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Research Article

Three Decades of Periodontics Research: A Scientometric Study with Special Reference to India

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ABSTRACT:

The data for this study was retrieved from the WoS platform using the Boolean search string (TS=periodont* OR gingiv*) AND (Year=1989 to 2018). The total number of bibliographic records retrieved was 69952. This study found that the literature growth pattern at the global level to be linear. Journal of Dental Research is the most favored journal; Offenbacher is top contributing author and University of Washington is the top contributing institution. The study also emphasizes the importance of research collaboration among the Periodontists.

Keywords: Scientometrics, Bibliometrics, Periodontology, Periodontics, Gingivitis.

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INTRODUCTION

The term scientometrics is an amalgam of two words, 'science' and 'metrics'. In simpler terms scientometrics is measuring or quantifying of science as evidenced by its research literature output. Research culminates in research publications such as journal articles, scientific communications, etc. and also as patents. Studying these research communications can provide insights into the dynamics of science. Science and scientific progress can be sized through statistical analysis of publications because a publication is an isolated and definite piece of work, it is permanent, accessible, and may be judged, and in most cases it is not difficult to ascertain when, where, and by whom it was done, and to plot the results on squared paper.[1]

In 1960s, Nalimov and Mulchenko used simple mathematical tools to model international scientific growth and suggested the Russian term '*naukometriya*' meaning scientometrics, for this kind of studies.[2] However, two milestones in the growth of Scientometrics as a discipline are (i) the launching of *Science Citation Index (SCI)* by Eugene Garfield in the year 1964 and (ii) the founding of the journal *Scientometrics* by Tibor Braun in 1978.

The world of science and technology is not static. The dynamics of the academic world of science and technology keeps on changing the landscape characterized by the continuous emergence and development of new research directions, funding initiatives, scientific publications, and communication and collaboration networks.[3] Scientific and research publications provide a relevant point of entry to study the nature, trajectory, and structure of scientific fields.[4] Hence scientometrics can be defined as a quantitative and qualitative measuring technique for evaluation and interpretation of science and its different activities such as productivity, progress, organization and management.[5]

BACKGROUND

Scientometrics often borrows and uses the bibliometric techniques. Scientometric / Bibliometric studies are being conducted to measure the progress and development of research in any country, institution, or subject or individual at a given period of time. Such studies on dentistry and its specialties such as Endodontics, Prosthodontics, Orthodontics, Periodontics and Implantology have been conducted. The bibliographic source for these studies too may vary. However these studies enable the researchers to evaluate and visualize the dynamics of dentistry. Some of these studies are as follows.

A paper investigated the possibility of SCImago Journal Rank (SJR) indicator as an alternative to the Journal Impact Factor (JIF) in the field of dentistry using the SJR and JIF scores and ranking order of 88 dental journals.[6] A study analyzing the characteristics of the top-100 most cited articles published in international dental journals with at least one coauthor affiliated to Brazil indexed in Scopus database between 1996 and 2017 was carried out in the 178 journals belonging to the category "Dentistry" identified in SCImago Journals and Country Rank. From the top-100 most cited articles, the most frequent subjects were Dental Materials, Endodontics, and Periodontology.[7]

A study on the growth of publications of the researchers in the field of dentistry affiliated to the Kingdom of Saudi Arabia (KSA) was compared with the dental literature produced by 22 Arab countries during two decades from 1998 to 2017based upon the data retrieved from Scopus database.[8] Spanish scientific output in Dentistry through the analysis of Web of Science database in a 20-year period by means of a bibliometric indicators' study of documents revealed quantitative and qualitative aspects of the increased productivity.[9] A total of 21 Spanish universities offering a bachelor's degree in dentistry were bibliometrically examined. The search for papers published by authors associated with these institutions was carried out using the selection of journals listed in the Journal Citation Reports (JCR) and the Web of Knowledge database for the period 1986-2017. On the basis of these data, the *h*-, *g*- and *hg*-indices, the most productive authors, international collaborations, and the most relevant journals were determined.[10]

