Research output of Indian institutions during 2011–2016: quality and quantity perspective

K. S. Rajan, S. Swaminathan and S. Vaidhyasubramaniam*

The publication output from Indian institutions has been steadily increasing during the last few years. This may be attributed to the higher investment in research and also linking the number of publications with career advancement. There is a need to analyse the publication output of Indian institutions in terms of quality of publications. In this study, output in the top 10 percentile, as computed by SciVal (a product of Elsevier), has been used as an indicator of the quality of research output, since it reflects the percentage of an institution's publication in the top 10 percentile of the most cited articles. Out of the 15 subject areas listed in SciVal, 7 contribute to more than 65% of publications from Indian institutions. Accordingly, Indian institutions with output in the top 10 percentile greater than the national average in these 7 major subject areas have been identified to compare their research output in terms of quality.

Keywords: Public and private institutions, performance assessment, quality and quantity perspective, research output.

SCHOLARLY research output in terms of publication in journals is continuously used as an indicator by various funding agencies in the country as well as by the University Grants Commission to compute the academic performance index (API) for faculty recruitment and promotion. To improve the API scores, some faculty have started their own journals for increasing the publication output. It has been reported that about 27% of the publishers of the fake journals and 42% of the fake single-journal publishers are based in India[1,2]. Over a period of time, more importance has been given to the number of publications and analysis of research output has also been based on the quantity[3]. Hence the quantity has taken over the quality aspects in measuring the scholarly output of institutions[3].

The scientometric profiles of Indian institutions based on publication output, as reflected in the *Science Citation Index* (*SCI*) and *Indian Science Abstracts* (*ISA*), have been reported[4,5]. A scientometric study revealed that 29 institutions contributed to 45% of all publications from India in *SCI* journals in 1997 (ref. 4). Another analysis carried out on the publication output of Indian institutions during 2006 in journals abstracted in *ISA* revealed that the universities, colleges, state Agricultural Universities and medical institutions contributed to more than 70% of the country's publication output[5]. In terms of the number of publications, top 50 institutions contributed to 25% of India's publication output and more than 3380 other institutions contributed to the remaining 75% (ref. 5). The authors concluded that Scopus and Web of Science (WoS) could be used along with *ISA* for assessment of publication output[5]. Prathap and Gupta[6] ranked the Indian engineering and technological institutions based on their publication performance during 1998–2008 computed using *p*-index, a function of the number of citations and number of publications.

A composite index containing total number of papers, number of citations, highly cited papers and number of papers with international collaborations has also been proposed in the literature[7]. The Central Universities in India were ranked based on the composite index calculated for the period 2010–2014. University of Delhi and Banaras Hindu University (BHU), Varanasi emerged as the top-ranked Central Universities[7].

Databases such as Scopus, WoS, Google Scholar, etc. provide information about articles, authors, citations, institutions and countries. Some of the common parameters that are used to evaluate the performance of the faculty or institutions are the number of publications, impact factor, citations and *h*-index. These parameters suffer from the following limitations while considering them for assessment of the performance of faculty: (i) impact factor of science journals is higher when compared to those of engineering, social sciences and humanities journals; (ii) the number of citations can be polarized through a few highly cited articles, and (iii) *h*-index does

K. S. Rajan and S. Swaminathan are in the Centre for Nanotechnology & Advanced Biomaterials, SASTRA Deemed University, Thanjavur 613 401, India and S. Vaidhyasubramaniam is in SASTRA Deemed University, Thanjavur 613 401, India.
*For correspondence. (e-mail: ksrajan@chem.sastra.edu)

Table 1. Global and national subject area-wise distribution of publications during 2011–2016

