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RESEARCH ARTICLE

A study on recency patterns of cited resources in the cytokine publications from web of science

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Abstract

The main aim of this article is to study the trends of cited articles and their recency cited value, weighted recency and average weighted recency of each cited item in the articles published on the subject of cytokine from 1998 to 2022 by using statistical methods based on sampling. The objectives include outlining data collection methods, discussing limitations, and employing analytical tools for data interpretation. Data was gathered from the Web of Knowledge using the search term "Cytokine," covering various cited items such as books, theses, dissertations, and websites while excluding citations without publication years and those for reviews and editorials. Self-citations and co-citations were included. The study calculates recency values and weighted recency of citations, converting the data into tabular and graphical formats for analysis. Year-wise data from 1989 to 2020 was analyzed, to key findings reveal that articles from 2020 had the highest average weighted recency, indicating more recent citations. This study result reveals that the average weighted recency of the citations of the articles published in 2020 is more than in other sample years. This indicates that the articles published in 2021 are of more recent origin than those of other years.

Keywords: Cytokine publications, Citation analysis, Recency, Weighted recency, Average weighted recency, Recency index, Citation pattern.

Introduction

Cytokines are a broad and loose category of small proteins important in cell signaling. Due to their size, cytokines cannot cross the lipid bilayer of cells to enter the cytoplasm and, therefore, typically exert their functions by interacting with specific cytokine receptors on the target cell surface. Cytokines are involved in autocrine, paracrine, and endocrine signaling as immunomodulating agents. They act through cell surface receptors and are especially important in the immune system; cytokines modulate the balance between humoral and cell-based immune responses, and they regulate the maturation, growth, and responsiveness of particular cell populations. Some cytokines enhance or inhibit the action of other cytokines in complex ways. They are different from hormones, which are also important cell signaling molecules. Hormones circulate in higher concentrations and tend to be made by specific kinds of cells. Cytokines are important in health and disease, specifically in host immune responses to infection, inflammation, trauma, sepsis, cancer, and reproduction, Amsaveni, N & Harikrishnan C A (2018), Amsaveni, N & Shivashankar KR (2019), Amsaveni, N & Shivashankar KR (2019).

Citation analysis is one of the important and quite old branches of bibliometric study. It examines the different frequencies, their patterns and graphs of citations given in articles, review papers, technical communication, thesis, and books. Citation analysis uses citations in scholarly works to establish links to other works or other researchers. Many different links can be ascertained, such as links between authors, scholarly works, journal publications, fields, or even countries. A number of such citation analyses have been proposed and citations have been analyzed with their various aspects. For example, bibliographic coupling, co-citation, impact factor, citation impact, and citation index, and so on are measures based on citation analysis, Amsaveni, N.,& Manikandan, M. (2014), Amsaveni, N.,& Ramesh K. (2016), Bandyopadhyay, A. K. (1996).

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The researchers have not given the recency of citations adequate attention. Recency not only reflects the origin relevance in the present time or in recent past of the topic on which the paper is written but also gives an indication of the standard of the concerned journal.

Citation Analysis

Counting citations is often called "citation analysis." Citation analysis is the assessment of the frequency, patterns, and graphs of citations in articles and books. It uses citations in scholarly works to establish links to other works or other researchers. Citation analysis is one of the most widely used methods of bibliometrics, Garfield, E. (1979), Khan, Swapan. (2012).

Survey of Literature Review

Bibliometrics is now being vigorously pursued. It has been estimated that 25 percent of all the articles published in library and information science journals are on bibliometrics and related topics. Many of the social science journals also carry a good number of articles in bibliometrics. Several review articles and books on the development of bibliometrics have been published. Alan Pritchard (1981) collected a comprehensive bibliography of bibliometric publications of many years. He, together with Wittig (1981) edited one book containing 600 items published during 1874 -1959. Peritz (1988) counted 3225 items of which 2675 were papers in journals and proceedings. Rests 550 were reports, dissertations, collected works, monographs etc; Lawani, S. M. (1981), Liu, M., Li, W., Qiao, W., Liang, L., & Wang, Z. (2023).

The most comprehensive historical review so far has been published in 1987 (written in 1985) in the Encyclopaedia of Library and Information Science. Yet, this history written by Hertzel has some obvious lapses. It does not cite or discuss Campbell's work (1898) or does not discuss the status of the publications between 1874 and 1917 covered in Prichard's bibliography. The review does not also indicate that Estoup anticipated in 1916 the relation named after Zipf. This was noted in Fairthorne's 1969 article which has been listed as one of the important papers in the review but not as a seminal paper. Hertzel has selected and listed in this historical review seminal publications in bibliometrics between 1917 and 1973. They are Cole and Eales has examine the History of comparative anatomy, Hulme's book Statistical bibliography..., Lotka's paper on scientific productivity, Gross & Gross's paper in 1927 where citation count technique was used for the first; Garfield's paper' citation indexes for science in Science' in 1955 for the use of the term impact factor, Small's paper on Cited documents as concept symbols in 1978, Cronin" s paper., The Need for a theory of citing in 1981, Cozzens's paper., Comparing the sciences: citation context analysis of paper from neuro-pharmacology and the sociology of science in 1985, Bandopadhya's paper on Citation analysis of doctoral dissertations in mathematics using dbase III+ in 1996, Singh's paper on Styles of bibliographical citation in 2004, PillaiRajan and PillaiShudhier's paper on Citations in the physics doctoral dissertations in 2007, Verma and Thakur's paper., Citation analysis of doctoral dissertations in botany in 2010, Khan's paper., A Study of recency of cited items appended in the articles published in the Journal of Documentation in 2012, Lotka, A. J. (1926), Nikhil Kumar Sardar, (2014), RavichandraRao, I. K. (1983).

These types of studies are not done very much. It is a new aspect of the worthwhile area of research in the field of library science. The lists are obviously incomplete but sufficiently good enough for an indication of the trends, Singh, S. P. (2004), Wang, K. T., Xu, D., Wang, Y. L., Dong, X. R., Tang, J., Wang, Y., Qiao, T., Zhang, H., Wang, Q. S., & Cui, Y. L. (2022), Zhang, H., Chen, Y., Jiang, X., Gu, Q., Yao, J., Wang, X., & Wu, J. (2024).