Statistical methods play an important role in medical and dental research. A study aimed to compare statistical methods and reporting between dental articles and reports published in highly visible medical journals found the median number of authors in articles in the dental versus those in the Lancet and New England Journal of Medicine articles was 5 versus 12.[11] The bibliometric assessment of research performance on dental science literature by researchers affiliated to King Saud bin Abdulaziz University for Health Sciences (KSAU-HS), its teaching hospitals and Research Centre, to determine the statistical scenario and highlight the emerging trends in dental research was done from the data collected from different online sources; Web of Science, PubMed, Google Scholar, ResearchGate and the archival record of King Abdullah International Research Centre and a rising tendency in publication and collaborative research was observed in articles published during 2015-2017. Original research article (72.22%) being favorite design and Public Health Dentistry (30.55%) found to be the most preferred area of research.[12] A bibliometric study aimed to determine the number and quality of scientific publications in dentistry from the Baltic countries of Lithuania, Latvia, and Estonia between 1996 and 2018 using the Web of Science and Scopus databases identifies scientific publications in dentistry between 1996 and 2018 by authors from centers in Lithuania, Latvia, and Estonia.[13]

The research activities of dental sciences in India during 1997-2016 as reflected in Web of Science database, based on the total publications and their relative growth rate and doubling time, impact of top 20 journals, top 20 research organizations, etc. have been examined.[14] The study examines India's performance based on its publication output in dental sciences during 1999–2008, based on several parameters, uses 10 years (1999–2008) publications data in dental sciences of India and other countries drawn from Scopus international multidisciplinary bibliographical database.[15] A study analyzing the research activities of India in Dentistry, Oral Surgery and Medicine Research during 2007–2016, based on the total publication output, its growth rate, quality of papers published and rank of India in the global context provides the patterns of international collaborative research output and the major partner countries of India.[16] There is a paucity of information about the dental specialties related articles published in the Medical Journal Armed Forces India (MJAFI). Hence a bibliometric study was performed using web-based search aimed to audit the dental specialties related articles published in MJAFI from 2000 to 2014 over a 15-year period. The articles published were analyzed for type of article and topic of individual dental specialties.[17]

Some other specialties of dentistry explored scientometrically are Endodontics in Brazil using the citation data of Scopus.[18] Implant therapy based on the data retrieved from SCI,[19] most cited articles in Orthodontics as observed from WoS,[20] research collaboration in Orthodontics,[21] highly cited Orthodontic articles,[22] most cited Prosthodontic articles.[23] Implantology in Spain.[24] Forensic Odontology as observed from Google Scholar[25] and most cited Prosthodontic articles as seen in Google Scholar.[26]

The study of the evolution of research activity during the last thirty years on regenerative periodontal surgery revealed that small number of authors is highly productive

with more than 10 publications and the main journals on the field of regenerative periodontal surgery are Journal of Periodontology and Journal of Clinical Periodontology.[27] A bibliometric analysis of Iranian periodontal literature published from 1995 to 2015 in PubMed found periodontal research production has made significant progress in Iran. It seems that the Iranian Periodontists should emphasize more on the design and quality of works in addition to the quantity of articles.[28] To identify the most cited articles in Periodontology published from January 1990 to March 2005 and to analyze the differences between citation Classics and less cited articles a search was carried out in four international periodontal journals: Journal of Periodontology, Journal of Clinical Periodontology, International Journal of Periodontics and Restorative Dentistry and Journal of Periodontal Research. Fifty-five Classics and 55 Controls were identified. Classic articles were longer, used more images, had more authors, and contained more self-references than Controls. Moreover, Classics had on the average a bigger sample size, often dealt with etiopathogenesis and prognosis, but were rarely controlled or randomized studies. Classic articles play an instructive role, but are often non-Controlled studies.[29]

The study aimed at assessing the trends of Indian Periodontist's publications in PubMed database till 1st March, 2012 by taking quantitative bibliometric approach shows the number of articles published by Indian Periodontists is 764 across 107 journals, starting from 1960. The number of original articles published were 510 (66.75 %) as opposed to 127 (16.62 %) each for review articles and case reports/case series. The average contribution of an Indian Periodontist to PubMed database is 0.53 articles.[30] The analysis of citations received by publications of Indian Periodontists available with PubMed database which were published till 1st March, 2012 revealed articles without citations outnumbered articles with citations, the articles published by Indian Periodontists in international journals were moderately acknowledged by non-Indian authors. Developing nations are also progressing in right directions and are catching up with developed nations, albeit to smaller scales. There is a need to publish more and more cutting-edge research manuscripts in national and international reputed journals.[31]

MATERIALS AND METHODS

The data for this study was the publication records of Periodontists both at global and national level as reflected in the Web of Science (WoS) bibliographic database. WoS is a citation indexing and abstracting service started by Eugene Garfield. It was originally published by the Institute for Scientific Information (ISI), and then by Thomson Reuters. At present it is maintained by Clarivate Analytics and is available online on subscription basis.

