

## RESEARCH CONTRIBUTION OF INDIAN DENTAL SCIENTISTS DURING 2010-2019: A SCIENTOMETRIC ANALYSIS

*Samir Kumar Jalal*

**Dr. Samir Kumar Jalal**

Deputy Librarian,

Central Library, IIT

Kharagpur

Email:

jalalsk1971@gmail.com

The paper focuses on the growth and development of dental science literature in India through publication analysis during 2010-2019 in dental science or dentistry in India. The total number of 12,830 research articles downloaded from Scopus along with 57,793 citations with h-index 55. The aim of the study is to find out core authors and productive journals in the field. The visualization trend, keyword growth analysis and authorship study made using SciMAT and bibliometrix R. The findings of the study revealed that Indian dental scientist published nearly 64% of their articles in top twenty reputed journals in dental science. A few of them are Indian Journal of Dental Research with (9.66%), Journal of Indian Society of Periodontology (6.96%) and Journal of Maxillofacial and Oral Surgery (6.33%). Department of Periodontics, College of Dental Sciences; Karnataka published the highest number of articles (n=24). The relative growth (RG) rate, doubling time (Dt) and citation pattern were calculated to show the growth rate. The study found that Bradford's law on journal productivity does not fit into the dental science research in India.

**Keywords:** Research Contribution; Dental Sciences; Dentist; Bradford's Law, SciMAT; Bibliometrix R, Relative Growth, Doubling Time, Citation Distribution.

### INTRODUCTION

The purpose of scientific communication is to communicate their research results not only to their peers but to the entire scientific community also. Research articles are one of the key components in measuring research output in a scholarly world. It carries the information to the future researchers with an aim to distribute and re-use for the progress of the society. Research contribution is adding knowledge to the existing facts or domain of knowledge. Scientometrician measures research contribution of a subject field through publication counts, citations, keyword analysis, co-citation analysis and other indicators. Subramanyam (Subramanyam, 1983) argued that a holistic approach may be emphasized when evaluating collaboration and argued the nature of research collaboration is difficult to measure due to complex nature of human interaction.

Bibliometrics are the set of methods applied for analyzing academic literature quantitatively. Quality research publications in dental science help to assess the progress of Indian dental science. Major bibliometric indicators e.g. number of publications, h-index, citations counts, impact factor of journals are some of the indicators to measure the research productivity. Research collaboration in the field may help to know top dentists and institutes and their collaboration with foreign country for the development of dental science. The main objective of the study is to know the publications growth pattern and find out the major institutions and authors contributing for the development of dental science research in India.

### **INDIAN DENTAL SCIENCE: AN OVERVIEW**

Dentistry or dental science is one of the special branches of medical science dealing with prevention and curation of oral diseases including misalignment of teeth and anomalies of oral cavities (Ring, n.d.). Indian dental scientists are working hard in their chambers and hospitals for checking up patients, diagnose, caring oral cavities and related diseases. Dentists also associated with teaching BDS and MDS, side by side, they conduct research and communicate the results in the journals. Major branches of dental science are Endodontics, Orthodontics, Periodontics, Prosthodontics, Pedodontics, Oral and Maxillo-facial Surgery, Cosmetic Dentistry, Oral Pathology, Forensic Dentistry, Oral Medicine and many more. The world's first dental journal is the *American Journal of Dental Science* started its publications in 1839 (Ring, 1986). Journal is the

main source of primary information to update knowledge of the dentists. The Dental Council of India (DCI) under *The Dentists Act, 1948* regulates the dental education and practice in India. NEET (National Eligibility cum Entrance Test) is the only entrance examination for admission to as many as MBBS (82,926), MDS (6228) and BDS (26,949) seats across India. It is also worth to mention here that there are MDS and BDS colleges are 259 and 313 respectively (DCI, n.d.). It is worth to point out here that as the DCI, there are 34321 faculty members working in the field of dental science.

### **LITERATURE REVIEW**

Kaur and Gupta (2010) examines India's performance based on its publication output from Scopus on dental sciences during 1999–2008 and the analysis found top fifteen most productive authors, patterns of communication in national and international journals. Pulgar et al. (2013) analysed the scientific productivity of dental sciences at the world level over last 30 years with all citable dental science related documents from Web of Science database in the period 1986–1988, 1996–1998 and 2006–2008. Another study (Primo, 2014) showed that 635 articles published in Dental Press Journal of Orthodontics and American Journal of Orthodontics and Dentofacial Orthopedics over a 10-year period; wherein articles were described in terms of knowledge domain, study design, and country of origin. The findings showed that journals tend to publish studies produced in their own country of origin, and that are marked discrepancies in the number of papers published by different Brazilian states. The evolution of dental journals available

in WoS database during 2003-2012 for the subject category grouped in the JCR as “Dentistry, Oral Surgery & Medicine” and it revealed significant growth of dental literature in absolute terms, as well as upward trends for most of the citation-based bibliometric indices during the period (Jayaratne & Zwahlen, 2015).