Subject area	Total number of publications from all countries	Total number of publications from India	National percentage in the subject area	Minimum number of publications from Indian institutions required for analysis
Agriculture and biological sciences	1,229,433	58,161	4.9	88
Biochemistry, genetics and molecular biology (BGM)	1,885,544	88,330	7.4	133
Chemical engineering	695,280	46,318	3.9	70
Chemistry	1,328,548	92,346	7.8	140
Computer science	1,868,591	107,052	9.0	162
Earth and planetary sciences	681,225	24,579	2.1	38
Energy	514,738	26,644	2.2	40
Engineering	3,181,716	147,449	12.4	223
Environmental science	791,467	40,082	3.4	61
Materials science	1,533,968	83,051	7.0	126
Mathematics	1,033,647	40,944	3.4	61
Medicine	4,949,347	157,610	13.2	238
Pharmacology and toxicology	535,727	63,406	5.3	95
Physics and astronomy	1,811,987	92,804	7.8	140
Social sciences	1,418,179	25,372	2.1	38

not take into account the age of the publications, thus favouring older publications whose citations accumulate with time. While considering the performance of the institutions based on the above parameters, the number of publications is not normalized to the number of faculty in the institutions and the *h*-index does not take into account the age of the institutions. An institution with higher faculty strength is naturally expected to have higher publication productivity and hence the absolute number of publications cannot be used as a basis of comparison of different sized institutions. This has been accounted in the National Institutional Ranking Framework (NIRF) of the Ministry of Human Resource Development (MHRD), Government of India, and hence the publication output is normalized on the basis of the number of publications per faculty. Also, *h*-index of an institution is based on the number of cited papers and does not account for the age of the publication. Hence, this gives rise to older institutions (>40 years) having higher *h*-index when compared to newer institutions (<25 years), though the research productivity is low for some of the older institutions in the recent times. As the absolute number of publications and their corresponding citations along with *h*-index do not provide information on the quality of publications, we have used SciVal (a product of Elsevier) to determine the quality of publications.

SciVal is a bibliometric tool to assess the research performance of individuals, institutions and countries with data taken from Scopus. Using SciVal, it is possible to analyse the research performance of countries and benchmark institutions relative to their peers and obtain insights into the research trends across 7500 institutions in 220 nations.

In this study, we have used output in top citation percentile to evaluate the performance of institutions in the country. The output in top 10 percentile indicates the extent of an institution's publication within the top 10 percentile of most cited papers. In addition, the output in top 10 percentile (of cited papers) can be used to benchmark institutions based on their contribution to the most influential and highly cited publications[8]. This parameter serves to distinguish the performance of organizations that have similar publication output, citations per paper and *h*-index on the basis of contribution to highly cited articles[8].

Methodology

The output in the top 10 percentile was considered for the period 2011–2016 (6-year period) for analysing the scholarly performance of Indian institutions and laboratories. The period of study was chosen to reflect the performance of Indian institutions in the most recent past, and a significant number of scientometric reports are available for different subject areas for other periods[9–13]. The output in the top 10 percentile was obtained for 15 different fields (Table 1). The national percentage in the subject area (Table 1) indicates the percentage of the country's total publications in the specified subject area. For instance, 4.9% of India's total publications during the period 2011–2016 was in the subject area of agriculture and biological sciences as revealed by SciVal. A total of 365 institutions were listed in a SciVal search for publication output from India during 2011–2016. The analysis of total research publications was limited to institutions that published at least an average of 300 papers per year during the 6-year period (minimum total publications of 1800 for the 6-year period) and had output in top 10 percentile greater than the national average of 9%, as obtained from SciVal for the period of study. With respect

to subject-wise analysis, institutions were filtered based on the number of publications calculated as the product of national percentage in the respective subject areas and the minimum threshold number of publication (1800) by an institution for the period. Accordingly, Table 1 gives the minimum number of publications in each area for the period 2011–2016 required for an institution to be included in the analysis.

Results

During the period 2011–2016, 789,089 papers have been published by India and the global publication output was 23,459,397. More than 65% of total research publications with Indian affiliations was from seven subject areas – medicine, engineering, computer science, physics and astronomy, chemistry, biochemistry and materials science. This observation is reasonably in good agreement with the findings of Prathap[13] that the publications of major Indian institutions are in the fields of physical sciences and engineering, with no substantial contributions in social sciences, arts and humanities. Out of the 365 Indian institutions listed in SciVal for the 6-year period, 51 had at least 1800 papers with output in top 10 percentile greater than the national average of 9%. Of these 51 institutions, there are only 3 private deemed universities, namely BITS Pilani, Thapar University and SASTRA University (Table 2).