Organization of the Paper

First, outline the list of objectives related to our study and give a brief description regarding the data collection methodology, limitations and use of analytical tools. Then, explain the meaning of citation, the necessity of cited works and the researcher taking reference times from different sources. From the cited references have to calculate the recency value and weighted recency. The collected data is converted to the tabular format, followed by its graphical representation and subsequent observation thereon for further analysis. This is done year-wise for the total sample years (1989 to 2020) as mentioned in the title. Finally, we obtain a bar diagram comparing the year-wise average weighted recency.

Objectives

The following are the objectives of the study:

- To identify the number of articles published in each year.
- To identify the number of citations that appeared in each year.
- To find out the number of cited references per year.
- To find the number of contributing authors per year
- To find out the recency value and weighted recency values of cited documents.
- To find out the average weighted recency of references that appeared in the articles published in the cytokine for a period of 1998 to 2022.

Data Collection

The necessary data collected from the Web of Knowledge database. The search key term is "Cytokine" during a time span of 1989 to 2022. There are various types of cited items like books, thesis, dissertations, websites etc. in the references of articles found in a sample. Here all types of cited items have been included for this study. The citations without publication year have been excluded and citations

for reviews and editorials have not been considered here. On the other hand, self-citations given by the author and co-citations are all included for the study. Total number of published articles 5534, Total local citation score is 3782; total global citation score is 115300; total cited references are 224846; the total contributing authors are 35509, but the actual authors are 18405 and the total Global citations are 310077, respectively.

Data Interpretation and Analysis

Tables 1 represent the 25 years sample data, which has published records with earned citations, cited references and contributed a number of authors during the sample periods of 1998 to 2022, which data was indexed from Web of Science database.

The year wise publications and its related information are; totally 5534 publications were taken for this study, those 5534 publications were earned 310077 citations; total cited references 24846 and 35509 contributed authors; among those, the year of 1998, 34 (0.61%) articles were 1089 citations, 1042 cited references, 148 contributed authors; 1999, 39 (0.70%) articles were earned 1820 citations, 1339 cited references, 180 contributed authors; at 2000, 24 (0.43%) articles were earned 1382 citations, 804 cited references, 100 contributed authors; at 2001, 35 (0.63%) articles were earned 1871 citations, 1268 cited references, 145 contributed authors; at 2002, 37 (0.67%) articles were earned 2322 citations, 1268 cited references, 197 contributed authors; at 2003, 47 (0.85%) articles were earned 2549 citations, 1649 cited references, 268 contributed authors; at 2004, 60 (1.08%), 5235 citations, 2471 cited references, 291 contributed authors; at 2005, 71 (1.28%) articles were earned 5730 citations, 2445 cited references, 389 contributed authors; at 2006, 90 (1.63%) articles were earned 4572 citations, 2937 cited references, 455 contributed authors; at 2007, 125 (2.26%) articles were earned 7452 citations, 4142 cited references, 629 contributed authors; at 2008, 165 (2.98%) articles were earned 7042 citations, 5516 cited references, 881 contributed authors; at 2009, 166 (3.0%) articles were earned 7405 citations, 5377 cited references, 1032 contributed authors; at 2010, 190 (3.43%) articles were earned 10453 citations, 6802 cited references, 1121 contributed authors; at 2011, 224 (4.05%) articles were earned 14709 citations, 1375 cited references, 1375 contributed authors; at 2012, 232 (4.19%) articles were earned 13818 citations, 7802 cited references, 1502 contributed authors; at 2013, 256 (4.63%) articles were earned 18611 citations, 8560 cited references, 1619 contributed authors; at 2014, 339 (6.13%) articles were earned 22071 citations, 10374 cited references, 2135 contributed authors; at 2015, 316 (5.71%) articles were earned 33545 citations, 11348 cited references, 2360 contributed authors; at 2016, 388 (7.01%) articles were earned 22673 citations; 11901 cited references, 2413 contributed authors; at 2017, 316 (5.71%) articles were earned 24004 citations, 10924 cited references, 2383 contributed authors; at 2018, 385 (6.96%) articles were earned 22897 citations, 15275 cited references, 2688 contributed authors; at 2019, 336 (6.07%) articles were earned 26570 citations, 15927 cited references, 2667 contributed authors; at 2020, 496 (8.96%) articles were earned 26599 citations, 25527 cited references, 2175 contributed authors; at 2021, 683 (12.34%) articles were earned 19934 citations, 36352 cited references, 4261 contributed authors; and at 2022, 480 (8.67%) articles were earned 5124 citations, 26401 cited references, 4095 contributed authors respectively.

The highest publications are in the year of 2021 followed by 2020 and 2019. The publication growth rate shows in declining trend. The year 2022 having less numbers of records compared to its previous year for that reason is the data retrieved date is a month of October 2022. Totally 310077 citations were earned all 5534 articles in the subject of cytokine during the sample year. Among those 2015 and 2018 had the highest citations. Totally 224846 cited references were found from the total publications among those 2022 publications, the highest number of articles. Totally 35509 contributed authors were found from this analysis. Among those 2022 year publications had the highest number of contributing authors.

