A Meta-Analysis of Scholarly Research on Corona virus through Big Data Approach

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ABSTRACT

The purpose of the study is to examine the status of scholarly literature on Corona virus indexed in the big database, the Lens, taking into account, top-cited articles, top contributors, top active country region, most accepted study field and open access status. Relative growth rate (RGR) and Doubling time (D_t) calculation is also a major reflects of the paper. The study analyzes the status of scholarly publications on Corona virus research as indexed by Lens spanning a period from the oldest record until July 15, 2020. "Structured Search" was made under "New Scholar Search" using the term "Corona virus" and restrict the search result only for "Journal Article". Results obtained were imported through email (.csv file) for further analysis and visualization using spreadsheet software. The results of the study show that out of total 26628 scholarly outputs 2109 are cited in a patent while 15963 in another scholarly literature. "The University of Hong Kong" is the most productive university with 412 scholarly literature, "The United States" as a most contributing country provides 8433 publications, "Journal of Virology" is the most contributing journal with 1012 publications, "Kwok-Yung Yuen" contributed maximum as an individual author and "Elsevier" as a top journal publisher. Among the Lens indexed scholarly publications on Corona virus, 64.04% obtained open accessibility in terms of open access colour while 64.09% under an open-access. No previous study could be identified dealing with such meta-analysis using the Lens database.

KEYWORDS: Big Data Approach, Corona virus, COVID-19, Doubling Time, Meta Analysis, Relative Growth Rate, SARS-CoV-2, The Lens, 5 A's of Access

INTRODUCTION

Scholarly literature is intended for use in support of conducting in-depth research, often containing specialized vocabulary and extensive references to sources. The rate of the research output of a country depends upon the present economics, academic structure, research facilities, health issues and involvement of government ministry. The outbreak of present pandemic Corona virus [first called 2019-nCoV and officially renamed as SARS-CoV2 (the virus) and COVID-19 (the disease)] (Sarukhan, 2020) is become a global threat and has a clear negative impact on

humanity, including human life and knowledge creation, as a standard of human development. People keep themselves at home to maintain social distancing for reducing the outbreak of community transmission. This COVID-19 epidemic is neither the first and confidently nor the last epidemic that will pose a threat to human life. This Corona virus belongs to a family of viruses that attack the respiratory system. And it is also interesting to note that the Corona virus appears to be a new virus, but it is a prevailing strain of the virus which exists in the earth from many more years in many other forms. Most Corona viruses infect only animals but seven, including SARS and MERS, are known to infect humans and the 2019 Novel Corona virus or 2019-nCoV is one of the deadlier ones. As of it is not a totally new class of virus, the research on Corona virus also started from many more years ago and scholarly literature also published in health science for the same. First Literature Published on Corona virus entitled "Antigenic Relationships Among the Corona viruses of Man and Between Human and Animal Corona viruses" published in the year 1969 in the "Journal of Immunology". This paper examined the status of scholarly literature on Corona virus indexed in the big database, the Lens, taking into account, top-cited articles, top contributors, top active country region, most accepted study field and open access status. Another major focus of the present study is to calculate relative growth rate (RGR) and doubling time (D_t) of global research output on Corona virus.

COVID-19 AND GLOBAL IMPACT

Pandemics are mostly outbreaks of disease which become widespread as a result of the spread of human-to-human infection. In history, among the major outbreaks of disease and pandemics, Spanish Flu, Hong Kong Flu, SARS, H7N9, Ebola, Zika are significant ones (WHO, 2020b) (Rewar, Mirdha, & Rewar, 2015) (Maurice, Zhu, Kim, & Abouassaly, 2016). The recent pandemic, Corona virus belongs to a family of viruses that attack the respiratory system. Corona in Latin means 'crown', and ancient Greek 'Korone' means 'garland'. The name refers to the pointy fringe circling these viruses (Belluz, 2020). The COVID-19 virus has various ways of affecting different individuals. COVID-19 is a respiratory disease and most infected patients may experience mild to moderate symptoms and recover without any special treatment. According to the report, people with chronic medical problems and those above the age of 60 have a higher risk of developing serious illness and death. Popular COVID-19 symptoms include fever, fatigue, and dry cough. For others, shortness of breath, aches & pains and sore throat is important, although very few people experience diarrhoea, diarrhoea or a runny nose.

Situation Reports, official publications of the World Health Organization (WHO) provide the latest updates on the novel Corona virus outbreak. This includes an updated number of infected people, total cases, active cases, total recovered, total death etc. As per the latest situation report (Situation Report-177, July 15, 2020), globally approximately 10357662 (163939 new) confirmed cases with 508055 (4188 new) death due to Corona virus. This deadly virus originates from China in December 2019 and reached at the stage of community transmission within one and half months. The situations of the world's top countries affected by Corona virus are listed below,

Table 1. Top 10 COVID-19 effected countries

SN	Reporting Country	Total confirmed cases	Total confirmed new cases	Total deaths	Total new deaths	Transmission situation
1	United States of	3344783	58720	135053	349	Community