Jalal (2019) discussed research collaboration between India and Bangladesh during 1991-2017 using WoS based on 1156 papers jointly published by both the countries; where collaboration networks on co-authorship, co-occurrences and keyword analysis were made using BibliometrixR package. Rooban, Kumar and Ramachandran (Rooban T, Kumar PDM, 2010) found in their studies that Indian contribution is of 1.21% to the global dental research and only 2% to in Asia. One of the study revealed that “about 72.6% of dental professionals were involved in publishing of their research work and the number of publications increased steadily with an increase in their academic experience” (Verma et al., 2015).

The need of the present study is to explore the present situation of literature growth of dental science in India during last 10 years. Although some studies were conducted in Brazil, Spain, USA, UK, a very few scientometric studies were conducted in India on dental sciences. Among them, Ramakrishna, et al. (Ramakrishna, Talawar, & Urs, 2018) made a study on the growth of dental sciences in India during 1997-2016 using 3098 records from WoS and found that Journal of clinical paediatric dentistry is the top journal with 191 publications and 26.12% publications are having international collaboration. Therefore,

an initiative has been taken up to highlight the growth and development dental science under study.

## OBJECTIVES OF THE STUDY

The present study has been undertaken:

1. To find out the annual growth, relative growth rate and doubling time of publications in the dental science research in India during 2010-2019;
2. To identify the citation distribution pattern of publications in dental science;
3. To identify the most productive authors, journals and countries in dental science;
4. To visualize author preferred keywords and keyword assigned by database using R;
5. To verify whether Bradford’s Law is fitted in dental science research in India.

## MATERIALS AND METHODS

A total of 12830 records are retrieved from Scopus database in 25 January 2020 in the subject area of Dentistry during 2010-2019. The query is ‘*India as affiliating country and under the subject group ‘Dental science and dentistry’*’ and filtered with the year limit i.e. 2010-2019. Those papers having at least one Indian dental scientist involved as co-author with an affiliation country as India consider for analysis. The document types i.e. article, review, book chapter, conference paper and book have been considered for the study but letter, note, editorial, short survey, erratum, article-in-press are excluded as they don’t have true research impact. The predominant open source software used in Scientometric analysis are Bibliometrix R, PoP, Bibexcel, SciMat,

Vosviewer, Histcite, Citespace-II, NodeXL, Pajek, Uninet, Gephi etc. In the study, two bibliometric tools, SciMAT and Bibliometrix R are applied for data analysis.

### FEATURES OF SCIMAT AND BIBLIOMETRIX R

SciMAT(Cobo, L pez-Herrera, Herrera-Viedma, & Herrera, 2012) is java based application and compatible in Linux and, Windows operating systems. It has inbuilt knowledge base with sixteen entities like author, title, publishers, keywords, journal name etc. SciMAT uses SQLite database to store data in the knowledge base. It generates a knowledge base from a set of scientific documents, where the relations of the different entities related with each document (authors, keywords, journal, references, etc.) are stored. Knowledge Base Manager manages the knowledge base and it is responsible for importing the data from different bibliographical sources, cleaning and fixing the possible errors in the entities. The download data from any bibliographic database e.g. Scopus WoS, Medline

etc preferable in \*.ris format can be uploaded using ‘add files option’ of the software to the knowledge base.

Bibliometrix R (Aria & Cuccurullo, 2017) is a package for bibliometric analysis written in R language and available in open source platform. In other words, it is a comprehensive science-mapping tool. Some of the bibliometric analysis like: to import data from Scopus, Web of Science, PubMed etc.; helps to build network diagram on co-authors, co-citation, bibliographic coupling, co-occurrences etc.; calculate Lotka’s coefficients using lotka(); calculate h-index, g-index and other indices for the authors and this package also helps to undertake co-word analysis.