The data was retrieved from the WoS platform using the Boolean search string (TS=periodont* OR gingiv*) AND (Year=1989 to 2018). The total number of bibliographic records retrieved was 69952. The data was again filtered as three decades, ie., 1989 to 1998; 1999 to 2008; and 2009 to 2018. Similarly the data pertaining to India as a whole set and then as three decades was filtered and retrieved. The retrieved data were further analyzed and visualized using Microsoft Excel™ tools and VOSviewer. VOSviewer is free software for visualization of similarities (VOS) in the scientific landscape using bibliographic data. It was developed by Nees Jan van Eck and Ludo Waltman and supported by the Centre for Science and Technology Studies of Leiden University. The software can be downloaded from www.vosviewer.com.

RESULTS AND DISCUSSION

Country-wise Contributions

The contributions made by the top 20 countries and their world-share are enumerated and presented in Table 1.

The USA is the top contributor of global Periodontics research literature with 19933 records during the past three decades. The USA's total contribution to the Periodontics research literature during the three decades under study is 28.5%. The second highest contributor is Japan with 8083 records, followed by Brazil with 5178 records. India is in the 17th

Table 1: Top 20 Contributing Countries.

Rank	Country	Frequency	Share
1	USA	19933	28.50
2	Japan	8083	11.56
3	Brazil	5178	7.40
4	England	4563	6.52
5	Germany	4318	6.17
6	China	3984	5.70
7	Italy	3127	4.47
8	Sweden	2713	3.88
9	Turkey	2492	3.56
10	South Korea	2130	3.05
11	Canada	2126	3.04
12	Switzerland	1991	2.85
13	Australia	1845	2.64
14	Netherlands	1568	2.24
15	Spain	1518	2.17
16	France	1462	2.09
17	India	1375	1.97
18	Taiwan	1226	1.75
19	Finland	1204	1.72
20	Israel	1021	1.46
TOTAL		71857	

position with 1375 records, which is about 2% of the global share of publications. The bibliometric study conducted with PubMed database revealed that the contributions of Indian Periodontists as 1.45%.[31] Hence it can be stated that the publication trend does not vary much across the different bibliographical databases. It is also found that the contribution made by India with a huge population is very minimal when compared to other small countries such as Japan, which has contributed 11.56%; Italy, which has contributed 4.47%; Sweden, which has contributed 3.88%; Turkey, which has contributed 3.56%; South Korea, which has contributed 3.05%; and Canada, which has contributed 3.04% and all these countries along with countries Taiwan, Finland and Israel have been ranked in the top twenty category.

Growth of Literature

The year-wise growth of literature on Periodontics both at the global level and India and a percentage analysis done are presented in Table 2.

It is found that the Periodontics literature at the global level grew from 673 publications in the year 1989 to 4188 in the year 2018. However, the growth has not been even but has been haphazard. Till 1998 a steady growth could be observed but in 1999 fell sharply. Again in 2001 there is a fall in the growth and also in 2004 and 2018 negative trends could be observed. The Lowest number of publications is recorded in the year 1989 and the highest number in the year 2017.

Indian Periodontists' publication record in WoS indexed journals from 1989 to 2001 has been in single digits and

Table 2: Growth of Literature.