	America					Transmission
2	Brazil	1884967	20286	72833	733	Community Transmission
3	India	936181	29429	24309	582	Cluster of Cases
4	Russian Federation	746369	6422	11770	156	Cluster of Cases
5	Peru	330123	3797	12054	184	Community Transmission
6	Chile	319493	1836	7069	45	Community Transmission
7	Mexico	304435	4685	35491	485	Community Transmission
8	The United Kingdom	291377	1240	44968	138	Community Transmission
9	Iran	262173	2521	13211	179	Community Transmission
10	Spain	256619	666	28409	3	Community Transmission
	Total	**8676520**	**129602**	**385167**	**2854**	-

According to WHO Situation Report-177 (July 15, 2020), USA remain the top effected country (with 3344783 confirmed cases and 135053 deaths) since 21st March (2020) when it crossed China, the country where the virus first originated. In the second and third position there are Brazil and India with 1884967 confirmed cases (72833 deaths) & 936181 confirmed cases (24309 deaths) respectively. It is interesting to note that these top 10 countries covers almost 65.98% of total confirmed case, 69.74% new cases, 67.05% deaths, and 68.34% new deaths.

THE LENS (OVERVIEW)

Builds upon an open platform for innovation cartography, the Lens is an open global cyber infrastructure to make the innovation system more efficient and fair, more transparent and inclusive; serves nearly all of the patent documents in the world as open, a notable digital public good that is integrated with scholarly and technical literature along with regulatory and business data. The Lens also allows document collections, aggregations, and analyses to be shared, annotated, and embedded to forge open mapping of the world of knowledge-directed innovation. The scope of the scholarly database of the Lens is a combination of PubMed, Crossref, Microsoft Academic, CORE, PubMed Central, ORCID, and Impact story. This enormous database is driven by several Open Source Software/Technologies including PostgreSQL, MySQL, & MongoDB databases, Elastic search & Apache Lucene are used for text search, NGINX & Apache HTTP Servers are used for proxies & load balancing, backend applications are powered by Apache Tomcat & Gunicorn, images & static resources are stored & served using Amazon S3/CloudFront and Lens servers run within the Amazon EC2 cloud-computing platform. (The Lens, 2020)

REVIEW OF LITERATURE

Nasab & Rahim (2020) in their study conducted a qualitative and quantitative analysis of Global Scientific Research on SARS-CoV-2 publication outputs, journals, taking into account, authors, institutions, countries, cited references, keywords, and terms according to bibliometric methods using the help of the VOS viewer c software packages. To detect the recent research publications the was data collected in-between the period 2019-2020 from Web of Science (WOS), PubMed, and Scopus Core Collection on March 02, 2020. Similarly, Chahrour et al. (2020) explored the PubMed database and the World Health Organization (WHO) database; Radha (2020) examined Web of Science (WOS) database and Dehghanbanadaki et al. (2020) extracted from Scopus database for relevant observational and interventional publications pertaining to COVID-19 since December 2019. Again in another study Ram (2020) try to explore 50 years of bibliographic assessment using Scopus database where annual growth, productive countries, institutes, authors, journals, highly cited papers, and keywords using in Corona virus research article are of primary focus. Mao, Guo, Fu, & Xiang (2020) studied research publications related to Corona virus from January 2003 to February 2020 and retrieved from the Science Citation Index-Expanded (SCI-E) of the Web of Science database, while Sivankalai & Badhusha (2020) were doing a thorough bibliometric study using Web of Science core collection in between the time period 2005-2019. The results of the recent studies that means in which the time coverage is from or near about December 2019, when the outbreak of the pandemic recently originated at Wuhan, China indicated that China accounted for the highest number of publications followed by the USA & Canada; The Lancet & BMJ Clinical Research Ed were the most published journals and University of Hong Kong and Huazhong University of Science & Technology were the most productive institution. But in the case of metrics study based on decadal or 50 years growth trend, the USA obtained the most of the research publications, The Journal of Virology published most number of publications and the University of Hong Kong was the most productive institute. The variation of the result may come from the point of time range selected for those study.

OBJECTIVES OF THE STUDY

(i) The main objectives of this study is to focus on the present status of global publication output in Corona virus research and its citation impact.

(ii) To identify top ten scholarly publications on Corona virus research attaining highest scholarly & patent citations.

(iii) To examine the contribution of top 10 most productive institutions, countries, publishers and authors;

(iv) To analyse the global publication output of Corona virus research among top 10 subject field;

(v) Examine the OA status of scholarly publications on Corona virus research in terms of degree of access/usage freedom expressed universally by OA Colour and CC Licenses.

(vi) Evaluate the RGR and Doubling time of scholarly publications on Corona virus ranging from 16 July 1969 to 15 July 2020.

SCOPE OF THE STUDY

The study analyze the status of scholarly publications on Corona virus (n-CoV/COVID-19) research as indexed by Lens spanning a period from the oldest record until July 1, 2020. The literature on a different dimension of COVID-19 including types of scholarly publications based on scholarly citation & patent citation count, leading institutions & countries engaged in R&D, fields of study, leading authors and publishers, open access status etc., have been analyzed to reveal significant findings. The types of research publications restricted to only journal article for this

study. Additionally, the relative growth rate (RGR) and the doubling time (D$_t$) estimation are also prominent in this paper.

RESEARCH METHEDOLOGY

This study was based on quantitative data extracted manually from the Lens database up to 15 July 2020. "Structured Search" was made under "New Scholar Search" using the term "Corona virus" using the field values "title, Abstract, Keyword, Field of Study" and and further filtered the search with restrict the search result only for "Journal Article". Results obtained were imported through email (.csv file) for further analysis and visualization using spreadsheet software. Again, for the purpose of evaluate the relative growth rate and doubling time the formula, $RGR = \frac{LN(P2) - LN(P1)}{T2 - T1}$ and $Dt = \frac{0.693}{RGR}$ are used respectively.

