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GROWTH IN GLOBAL RESEARCH PRODUCTIVITY OF VIROLOGY LITERATURE OVER 10 YEARS: A SCIENTOMETRIC STUDY

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Abstract

To expand upon the limited literature estimating the quantity and quality of worldwide research output in the field of virology, a bibliometric analysis was conducted for the period 2011-2020 using the web of science databases. The major focus was only growth perspective for example year-wise productivity, Relative Growth rate, Annual growth rate, Compound growth rate, doubling time, Annual Ratio of growth, Exponential Growth rate, and Arithmetic mean over the years. It is found that India shared 2.46% of global publications. The RGR has been decreasing from 2012 (0.69) to 2020 (0.10) but other hand Doubling time increased from 1.01 in 2012 to 7.18 in 2020. By calculating the Exponential growth rate it is found that the highest growth rate was in the year 2013 with a 1.13 growth frequency.

Keywords: Virology, scientometrics, Relative Growth rate (RGR), Doubling time, Annual Growth rate, Exponential Growth rate, and Arithmetic mean, etc.

1. BACKGROUND OF THE STUDY

In the traditional sense, Virology is the scientific discipline dealing with the biology of viruses (including molecular biology and biochemistry) and viral disease (including physiology, epidemiology, and clinical aspects of viruses). In a more modern sense, virology has acquired a broader significance as it encompasses the study of ecology, evolution of viruses, interaction among viruses and other microorganisms, and the ability of viruses to

deliver their own and heterologous genetic information into cells. The specificity of the discipline came from the concept of the virus as a replication 'organism' very different from other microorganisms, and indeed they have very peculiar characteristics ([Antonelli, G. & Pistello, M., 2019](#)). Firstly, the growing importance of virology is directly related to the fact that we are learning more about viruses, better understanding their ties to a specific disease, and epidemiology is looking at viral infections in new ways: we are suddenly recognizing viruses where we have never seen them before. A good example is Zika virus infections, or the spread of the chikungunya virus, which has spread across the USA in recent years ([Walter D, 2017](#)).

One of the advantages of bibliometric analysis is the opportunity to put a large amount of research into context. Virology, a fast-paced field with topics that inevitably rise and fall in prominence as outbreaks occur, is especially well suited to this type of time-lapse visualization of hot topics. ([Richardson, 2014](#)). This research is a large-scale scientometrics study in the field of virology. We focus on the quantitative features and characteristics of infectious disease research over the past 10 years. This paper presents studies that analyze and real-world trends in virology and studies that relate to bibliometric trends in general and public health in particular ([Kagan, D. & et.al, 2020](#)).

2. LITERATURE REVIEW

Several researchers have carried out bibliometric studies of research productivity in various parts of the world, with an emphasis on biomedical fields. According to these bibliometric studies, microbiology ([Falagas, ME, et.al, 2006](#); [Michalopoulos, A & Falagas, ME, 2005](#)) and virology ([Vergidis PI, 2005](#)) research is concentrated in developed areas (the United States and Western Europe), which have provided the majority of the world's virology research in terms of both quantity and quality of knowledge. These two world regions, in particular, have provided 77.7% of the published papers in this field ([Falagas, ME & et.al, 2005](#)). In 2005, [Vergidis et.al](#) used PubMed and JCR (Journal Citation Report) to study trends in microbiology publications. They discovered that microbiology research in the USA had the highest average impact factor, but in terms of research production, Western Europe was first. In 2015, [Ruiz-Saenz, J. & Martinez-Gutierrez, M.](#) evaluate Colombian publications on viruses and viral diseases in indexed journals during the period from 2000 to 2013. The data were collected from MedLine, SciELO, LILACS, and Scopus databases. They found that the number of papers published was 711, of which 40.4% were published in local journals, and 59.6% were published

in foreign journals. In 2017, [Al- Jabi, S.W.](#) examined bibliometrically analyze the quantity and quality of publications indexed in Scopus from different countries to reveal the characteristics of global research output regarding the West Nile virus from 1943-2016. He found that the annual quantity of literature published before 2000 followed a low rate. The USA is the greatest number of published with 2304 (48.7%). In 2016, [Zyoud, H.](#) did a bibliometric analysis of worldwide and Arab publications of Dengue research during 1872-2015. There was a total of 19,581 dengue-related documents identified in the Scopus database. The USA was Arab's most main cooperative partner (46, 20.4%), followed by India (36, 15.9%). [Mao, Xingjia MS & et.al.](#) The number of publications about coronavirus research increased sharply in 2004 for the SARS outbreak and increased again in 2012 for the MERS outbreak. In 2020 Ram, S. discovered 50-year bibliometrics assessment coronavirus research trends. Most of the research publications were from the USA (31.67%), and the University of Hong Kong was the most productive institute.

