

Identifying the Institutional Shifts in Contribution to Indian Research Output

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ABSTRACT

In the past few decades, India has emerged as a major knowledge producer, with the research output being contributed by a diverse set of institutions. These include centrally funded, state funded and private institutions. However, a significant change has been witnessed in research contributions of the Indian institutional actors during the last two decades. In this rapidly evolving landscape, it is important to explore the extent to which the composition of the list of the top 100 research output producing institutions has changed during the last two decades. This analysis may contribute to a better understanding of the dynamic institutional research ecosystem of the country, particularly in view of the fact that several new institutions have come up during the period, including in the private sector. The Web of Science research publication data during the two 10-year periods (2004-13 and 2014-23) is analysed for the purpose. The institutions which retain their position within the top 100 during both periods are identified, along with the change in their positions. Similarly, institutions that were there in the top 100 list during the first time period (2004-13) and went out of the top 100 list during the second time period (2014-23) are also identified. In the same line, the new entrant institutions in the top 100 list during the second time period (2014-23) are identified too. The results obtained indicate an institutional shift in the contribution to Indian research output, with a greater contribution coming from institutions in the private sector and a general decline of output from several state universities. The analysis thus provides empirical evidence towards the impacts of structural and policy changes in the Indian Institutional system.

Keywords: Indian Research, Indian Science, Institutional Shifts, Productivity Shifts.

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INTRODUCTION

India has now emerged as a major knowledge producer, with some reports indicating that it ranks at third place in research output after the United States of America (USA) and China (National Science Board 2021, DST R&D Statistics Report 2021-22, Singh *et al.*, 2020). This research output is contributed by a diverse set of institutions, ranging from centrally funded to state funded, and from public funded to private funded institutions. In fact, a recent study suggested that a majority of research publications in India are produced by the centrally funded institution systems (67.58%), which include, Indian Institutes of Technology (IITs), Institutions of Council of Scientific and Industrial Research (CSIR), Central Universities, Department of Atomic Energy (DAE) institutions, National Institutes of Technology (NITs), Indian Council of

Agricultural Research (ICAR), and Department of Science and Technology (DST) institutions. In contrast, all other sources (state universities, private universities, Industry etc.) together account for the rest 32.42% of the publications (Kanaujia *et al.*, 2022). Some other studies have also identified the major institutions and systems contributing to Indian research output. For example, Prathap (2014) identified the role of several elite institutions (also recognised as Institutes of National Importance) as contributors to Indian research output.

A significant change has been witnessed in the research and development activities of the Indian institutional actors during the last two decades. The CII-ICI report 2016 on research productivity of Indian universities underlined the increase in the number of private universities and a shift in their focus towards research activities as well. A look at the number of universities in India shows that the number of private universities has increased from a few private universities in 2003, to about 261 (in 2014) and about 430 (in 2023), state universities increased from 183 (in 2003) to 316 (in 2014) and 460 (in 2023), and Central Universities increased from 18 (in 2003), and 43 (in 2014) to 56 (in 2023) (AISHE 2014-15; 2021-22; University Grants Commission 2003;



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2023). The number of Institutes of National Importance (INIs) also increased from 75 (in 2014) to 153 (2022). The most notable growth, however, is in the number of private Universities. Prathap and Sriram, (2017) while analysing the performance of selected private universities between 2013-2016, noted that while several of them had more than three times the number of faculty staff, and similar overall budget as that of IISc (the leading Institutes of National Importance in the period), their spending per faculty was much lower and the research activities were much less efficient resulting in lower publication output. However, a later study noted that some of the private universities are on the path towards positioning them as more research and innovation driven institutions (Banshal *et al.*, 2019).

The recently released NIRF rankings 2024 reflects a share of 23.48% publications by the private institutions/universities, and a share of 6% by the State Private Universities, in the national research output specifically from top 100 ranked institutions in National Institutional Ranking Framework (NIRF) (Department of Higher Education, 2024). These changes suggest a possible shift in the direction of the academic ecosystem of the country, where new universities/institutions may become important in terms of research publications. Some other recent studies have also indicated that the rate of publication output of some of the major institutions have slowed down in the past few years, and several new research institutions have come to the fore in the R&D landscape (Kanauija *et al.*, 2022; 2023).

