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Analysis Of Research Publications Of Icmr Institutes Of Western Region, India: A Scientometric Study Based On Citation Analysis

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Abstract
Citation analysis is a research method used to evaluate the impact and influence of scholarly work by examining the frequency and patterns of citations within publications. It helps to identify influential authors, articles, and research areas, as well as understand the flow of knowledge and evolution of research over time. Essentially, it provides insights into the impact and reach of a specific institution's research output. In this paper we analyze the research publications of ICMR institutes situated in Western Region of India from 2017 to 2021. There are five institutes NIV, Pune, NARI, Pune, NIRRCH, Mumbai, NIIH, Mumbai and NIOH Ahmadabad established in Western Region of India. Citation Analysis of articles, Annual Growth Rate, year-wise distribution of articles under Scietometric study is used to evaluate the data. A total 1152 papers are indexed in WoS database in which highest 348 papers were published by NIV followed by 342 papers by NIRRCH, 192 papers by NIIH, 189 papers by NARI and only 81 papers by NIOH. NIV has continuous increases in AGR whereas NARI, NIRRCH, NIIH and NIOH have some fluctuation in graph of AGR during the period. Among the five institutes, NIV received highest 8421 citations followed by 6696 citations by NARI, 5729 citations by NIRRCH, 2951 citations by NIOH and 1693 citations by NIIH from 2017 to 2024 and many more findings were observe in the paper.

Keywords: *Annual Growth Rate, Scientometric Study, Research Publications, Citation Analysis, Indian Council of Medical Research.*

1. Introduction:

Research publications are scholarly writings, articles or journals that communicate research findings to a wider audience, especially within academia and the scientific community. They serve to make research accessible, promote knowledge sharing and facilitate the assessment of the quality of research by peers and other researchers. Scholarly journals, conference proceedings, books, reports, technical reports, patents and other publications including dissertations, theses and technical notes fall under research publications[1]. The scientists of the research institutes publish the research papers in various journals. They use various journals, including those listed in the UGC CARE list or reputed publishers such as Springer, Elsevier and other indexed databases Web of Science, SCOPUS, PubMed etc. Authors follow submission guidelines, prepare manuscripts and navigate the peer review process before publication[2]. Authors gets benefits to publish the papers like career advancement, receiving of citations, professional reputation etc. It also promotes collaboration; increases credibility and can have an impact on society[3]. Publishing research papers also provides many benefits to the institutions, mainly increasing their reputation, increasing funding opportunities, getting projects from the government and increasing the ranking of the institution, etc. It also promotes academic collaboration, facilitates interdisciplinary research, and contributes to the advancement of knowledge[4].

Scientometric studies of research publications are used to analyze and understand the quantitative aspects of scientific communication and research. This analysis helps in identifying patterns, trends, and the impact of scientific research. Scientometric studies provide insights into the structure, growth, and interrelationships within a specific research field or discipline. The findings from scientometric analyses can inform science and technology policy decisions, resource allocation, and research funding. It studies,

particularly citation analysis, can help assess the impact of individual publications and journals on the scientific community. These studies can serve as a valuable tool for training and familiarizing researchers with a new topic or discipline. By analyzing the existing literature, scientometric studies can highlight gaps and areas where further research is needed. Its analysis helps track research trends and the evolution of scientific fields over time[5].

The Indian Council of Medical Research (ICMR) is India's top body for biomedical research, playing a crucial role in formulating, coordinating, and promoting medical research. It is one of the oldest and largest medical research organizations in the world. ICMR supports biomedical research. It focuses on translating research findings into practical applications, introducing new products and processes into the public health system. ICMR develops and disseminates guidelines and regulations on public health issues, providing valuable resources for researchers, healthcare professionals, and policymakers. ICMR provides evidence-based policy inputs to help inform healthcare decisions and the development of effective policies. ICMR collaborates with international organizations and researchers to enhance global health research and address emerging diseases. It supports the development of research infrastructure, including labs and facilities, to facilitate cutting-edge research. ICMR focuses on research related to the health issues of vulnerable populations and marginalized communities[6]. It has 28 permanent institutes and 3 Centres under institutes. This paper study the ICMR institutes established in Western Region of India. A total five institutes are situated in Western Region of India i.e. two institutes in Pune, Maharashra e.g. National Instititute of Virology and National AIDS Research Institute and two institutes in Mumbai e.g. National Institute for Research in Reproductive and Child Health and National Institute of Immunohaematology. One more institute is established in Ahmedabad, Gujarat i.e. National Institute of Occupational Health. These all institutes come under Western Region of India.

2. Literature Review:

Aswathy and Gopikuttan (2013)[7] studied productivity pattern of three state universities of Kerala using the scientometric parameters authorship pattern and Degree of Collaboration, year-wise growth of publications etc and found that a total 2335 papers are published by the three universities and multiauthorship pattern is used for the publishing of papers by the teachers of the universities. A range between 0.85-0.93 DC is used for publishing of papers. Yadav, Verma and Singh (2020)[8] studied the research publications of Mijoram University from 2004 to 2017 as data collected from Indian Citation Index and found that a total 265 papers were published during the period. They used year-wise growth of papers, Co-authorship pattern, Degree of collaboration, most productive authors, top ranked subjects, top ranked publications criteria to analyze the publications. An average 18.93 papers were published per year in which Sahoo UK published highest 25 papers during the period. Highest 16 papers were published in Current Science Journal. Highest papers were published in Biology Subject and many more findings were observed in the research.

One more study of publications of ICAR-Indian Institute of Horticultural Research institutes was done by Suresh and Thanuskodi in 2019[9] during the period 1989 to 2018. The data was retrieved from Web of Science Database and received 1095 articles as indexed in the database. He analyzed the data and found that Indian Journal of Agricultural Sciences is most preferred journal for the publishing of papers. United State is most collaborative country for the collaboration of research. Highest papers were published on Agriculture and Plant Sciences. They observed 0.90 DC for publishing of papers.

Singh (2015)[10] mapped the research publications of Indian Institute of Technology, Delhi from the period 1990-2014 using the Web of Science database and found a total 13208 papers were published during the period and approximately 94.82% papers were published in collaboration and many more research were found in their study. Patel and Malhan[11] also used the sientometric study to analyze the publications of National Institute of Technology, Hamirpur from the period 2013 to 2017 using the papers indexed in Web of Science database. Shetter and Hadagali analyzed the research publications of 31 National Institute of Technology Publications using the scientometric analysis from the period 2009 to 2018. WoS is used to retrieve the data. They used year-wise publication growth, Degree of

collaboration, Citation Analysis of publications, Average Citation Per Paper, Authorship Pattern etc and found the research as published in their paper[12].