Subject-wise analysis

The following sections provide a detailed analysis of the publications in the seven main subject areas along with the list of contributing institutions in the corresponding areas. Field weighted citation index (FWCI) compares the citation of an institution's publication with those of similar publications in the data universe[8]. Hence, FWCI has also been included in the analysis of publications in the seven main subject areas. The global average output in the top 10 percentile and global FWCI have also been taken for these 7 main subject areas for comparison.

Medicine

In the subject area of medicine, a total of 157,610 papers were published during the period 2011–2016 and the national average output in top 10 percentile was 8.7%, with FWCI of 0.74. India's contribution to the total publications in this subject area during the period was 3.18%. Forty-eight Indian institutions had at least 238 publications during this period and their outputs in top 10 percentile were greater than the national average of 8.7% (Table 3). Of these 48 institutions (41 public funded and 7 private), 44 had FWCI greater than the national average of 0.74, and 32 institutions had FWCI greater or equal than the global average of 1.03. The global average output in top 10 percentile for this subject was 14.2%. Only 31 institutions (shown in bold in Table 3) had both output in top 10 percentile and FWCI equal to or greater than the global average.

Engineering

In engineering, a total of 147,449 papers were published during 2011–2016 and the national average output in top 10 percentile was 7.9%, with FWCI of 0.84. The global average output in top 10 percentile was 7.6%, closer to the national average. India contributed to an extent of 4.63% of global publications in this subject area. Forty Indian institutions had output in top 10 percentile greater than the national average (Table 3). Of these 40 institutions, 25 (shown in bold face in Table 3) had FWCI greater than the global average of 0.99.

Computer science

In computer science, a total of 107,052 papers were published during 2011–2016 and the national average output in top 10 percentile was 3.2%. Thirty-one institutions (25 public and 6 private; Table 3) had output in top 10 percentile greater than the national average, and only 12 (10 public and 2 private) had output in the top 10 percentile greater than the global average (5.6%). Of these 31 institutions, only Jadavpur University had FWCI equal to the global average of 1.05. India's contribution to total publications was 5.73% and national FWCI was 0.69.

Physics and astronomy

In physics and astronomy, a total of 92,804 papers were published during 2011–2016 in India. The national average output in top 10 percentile and FWCI were 13.1% and 0.92 respectively. Thirty-eight institutions (31 public and 7 private; Table 3) published more than 116 papers in this subject in the last six years and had greater than 13.1% as output in top 10 percentile. The global FWCI was 1.05 and only 22 institutions (shown in bold face in Table 3) had both FWCI greater than the global FWCI and output in top 10 percentile greater than the global average (13%). Among these institutions, 19 are public funded and 3 are private institutions.

Chemistry

In chemistry, a total of 92,346 papers were published during 2011–2016 and the national average output in top 10 percentile was 19.4%. Forty institutions had output in top

Table 2. Indian institutions with average annual publication output greater than 300 per year and having an output in top 10 percentile greater than the national average of 9.0%

