
Research Trends of Coronavirus: Bibliometric Analysis from 1989-2019

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ARTICLE INFO

Article history:

Received 5 April 2021

Revised 6 May 2021

Accepted 1 July 2021

Keywords:

Acute Respiratory Syndrome,
Coronavirus,
Bibliometrics,
MERS,
Mouse Hepatitis,
Protein, SARS,
Syndrome,
Virus

ABSTRACT

The world is going through the most unprecedented time with the outbreak of novel Coronavirus disease (COVID-19), which has become a threat to millions. A Coronavirus is a group of viruses that cause a variety of diseases in mammals and birds leading to a range of illnesses in humans including common cold and more severe forms like severe acute respiratory syndrome Coronavirus (SARS-CoV), Middle East respiratory syndrome Coronavirus (MERS-CoV) and COVID-19, which are life-threatening. The virus gets its name from its shape which takes the form of a crown with protrusions around it. In December 2019, a pneumonia outbreak was reported in the Wuhan City of China, which was later traced to a novel strain of Coronavirus and termed as Novel COVID-19. It typically causes flu-like symptoms including fever, cough and shortness of breath and is transmitted through human-to-human and there is no cure for it till now. Thus, this bibliometric study has been carried out to analyze the research progress in Coronavirus and literature published during a period of 30 years (1989-2019). Data for the study were fetched from Web of Science(WoS) multidisciplinary database and the publication trends in terms of total articles, productive countries, institutions, journals, productive authors, most cited articles and authors, etc have been analyzed. In total, 4917 articles were retrieved; these were from 711 sources and were contributed by 14442 authors. The collaboration index was 3.11, which clearly indicates that there has been a lot of collaboration in this field. The most preferred journal for the study period was "Journal of Virology" and the maximum contribution has been from the University of Hong Kong.

1. Introduction

Every year, around 12,000-61,000 people die of flu around the world (<https://www.cdc.gov/>). China was dealing with the outbreak of a mysterious virus in Wuhan City by the end of December 2019, when few hundred people with pneumonia and flu-like symptoms died. Researchers reported

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International Journal of Knowledge Content Development & Technology, 11(4): 101-111, 2021.
<http://dx.doi.org/10.5865/IJKCT.2021.11.4.101>

that the disease was contagious and in a matter of 3-4 months, the disease was transmitted throughout the globe like wildfire. On March 11, 2020, the World Health Organization (WHO) declared the Coronavirus outbreak as a global pandemic (Cucinotta & Vanelli, 2020).

The outbreak of this pandemic has already caused vast devastation worldwide with death, lockdown, unemployment, overwhelmed healthcare systems and failure of the Government in safeguarding lives. Considering all these damages of the outbreak, an attempt has been made to analyze the literature of the last three decades on Coronavirus using Bibliometrics. This type of analysis has been extensively performed to measure scientific activities in many fields.

1.1. Objectives of the Study

The overall goal of the study was to assess Coronavirus literature with bibliometric technique.

- Year-wise growth of publication.
- To identify the top sources/journals contributing to Coronavirus research publications.
- To study the research performance of World institutions in the field of Coronavirus.
- To identify top authors in the field of Coronavirus.

1.2. Scope and Limitations of the Study

The data has been collected for 30 years for a period 1989-2019 from the Web of Science (WoS) database. Relevant bibliometrics techniques were used for publication or citation analysis.

2. Literature Review

COVID-19, an infectious disease is caused by a newly discovered coronavirus. People infected with the COVID-19 virus experience mild to moderate respiratory problems and can recover by home isolation with proper medication (WHO). The outbreak of the disease in December 2019 posed a serious turn and took the shape of an international pandemic within a very short span of time causing mass devastation.

