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Assessment of Global Performance on COVID-19 Research during 1990-2019: An Exploratory Scientometric Analysis

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Abstract. The recent outbreak of novel coronavirus (COVID-19), a pandemic threat to humans, has raised huge concerns worldwide. It causes intestinal and respiratory infections of both humans and animals. The main objective of the present study was to explore the Scopus database to find out the research publications made on novel coronavirus during the last three decades and quantify its performance on a global scale. Scopus database has been used to retrieve related literature on novel coronavirus during 1990-2019. In total, 21,559 documents were published with an average of 23.55 citations per document. Research publications showed a noticeable and steep growth after 2002. Researchers from 157 countries or territories participated in coronavirus articles with the USA noted with the highest number of publications (6,378), highest citations (223,641). The Journal of Virology registered as the most preferred journal among the research community with 1,055 (4.89%) articles and the top productive organization was The University of Hong Kong. The author, Yuen, K.Y. contributed to the highest number of research publications during this time span. The highest proportion of documents was research articles (65.74%) and English was the most preferable language of communication in the research domain. Besides, 'coronavirus' and 'SARS' were the most frequently used term. It is quite coherent that during and within 1-3 years of any major outbreak of such viral infected disease, the number of publications all over the globe has also been increased by 2-4 times than the previous year. Therefore, it is expected that during 2020-2023, the number of yearly publications regarding coronavirus research would have reached up to 1500 or more than that.

Keywords: COVID-19; Coronavirus; SARS-CoV; MERS-CoV; HCoV-19; Scientometrics.

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1. Introduction

The coronavirus disease is a common disease in humans and animals that cause intestinal and respiratory infections (Cui et al., 2019:181). The novel pneumonia (COVID-19) i.e. coronavirus disease caused by the virus named SARS-CoV-2 (Calisher et al., 2020:e42; Gorbalenya et al., 2020:1) and HCoV-19 (Jiang et al., 2020:949) has recently emerged from Wuhan, Hubei province, China (Wu et al., 2020: 265; Zhou et al., 2020: 1054), having a total number of 81,470 confirmed cases (4.06% death) within China only and has simultaneously widespread across the globe infecting 198 countries and territories with 770,165 confirmed cases (4.80% death) as on March 29, 2020[1]. HCoV-19 is basically the seventh coronavirus known to infect humans which are associated with mild symptoms but can cause severe disease (Corman et al., 2018:164). This is also the third highly pathogenic human coronavirus that has emerged in 21st century after the outbreak of Severe Acute Respiratory Syndrome (SARS) coronavirus in Guangdong Province, China in 2002 and 2003 (Drosten et al., 2003:1968; Zhong et al., 2003:1353). After ten years of SARS, another pathogenic coronavirus has emerged in Middle Eastern Countries namely Middle East Respiratory Syndrome CoronaVirus (MERS-CoV) (Zaki et al., 2012:1815).

MERS-CoV was first detected in Saudi Arabia and it was extended to other Asiatic countries. Person-to-person transmission of this coronavirus from contaminated dry surfaces has been postulated by healthcare departments (Otter et al., 2016:235). A robust technology i.e. real-time RT-PCR which is routinely used to detect causative viruses from respiratory secretions has been widely deployed in diagnostic virology functioned by the proposed workflow from Corman et al., (2020:1) in proficient diagnostic laboratories throughout the world for the sake of public health emergency. Study also revealed that human coronavirus can remain infectious on inanimate surfaces for up to 9 days (Kampf et al., 2020:246) which emphasizes the necessity of detail understanding of nature of coronavirus. Here lies the importance of this investigation for quantitative analysis about the studies made regarding coronavirus in different countries throughout the world as well as to find out whether there is any specific pattern in publication that encourage the combat situation for various countries against such pandemic outbreak on global scale.

Several research articles show the pattern of publication outcomes on particular topic of research in various disciplines at different time span on global scale with the help of scientometric indicators. Scholarly publications on MERS-CoV published during 2012 to 2015 included in Scopus database have been analyzed by Zyoud, Sa'ed H. (2016:1). It shows 833 publications originated from 92 countries or territories across the globe, where USA noted with the highest count of publications (319 articles) and Netherland accounts highest counts of international collaborative paper with average Citations Per Paper (CPP) of 9. A

[1] https://www.worldometers.info/coronavirus/

similar study of the publications on MERS based on PubMed database during 2012-15 by Wang et al., (2016:1)stated that out of 443 articles, the major focus outcome was clinical studies and medical sciences with 'coronavirus'; 'case' and 'transmission' as most frequent terms used. Using the huge database of 18158 articles regarding CoV during January, 1951 to January, 2020 acquired from Scopus, PubMed and Science Citation Index revealed that USA and China have played the leading role in the research on coronavirus (Bonilla-Aldana et al., 2020:2). Interestingly, study on coronavirus research using WoS database of 5128 articles during 1970-2019 by Danesh & GhaviDel, (2020:1) has marked out the University of Hong Kong as outperformer among any other institutions in the world in publication count and agreed USA as the most productive country on this research aspect.