### ANALYSIS AND RESULTS

After analyzing the data on dental science, key bibliometric indicators are mentions in the results section. A few of them are total citation (57,793), citation per paper (4.50), author per paper (4.15), h-index (55) and g-index (73). Out of 12,830 documents, there were 11550 numbers of articles, 77 conference papers, 16 books, 204

**Table 1: Year-wise distribution of publications on dental sciences in India**

| Year         | No. of Articles | Growth rate (AGR) | Cumulative Publications | W <sub>1</sub> | W <sub>2</sub> | RGR  | Mean RGR | Dt   | Mean Dt |
|--------------|-----------------|-------------------|-------------------------|----------------|----------------|------|----------|------|---------|
| 2010         | 696             | -                 | 696                     | -              | 6.55           | -    | 0.42     |      | 1.33    |
| 2011         | 1136            | 63.22             | 1832                    | 6.55           | 7.51           | 0.97 |          | 0.72 |         |
| 2012         | 1329            | 16.99             | 3161                    | 7.51           | 8.06           | 0.55 |          | 1.27 |         |
| 2013         | 1298            | -2.33             | 4459                    | 8.06           | 8.40           | 0.34 |          | 2.01 |         |
| 2014         | 1322            | 1.85              | 5781                    | 8.40           | 8.66           | 0.26 |          | 2.67 |         |
| 2015         | 1501            | 13.54             | 7282                    | 8.66           | 8.89           | 0.23 | 0.16     | 3.00 | 4.64    |
| 2016         | 1470            | -2.07             | 8752                    | 8.89           | 9.08           | 0.18 |          | 3.77 |         |
| 2017         | 1267            | -13.81            | 10019                   | 9.08           | 9.21           | 0.14 |          | 5.13 |         |
| 2018         | 1436            | 13.34             | 11455                   | 9.21           | 9.35           | 0.13 |          | 5.17 |         |
| 2019         | 1375            | -4.25             | 12830                   | 9.35           | 9.46           | 0.11 |          | 6.11 |         |
| <b>Total</b> | <b>12830</b>    | <b>-</b>          | <b>-</b>                |                |                |      |          |      |         |

books chapters and 983 review papers.

### Calculation of Annual Growth, Relative Growth and Doubling Time of Publication

The Table 1 shows the distribution of yearly research output in the field of dental science indexed in Scopus database in India during 2010-2019. Out of total 12830 publications, the highest publication (1501) was in 2015. Some of the indicators: a) Frequency of article productivity per year, b) Compound Annual Growth Rate (CAGR), c) Relative Growth Rate (RGR) and d) Doubling Time (Dt) are used to calculate publication growth rate.

The Relative Growth Rate (RGR) is defined as the increase in the number of articles per year (M. Mahapatra, 1985). The mean relative growth is calculated based on 5-year window and the value of mean RG (2010- 2014) was 0.42 and its value decreased to 0.16 in 2015-2019. The formula for calculating the RGR is given below and RGR value for the year 2011 is calculated as:

$$RGR_{2011} = \frac{W_2 - W_1}{T_2 - T_1} = \frac{7.51 - 6.55}{2 - 1} = \frac{0.97}{1} = 0.97,$$

where,  $W_2$  = Natural Logarithm of cumulative publication (1832) in 2011 = 7.51.  $W_1$  = Natural Logarithm of cumulative publication (696) in 2010 = 6.55. While calculating RGR natural logarithm is followed for example,  $\ln(1000) = 6.91$  whereas the common logarithm i.e  $\log(1000) = 3$ . So, is the difference between natural logarithm and common logarithm. The major difference is that while the base of a common logarithm is 10, the base of a natural logarithm is the special number 'e', whose value is 2.7182.

