Growth and Obsolescence of Literature in Virology Research

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Abstract

The present study has tried to identify the growth and obsolescence of virology research at the global and Indian levels from the period 1990 to 2019. The data have been collected from Scopus bibliographic database. The highest India's share in virology research came in the year 2019. It is observed that the mean relative growth rate for Indian virology research during 1990-2019 was 0.57, 0.16, and 0.17 respectively. The corresponding mean doubling time for the same period was 2, 4.5, and 4.45 respectively. The rate of doubling time (DT) slows as the number of publications rises over time (a year), as a consequence, when publications increase, RGR declines, and DT rises. The mean figures of relative growth rate and doubling time for global virology research output are 0.47, 0.14, and 0.13 (RGR) and 1.89, 5.1, and 5.84 (DT) respectively. The literature on virology best fits into the exponential growth model. The number of citations decreased with an increase in age, except in some years, the citations increased by a small margin. The annual aging factor (AAF) of the virology literature is 0.986, half-life = 14 years, mean life = 70.93 and utility factor = 71.43. The growth study will help to monitor the number of new yearly publications in the field of virology. Knowing in advance which areas of virology are likely to increase more than others may be helpful for research funders, academics, students, established researchers, and policy officials. After De Solla Price's 1963 publication of his masterpiece Little science, Big science, this type of study would take on a special relevance.

Keywords: Exponential model, Growth dynamics study, Linear model, Obsolescence of literature, Scientometrics, Virology research

1. Introduction

The term "growth" means an increase in size, and the term "literature" denotes the subset of periodicals published on a given topic. In the context of science, the term 'growth' indicates an increase in the quantity of scientific literature and scientific output along with the number of the scientific community and research organisations. The growth dynamics study of literature is measured by scientific indicators like citation analysis and counting of publications.

The concept of 'Obsolete' (aging or decay) denotes that the usage of literature is reduced over a period of time or is no longer in use on a certain topic. The process of

becoming obsolete is known as obsolescence. It is also often referred to as the 'phenomenon of replacement'. Gross and Gross first used the term obsolescence in the year 1927. Actually, Obsolescence indicates a connection between time and use, yet the impact of time is seen in several ways (Sangam and Meera, 2012).

Virology is the scientific study of various types of viruses. After the COVID-19 pandemic, the subject has taken on even greater relevance for us. Virus particles contain with the nucleic acid genome, one or two standards of DNA or RNA. Viruses are non-cellular organisms. Virus particles can be seen by electron microscopy. The German scientists Ernst Ruska and Max Knoll used electron microscopy to capture the first photographs of viruses in 1931. According to the type of nucleic acid, viruses are categorized into two types, i.e., DNA virus and RNA virus. For replication, viruses are dependent on living organisms. Molecular methods like polymerase chain reaction (PCR) are used to detect an active virus. Some of the viruses interfere with the normal cellular process and cause disease inside the human body. Some of the devastating diseases caused by viruses are AIDS, Chickenpox, Hepatitis, Influenza, SARS, Smallpox, etc. Two widely renowned viral research institutes in the country are ICMR's National Institute of Virology and National Centre for Diseases Control, Delhi under the Ministry of Health & Family Welfare (History of virology, n.d.).

2. Review of literature

The growth of the scientific literature in the area of Bioinformatics as available from NCBI PubMed was analysed. The study concluded that bioinformatics literature followed exponential and steady growth (Patra and Mishra 2006). Rao and Srivastava (2010) analysed growth of literature in Malaria research and discovered that Malaria research followed an exponential model. A study based on the growth rate of ecology research for the period of 1976 to 1993, concluded that it followed an exponential growth model (Rodriguez and Moreiro, 1996). Sangam, S. L., Madalli, D., and Arali, U. B. (2015) have analysed the growth pattern, doubling time of world and Indian genetic literature. A total of 3,87,605 publication from the period 1993 to 2002 are analysed for this study. The study concluded that the world genetics literature followed logarithmic and linear growth models, but for India, the best fits are exponential and logistic models. The growth and obsolescence study of superconductivity research was investigated in India. The WOS database was used as a data source from 1989 to 2014 and the data were compared with the global output. The study revealed that the growth pattern of the global superconducting literature follows almost a logistic pattern, but the growth trend of the literature on superconductivity in India followed two curves, one of which was logistic and the other was parabolic (Teli & Dutta, 2017).