2. Objectives

The main objective of the present research is to explore the Scopus database to find out the research publications made on novel coronavirus during last three decades and quantify its performance in a global scale. Thus, the present study also allows us to investigate and identify the most used keywords during the research, which helps to get the diversities of major research aims in this topic.

Additionally, the present study enumerate the most productive countries, organizations, authors, journals on this research field and also find out the preferred mode of communications and language used during the research in this domain.

3. Methods

The metadata and associative information regarding coronavirus literatures were retrieved in CSV and RIS format on 13th March 2020. In order to search these literatures, the keywords - Coronavirus, SARS, MERS, SARS-CoV and MERS-CoV were tagged with "TITLE-ABS-KEY" field, thus formulate the search strategy as- ((TITLE-ABS-KEY "Coronavirus" OR "SARS-CoV" OR "Severe acute respiratory syndrome" OR "MERS-CoV" OR "middle east respiratory syndrome") AND PUBYEAR > 1989 AND PUBYEAR <2020). There were total 21,559 bibliographic records found of these selected literature from Scopus database during 1990-2019. The retrieved datasets were refined, tabulated and analyzed to get the global research pattern and trend. The entire datasets were analyzed with the aid of MS-EXCEL and BibExcel[2] statistical software, while the mapping of country wise spatial distribution of research publications was done in ArcGIS 10.5[3] software. The Impact Factors of journals were obtained from JCR (2018) for measuring scholarly impact of publishing journals and SJR values were collected from the Scimago portal[3]. VOSViewer[4] scientometric tool was used for analyzing the details of such large number of literatures on

[2] https://homepage.univie.ac.at/juan.gorraiz/bibexcel/
[3] https://www.scimagojr.com/journalrank.php
[4] https://www.vosviewer.com/

coronavirus. The analysis based on the publication counts is made through calculating the Average Growth Rate (AGR), Relative Growth Rate (RGR) and Doubling Time (DT) for each respective year, while CPP, International Collaborative Paper (ICP) and %ICP have been calculated for each authors, their respective institutions and countries. Moreover, percentage of keyword usage and the languages of publications have also been analyzed while the mode of publication has also been checked to get the authors' major choice of scientific communication. The Relative Growth Rate is a measure of per unit increase in number of articles or publications or pages with per unit of time (Santha kumar & Kaliyaperumal, 2015:927). DT indicates the existing equivalence between RGR and DT as it measures the required time (years) to double up the number of publications from any particular year. AGR, RGR and DT were calculated using the formula –

AGR = {(Ending value-First value)/First Value} × 100 ….. …….(i)

RGR = (W2-W1)/(T2-T1) ……

……(ii)

DT= 0.693/RGR …...

…...(iii)

Where, W2 and W1 indicate the natural logarithm value of a cumulative total of publications in the year T2 and T1 respectively.

4. Results

4.1. Yearly Distribution and Growth Rate of Publications

During the last three decade, total 21,559 research documents were published by the scientific community with an average rate of 718.6 documents per year. Moreover, which citied total 507,763 times, out-turn of 25.55 citations per document. However, 43.94% of the publications (9,474) were published during the last decade, 47.01% of the publications (10,135) during 2000-09 and only 9.04% documents during 1990-99. While both of the highest (2,014) and lowest (150) yearly publications were recorded during the first decade of 21st century only, precisely during 2003 and 2002 respectively. It exhibits the researchers' interest to the sudden outbreak of SARS-CoV and MERS-CoV during 2003-2004 and 2012, which results the sudden spike in the yearly pattern of publications. It also gets supported by the trend of yearly citation which depicts average of 16925.43 citations per year with the highest citations (54,253) during 2003 and the lowest citations (1,659) during 2019. The 4th order polynomial trend line has fitted with R^2 value of 0.6482 and 0.5315 respectively for the yearly distribution of publications and citations received during entire period (Figure1). The equation of the trend line came as follows –

$y = 0.0398x^4 - 2.637x^3 + 55.561x^2 - 353.3x + 701.41$..... …...(iv)

$y = 0.0009x^4 - 0.0673x^3 + 1.4651x^2 - 9.3583x + 19.652$….. ……(v)

$y = -0.0003x^4 + 0.0189x^3 - 0.4242x^2 + 3.4953x + 27.753$….. ..…(vi)