Year	Global records	Global %	Cumulative growth	Cumulative %	India – records	India %	Cumulative growth	India %
1989	673	0.96	673	0.96	1	0.07	1	0.07
1990	821	1.17	1494	2.14	3	0.22	4	0.29
1991	1020	1.46	2514	3.59	7	0.51	11	0.80
1992	1035	1.48	3549	5.07	6	0.44	17	1.24
1993	1117	1.60	4666	6.67	1	0.07	18	1.31
1994	1356	1.94	6022	8.61	3	0.22	21	1.53
1995	1707	2.44	7729	11.05	2	0.15	23	1.67
1996	1814	2.59	9543	13.64	6	0.44	29	2.11
1997	1829	2.61	11372	16.26	1	0.07	30	2.18
1998	2010	2.87	13382	19.13	3	0.22	33	2.40
1999	1557	2.23	14939	21.36	2	0.15	35	2.55
2000	2042	2.92	16981	24.28	5	0.36	40	2.91
2001	1816	2.60	18797	26.87	6	0.44	46	3.35
2002	2234	3.19	21031	30.06	14	1.02	60	4.36
2003	2459	3.52	23490	33.58	14	1.02	74	5.38
2004	1798	2.57	25288	36.15	16	1.16	90	6.55
2005	1965	2.81	27253	38.96	20	1.45	110	8.00
2006	2082	2.98	29335	41.94	31	2.25	141	10.25
2007	2336	3.34	31671	45.28	46	3.35	187	13.60
2008	2649	3.79	34320	49.06	45	3.27	232	16.87
2009	2885	4.12	37205	53.19	62	4.51	294	21.38
2010	2851	4.08	40056	57.26	73	5.31	367	26.69
2011	3096	4.43	43152	61.69	123	8.95	490	35.64
2012	3348	4.79	46500	66.47	126	9.16	616	44.80
2013	3544	5.07	50044	71.54	152	11.05	768	55.85
2014	3676	5.26	53720	76.80	133	9.67	901	65.53
2015	3824	5.47	57544	82.26	111	8.07	1012	73.60
2016	3999	5.72	61543	87.98	131	9.53	1143	83.13
2017	4221	6.03	65764	94.01	127	9.24	1270	92.36
2018	4188	5.99	69952	100	105	7.64	1375	100
Total	**69952**	**100.03**			**1375**	**100.01**		

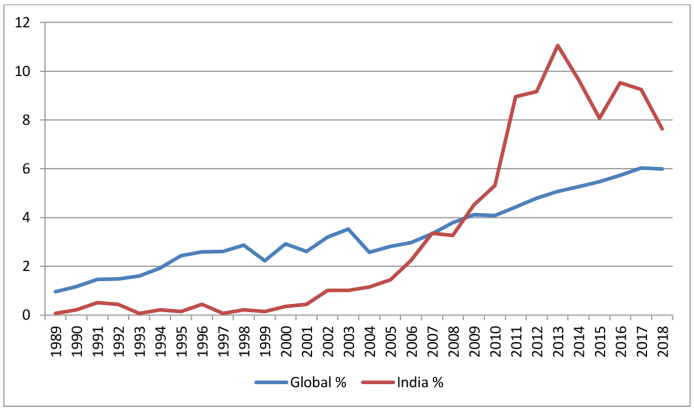

Figure 1: Year-wise growth of the literature.

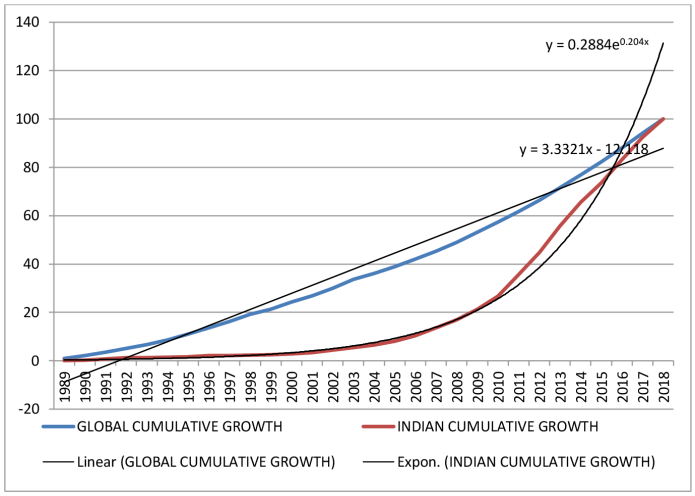

Figure 2: Growth Pattern of Periodontics Literature.

absolutely dismal. After that period, it grew steadily till it reached the zenith in 2013 and then showed negative trend for the next two years, i.e., 2014 and 2015 again showed negative trend in 2017 and 2018. The lowest numbers of publication records were observed in the years 1989, 1993 and 1997, where it was only one and highest number was observed in 2013, where it was 152.