Based on earned citation level categorized in Table 1, such that not cited documents (0 citations); between 1 to 5 citations; between 6 to 10 citations; between 11 to 15 citations; between 16 to 20 citations; between 21 to 25 citations; between 26 to 50 citations; between 51 to 75 citations; between 76 to 100 citations; and above 101 citations. The table data is in four types which in first data shows the number of documents based on the citation category, next to that with in parentheses reveals the number of earned total citations followed by number of cited references and number of contributed authors (example: the year of 2005, 16 to 20 citations are represents to 9(460); 279(50), it reveals that 9 records earned between 16 to 20 citations, 460 total citations earned between 16 to 20 citations, 279 indicates the 9 records used cited references and 50 means the contributed authors in 9 records.). 34 articles were earned 1089 citations during 1998 and average citation per articles is 32.08, among those, 2 articles were does not having citation, the highest earned citations between 6 to 10 are highest. 39 articles were earned 1820 citations during 1999 and average citation per articles is 46.74, among those, 3 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 24 articles were earned 1382 citations during 2000 and average citation per articles is 57.71, among those 3 articles were does not having citation, the highest earned citations between 6 to 10 and 21 to 25 are highest. 35 articles were earned 1871 citations during 2001 and average citation per articles is 53.51, among those 2 articles were does not having citation,

the highest earned citations between 26 to 50 are highest. 37 articles were earned 2322 citations during 2002 and average citation per articles is 62.78, among those 2 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 47 articles were earned 2549 citations during 2003 and average citation per articles is 54.26, among those 2 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 60 articles were earned 5235 citations during 2004 and average citation per articles is 87.27, among those 1 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 71 articles were earned 5730 citations during 2005 and average citation per articles is 80.72, among those 1 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 90 articles were earned 4572 citations during 2006 and average citation per articles is 50.84, among those 1 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 125 articles were earned 7452 citations during 2007 and average citation per articles is 59.69, among those 9 articles were does not having citation, the highest earned citations between 26 to 50 are highest.

165 articles were earned 7642 citations during 2008 and average citation per articles is 46.42, among those 18 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 166 articles were earned 7405 citations during 2009 and average citation per articles is 44.63, among those 18 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 190 articles were earned 10453 citations during 2010 and average citation per articles is 44.63, among those 11 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 224 articles were earned 14709 citations during 2011 and average citation per articles is 65.7, among those 10 articles were does not having citation, the highest earned citations between 26 to 50 are highest.

232 articles were earned 13818 citations during 2012 and average citation per articles is 59.7, among those 10 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 256 articles were earned 18611 citations during 2013 and average citation per articles is 72.7, among those 12 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 339 articles were earned 22071 citations during 2014 and average citation per articles is 65.2, among those 21 articles were does not having citation, the highest earned citations between 26 to 50 are highest.

316 articles were earned 335451 citations during 2015 and average citation per articles is 106.3, among those 33 articles were does not having citation, the highest earned citations between **6 to 10** are highest. 388 articles were earned 22673 citations during 2016 and average citation per articles is 58.6, among those 20 articles were does not having citation, the highest earned citations between 2**6 to 50** are highest. 316 articles were earned 24004 citations during 2017 and average citation per articles is 76.1, among those 20 articles were does not having citation, the highest earned citations between 2**6 to 50** are highest.

385 articles were earned 22897 citations during 2018 and average citation per articles is 59.6, among those 28 articles were does not having citation, the highest earned citations between 26 to 50 are highest. 336 articles were earned 26570 citations during 2019 and average citation per articles is 79.3, among those 29 articles were does not having citation, the highest earned citations between 6 to 10 are highest. 496 articles were earned 26599 citations during 2020 and average citation per articles is 53.9, among those 64 articles were does not having citation, the highest earned citations between 6 to 10 are highest. 683 articles were earned 19934 citations during 2021 and average citation per articles is 29.5, among those 64 articles were does not having citation, the highest earned citations between 6 to 10 are highest. 480 articles were earned 5124 citations during 2022 and average citation per articles is 11.9, among those 285 articles were does not having citation, the highest earned citations between 6 to 10 are highest.

Overall 5534 articles were earned citations 310077, out of 689 articles were doesn't earn citations. followed by 1260 articles were earned between 1 to 5 (11634) citations; 890 articles were earned between 6 to 10 (17431) citations; 630 articles were earned between 11 to 15 (20153) citations; 443 articles were earned between 16 to 20 (20987) citations; 332 articles were earned between 21 to 25 (20604) citations; 822 articles were earned between 26 to 50 (20987) citations; 235 articles were earned between 51 to 75 (54402) citations; 103 articles were earned between 76 to 100 (33008) citations; and 130 articles were earned more than 101 (46369) citations respectively. it could be noted that from this table analysis, the highest number of articles were comes under the category of between 1 to 5 and the highest citations score is between 26 to 50. Total mean citation value of per article is 56.03.

The Table 2 represents the most cited resources by the cytokine researchers during 1998 to 2022. The top ten sources only shows in the table which articles cited more than 100 time by other researchers. The authored "Livak KJ" 2001 published in the journal of "Methods" of articles is cited by more than 207 times; followed by authored "Lowry" 1951 published in the journal of "Journal of Biological Chemistry" of articles is cited more than 199 times; authored "Huang CL" 2020 published in the journal of "Lancet" of articles is cited more than 155 times; and remaining resources were below 150 times cited by others respectively.

Table 3 outlines the highly cited reference journals within the realm of cytokine research from 1998 to 2022. The top thirty journals, each with articles cited more than

Table 1: Number of Records with Citations, number of Cited references and number of contributed authors in cytokine research publications during 1998 to 2022