The first equation (iv) stands for the trend equation of publications, while the other equation (v) represents the trend of citations. The CPP values was found to be varied from 1.75 (during 2019) to 49.06 (during 1999) with a decrease trend in 4^{th} order polynomial trend line having equation (vi). Interestingly, only the trend of CPP found to be decreased with significant R^2 (0.6844) suggests that researchers' tendency to review large number of literature during their publication was declining 2006 onwards. Mention worthy, this 4^{th} order polynomial trend line was fitted to get highest possible value of R^2 since the rest trend line techniques such linear, logarithmic, power or exponential produced R^2 lesser than this. Therefore, it suggests the consecutive fluctuations present in the yearly pattern of publications and citations received. On other hand, highest (1242.67) and lowest (-36.36) AGR was achieved for the year 2003 and 1996 respectively. Since, DT found least during the early half of the study period when the RGR was highest during that time, thus it infers the negative relation (r=-0.81) between DT and RGR during this period. The common thing comes from the yearly pattern of AGR and RGR is that there was a sudden rise in publication growth during 2003 thereafter it was continuously decreasing (Figure 2). The detailed year-wise information regarding number of publications, counted citations, and thus calculated CPP, cumulative publications, AGR, RGR and DT have been mentioned in Table 1.

Table-1: Year-Wise Publications and Growth Rate of Coronavirus research during 1990-2019

Year	Total Publications	% Publications	Cumulative Publications	AGR	RGR	Doubling Time
1990	249	1.153	249	0	0	0
1991	162	0.750	411	-34.940	0.501	1.383
1992	155	0.718	566	-4.321	0.320	2.166
1993	168	0.778	734	8.387	0.260	2.666
1994	229	1.060	963	36.310	0.272	2.552
1995	253	1.171	1216	10.480	0.233	2.971
1996	161	0.745	1377	-36.364	0.124	5.573
1997	184	0.852	1561	14.286	0.125	5.525
1998	229	1.060	1790	24.457	0.137	5.062
1999	160	0.741	1950	-30.131	0.086	8.094
2000	157	0.727	2107	-1.875	0.077	8.949
2001	230	1.065	2337	46.497	0.104	6.689
2002	150	0.694	2487	-34.783	0.062	11.140
2003	2014	9.325	4501	1242.667	0.593	1.168
2004	1961	9.079	6462	-2.632	0.362	1.916
2005	1523	7.051	7985	-22.336	0.212	3.275
2006	1277	5.912	9262	-16.152	0.148	4.671
2007	984	4.556	10246	-22.944	0.101	6.864
2008	924	4.278	11170	-6.098	0.086	8.026

2009	915	4.236	12085	-0.974	0.079	8.802
2010	771	3.570	12856	-15.738	0.062	11.205
2011	730	3.380	13586	-5.318	0.055	12.548
2012	755	3.496	14341	3.425	0.054	12.814
2013	998	4.621	15339	32.185	0.067	10.301
2014	1085	5.023	16424	8.717	0.068	10.140
2015	1173	5.431	17597	8.111	0.069	10.046
2016	1063	4.922	18660	-9.378	0.059	11.815
2017	990	4.584	19650	-6.867	0.052	13.406
2018	965	4.468	20615	-2.525	0.048	14.455
2019	944	4.371	21559	-2.176	0.045	15.478

AGR= Average Growth Rate; RGR= Relative Growth Rate.

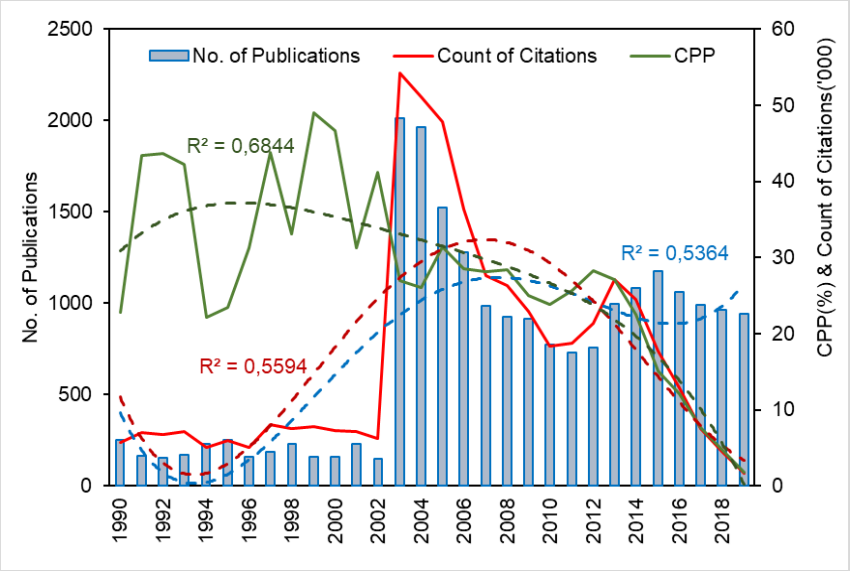

Figure-1: Trend in number of publications and count of citations across the world during last three decades. The break line represents the 4th order polynomial curve of the trend.