Institution	No. of publications during 2011–2016	Output in top 10 percentile (%)
Indian Association for the Cultivation of Science, Kolkata	2,898	26.3
Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru	2,045	25.5
Saha Institute of Nuclear Physics, Kolkata	2,680	24.1
Indian Institute of Chemical Technology, Hyderabad	11,946	23.4
Tata Institute of Fundamental Research, Mumbai	5,737	21.9
Panjab University, Chandigarh	5,514	21.1
Visva-Bharati University, Santiniketan	1,831	21.0
Shivaji University, Kolhapur	1,928	20.4
Tezpur University, Tezpur	1,981	17.5
Guru Nanak Dev University, Amritsar	2,383	16.2
Madurai Kamaraj University, Madurai	2,336	16.1
University of Mumbai, Mumbai	3,828	15.6
Indian Institute of Technology, Guwahati	5,352	15.4
Indian Institute of Science, Bengaluru	14,593	15.1
Indian Institute of Technology, Roorkee	7,579	14.6
University of Delhi, New Delhi	11,964	14.6
University of Hyderabad, Hyderabad	4,180	14.3
Banaras Hindu University, Varanasi	9,111	14.1
Bharathiar University, Coimbatore	3,621	14.1
Indian School of Mines University, Dhanbad	3,216	14.1
Indian Institute of Technology, Mumbai	9,657	14.0
Bharathidasan University, Tiruchirappalli	2,390	13.9
Jamia Hamdard University, New Delhi	2,335	13.9
Indian Institute of Technology, Kanpur	7,069	13.7
Indian Institute of Technology, Kharagpur	10,470	13.7
Jamia Millia Islamia, New Delhi	2,907	13.5
Aligarh Muslim University, Aligarh	5,880	13.4
National Institute of Technology, Tiruchirappalli	3,177	13.3
Indian Institute of Technology, New Delhi	9,813	13.2
University of Allahabad, Allahabad	2,077	12.9
University of Rajasthan, Jaipur	2,034	12.8
Birla Institute of Technology and Science (BITS), Pilani (P)	3,002	12.7
Indian Institute of Technology, Chennai	9,189	12.3
University of Madras, Chennai	3,346	12.1
University of Pune, Pune	3,171	12.1
University of Lucknow, Lucknow	2,013	12.0
University of Calcutta, Kolkata	5,872	11.9
National Institute of Technology, Rourkela	3,628	11.4
Jadavpur University, Kolkata	8,954	11.3
Jawaharlal Nehru University, New Delhi	4,003	11.1
University of Burdwan, Bardhaman	1,903	11.0
Sri Venkateswara University, Tirupati	2,704	10.8
Thapar University, Patiala (P)	2,995	10.5
M.S. University of Baroda, Vadodara	1,983	9.6
Annamalai University, Chidambaram	5,313	9.5
Pondicherry University, Puducherry	3,676	9.5
National Institute of Technology, Durgapur	2,114	9.2
Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow	2,641	9.2
University of Kalyani, Kalyani	1,810	9.2
Christian Medical College, Vellore	3,219	9.1
SASTRA University, Thanjavur (P)	4,499	9.1

P, Private deemed university.

10 percentile greater than the national average of 19.4%. Of these 40 institutions, 33 had FWCI greater than or equal to the global average of 1.05. Twenty-five institutions (23 public and 2 private, shown in bold in Table 3) had both output in top 10 percentile and FWCI greater than the global averages (23.2% and 1.05 respectively). The national FWCI during this period was 0.99.

Biochemistry, genetics and molecular biology

In biochemistry, genetics and molecular biology, a total of 88,330 papers were published during 2011–2016, with the national average of output in top 10 percentile and FWCI being 13.5% and 0.75 respectively. The number of institutions with a minimum of 133 publications in this

Table 3. Indian institutions with publication output greater than or equal to the minimum number of publications required (as shown in Table 1) and output in top 10 percentile greater than the national average. Data are tabulated subject-wise. The field weight citation index (FWCI) of these institutions is also shown subject-wise, wherever applicable

