second most by Drosten C et al. in the same year. United States Department of Health and Human Services is the highest supporter funding agency in coronavirus research among all other agencies globally.

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