3. Objectives:

- To know the research papers published by the ICMR institutes situated in Western Region of India (Total Five Institutes i.e. NIV, NARI, NIRRCH, NIIH and NIOH).
- To know the Annual Growth Rate of Publications of all five institutes.
- To analyze the Citations of Papers received during the period.
- To know the top ten papers received highest citations.

4. Scope & Methodology:

This paper study the research publications of ICMR institutes situated in Western Region of India. There are five institutes established in Western region in which two institutes is situated in Pune, Maharashtra i.e. National Institute of Virology and National AIDS Research Institute, two institutes situated in Mumbai, Maharashtra i.e. National Institute for Research in Reproductive and Child Health, Mumbai and National Institute of Immunohaematology, Mumbai and one situated in Ahmedabad, Gujarat i.e. National Institute of Occupational Health, Ahmadabad, Gujarat. Five years research paper published from 2017 to 2021 by the institutes is considered for the study. The bibliographic data was collected from Web of Science database using the simple and advance search term from 2017 to 2021 and the citation data of five years publications retrieved from 2017 to 2024 to analyze the latest citations data of publications. A total 1152 paper were retrieved and analyze the publications using various scientometric parameters which includes year-wise growth of publications, Annual Growth Rate, citation analysis of papers and top ten papers received highest citations. MS Excel is used to tabulate the data and show in figures. To know the Annual growth of Publications, a formula given by Kumar and Kaliyaperumal used to calculate[13]. The formula is:

$$\textbf{Annual Growth Rate} = \frac{\textbf{End Value} - \textbf{First Value}}{\textbf{First Value} * \textbf{100}}$$

5. Data Analysis & Interpretation:

5.1. Year-wise Growth of Publications: A year-wise study of publication growth reveals a trend of increasing publication numbers over time, with some fluctuations. This paper study the year-wise growth of publications of five institutes of ICMR situated in Western Region of India. We found that highest 348 papers were published by NIV followed by 342 papers by NIRRCH, 192 papers by NIIH, 189 papers by NARI and only 81 papers by NIOH as papers indexed in Web of Science database and published from 2012 to 2021. We observe that all the institutes published their highest papers in 2021 so this year has exponential growth of publications. Table 5.1 and Figure 1 demonstrates the year-wise number of papers published during the period as given below:

Table 5.1: Year Wise Distribution of Articles

Year	NIV		NARI		NIRRCH		NIIH		NIO H	
	TP	% of TP	TP	% of TP	TP	% of TP	TP	% of TP	TP	% of TP
2017	50	14.37	31	16.4	52	15.2	39	20.31	12	14.81
2018	55	15.8	29	15.34	71	20.77	34	17.7	9	11.11
2019	66	18.97	33	17.47	47	13.74	37	19.28	9	11.11
2020	72	20.69	39	20.63	65	19	33	17.19	25	30.87
2021	105	30.17	57	30.16	107	31.29	49	25.52	26	32.1
Total	**348**	**100**	**189**	**100**	**342**	**100**	**192**	**100**	**81**	**100**

*TP- Total Publications

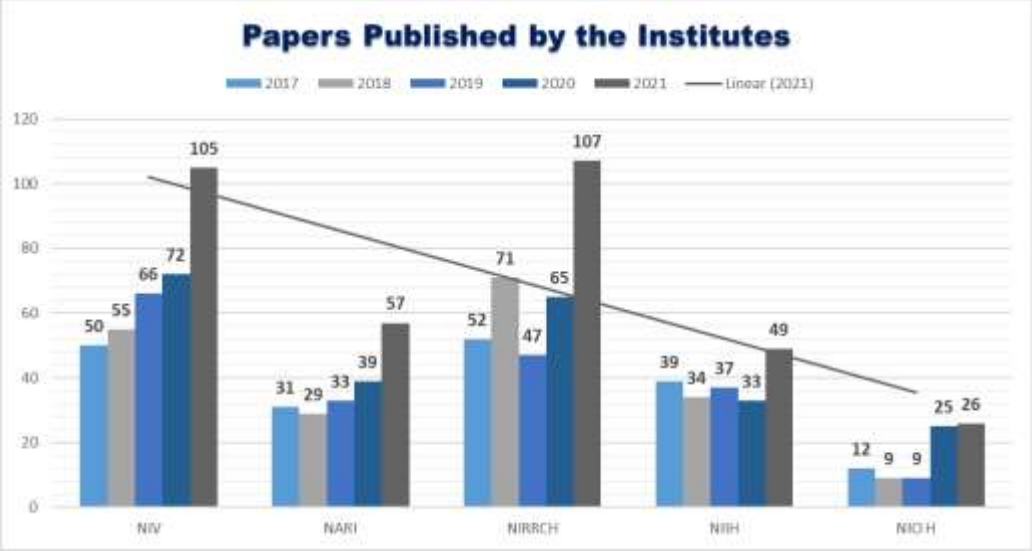

Figure 1: Year Wise Distribution of Articles

5.2. Annual Growth Rate of Publications: A study on the annual growth rate (AGR) of publications reveals varying trends depending on the field and timeframe. Some studies show steady growth, while others indicate fluctuating growth rates or a decline in growth over time. Researchers use various methods, including annual growth rate (AGR) of publications under scientometric analysis, to track publication trends and analyze factors influencing growth. The study of AGR shows that NIV has highest 45.83 AGR in 2021 and lowest 9.09 AGR in 2020. There are no negative and nil AGR in five years. NARI also has highest 46.15 AGR in 2021 and lowest negative -6.45 AGR in 2018. In the context of NIRRCH, it has highest 64.62 AGR in 2021 and lowest negative -33.8 AGR in 2019 where NIIH has highest 48.48 AGR in 2021 and two negative -12.82 AGR in 2018 and -10.81 AGR in 2020. NIOH has nil AGR in 2019 and negative -25 AGR in 2018 and highest 177.78 AGR in 2020. Among the five institutes NIOH has highest 177.78 AGR in 2020.