Institution	Output in top 10 percentile for different fields						
	Medicine (FWCI)	Engineering (FWCI)	Computer science (FWCI)	Physics and astronomy (FWCI)	Chemistry (FWCI)	BGM (FWCI)	Materials science (FWCI)
Public institutions/research laboratories							
Aligarh Muslim University, Aligarh	11.9 (0.80)	**12.3 (1.02)**	3.8 (0.64)	**22.4 (1.41)**	20.2 (0.96)	**23.6 (1.18)**	**22.5 (1.12)**
Banaras Hindu University, Varanasi	12.8 (0.89)	**13.1 (1.03)**	4.2 (0.72)	**14.3 (1.13)**	**24.9 (1.26)**	17.9 (0.91)	16.9 (1.09)
Indian Institute of Science, Bengaluru	**21.2 (1.20)**	**10.2 (1.16)**	4.5 (0.98)	14 (1.04)	**28.7 (1.38)**	20.3 (1.01)	**21.3 (1.25)**
Indian Institute of Technology, Roorkee	**22.8 (1.52)**	**12.5 (1.25)**	7.4 (0.96)	**16.3 (1.34)**	**30.2 (1.62)**	19.5 (1.04)	**21.5 (1.45)**
Indian Institute of Technology, Bombay	**21 (1.23)**	**9.1 (1.04)**	4.4 (0.83)	**16.5 (1.20)**	**26.3 (1.20)**	20.7 (1.03)	16.7 (1.05)
Indian Institute of Technology, New Delhi	**18.6 (1.21)**	**13.1 (1.21)**	7.9 (1.03)	13.2 (0.98)	23.1 (1.16)	17.1 (0.98)	17.1 (1.07)
Indian Institute of Technology, Guwahati	**23.8 (1.50)**	9.8 (0.93)	4.3 (0.63)	**18 (1.15)**	**29.9 (1.37)**	21.5 (1.04)	**20.7 (1.11)**
University of Delhi, New Delhi	12.5 (0.87)	10.9 (0.97)	4 (0.77)	**23.3 (1.49)**	**26.4 (1.15)**	19.2 (0.94)	21.1 (1.05)
Bharathiar University, Coimbatore	**22.6 (2.07)**	10.9 (0.78)	9.3 (0.93)	14.8 (0.89)	22 (1.12)	–	**20.8 (1.16)**
Guru Nanak Dev University, Amritsar	**18.8 (1.12)**	**16.2 (1.01)**	–	15.2 (0.88)	**28.5 (1.30)**	21 (1.08)	**21.3 (1.14)**
Indian Institute of Chemical Technology, Hyderabad	**30.8 (1.64)**	–	6.8 (0.60)	**18.2 (1.23)**	**25 (1.23)**	22.6 (1.21)	**26.2 (1.38)**
Indian Institute of Technology, Kharagpur	**21.4 (1.28)**	**12.5 (1.17)**	6.9 (0.99)	–	**24.9 (1.25)**	23.1 (1.11)	**18.5 (1.16)**
Indian Institute of Technology, Chennai	**19.9 (1.20)**	**8.5 (0.99)**	4.7 (0.90)	–	**23.2 (1.18)**	18.2 (0.98)	16.7 (1.06)
Jadavpur University, Kolkata	**18.5 (1.36)**	**10 (1.05)**	6.6 (1.05)	–	**23.2 (1.15)**	16.2 (0.86)	17.1 (1.04)
Jamia Millia Islamia, New Delhi	18.2 (1.02)	10.6 (0.90)	–	14.3 (0.89)	25.8 (1.05)	**24.4 (1.16)**	17.4 (1.02)
Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru	**21 (1.27)**	**23.1 (1.93)**	–	**17.1 (1.37)**	**35.6 (1.61)**	17.8 (1.08)	**33.5 (1.74)**
Jawaharlal Nehru University, New Delhi	**17.1 (1.15)**	10.3 (0.96)	3.6 (0.77)	–	22.4 (1.43)	19.2 (1.02)	18.4 (0.96)
Panjab University, Chandigarh	**16.4 (1.38)**	**16.7 (1.36)**	–	**33.7 (2.01)**	23.4 (1.06)	19.7 (0.97)	**22.2 (1.16)**
Tata Institute of Fundamental Research, Mumbai	**19.5 (1.28)**	**16.3 (1.37)**	–	**25.6 (1.61)**	**27.9 (1.18)**	21.2 (1.01)	16.1 (0.91)
University of Hyderabad, Hyderabad	**18.5 (1.16)**	**9.3 (1.00)**	3.3 (0.85)	–	**24 (1.25)**	19.3 (1.10)	18 (1.09)