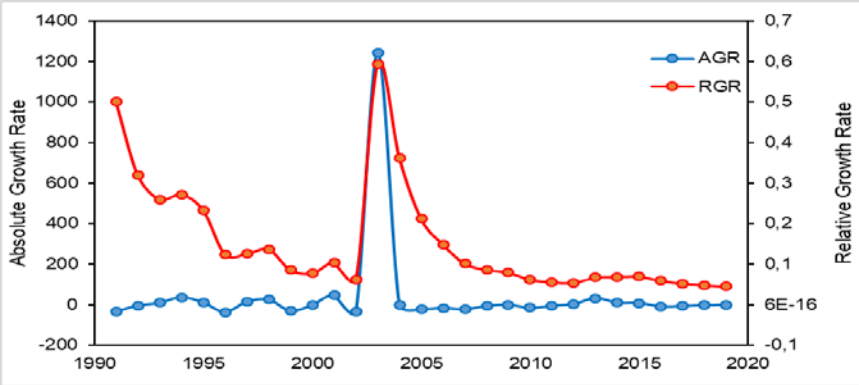

Figure-2: Year-wise Absolute and Relative Growth Rate of the publications used in present study.

4.2. Geographical Distribution of Publications

On the basis of retrieved database, researchers from 157 different countries or territories across the world have contributed in the research on coronavirus during last 30 years. Research outcome from USA noted with highest number of publications (6,378) and highest number of citations (223,641). In terms of numbers of publications, USA is followed by China (3,245), United Kingdom (1,555), Hong Kong (1,351), Canada (1,305) and Germany (1,116) while in terms of received citations, USA is followed by China (59,723), UK (57,698), Hong Kong (49,874) and Netherlands (46,921) successively. However, in terms of CPP, Netherland (54.12) outstand the other countries, followed by Switzerland (44.09), Sweden (41.58), Germany (41.48) and United Kingdom (37.10) successively. It suggests that Dutch researchers tend more to cite publications from their own country which found to be very less in country like Brazil (CPP=13.06), India (CPP=11.83) etc. Another interesting fact that comes out through the analysis is USA had highest number of international collaboration for publication (1,210), followed by China (698) and Netherlands (428), whereas the statistics of %ICP flagged for Netherlands (49.37%) as the highest one, followed by Brazil (45.67) and Singapore (44.24%). It makes us understood that the countries like Netherlands, Brazil, Singapore, Saudi Arabia, Japan, Sweden etc. were more depended in international collaboration for their publications, thus registering higher %ICP than the countries with leading number of publications like USA, Hong Kong and United Kingdom have quite lesser %ICP (18.97, 19.17 and 20.51) respectively. Detailed information of publications, citations, CPP, ICP, %ICP for leading 20 countries were shown in Table 2. The global distribution of country-wise publications shows higher productivity comes from North America than rest of the world, where Brazil leads from South America, United Kingdom from Europe, China from Asia and Egypt from Africa (Figure 3). It reflects the researchers' interest towards the emerging medical issues all over the world. It also showed a skewed distribution of country-wise publication since only 03.82% countries had more than one

thousand publications, 82.17% of countries had lesser than 100 publications and 49.68% countries had publications lesser than 10.

Table-2: Statistics of Total Publications, Citations, calculated CPP, ICP and %ICP of leading 10 countries contributed in research on coronavirus during 1990-2019.

Country	Total Publications	Total Citations	CPP	ICP	% ICP
United States	6378	223641	35.06	1210	18.97
China	3245	59723	18.40	698	21.51
United Kingdom	1555	57698	37.10	319	20.51
Hong Kong	1351	49874	36.92	259	19.17
Canada	1305	37630	28.84	405	31.03
Germany	1116	46287	41.48	369	33.06
Netherlands	867	46921	54.12	428	49.37
Japan	859	16360	19.05	342	39.81
France	827	23712	28.67	313	37.85
South Korea	690	10032	14.54	255	36.96
Taiwan	688	14789	21.50	238	34.59
Singapore	590	17565	29.77	261	44.24
Australia	574	16568	28.86	133	23.17
Italy	541	13691	25.31	148	27.36
Saudi Arabia	474	14070	29.68	203	42.83
Spain	460	13550	29.46	113	24.57
Switzerland	439	19354	44.09	125	28.47
Brazil	300	3917	13.06	137	45.67
India	290	3430	11.83	99	34.14
Sweden	240	9978	41.58	91	37.92