Table 5.2 Annual Growth Rate Publications

Year	NIV		NARI		NIRRCH		NIIH		NIOH	
	Articles	AGR	Articles	AGR	Articles	AGR	Articles	AGR	Articles	AGR
2017	50	-	31	-	52	-	39	-	12	-
2018	55	10	29	-6.45	71	36.54	34	-12.82	9	-25
2019	66	20	33	13.79	47	-33.8	37	8.82	9	0
2020	72	9.09	39	18.18	65	38.3	33	-10.81	25	177.78
2021	105	45.83	57	46.15	107	64.62	49	48.48	26	4

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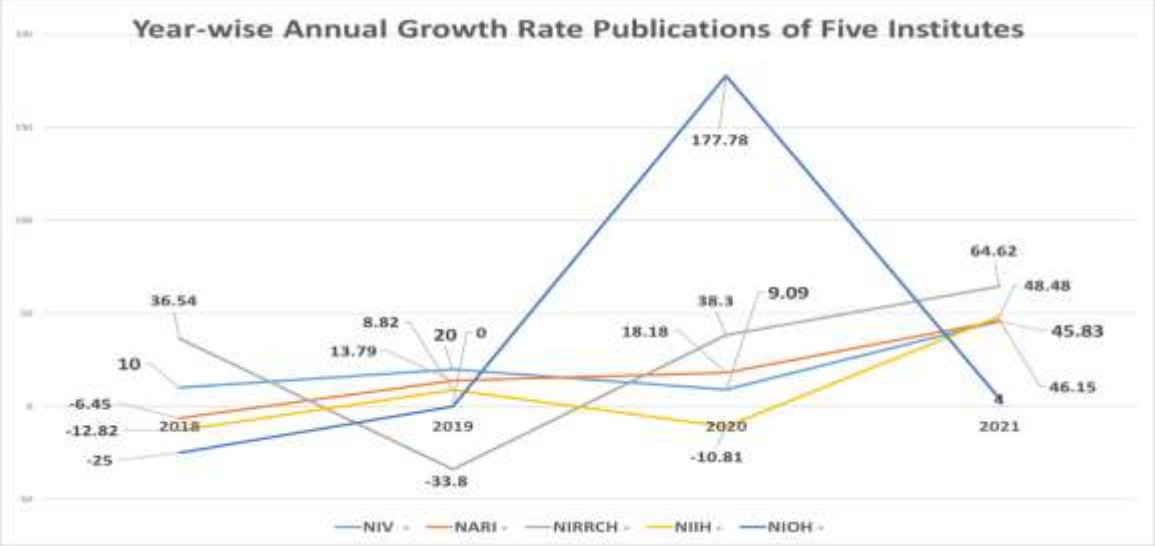

Figure 2: Annual Growth Rate Publications

5.3. Citation Analysis of Papers: Citation analysis involves examining the frequency, patterns, and graphs of citations received by the articles. It's used to assess the impact and quality of publications, researchers, or institutions by counting how many times they've been cited by others. This method helps identify influential works, track research trends, and facilitate literature searches. Citation analysis is a bibliometric technique that examines the citations between documents to understand their relationships and influence. It focuses on the frequency of citations, the patterns of citation (e.g., who cites whom), and the overall citation network. The goal is to determine the importance and impact of a publication, author, or institution based on how frequently they are cited.

Table 5.3.1 shows that out of total NIV 348 papers, 335 papers received 8421 citations, which were published from 2017 to 2021 and have citations received till 31 December 2024. Highest 2859 citations in 2017 and lowest 632 citations in 2018 received by the papers. An Average 24.19 Citations received by the papers in five years.

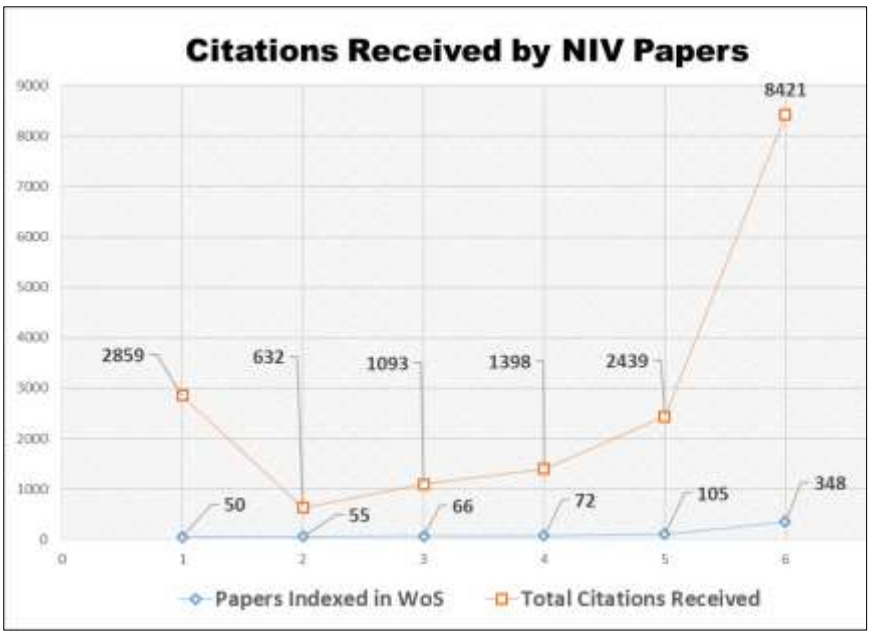

Table 5.3.1: Citations Received by NIV Papers

Year	Papers Indexed in WoS	TPRC	Total Citations Received	ACPP
2017	50	48	2859	57.18
2018	55	55	632	11.49
2019	66	62	1093	16.56
2020	72	71	1398	19.41
2021	105	99	2439	23.22
Total	348	335	8421	24.19

* TPRC- Total Papers Received Citations, ACPP- Average Citation Per Paper

Table 5.3.2 demonstrates the citations analysis of NARI papers and observes that 182 papers out of 189 papers received 6696 citations in which highest 4906 citations and 86.07 average Citations were received in 2021 and lowest 253 citations and average 8.72 citations were received in 2018. An average 35.42 citations were received in five years.