National Institute of Technology, Rourkela	–	**10.3 (1.03)**	4.1 (0.72)	15.4 (0.96)	**25.6 (1.19)**	24 (1.10)	**18 (1.11)**
Bharathidasan University, Tiruchirappalli	**17.4 (1.09)**	9.8 (0.72)	–	14.9 (1.00)	23.7 (1.06)	18.7 (0.94)	–
Indian Institute of Technology, Kanpur	**23.4 (1.21)**	9.5 (0.98)	5.5 (0.94)	–	**26.4 (1.31)**	20.4 (1.15)	–
Indian School of Mines University, Dhanbad	–	**12.4 (1.06)**	6.3 (1.02)	**16.6 (1.23)**	**31.9 (1.59)**	–	**18.8 (1.19)**
Saha Institute of Nuclear Physics, Kolkata	–	**25 (1.64)**	–	**23.4 (1.64)**	19.5 (0.96)	15.7 (0.86)	18.8 (0.94)
Shivaji University, Kolhapur	–	**22.3 (1.35)**	–	**26.1 (1.32)**	**26.6 (1.20)**	16.7 (0.84)	**29.8 (1.49)**
Tezpur University, Tezpur	–	**15.6 (1.08)**	6.1 (0.70)	–	**27.1 (1.19)**	23.9 (0.95)	**20.9 (1.15)**
University of Lucknow, Lucknow	11.6 (0.80)	**12.8 (0.99)**	–	17.4 (1.00)	–	14.3 (0.75)	16.8 (0.84)
University of Mumbai, Mumbai	**23.6 (1.40)**	**15.4 (1.13)**	–	**19.2 (1.29)**	20.3 (0.95)	17.3 (0.90)	–
University of Pune, Pune	**17.3 (1.16)**	8.2 (0.68)	3.3 (0.57)	–	–	16.9 (0.97)	**19.1 (1.11)**
Annamalai University, Chidambaram	**18.9 (1.35)**	–	3.5 (0.72)	**16.2 (1.10)**	–	14.2 (0.89)	–
Indian Association for the Cultivation of Science, Kolkata	–	–	–	15.2 (1.00)	**31 (1.30)**	24 (1.09)	**30.5 (1.39)**
Madurai Kamaraj University, Madurai	**22.5 (1.39)**	**15.1 (1.02)**	–	–	21.7 (1.13)	18.5 (1.07)	–
Sri Venkateswara University, Tirupati	–	12.6 (0.92)	5.8 (0.44)	**21 (1.11)**	–	–	**21.4 (1.11)**
University of Allahabad, Allahabad	12.9 (1.25)	12 (0.96)	–	–	–	18.2 (1.03)	19.1 (1.05)
Visva-Bharati University, Santiniketan	–	–	–	**27.1 (1.48)**	**25.7 (1.22)**	**24 (1.25)**	18.4 (1.02)
Indian Statistical Institute, Kolkata	**16.5 (1.03)**	**12.7 (1.52)**	6.5 (1.02)	–	–	–	–
M.S. University of Baroda, Vadodara	**14.4 (1.04)**	13.2 (0.89)	–	–	–	16.7 (0.89)	–
National Institute of Technology, Tiruchirappalli	–	11.4 (0.94)	5.1 (0.71)	–	**26.8 (1.22)**	–	–
Pondicherry University, Puducherry	**20.8 (1.13)**	–	–	–	22.3 (0.99)	19.6 (0.84)	–
Punjabi University, Patiala	10.2 (0.73)	–	3.6 (0.61)	–	–	13.5 (0.73)	–
University of Burdwan, Bardhaman	–	**11.5 (1.15)**	–	13.5 (0.94)	21.6 (1.04)	–	–
University of Calcutta, Kolkata	**17.5 (1.05)**	–	–	–	23.1 (1.07)	18.8 (0.84)	–
University of Madras, Chennai	**15.4 (1.10)**	12.4 (0.87)	–	–	–	19.3 (0.88)	–
Jamia Hamdard University, New Delhi	15.5 (0.82)	–	–	–	–	17.8 (0.97)	–
National Institute of Technology, Durgapur	–	7.9 (0.82)	–	–	**24.9 (1.24)**	–	–
University of Mysore, Mysuru	8.7 (0.72)	–	–	–	–	14.7 (0.72)	–
University of Rajasthan, Jaipur	9.6 (0.70)	–	–	**22.2 (1.58)**	–	–	–
All India Institute of Medical Sciences, New Delhi	–	–	–	–	–	13.8 (0.76)	–

