# Indian Research Output on Laser in Medical Field: A Bibliometric Study

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Abstract

*The research aims to study the Indian research output on Laser in Medical Sciences. The global multidiscipline citation database 'Scopus' was used for this study. A total of 180261 records contributed globally over a period between 1981 to 2015 of which 3034 publications have Indian contribution.. This study found that a steady growth could be seen on the Indian research out put and 9984% publications are in English language. Among the 3034 publications, 75.51% of the publications are in journal articles. 7.58% of the Indian contributions collaborated with United States followed by United Kingdom. Out of 3034 publications, 67.73% are cited and the remaining are uncited publications.*

Keywords

Bibliometric; Scientometric; Indian Output; Laser; Laser in Medical

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## INTRODUCTION

The knowledge of scientific literature has augmented a considerable body of statistical research. The effectiveness of scientific research performance could be realised only through a proper communication system. The metric studies are used to measure scholarly communication; identify research trends and growth of knowledge; identify users of different subjects; estimate comprehensiveness of secondary periodicals; forecast past, present and future publishing trends; adopt an accurate weeding and stacking policy; develop norms and standardization; identify authorship and its trends in documents on various subjects; predict productivity of publishers, individual authors, organizations, country or that of an entire discipline. Metrics studies such as librametrics, bibliometrics, scientometrics, and informetrics are well known and a number of studies have been carried out in these areas.

Bibliometric analysis throws light on the pattern of growth of literature, inter-relationship among different branches of knowledge, productivity, authorship pattern, degree of collaboration, pattern of collection building, and their use. Gradually bibliometric studies are attaining the status of inter-disciplinary in nature.

## LASER IN MEDICAL SCIENCES

Laser technology has made great progress, and its many applications make it essential in everyday life. However, this technology is still open to numerous developments. A cross multiple applications, there is particular focus in the field of medicine, for diagnosis for tailored therapies, and as a research tool in biology. The first use of lasers in medicine was to damage the retina to understand ocular injury due to accidental exposure [1]. Since the first ruby laser, several devices have been improved placing ophthalmology at the forefront of medical specialties using this technology. In medicine, the energy delivered by the laser, whose intensity can be modulated, can cut, destroy or alter the cellular or extracellular structure of biological tissue. In addition, laser applications have the advantage of reducing the risk of infection and promoting healing. Now integrated in surgical procedures, for a better focus and precise cutting, laser surgery is not however without risks for pregnancy or contra-indications for the use of photosensitizing drug.

## REVIEW OF LITERATURE

A bibliometric method, common research tool, has already been widely applied in scientific production and research-trend studies in many disciplines of science and engineering (Almind&Ingwersen, 1997; Cronin, 2001; Moed, Debruin, &Vanleeuwen, 1995). The popularity in the adaptation of bibliometric techniques in various disciplines stimulated stupendous growth of literature on bibliometrics and its related areas. Conventional bibliometric methods generally evaluate the research trend by investigating the publication outputs of subjects (Rajendran , Ramesh Babu , &Gopalakrishnan , 2005,), research fields(Davis & Gonzalez, 2003 , Krishnamoorthy, Ramakrishnan, & Devi, 2009), different countries (Rahman, Haque, & Fukui, 2005) and research institutes (Rajendram, Lewison, &Preedy, 2006), journals (Dannenberg, 1985),. Global research out put on genetic engineering (Balasubramani el al , 2014), Neurology (jeyshankar 2015) and Indian research output on Indian brain tumor( Ramesh et al, 2014). Further uncited publications in mems (Gopalakrishnan et al, 2015) has been studied.

**OBJECTIVES**

The objectives of the study are:

- To examine the Indian research output on Laser in Medical Sciences during the period 1981 - 2015.
- To analyse the bibliographic form/document type of the publications on Laser in Medical Sciences.
- To identify the Indian organisations conducting the research on Laser in Medical Sciences
- To identify the top Indian authors conducting research on Laser in Medical Sciences
- To identify the top source titles those carry the research productions on Laser in Medical Sciences.
- To identify the language preferred by Indian research outputs are published.
- To identify the citation impact of Indian Research Output on Lasers in Medicine.

**HYPOTHESES**

The following hypotheses will be formulated for this study based on the objectives.

- There are more literatures published worldwide on Laser in Medical Sciences.
- There exist study Growth of literature on Laser in medicine in India.
- The research productivity Laser in Medical Sciences is dominated by English language.
- Journals are major source of publications on Laser in Medical Sciences.
- There exists no steady growth in research output Laser in Medical Sciences research.
- The Indian research out put on laser research in medicine were highly cited.