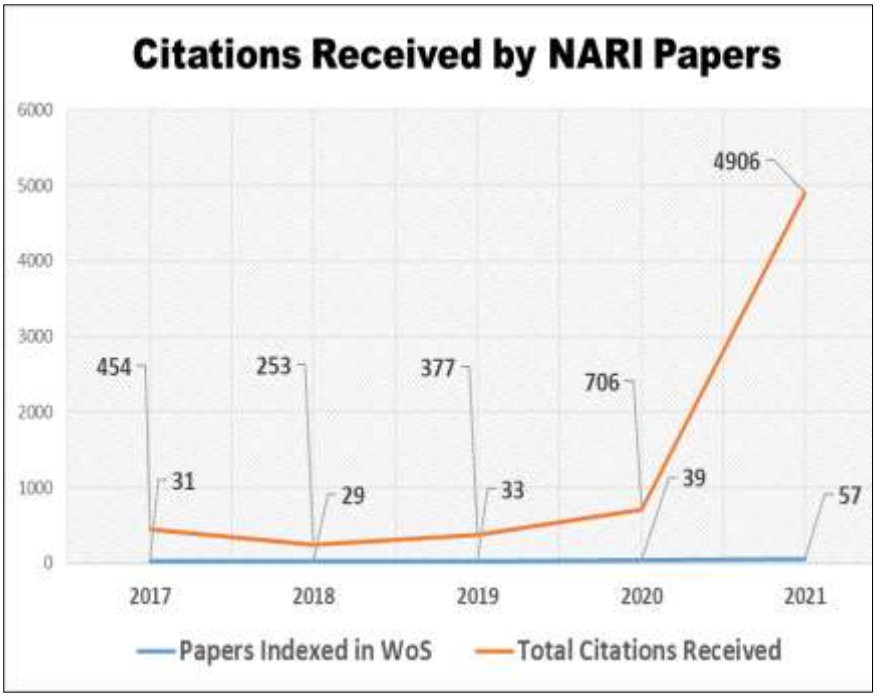

Table 5.3.2: Citations Received by NARI Papers

Year	Papers Indexed in WoS	TPRC	Total Citations Received	ACPP
2017	31	30	454	14.64
2018	29	28	253	8.72
2019	33	31	377	11.42
2020	39	39	706	18.10
2021	57	54	4906	86.07
Total	189	182	6696	35.42

* TPRC- Total Papers Received Citations, ACPP- Average Citation Per Paper

NIRRCH received 5729 citations from 327 papers out of 342 total papers in which a highest 1461 citations and average citation per paper 20.57 citations were received in 2018 and lowest 837 citations in

2019 and lowest average citation per paper 12.25 citations were received in 2021. An average citation per paper 16.75 citations was received of five years papers. Details data are shown below in Table 5.3.3.

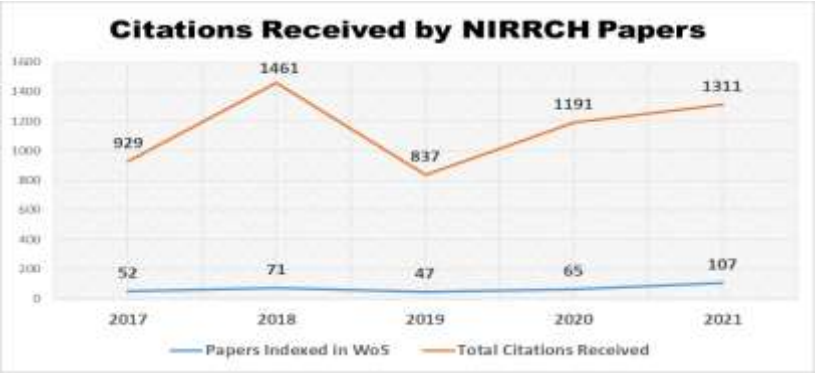

Table 5.3.3: Citations Received by NIRRCH Paper

Year	Papers Indexed in WoS	TPRC	Total Citations Received	ACPP
2017	52	47	929	17.86
2018	71	69	1461	20.57
2019	47	44	837	17.80
2020	65	63	1191	18.32
2021	107	104	1311	12.25
Total	342	327	5729	16.75

* TPRC- Total Papers Received Citations, ACPP- Average Citation Per Paper

NIIH 174 papers out of 192 papers received 1693 citations. A highest 433 citations in 2021 and lowest 228 citations in 2020 were received. An 8.81 ACPP were received in which highest ACPP was in 2018 with 10 citations and lowest 6.90 ACPP was received in 2020 as shown in Table

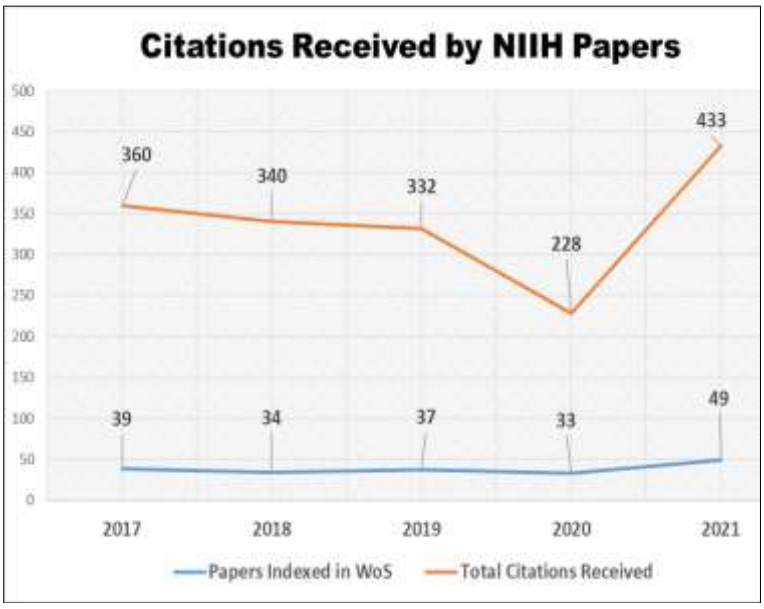

Table 5.3.4: Citations Received by NIIH Paper

Year	Papers Indexed in WoS	TPRC	Total Citations Received	ACPP
2017	39	37	360	9.23
2018	34	30	340	10
2019	37	34	332	8.97
2020	33	29	228	6.90
2021	49	44	433	8.83
Total	192	174	1693	8.81

* TPRC- Total Papers Received Citations, ACPP- Average Citation Per Paper

Table 5.3.5 shows that a total 76 papers out of 81 papers received 2951 citations in which highest 990 citations were received in 2017 and lowest 336 citations were received in 2018. An average 36.43 citations were received during the period. A highest 82.50 ACPP in 2017 and lowest 21.68 ACPP were received during the period.