3. OBJECTIVES OF THE STUDY

The paper represents particularly growth aspects of virology research over the 10 years. To retrieve the results, the major objective of this present study is to understand the level of growth and cumulative growth in the virology research from 2011 to 2020. To examine the Relative Growth Rate (RGR), doubling time (Dt), Annual Growth Rate (AGR), Annual Ratio of growth rate (ARoR), and Compound Annual Growth Rate (CAGR) of virology. To evaluate the exponential growth rate and to calculate the Arithmetic mean of virology research over time.

4. MATERIALS AND METHODS

The data relating to the studies of Virology research from 2011 to 2020 were retrieved from the Science Citation Index- Expanded (SCI-E) of the Web of Science database. There was advanced search string was adopted i.e. SU= (virology) PY= (2011-2020). A total of 80220 publications were included. There were mainly growth aspects included in this paper i.e. RGR, ARG, ARoG, CAGR, Dt. There was a graphical exponential growth rate also drawn.

Relative Growth Rate (RGR) of publications $R(P) = \frac{P_2 - P_1}{T_2 - T_1}$ Where, P_2 and P_1 is the Cumulative number of publications in the years T_2 and T_1 . R is the Mean relative growth rate over the specific period of intervals. $P_1 = \log P_1$ (Natural log of the initial number of publications) $P_2 = \log P_2$ (Natural log of the final number of publications).

Doubling Time (Dt) is a direct equivalence between the relative growth rate and the doubling time. If the number of articles/pages of a subject doubles during a given period then the difference between the logarithms of numbers at the beginning and end of this period must be logarithms of number 2. If a natural logarithm is used this difference has a value of 0.693. Thus the corresponding doubling time for each specific period of interval and both articles and pages can be calculated by the formula: Doubling time (Dt) = 0.693/ R.

5. DATA COLLECTION & ANALYSIS

5.1 World's and India's Research productivity in virology science literature

There were a total of 80220 records are retrieved in the Web of Science database on Virology research literature from 2011 to 2020.

Table: 1 year-wise analysis of virology from 2011 to 2020.

Years	Record	%	Cumulative	%	India	%	Cumulative	%	Global share of India
2011	8373	10.44	8373	1.84	164	8.29	164	1.48	1.96
2012	8258	10.29	16631	3.65	214	10.82	378	3.41	2.59
2013	9335	11.64	25966	5.70	239	12.08	617	5.56	2.56
2014	8425	10.50	34391	7.55	212	10.72	829	7.47	2.52
2015	8236	10.27	42627	9.36	198	10.01	1027	9.26	2.40
2016	8181	10.20	50808	11.15	212	10.72	1239	11.17	2.59
2017	6904	8.61	57712	12.67	185	9.35	1424	12.84	2.68
2018	8237	10.27	65949	14.48	216	10.92	1640	14.78	2.62
2019	6893	8.59	72842	15.99	157	7.94	1797	16.20	2.28
2020	7378	9.20	80220	17.61	181	9.15	1978	17.83	2.45
Total	80220	100	455519	100	1978	100	11093	100	24.65

Table 1 depicts the virology research output of the world and India. From 2011 to 2020 the total publication was 80220 globally, out of it India published a 1978 very low record. India shared 2.46% of global publications from 2011 to 2020. The cumulative publications growth had increased from 16631 (2012) to 80220 (2020). The highest publications were published in

2013 with 9335 records and the lowest in 2019 with 6893 records. In the Indian context, the highest publications were discovered in 2017 with 216 records and least in 2019 with 157 records.

5.2 Relative growth rate and doubling time

There were Relative growth rate and doubling time calculated of virology research area from 2011 to 2020. The data was increase every next year.