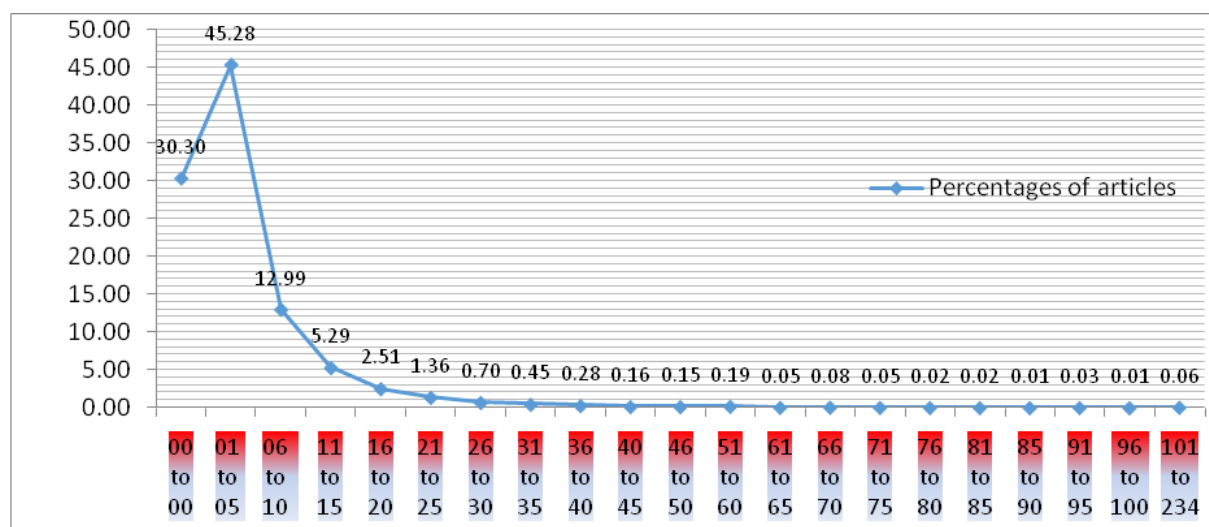
Doubling time is the time required for the publications/ citations to become double of the existing amount. Several studies show an inverse relationship between RGR and Dt. Mahapatra (G. Mahapatra, 1994) studied both the relative growth rate (RGR) and doubling time (Dt) for publications and citations in the field of library and information science journals during 1975 to 1985. Findings put forwarded the logistic growth curve to be best suited for the growth of publications. The formula for calculating doubling time (dt) is as follows:

$$Dt_{2011} = \frac{\ln(2)}{RGR(2011)} = \frac{0.693}{0.97} = 0.72.$$

Table 1 shows the details calculation of RGR and Dt. The study found that the mean doubling time is 1.33 for the period 2010-2014 whereas its value has increased to 4.64 during 2015 - 2019. It is clear from the study that Annual Growth Rate (AGR) is the highest (63.22%) in 2011 and lowest in 2017 (-13.81%).

### Citation distribution of publications and highly cited papers

The Figure 1 shows that the citation distribution of publication in dental science resembles like a reverse-J shaped curve as because the values of percentage of articles are more in the left side and decreasing as we move towards right. There is an inverse relationship between the number of articles and number of citations. If zero citations values excluded, the distribution shows a negative exponential distribution.



**Figure 1: Citation distribution of publications during 2010 to 2019**

The x-axis has been plotted the range of citations and y-axis shows the percentages of articles. As the number of citations in the last class has a wide range with i.e. 100 to 234 with only 8 number of papers. Figure 1 reflects that only 8 (0.06%) papers are having more than 100 citations each; 67 (0.52%) papers have citations (50-100). The study also showed that 5810 (45.28%) papers are having citations (1- 5) whereas 3888 (30.30%) papers have zero citations.

### **Most Productive Authors, Journals and Countries in Dental Science in India**

#### **Most productive authors based on Dominance Factor (DF)**

The Dominance Factor is a ratio indicating the fraction of multi-authored articles in which a scholar appears as the first author. The function *dominance* calculates the authors' dominance ranking as proposed by Kumar & Kumar (Kumar, Sudhir and Kumar, 2008). Using the function arguments i.e. *results* (object of

**Table 2: Most Productive Authors based on DF**

| Sl. No. | Author     | Dominance Factor (DF) | Multi-Author | First author | Rank by DF | Rank by Articles (Multi-author) |
|---------|------------|-----------------------|--------------|--------------|------------|---------------------------------|
| 1       | Pradeep AR | 0.5625000             | 96           | 54           | 1          | 4                               |
| 2       | Singh V    | 0.3666667             | 60           | 22           | 2          | 10                              |
| 3       | Sharma A   | 0.3541667             | 96           | 34           | 3          | 5                               |
| 4       | Singh A    | 0.3370787             | 89           | 30           | 4          | 6                               |
| 5       | Kumar S    | 0.3095238             | 168          | 52           | 5          | 1                               |
| 6       | Kumar P    | 0.295082              | 61           | 18           | 6          | 9                               |
| 7       | Singh S    | 0.2941176             | 85           | 25           | 7          | 7                               |
| 8       | Kumar A    | 0.2719298             | 114          | 31           | 8          | 2                               |
| 9       | Gupta R    | 0.2666667             | 75           | 20           | 9          | 8                               |
| 10      | Gupta A    | 0.2600000             | 100          | 26           | 10         | 3                               |

class *bibliometrix*) obtained by *biblioAnalysis*; and *k* (the number of authors to consider in the analysis), value of DF has been calculated (table 3). DF <-dominance (results, *k* =10) and DF (for Print the output).