The percentage analysis done on the year-wise growth of global and Indian Periodontics research literature is plotted as a graph and illustrated in Figure 1. The growth as well the fall and regain pattern of the global literature could be easily identified. Starting from the lowest point in 1989 and the highest point in 2017 could be observed. The growth pattern of Indian literature has been very low close to the X-axis till 2001 and it grew steadily and sharply with occasional fall to reach the peak in 2013. It is also found that percentage-wise the growth rate of Indian literature greater than that of global literature after 2009.

The cumulative growth of Periodontics literature during the period of study has been analyzed and plotted as a graph in Figure 2.

Research literature grows exponentially and doubles every 10 years.[32] Some studies suggest doubling of scientific research literature happens in lesser period too.[33] Similarly there are studies which show the growth rate to be linear rather than exponential.[34] It is observed from Figure 2 that the growth of global Periodontics literature is linear while the Indian Periodontics literature, though small in numbers when compared to the global literature output, exhibits exponential growth pattern.

Journal-wise Contribution

The source journals in which the Periodontists made their scientific publication contributions are observed and the top twenty source journals are ranked and tabulated in Table 3. Similarly, the ranked list of top contributing source journals of Indian Periodontists is presented in the same table.

The data presented in the table reveals that at the global level 'Journal of Dental Research', with the JIF of 5.125 is the most preferred journals. However, from the available data no Indian article related to Periodontics has been published during the years 1989 to 2018 in this journal. 'Journal of Periodontology', which has an Impact Factor of 2.768, ranked second at the global level is the first choice of Indian Periodontists. 'Journal of Clinical Periodontology' which has an Impact Factor 4.164 is the third choice of Periodontists at the global level whereas at the Indian level it is ranked the fifteenth position.

The mean Impact Factor of the top twenty source journals at the global level is 2.8473. The ranked list of source journals at the Indian level consists of two journals at rank 2; two journals at rank 5; and six journals at rank 15. Hence there are 21 journals in the top-ranking journals and the mean IF of these journals is 2.0215. The IF of the top twenty source journals both at the global and Indian levels are plotted as a graph and presented in Figure 3 for comparative visualization.

The figure reveals that at the global level the graph at rank one starts with the IF of 5.125 drops to 2.768, then recovers to 4.164 and reaches the zenith at rank 11 with the IF value 7.861 and finally ends at 2.787. The Indian source journal IF starts with a value 2.768, drops down to 1.392 and then to 0.908 and has many ups and downs and reaches the zenith at rank 20 with value of 4.164. This could be due to either the Indian Periodontists are not bothered about the JIF or they are finding it difficult to publish in journals with high IF.

Prolific Author

The Periodontists with the highest publication records and their contributions were analyzed and presented in Table 4. At the global level, 21 authors share ranks 1 to 20 and among the Indian authors, 23 authors share ranks 1 to 18.

Table 3: Top Contributing Journals.

Source Journal	JIF	Global -Frequency	Global - Rank	India - Frequency	India - Rank
Periodontology 2000	7.861	710	11	-	
Journal of Dental Research	5.125	6489	1	5	
Clinical Oral Implants Research	4.305	668	14	3	
Journal of Clinical Periodontology	4.164	3879	3	12	15
Oral Oncology	3.73	137		20	9
Gerodontology	3.353	132		12	15
Infection and Immunity	3.256	841	8	-	
International Endodontic Journal	3.015	628	15	12	15
Oral Microbiology and Immunology	2.925	832	9	-	
Journal of Endodontics	2.833	1371	5	27	4
Journal of Prosthetic Dentistry	2.787	470	20	-	
Plos One	2.776	742	10	10	
Journal of Periodontology	2.768	5587	2	142	1
Disease Markers	2.761	-		12	15
Oral Diseases	2.625	554	18	11	
Journal of Periodontal Research	2.613	2268	4	23	7
Journal of the American Dental Association	2.572	674	13	-	
Clinical Oral Investigations	2.453	678	12	5	
American Journal of Orthodontics and Dentofacial Orthopedics	1.98	593	16	-	
Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology	1.690	465		12	15
Archives of Oral Biology	1.663	1301	6	15	13
International Dental Journal	1.628	295		17	12
Journal of Periodontal and Implant Science	1.472	190		18	11
British Dental Journal	1.438	517	19	5	
Quintessence International	1.392	564	17	41	2
Journal of Cancer Research and Therapeutics	1.392	-		13	14
Medicina Oral Patologia Oral Y Cirugia Bucal	1.284	241		12	15
Australian Dental Journal	1.282	334		19	10
International Journal of Dental Hygiene	1.233	244		22	8
International Journal of Periodontics Restorative Dentistry	1.228	927	7	26	5
Journal of Oral Science	1.104	125		12	15
Journal of Clinical Pediatric Dentistry	0.94	93		25	5
Oral Health Preventive Dentistry	0.908	222		41	2