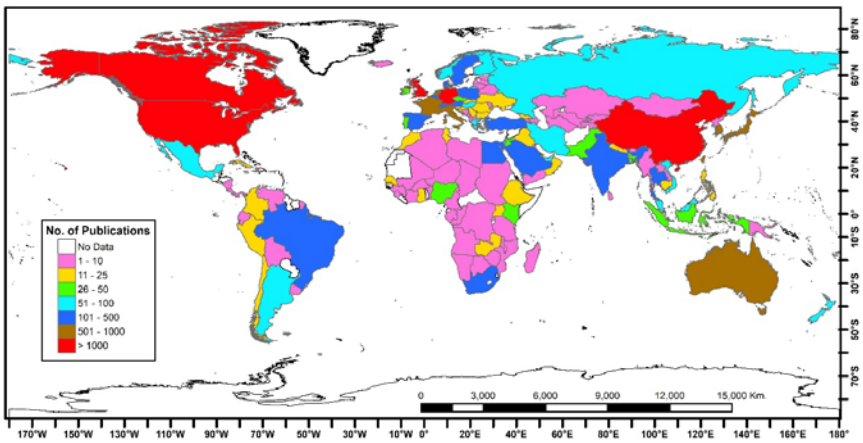

Figure-3: Country wise spatial distribution of publications regarding coronavirus made during 1990-2019.

4.3. Forms and Language of publications

Out of 21,599 publications, 65.74% of publications (14,199) are research article, while review article accounts 13.07% of publications (2,823), rest of the publication types account for lesser than 5% each. (Table 3)

Languages have a great role in inter-communication of scientific information among the researchers as well as sharing of knowledge in the outer society. Present study found that in English language, 91.86% of research documents were published during last 30 years, and thus it depicts English as most preferable language of communication in research domain. Besides English, there were 31 more languages in which researchers have published their documents, among them Chinese (3.66%), French (1.55%) and German (1.00%) were the major one (Table 4).

Table-3: Forms of publication on coronavirus made during study period.

Document Type	Frequency	%
Research Article	14199	65.74
Review Article	2823	13.07
Editorial	1030	4.77
Note	945	4.38
Conference Paper	944	4.37
Letter	773	3.58
Short Survey	415	1.92
Book Chapter	343	1.59

Erratum	97	0.45
Book	21	0.10
Conference Review	7	0.03
Business Article	2	0.01

Table-4: Major languages used as the mode of Publications regarding Coronavirus.

Language	Total Publications	%
English	19731	91.52
Chinese	788	3.66
French	335	1.55
German	216	1.00
Spanish	129	0.60
Japanese	105	0.49
Russian	65	0.30
Italian	59	0.27
Korean	48	0.22
Polish	33	0.15
Others	196	0.91

4.4. Most Productive Authors

During the analysis, it has been found that total 143285 researchers across the globe have contributed their research works on coronavirus in 21599 publications, which shows around 6.63 authors have contributed in each publication. It also indicates the tendency of collaborative work for this research domain which is really encouraging for the scientific community. Based on the retrieved data, 11 authors have published more than 100 publications on coronavirus during last 30 years (Table 5). All of them have received citations more than 3500 and achieved H-index of more than 34. Cumulatively, these 11 authors have made 6.94% of total publications but achieved 18.21% of total citations (average CPP=61.64). It suggests, all the leading authors have excellence expertise on their research field and very high fame among the researchers. Interestingly, Peiris, J.S.M. from the University of Hong Kong is the only author to be found who have received more than 100 CPP. Not only that, 2 among those leading authors, Yuen, K.Y. and Peiris, J.S.M. are belong to same institution (University of Hong Kong) while rest of the leading authors belong to different institutions from different countries.

Table-5: Leading authors in coronavirus research during mentioned time.