**SEARCH TERM**

(TITLE-ABS-KEY(laser )AND AFFILCOUNTRY(India) AND SUBJAREA(MULT OR MEDI OR NURS OR VETE OR DENT OR HEAL) AND PUBYEAR > 1980 AND PUBYEAR < 2016)

**ANALYSIS**

The global research output on Laser in Medical Sciences has been analysed using various scientometric / bibliometric tools such as Rate of Growth (RoG), Relative Growth Rate (RGR) and Doubling Time (Dt) apart from the percentage and cumulative percentage. The literature on Laser in Medical Sciences covered in SCOPUS bibliographic database has been considered for the purpose of quantitative analysis. The data retrieved on laser in medical sciences were for the period 1981 to 2015 and a total of 180261 records were found. Out of which Indian contribution is 3034 (1.68%) taken up for this study.

**COUNTRYWISE PUBLICATIONS**

The growth of literature of any research globally is gauged through the region or the country where more no of publications are published. The researcher also studied the countrywise publication on laser in medical sciences for the period 1981 to 2015 which helps to find out the total no. of publications published in the subject. The top 20 country publications were shown in table 1. The details of total no. of publications alongwith the percentage of contribution globally is shown in table 1.

**Table 1:** Country wise Research Publications

| S.No | Country | Publications | Percentage |
|---|---|---|---|
| 1 | United States | 51196 | 28.40 |
| 2 | Germany | 17562 | 9.74 |
| 3 | Japan | 13592 | 7.54 |
| 4 | United Kingdom | 12378 | 6.87 |
| 5 | China | 12146 | 6.74 |

| | | | |
|---|---|---|---|
| 6 | France | 7159 | 3.97 |
| 7 | Italy | 7031 | 3.90 |
| 8 | Canada | 4581 | 2.54 |
| 9 | Spain | 3840 | 2.13 |
| 10 | Brazil | 3793 | 2.10 |
| 11 | Netherlands | 3712 | 2.06 |
| 12 | Australia | 3500 | 1.94 |
| 13 | Switzerland | 3313 | 1.84 |
| 14 | South Korea | 3160 | 1.75 |
| 15 | India | 3034 | 1.68 |
| 16 | Sweden | 2631 | 1.46 |
| 17 | Turkey | 2464 | 1.37 |
| 18 | Austria | 2362 | 1.31 |
| 19 | Taiwan | 1996 | 1.11 |
| 20 | Belgium | 1840 | 1.02 |
| 21 | Other | 18971 | 10.52 |
| **Total** | | **180261** | **100.00** |

Table 1 reveals that the maximum of publications i.e 28.40% were from the United States followed by Germany (9.47%) and Japan (7.54%). It is also to note than India occupies 15th position with total production of 1.68%.

## QUANTUM OF INDIAN RESEARCH OUTPUT ON LASER IN MEDICAL SCIENCES

The year wise distribution of Indian research output on Laser in Medical Sciences with its total publications (TP), percentage, cumulative, cumulative percentage and RoG were calculated and the same is shown in Table 2 and Figure 1 and 2.