Although by now, it is well known throughout the world that COVID-19 is very different and complicated from SARS and MERS but the scientific knowledge of COVID-19 is still at a nascent stage. There are several studies conducted through bibliometrics on a wide range of subjects. It is therefore important to understand the trends of scientific knowledge in this particular domain (Hossain, 2020). Bibliometric studies in healthcare are conducted to help in assessing the impact of a certain disease across the world, publication pattern over a period of time, most productive countries or institutes, prolific authors, collaboration patterns, etc., which further helps in decision making among researchers as in (Cruz-Calderón et al., 2015), (Chauhan, 2019), (Bundschuh et al., 2013) and many more. Taking into consideration the severity and complexity of the topic, the author selected 30 years as the timeline to understand how the disease has modified from

the past as a study on Drone (Chauhan, 2019) for 50 years had been carried to understand its modification and usage patterns.

3. Methodology

The data for this study has been obtained from the renowned database, WoS by Thomson Reuters for a period of 30 years from 1989-2019. A total of 4917 documents were obtained. By using scientometric tools, an investigation was performed to assess the quality and quantity of research activity for the total number of published items, prolific authors in the field, type of research activities, journals with high citations, etc.

The term ‘Coronavirus’ (also accommodating COVID-19, Coronavirus (SARS-CoV), the Middle East respiratory syndrome Coronavirus (MERS-CoV) was taken and searched in the title, abstract and keyword indexes. The data were then analyzed further using MS Excel and Bibliometrix-R. The analysis has been done to extract the growth of publication, citations of publication, top journals and prolific authors and their organization.

4. Results

Based on the analysis of data, 4917 documents were extracted in the form of articles, review papers, book chapters, proceedings, notes, etc. These 4917 documents were contributed by 14442 authors and were published in 711 sources and the average citation per document is 33.69.

Fig. 1 shows the year-wise growth of research publications on Coronavirus from 1989-2019. A total of 4917 articles studied during this period showed a progressive increase in number during the tenure of 30 years. With an average of 1280 publications or 26.03% of growth, the period from 2005-2009 can be marked to have published the highest number followed by the year 2015-2019 with 1153 or 23.45% publications.

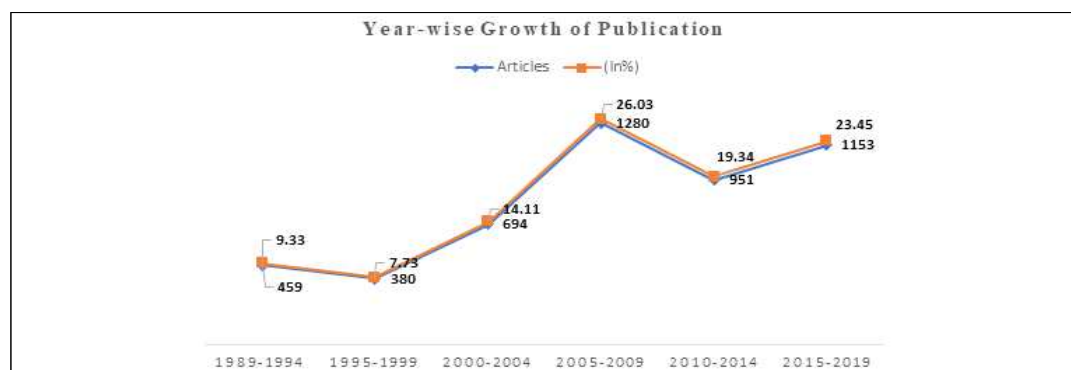


Fig. 1. Year-wise growth of publication

Table 1 gives the characteristics of the growth of the publications studied for a time span of 30 years. **Table 1** gives an analysis of the citations received by these 4,917 articles including the citations received per article and per year. The articles published in 2003 scored the highest number of citations (138.5 citations per article). This year was remarkable as World Health Organization announced that a new pathogen, a member of the Coronavirus family which was the cause of Severe Acute Respiratory Syndrome (SARS). The articles published during 2003-2005 also have an average citation of over 50 citations on average per paper.