Table: 2 Status of World Virology literature as reflected over 2011-2020 by calculating Relative Growth rate and Doubling time

Years	Record	Cumulative	log W1	log W2	RGR	(Dt)	Mean RGR	Mean Dt
2011	8373	8373	0	9.03	0	0		
2012	8258	16631	9.03	9.72	0.69	1.01		
2013	9335	25966	9.72	10.16	0.45	1.56		
2014	8425	34391	10.16	10.45	0.28	2.47		
2015	8236	42627	10.45	10.66	0.21	3.23	0.04	0.65
2016	8181	50808	10.66	10.84	0.18	3.95		
2017	6904	57712	10.84	10.96	0.13	5.44		
2018	8237	65949	10.96	11.10	0.13	5.19		
2019	6893	72842	11.10	11.20	0.10	6.97		
2020	7378	80220	11.20	11.29	0.10	7.18	0.02	1.44
Total	80220	455519	94.11	105.41	2.26	36.99	0.23	3.70

RGR= Relative Growth Rate, Dt= Doubling time.

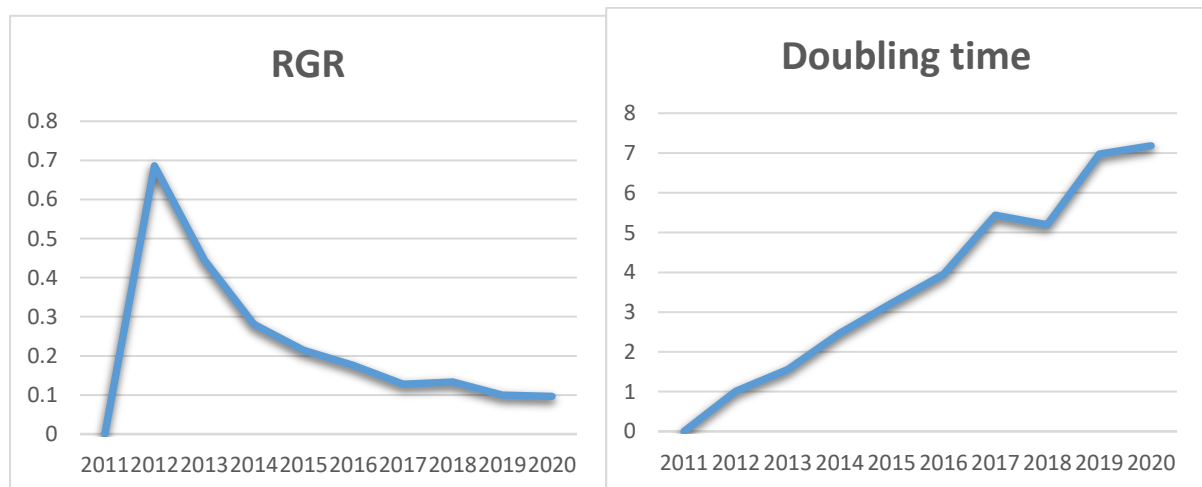


Figure: 1 Graphical representation of Relative Growth rate & doubling time.

It is seen in table 2 and figure 1 that RGR has been decreasing from 2012 (0.69) to 2020 (0.10). The mean RGR is 0.04 from 2011 to 2015 and 0.02 from 2016 to 2020. On the other hand, the Doubling Time (Dt) has shown an increasing trend. The data in table 2 reveals that doubling time has increased from 1.01 in the year 2012 to 7.18 in the year 2020. The slope in figure 1 is increasing trend.

5.3 Annual Growth Rate, Annual Ratio of Growth and Compound Annual Growth Rate

The total 80220 records used for analysis to calculate Annual Growth Rate, Annual Ratio of Growth and Compound Annual Growth Rate from 2011 to 2020.

Table: 3 Description of Annual Growth rate, Annual ratio of Growth and compound annual Growth rate of virology from 2011-2020.

Years	Record	ARoG	AGR	CAGR
2011	8373	-	-	-1.79
2012	8258	0.99:1	0.99	-1.80
2013	9335	1.13:1	0.56	-1.71
2014	8425	0.90:1	0.32	-1.79
2015	8236	0.98:1	0.24	-1.81
2016	8181	0.99:1	0.19	-1.81
2017	6904	0.84:1	0.14	-1.96
2018	8237	1.19:1	0.14	-1.81
2019	6893	0.84:1	0.10	-1.96
2020	7378	1.07:1	0.10	-1.90
Total	80220	8.93:1	2.79	-18.35

ARoG= Annual Ratio of Growth, AGR= Annual Growth Rate, CAGR=Compound Annual Growth rate.