**Table 2:** Indian Research Output - Year wise Contribution

| S.No | Year | TP | % | Cum | CUM % | RoG | CAGR |
|---|---|---|---|---|---|---|---|
| 1 | 1981 | 4 | 0.13 | 4 | 0.13 | 1.00 | 0.87 |
| 2 | 1982 | 7 | 0.23 | 11 | 0.36 | 1.75 | 0.88 |
| 3 | 1983 | 0 | 0.00 | 11 | 0.36 | 0.00 | 0.00 |
| 4 | 1984 | 5 | 0.16 | 16 | 0.53 | 0.71 | 0.87 |
| 5 | 1985 | 3 | 0.10 | 19 | 0.62 | 0.60 | 0.85 |
| 6 | 1986 | 1 | 0.03 | 20 | 0.66 | 0.33 | 0.82 |
| 7 | 1987 | 1 | 0.03 | 21 | 0.69 | 1.00 | 0.81 |
| 8 | 1988 | 6 | 0.20 | 27 | 0.89 | 6.00 | 0.86 |
| 9 | 1989 | 11 | 0.36 | 38 | 1.25 | 1.83 | 0.87 |
| 10 | 1990 | 6 | 0.20 | 44 | 1.45 | 0.55 | 0.85 |
| 11 | 1991 | 9 | 0.30 | 53 | 1.75 | 1.50 | 0.85 |
| 12 | 1992 | 4 | 0.13 | 57 | 1.88 | 0.44 | 0.82 |
| 13 | 1993 | 14 | 0.46 | 71 | 2.34 | 3.50 | 0.86 |
| 14 | 1994 | 24 | 0.79 | 95 | 3.13 | 1.71 | 0.88 |
| 15 | 1995 | 16 | 0.53 | 111 | 3.66 | 0.67 | 0.85 |
| 16 | 1996 | 21 | 0.69 | 132 | 4.35 | 1.31 | 0.86 |
| 17 | 1997 | 31 | 1.02 | 163 | 5.37 | 1.48 | 0.87 |
| 18 | 1998 | 35 | 1.15 | 198 | 6.52 | 1.13 | 0.87 |
| 19 | 1999 | 49 | 1.62 | 247 | 8.14 | 1.40 | 0.88 |
| 20 | 2000 | 57 | 1.88 | 304 | 10.02 | 1.16 | 0.88 |
| 21 | 2001 | 53 | 1.75 | 357 | 11.76 | 0.93 | 0.87 |
| 22 | 2002 | 58 | 1.91 | 415 | 13.68 | 1.09 | 0.86 |
| 23 | 2003 | 91 | 3.00 | 506 | 16.68 | 1.57 | 0.88 |
| 24 | 2004 | 90 | 2.97 | 596 | 19.64 | 0.99 | 0.87 |
| 25 | 2005 | 96 | 3.16 | 692 | 22.81 | 1.07 | 0.87 |
| 26 | 2006 | 120 | 3.96 | 812 | 26.76 | 1.25 | 0.88 |
| 27 | 2007 | 99 | 3.26 | 911 | 30.02 | 0.83 | 0.84 |
| 28 | 2008 | 131 | 4.32 | 1042 | 34.34 | 1.32 | 0.86 |
| 29 | 2009 | 160 | 5.27 | 1202 | 39.62 | 1.22 | 0.86 |
| 30 | 2010 | 173 | 5.70 | 1375 | 45.32 | 1.08 | 0.85 |
| 31 | 2011 | 247 | 8.14 | 1622 | 53.46 | 1.43 | 0.89 |
| 32 | 2012 | 233 | 7.68 | 1855 | 61.14 | 0.94 | 0.85 |
| 33 | 2013 | 289 | 9.53 | 2144 | 70.66 | 1.24 | 0.86 |
| 34 | 2014 | 438 | 14.44 | 2582 | 85.10 | 1.52 | 0.98 |
| 35 | 2015 | 452 | 14.90 | 3034 | 100.00 | 1.03 | 1.00 |
| | | 3034 | 100.00 | 20787 | | | |

It is seen from the Table 2 that the total number of publications are more than 100 from the period between 2008 and 2015 and in the year 2006. The highest no. of publications (452) could be seen in the year 2015. From the year 2008, the research output could be seen in upward direction and the data reveals that a periodical growth could be seen till the year 2015 i.e end of the study period. The cumulative total of the publication is 20787. The Ratio of Growth (RoG) varies from 0.33 to 6.00 between the study period 1981 and 2015 except the year 1983 which is 0.00. It is also to note that there was no publication in the year 1983 and only one publication

could be seen in the years 1986 and 1987. The RoG value 6.00 is seen in the year 1988. From the year 1996 onwards, the RoG shows that there is a steady growth on the research output of Indian contribution on laser in medical sciencesThis confirms that the Indian researchers are interested to publish papers on laser in medical sciences.

It is seen from the table that CAGR values are between 0.81 and 1.00 during the years of study period except the year 1983 where there is no publication. It is also to note that the CAGR values are more or less same during the whole study period except the year 1983.

**RELATIVE GROWTH RATE (RGR) AND DOUBLING TIME (DT) OF RESEARCH PRODUCTIVITY ON LASER IN MEDICAL SCIENCES**

The research productivity on Laser in Medical Sciences have been calculated based on RGR and the Dt () which is shown in table 2 and figure 3. The Relative Growth Rate (RGR) is the increase in number of articles/pages per unit of time. This definition is derived from the definition of relative growth rates in the study of growth analysis of individual plants and effectively applied in the field of botany (Hunt, R 1978), which in turn, had its origin from the study of the rate of interest in the financial investment (Blackman, V.H. 1919). The mean Relative Growth Rate (RGR) over the specific period of interval can be calculated from the following equation:

$$RGR\ 1\text{-}2\ ^{R} = \frac{Log_e\ {}_2W - log_e\ {}_1W}{{}_2^{T} - {}_1^{T}}$$

whereas

1-2 $\bar{R}$ = mean relative growth rate over the specific period of interval

$log_{e1}W$ = log of initial number of articles/pages

$log_{e2}$W = log of final number of articles/pages after a specific period of interval

$_2T$- $_1T$ = the unit difference between the initial time and the final time

The year can be taken here as the unit of time. The RGR for both articles and pages can be calculated separately. Therefore

- 1- 2 $^{R}$(aa−1 year −1) can represent the mean relative growth rate per unit of articles per unit of year over a specific period of interval and
- 1 - 2 $^{R}$ (pp−1 year −1) can represent the mean relative growth rate per unit of pages per unit of year over a specific period of interval.