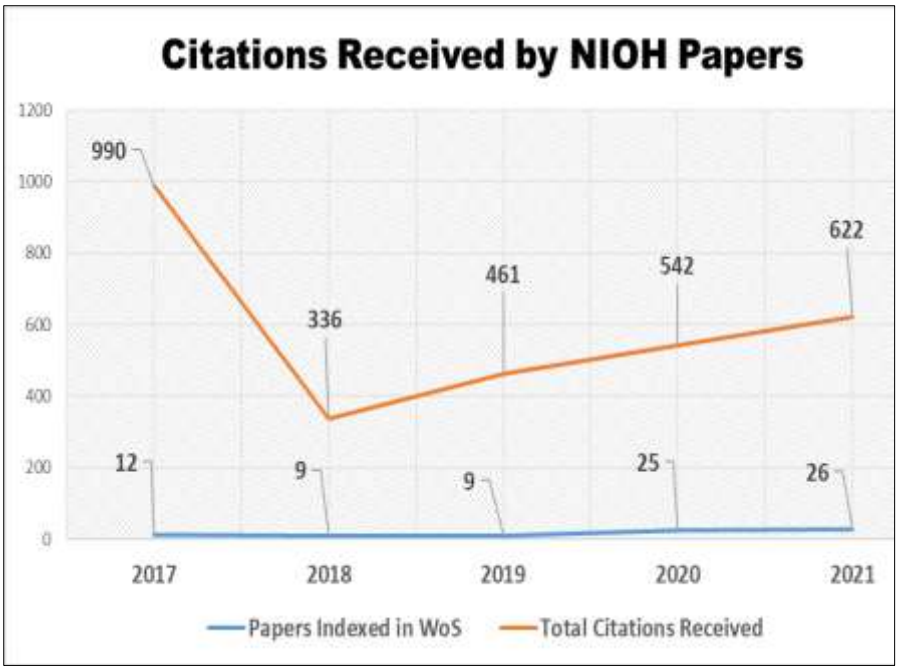

Table 5.3.5: Citations Received by NIOH Papers

Year	Papers Indexed in WoS	TPRC	Total Citations Received	ACPP
2017	12	9	990	82.50
2018	9	9	336	37.33
2019	9	9	461	51.22
2020	25	24	542	21.68
2021	26	25	622	23.92
Total	81	76	2951	36.43

* TPRC- Total Papers Received Citations, ACPP- Average Citation Per Paper

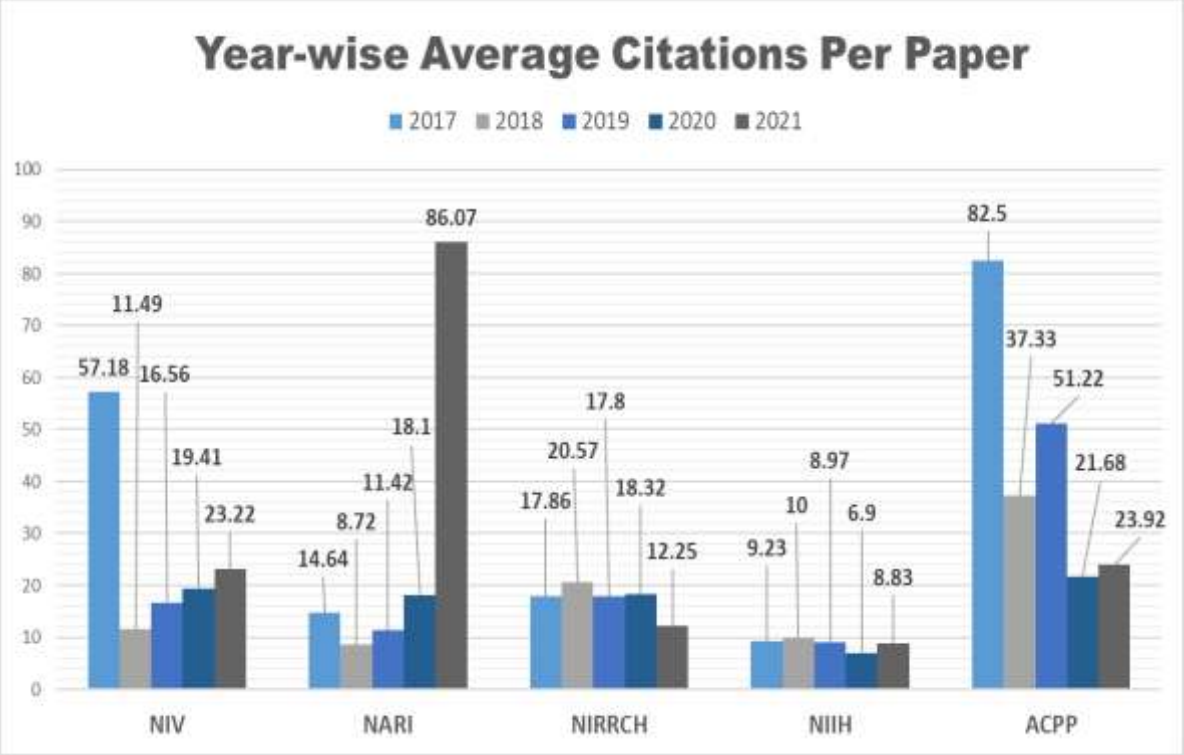

Figure 3: Average Citations per Paper of Five Institutes

5.4. Papers Received Highest Number of Citations: Studying highly cited papers is important because they represent a significant impact on a field, often indicating influential research, groundbreaking discoveries, or widely used techniques. These papers are frequently cited because they contribute to the scientific knowledge base, are well-regarded within the academic community, and may offer valuable insights. These papers show emerging topics and methodological advancements in the field and have influence in research community.

In the study of top ten most cited NIV papers, we observe that Chadha M paper published in Lancet journal in 2017 received 1587 citations followed by Tandale BV paper published in Lancet Journal with 445 citations, Sapkal, Yadav and Abraham paper published in Lancet Infectious Diseases with 375 citations etc. received highest citations as shown below in Table 5.4.1.