RESULTS AND DISCUSSION

Table 2. Worldwide Status on Corona virus Research				
Works in Set	Works Cited by Patents	Patent Citations	Works Cited by Scholarly	Scholarly Citations
26628	2109	8174	15963	529494

Table 2 above depicts the worldwide status of Corona virus research retrieved from the Lens database comprise 26628 scholarly publications. As indexed by the Lens, out of these publications only 2109 (~8%) works have been cited by patents and received 8174 patent citations (~4 patent citations/paper) and 15963 (~60%) works were cited by scholarly and received 529494 scholarly citations (~33 scholarly citations/paper).

1. Top Publications in terms of Citation Count:

In terms of citation count, the top 10 scholarly publications represent the most relevant research publications on that field which is recommended by the maximum number of researchers of that field. Tables 3 and 4 display the status of the top 10 publications with regards scholarly citations and patent citations respectively.

Table 3. Top 10 Publications according to Scholarly Citations						
SN	Title	Author	Journal Name	YoP	Scholarly Citations	OA Status
1	Database resources of the National Center for Biotechnology Information	David L. Wheeler; Deanna M. Church; Alex E. Lash; et al.	Nucleic Acids Research	2004	6617	OA
2	Clinical features of patients infected with 2019 novel Corona virus in Wuhan, China	Chao-Lin Huang; Yeming Wang; Xing-Wang Li; et al.	The Lancet	2020	4062	OA

3	A novel Corona virus associated with severe acute respiratory syndrome.	Thomas G. Ksiazek; Dean D. Erdman; Cynthia S. Goldsmith; et al.	The New England Journal of Medicine	2003	2525	OA
4	Identification of a novel Corona virus in patients with severe acute respiratory syndrome	Christian Drosten; Stephan Gunther; Wolfgang Preiser; et al.	The New England Journal of Medicine	2003	2443	OA
5	Clinical Characteristics of Corona virus Disease 2019 in China	Wei-jie Guan; Zheng-yi Ni; Yu Hu; et al.	The New England Journal of Medicine	2020	2276	OA
6	Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Corona virus-Infected Pneumonia in Wuhan, China	Dawei Wang; Bo Hu; Chang Hu; et al.	JAMA	2020	2227	OA
7	A Novel Corona virus from Patients with Pneumonia in China, 2019	Na Zhu; Dingyu Zhang; Wenling Wang; et al.	The New England Journal of Medicine	2020	2154	OA
8	Epidemiological and clinical characteristics of 99 cases of 2019 novel Corona virus pneumonia in Wuhan, China: a descriptive study	Nanshan Chen; Min Zhou; Xuan Dong; et al.	The Lancet	2020	2116	OA
9	Early Transmission Dynamics in Wuhan, China, of Novel Corona virus–Infected Pneumonia	Qun Li; Xuhua Guan; Peng Wu; et al.	The New England Journal of Medicine	2020	2069	OA
10	Isolation of a novel Corona virus from a man with pneumonia in Saudi Arabia	Ali Moh Zaki; Sander van Boheemen; Theo M. Bestebroer; et al.	The New England Journal of Medicine	2012	1954	OA
Total Scholarly Citations as covered by the Top 10 Publications					**28443**	

Table 3 above reveals the overall status of top 10 publications on Corona virus research in terms of scholarly citation count. It may be noted here that "The New England Journal of Medicine" acquire the maximum articles in the top 10 list, which is a precious journal in the field of medical science with almost 74.699 journal impact factor (JIF Quartile). The paper entitled "Database resources of the National Center for Biotechnology Information" authored by David L. Wheeler; Deanna M. Church; Alex E. Lash; et al. published in 2004 received the highest scholarly citations i.e., 6617. The year of publication (YoP) of these research articles ranges from 2003 to 2020. It is also interesting to note that all of these scholarly research articles under top 10 citation count is available as open access (OA). Again, these top 10 publications cover 5.37% of total scholarly citations received by scholarly research publications on Corona virus.

		Table 4. Top 10 Publications according to Patent Citations				
SN	**Title**	**Author**	**Journal Name**	**YoP**	**Patent Citations**	**OA Status**
1	Mapping of linear antigenic sites on the S glycoprotein of a neurotropic murine Corona virus with synthetic peptides: a combination of nine prediction algorithms fails to identify relevant epitopes and peptide immunogenicity is drastically influenced by the nature of the protein carrier.	Claude Daniel; Martial Lacroix; Pierre J. Talbot	Virology	1994	172	OA
2	An efficient method to make human monoclonal antibodies from memory B cells: potent neutralization of SARS Corona virus	Elisabetta Traggiai; Stephan Becker; Kanta Subbarao; et al.	Nature Medicine	2004	156	OA
3	The Genome Sequence of the SARS-associated Corona virus	Marco A. Marra; Steven J.M. Jones; Caroline R. Astell; et al.	Science	2003	101	OA
4	Characterization of a novel Corona virus associated with severe acute respiratory syndrome	Paul A. Rota; M. Steven Oberste; Stephan S. Monroe; et al.	Science	2003	98	OA
5	Identification of a novel Corona virus in patients with severe acute respiratory syndrome.	Christian Drosten; Stephan Gunther; Wolfgang Preiser; et al.	The New England Journal of Medicine	2003	81	NOA
6	A novel Corona virus associated with severe acute respiratory syndrome.	Thomas G. Ksiazek; Dean D. Erdman; Cynthia S. Goldsmith; et al.	The New England Journal of Medicine	2003	73	NOA
7	Isolation of sequences from a random-sequence expression library that mimic viral epitopes.	Johannes A. Lenstra; Joannes H.F. Erkens; J.G.A. Langeveld; et al.	Journal of Immunological Methods	1992	69	OA