Year	*0*	*1 - 5*	*6 - 10*	*11-15*	*16-20*	*21-25*	*26-50*	*51-75*	*76-100*	*>101*	*Total*	*Mean PA/PY*
1998	2 (0); 55 (5)	6 (12); 181 (23)	7 (57); 198 (32)	5 (62); 137 (20)	1 (26); 36 (3)	3 (71); 179 (14)	6 (305); 156 (29)	2 (213); 50 (6)	0	2 (343); 50 (16)	34 (1089); 1042 (148)	(32.08); 30.64 (4.35)
1999	3 (0); 101 (4)	5 (16); 143 (16)	4 (32); 122 (24)	7 (98); 220 (33)	2 (45); 66 (17)	2 (46); 69 (13)	11 (483); 249 (52)	0	3 (554); 143 (17)	2 (546); 226 (4)	39 (1820); 1339 (180)	(46.74); 34.33 (4.62)
2000	3 (0); 46 (12)	3 (8); 99 (10)	4 (34); 103 (18)	2 (29); 90 (7)	2 (58); 54 (11)	4 (95); 124 (21)	2 (186); 148 (8)	0	2 (482); 65 (6)	2 (490); 75 (7)	24 (1382); 804 (100)	(57.71); 33.5 (4.17)
2001	2 (0); 39 (9)	5 (18); 195 (27)	6 (56); 263 (23)	4 (52); 240 (10)	3 (64); 78 (8)	0	9 (430); 183 (37)	1 (255); 39 (4)	4 (737); 202 (19)	1 (259); 29 (8)	35 (1871); 1268 (145)	(53.51); 36.23 (4.14)
2002	2 (0); 30 (5)	4 (11); 99 (18)	7 (54); 231 (30)	5 (61); 183 (32)	3 (72); 77 (10)	2 (45); 71 (10)	8 (418); 276 (44)	3 (363); 164 (21)	2 (980); 91 (23)	1 (317); 46 (4)	37 (2322); 1268 (197)	(62.78); 34.27 (5.32)
2003	1 (0); 0 (8)	4 (7); 262 (15)	5 (69); 234 (28)	4 (57); 157 (18)	6 (208); 253 (26)	5 (113); 121 (26)	11 (476); 246 (64)	8 (688); 227 (52)	1 (288); 22 (19)	2 (643); 127 (12)	47 (2549); 1649 (268)	(54.26); 35.09 (5.70)
2004	1 (0); 93 (8)	5 (15); 211 (19)	8 (76); 267 (35)	5 (71); 203 (23)	6 (306); 185 (29)	4 (87); 142 (19)	17 (823); 520 (85)	6 (552); 236 (36)	0 (0)	8 (3305); 614 (37)	60 (5235); 2471 (291)	(87.27); 41.18 (4.85)
2005	1 (0); 0 (6)	9 (26); 219 (31)	7 (84); 149 (31)	7 (94); 329 (33)	9 (460); 279 (50)	4 (88); 94 (23)	19 (866); 613 (105)	5 (518); 270 (34)	6 (731); 301 (55)	4 (2863); 191 (21)	71 (5730); 2445 (389)	(80.72); 34.44 (5.48)
2006	4 (0); 38 (20)	4 (12); 197 (18)	12 (98); 381 (47)	4 (53); 105 (18)	9 (657); 382 (45)	10 (230); 277 (37)	29 (1381); 839 (162)	8 (698); 283 (61)	6 (911); 327 (34)	4 (532); 108 (13)	90 (4572); 2937 (455)	(50.84); 32.63 (5.06)
2007	9 (0); 71 (46)	8 (21); 219 (39)	15 (117); 686 (63)	9 (113); 333 (38)	8 (138); 312 (30)	15 (344); 314 (79)	35 (1617); 958 (185)	8 (709); 313 (45)	5 (743); 194 (32)	13 (3050); 742 (72)	125 (7452); 4142 (629)	(59.69); 33.14 (5.03)
2008	18 (0); 102 (97)	17 (56); 521 (57)	27 (226); 751 (131)	16 (202); 501 (70)	12 (815); 462 (58)	14 (321); 489 (78)	29 (1870); 1043 (144)	16 (1084); 622 (108)	5 (836); 222 (46)	11 (2232); 803 (92)	165 (7642); 5516 (881)	(46.42); 33.43 (5.34)
2009	3 (0); 87 (16)	6 (68); 153 (20)	20 (158); 876 (79)	23 (298); 858 (100)	22 (989); 569 (119)	15 (347); 527 (91)	58 (2282); 1192 (456)	6 (552); 234 (50)	7 (783); 393 (51)	6 (1928); 488 (50)	166 (7405); 5377 (1032)	(44.63); 32.4 (6.2)