It is in table 3 the Annual Growth rate decreasing with 0.99 in year 2012 to 0.10 in year 2020. In Annual Ratio of Growth the values are increasing over the year, in 2012 it was 0.99:1 and in 2020 it increased into 1.07:1. On the other hand compound Annual growth rate is negative value but it increased from -1.79 in 2011 to -1.90.

5.4 Arithmetic Mean

Arithmetic Mean = Total of the observation/Number of the observations

$$= X_1+X_2+X_3+X_4.....+ X_N / N$$

$$=\sum X/N$$

$$=80220/10$$

$$=8022$$

Table: 4 Arithmetic Mean

Years	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total	Arithmetic mean
Record	8373	8258	9335	8425	8236	8181	6904	8237	6893	7378	80220	8022

The arithmetic mean of the entire publication for the study period has been determined as 8022 i.e. during the study period and average of 8022 publications were published per year.

5.5 Exponential Growth Rate

The exponential growth rate of Virology research publications during the study period (2011-2020) has been determined and presented in table 4 and figure 3.

Table: 5 Description of Exponential growth rate over the years.

Years	Publications	%	Exponential Growth Rate $b=yt1/yt0$
2011	8373	10.44	0
2012	8258	10.29	0.99
2013	9335	11.64	1.13
2014	8425	10.50	0.90
2015	8236	10.27	0.98
2016	8181	10.20	0.99
2017	6904	8.61	0.84
2018	8237	10.27	1.19
2019	6893	8.59	0.84
2020	7378	9.20	1.07
Total	80220	100	8.93

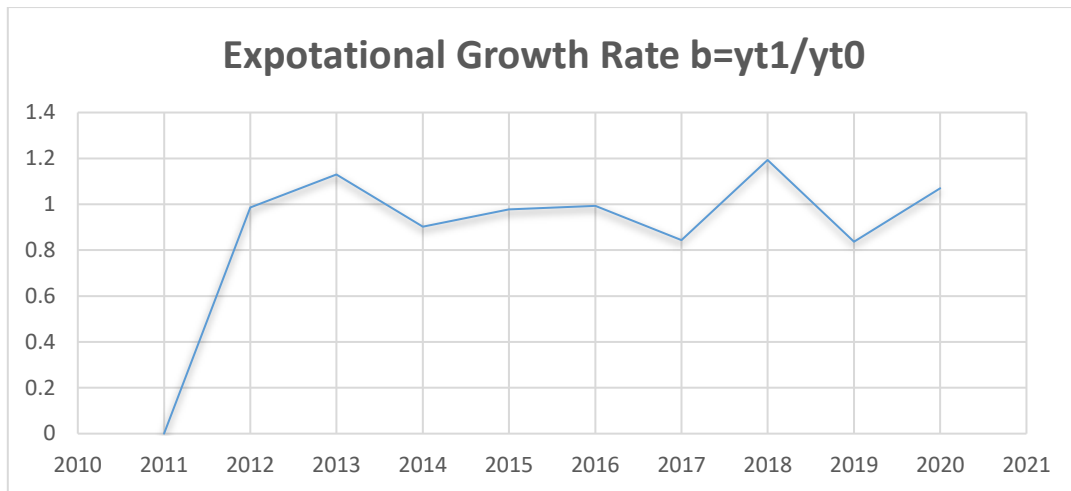


Figure: 2 Exponential Growth rate

It is identified that the growth rate was in 2012 is 0.99 and increased in 2013 with 1.13 after that again increase from 0.98 in 2014 to 0.84 in 2017 than again increased in 2020 with 1.07. The trend of Exponential growth rate is ups and down over the years. The highest growth rate was in the year 2013 with 1.13 growth frequency. The lowest in 2011 and 2019 with 0.84 growth frequency. During the study period, the growth rate has been inconsistent.

6. CONCLUSION

Bibliometric analysis is a reliable tool to evaluate the development and quality of scientific production. It can be inferred from this study that Virology is a most important branch of health science in this era. We need more and more virologist and microbiologist to discover and study microorganisms that quickly duplicate, resulting in the rapid spreading of viruses. Their primary work is to figure out how diseases like AIDS, SARS and hepatitis spread, in order to prevent more rampant development and to assist in vaccine development. The data was suggested that it was a significant research activity in the field of virology during the study period. In this we only examined growth perceptible but there lot more to discover. The Indian contribution to the body of literature on virology is so low with more contentious efforts by the researchers.

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