**Doubling Time (Dt (P))**

There exists a direct equivalence between the relative growth rate and the doubling time. If the number of articles/pages of a subject doubles during a given period then the difference between the logarithms of numbers at the beginning and end of this period must be the logarithms of number 2. If natural logarithm is used this difference has a value of 0.693. Thus the corresponding doubling time for each specific period of interval and for both articles and pages can be calculated by the following formula:

Doubling time (Dt) = Log $_e$2 / $\bar{R}$

Therefore

$$\text{Doubling time for articles Dt (a)} = \frac{\text{Log}_e 2}{1\text{-}2\ \bar{R}}$$

( aa-1 year-1 ) Log $_e$2 = 0.693

**Table**
**Indian Research Output on Laser in Medical Sciences Vs RGR and Dt ()**

| S.No | Year | TP | % | Cum | CUM % | w1 | w2 | RGR | Dt |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1981 | 4 | 0.13 | 4 | 0.13 | | 1.386294 | 1.39 | 0.50 |
| 2 | 1982 | 7 | 0.23 | 11 | 0.36 | 1.386294 | 2.397895 | 1.01 | 0.69 |
| 3 | 1983 | 0 | 0.00 | 11 | 0.36 | 2.397895 | 2.397895 | 0.00 | 0.00 |
| 4 | 1984 | 5 | 0.16 | 16 | 0.53 | 2.397895 | 2.772589 | 0.37 | 1.85 |
| 5 | 1985 | 3 | 0.10 | 19 | 0.62 | 2.772589 | 2.944439 | 0.17 | 4.03 |
| 6 | 1986 | 1 | 0.03 | 20 | 0.66 | 2.944439 | 2.995732 | 0.05 | 13.51 |
| 7 | 1987 | 1 | 0.03 | 21 | 0.69 | 2.995732 | 3.044522 | 0.05 | 14.20 |
| 8 | 1988 | 6 | 0.20 | 27 | 0.89 | 3.044522 | 3.295837 | 0.25 | 2.76 |
| 9 | 1989 | 11 | 0.36 | 38 | 1.25 | 3.295837 | 3.637586 | 0.34 | 2.03 |
| 10 | 1990 | 6 | 0.20 | 44 | 1.45 | 3.637586 | 3.78419 | 0.15 | 4.73 |
| 11 | 1991 | 9 | 0.30 | 53 | 1.75 | 3.78419 | 3.970292 | 0.19 | 3.72 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 12 | 1992 | 4 | 0.13 | 57 | 1.88 | 3.970292 | 4.043051 | 0.07 | 9.52 |
| 13 | 1993 | 14 | 0.46 | 71 | 2.34 | 4.043051 | 4.26268 | 0.22 | 3.16 |
| 14 | 1994 | 24 | 0.79 | 95 | 3.13 | 4.26268 | 4.553877 | 0.29 | 2.38 |
| 15 | 1995 | 16 | 0.53 | 111 | 3.66 | 4.553877 | 4.70953 | 0.16 | 4.45 |
| 16 | 1996 | 21 | 0.69 | 132 | 4.35 | 4.70953 | 4.882802 | 0.17 | 4.00 |
| 17 | 1997 | 31 | 1.02 | 163 | 5.37 | 4.882802 | 5.09375 | 0.21 | 3.29 |
| 18 | 1998 | 35 | 1.15 | 198 | 6.52 | 5.09375 | 5.288267 | 0.19 | 3.56 |
| 19 | 1999 | 49 | 1.62 | 247 | 8.14 | 5.288267 | 5.509388 | 0.22 | 3.13 |
| 20 | 2000 | 57 | 1.88 | 304 | 10.02 | 5.509388 | 5.717028 | 0.21 | 3.34 |
| 21 | 2001 | 53 | 1.75 | 357 | 11.76 | 5.717028 | 5.877736 | 0.16 | 4.31 |
| 22 | 2002 | 58 | 1.91 | 415 | 13.68 | 5.877736 | 6.028279 | 0.15 | 4.60 |
| 23 | 2003 | 91 | 3.00 | 506 | 16.68 | 6.028279 | 6.226537 | 0.20 | 3.50 |
| 24 | 2004 | 90 | 2.97 | 596 | 19.64 | 6.226537 | 6.390241 | 0.16 | 4.23 |
| 25 | 2005 | 96 | 3.16 | 692 | 22.81 | 6.390241 | 6.539586 | 0.15 | 4.64 |
| 26 | 2006 | 120 | 3.96 | 812 | 26.76 | 6.539586 | 6.6995 | 0.16 | 4.33 |
| 27 | 2007 | 99 | 3.26 | 911 | 30.02 | 6.6995 | 6.814543 | 0.12 | 6.02 |
| 28 | 2008 | 131 | 4.32 | 1042 | 34.34 | 6.814543 | 6.948897 | 0.13 | 5.16 |
| 29 | 2009 | 160 | 5.27 | 1202 | 39.62 | 6.948897 | 7.091742 | 0.14 | 4.85 |
| 30 | 2010 | 173 | 5.70 | 1375 | 45.32 | 7.091742 | 7.226209 | 0.13 | 5.15 |
| 31 | 2011 | 247 | 8.14 | 1622 | 53.46 | 7.226209 | 7.391415 | 0.17 | 4.19 |
| 32 | 2012 | 233 | 7.68 | 1855 | 61.14 | 7.391415 | 7.52564 | 0.13 | 5.16 |
| 33 | 2013 | 289 | 9.53 | 2144 | 70.66 | 7.52564 | 7.670429 | 0.14 | 4.79 |
| 34 | 2014 | 438 | 14.44 | 2582 | 85.10 | 7.670429 | 7.85632 | 0.19 | 3.73 |
| 35 | 2015 | 452 | 14.90 | 3034 | 100.00 | 7.85632 | 8.017637 | 0.16 | 4.30 |
| **Total** | | **3034** | **100.00** | | | | | | |