The study identifies that although S. Kumar has published 168 multi-authored paper, the highest among all, yet A.R. Pradeep becomes the top listed author based on dominance factor.

**Table 3: Top 20 journals preferred by Indian dental scientist**

| Sl. No.      | Name of Journals                                                       | Publishers                               | Publications | Percentage   |
|--------------|------------------------------------------------------------------------|------------------------------------------|--------------|--------------|
| 1            | Indian Journal of Dental Research                                      | Indian Society of Dental Research        | 1239         | 9.66         |
| 2            | Journal of Indian Society of Periodontology                            | Indian Society of Periodontology (India) | 893          | 6.96         |
| 3            | Journal of Maxillofacial and Oral Surgery                              | Springer                                 | 850          | 6.63         |
| 4            | Journal of Contemporary Dental Practice                                | Jaypee Brothers Medical Publishers       | 707          | 5.51         |
| 5            | Journal of Conservative Dentistry                                      | Federation of Operative Dentistry        | 653          | 5.09         |
| 6            | Contemporary Clinical Dentistry                                        | Maharishi Markandeshwar University       | 621          | 4.84         |
| 7            | Journal of Indian Society of Pedodontics and Preventive Dentistry      | ISPPD                                    | 592          | 4.61         |
| 8            | Journal of Indian Prosthodontist Society                               | Medknow Publications                     | 537          | 4.19         |
| 9            | Journal of Oral Biology and Craniofacial Research                      | Elsevier                                 | 314          | 2.45         |
| 10           | Journal of Clinical and Experimental Dentistry                         | SECIB                                    | 248          | 1.93         |
| 11           | World Journal of Dentistry                                             | IAGD                                     | 220          | 1.71         |
| 12           | Journal of International Society of Preventive and Community Dentistry | ISPCD                                    | 209          | 1.63         |
| 13           | Journal of Clinical Pediatric Dentistry                                | Journal of Clinical Pediatric Dentistry  | 179          | 1.40         |
| 14           | Journal of Oral and Maxillofacial Surgery                              | Elsevier                                 | 174          | 1.36         |
| 15           | Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology     | Elsevier                                 | 167          | 1.30         |
| 16           | Journal of International Oral Health                                   | ISPCD                                    | 161          | 1.25         |
| 17           | International Journal of Clinical Dentistry                            | ISPCD                                    | 136          | 1.06         |
| 18           | European Journal of Dentistry                                          | Dental Investigations Society            | 120          | 0.94         |
| 19           | General Dentistry                                                      | Academy of General Dentistry             | 115          | 0.90         |
| 20           | Journal of Prosthodontics                                              | Wiley                                    | 111          | 0.87         |
| <b>Total</b> |                                                                        |                                          | <b>8246</b>  | <b>64.29</b> |

NB: ISPCD International Society of Preventive and Community Dentistry, IAGD = International Association of General Dentistry; SECIB = Spanish Society of Oral Surgery

### Most Productive Journals in Dental Science

Table 3 displays the list of top twenty (20) journals based on number of publications indexed in Scopus database during 2010-2019. It is found that '*Indian Journal of Dental Research*' has published 1239 (9.66%) of total publications, followed by *Journal of Indian Society of Periodontology* with 893 (6.96%).

### Pattern of Authorship Collaboration

The Table 4 explained the pattern of authorship collaboration. The study found that there are 491(3.83%) publications do not have any collaboration and remaining 12339 (96.17%) publications do have collaboration with authors ranges between two and twenty-eight.

**Table 4: Authorship Distribution in Dental Science**

| No. of Authors (y) | Publications (x) | Percentages (%) | No. of Authors (y) | Publications (x) | Percentages (%) |
|--------------------|------------------|-----------------|--------------------|------------------|-----------------|
| Single             | 491              | 3.83            | 11 authors         | 11               | 0.09            |
| 2 authors          | 1778             | 13.86           | 12 authors         | 7                | 0.05            |
| 3 authors          | 2565             | 19.99           | 13 authors         | 2                | 0.02            |
| <b>4 authors</b>   | <b>3349</b>      | <b>26.10</b>    | 14 authors         | 9                | 0.07            |
| 5 authors          | 1771             | 13.80           | 15 authors         | 7                | 0.05            |
| 6 authors          | 2298             | 17.91           | 16 authors         | 2                | 0.02            |
| 7 authors          | 352              | 2.74            | 18 authors         | 2                | 0.02            |
| 8 authors          | 130              | 1.01            | 20 authors         | 1                | 0.01            |
| 9 authors          | 36               | 0.28            | 25 authors         | 3                | 0.02            |
| 10 authors         | 14               | 0.11            | 28 authors         | 2                | 0.02            |
|                    |                  |                 | <b>Total</b>       | <b>12830</b>     | <b>100.00</b>   |

Another finding of the study is that the highest percentages of collaboration happens to be for the case of 4-authors (26.10%) followed by 3-authors 19.99%; 2-authors (13.86%) and 5-authors (13.80%).