8	Universal oligonucleotides for the detection of infectious bronchitis virus by the polymerase chain reaction	Azri Adzhar; Kathy Shaw; Paul Britton; et al.	Avian Pathology	1996	55	NOA
9	Heptad repeat sequences are located adjacent to hydrophobic regions in several types of virus fusion glycoproteins.	Philip Chambers; Craig R. Pringle; Andrew J. Easton et al.	Journal of General Virology	1990	47	OA
10	Equine arteritis virus is not a togavirus but belongs to the Corona viruslike superfamily.	J. A. Den Boon; Eric J. Snijder; E. D. Chirnside; et al.	Journal of Virology	1991	46	OA
	Total Patent Citations as covered by the Top 10 Publications				**898**	

Table 4 above reveals the overall status of the top 10 publications on Corona virus research in terms of patent citation count. It is considered as a recognition if a research paper cited in a patent. The paper entitled "Mapping of linear antigenic sites on the S glycoprotein of a neurotropic murine Corona virus with synthetic peptides" authored by Claude Daniel; Martial Lacroix; and Pierre J. Talbot published in 1994 received the highest patent citations i.e., 172. The total number of patent citations gained by these highly influential papers were 898 which is almost 11% of the total patent citations gained. The year of publication (YoP) of the articles ranges from 1990 to 2004. It is also interesting to note that 70% of these top 10 papers are available as open access (OA).

2. Institution Wise Distribution:

Whatever methods used, the status of research publications is an essential factor in the overall ranking of an institution. Among the top 10 institutions of scholarly publications on Corona virus (Table 5), "University of Hong Kong" contributed the maximum number of publications (i.e. 412, 14.28%) followed by "Centers for Disease Control and Prevention" & "Chinese Academy of Sciences" with 364 (i.e. 12.61%) and 353 (i.e. 12.23%) publications respectively. Again the scholarly research on Corona virus obtained 10.84% of its overall publications from these top 10 institutions.

Table 5. Top 10 Institution of Scholarly Publications on Corona virus Research		
SN	**Name of the Institution**	**Total Scholarly Publications**	**Percentage (%)**
1	University of Hong Kong	412	14.28
2	Centers for Disease Control and Prevention	364	12.61
3	Chinese Academy of Sciences	353	12.23
4	National Institutes of Health	347	12.02
5	Huazhong University of Science and Technology	345	11.96
6	Wuhan University	258	8.94
7	Utrecht University	234	8.11

8	The Chinese University of Hong Kong	205	7.10
9	University of North Carolina at Chapel Hill	191	6.62
10	Fudan University	177	6.13
Total		**2886**	**100**

3. Institution Country/Region Wise Distribution:

The rate of the scholarly output of a country depends upon the present economics, academic structure, research facilities, health issues and involvement of government ministry. In the case of the present study "United States" occupied almost 43.50% (i.e. 8433) of scholarly output covered under top 10 countries or institution region. "United Kingdom" and "Netherlands" positioned in second and third position with 4752 (i.e. 24.51%) and 2674 (i.e. 13.79%) of publications respectively. It is interesting to note that, 19.88% of total works didn't mention any country/region. These top 10 country region occupied almost 72.80% of total scholarly research publications on Corona virus.

Table 6. Top 10 Institution Country/Region of Scholarly Publications on Corona virus Research			
SN	Institution Country/Region	Total Scholarly Publications	Percentage (%)
1	United States	8433	43.50
2	United Kingdom	4752	24.51
3	Netherlands	2674	13.79
4	Germany	949	4.89
5	China	773	3.99
6	Switzerland	709	3.66
7	Canada	347	1.79
8	France	277	1.43
9	India	238	1.23
10	Italy	234	1.21
Total		**19386**	**100**