Longyear conducted an obsolescence study in the subject domain of musicology. The study calculates synchronous half-life and diachronic half-life (Longyear, 1977). Tsay (1998) examined citation half-life in the subject domain of medical sciences. The study concludes half-life of medical sciences journals is 3.43 years. Clark (1976) conducted an obsolescence study of US patents year-by-year issues since 1836. Another study examined multi-synchronous obsolescence in two computing journals. The study found that the aging rate is high. The half-life of two computing journals is 4 years (Cunningham and Bocock, 1995).

The literature review revealed that several studies had been made on the growth and obsolescence in the different subject domains but no study explored growth and obsolescence in different facets of biological sciences. Due to the growth of biological sciences, new disciplines explored and well-established disciplines are overlapping. Vaccines for diseases like HIV, hepatitis C, and Ebola, to name a few, would undoubtedly save a great deal of lives. In addition to the ongoing emergence of new infections, established nonviral pathogens can develop drug resistance. Therefore, taking virology to examine their growth pattern and obsolescence is worthwhile.

3. Objectives

i. To find out growth pattern of virology literature from 1990 to 2019

ii. To find out Relative Growth Rate (RGR) and Doubling Time (DT)

iii. Comparative study between Indian and global growth of literature

iv. Obsolescence patterns of virology literature.

4. Methodology

The present study has selected the Scopus databases for data collection. Keyword used for searching (in the field: Article, Title, Abstract) was: virology. The study has given equal emphasis to the research contribution of India to global research output during the period of study. A total of 166822 numbers of research articles were retrieved for the period of 1990-2019. All the bibliographic data of the retrieved articles were recorded in an MS Excel spreadsheet. MS Excel is used to analyse the data. R statistical software is used to draw the growth models.

5. Result and discussion

Growth dynamics study of virology

The value of the current growth in relation to that of the prior year is shown by the relative growth rate. The following equation is used to calculate the mean RGR over a certain period of time:

$$RGR = (W_2 - W_1) / (t_2 - t_1)$$

Where, W_1 = Log of initial number of papers; W_2 = Log of final number of papers; t_1 = Initial year and t_2 = Final year.

The Doubling Time refers to the time in years taken by a subject to double its publication output. The equation for the Doubling Time is DT = 0.693/RGR.