Authors	Affiliation	TP	Total Citations	CPP	ICP	%ICP	H-Index
Yuen, K.Y.	The University of Hong Kong	186	16399	88.17	59	31.72	63
Enjuanes, L.	Centro Nacional de Biotecnologia, Spain	178	6756	37.96	71	39.89	46
Perlman, S.	University of Iowa	164	5933	36.18	57	34.76	44
Baric, R.C.	University of North Carolina	139	6389	45.96	43	30.94	48
Drosten, C.	Bernhard-Nocht Inst. for Trop. Med., Hamburg, Germany	139	12186	87.67	66	47.48	49
Rottier, P.J.M.	Utrecht University	127	7078	55.73	61	48.03	45
Weiss, S.R.	University of Pennsylvania School of Medicine	125	3933	31.46	56	44.80	37
Peiria, J.S.M.	University of Hong Kong	118	12718	107.78	46	38.98	49
Memish, Z.A.	Global Center for Mass Gatherings Medicine, Saudi Arabia	114	6381	55.97	44	38.60	43
Holmes, K.V.	University Colorado	107	5566	52.02	41	38.32	39
Stohlman, S.A.	University of Southern California	103	9122	88.56	38	36.89	35

4.5. Most Productive Journals

The retrieved documents were found to be published in 2,691different journals. Out of those, top most 20 productive journals published 5,265 research documents that were cited 200,714 times during last 30 years (Table 6). There were only 0.85% journals where more than 100 publications were made while 88.11% of journals made lesser than 10 publications (Figure 4). The active list of 20 journals demonstrates the *Journal of Virology* registered as most productive journal with 1055 (4.89% of retrieved articles) publications and *Proceedings of The National Academy of Sciences of The United States Of America*, which has produced only 129 publications and earned 13,994 citations and hence, it achieved the highest CPP (108.48). In terms of IF, *The Lancet* achieved of 59.10, followed by *Nature* (43.07) and Science (41.06) and rest of the journals have IF of 3.9 on an average. Analysis also reveals that most of the leading thirteen journals belong to Virology field, five journals in multidisciplinary research domain and only two in medicine and microbiology field.

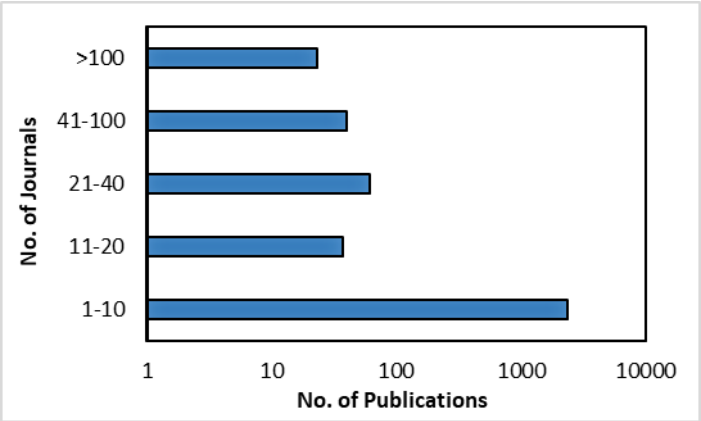

Figure-4: Horizontal Bar graph with logarithmic scale showing number of publications which have been published by journals.

Table-6: Top most 20 journals in publications of research documents on coronavirus.

Journals	Country	Total Publications	Total Citations	CPP	IF-2018	SJR-2018
Journal Of Virology	United States	1055	52103	49.39	4.32	2.59
Advances In Experimental Medicine And Biology	United States	516	3092	5.99	2.13	0.65
Virology	United States	427	15525	36.36	2.46	1.64
Emerging Infectious Diseases	United States	392	15870	40.48	7.42	3.14
Plos One	United States	290	5855	20.19	2.78	1.10
Journal Of General Virology	United Kingdom	242	9037	37.34	2.80	1.32
Virus Research	Netherlands	226	5904	26.12	2.74	1.09
Archives Of Virology	Germany	222	5397	24.31	2.26	0.91
The Lancet	United Kingdom	216	14364	66.50	59.10	15.87
Veterinary Microbiology	Netherlands	203	4571	22.52	1.67	1.17
Journal Of Virological Methods	Netherlands	180	3500	19.44	1.75	0.78
Viruses	Switzerland	174	2471	14.20	2.74	1.81
Vaccine	Netherlands	154	3648	23.69	3.27	1.76
Clinical Infectious Diseases	United Kingdom	148	7047	47.61	9.06	4.40
Science	United States	145	11487	79.22	41.06	13.25

Nature	United Kingdom	140	11569	82.64	43.07	16.35
Journal Of Clinical Microbiology	United States	137	7433	54.26	4.96	2.31
Journal Of Infectious Diseases	United Kingdom	135	4880	36.15	5.05	3.12
Avian Diseases	United States	134	2967	22.14	1.31	0.61
Proceedings Of The National Academy Of Sciences Of The United States Of America	United States	129	13994	108.48	9.58	5.60

4.6. Most Productive Institutions

All of the publications were outcomes of the effort from 25,668 research organizations. The University of Hong Kong outstands all the institutions in the world with 689 publications followed by the Chinese University of Hong Kong which have produced 483 publications. The active list included 11 leading institutions who had published at least two hundreds publications (Table 7). Among the leading 11 institutions regarding this publication, 3 institutions are located in USA, 4 in Hong Kong, 2 in Netherlands and one each in China and Canada. It indicates highly enthusiastic environment of such research in USA and Hong Kong.