4. Study Field wise Distribution:

As the study field are correlated with each other, normal distribution and differentiation can't be possible in that case. Thus except of collecting individual data in tabular form it is better to display it in a comparative bar-chart. Figure 1 depicts the most accepted field of study related to Corona virus research. As expected in medical science subject field specified with "Corona virus" & "Virology" occupied maximum area of research followed by "Medicine" and "Biology" with 15% & 14% coverage respectively.
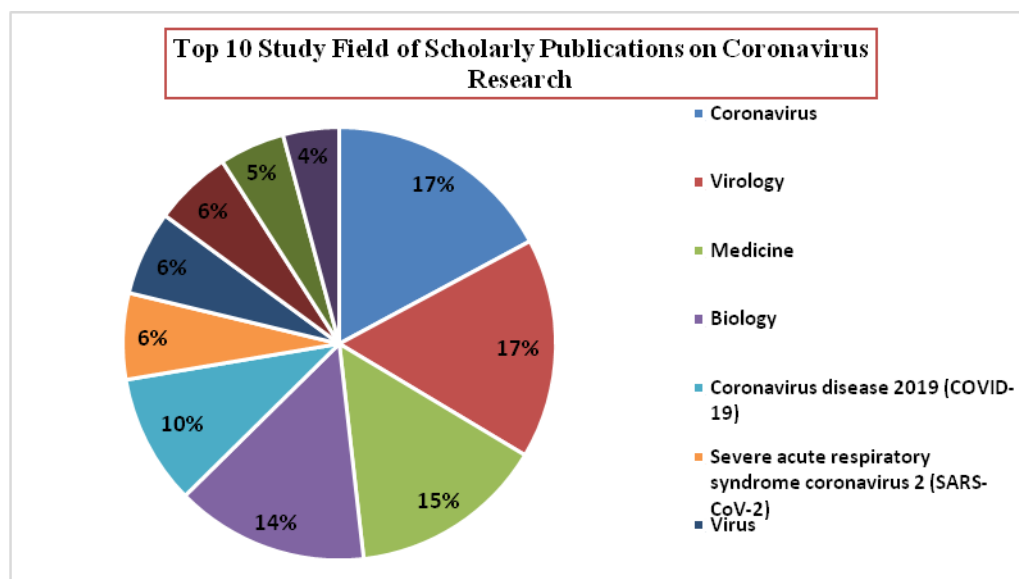
Figure 1. Top 10 Study Field on Corona virus Research

5. Author wise Distribution:

The below table 7 reveals that the top 10 prolific authors of the subject of COVID 19 research belongs to their highest productivity and given the rank according to their research output. "Kwok-Yung Yuen" with 209 publications is in top of the list followed by "Ralph S Baric" and "Luis Enjuanes" with 158 & 148 publications respectively. This list refer only overall individual contribution but not single contribution. The overall contribution of these top contributors occupied only 4.35% of the total publications on Corona virus research.

SN	Name of the Author	Total Scholarly Publications	Percentage (%)
Table 7. Top 10 Authors of Scholarly Publications on Corona virus Research
1	Kwok-Yung Yuen	209	18.03
2	Ralph S Baric	158	13.63
3	Luis Enjuanes	148	12.77
4	Stanley Perlman	135	11.65
5	Christian Drosten	124	10.70
6	Peter J M Rottier	86	7.42
7	Susan R Weiss	82	7.08
8	Bart L Haagmans	80	6.90
9	Ziad A Memish	69	5.95
10	Kathryn V Holmes	68	5.87
	Total	**1159**	**100**

6. Journal wise Distributions:

Analysis on ranking of top 10 high productivity journals among the total journals for the study period that were contributed on COVID 19 could reveal that the journals of "Journal of Virology" (1012), "SSRN Electronic Journal"

(506), and "Virology" (413) are having scored first three positions both in terms of publications productivity. It is also noted that the total publications of these top 10 journals occupied 14.62% of total research publications on Corona virus.

SN	Journal Name	Total Scholarly Publications	Percentage (%)
Table 8. Top 10 Journals of Scholarly Publications on Corona virus Research		
1	Journal of Virology	1012	25.99
2	SSRN Electronic Journal	506	12.99
3	Virology	413	10.61
4	Advances in Experimental Medicine and Biology	403	10.35
5	Emerging Infectious Diseases	319	8.19
6	Journal of Medical Virology	293	7.52
7	Journal of General Virology	286	7.35
8	Science	273	7.01
9	The Journal of general virology	200	5.14
10	Archives of Virology	189	4.85
	Total	**3894**	**100**

7. Publisher wise Distribution:

The following table (*Table 9*) is the list of the top 10 eminent publishers who have published articles, works on Corona virus. As evident from the table 9 Elsevier is the most preferred publisher publishing 16.60% of the total works published on Corona virus research. American Society for Microbiology is also a widely preferred publisher with 15.97% of the total works along with Elsevier BV with 15.17%, Wiley-Blackwell with 13.27% & Academic Press inc. with 8.25% contribution made the research more rich and wide-spread. The total contribution of these top 10 publishers covered 32.87% of total Corona virus research publication.

SN	Publisher Name	Total Scholarly Publications	Percentage (%)
Table 9. Top 10 Publisher of Scholarly Publications on Corona virus Research		
1	Elsevier	1453	16.60
2	American Society for Microbiology	1398	15.97
3	Elsevier BV	1328	15.17
4	Wiley-Blackwell	1161	13.27
5	Academic Press Inc.	722	8.25
6	Springer New York	581	6.64
7	Oxford University Press	570	6.51
8	Nature Publishing Group	562	6.42
9	Society for General Microbiology	513	5.86

10	Lippincott Williams and Wilkins	465	5.31
Total		**8753**	**100**

8. OA Status of Research Publications on Corona virus:

There are many types of open access, perhaps because it is such a young movement that it's still developing standards. According to SHERPA/RoMEO journal publishers are classified into four basic types and which indicates by four different colours, viz. Green, Blue, Yellow and White. Again OA policy also uses some license (Creative Common License) for valid distribution of publications under OA but with some terms and conditions. In the present study, the Lens database categorized the OA status of the scholarly LIS publications into two different way, viz. according to OA Colour and according to OA License.