Table 1: Year-wise distribution of number of Indian publications in Virology

Publication years	No. & (AIS in %) of total publications	Cumulative no. of publications	W1	W2	RGR	Mean RGR	Doubling Time (DT)	Mean DT
1990	1 (0.02)	1		0.00				
1991	2 (0.04)	3	0.00	1.10	1.10		0.63	
1992	3 (0.07)	6	1.10	1.79	0.69		1.00	
1993	4 (0.09)	10	1.79	2.30	0.51		1.36	
1994	18 (0.39)	28	2.30	3.33	1.03		0.67	
1995	37 (0.81)	65	3.33	4.17	0.84		0.82	
1996	27 (0.59)	92	4.17	4.52	0.35		1.99	
1997	29 (0.63)	121	4.52	4.80	0.27		2.53	
1998	37 (0.81)	158	4.80	5.06	0.27		2.60	
1999	18 (0.39)	176	5.06	5.17	0.11	0.57	6.42	2
2000	31 (0.68)	207	5.17	5.33	0.16		4.27	
2001	36 (0.79)	243	5.33	5.49	0.16		4.32	
2002	64 (1.40)	307	5.49	5.73	0.23		2.96	
2003	41 (0.90)	348	5.73	5.85	0.13		5.53	
2004	64 (1.40)	412	5.85	6.02	0.17		4.10	
2005	66 (1.44)	478	6.02	6.17	0.15		4.66	
2006	59 (1.29)	537	6.17	6.29	0.12		5.95	
2007	86 (1.88)	623	6.29	6.43	0.15		4.67	
2008	101 (2.21)	724	6.43	6.58	0.15		4.61	
2009	141 (3.08)	865	6.58	6.76	0.18	0.16	3.89	4.5
2010	177 (3.86)	1042	6.76	6.95	0.19		3.72	
2011	154 (3.36)	1196	6.95	7.09	0.14		5.03	
2012	161 (3.52)	1357	7.09	7.21	0.13		5.49	
2013	148 (3.23)	1505	7.21	7.32	0.10		6.69	
2014	416 (9.08)	1921	7.32	7.56	0.24		2.84	
2015	492 (10.74)	2413	7.56	7.79	0.23		3.04	
2016	521 (11.38)	2934	7.79	7.98	0.20		3.54	
2017	527 (11.51)	3461	7.98	8.15	0.17		4.20	
2018	557 (12.16)	4018	8.15	8.30	0.15		4.64	
2019	562 (12.27)	4580	8.30	8.43	0.13	0.17	5.29	4.45

Table 1 indicates the highest number of Indian virology publications was 562, published in 2019. The lowest number of publications, i.e., 1 was published in 1990. It has been observed that the mean relative growth rate was found to have dropped to 0.17 (2019) from 0.57 (1999), though the mean DT pattern follows reverse direction, which has increased to 4.45 (2019) from 2 (1999).

Table 2: Year-wise distribution of number of global publications in Virology

Publication years	No. & (AGS in %) of total publications	Cumulative no. of publications	W1	W2	RGR	Mean RGR	Doubling Time (DT)	Mean DT
1990	170 (0.10)	170		5.14				
1991	190 (0.11)	360	5.14	5.89	0.75		0.92	
1992	273 (0.16)	633	5.89	6.45	0.56		1.23	
1993	291 (0.17)	924	6.45	6.83	0.38		1.83	
1994	1133 (0.68)	2057	6.83	7.63	0.80		0.87	
1995	1924 (1.15)	3981	7.63	8.29	0.66		1.05	
1996	1891 (1.13)	5872	8.29	8.68	0.39		1.78	
1997	1967 (1.18)	7839	8.68	8.97	0.29		2.40	
1998	1941 (1.16)	9780	8.97	9.19	0.22		3.13	
1999	1939 (1.16)	11719	9.19	9.37	0.18	0.47	3.83	1.89
2000	2055 (1.23)	13774	9.37	9.53	0.16		4.29	
2001	2169 (1.30)	15943	9.53	9.68	0.15		4.74	
2002	2971 (1.78)	18914	9.68	9.85	0.17		4.06	
2003	2716 (1.63)	21630	9.85	9.98	0.13		5.16	
2004	3118 (1.87)	24748	9.98	10.12	0.13		5.15	
2005	3068 (1.84)	27816	10.12	10.23	0.12		5.93	
2006	3543 (2.12)	31359	10.23	10.35	0.12		5.78	
2007	3880 (2.33)	35239	10.35	10.47	0.12		5.94	
2008	5197 (3.12)	40436	10.47	10.61	0.14		5.04	
2009	6106 (3.66)	46542	10.61	10.75	0.14	0.14	4.93	5.1
2010	6863 (4.11)	53405	10.75	10.89	0.14		5.04	
2011	5844 (3.50)	59249	10.89	10.99	0.10		6.67	
2012	5382 (3.23)	64631	10.99	11.08	0.09		7.97	
2013	5250 (3.15)	69881	11.08	11.15	0.08		8.87	
2014	12775 (7.66)	82656	11.15	11.32	0.17		4.13	
2015	16901 (10.13)	99557	11.32	11.51	0.19		3.72	
2016	17091 (10.25)	116648	11.51	11.67	0.16		4.37	
2017	16928 (10.15)	133576	11.67	11.80	0.14		5.11	
2018	16571 (9.93)	150147	11.80	11.92	0.12		5.93	
2019	16675 (10.00)	166822	11.92	12.02	0.11	0.13	6.58	5.84