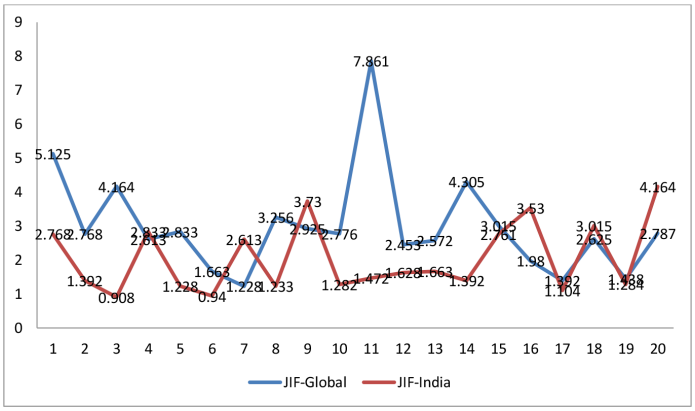

Figure 3: Journal Impact Factors of Top Contributing Journals.

At the global level, R S Offenbacher with 315 publications tops the list, followed by N P Lang and R J Genco with 287 and 284 publications respectively. Among the Indian authors, A R Pradeep is the top contributor with 101 records while S Tewari with 32 records is the distant second ranked author. No Indian author finds a place in the top 20 ranked authors at the global level.

Institution-wise Contributions

The institution-wise contributions were analyzed and ranked at the global level and also within India. The ranked lists of top twenty institutions are presented in Table 5.

Table 4: Globally top-ranking authors.

Rank	Author	Records	Rank	Indian Author	Records
1	Offenbacher, R S	315	1	Pradeep, A R	101
2	Lang, N P	287	2	Tewari, S	32
3	Genco, R J	284	3	Naik, S B	31
4	Sculean, A	260	4	Sharma, A	23
5	Sorsa, T	259	5	Sharma, R K	21
6	Potemba, J	255	5	Singh, A	21
7	Ishikawa, I	212	7	Kumari, M	19
8	Wang, H L	209	7	Rao, N S	19
9	Grenier, D	208	9	D'Cruz, A K	18
10	Izumi, Y	207	9	Kumar, S	18
11	Ebersole, J L	205	9	Narula, S C	18
12	Seymour, G J	200	12	Gupta, A	17
13	Bartold, P M	191	13	Bhat, K M	16
13	Slots, J	191	13	Kumar, A	16
15	Kocher, T	189	15	Chaturvedi, P	15
15	Quirynen, M	189	15	Rao, S R	15
15	Sanz, M	189	17	Bajaj, P	14
18	Yoshie, H	185	18	Agarwal, E	13
19	Lamont, R J	184	18	Anil, S	13
20	Abiko, Y	182	18	Bhat, G S	13
20	Van Dyke, T E	182	18	Chandra, R V	13
			18	Sharma, S	13
			18	Shetty, S	13
	Total	4583		Total	492

University of Washington is the numero uno institution in terms of the number of publications at the global level. It is followed by the State University of New York and the University of London. The top ranking twenty institutions together have contributed 23281 publications.

At the national level, Manipal University is the top ranked Indian institution. The Government Dental College Research Institute Bangalore and the Government Dental College Punjab are the second and third ranked institutions. The top ranking twenty Indian institutions together have contributed a small amount of just 706 publications.