(*Contd*)

Table 3. (*Contd*)

Institution	Output in top 10 percentile for different fields						
	Medicine (FWCI)	Engineering (FWCI)	Computer science (FWCI)	Physics and astronomy (FWCI)	Chemistry (FWCI)	BGM (FWCI)	Materials science (FWCI)
Anna University, Chennai	16 (0.88)	–	–	–	–	–	–
Chhatrapati Shahuji Maharaj Medical University, Lucknow	–	–	–	–	–	15.2 (0.72)	–
Indian Agricultural Research Institute, New Delhi	**14.7 (1.36)**	–	–	–	–	–	–
Indian Veterinary Research Institute, Bareilly	10.4 (0.81)	–	–	–	–	–	–
Motilal Nehru National Institute of Technology, Allahabad	–	–	–	**21.5 (1.55)**	–	–	–
Osmania University, Hyderabad	10 (0.78)	–	–	–	–	–	–
Postgraduate Institute of Medical Education and Research, Chandigarh	–	–	–	–	–	13.6 (0.85)	–
Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow	–	–	–	–	–	15.6 (0.90)	–
Sardar Vallabhbhai National Institute of Technology, Surat	–	–	–	16.9 (1.00)	–	–	–
University of Kalyani, Kalyani	–	–	–	–	–	14.5 (0.68)	–
Private institutions							
SASTRA University, Thanjavur	**19 (1.03)**	–	6.1 (0.73)	**27 (1.59)**	20.6 (0.91)	16.6 (0.77)	21.7 (1.09)
Amrita Vishwa Vidyapeetham, Coimbatore	14.4 (1.00)	–	–	14.3 (0.74)	**32.9 (1.52)**	25.7 (1.11)	**26.8 (1.42)**
BITS, Pilani	**21.3 (1.15)**	**9.6 (1.19)**	4.8 (0.69)	–	**23.4 (1.26)**	**23.2 (1.21)**	–
Vellore Institute of Technology, Vellore	11.5 (0.85)	–	3.5 (0.73)	14.3 (1.01)	20.2 (0.99)	–	–
Jaypee University of Information Technology, Solan	–	–	–	16 (1.02)	–	16 (1.08)	**17.5 (1.21)**
SRM University, Chennai	9.1 (0.66)	–	–	13.2 (0.95)	–	–	16.5 (0.98)
Thapar University, Patiala	–	9.3 (0.95)	8.6 (0.95)	–	–	13.6 (0.71)	–
Christian Medical College, Vellore	9 (1.00)	–	–	–	–	13.5 (0.92)	–
Amity University, Noida	**16.7 (1.13)**	–	–	–	–	–	–
Birla Institute of Technology-Mesra, Ranchi	–	–	–	–	–	14 (0.65)	–
Institute of Technical Education and Research of Siksha 'O' Anusandhan University, Bhubaneswar	–	–	4.4 (0.63)	–	–	–	–
Karunya University, Coimbatore	–	–	–	**19.7 (1.15)**	–	–	–
Manipal University, Manipal	–	–	3.7 (0.70)	–	–	–	–
Sathyabama University, Chennai	–	–	–	**16 (1.12)**	–	–	–

discipline and with output in top 10 percentile greater than 13.5% was 52 (Table 3). The FWCI of 46 institutions was greater than or equal to the national average of 0.75. The global average for output in top 10 percentile and FWCI area were 22.8% and 1.16 respectively. Four institutions (shown in bold in Table 3), had both output in top 10 percentile and FWCI greater than the global average.