Table 5.4.1: NIV Papers Received Highest Citations

S.N.	Articles Details	NIV Authors	Journal's Name	Year	Country Name	Total Citations
1.	Shi T etal. Global, regional, and national disease burden estimates of acute lower respiratory infections due to respiratory syncytial virus in young children in 2015: a systematic review and modelling study. Lancet. 2017 Sep 2;390(10098):946-958.	Chadha M	Lancet	2017	England	1587
2.	India State-Level Disease Burden Initiative Collaborators. Nations within a nation: variations in epidemiological transition across the states of India, 1990-2016 in the Global Burden of Disease Study. Lancet. 2017 Dec 2;390(10111):2437-2460.	Tandale BV	Lancet	2017	England	445
3.	Ella R etal. Safety and immunogenicity of an inactivated SARS-CoV-2 vaccine, BBV152: a double-blind, randomised, phase 1 trial. Lancet Infect Dis. 2021 May;21(5):637-646.	Sapkal G, Yadav P, Abraham P	Lancet Infectious Diseases	2021	United States	375
4.	Cherian S etal. SARS-CoV-2 Spike Mutations, L452R, T478K, E484Q and P681R, in the Second Wave of COVID-19 in Maharashtra, India. Microorganisms. 2021 Jul 20;9(7):1542.	Cherian S, Potdar V, Jadhav S, Yadav P, Das M, Abraham P	Microorganisms	2021	Switzerland	364
5.	Ella R etal. Efficacy, safety, and lot-to-lot immunogenicity of an inactivated SARS-CoV-2 vaccine (BBV152): interim results of a randomised, double-blind, controlled, phase 3 trial. Lancet. 2021 Dec 11;398(10317):2173-2184.	Potdar V, Yadav P, Sapkal G, Abraham P	Lancet	2021	England	211
6.	Arunkumar G etal. Outbreak Investigation of Nipah Virus Disease in Kerala, India, 2018. J Infect Dis. 2019 May 24;219(12):1867-1878.	Mourya DT	Journal of Infectious Diseases	2019	Canada	160
7.	Murhekar MV etal. Prevalence of SARS-CoV-2 infection in India: Findings from the national serosurvey, May-June 2020. Indian J Med Res. 2020 Jul & Aug;152(1 & 2):48-60.	Sapkal GN	Indian Journal of Medical Research	2020	India	150
8.	Singh RK etal. Nipah virus: epidemiology, pathology, immunobiology and advances in diagnosis, vaccine designing and control strategies - a comprehensive review. Vet Q. 2019 Dec;39(1):26-55.	Mourya DT	Veterinary Quarterly	2019	England	133
9.	Lafond KE etal. Global burden of influenza-associated lower respiratory tract infections and hospitalizations among adults: A systematic review and meta-analysis. PLoS Med. 2021 Mar 1;18(3):e1003550.	Chadha M	PloS Medicine	2021	United States	126
10.	Hegde NR, Gore MM. Japanese encephalitis vaccines: Immunogenicity, protective efficacy, effectiveness, and impact on the burden of disease. Hum Vaccin Immunother. 2017 Jun 3;13(6):1-18.	Gore MM	Human Vaccines & Immunotherapeutics	2017	United States	105

Table 5.4.2 reveals that a paper published by Godbole S published in New England Journal of Medicine in 2021 received highest 1866 citations followed by two papers by Panda S published in Indian Journal of Medical Research in 2020 received 152 and 150 citations. After that a paper published in Lancet Global Health in 2021 by Banger and Sahay S received 108 citations. Lancet Infectious Diseases, International Journal of Infectious Diseases, Microbial Pathogenesis, Journal of Environmental Chemical engineering, Viruses are some of the journals in which papers published and received highest citations.

Table 5.4.2: NARI Papers Received Highest Citations

S.N.	Articles Details	NARI Authors	Journal's Name	Year	Country Name	Total Citations
1.	WHO Solidarity Trial Consortium etal. Repurposed Antiviral Drugs for Covid-19 - Interim WHO Solidarity Trial Results. N Engl J Med. 2021 Feb 11;384(6):497-511.	Godbole S	New England Journal of Medicine	2021	United States	1866
2.	Murhekar MV etal. Prevalence of SARS-CoV-2 infection in India: Findings from the national serosurvey, May-June 2020. Indian J Med Res. 2020 Jul & Aug;152(1 & 2):48-60. doi: 10.4103/ijmr.IJMR_3290_20. PMID: 32952144; PMCID: PMC7853249.	Panda S	Indian Journal of Medical Research	2020	India	152
3.	Chatterjee P etal. Healthcare workers & SARS-CoV-2 infection in India: A case-control investigation in the time of COVID-19. Indian J Med Res. 2020 May;151(5):459-467.	Panda S	Indian Journal of Medical Research	2020	India	150
4.	Murhekar MV etal. SARS-CoV-2 antibody seroprevalence in India, August-September, 2020: findings from the second nationwide household serosurvey. Lancet Glob Health. 2021 Mar;9(3):e257-e266.	Bangar SD, Sahay S	Lancet Global Health	2021	England	108
5.	Kalokhe A, Del Rio C, Dunkle K, Stephenson R, Metheny N, Paranjape A, Sahay S. Domestic violence against women in India: A systematic review of a decade of quantitative studies. Glob Public Health. 2017 Apr;12(4):498-513.	Sahay S	Global Public Health	2017	London	99
6.	Lin C etal. Cervical determinants of anal HPV infection and high-grade anal lesions in women: a collaborative pooled analysis. Lancet Infect Dis. 2019 Aug;19(8):880-891.	Godbole S	Lancet Infectious Diseases	2019	United States	82
7.	Murhekar MV etal. SARS-CoV-2 seroprevalence among the general population and healthcare workers in India, December 2020-January 2021. Int J Infect Dis. 2021 Jul;108:145-155.	Bangar SD, Sahay S	International Journal of Infectious Diseases	2021	Canada	81
8.	Singh H etal. ACE2 and TMPRSS2 polymorphisms in various diseases with special reference to its impact on COVID-19 disease. Microb Pathog. 2021 Jan;150:104621.	Singh H, Nema V, Khan AA	Microbial Pathogenesis	2021	England	69
9.	Ahmad Reza Bagheri AR, Aramesh N, Khan AA, Gul I, Ghotekar S, Bilal M. Molecularly imprinted polymers-based adsorption and photocatalytic approaches for mitigation of environmentally-hazardous pollutants A review. J Environ Chem Engi. 2021;9(1):104879	Khan AA	Journal of Environmental Chemical Engineering	2021	Netherlands	64
10.	Nanaware N etal. Dengue Virus Infection: A Tale of Viral Exploitations and Host Responses. Viruses. 2021 Sep 30;13(10):1967.	Nanaware N, Banerjee A, Mukherjee A	Viruses-Basel	2021	Switzerland	56

Table 5.3.3 shows a detailed list of NIRRCH papers received highest citations that demonstrates that Colaco and Modi paper published in Reproductive biology and Endocrinology published in 2018 received highest 160 citations after that Ashary, Tiwari and Modi paper published in Endocrinology received 119 citations, Shukla P paper published in Ageing Research Review received 110 citations, Colaco S paper published in Journal of Assisted reproduction and Genetics received 104 citations and many more.