Table-7: Leading institutions

Institutions	Country	Total Publications	Total Citations	CPP
The University of Hong Kong	Hong Kong	689	35117	50.97
Chinese University of Hong Kong	Hong Kong	483	14918	30.89
Centers for Disease Control and Prevention	United States	402	15874	39.49
Chinese Academy of Sciences	China	345	9751	28.26
National Institutes of Health, Bethesda	United States	321	15735	49.02
University of Toronto	Canada	309	10687	34.59
Prince of Wales Hospital Hong Kong	Hong Kong	303	10777	35.57
Utrecht University	Netherlands	294	13511	45.96
The University of North Carolina at Chapel Hill	United States	238	9460	39.75
Queen Mary Hospital Hong	Hong	216	20072	92.93

Kong	Kong			
Erasmus Medical Center	Netherlands	200	12465	62.33

4.7. Author's Keywords

Analyzing the keywords of the research publications, we are able to provide insights into key topics, research hotspots as well as the trends in research ideas. The most used keyword found was "Coronavirus", which was used in 1457 publications, followed by the keywords "SARS" (899), "Severe Acute Respiratory Syndrome" (582) etc. The 15 mostly used keywords along with their frequency of use are mentioned in Table 8. Total 218 keywords mentioned in at least 25 publications were further analyzed using VOSviewer software and demonstrated in Figure 5.

Table-8: 15 most used Keywords during research and their frequencies.

Keywords	Frequency	%
Coronavirus	1457	24.80
SARS	899	15.30
Severe Acute Respiratory Syndrome	582	9.90
SARS-CoV	412	7.01
MERS-CoV	409	6.96
Infectious bronchitis virus	310	5.28
Epidemiology	275	4.68
Virus	253	4.31
Severe acute respiratory syndrome (SARS)	216	3.68
Porcine epidemic diarrhea virus	201	3.42
Vaccine	192	3.27
Spike protein	174	2.96
MERS	173	2.94
Pneumonia	163	2.77
Respiratory viruses	160	2.72

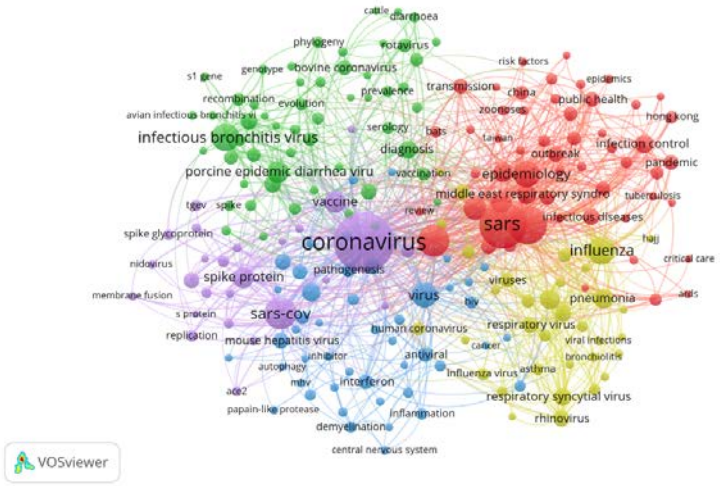

Figure-5: Keywords analysis of COVID-19 research publications.

5. Discussion

The present study was aimed to demonstrate and analyze the pattern of research on coronavirus and its trends on a global scale. Scientometric indicators are nothing but the metrics founded based on bibliographic facts and figures employed to quantify and evaluate scientific scholarly output of an individual, institution, nation and so on. The outcomes are achieved using several scientometric indicators such as CPP, ICP, %ICP, H-index etc. and based on different bibliographic information such as year wise number of publications, citations, authors, their organizations, published journals, documentation types and languages used for publications. Research on coronavirus was started more than seven decades back (Peiris, 2012:1). The publications were not consistent at very early stage of research, however, there were significant changes in trend of publications in last 2 decades, as there were two peaks in yearly distribution.

The same pattern of trend can be seen in case of citations also, however, trend of CPP found to be highly inconsistent and significantly decreasing during last 2 decades. Hence, the 4th order polynomial trend line was used to get the pattern of trend which found to be suitable with high value of R^2. It is well understood that during last 2 decades, the research interest in this domain have developed a lot since the number of authors were also increased very significantly which results tri-fold increase in number of publications in last 2 decade than previous.