However, there is a lack of sufficient empirical analysis of the transition in Institutional R&D activities. The extent to which private institutions are contributing to Indian research output, and the dynamic changes in their relative positioning with the older institutions, needs a detailed analysis. Such an analysis would not only provide empirical evidence to further explore the factors and impacts of these transitions, but also help understand the changing dynamics of Indian institutional actors w.r.t. research. With the recently initiated systemic and policy changes in Indian Education and R&D ecosystem, these insights may make valuable inputs to direct policy action. Thus, it becomes important to look at the changes in the list of institutions among the top contributors to Indian research. This study attempts to address this gap by identifying the major changes in the composition of the list of the top 100 research output producing institutions during the recent two decades, 2004-13 and 2014-23. The analysis focused on identifying institutions that figure in both lists, those that lose their positions, and the new entrants. More specifically, the study attempts to answer following research questions:

RQ1: Which Indian institutions figure in the list of top 100 research output producers during the last 20-year period (2004-13 and 2014-23)?

RQ2: What are the major changes in the composition of the top 100 list during 2004-13 and 2014-23, and what do these changes indicate?

Related Work

Over the past few years, performance assessment and ranking of Indian institutions has become an area of policy and academic interest at national level. The institutional rankings promoted by the Ministry of Education, Govt. of India, namely, NIRF and Atal Ranking of Institutions on Innovation Achievements (ARIIA) can be seen as two examples (MHRD, 2017). In addition to these efforts, various researchers have also analysed the research performance of an individual or a group of institutions.

The research performance of India and Indian Institutions has been compared to institutions in different countries on criteria of research productivity (Prathap 2017; Prathap and Sriram, 2017; Prathap 2018; Singh *et al.*, 2020; Rajan *et al.*, 2018). At national level, several individual studies have been conducted to analyse the performances of institutions or institution systems, such as the All India Institute of Medical Science (AIIMS) (Nishavathi and Jeyshankar, 2018), IITs (Prathap and Gupta, 2009; Prathap, 2014; Banshal *et al.*, 2017), NITs (Bala and Kumari, 2013; Banshal *et al.*, 2018), Indian Institute of Management (IIMs) (Tyagi, 2024; Singh, Nandy and Singh, 2022), Indian Medical Institutions (Ray *et al.*, 2016), IISERs (Solanki, Uddin and Singh, 2016), ICARs (Suresh and Thanuskodi, 2019), Central Universities (Basu *et al.*, 2016; Kanauija *et al.*, 2022), Private universities (Prathap and Sriram, 2017; Banshal *et al.*, 2019) etc. More recently, a group of researchers developed a portal named 'Indian Science Reports' (www.indianscience.net) that benchmarks research output related indices and analysis for 1000 Indian institutions (Singh *et al.*, 2022).

Though there have been several previous studies on analysis of research output and performance of Indian institutions, no previous study tried to see the institutional shifts in the contribution to Indian research output over time. It is not known as to whether and to what extent the composition of the list of the top 100 research output producing institutions have changed during the last 20 years. The study attempts to address this gap by identifying the major changes in the composition of the list of the top 100 research output producing institutions during the recent two decades, 2004-13 and 2014-23. The institutions that gain rank in the list, those that lose and go out of the list, and those that are able to retain their position, are identified. A discussion on the type and nature of the institutions losing and gaining in the list is developed.

Data and Method

The study has obtained research publication data (restricted to document types 'article' and 'review') of the Indian institutions from the Web of Science (WoS) database. WoS is a reputed and

reliable publication database with a standardised and predefined criteria for inclusion of research publications. It enlists data from more than 34,000 journals and is widely used for exploring scientific data. The choice of limiting search to Article and Review articles is to only include high quality publications.

The data collection has happened in two stages. In the first stage the WoS database has been queried with the search queries $CU="India" \text{ AND } DT="Article" \text{ OR } "Review" \text{ AND } PY="2004-2013"$ and $CU="India" \text{ AND } DT="Article" \text{ OR } "Review" \text{ AND } PY="2014-2023"$ to obtain the overall Indian research output for the said periods. The database search resulted in a total of 12,74,094 publication records. The second stage utilized the *Analyze Results* feature of WoS. This feature allows to delve the research outputs using multiple metadata fields like Affiliations, Web of Science Categories, Research areas etc. The result includes publication count and its percentage share in total output for each unique value of the selected metadata field. For our case specifically *Affiliations* were used. All the variations in the name of Institutions were consolidated and the variant with the highest publication count was used for further querying. Following this the most common name form of the institution was used for reporting. For instance, in case of Vellore Institute of Technology, variants included "Vellore Institute of Technology VIT" (20,865), "VIT Vellore" (17,269), "VIT AP University" (1,206), and "VIT Bhopal University" (729); the first was used for querying and "VIT Vellore" for reporting. No new entities were introduced. From the results a list of top institutions in terms of research output is identified for both the time periods. Thereafter, the united list for time periods, 2004-2013 and 2014-2023, is also obtained. This list contains a total of 140 unique institutions, appearing in the top 100 during each period.