Table 5.4.3: NIRRCH Papers Received Highest Citations

S.N.	Articles Details	NIRRCH Authors	Journal's Name	Year	Country Name	Total Citations
1.	Colaco S etal. Genetics of the human Y chromosome and its association with male infertility. Reprod Biol Endocrinol. 2018 Feb 17;16(1):14.	Colaco S, Modi D	Reproductive Biology and Endocrinology	2018	England	160
2.	Ashary N etal. Embryo Implantation: War in Times of Love. Endocrinology. 2018 Feb 1;159(2):1188-1198.	Ashary N, Tiwari A, Modi D.	Endocrinology	2018	United States	119
3.	Chiang JL etal. Mitochondria in Ovarian Aging and Reproductive Longevity. Ageing Res Rev. 2020 Nov;63:101168.	Shukla P	Ageing Research Reviews	2020	England	110
4.	Colaco S etal. Paternal factors contributing to embryo quality. J Assist Reprod Genet. 2018 Nov;35(11):1953-1968.	Colaco S	Journal of Assisted Reproduction and Genetics	2018	United States	104
5.	Kurian NK etal. Extracellular vesicle mediated embryo-endometrial cross talk during implantation and in pregnancy. J Assist Reprod Genet. 2019 Feb;36(2):189-198.	Kurian NK, Modi D	Journal of Assisted Reproduction and Genetics	2019	United States	100
6.	Waghu FH etal. Collection of antimicrobial peptides database and its derivatives: Applications and beyond. Protein Sci. 2020 Jan;29(1):36-42.	Waghu FH, Idicula-Thomas S	Protein Science	2020	United States	95
7.	Bhartiya D etal. Endogenous, very small embryonic-like stem cells: critical review, therapeutic potential and a look ahead. Hum Reprod Update. 2016 Dec;23(1):41-76.	Bhartiya D, Shaikh A, Anand S, Patel H, Kapoor S, Sriraman K, Parte S, Unni S	Human Reproduction Update	2017	England	91
8.	Ashary N etal. Single-Cell RNA-seq Identifies Cell Subsets in Human Placenta That Highly Expresses Factors Driving Pathogenesis of SARS-CoV-2. Front Cell Dev Biol. 2020 Aug 19;8:783.	Ashary N, Bhide A, Colaco S, Mishra A, Chhabria K, Modi D	Frontiers in Cell and Developmental Biology	2020	Switzerland	86
9.	Durairajanayagam D etal. Causes and consequences of sperm mitochondrial dysfunction. Andrologia. 2021 Feb;53(1):e13666.	Singh D	Andrologia	2020	Germany	81
10.	Aranha C etal. Cycle threshold values in RT-PCR to determine dynamics of SARS-CoV-2 viral load: An approach to reduce the isolation period for COVID-19 patients. J Med Virol. 2021 Dec;93(12):6794-6797.	Aranha C, Patel V, Bhor V, Gogoi D	Journal of Medical Virology	2021	United States	72

As shown in Table 5.4.4 in the study of top ten most cited NIIH papers, we observe that Pujari etal paper published in Drug Delivery journal in 2017 received 59 citations followed by Colah and Mukherjee paper published in Scientific Reports Journal with 52 citations, again Colah R paper published in Mediaterranean Journal of Hematology and Infectious Diseases with 44 citations and so on received highest citations.

Table 5.4.4: NIIH Papers Received Highest Citations

S.N.	Articles Details	NIIH Authors	Journal's Name	Year	Country Name	Total Citations
1.	Pranatharthiharan S etal. Asialoglycoprotein receptor targeted delivery of doxorubicin nanoparticles for hepatocellular carcinoma. Drug Deliv. 2017 Nov;24(1):20-29.	Pujari V, Gorakshakar A, Madkaikar M, Ghosh K	Drug Delivery	2017	England	59
2.	Hockham C etal. The spatial epidemiology of sickle-cell anaemia in India. Sci Rep. 2018 Dec 6;8(1):17685.	Colah R, Mukherjee MB	Scientific Reports	2018	England	52
3.	Jain D etal. Sickle Cell Disease and Pregnancy. Mediterr J Hematol Infect Dis. 2019 Jul 1;11(1):e2019040.	Colah R	Mediterranean Journal of Hematology and Infectious Diseases	2019	Italy	44
4.	Fujii J etal. Erythrocytes as a preferential target of oxidative stress in blood. Free Radic Res. 2021 May;55(5):562-580.	Warang P, Madkaikar M, Mukherjee MB	Free Radical Research	2021	England	41
5.	Taur PD etal. Clinical and Molecular Findings in Mendelian Susceptibility to Mycobacterial Diseases: Experience From India. Front Immunol. 2021 Feb 25;12:631298.	Madkaikar MR, Dalvi AD, Yadav RM, Bargir UA, Kambli PM,	Frontiers in Immunology	2021	Switzerland	36
6.	Bacchelli C etal. Mutations in linker for activation of T cells (LAT) lead to a novel form of severe combined immunodeficiency. J Allergy Clin Immunol. 2017 Feb;139(2):634-642.e5.	Madkaikar M	Journal of Allergy and Clinical Immunology	2017	United States	35
7.	Rawat A etal. Clinical, Immunological, and Molecular Profile of Chronic Granulomatous Disease: A Multi-Centric Study of 236 Patients From India. Front Immunol. 2021 Feb 25;12:625320.	Kulkarni M, Hule G, Bargir U, Kambli P, Madkaikar M	Frontiers in Immunology	2021	Switzerland	32
8.	Aluri J etal. Clinical, Immunological, and Molecular Findings in 57 Patients With Severe Combined Immunodeficiency (SCID) From India. Front Immunol. 2019 Feb 4;10:23.	Aluri J, Gupta M, Dalvi A, Mhatre S, Bargir U, Kulkarni M, Madkaikar M	Frontiers in Immunology	2019	Switzerland	31
9.	Chougule D etal. Adipokine interactions promote the pathogenesis of systemic lupus erythematosus. Cytokine. 2018 Nov;111:20-27. doi: 10.1016/j.cyto.2018.08.002. Epub 2018 Aug 8. PMID: 30098476.	Chougule D, Khadilkar P, Madkaikar M	Cytokine	2018	England	30
10.	Vignesh P etal. Clinical, Immunological, and Molecular Features of Severe Combined Immune Deficiency: A Multi-Institutional Experience From India. Front Immunol. 2021 Feb 8;11:619146.	Dalvi A, Jodhawat N, Kambli P, Madkaikar MR	Frontiers in Immunology	2021	Switzerland	30

In the Table 5.4.5 NIOH papers received highest citations shows that Sadhu H and Agarwal S paper Published in Lancet journal in 2017 received highest 444 and 437 citations followed by Kumar and Sharma paper with 211 citations, Pagdhune, Viramgami and Sarkar with 150 citations, Upadhyay and Dodia with 121 citations and many more.