Table 10. OA Status according to Open Access Colour			
SN	Open Access Colour	Description	Total Scholarly Publications
1	Bronze	Refers to publishers whose policies allow some of the journal articles made free-to-read on the publisher website, without an explicit open license	7559 (44.33%)
2	Gold	Gold OA makes the final version of the article freely and permanently accessible for everyone, immediately after publication.	4961 (29.09%)
3	Unknown	Status not known explicitly mentioned.	1766 (10.36%)
4	Green	Publisher allows authors specific copy of the article (i.e. pre-print, post-print or publisher's version/PDF) for self-archiving in a freely accessible institutional repository.	1731 (10.15%)
5	Hybrid	Publishers' policies allow *immediate* open access to some of their articles on condition that an 'Article Processing Charge - APC' is paid	1035 (6.07%)
Total			**17052 (100%)**

Table 10 displayed the distribution of scholarly LIS publications according to OA Colour. It has four basic types with colour code Green, Gold, Bronze & Hybrid. There are also some OA publications owning no OA colour. In the case of OA publications by colour, Bronze OA covers the highest number of OA publications i.e. 7559 (44.33%), followed by Gold and no OA colour with 4961 (20.09%) & 1766 (10.36%) publications respectively. Again, 1731 publications cover under Green OA policy and 1035 number of OA publications under hybrid OA colour. The total number of publications covers under OA colour obtain 64.04% of total scholarly publications on Corona virus. However, Lens does not categorizes research publications into other prevalent OA colours such as Blue, Yellow, White, Diamond and Platinum.

In the case of CC licenses, one aspect is important to note that CC0 and PDM differ in important respects and have distinct purposes. CC0 (No Rights Reserved) can only be used by the original creator of a work and PDM (No Known Copyright) anyone who wants (Creative Commons, 2016).

SN	License Type	Description	Total Scholarly Publications
Table 11. OA Status according to Open Access License			
1	Unknown	License information unavailable or does not exist.	10726 (62.84%)
2	CC BY	This license allows other to copy & republish, modify & adapt (remix, addition or deletion), with or without follow original licensing term, also for commercial use but only with proper attribution.	3388 (19.85%)
3	CC BY-NC-ND	This license allows other to copy & publish, with or without follow original licensing term but with proper attribution, without any derivation of original work and for non-commercial purpose.	1361 (7.97%)
4	CC BY-NC	This license allows other to copy & republish, modify & adapt (remix, addition or deletion), with or without follow original licensing term but with proper attribution and for non-commercial purpose.	987 (5.78%)
5	CC BY-NC-SA	This license allows other to copy & republish, modify & adapt (remix, addition or deletion) but with proper attribution & identical licensing term and for non-commercial purpose.	277 (1.62%)
6	Implied OA	Publications in which it has evidence that an OA license of some kind was used, but it's not reported directly on the webpage at this location.	113 (0.66%)
7	Elsevier User License	Elsevier user license gives copyright protection of a document published under it but allows non-commercial use e.g. access, download, copy, translate, text mining and data mining of the article. (Elsevier, n.d.)	107 (0.63%)
8	CC BY-SA	This license allows other to copy & republish, modify & adapt (remix, addition or deletion), also for commercial use but with proper attribution and identical licensing term.	42 (0.25%)
9	Publisher Specific	When the OA policies totally depends upon the	36

		agreements and conditions agreed by the author at the time of submission or publish a article.	(0.21%)
10	Public Domain	Public domain articles don't protected by any kind of intellectual property laws & licenses, neither need any permission or attribution for use, but obviously can't own it.	31 (0.18%)
Total			**17068 (100%)**

Table 11 above indicates the result of the OA status of the present study according to several OA licenses. It is evident from the table that OA publications on Corona virus without any known license covers the highest percentage (62.84%) and OA publications with CC BY (19.85%) and CC BY-NC-ND (7.97%) are in second and third position respectively. The total number of publications covers under OA license obtain 64.09% of total scholarly publications on Corona virus which is slightly higher than covered by OA colour.

RELATIVE GROWTH RATE (RGR) & DOUBLING TIME (Dt):

The study also examines the research trends on Corona virus over fifty years (i.e. starting from 1969). The growth of publications was analysed by using two parameters Relative Growth Rate and Doubling time (Mahapatra, 1985). The Relative Growth Rate displays the increase in the number of publications on Corona virus research output during different periods. RGR is a measure to study the increase in the number of publications of time. It is calculated as,

$$RGR = \frac{LN(P2) - LN(P1)}{T2 - T1}$$

Where,

P2 and P1 are the cumulative number of publications in the year's T2 and T1;

P1= LogP1 (Natural log of initial number of publication);

P2=LogP2 (Natural log of final number of publication).