Table 2 shows that the highest number of global virology publications was 17091, published in 2016. The lowest number of publications, i.e., 170 was published in 1990. It has been observed that the mean RGR has decreased to 0.13 (2019) from 0.47 (1999). The mean DT increased by 5.84 (2019) from 1.89 (1999).

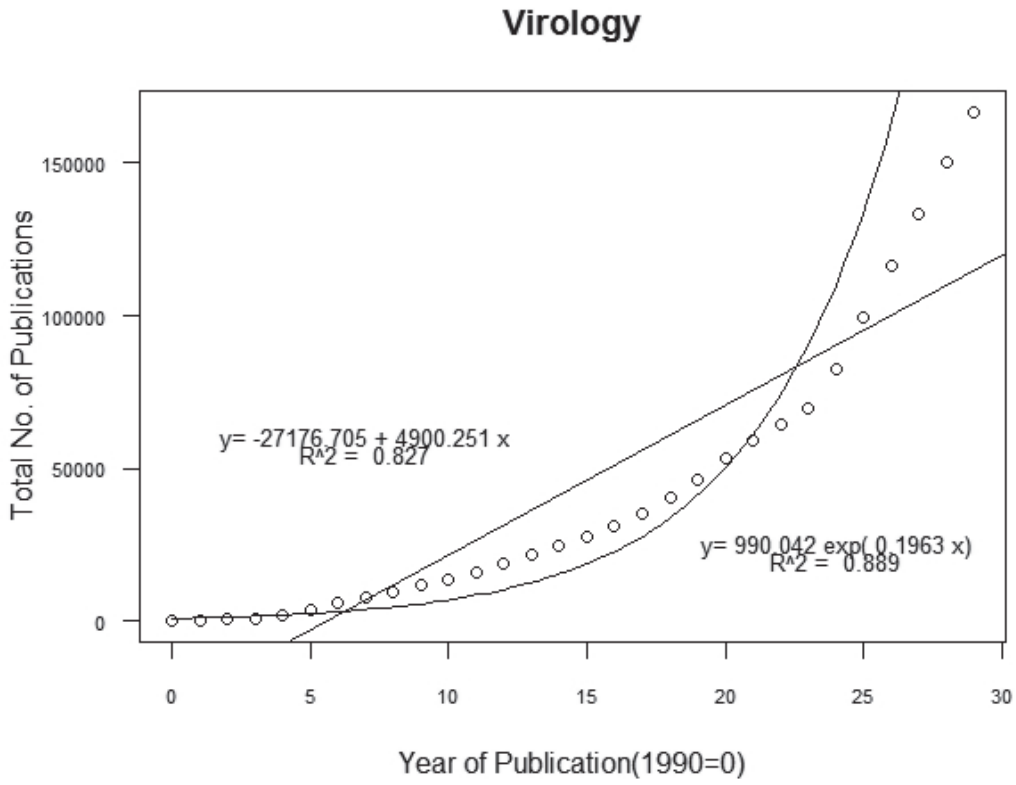

Figure 1: Growth curve of global virology publications

Figure 1 reveals that the exponential trend has a higher R2 value (0.889) than the linear fitting (0.827). The result shows that the global Virology literature fits better exponentially than the linear trend.