### Geographical distribution of publications based on corresponding authors

Based on the studies of corresponding authors, table 5 has listed top level collaborating countries in dental sciences e.g. USA, UK, Malaysia etc. The value of SCP indicates single country publications and MCP denotes multiple country publications.

As 491 publications do not have any collaboration (table4), the rest of 12,339 papers

have collaboration, but such collaboration may happen: a) within India, or b) with one country and India or c) India with more than one country. Table 5 shows that Indian dental scientist has published 6862 articles with single country collaboration and 283 papers with more than one country collaboration.

### Most prolific institutions and departments

Total 12830 publications uploaded in the SciMAT software for the analysis and the results of only top 10 departments are given below in table 6.

**Table 5: Country Collaboration in Dental Science**

| Sl. No. | Country        | Articles | Freq     | SCP  | MCP |
|---------|----------------|----------|----------|------|-----|
| 1       | India          | 7145     | 0.953048 | 6862 | 283 |
| 2       | USA            | 93       | 0.012405 | 3    | 90  |
| 3       | United Kingdom | 43       | 0.005736 | 1    | 42  |
| 4       | Malaysia       | 33       | 0.004402 | 1    | 32  |
| 5       | Saudi Arabia   | 31       | 0.004135 | 2    | 29  |
| 6       | Canada         | 17       | 0.002268 | 0    | 17  |
| 7       | Australia      | 16       | 0.002134 | 0    | 16  |
| 8       | Japan          | 11       | 0.001467 | 0    | 11  |
| 9       | France         | 8        | 0.001067 | 0    | 8   |
| 10      | Hong Kong      | 8        | 0.001067 | 0    | 8   |

*SCP: Single Country Publications and MCP: Multiple Country Publications*

**Table 6: Top 10 Departments based on number of articles in Dental Science**

| Sl. No. | Department Affiliation                                                                                                      | No. of Papers | Country   |
|---------|-----------------------------------------------------------------------------------------------------------------------------|---------------|-----------|
| 1       | Dept. of Periodontics, College of Dental Sciences, Davangere, Karnataka                                                     | 24            | India     |
| 2       | Dept. of Prosthodontics, Maulana Azad Institute of Dental Sciences, New Delhi                                               | 21            | India     |
| 3       | School of Dentistry and Health Sciences, Charles Sturt University, Orange, NSW, Australia                                   | 21            | Australia |
| 4       | Dept. of Prosthodontics, Goa Dental College and Hospital, Goa                                                               | 20            | India     |
| 5       | Manipal University College of Dental Sciences, Manipal.                                                                     | 20            | India     |
| 6       | Dept. of Conservative Dentistry and Endodontics, Manipal College of Dental Sciences, Manipal University, Manipal, Karnataka | 18            | India     |
| 7       | Dept. of Orthodontics, Case Western Reserve University, Cleveland, United States                                            | 16            | USA       |
| 8       | Dept. of Oral and Maxillofacial Surgery, Navodaya Dental College and Hospital, Raichur, Karnataka                           | 14            | India     |
| 9       | Dept. of Conservative Dentistry and Endodontics, Centre for Dental Education and Research, AIIMS, New Delhi.                | 14            | India     |
| 10      | Dept. of Conservative Dentistry and Endodontics, Maulana Azad Institute of Dental Sciences, New Delhi                       | 14            | India     |

It is worth to point out here that out of top 10 departments, two are from other countries like School of Dentistry and Health Sciences, Charles Sturt University, Australia and Department of Orthodontics, Case Western Reserve University, United States because of joint/ multi-author publications. Result shows that the more concentration of departments are from Karnataka and New Delhi.

### Keywords Growth analysis

Using the R Bibliometrix package, total number of 12,830 papers were analyzed and found 16895 numbers of keyword plus (ID) and 18746 number of author's keyword (DE). Out of which top 10 keywords of both kinds along with frequencies are listed in table 7.