Doubling time is the time required for publications to become double of the existing amount. It is directly related to RGR and is defined as the time required for the articles to become two-fold of the existing amount. If the number of articles in subject doubles during a given period, then difference between logarithms of numbers at the end of this period must be the logarithm of the number 2. In this study Napier logarithm is used, and the taken value of loge2 is 0.693. Hence, as per this (0.693), an average growth rate we calculated by what time interval the Napier logarithm of numbers does increase by 0.693 (Basavraja, Vinay & Kori, 2019). So the Doubling time is calculated using the following formula:

$$Dt = \frac{0.693}{RGR}$$

Where,

Dt= Doubling time

RGR= Relative Growth Rate

Decade	Pub. Count	Avg. Pub. Count (per year)	Cumulative Publication Count	LN (P1)	LN (P2)	Decadal RGR	Mean RGR $R_t(P)$	$D_t(P)$	Mean $D_t(P)$
Jul. 1969-Jul. 1979	161	18	18	2.89	-	0		0	
Jul. 1979-Jul. 1989	548	61	79	4.11	4.37	1.48		0.468	
Jul. 1989-Jul. 1999	933	104	182	4.64	5.20	1.09		0.636	
Jul. 1999-Jul. 2009	3691	410	593	6.02	6.39	1.75	1.75	0.396	0.473
Jul. 2009-Jul. 2019	5232	581	1174	6.36	7.07	1.05		0.660	
Jul. 2019-Jul. 2020	15935	15935	17109	9.68	9.75	3.39		0.204	

Table 12. Relative Growth Rate (RGR) and Doubling Rate (D_t) of Scholarly Publications on Corona virus

The table 12 outlines the status of RGR and the doubling time of the scholarly LIS research ranging from 16 July, 1969 to 15 July, 2020. The result of the study indicates that the decadal RGR and doubling time of scholarly literature on Corona virus is not constant, rather it shows an up & down in growth curve (figure 2). As expected the research on Corona virus increased with a certain rate in each time-span started from July 1969 - July 1979 to July 2009 -July 2019 but in last one year i.e. July 2019 - July 2020 it shows an immense rise.
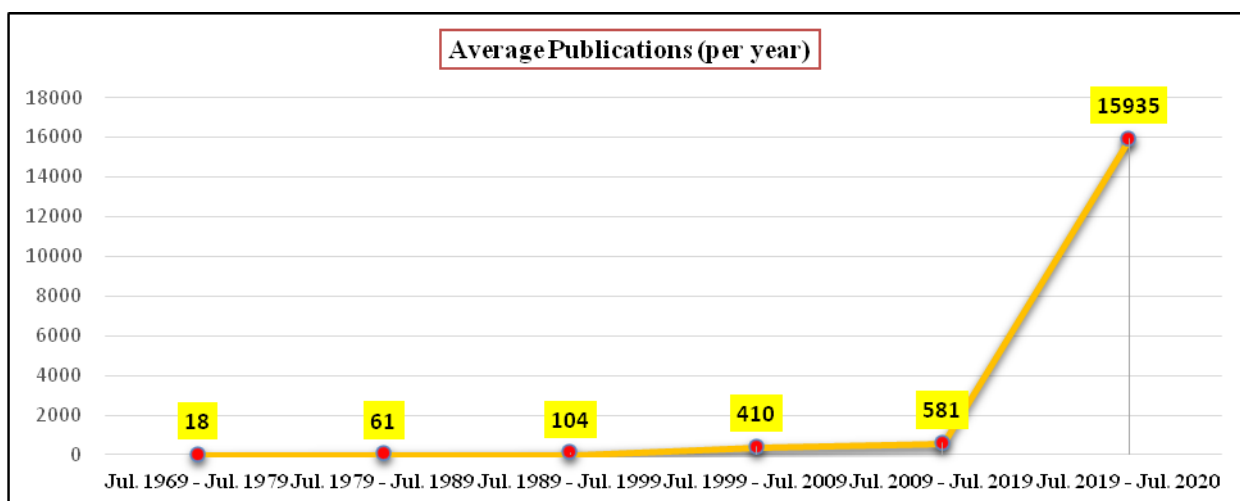

Figure 2. Growth Rate of Average Publications

It is evident from the figure 3 that the time span between July 2019- July 2020 obtained maximum relative growth rate (RGR) value (i.e. 3.39) while July 2009-2019 has the lowest RGR value (= 1.05). The average value of the RGR is 1.75 also indicated as Mean RGR.
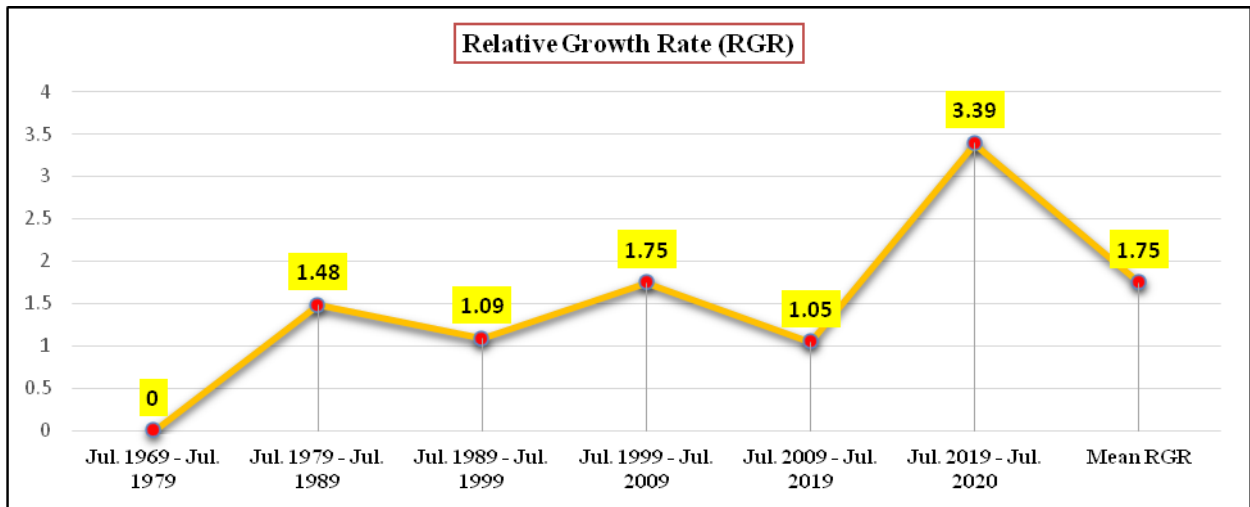