Table 1. Year-wise distribution of articles published

Year	No of Articles	Mean Total Citation per Articles	Mean Total Citation per Year	Citable Years
1989	74	36.89	1.19	31
1990	85	44.93	1.50	30
1991	92	41.37	1.43	29
1992	83	46.01	1.64	28
1993	58	34.86	1.29	27
1994	67	33.51	1.29	26
1995	80	31.53	1.26	25
1996	69	37.22	1.55	24
1997	76	42.79	1.86	23
1998	89	29.94	1.36	22
1999	66	32.12	1.53	21
2000	70	38.40	1.92	20
2001	99	32.14	1.69	19
2002	59	38.81	2.16	18
2003	133	138.85	8.17	17
2004	333	53.93	3.37	16
2005	349	50.44	3.36	15
2006	312	32.29	2.31	14
2007	237	35.00	2.69	13
2008	207	27.45	2.29	12
2009	175	23.82	2.17	11
2010	166	26.30	2.63	10
2011	127	25.24	2.80	9
2012	157	35.94	4.49	8
2013	225	43.76	6.25	7
2014	276	33.92	5.65	6
2015	225	19.32	3.86	5
2016	259	14.21	3.55	4

2017	215	8.81	2.94	3
2018	220	4.67	2.33	2
2019	234	1.39	1.39	1

Table 2 enlists 15 top-notch journals publishing on Coronavirus since 1989-2019. Different methodologies were adopted to assess the value of the journals publishing research articles. The top five most productive journals emanating from this analysis include Journal of Virology, Virology, Journal of General Virology, Virus Research, and Emerging Infectious Diseases. All these publications were started in 1989 except Emerging Infectious Diseases that published in this genre in 2003.

Among the top journals studied in this paper, the Journal of Virology published 759 articles, which is 15.44% of the total share of a number of articles during the study period of 30 years (1989-2019). It also received a huge number of citations (36,955) with h-index at 91 and g-index at 124. Journal impact factors for this paper is based on Journal Citation Report (JCR). JCR ranking for this journal stood at 4.368. Virology had a JCR ranking 3.374 followed by the Journal of General Virology (2.514) and the journal of Virus Research and journal of Emerging Infectious Diseases at 2.484 and 7.422 ranking, respectively. Journal of Virology received a total of 10697 citations for 279 articles and obtained h-index of 57 and g-index of 82 obtaining 3.374 JCR ranking. Journal of General Virology received a total of 4807 citations on 145 articles. It's h-index was at 42 and g-index at 61. The journal of Virus Research received a total of 2,585 citations for 119 papers and journal of Emerging Infectious Diseases received a total of 4,687 citations for 114 papers. Journal of Virus Research received h-index of 30 and g-index of 41. Journal of Emerging Infectious Diseases received an h-index of 41 and g-index of 64.

JCR impact factor is a ratio between citations and recent citable items published. The impact factor of a journal is calculated by dividing the number of current year citations to the source items published in that journal during the previous two years.

Table 2. Top journals along with their metrics

S. No.	Name of Journal	h_index	g_index	m_index	Total Citation	No. of articles	Publicati on start	IF (JCR 2017)
1	Journal of Virology	91	124	2.84	36,955	759	1989	4.368
2	Virology	57	82	1.78	10,697	279	1989	3.374
3	Journal of General Virology	42	61	1.31	4,807	145	1989	2.514
4	Virus Research	30	41	0.94	2,585	119	1989	2.484
5	Emerging Infectious Diseases	41	64	2.28	4,687	114	2003	7.422
6	Archives of Virology	22	35	0.69	1,642	87	1989	2.16
7	Veterinary Microbiology	27	37	0.84	1,800	84	1989	2.524
8	Plos One	21	33	1.40	1,328	76	2006	2.766
9	Journal of Virological Methods	23	34	0.72	1,389	74	1989	1.756
10	Journal of Infectious Diseases	31	51	1.03	2,716	72	1991	5.186
11	Viruses-Basel	20	30	1.67	1,004	68	2009	3.761