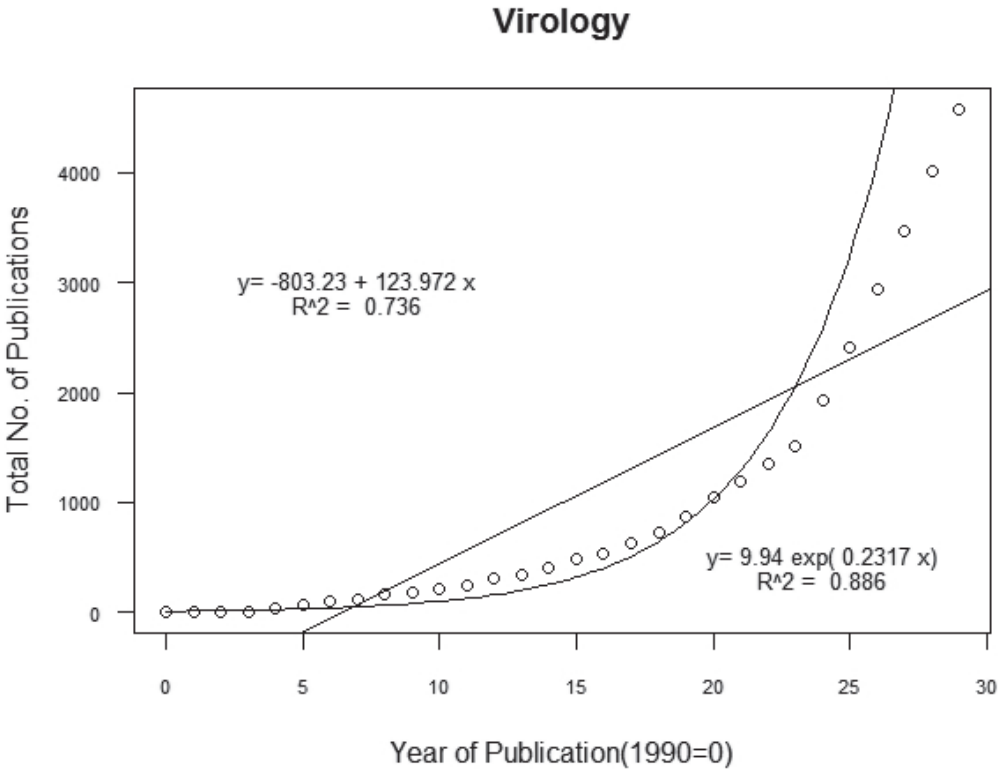

Figure 2: Growth curve of Indian virology publications

Figure 2 reveals that the exponential trend has a higher R2 value (0.886) than the linear trend (0.736). This figure shows that Indian virology literature data fits better exponentially than the linear trend.

Table 3: Comparative study between AIS and AGS

Year	AGS	AIS	AIS/AGS
1990	0.10	0.02	0.21
1991	0.11	0.04	0.38
1992	0.16	0.07	0.40
1993	0.17	0.09	0.50
1994	0.68	0.39	0.58
1995	1.15	0.81	0.70
1996	1.13	0.59	0.52
1997	1.18	0.63	0.54
1998	1.16	0.81	0.69
1999	1.16	0.39	0.34
2000	1.23	0.68	0.55
2001	1.30	0.79	0.60
2002	1.78	1.40	0.78
2003	1.63	0.90	0.55
2004	1.87	1.40	0.75
2005	1.84	1.44	0.78
2006	2.12	1.29	0.61
2007	2.33	1.88	0.81
2008	3.12	2.21	0.71
2009	3.66	3.08	0.84
2010	4.11	3.86	0.94
2011	3.50	3.36	0.96
2012	3.23	3.52	1.09
2013	3.15	3.23	1.03
2014	7.66	9.08	1.19
2015	10.13	10.74	1.06
2016	10.25	11.38	1.11
2017	10.15	11.51	1.13
2018	9.93	12.16	1.22
2019	10.00	12.27	1.23

The ratio of AIS and AGS in the virology domain is presented in table 3, which demonstrates that AIS/AGS was less than 1 from 1990 to 2011, whereas AIS/AGS was greater than 1 from 2012 to 2019. However, the proportion of research production in virology is currently growing faster in India than in its global counterpart.