Figure 3. Relative Growth Rate (RGR) of Scholarly Research on Corona virus

As RGR is reversely proportional to Doubling Time (D_t), July 2019- July 2020 time span associated with lowest value of D_t (= 0.204) and July 2009- July 2020 is in top position with D_t= 0.660.
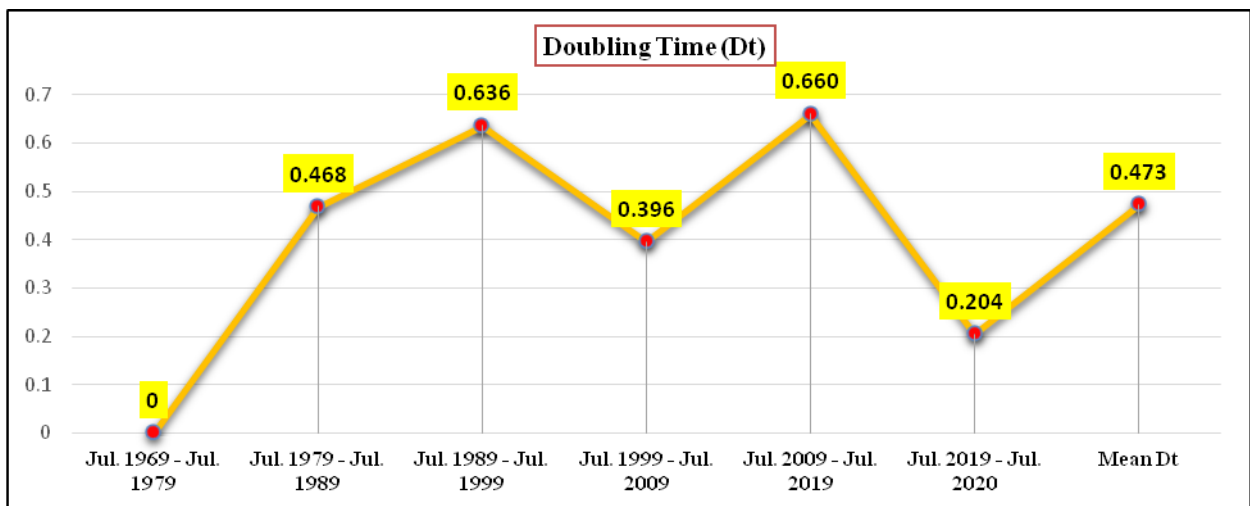
Figure 4. Doubling rate of Scholarly Research on Corona virus

The figures above displays that though the growth rate of average publication follow a fixed increasing trend (figure 2) but the Relative Growth Rate (RGR) & Doubling Time (D_t) (i.e. figure 3 & 4) don't follow any fixed pattern.

CONCLUSION

The first literature published on Corona virus was "Antigenic Relationships Among the Corona viruses of Man and Between Human and Animal Corona viruses" published in the year 1969 in the "Journal of Immunology". Therefore, it is evident that neither the Corona virus disease nor the research output in this area is new and the present study analyzed a qualitative and quantitative description of more than 50 years of world research output on Corona virus. As the study conducted through "The Lens", it also promotes the use of Lens as a big data academic search engine. A total of 26,628 scholarly outputs are indexed in the Lens related to Corona virus research and out of which 2109 are cited in a patent with 8174 patent citations while 15963 works are cited in another scholarly literature with 529494 scholarly citations. "The University of Hong Kong" is the most productive university with 412 scholarly literature, "The United States" as a most contributing country provides 8433 publications, "Journal of Virology" is the most contributing journal with 1012 publications, "Kwok-Yung Yuen" contributed maximum (i.e. 209 publications) as an individual author and "Elsevier" as a top published (i.e. 1453 publications) journal publisher. As the medical community needs the latest research update, open accessibility is the only way that scientific research can be spread uniformly around the globe. Among the scholarly research publications on Corona virus indexed in the Lens, 64.04% obtained open accessibility in terms of open access colour and among which "Bronze" open access occupied 44.33 % of publications. Again, 64.09% of total scholarly output also ensures open accessibility under an open-access license and among which 62.84% don't possess any open access licensing information. The mean RGR and mean D_t of the study calculated as 1.75 & 0.473 respectively (in between the time span July 1969-July 2020). The present study can be concluded with the fact that the Lens database is a combination of PubMed, Crossref, Microsoft Academic, CORE, PubMed Central, ORCID, & Impact story. It includes almost the entire field of the scholarly research output and gives a clear picture to a user about their relative field of interest. Hence, the Lens knows backwards and forwards of any field and prove itself as an available, adequate, accessible, affordable & appropriate (5 A's of Access) (Patient Access Partnership, n.d.) database by giving its users an authoritative source for their research.

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