12	Journal of Clinical Microbiology	30	49	0.97	2,538	65	1990	4.054
13	Proceedings of the National Academy of Sciences of the United States of America	41	62	1.28	6,453	62	1989	9.504
14	Nidoviruses: Toward Control of SARS and Other Nidovirus Diseases	9	11	0.60	241	57	2006	-
15	Biochemical and Biophysical Research Communications	26	43	1.44	1,963	51	2003	2.559

Based on the total publication, top 20 author's contributions and research impact for the study period were analyzed in **Table 3** along with their index factors including h-index, g-index and their total citation (TC).

All the authors have more than 50 publications and the top three prolific authors including Yuen KY, Enjuanes L and Perlman S are having more than 100 publications. Yuen KY has been found to be the most productive author with 114 papers which received a hooping (10,471 TC), (h-index = 51), (g-index = 102) and (m-index = 2.83) followed by Enjuanes L with 111 articles that received a TC of 4,440, (h-index = 43), (g-index = 61) and (m-index = 1.34) followed by Perlman S (104 articles) and Drosten C (94 articles). Regarding the parameter of citation impact, Drosten C was more impactful with the second-highest number of citations (8,986 citations) for 94 papers followed by Chan KH with (7,820 citations) for 66 papers and Peiris JSM with 6,875 citations on 58 papers. However, all these authors had more than 1,000 TC.

Table 3. Most productive authors of Coronavirus with impact factors

S. No.	Author	h_index	g_index	m_index	TC	NP	PY_Start
1	Yuen KY	51	102	2.83	10,471	114	2003
2	Enjuanes L	43	61	1.34	4,440	111	1989
3	Perlman S	37	52	1.16	3,402	104	1989
4	Drosten C	41	94	2.28	8,986	94	2003
5	Rottier PJM	43	74	1.48	5,697	91	1992
6	Baric RS	36	59	1.16	3,640	86	1990
7	Liu DX	30	40	1.00	1,916	76	1991
8	Weiss SR	33	51	1.03	2,851	75	1989
9	Woo PCY	34	70	2.00	4,976	71	2004
10	Makino S	33	51	1.03	2,768	68	1989
11	Chan KH	44	66	2.44	7,820	66	2003
12	Saif LJ	30	41	0.94	1,999	66	1989
13	Talbot PJ	27	40	0.84	1,773	66	1989
14	Lau SKP	32	64	1.88	4,729	64	2004
15	Holmes KV	32	55	1.00	3,061	60	1989
16	Memish ZA	31	59	3.44	3,769	59	2012
17	Peiris JSM	36	58	2.00	6,875	58	2003

18	Buonavoglia C	25	36	1.14	1,465	56	1999
19	Taguchi F	23	37	0.72	1,449	54	1989

*TC=Total citation, NP=Number of publications, PY_Start= Publication Starting Year

Table 4 shows organization-wise contributions on Coronavirus. Top 20 organization along with their countries across the globe are presented. The highest five countries include the US with 1386 publications, Hong Kong with 791 followed by the Netherlands with 292 publications. India secured 4th position with 124 articles from the National Institute of Infectious Disease and China 5th with 100 articles from Fudan University.

Significant universities from the US include the University of Iowa, University of North Carolina, Vanderbilt University, Centres for Disease Control and Prevention, The University of Texas Medical Branch, University of Penn, University of South California, University of Texas, Ohio State University, Scripps Research Institute and Purdue University. The University of Hong Kong and Chinese University of Hong Kong were the top institutes in contributing to the publication of articles in the Corona Virus. Authors from Utrecht University and Leiden University from the Netherlands contributed significantly to the Corona virus.