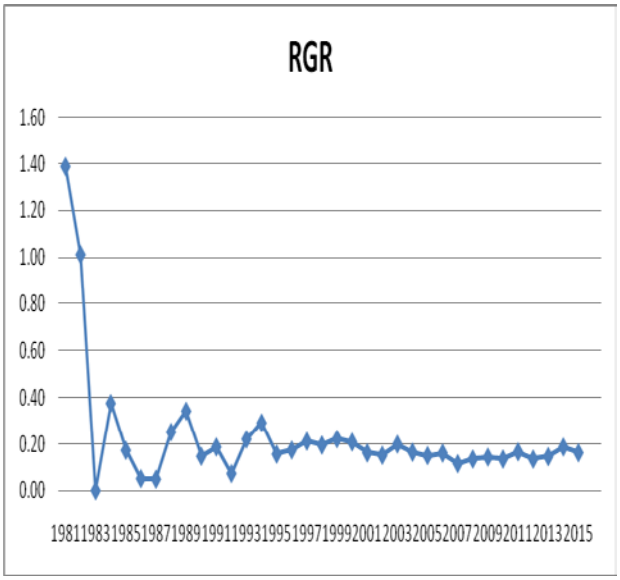



***Figure1: Indian Research Output on Laser in Medical Sciences Vs RGR***

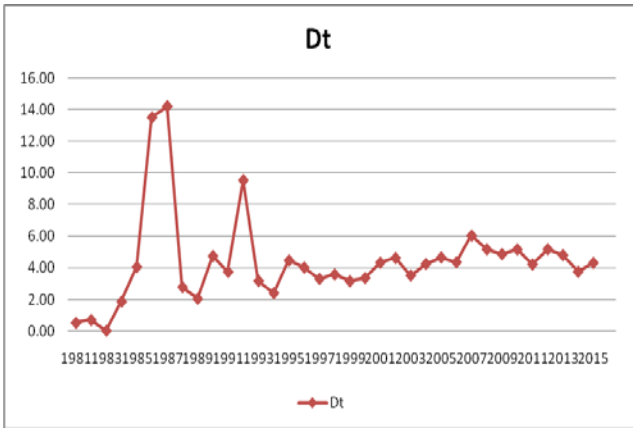



***Figure 2: Indian Research Output on Laser in Medical Sciences Vs Dt ()***

It is observed from the table 1 and figures 2 and 4 that the relative growth rate (RGR) lies between 0.05 and 1.39 except the year 1983 where there is no publications. It is also to note that some of the RGR values are same in few years of 1981 to 2015. This shows that the Indian contribution on laser on medical sciences is increasing and the range of publications are on many folds.

**LANGUAGE AND BIBLIOGRAPHIC FORM OF PUBLICATIONS BY INDIAN AUTHORS**

The language as well as the bibliographic form of publications in respect of Indian research output on Laser in Medical Sciences were analysed and the same is presented in table 4.