2010	11 (0); 121 (43)	18 (91); 534 (96)	22 (170); 968 (106)	21 (278); 762 (90)	25 (1043); 612 (118)	15 (348); 443 (84)	46 (2605); 1328 (357)	14 (1043);591 (70)	8 (986); 502 (60)	10 (3889); 941 (97)	190 (10453); 6802 (1121)	(55.1); 35.8 (5.9)
2011	10 (0); 68 (38)	19 (183); 501 (95)	24 (289); 981 (126)	21 (274); 989 (108)	35 (1126); 769 (182)	17 (394); 662 (116)	60 (3101); 1424 (452)	23 (5426);877 (145)	7 (1914); 319 (58)	8 (2002); 805 (55)	224 (14709); 7395 (1375)	(65.7); 33.0 (6.1)
2012	12 (0); 107 (52)	25 (475); 516 (113)	31 (351); 1031 (171)	37 (892); 1045 (174)	20 (1150);841 (112)	19 (1433); 744 (122)	55 (3366); 1579 (436)	14 (1881);663 (201)	10 (1959);652 (64)	9 (2323); 624 (57)	232 (13818); 7802 (1502)	(59.7); 33.6 (6.5)
2013	12 (0); 110 (43)	27 (596); 604 (157)	33 (444); 1097 (189)	41 (928); 1141 (215)	31 (1254); 996 (165)	20 (1458); 846 (127)	58 (3926); 1967 (397)	21 (5279);1105 (235)	5 (2546); 214 (50)	8 (2192); 480 (41)	256 (18611); 8560 (1619)	(72.7); 33.4 (6.3)
2014	21 (0); 370 (92)	40 (712); 1016 (205)	47 (586); 1196 (244)	52 (1071); 1224 (250)	33 (1300); 1039 (191)	26 (1602); 952 (168)	80 (7775); 2028 (538)	23 (4408);1320 (297)	9 (2926); 497 (104)	8 (1712); 732 (46)	339 (22071); 10374 (2135)	(65.2); 30.6 (6.3)
2015	15 (0); 356 (60)	50 (862); 1304 (287)	56 (619); 1267 (286)	48 (1515); 1930 (336)	38 (1417);1217 (268)	33 (1751); 1368 (211)	54 (19655); 2105 (479)	10 (2598);1052 (271)	5 (3519); 333 (77)	7 (1624); 416 (85)	316 (33545); 11348 (2360)	(106.3); 35.9 (7.5)
2016	33 (0); 275 (79)	72 (938); 2007 (380)	85 (780); 1350 (451)	62 (1507); 2061 (360)	32 (1564);1389 (194)	23 (1759);777 (227)	54 (6862); 2210 (415)	19 (4124);1157 (243)	4 (4437); 308 (28)	4 (735); 367 (36)	388 (22673); 11901 (2413)	(58.6); 30.7 (6.2)
2017	20 (0); 140 (67)	57 (1171); 2061 (325)	77 (810); 355 (446)	46 (1601); 2167 (266)	31 (1673);1456 (276)	26 (1865);1527 (271)	48 (5624); 2202 (452)	6 (6367); 473 (226)	3 (2367); 357 (34)	2 (2546); 186 (20)	316 (24004); 10924 (2383)	(76.1); 34.6 (7.5)
2018	28 (0); 565 (101)	99 (1312); 3105 (608)	83 (957); 1903 (343)	56 (1823); 2320 (389)	32 (1718); 1853 (330)	30 (1985); 1528 (267)	40 (6309); 2061 (290)	10 (2622); 1109 (255)	5 (3466); 369 (61)	2 (2733); 462 (44)	385 (22897); 15275 (2688)	(59.6); 39.7 (7)
2019	29 (0); 1064 (108)	103 (1321); 3059 (605)	75 (1594); 2835 (450)	41 (1915); 3004 (483)	28 (1732);1606 (283)	18 (2613);1090 (224)	32 (6715); 2148 (217)	7 (5366); 725 (247)	1 (190); 135 (10)	2 (5153); 261 (40)	336 (26570); 15927 (2667)	(79.3); 47.4 (8)
2020	64 (0); 3182 (112)	180 (1491); 8054 (110)	94 (1710); 3104 (464)	61 (2781); 3864 (547)	24 (1928);1428 (221)	11 (2238);1080 (70)	34 (7130); 2055 (314)	14 (4857);1369 (193)	1 (196); 146 (15)	13 (4332); 1245 (129)	496 (26599); 25527 (2175)	(53.9); 51.5 (4.4)
2021	100 (0);3912 (121)	328 (1884); 12624 (2182)	127 (3954); 7832 (749)	42 (3547); 3598 (417)	29 (609); 3022 (320)	15 (1309);1460 (102)	26 (1855); 2423 (218)	11 (4799);1142 (101)	4 (1457); 250 (44)	1 (620); 89 (7)	683 (19934); 36352 (4261)	(29.5); 53.2 (6.2)
2022	285 (0);11087 (137)	166 (328); 12140 (3039)	14 (4106); 1885 (828)	11 (831); 1034 (44)	2 (35); 65 (35)	1 (62); 129 (10)	1 (47); 61 (2)	0	0	0	480 (5124); 26401 (4095)	(11.9); 55 (8.5)
Total	689 (0); 22019 (1289)	**1260** (11634); 50024 (8495)	890 (17431); 30065 (5394)	630 (20153); 28495 (4081)	443 (20987);19046 (3101)	332 (20604); 15013 (2410)	822 (**86107**); 30014 (5938)	235 (54402); 14021 (2901)	103 (33008); 6042 (907)	130 (46369); 10107 (993)	5534 (310077); 224846 (35509)	(56.3); 40.6 (6.4)

Table 2: Highly cited resources by Cytokine researchers

S. No	*Author / Year / Journal*	*Recs.*	*%*
1	Livak KJ, 2001, Methods, V25, P402, DOI 10.1006/meth.2001.1262	207	3.7
2	Lowry OH, 1951, J Biol Chem, V193, P265	199	3.6
3	Huang CL, 2020, Lancet, V395, P497, DOI 10.1016/S0140-6736(20)30183-5	155	2.8
4	Hoffmann M, 2020, Cell, V181, P271, DOI 10.1016/j.cell.2020.02.052	128	2.3
5	Mehta P, 2020, Lancet, V395, P1033, DOI 10.1016/S0140-6736(20)30628-0	128	2.3
6	Ohkawa H, 1979, Anal Biochem, V95, P351, DOI 10.1016/0003-2697(79)90738-3	111	2.0
7	Green LC, 1982, Anal Biochem, V126, P131, DOI 10.1016/0003-2697(82)90118-X	104	1.9
8	Mosmann T, 1983, J Immunol Methods, V65, P55, DOI 10.1016/0022-1759(83)90303-4	103	1.9
9	Bradford MM, 1976, Anal Biochem, V72, P248, DOI 10.1016/0003-2697(76)90527-3	102	1.8
10	Guan W, 2020, New Engl J Med, V382, P1708, DOI 10.1056/NEJMoa2002032	99	1.8

Table 3: Highly cited journals in cytokine publications during 1998 to 2022

Journals	*No. of citation Ref.*	*Journals*	*No. of citation Ref.*
JRL. IMMUNOLOGY	2436	EUR J IMMUNOL	415
P NATL ACAD SCI USA	1090	NEW ENGL J MED	405
J BIOL CHEM	1076	LANCET	382
INFECT IMMUN	953	NAT IMMUNOL	382
PLOS ONE	917	NAT REV IMMUNOL	381
J EXP MED	821	VACCINE	375
NATURE	812	CANCER RES	350
SCIENCE	669	CLIN EXP IMMUNOL	345
BLOOD	597	NAT MED	333
J CLIN INVEST	542	J LEUKOCYTE BIOL	290
J INFECT DIS	527	SCI REP-UK	290
CELL	460	CYTOKINE	287
J VIROL	456	IMMUNOLOGY	261
FRONT IMMUNOL	445	PLOS PATHOG	248
IMMUNITY	441	NUCLEIC ACIDS RES	241

200 times by researchers, are presented. Leading the list is the "Journal of Immunology," which stands out as the most cited journal with 2436 citations across the sampled cytokine publications during the specified period. Following closely is the "P National Academic Science USA" journal, cited 1090 times within the 55334 articles included in the dataset. The "Journal of Biological Chemistry" also emerges as a highly referenced journal, garnering 1076 citations from cytokine researchers. Other journals in the list received citations below the 1000 times by fellow researchers.