**Table 7: Most used keywords in dental science in India**

| Sl. No. | Author Keywords (DE)    | Articles | SN  | Keywords-Plus (ID) | Articles |
|---------|-------------------------|----------|-----|--------------------|----------|
| 1       | Periodontitis           | 266      | 1.  | Male               | 5374     |
| 2       | Chronic Periodontitis   | 208      | 2.  | Female             | 5042     |
| 3       | Dental Caries           | 203      | 3.  | Human              | 5011     |
| 4       | Oral Cancer             | 151      | 4.  | Humans             | 4825     |
| 5       | Periodontal Disease     | 142      | 5.  | Article            | 2646     |
| 6       | Chlorhexidine           | 120      | 6.  | Middle Aged        | 1996     |
| 7       | Oral Submucous Fibrosis | 117      | 7.  | Adult              | 1865     |
| 8       | India                   | 111      | 8.  | Child              | 1855     |
| 9       | Saliva                  | 111      | 9.  | India              | 1542     |
| 10      | Oral Health             | 102      | 10. | Case report        | 1371     |

The Table 7 shows that the keyword 'periodontitis' is used in 266 articles by the authors themselves followed by 'Chronic Periodontitis' in 208 articles; 'Dental Caries' in 203 articles; 'Oral Cancer' in 151 articles etc. The keyword-plus is assigned by Scopus while indexing full-text for enable searches and retrieval of information.

### Lotka's Law and the calculation of 'n', and 'C'

Lotka's law described the frequency of publications by authors in a given field. According to Lotka's Law, when "... a handful of researchers are responsible for most of the literature. ... the

contribution of the large majority of researchers is very low in terms of number of publications" (Lotka, 1926). The general form of Lotka's law is:  $Y = \frac{C}{x^n}$  .....(1), where x is the number of publications; and y is the relative frequency of authors with x publications, and n and C are constant. Lotka's law is popularly known as 'the inverse square law of scientific productivity' taking into consideration  $n=2$ . Lotka's Law states that number of authors making n contributions is about  $\frac{1}{n^2}$  of those making single publication. Applying the Linear Least Square method, the values of 'n' and 'C' can be calculated:

$$n = \frac{N \sum XY - \sum X \sum Y}{N \sum X^2 - (\sum X)^2} \dots\dots\dots(2) \text{ and}$$

$$C = \frac{1}{\sum (\frac{1}{x^n})} \dots\dots\dots(3)$$

After getting the value of C and ‘n’ we can get the actual Lotka’s law by replacing in equation (1) above.

On the other hand, the value of n and C can also be calculated using lotka() in, Bibliometrix R. The function **L\$AuthorProd** shows the observed distribution of scientific productivity in the given dataset under study. Using \$Beta function, the values of ‘n’, C’, R<sup>2</sup> and ‘p’ can be calculated: n= 2.3201; C=0.4633; R<sup>2</sup>=0.92306 and p-value is 0.0079. As we know that Kolmogorov-Smirnoff two-sample-test provides the validity of the results. Therefore, the p-value of 0.0079 means that there is not a significant difference between the observed and the theoretical Lotka distributions. Therefore, it

validates the Lotka’s law mathematically and identified the reverse-J shaped distribution curve.

### Bradford’s Law and Core Journals

Bradford (1934) proposed that most of the papers are published by a handful number of specialized journals. Bradford formulated his law as follows. *“If scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same articles as the nucleus, when the number of periodicals in the nucleus and succeeding zones will be as 1: n: n<sup>2</sup>, where ‘n’ is a multiplier.”*

In the present study, scattering of journals in dental science in India were exercised through the rank list (not shown here due to space problem) and the summary of the result is reflected in table 8.

**Table 8: Scattering of journals in dental science in India**

| Zone   | Journals   | % of Journals | Articles |
|--------|------------|---------------|----------|
| Zone-1 | 5          | 1.82          | 4342     |
| Zone-2 | 18         | 6.57          | 4224     |
| Zone-3 | 251        | 91.61         | 4264     |
| Total  | <b>274</b> | 100.00        | 12830    |

Table 8 expressed that in zone-1, 5 journals cover 4342 articles; in zone-2, 18 journals cover 4224 journals and 251 journals covers 4262 journals in zone-3. In order to verify the algebraic interpretation of the law, the 274 journals are divided into three zones. Here, the Bradford’s multiplier can be obtained by dividing journals of second zone by the first zone and similarly by dividing journals in the third zone by journals in

the second zone to get the value of n. Therefore, in the present study, the relationship of each zone is 5:18:251, which does not comply with the 1:n:n<sup>2</sup>. Therefore, Bradford law does not fit into the field of dental science research in India.