Table 4. Top organizations with corona virus publications

S. No.	Name of Organization	Country	No. of Articles
1	Univ Hong Kong	Hong Kong	514
2	Univ Iowa	United States	229
3	Univ N Carolina	United States	217
4	Univ Utrecht	Netherlands	203
5	Chinese Univ Hong Kong	Hong Kong	191
6	Vanderbilt Univ	United States	139
7	Ctr Dis Control and Prevent	United States	131
8	Natl Inst Infect Dis	India	124
9	Univ Texas Med Branch	United States	112
10	Univ Penn	United States	111
11	Univ So Calif	United States	102
12	Fudan Univ	China	100
13	Univ Texas	United States	97
14	Natl Taiwan Univ	Taiwan	90
15	Leiden Univ	Netherlands	89
16	Univ Bonn	Germany	88
17	Ohio State Univ	United States	83
18	Scripps Res Inst	United States	83
19	Purdue Univ	United States	82
20	Natl Univ Singapore	Singapore	79

Table 5 shows country-wise total citations and average article citations of articles on the Corona virus during the study period of 30 years. Top 15 countries with total citations along with their average citations per article.

The top five countries include the USA with 52405 total citations (TC), China followed with 26288 TCs and the Netherlands with 16009. Germany and the UK each had 12490 TC and 9033 TCs. However, the Netherlands had the highest average article citation per article with the highest number at 67.83 followed by Switzerland with 46.22 average article citation per article and Germany 43.67. The UK followed with 42.41 and the US with 38.76 average citations per article.

Table 5. Top countries with total citations & average article citations

S. No.	Country	TC	Average Article Citations
1	USA	52,405	38.76
2	China	26,288	32.45
3	Netherlands	16,009	67.83
4	Germany	12,490	43.67
5	United Kingdom	9,033	42.41
6	Canada	5,739	28.41
7	Saudi Arabia	4,857	33.5
8	France	4,372	31.45
9	Japan	4,141	18.08
10	Spain	3,945	32.88
11	Singapore	3,548	28.38
12	Taiwan	2,629	19.47
13	Italy	2,604	22.84
14	Switzerland	2,080	46.22
15	Australia	1,806	30.61

*TC=Total citations

Top 20 articles cited during the study period of 30 years (1989-2019). The most cited articles were analyzed based on the total number of citations scores by these articles during the study period of 30 years in **Table 6**.

Out of 4,917 articles, the top five authors with high total citations include Ksiazek TG obtained the highest citations of 1823 and (TC per year = 101.2778) followed by Drosten C with 1,732 citations (TC per year = 96.2222) and Rota PA with 1,487 citations, Peiris JSM with 1,436 and Zaki AM with 1275 citation. However, articles by author Zaki AM in the journal New England Journal of Medicine received highest TC per year at 141.67.

Table 6. Most Frequently Cited Articles on Corona Virus

S. No.	Authors, Years & Publications	TC	TC (Per Year)
1	Ksiazek Tg, 2003, New Engl J Med	1,823	101.2778
2	Drosten C, 2003, New Engl J Med	1,732	96.2222
3	Rota Pa, 2003, Science	1,487	82.6111
4	PEIRIS JSM, 2003, LANCET-A	1,436	79.7778
5	Zaki Am, 2012, New Engl J Med	1,275	141.6667
6	Marra Ma, 2003, Science	1,273	70.7222
7	Li Wh, 2003, Nature	968	53.7778
8	Guan Y, 2003, Science	881	48.9444
9	Li Wd, 2005, Science	841	52.5625
10	Peiris Jsm, 2003, Lancet	826	45.8889
11	Van Der Hoek L, 2004, Nat Med	742	43.6471
12	Snijder Ej, 2003, J Mol Biol	677	37.6111
13	Woo Pcy, 2005, J Virol	646	40.375
14	Lau Skp, 2005, P Natl Acad Sci Usa	643	40.1875
15	Lai Mmc, 1997, Adv Virus Res	545	22.7083
16	Assiri A, 2013, New Engl J Med	536	67
17	Kuiken T, 2003, Lancet	483	26.8333
18	Anand K, 2003, Science	467	25.9444
19	Brierley I, 1989, Cell	465	14.5312
20	Raj Vs, 2013, Nature	460	57.5