Materials science

In the subject area of materials science, a total of 83,051 papers were published during the period 2011–2016 and the national average output in top 10 percentile was 16%. The global average output in top 10 percentile was lower than the national average in this subject category. The number of institutions with output in top 10 percentile greater than the national average was 35, out of which 19 institutions (shown in bold in Table 3) had FWCI greater than the global average of 1.10. Three other institutions (University of Hyderabad, BHU and SASTRA University) had FWCI (1.09) very close to the global average. The national FWCI for materials science during this period was 0.98.

Summary

The quality-based analysis of publications by Indian institutions, in terms of output in top 10 percentile and FWCI revealed that a reasonable number of institutions engage in scholarly research leading to impactful papers. Materials science, physics and astronomy were strong subject areas with output in top 10 percentile better than

the respective global average. Jawaharlal Nehru Centre for Advanced Scientific Research, Tata Institute of Fundamental Research, Indian Institute of Science, Indian Institute of Technology-Roorkee, Shivaji University, Panjab University and Aligarh Muslim University were among the top 10 contributors in three of the seven major subject areas, with both FWCI and output in top 10 percentile greater than the global average. In the private sector, BITS-Pilani, SASTRA University and Amrita Vishwa Vidyapeetham were among the top three contributors in at least two of the seven major subject areas, with both FWCI and output in top 10 percentile greater than the global average.

1. Singh, A., Are our all research journals scholarly and peer reviewed? *Curr. Sci.*, 2014, **107**(2), 161.
2. http://www.thehindu.com/sci-tech/fake-journals-make-in-india-gone-wrong/article7800231.ece (last viewed on 22August 2017).
3. Prathap, G., Excellence mapping of research performance in India during the 2009–2013 window. *Curr. Sci*., 2017, **112**(3), 437–438.
4. Garg, K. C., Dutt, B. and Kumar, S., Scientometric profile of Indian science as seen through Science Citation Index. *Ann. Libr. Inf. Stud*., 2006, **53**, 114–125.
5. Kumar, S., Garg, K. C. and Dutt, B., Indian scientific output as seen through Indian Science Abstracts. *Ann. Libr. Inf. Stud*., 2009, **56**, 163–168.
6. Prathap, G. and Gupta, B. M., Ranking of Indian engineering and technological institutes for their research performance during 1999–2008. *Curr. Sci.*, 2009, **97**(3), 304–306.
7. Basu, A., Banshal, S., Singhal, K. and Singh, V., Designing a Composite Index for research performance evaluation at the national or regional level: ranking Central Universities in India. *Scientometrics*, 2016, **107**(3), 1171–1193.
8. https://www.elsevier.com/__data/assets/pdf_file/0020/53327/scival-metrics-guidebook-v1_01-february2014.pdf (last viewed on 22 August 2017).
9. Garg, K. C. and Kumar, S., Scientometric profile of Indian scientific output in life sciences with a focus on the contributions of women scientists. *Scientometrics*, 2014, **98**(3), 1771–1783.
10. Karpagam, R., Gopalakrishnan, S., Natarajan, M. and Ramesh Babu, B., Mapping of nanoscience and nanotechnology research in India: a scientometric analysis, 1990–2009. *Scientometrics*, 2011, **89**(2), 501–522.
11. Kaur, H. and Mahajan, P., Ranking of medical institutes of India for quality and quantity: a case study. *Scientometrics*, 2015, **105**(2), 1129–1139.
12. Singh, V., Uddin, A. and Pinto, D., Computer science research: the top 100 institutions in India and in the world. *Scientometrics*, 2015, **104**(2), 529–553.
13. Prathap, G., A three-dimensional bibliometric evaluation of recent research in India. *Scientometrics*, 2017, **110**(3), 1085–1097.

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