Table 4: Computation of straight line trend by the least squares method

Publication years	No. of publications (Y)	Deviation	Multiply (X)	XY	X^2	No. of publications trend
1990	170	-14.5	-29	-4930	841	-2629.16
1991	190	-13.5	-27	-5130	729	-2064.34
1992	273	-12.5	-25	-6825	625	-1499.52
1993	291	-11.5	-23	-6693	529	-934.7
1994	1133	-10.5	-21	-23793	441	-369.88
1995	1924	-9.5	-19	-36556	361	194.94
1996	1891	-8.5	-17	-32147	289	759.76
1997	1967	-7.5	-15	-29505	225	1324.58
1998	1941	-6.5	-13	-25233	169	1889.4
1999	1939	-5.5	-11	-21329	121	2454.22
2000	2055	-4.5	-9	-18495	81	3019.04
2001	2169	-3.5	-7	-15183	49	3583.86
2002	2971	-2.5	-5	-14855	25	4148.68
2003	2716	-1.5	-3	-8148	9	4713.5
2004	3118	-0.5	-1	-3118	1	5278.32
2005	3068	1	1	3068	1	5843.14
2006	3543	1.5	3	10629	9	6407.96
2007	3880	2.5	5	19400	25	6972.78
2008	5197	3.5	7	36379	49	7537.6
2009	6106	4.5	9	54954	81	8102.42
2010	6863	5.5	11	75493	121	8667.24
2011	5844	6.5	13	75972	169	9232.06
2012	5382	7.5	15	80730	225	9796.88
2013	5250	8.5	17	89250	289	10361.7
2014	12775	9.5	19	242725	361	10926.52
2015	16901	10.5	21	354921	441	11491.34
2016	17091	11.5	23	393093	529	12056.16
2017	16928	12.5	25	423200	625	12620.98

2018	16571	13.5	27	447417	729	13185.8
2019	16675	14.5	29	483575	841	13750.62
2020			31			14315.44
2021			33			14880.26
2022			35			15445.08
2023			37			16009.9
2024			39			16574.72
2025			41			17139.54
2026			43			17704.36
2027			45			18269.18
2028			47			18834
2029			49			19398.82
	166822			2538866	8990	

Least squares method has been employed to fit the following straight-line equation:

$$Y = a + bX \text{ since } \sum X = 0, \text{ therefore}$$

$$a = \frac{\sum Y}{N} = \frac{166822}{30} = 5560.73$$

$$b = \frac{\sum XY}{\sum X^2} = \frac{2538866}{8990} = 282.41$$

So, if we put the values of 'a' and 'b' into the trend line, we get:

$$Y = a = bX \Rightarrow Y = 5560.73 + 282.41 \times X$$

The estimate of 2029 will be computed on the basis of X = 49

$$Y_{2029} = 5560.73 + 282.41 \times 49 = 19398.82$$

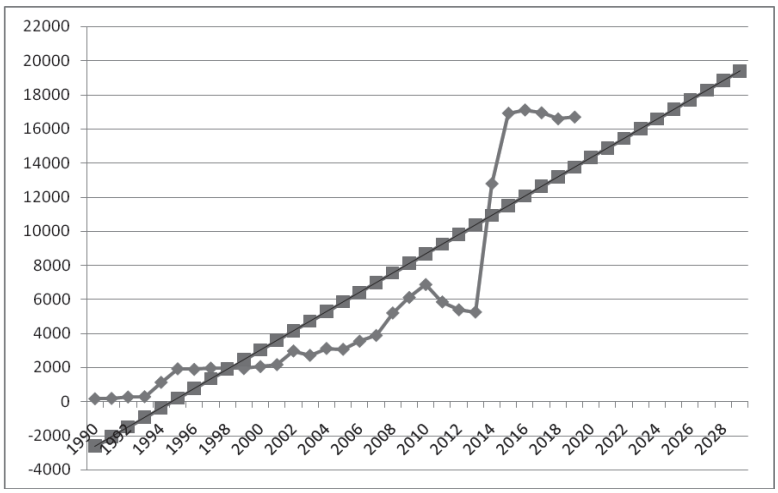

Figure 3: Trend of the Virology literature

The global virology literature's total trend value for publications from 1990 to 2019 is shown in figure 3. An upward tendency in the expansion of virology literature is also indicated by the trend projection given up to the year 2029.