*TC=Total citations

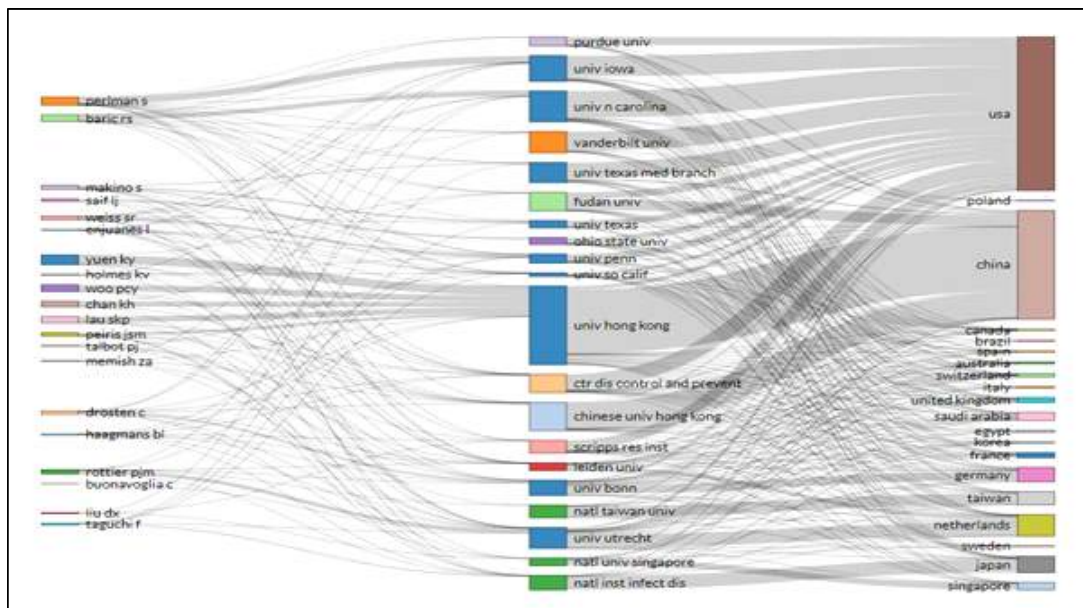


Fig. 2. Top 20 Authors from top 20 countries along with affiliation

Fig. 2 summarizes the complete analysis, of the top 20 authors along with their affiliation. These top 20 authors have the affiliation from 20 countries. A strong network is seen from the University of Hong Kong though a majority of them have the roots in the USA.

5. Discussion

Bibliometric methods use various mathematical and statistical measures which are quantitative in nature but they lead to qualitative features, such as publication patterns, prospecting research opportunities, author collaboration patterns, etc. Bibliometric studies often focus on a specialized subject matter and look after its publishing patterns. The patterns may include geographical or institutional aspects, performance indicators in the field for the time period under study, top institutes, country-level participation in publications and authorships. Different significant variants including h-index, g-index or m-index are also important indicators. The amount of international collaborations or co-authorships also play a significant part as it creates awareness among the scientific community. Through this study, an effort has been made to quantify research productivity during a period of 30 years.

6. Conclusion

Based on the WoS database, the characteristics of Coronavirus research output from 1989-2019 were investigated by the authors through bibliometric methods. The study demonstrated some interesting facts about the Coronavirus literature. In total, there were 4,917 documents contributed by 14,442 researchers in 711 sources. The articles published in 2003 scored the highest number of mean citations of 138.85. The Journal of Virology was the topmost journal. The maximum researchers were affiliated with the University of Hong Kong. A significant contribution has been seen from the organization USA, Hong Kong and the Netherlands. Ksiazek TG emerged as the most productive author with the highest citation and h-Index value.

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