Numerical Explanation of Recency and Weighted Recency

In order to find out the recency of cited articles, each of the citation years (i.e., the years of publication of cited items) is subtracted from the article year (the year of publication of the article which contains cited items) individually and then 1 is divided by each such difference. This formula for recency has the following implication. The more is the recency the larger is the recency value and vice - versa. On the other hand, the less is the recency the smaller is the recency value and vice - versa. Also the recency always lies between 0 and 1(except possibly for an exceptional case mentioned below). What we have said about the definition of recency above is illustrated below by taking a particular case. If a citation year is 1998 with an article year 2022, then the difference is 24 years and the recency of the article for the citation is $\frac{1}{24} = 0.042$.

Weighted recency is defined as the product of recency and the frequency of the citation year. For a particular publication year if the weighted recency of a citation year is known then frequency of the citation year can be easily determined e.g. if the publication year 2012 and the citation year is 2020 the weighted recency for the year 2020 is w then the frequency of the citation is $= \frac{w}{recency} = \frac{w}{0.5}(0.5 = \frac{1}{2020 - 2012})$

Table 4: Showing Cytokine scientists accessed recency of citation for the articles published during 1998 to 2022

Y_c	F_{c2}	%	Cum. %	$Y_{a2} - Y$	$\frac{1}{Y_{a2} - Y_c}$	$F_{c2} \times \frac{1}{Y_{a2} - Y_c}$	Y_c	F_{c2}	%	Cum. %	$Y_{a2} - Y$	$\frac{1}{Y_{a2} - Y_c}$	$F_{c2} \times \frac{1}{Y_{a2} - Y_c}$
1600	2	0.0009	0.0009	422	0.002	0.005	1943	7	0.0031	0.10	79	0.013	0.089
1789	1	0.0004	0.001	233	0.004	0.004	1944	12	0.0053	0.10	78	0.013	0.154
1790	1	0.0004	0.002	232	0.004	0.004	1945	6	0.0027	0.11	77	0.013	0.078
1800	1	0.0004	0.002	222	0.005	0.005	1946	13	0.0058	0.11	76	0.013	0.171
1819	1	0.0004	0.003	203	0.005	0.005	1947	8	0.0036	0.12	75	0.013	0.107
1829	1	0.0004	0.003	193	0.005	0.005	1948	16	0.0071	0.12	74	0.014	0.216
1842	1	0.0004	0.004	180	0.006	0.006	1949	13	0.0058	0.13	73	0.014	0.178
1843	1	0.0004	0.004	179	0.006	0.006	1950	27	0.0120	0.14	72	0.014	0.375
1845	1	0.0004	0.004	177	0.006	0.006	1951	24	0.0107	0.15	71	0.014	0.338
1847	1	0.0004	0.005	175	0.006	0.006	1952	20	0.0089	0.16	70	0.014	0.286
1849	1	0.0004	0.005	173	0.006	0.006	1953	26	0.0116	0.17	69	0.014	0.377
1851	1	0.0004	0.006	171	0.006	0.006	1954	19	0.0085	0.18	68	0.015	0.279
1857	1	0.0004	0.006	165	0.006	0.006	1955	40	0.0178	0.20	67	0.015	0.597
1858	1	0.0004	0.007	164	0.006	0.006	1956	34	0.0151	0.21	66	0.015	0.515
1858	1	0.0004	0.007	164	0.006	0.006	1957	44	0.0196	0.23	65	0.015	0.677
1859	1	0.0004	0.008	163	0.006	0.006	1958	47	0.0209	0.25	64	0.016	0.734
1863	2	0.0009	0.008	159	0.006	0.013	1959	41	0.0182	0.27	63	0.016	0.651
1865	1	0.0004	0.009	157	0.006	0.006	1960	56	0.0249	0.30	62	0.016	0.903
1867	1	0.0004	0.009	155	0.006	0.006	1961	43	0.0191	0.32	61	0.016	0.705
1869	1	0.0004	0.010	153	0.007	0.007	1962	44	0.0196	0.34	60	0.017	0.733
1870	1	0.0004	0.010	152	0.007	0.007	1963	56	0.0249	0.36	59	0.017	0.949
1874	1	0.0004	0.011	148	0.007	0.007	1964	68	0.0302	0.39	58	0.017	1.172
1877	2	0.0009	0.012	145	0.007	0.014	1965	84	0.0374	0.43	57	0.018	1.474
1878	1	0.0004	0.012	144	0.007	0.007	1966	74	0.0329	0.46	56	0.018	1.321
1879	1	0.0004	0.012	143	0.007	0.007	1967	93	0.0414	0.50	55	0.018	1.691
1881	1	0.0004	0.013	141	0.007	0.007	1968	125	0.0556	0.56	54	0.019	2.315
1882	2	0.0009	0.014	140	0.007	0.014	1969	118	0.0525	0.61	53	0.019	2.226
1884	1	0.0004	0.014	138	0.007	0.007	1970	126	0.0560	0.67	52	0.019	2.423
1885	1	0.0004	0.015	137	0.007	0.007	1971	164	0.0729	0.74	51	0.020	3.216
1888	1	0.0004	0.015	134	0.007	0.007	1972	136	0.0605	0.80	50	0.020	2.720
1889	1	0.0004	0.016	133	0.008	0.008	1973	170	0.0756	0.88	49	0.020	3.469
1890	1	0.0004	0.016	132	0.008	0.008	1974	185	0.0823	0.96	48	0.021	3.854
1891	2	0.0009	0.017	131	0.008	0.015	1975	202	0.0898	1.05	47	0.021	4.298
1892	1	0.0004	0.017	130	0.008	0.008	1976	235	0.1045	1.15	46	0.022	5.109
1893	2	0.0009	0.018	129	0.008	0.016	1977	240	0.1067	1.26	45	0.022	5.333
1894	1	0.0004	0.019	128	0.008	0.008	1978	269	0.1196	1.38	44	0.023	6.114
1895	1	0.0004	0.019	127	0.008	0.008	1979	65	0.0289	1.41	43	0.023	1.512
1896	2	0.0009	0.020	126	0.008	0.016	1979	259	0.1152	1.52	43	0.023	6.023
1896	1	0.0004	0.020	126	0.008	0.008	1980	410	0.1823	1.71	42	0.024	9.762
1897	2	0.0009	0.021	125	0.008	0.016	1981	397	0.1766	1.88	41	0.024	9.683