Table 5.4.5: NIOH Papers Received Highest Citations

S. N.	Articles Details	NIRRCH Authors	Journal's Name	Year	Country Name	Total Citations
1.	India State-Level Disease Burden Initiative Collaborators. Nations within a nation: variations in epidemiological transition across the states of India, 1990-2016 in the Global Burden of Disease Study. Lancet. 2017 Dec 2;390(10111):2437-2460.	Sadhu H	Lancet	2017	England	444
2.	GBD 2015 Healthcare Access and Quality. Healthcare Access and Quality Index based on mortality from causes amenable to personal health care in 195 countries and territories, 1990-2015: a novel analysis from the Global Burden of Disease Study 2015. Lancet. 2017 Jul 15;390(10091):231-266.	Agarwal S	Lancet	2017	England	437
3.	Kumar S, Sharma A. Cadmium toxicity: effects on human reproduction and fertility. Rev Environ Health. 2019 Dec 18;34(4):327-338.	Kumar S, Sharma A	Reviews on Environmental Health	2019	Germany	211
4.	Murhekar MV etal. Prevalence of SARS-CoV-2 infection in India: Findings from the national serosurvey, May-June 2020. Indian J Med Res. 2020 Jul & Aug;152(1 & 2):48-60.	Pagdhune A, Viramgami A, Sarkar K	Indian Journal of Medical Research	2020	India	150
5.	Upadhyay KD etal. Synthesis and Biological Screening of Pyrano[3,2-c]quinoline Analogues as Anti-inflammatory and Anticancer Agents. ACS Med Chem Lett. 2018 Feb 23;9(3):283-288.	Upadhyay KD, Dodia NM	ACS Medicinal Chemistry Letters	2018	United States	121
6.	Choudhari R. COVID 19 pandemic: Mental health challenges of internal migrant workers of India. Asian J Psychiatr. 2020 Dec;54:102254.	Choudhari R	Asian Journal of Psychiatry	2020	Netherlands	108
7.	Murhekar MV etal. SARS-CoV-2 antibody seroprevalence in India, August-September, 2020: findings from the second nationwide household serosurvey. Lancet Glob Health. 2021 Mar;9(3):e257-e266.	Balachandar R, Viramgami A	Lancet Global Health	2021	England	107
8.	Gangwar C etal. Assessment of air pollution caused by illegal e-waste burning to evaluate the human health risk. Environ Int. 2019 Apr;125:191-199.	Choudhari R	Environment International	2019	Netherlands	105
9.	Sedha S etal. Reproductive toxic potential of phthalate compounds - State of art review. Pharmacol Res. 2021 May;167:105536.	Kumar S	Pharmacological Research	2021	Netherlands	84
10.	Murhekar MV etal. SARS-CoV-2 seroprevalence among the general population and healthcare workers in India, December 2020-January 2021. Int J Infect Dis. 2021 Jul;108:145-155.	Balachandar R, Dhatrak S, Viramgami A, Chakrabarti A	International Journal of Infectious Diseases	2021	Canada	80

6. Findings:

There are some major findings of the study are given below:

- The study found that a 1152 papers were published by all five institutes in which highest 348 papers were published by NIV followed by 342 papers by NIRRCH, 192 papers by NIIH, 189 papers by NARI and only 81 papers by NIOH (From 2012 to 2021).

- The study of AGR shows that NIV has highest 45.83 AGR in 2021 and lowest 9.09 AGR in 2020. There are no negative and nil AGR in five years.
- NARI also has highest 46.15 AGR in 2021 and lowest negative -6.45 AGR in 2018. In the context of NIRRCH, it has highest 64.62 AGR in 2021 and lowest negative -33.8 AGR in 2019 where NIIH has highest 48.48 AGR in 2021 and two negative -12.82 AGR in 2018 and -10.81 AGR in 2020.
- NIOH has nil AGR in 2019 and negative -25 AGR in 2018 and highest 177.78 AGR in 2020. Among the five institutes NIOH has highest 177.78 AGR in 2020.
- NIV has continuous increases in AGR whereas NARI, NIRRCH, NIIH and NIOH have some fluctuation in graph of AGR during the period.
- Among the five institutes, NIV received highest 8421 citations followed by 6696 citations by NARI, 5729 citations by NIRRCH, 2951 citations by NIOH and 1693 citations by NIIH from 2017 to 2024.
- In the context of Average Citations Per Paper, NIOH has highest 36.43 ACPP, NARI has 35.42 ACPP, NIV has 24.19 ACPP, NIRRCH has 16.75 ACPP and lowest NIIH has 8.81 ACPP sequentially.
- The ranking of top ten papers received highest citations is prominent in scientometric analysis of papers. Godbole S from NARI received highest 1866 citations in 2021 by publishing a paper in New England Journal of Medicine. NIV author Chadha M received highest 1587 citations paper published in Lancet Journal in 2017.
- Sadhu S from NIOH published a paper in Lancet Journal in 2017 received highest 444 citations as clearly shown in Table 5.4.5 above.
- In the context of NIRRCH, Colaco S and Modi D paper published in Reproductive Biology and Endocrinology in 2018 received highest 160 citations.
- A paper of Pujari V, Gorakshakar A, Madkaikar M and Ghosh K published in Drug Delivery in 2017 received highest 59 citations among the NIIH scientists.

7. Conclusion:

This work analyze the research productivity of the scientists of ICMR five institutes, in terms of the number of publications, Annual Growth Rate and the quality of the publication in the context of citation analysis of papers. Publishing of number of publications of all five institutes are continuous increased from 2017 to 2021 and a total 1152 papers are published during the period. The scientist are focusing to publish their papers in reputed journals which are indexed in web of Science, SCOPUS and PubMed and receiving high citations. Among the five institutes, NIV received highest 8421 citations followed by 6696 citations by NARI, 5729 citations by NIRRCH, 2951 citations by NIOH and 1693 citations by NIIH from 2017 to 2024. In the context of Average Citations Per Paper, NIOH has highest 36.43 ACPP, NARI has 35.42 ACPP, NIV has 24.19 ACPP, NIRRCH has 16.75 ACPP and lowest NIIH has 8.81 ACPP sequentially. Godbole S paper from NARI, Chadha M paper from NIV, Sadhu S paper from NIOH, Colaco S and Modi D paper from NIRRCH Pujari V, Gorakshakar A, Madkaikar M and Ghosh K paper from NIOH received highest citations during the period. Thus this study found many prominent findings which are useful to know the research output of all five institutes.

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