Obsolescence study of virology

Table 5: Age-wise distribution of citations in the field of virology

Publication years	Age (x)	No. of citation f(x)	Cum. citation	%	Rev. Cum. citation (T)	Fr. Rev. Cum. citation	Xf(x)	$X^2f(x)$
2019	0	17613	17613	1.38	1280390	1	0	0
2018	1	24094	41707	3.26	1262777	0.986244035	24094	24094
2017	2	29952	71659	5.60	1238683	0.967426331	59904	119808
2016	3	37347	109006	8.51	1208731	0.944033459	112041	336123
2015	4	42196	151202	11.81	1171384	0.914865002	168784	675136
2014	5	47403	198605	15.51	1129188	0.881909418	237015	1185075
2013	6	45485	244090	19.06	1081785	0.844887105	272910	1637460
2012	7	43331	287421	22.45	1036300	0.809362772	303317	2123219
2011	8	53734	341155	26.64	992969	0.77552074	429872	3438976
2010	9	62120	403275	31.50	939235	0.733553839	559080	5031720
2009	10	62525	465800	36.38	877115	0.685037371	625250	6252500
2008	11	76831	542631	42.38	814590	0.636204594	845141	9296551
2007	12	65952	608583	47.53	737759	0.576198658	791424	9497088
2006	13	69539	678122	52.96	671807	0.524689352	904007	11752091
2005	14	85565	763687	59.64	602268	0.470378557	1197910	16770740
2004	15	87087	850774	66.45	516703	0.403551262	1306305	19594575
2003	16	61104	911878	71.22	429616	0.335535267	977664	15642624
2002	17	61045	972923	75.99	368512	0.287812307	1037765	17642005
2001	18	45221	1018144	79.52	307467	0.240135427	813978	14651604
2000	19	47917	1066061	83.26	262246	0.204817282	910423	17298037
1999	20	33461	1099522	85.87	214329	0.167393529	669220	13384400
1998	21	34919	1134441	88.60	180868	0.141260085	733299	15399279
1997	22	36214	1170655	91.43	145949	0.113987926	796708	17527576
1996	23	36306	1206961	94.27	109735	0.085704356	835038	19205874
1995	24	36122	1243083	97.09	73429	0.057348933	866928	20806272
1994	25	19509	1262592	98.61	37307	0.029137216	487725	12193125
1993	26	5835	1268427	99.07	17798	0.013900452	151710	3944460
1992	27	5467	1273894	99.49	11963	0.009343247	147609	3985443
1991	28	3754	1277648	99.79	6496	0.005073454	105112	2943136
1990	29	2742	1280390	100	2742	0.002141535	79518	2306022

Table 5 depicts the age-wise distribution of citations in the field of virology. It is observed that more citations are distributed in the age of 0-13. It is shown that the maximum number of citations i.e., 87087 received in the year 2004, and the number of citations distributed (83.26%) in the last 19 years. The number of citations decreased with an increase in age, except in some years, the citations increased by a small margin. The AAF of the literature is 0.986, half-life = 14 years, mean life = 70.93 and utility factor = 71.43.

6. Conclusion

The present study examined the growth of virology research both globally and nationally in from 1990 to 2019. The maximum number of publications in Virology globally was 17091, which was published in

2016. The lowest number of publications, i.e., 170 was published in 1990. The highest number of publications in virology nationally was 562, which was published in 2019. The lowest number of publications, i.e., 1 was published in 1990. Indian Virology research has produced more growth than its global counterpart. The exponential growth model fits well in both the global and Indian Virology literature. The mean life for virology literature was 70.93, half-life = 14 years; AAF = 0.986, and utility factor = 71.43.

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