1897	1	0.0004	0.022	125	0.008	0.008	1982	461	0.2050	2.09	40	0.025	11.53
1898	1	0.0004	0.022	124	0.008	0.008	1983	507	0.2255	2.31	39	0.026	13.00
1901	1	0.0004	0.023	121	0.008	0.008	1984	589	0.2620	2.57	38	0.026	15.50
1902	2	0.0009	0.024	120	0.008	0.017	1985	685	0.3047	2.88	37	0.027	18.51
1904	2	0.0009	0.024	118	0.008	0.017	1986	840	0.3736	3.25	36	0.028	23.33
1905	2	0.0009	0.025	117	0.009	0.017	1987	914	0.4065	3.66	35	0.029	26.11
1906	2	0.0009	0.026	116	0.009	0.017	1988	1102	0.4901	4.15	34	0.029	32.41
1907	3	0.0013	0.028	115	0.009	0.026	1989	1332	0.5924	4.74	33	0.030	40.36
1908	6	0.0027	0.030	114	0.009	0.053	1990	1618	0.7196	5.46	32	0.031	50.56
1909	5	0.0022	0.032	113	0.009	0.044	1991	1917	0.8526	6.31	31	0.032	61.84
1910	1	0.0004	0.033	112	0.009	0.009	1992	2118	0.9420	7.26	30	0.033	70.60
1911	2	0.0009	0.034	111	0.009	0.018	1993	2381	1.0589	8.31	29	0.034	82.10
1912	1	0.0004	0.034	110	0.009	0.009	1994	2784	1.2382	9.55	28	0.036	99.43
1913	3	0.0013	0.036	109	0.009	0.028	1995	3297	1.4663	11.02	27	0.037	122.11
1916	3	0.0013	0.037	106	0.009	0.028	1996	3711	1.6505	12.67	26	0.038	142.73
1917	2	0.0009	0.038	105	0.010	0.019	1997	4042	1.7977	14.47	25	0.040	161.68
1918	2	0.0009	0.039	104	0.010	0.019	1998	4594	2.0432	16.51	24	0.042	191.42
1919	3	0.0013	0.040	103	0.010	0.029	1999	4974	2.2122	18.72	23	0.043	216.26
1920	1	0.0004	0.040	102	0.010	0.010	2000	5943	2.6431	21.37	22	0.045	270.14
1921	3	0.0013	0.042	101	0.010	0.030	2001	6340	2.8197	24.19	21	0.048	301.90
1922	5	0.0022	0.044	100	0.010	0.050	2002	6672	2.9674	27.15	20	0.050	333.60
1923	2	0.0009	0.045	99	0.010	0.020	2003	7270	3.2333	30.39	19	0.053	382.63
1924	4	0.0018	0.047	98	0.010	0.041	2004	7667	3.4099	33.80	18	0.056	425.94
1925	3	0.0013	0.048	97	0.010	0.031	2005	7963	3.5415	37.34	17	0.059	468.41
1926	5	0.0022	0.050	96	0.010	0.052	2006	8259	3.6732	41.01	16	0.063	516.19
1927	4	0.0018	0.052	95	0.011	0.042	2007	8678	3.8595	44.87	15	0.067	578.53
1928	2	0.0009	0.053	94	0.011	0.021	2008	8852	3.9369	48.81	14	0.071	632.29
1929	2	0.0009	0.054	93	0.011	0.022	2009	9222	4.1015	52.91	13	0.077	709.38
1930	3	0.0013	0.055	92	0.011	0.033	2010	9728	4.3265	57.24	12	0.083	810.67
1931	7	0.0031	0.058	91	0.011	0.077	2011	9729	4.3270	61.56	11	0.091	884.45
1932	9	0.0040	0.062	90	0.011	0.100	2012	9917	4.4106	65.97	10	0.100	991.70
1933	11	0.0049	0.067	89	0.011	0.124	2013	9908	4.4066	70.38	9	0.111	1100.89
1934	2	0.0009	0.068	88	0.011	0.023	2014	9503	4.2264	74.61	8	0.125	1187.88
1935	12	0.0053	0.073	87	0.011	0.138	2015	8939	3.9756	78.58	7	0.143	1277.00
1936	7	0.0031	0.076	86	0.012	0.081	2016	8132	3.6167	82.20	6	0.167	1355.33
1937	3	0.0013	0.078	85	0.012	0.035	2017	7888	3.5082	85.71	5	0.200	1577.60
1938	10	0.0044	0.082	84	0.012	0.119	2018	7321	3.2560	88.96	4	0.250	1830.25
1939	6	0.0027	0.085	83	0.012	0.072	2019	6310	2.8064	91.77	3	0.333	2103.33
1940	5	0.0022	0.087	82	0.012	0.061	2020	12231	5.4397	97.21	2	0.5	6115.5
1941	10	0.0044	0.092	81	0.012	0.123	2021	5345	2.3772	99.59	1	1	5345.0
1942	9	0.0040	0.10	80	0.013	0.113	2022	932	0.4145	100	0	0	0
Total								224846			13888	5.647	30663.047

Tabular Representation of Data

Its reveals that the below in tabular form the year wise recency of the articles published in cytokine for sample consecutive years (1998 to 2022). Let us explain the meaning of some notations used in the following tables. R_{cy} stands for the recency of citations for the year Y, Y_{a18} for the Article Year 2018, Y_c for the Citation Year and Fc_{20} for the frequency of citations.