India's International Collaboration

The international collaborations of the Indian Periodontists were analyzed and tabulated in Table 6.

It is inferred from the table that the USA is the top most collaborating country with India in the field of Periodontics. India and the USA together have produced 74 bibliographic records. Saudi Arabia with 33 records is the distant second. England with 29 records is the third ranked collaborating country. The collaboration of India and other countries is represented visually in Figure 4.

Table 5: Top-ranking Institutions.

Rank	Institution	Records	Rank	Institution	Records
1	University of Washington	2141	1	Manipal University	88
2	State University of New York	2123	2	Government Dental College Research Institute Bangalore	80
3	University of London	2054	3	Government Dental College Punjab	50
4	Harvard University	1584	4	People's University Bhopal	48
5	Universidade de Sao Paulo	1405	5	CSIR	47
6	University of California	1223	6	Tata Memorial Hospital	42
7	University of Texas	1198	7	All India Institute of Medical Sciences New Delhi	41
8	University College London	1057	8	Saveetha Institute of Medical Technical Sciences	35
9	University of Michigan	1028	9	Dr DY Patil Vidyapeeth Pune	32
10	VA Boston Healthcare System	999	9	Sri Ramachandra University	32
11	University of Pennsylvania	903	11	IIT Kanpur	31
12	University of North Carolina	896	12	KLE Academy of Higher Education Research	27
13	Universidade Estadual Paulista	888	13	King George's Medical University Lucknow	24
14	University of Bern	886	13	Maulana Azad Institute of Dental Sciences	24
15	Karolinska Institutet	867	15	NITTE	20
16	Academic Center for Dentistry Amsterdam	830	15	Regional Cancer Centre	20
17	University of Gothenburg	820	17	Banaras Hindu University	18
18	Forsyth Institute	801	18	Department of Biotechnology	17
19	University of Helsinki	793	19	Amrita Viswa Vidyapeetham University	15
20	Osaka University	785	19	CLRI	15
Total		23281	Total		706

Table 6: **Top Collaborating Countries.**

Rank	Country	Records
1	USA	74
2	Saudi Arabia	33
3	England	29
4	Malaysia	26
5	China	19
6	Japan	13
7	Australia	12
8	Germany	11
9	Italy	9
10	Canada	7
Total		233

Table 7: **Top Collaborating Institutions.**

Rank	Institution	Records
1	King Saud University	17
2	International Medical University Malaysia	10
2	University of London	10
4	University of Hong Kong	9
5	Harvard University	7
5	State University of New York	6
5	VA Boston Healthcare System	6
5	Universiti Putra Malaysia	6
9	Faculty of Pharmacy, Ankara	5
9	Kings College London	5
	Total	81

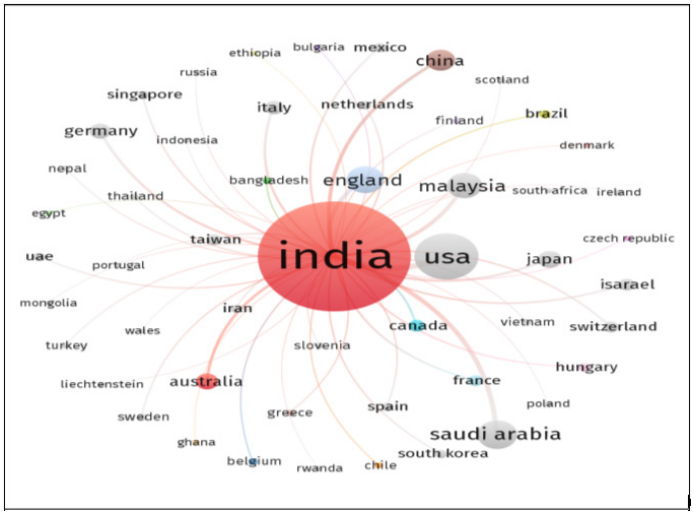

Figure 4: India International Collaboration.