**Table 4:**Indian Research Output on Laser in Medical SciencesVsLanguage and Bibliographic Form

| S. No | Description | No. of publications | % |
|---|---|---|---|
| **Language** | | | |
| 1 | English | 3029 | 99.84 |
| 2 | French | 2 | 0.07 |
| 3 | German | 1 | 0.03 |
| 4 | Spanish | 1 | 0.03 |
| 5 | Turkish | 1 | 0.03 |
| **Bibliographic Form** | | | |
| 1 | Article | 2291 | 75.51 |
| 2 | Review | 317 | 10.45 |
| 3 | Letter | 212 | 6.99 |
| 4 | Conference Paper | 122 | 4.02 |
| 5 | Note | 34 | 1.12 |
| 6 | Editorial | 25 | 0.82 |
| 7 | Book Chapter | 16 | 0.53 |
| 8 | Short Survey | 14 | 0.46 |
| 9 | Book | 3 | 0.10 |

It is observed from table 4 that the research output largely published in English language (99.84%). The Indian contribution can also be seen in other languages such as French, German, Spanish and Turkish which shows that the Indian contribution on Laser gone globally. 75.51% (2291) of the total Indian contribution in the form of articles followed by reviews (10.45%) and letters (6.99%). The contributions can also be seen in other bibliographic forms such as conference papers, note, editorial, book chapters, short surveys and books. By and large it is found that the scholarly communication of laser in medical sciences research output is mostly through journals and reviews.

**HIGHLY PUBLISHED INSTITUTIONS FROM INDIA**

The publications on laser in medical sciences published by the Indian authors with various institutes in India and the authors affiliation with the institutes are taken for the study. The top institutes which has more than 25 pubications are shown in Table 5which enumerates the affiliation of the authors.

**Table 5:** Research Productivity Vs Affiliation

| S.No | Institution | TP | % |
|---|---|---|---|
| 1 | All India Institute of Medical Sciences | 185 | 6.10 |
| 2 | Dr. Rajendra Prasad Centre for Ophthalmic Sciences | 138 | 4.55 |
| 3 | L.V. Prasad Eye Institute India | 128 | 4.22 |
| 4 | Postgraduate Institute of Medical Education and Research | 101 | 3.33 |
| 5 | Bhabha Atomic Research Centre | 57 | 1.88 |
| 6 | Aravind Eye Hospital | 53 | 1.75 |
| 7 | Indian Institute of Technology, Madras | 53 | 1.75 |
| 8 | Kasturba Medical College, Manipal | 51 | 1.68 |
| 9 | Indian Institute of Science | 47 | 1.55 |
| 10 | Raja Ramanna Centre for Advanced Technology | 45 | 1.48 |
| 11 | Manipal University Karnataka | 44 | 1.45 |
| 12 | Vision Research Foundation India | 39 | 1.29 |
| 13 | ChhatrapatiShahujiMaharaj Medical University | 36 | 1.19 |
| 14 | Maulana Azad Medical College | 32 | 1.05 |
| 15 | Medical Research Foundation, Chennai | 32 | 1.05 |
| 16 | Tata Memorial Hospital | 30 | 0.99 |
| 17 | Indian Institute of Technology, Kanpur | 27 | 0.89 |
| 18 | Tata Institute of Fundamental Research | 25 | 0.82 |

The Indian contribution by the authors affiliation is primarily with All India Institute of Medical Sciences (185, 6.10%) followed by Dr.Rajendra Prasad Centre for Ophthalmic Sciences (138, 4.55%) and L.V. Prasad Eye Institute India (128,4.22%).

**COLLABORATED COUNTRIES**

The collaborated countries where the Indian authors are part of the publications are shown in table 6.

**Table 6: Collaborated Countries**

| S.No | Country | No. of Publications | % |
|---|---|---|---|
| 1 | United States | 230 | 7.58 |
| 2 | United Kingdom | 75 | 2.47 |
| 3 | Germany | 72 | 2.37 |
| 4 | Singapore | 39 | 1.29 |
| 5 | Australia | 38 | 1.25 |
| 6 | Italy | 30 | 0.99 |
| 7 | Canada | 29 | 0.96 |
| 8 | Japan | 27 | 0.89 |
| 9 | Saudi Arabia | 27 | 0.89 |
| 10 | China | 22 | 0.73 |
| 11 | South Korea | 22 | 0.73 |
| 12 | Hong Kong | 19 | 0.63 |
| 13 | France | 17 | 0.56 |
| 14 | Brazil | 14 | 0.46 |
| 15 | Spain | 14 | 0.46 |
| 16 | Netherlands | 13 | 0.43 |
| 17 | Sweden | 13 | 0.43 |
| 18 | Taiwan | 13 | 0.43 |
| 19 | Thailand | 10 | 0.33 |

It is seen from the table 6 that the Indian authors mostly collaborated with United States (230, 7.58%) followed by United Kingdom (75, 2.47%) and Germany (72, 2.37%).

**SOURCE TITLES ON LASER IN MEDICAL SCIENCES**

The core journals which publishes more than 500 research work on laser in medical sciences has been presented in table 7.