### CONCLUSION

Research contribution in dental sciences got immense breakthrough from the beginning of 21<sup>st</sup>

century. The study shows a huge concentration of research in Karnataka and Delhi regions among other states in India. An indication of less research on dental sciences appears compared to other branches of medical sciences. This may be due to less number of dental scientists working in the field or more dentists are involved in practice only rather than conducting research works. The findings show the core journals, which can save the time of the researchers for keeping abreast of the latest development of the field. One of the weaknesses of the study is the use of short duration (i.e. 10 yrs) for trend analysis and secondly, the selection of Scopus database, which does not index all the articles published in on dental sciences. However, Indian government should take some initiatives to encourage young dental surgeons and faculty members in the concerned field to take dental research as their career besides clinical practices. In addition, Indian dentists should build connection with dentists from different countries for their research collaboration and joint projects for enhancing the growth of publications. Further research may be conducted in this area using data coverage from PubMed, Scopus, Web of Science and Indian Citation Index (ICI).

## REFERENCES

1. Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11(4), 959–975.
2. Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2012). SciMAT: A new science mapping analysis software tool. *Journal of the American Society for Information Science and Technology*, 63(8), 1609–1630.
3. DCI. (n.d.). Dental Council of India. Retrieved May 9, 2020, from <http://dciindia.gov.in/>
4. Jalal, S. K. (2019). Co-authorship and co-occurrences analysis using BibliometrixR package/ : a case study of India and Bangladesh. *Annals of Library and Information Studies*, 66(June), 57–64.
5. Jayaratne, Y. S. . &, & Zwahlen, R. A. (2015). The Evolution of Dental Journals from 2003 to 2012: A Bibliometric Analysis. *PLOS ONE*, 10(3), e0119503.
6. Kaur, H., & Gupta, B. M. (2010). Mapping of dental science research in India: A scientometric analysis of India's research output, 1999-2008. *Scientometrics*, 85(1), 361–376. <https://doi.org/10.1007/s11192-010-0213-9>
7. Kumar, Sudhir and Kumar, S. (2008). Collaboration in Research Productivity in Oil Seed Research Institutes of India. In *Proceedings of WIS 2008, Berlin edited by H. Kretschmer & F. Havemann (Eds): .* Retrieved from <http://www.collnet.de/Berlin-2008/KumarWIS2008cir.pdf>
8. Lotka, A. J. (1926). The frequency distribution of scientific productivity. *Journal of Washington Academy of Science*, 16(12), 317–323.
9. Mahapatra, G. (1994). Correlation between growth of publications and citations: a study based on growth curves. *Annals of Library Science and Documentation*, 41(1), 8–12.

10. Mahapatra, M. (1985). On the Validity of the theory of Exponential Growth of Scientific Literature. In *Proceeding of the 15th IASLIC Conference* (pp. 61–70). Bangalore.
11. Primo, N.A, et al. (2014). Bibliometric analysis of scientific articles published in Brazilian and international orthodontic journals over a 10-year period. *Dental Press Journal of Orthodontics*, 19(2), 56–65. <https://doi.org/10.1590/2176-9451.19.2.056-065.oar>
12. Pulgar, R., Jiménez-Fernández, I., Jiménez-Contreras, E., Torres-Salinas, D., & Lucena-Martín, C. (2013). Trends in World Dental Research: An overview of the last three decades using the Web of Science. *Clinical Oral Investigations*, 17(7), 1773–1783. <https://doi.org/10.1007/s00784-012-0862-6>
13. Ramakrishna, Talawar, V. G., & Urs, R. R. (2018). Growth of Dental Sciences literature in India: A Scientometric Analysis. *Library Progress (International)*, 38(1), 41. <https://doi.org/10.5958/2320-317x.2018.00004.1>
14. Ring, E. (n.d.). Dentistry. Retrieved March 9, 2019, from <https://www.britannica.com/science/dentistry>
15. Ring, M. E. (1986). The world's first dental journal. *The Compendium of Continuing Education in Dentistry*, 7(9), 648–650. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/3536291>
16. Rooban T., Kumar, P.D.M. (2010). Contribution of Indian dental research to the Scimago™ Database during 1996-2007:a preliminary report. *Chron Young Sci*, 1,16–21.
17. Subramanyam, K. (1983). Bibliometric studies of research collaboration: A review. *Journal of Information Science*, 6(1), 33–38. <https://doi.org/10.1177/016555158300600105>
18. Verma, P., Sachdeva, S. K., Verma, K. G., Khosa, R., Basavraju, S., & Dutta, S. (2015). Attitude of Indian dental professionals toward scientific publications: A questionnaire based study. *Journal of Natural Science, Biology and Medicine*, 6, S118–S122.