Table 8: **Top Funding Agencies– Global.**

Rank	Agency	Records	% of 69952
1	National Institutes of Health, USA	4124	5.90
2	National Natural Science Foundation of China	1127	1.61
3	Japan Society for the Promotion of Science	535	0.76
4	Ministry of Education Culture Sports Science and Technology of Japan	296	0.42
5	National Institute of Dental and Craniofacial Research	237	0.34
6	FAPESP, Brazil	192	0.27
7	NIDCR, USA	185	0.26
8	CNPQ, Brazil	184	0.26
9	Swedish Research Council	135	0.19
10	Wellcome Trust	129	0.18
	Total	7144	10.19

The institutions collaborating with India were studied. The top ranking ten such institutions are presented in Table 7.

King Saud University during the period of study has contributed 17 papers in collaboration with India and is ranked first. The second highest collaborative contributions had come from the International Medical University Malaysia and the University of London each contributing 10 papers each.

Papers with high levels of collaboration lead to high citation impact and also papers with international collaboration receive more citations than papers with national level collaboration.[35] Hence it is imperative the researchers, institutions, funding agencies and authorities should focus more on collaborative research in-order-to attain more success.

Top Funding Agencies

The bibliographic data pertaining to Periodontics was analyzed to find the top funding agencies of Periodontics research projects. The results obtained from this analysis are presented in Tables 8, 9 and 10.

The National Institutes of Health, USA has sponsored 4124 publications, which is 5.9 percent of the total world share of Periodontics research publications. The second highest sponsor of Periodontics research at the global level is National Natural Science Foundation of China, followed by the Japan Society for the Promotion of Science. The ten top ranking funding agencies together have contributed about 10 percent of the total global contributions.

The Council of Scientific and Industrial Research (CSIR) ranks first among the top sponsors of Indian Periodontics research followed by the Department of Biotechnology (DBT) and the Department of Science and Technology (DST) in that order. It is found that more papers at the global level are funded than the Indian papers. It is presumed that one of the reasons for lesser literary output from Indian Periodontists may be due to lack of funding.

Table 9: Top Funding Agencies– Indian.

Rank	Agency	Records	% of 1375
1	Council of Scientific and Industrial Research	35	2.55
2	Department of Biotechnology	28	2.04
3	Department of Science and Technology	15	1.09
3	University Grants Commission	15	1.09
5	Colgate Palmolive	14	1.02
6	Indian Council of Medical Research	13	0.95
7	ACTREC	6	0.44
Total		**126**	**9.18**

Table 10: Foreign Agencies Funding Indian Periodontics Research.

Sl. No.	Agency	Records
1	National Institutes for Health	4
2	Alexander Von Humboldt Foundation	2
3	Slovenian Research Agency	2
4	University of Hong Kong	2
5	European Union	2
6	Global Alliance	2
7	Canadian Institutes of Health Research	2
8	Chinese Scholarship Council	2
9	National Institute for Health Research UK	2
10	Ministry of Science and Sport of the Republic of Slovenia	2
Total		**22**

The funding pattern of Indian Periodontics research papers were studied to find their collaboration pattern. Table 10 reveals that the National Institutes for Health, USA is the top ranked foreign funding agencies which sponsored the most number of the research project in India. Nine other funding agencies had funded two projects each. Other funding agencies with one record each are British Society of Periodontology; Bulgarian Ministry of Education and Science; Canadian Dental Hygienists Association; Academy of Finland; Cathay General Hospital; Chilean Ministry of Education; American Society of Microbiology; Baxter Bioscience Grants California, USA; Chinese EBM Cochrane Center; British Orthodontic Society; British Society of Paediatric Dentistry; and Consortium of UK Universities.

CONCLUSION

This study found that the literature growth pattern at the global level to be linear. Journal of Dental Research is the most favored journal; Offenbacher is top contributing author and University of Washington is the top contributing institution. The study also emphasizes the importance of research collaboration among the Periodontists.

CONFLICT OF INTEREST

The authors declare that no conflict of interest.

ABBREVIATIONS

ACTREC: Advanced Centre for Treatment Research and Education in Cancer, India; **CLRI:** Central Leather Research Institute, India; **CNPQ:** National Council for Scientific and Technological Development, Brazil; **CSIR:** Council of Scientific and Industrial research, India; **FAPESP:** Sao Paulo Research Foundation, Brazil; **IIT:** Indian Institute of Technology, India; **NIDCR:** National Institute of Dental and Craniofacial Research, USA;

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