**Table 7:** Research Productivity Vs Source Title

| S.No. | Journal name | Publi cations | % |
|---|---|---|---|
| 1 | Indian Journal of Ophthalmology | 146 | 4.81 |
| 2 | Current Science | 87 | 2.87 |
| 3 | Journal of Cataract And Refractive Surgery | 71 | 2.34 |
| 4 | Indian Journal of Dermatology Venereology and Leprology | 70 | 2.31 |
| 5 | Plos One | 67 | 2.21 |
| 6 | SpectrochimicaActa Part a Molecular and Biomolecular Spectroscopy | 45 | 1.48 |
| 7 | Indian Journal of Otolaryngology and Head and Neck Surgery | 44 | 1.45 |
| 8 | Journal International Medical Sciences Academy | 40 | 1.32 |
| 9 | Journal of Clinical and Diagnostic Research | 39 | 1.29 |
| 10 | Progress in Biomedical Optics and Imaging Proceedings of SPIE | 39 | 1.29 |
| 11 | Journal of Refractive Surgery | 36 | 1.19 |
| 12 | Ophthalmology | 34 | 1.12 |
| 13 | Retina | 31 | 1.02 |
| 14 | American Journal of Ophthalmology | 30 | 0.99 |
| 15 | British Journal of Ophthalmology | 30 | 0.99 |
| 16 | Eye | 30 | 0.99 |
| 17 | Indian Journal of Dermatology | 30 | 0.99 |
| 18 | Cornea | 29 | 0.96 |
| 19 | Indian Journal of Urology | 26 | 0.86 |
| 20 | Lasers in Medical Science | 21 | 0.69 |
| 21 | Clinical and Experimental Ophthalmology | 20 | 0.66 |
| 22 | Medical Journal Armed Forces India | 20 | 0.66 |
| 23 | Sadhana Academy Proceedings in Engineering Sciences | 20 | 0.66 |

A total 3034Indian contribution on laser in medical sciences literature were published in various sources out of which 77.02% were published in the form of journal articles. The highly productive articles in journals are ranked and the first five ranked journals are:

i. Indian Journal of Ophthalmology (146, 4.81%)
ii. Current Science (87, 2.87%)

iii. Journal of Cataract And Refractive Surgery (71, 2.34%)
iv. Indian Journal of Dermatology Venereology and Leprology (70, 2.31%)
v. Plos One (67, 2.21%)

**HIGHLY PUBLISHED AUTHORS**

Among the 3034 publications, table 8 shows the authors with more than 20 publications. The name of the author, total no. of publications and the percentage are shown in table 8

**Table 8:** Highly Published Authors

| S.No. | Author Name | Papers | % |
|---|---|---|---|
| 1 | Sharma, N. | 51 | 1.68 |
| 2 | Vajpayee, R.B. | 51 | 1.68 |
| 3 | Gupta, A. | 43 | 1.42 |
| 4 | Dada, T. | 38 | 1.25 |
| 5 | Singh, M. | 37 | 1.22 |
| 6 | Venkatesh, P. | 30 | 0.99 |
| 7 | Sihota, R. | 29 | 0.96 |
| 8 | Jalali, S. | 25 | 0.82 |
| 9 | Titiyal, J.S. | 24 | 0.79 |
| 10 | Gupta, P.K. | 22 | 0.73 |
| 11 | Mahato, K.K. | 22 | 0.73 |
| 12 | Prakash, G. | 21 | 0.69 |
| 13 | Tewari, H.K. | 21 | 0.69 |

It is seen from table 8 that Sharma, N. with 51(1.68%) has the maximum no. of publications followed by Vajpayee, R.B.(51, 1.68%) and Gupta, A.(43, 1.42%) publications.

**CITED PUBLICATIONS**

The total cited and uncited publications. Total publications and percentage of publications is calculated in table 9.

**Table 9:** Cited/Uncited

| S. No. | Description | Frequency | % |
|---|---|---|---|
| 1 | Cited | 2052 | 67.73 |
| 2 | Uncited | 982 | 32.27 |
| Total | | 3034 | 100.0 |

Table 9 reveals that out of 3034 Indian contributions, 2052 (67.73%) publications are cited and 982 (32.27%) are uncited publications. Further the highly cited publications i.e more than 100 times were taken for the study which is shown in table 10.
Table 10illustrates the no. of authors, year of publication, source title, volume, issue, no. of citations ad age of the article.