Then Recency=$\frac{1}{Y_{a\text{Y}} - Y_c}$, Weighted Recency = $F_{c\text{Y}} \times \frac{1}{Y_{a\text{Y}} - Y_c}$

The analysis of recency of citation in cytokine articles spanning from 1998 to 2022 reveals distinct trends. Notably, two articles from the year 1600 were cited in the sampled research, signifying the inclusion of very old references. Subsequently, citations from the years 1789, 1790, and 1800 were observed in the earlier stages. During the period from 1600 to 1947, the number of cited resources remains relatively low. The years 1948 to 1967 witness a modest increase, with citations ranging from 16 to 93 times. Subsequently, a notable surge in citations is observed from 1968 to 1974, ranging from 125 to 185 times. The years 1975 to 1979 see a further increase, with citations ranging from 202 to 259 times. A significant uptick is noted in the years 1980 to 1987, where citations range from 410 to 914 times. The trend continues with a substantial increase in citations from 1988 to 1991, ranging from 1102 to 1917 times. The peak of citations is observed in the years 1992 to 1996, with a range of 2118 to 3711 times. The years 1997 to 2002 witness a continuous rise in citations, ranging from 4042 to 6672 times. This upward trend persists through the years 2003 to 2014, with citations ranging from 7270 to 9908 times. Notably, the years 2009 to 2014 stand out with the highest frequency of citations. However, a decline in citation frequency is observed in the years 2015 to 2018, with a range of 7321 to 9503 citations. The year 2019 records 6310 cited references, while a substantial peak is observed in 2020, with 12231 citations. The subsequent years, 2021 and 2022, show a decrease in citation frequency with 5345 and 932 times cited, respectively. In summary, the highest cited year is 2020, followed by the years 2009 to 2014, indicating a concentrated interest in and recognition of research during these periods.

The Weighted Recency Values (WRC) exhibit a notable pattern across different time periods. For the years spanning from 1600 to 1942, WRC ranges from 0.0009 to 0.0040, indicating relatively smaller values. Subsequently, between 1843 and 1867, WRC values increase to the range of 0.0049 to 0.20. The period from 1868 to 1968 sees WRC values in the range of 0.026 to 0.0414, followed by a significant rise to 0.0556 to 0.2050 between 1968 and 1982. The trend continues with WRC values escalating from 0.225 to 0.4065 between 1983 and 1987, reaching higher levels of 0.4901 to 0.8526 in the years 1988 to 1991. Notably, the WRC values peak between 1992 and 1996, ranging from 0.9420 to 2.2122. The subsequent years, 1997 to 2008, maintain elevated WRC values, ranging from 1.4663 to 4.2264.

However, a decline is observed in WRC values from 2009 to 2014, ranging from 4.1015 to 2.8064. This reduction continues in the years 2015 to 2019, where WRC values range from 3.9756 to 2.8064. The highest WRC value is recorded in 2020, reaching 5.4397, indicating a notable surge in weighted recency. The subsequent years, 2021 and 2022, witness a decrease in WRC values.

A noteworthy observation is that the oldest cited year is 1600, and WRC values remain relatively small (below 1) from the start until 1992. However, post-1993, WRC values consistently exceed 1, with a significant surge observed from 1995 onwards, crossing the 100-mark. The pinnacle is reached in 2020 with a WRC value of 6115.5, suggesting a substantial concentration of information during this period. This trend indicates a heightened interest in Cytokine topics, particularly those written after 2013, reflecting current and compelling research in the field.

Therefore, the Weighted Recency of Citation for the years of 1998 to 2022 WRc2022. So, $WRc_{2022} = \sum F_{c2} \times \frac{1}{Y_{a2} - Y_c} = 30663.047$

Total number of citation (N) =5534 (where N= (ΣFc_{22})

Average Weighted Recency of Citation ($AWRc_{2022}$) =WRc_{2022}/ N=5345/5534=0.97.

Discussion and Findings

The study reveals that articles published in 2020 have the highest average weighted recency compared to other years, indicating that the citations for these articles are more recent. The highest number of publications occurred in 2021, followed by 2020 and 2019. However, there is a declining trend in publication growth, with fewer records in 2022 due to data retrieval in October 2022. A total of 310,077 citations were earned by 5,534 articles on cytokine from 1998 to 2022. Among these, the years 2015 and 2018 had the highest citations. The study found 35,509 contributing authors, with 2022 having the highest number of contributing authors. The distribution of articles based on citation counts shows the highest number of articles fall into the category of 1 to 5 citations, while the highest citation score falls between 26 to 50 citations. Top Cited Resources: The most cited articles include those by "Livak KJ" (2001) with 207 citations, "Lowry" (1951) with 199 citations, and "Huang CL" (2020) with 155 citations. The recency of citations peaks in 2020, with 12,231 citations, followed by a decline in subsequent years. The findings from this study highlight several key trends and implications in the field of Cytokine research. The high average weighted recency for articles published in 2020 suggests a significant recent interest and rapid acknowledgment of these works. This trend indicates that newer research is quickly gaining traction and being cited, reflecting the dynamic nature of Cytokine research. The declining trend in publication growth and citation frequency

in recent years could be attributed to various factors, including the timing of data retrieval and possibly the impact of global events such as the COVID-19 pandemic on research activities and publication cycles. Despite this, the peak in 2020 demonstrates a period of intense research activity and recognition. The distribution of citation counts reveals that a large portion of articles receive moderate citations, while a select few achieve high citation scores, indicating a disparity in the influence and reach of different works. This pattern underscores the importance of identifying and focusing on highly cited, influential research to guide future studies and funding allocations. The study also underscores the utility of recency analysis in citation studies. By focusing on the recency of citations, researchers and librarians can better understand current trends and prioritize recent, impactful research. The proposed recency index offers a valuable tool for evaluating the timeliness and relevance of research articles, authors, and journals, which can aid in making informed decisions in academic and library settings. Overall, this study provides a comprehensive overview of citation trends in Cytokine research, offering valuable insights into the evolving landscape of scientific publications and the importance of recent contributions in shaping the field.

Conclusion

The researcher provided a summary of this study that emphasizes the importance of recency in citation analysis, particularly in the field of Cytokine research. The study suggests that considering the recency of citations can assist library professionals in the weeding out process, helping them prioritize time-sensitive publications. The recency of cited items is seen as a reflection of information-seeking behavior among researchers. Furthermore, the study proposes the creation of a recency index, which could be applied to measure the recency of articles, evaluate the year-wise impact of an article, compare articles, assess author impact in terms of recency, and potentially rank authors. This recency index could also be extended to evaluate journals, offering an alternative method for journal ranking. Additionally, the study highlights the potential application of this research in formulating policies for relevant community libraries. Overall, the findings suggest that citation analysis, particularly focusing on recency, can provide valuable insights for researchers, librarians, and policymakers in the realm of Cytokine research and beyond.

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