Role of institutions, funding agencies, peer-review policy also had a crucial role in such rise in number of publications on coronavirus research. Coincidently, the outbreak of highly human pathogenic SARS-CoV in 2002-03 and MARS-CoV in 2013-14 have created many necessities of new inventions and finer investigations in medical science that have encouraged the researchers to

produce more publications. Behind the high amount of international collaborations for publications, the possible reason could be that there is no boundary and prevention of infectious diseases; global efforts is necessary to control and eliminate infectious diseases (Sweileh et al., 2015:6). In 2018, the WHO published the annual review of priority diseases (*WHO Research and Development Blueprint*, 2018:2), where SARS and MERS-CoV were included and considered as major disease and suggested the essential requirement of further research to overcome such diseases including its improvement in diagnostics and surveillance policy implementations. It is indeed that due to emergence of newly advanced technologies, the possibilities of new inventions have also been boosted up rapidly. Present study depicted another interesting fact through the geographic distribution of research publications, i.e., the countries having higher GDP such as USA, UK, Germany, Canada, Hong Kong,

Netherlands, Japan, France etc. have higher scope of resource utilization in research thus their number of publications are also very high. Among the developing countries, only very few countries were able to produce good number of publications with the help of international collaboration like Egypt in Africa, Brazil in South America. It infers that the developing nations still need better infrastructure for research and development. During analysis, on the basis of retrieved data from Worldometer on 29thMarch, 2020, it has been found that countries which have more publication (hence, can be referred as higher research interest) are able to recover faster and cured more patients from coronavirus disease than the countries which have lesser research interest on that occasion. Figure 6 has shown the relation between country wise percentage of recovery and their number of publication in log-log scale.

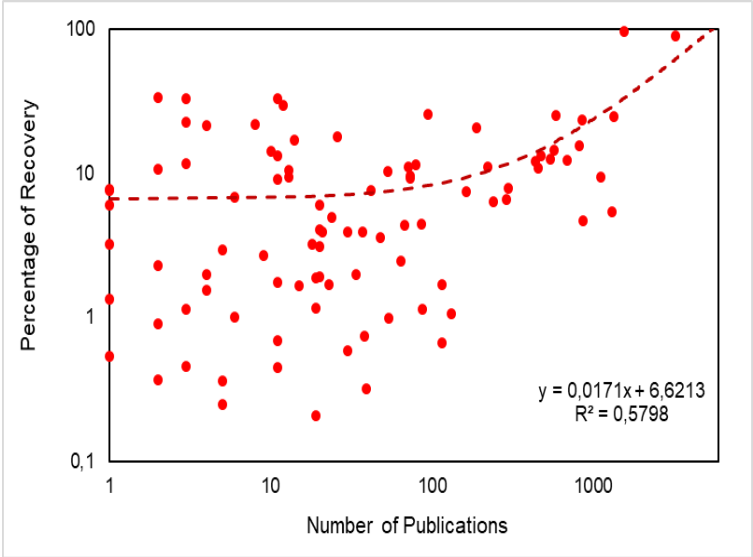

Figure-6: Scatter diagram with log-log scale for percentage of recovery in different countries in the world against their number of publications.

The global research on coronavirus had been published in twenty different sub-fields (based on Scopus subject classification), with largest amount of publications coming from the branch of medicine (7,032 publications), followed by immunology and microbiology (6,085 publications). Among the leading authors, most of the authors come from microbiology and molecular biology domain. Most of the leading institutions are from USA. However, highest publications came from two institutions in Hong Kong, this indicates the center of research hub regarding this particular subject. Researchers preferred English language for their publications in the form of Research Article and the Journal of Virology published maximum number of articles during last 30 years. Since, the study was limited by the time span of 1990-2019 and only Scopus is considered as the source of database, thus many documents were missed, which were published by non-indexed journals from developing and underdeveloped countries.

6. Conclusion

The scientometrics about rare disease COVID-19 caused by the coronavirus shows the productivity of the scientific community from various countries across the globe. The main findings using the scientometrics analysis for a limited period (1990-2019) and using the Scopus database is not cent percent comprehensive (Sweileh, 2018:10) because it can't cover un-indexed journal articles from developing and underdeveloped countries. The promising and developing performance on coronavirus research during last two decade have progressed the science and technology a step ahead for the better future.

However, a wide variation in research performance among developed and developing countries depict the biased research interest among scientific community. A large amount of coronavirus research articles were published globally recognized well-reputed journals and the universities were more productive than any other research organization. It is quite coherent that during and within 1-3 years of any major outbreak of such viral infected disease, the number of publications across the world will be increased by 2-4 times than previous year. Therefore, it is expected that during 2020-2023, the number of yearly publications regarding coronavirus research would have reached up to 1500 or more than that.

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