**Table 10:** HIGHLY CITED PAPERS

| S. No. | Noa | Year | Source title | Volume | Issue | Cited by | Age of the article |
|---|---|---|---|---|---|---|---|
| 1 | 6 | 1994 | Science | 263 | 5150 | 295 | 23 |
| 2 | 22 | 2009 | Journal of the American Academy of Dermatology | 60 | | 275 | 8 |
| 3 | 656 | 2009 | Nature | 460 | 7258 | 203 | 8 |
| 4 | 8 | 2001 | Ophthalmology | 108 | 3 | 200 | 16 |
| 5 | 4 | 2003 | Science | 299 | 5608 | 193 | 14 |
| 6 | 2 | 2003 | Sadhana - Academy Proceedings in Engineering Sciences | 28 | 42433 | 140 | 14 |
| 7 | 3 | 2011 | Journal of Cataract and Refractive Surgery | 37 | 1 | 135 | 6 |
| 8 | 3 | 2004 | Lancet Oncology | 5 | 4 | 134 | 13 |
| 9 | 5 | 1997 | Science | 275 | 5306 | 125 | 20 |
| 10 | 23 | 2004 | Nature | 432 | 7020 | 119 | 13 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11 | 4 | 2006 | BJU International | 97 | 1 | 116 | 11 |
| 12 | 4 | 2008 | PLoS ONE | 3 | 1 | 112 | 9 |
| 13 | 65 | 2006 | Nature Genetics | 38 | 6 | 108 | 11 |
| 14 | 7 | 2011 | Proceedings of the National Academy of Sciences of the United States of America | 108 | 7 | 105 | 6 |
| 15 | 4 | 2004 | American Journal of Ophthalmology | 137 | 4 | 104 | 13 |
| 16 | 3 | 1997 | Lasers in Surgery and Medicine | 21 | 5 | 100 | 20 |

It is seen from table that an article titled "Age of the earliest known hominids in Java, Indonesia" has been cited by 295 times and the age of the article is 23 years. If is followed by an article "New insights into the management of acne: An update from the Global Alliance to Improve Outcomes in Acne Group" which was cited by 275 times and the age of the article is 8 years. It is interesting to note that an article titled "An upper limit on the stochastic gravitational-wave background of cosmological origin" published in Nature has 656 authors which was cited by 203 times.

## CONCLUSION

The Indian contribution in Laser in Medical Sciences has been studied in the light of the global research has been taken for the study with the use of global database SCOPUS. The data which were analysed is for the period 1981 to 2015. A total of 3034 records were retrieved in the database for analysis purpose. This study reported the findings to determine the publication trend with respect to growth of literature on yearwise, languagewise and countrywise with the bibliographic form where the publications are published. This study also enumerated the affiliation of the authors, source titles and the top Indian authors. The objectives and the hypotheses set for this study were thoroughly investigated. The results computed were quite encouraging particularly on the use of laser in medical sciences. This study also found that there is a steady growth on the research publications on laser in medical from India.

## References

[1]. Almind, T.C. &Ingwersen, P. (1997).Informatic analysis on the World Wide Web, Methodological approaches to "Webometrics". *Journal of Documentation*, 53(4), 404-426.

[2]. Balasubramani C, Gopalakrishnan S and Gnanasekaran D (2014). Growth of Research output in Genetic Engineering: A Scientometric Study. *Journal of Advances in Library and Information Science*, 3(3), 179-185.

[3]. Dannenberg, A.L., 1985. Use of Epidemiology in Medical Specialties - an Examination by CitationAnalysis. *American Journal of Epidemiology*, 121 (1), 140–151.

[4]. Davis, J. C. and Gonzalez, J. G. (2003). Scholarly Journal Articles about the Asian tigereconomies: Authors, journals, and research fields, 1986-2001. *Asian-PacificEconomic Literature*, 17, 51-61.

[5]. Gopalakrishnan, S, Gopalakrishnan, S, Bathrinarayanan, A L, Tamizhchelvan, M, (2015). Uncited Publications in MEMS Literature: A Bibliometric Study. *DESIDOC Journal of Library & Information Technology*, 35 (2), 113-123.

[6]. Krishnamoorthy G., Ramakrishnan, J., & Devi.(2009). Bibliometric analysis of literature on diabetes (1995-2004), *Annals of Library and Information Studies*, 56, 150-155

[7]. Moed,H.F., Debruin, R.E.&Vanleeuwen, T.N. (1995). New bibliometric tools for the assessment of national research performance—Database description, overview of indicators and first applications.*Scientometics*, 33(3), 381-422.

[8]. Rahman, M., Haque, T.L., & Fukui, T. (2005). Research articles published in clinical radiology journals: Trend of contribution from different countries, *Academic Radiology*, 12(7), 825-829.

[9]. Rajendran, P., Ramesh Babu, B ,&Gopalakrishnan, S. (2005).Bibliometric analysis of "Fiber Optics" literature. *Annals of Library and Information Studies*, 52(3), 82-85

[10]. Ramesh, P., Gopalakrishnan, S., &Balasubramani, C. (2014). Growth of Indian research output on brain tumour: a bibliometric study using Scopus database. European Academic Research Journal, II (7), 9788-9816.