To analyse the different trends and indicators, programs written in Python were used. The different indicators computed for the given list of institutions include total research publications, proportionate share to Indian research output, and the Compounded Annual Growth Rate (CAGR) of publications in the two analysis periods.

The changes in these indicators for the different institutions were observed and have been reported in the results section. The institutions which entered and those which slipped out of the top 100 list in the 2014-2023 period were identified and reported. A discussion around the type and nature of these institutions is developed.

RESULTS

Research output of top 100 Indian institutions during the two time periods of 10-year each

For the top 100 institutions in the 2004-2013 period, the total publication count was 2,23,532. Among them, IISc Bangalore had the highest number of publications i.e., 13965 followed by

IIT Kharagpur (10561) and University of Delhi (9456). In the 2014-2023 period, the total publication count of the top 100 institutions was 4,60,813 (Table 1). Among them the top three institutions remained in their positions with 21976, 21349 and 21109 publications, respectively. In the top 10 institutions, IIT Kanpur moved from 9th position to 14th position, Jadavpur University moved from 10th to 22nd position, IIT Roorkee moved from 12th to 10th position, and Vellore Institute of Technology moved from 45th to 8th position. The total number of publications for the institute at 100th position in 2004-2013 period was 1107 while the same for 2014-2023 period was 3407, which matches with the overall increase in publication output from India. In Table 1, the positions of institutes in both periods are provided and arrows are used to indicate change in the position. Movements within top 100 are shown by single arrows ($\uparrow$ or $\downarrow$), and in or out of top 100 is shown by double arrows ($\Uparrow$ or $\Downarrow$), while dash (-) shows no change in position.

Notably, 40 institutions in the top 100 of 2004-2013 slipped out of the top 100 in the 2014-2023 period (Table 1). The overall CAGR (2004-2023) was highest for Saveetha Institute of Medical Technical Science at 53.29% and it moved from 420th position with 198 publications during 2004-2013 to 20th position with 10,777 publications during 2014-2023 in the top 100 institutions. It may also be noted from the table that the proportionate share of research contribution of almost all the institutions have decreased from first to second time period.

In between the two periods a total of 40 institutions moved out of the top 100 list based on their publication output. Among them eighteen (18) are universities (16 state and 2 central), eleven (11) are a part of the Council for Scientific and Industrial Research (CSIR), while others are different other institutions (Table 2). This may be related with findings reported in an earlier study, where it was found that CSIR system's proportionate share in national research output has declined from 2001-2005 to 2016-2020 (Kanauija et al., 2022).

Now we look at individual institutions which were in the top 100 list in the 1st period, but went out of the list in the 2nd time period. The major Universities moving out of top 100 were, University of Mysore which moved from 29th to 113th position, University of Rajasthan (35 to 191), University of Allahabad (41 to 104), Sri Venkateswara University (44 to 142), Maharaja Sayajirao University Baroda (47 to 111), Mangalore University (48 to 193), Andhra University (49 to 106), Shivaji University (55 to 120), University of Mumbai (57 to 172), Lucknow University (61 to 123), Madurai Kamaraj University (62 to 129), Kalyani University (65 to 117), Karnataka University (68 to 179), Kurukshetra University (74 to 149), Bangalore University (77 to 218), Jawaharlal Nehru Technological University Hyderabad (78 to 146), Govind Ballabh Pant University of Agriculture Technology (89 to 162), and Dr. Hari Singh Gour University (96 to 256). Thus, many state universities, which were among the

top 100 contributors to Indian research output during 2004-13 moved out of this list during 2014-23.

Several CSIR institutions have also lost their position, such as Central Drug Research Institute (CDRI) (33 to 107), Central Food Technological Research Institute (CFTRI) (53 to 176), National Institute Interdisciplinary Science Technology (NIIST) (52 to 139), Central Leather Research Institute (CLRI) (59 to 185), Indian Institute of Chemical Biology (IICB) (70 to 194), National Institute of Oceanography (NIO) (73 to 168), Central Electrochemical Research Institute (CECRI) (76 to 138), Central Salt Marine Chemical Research Institute (CSMCRI) (82 to 156), Centre for Cellular Molecular Biology (CCMB) (86 to 255), National Geophysical Research Institute (NGRI) (88 to 206), Central Glass Ceramic Research Institute (CGCRI) (100 to 220). This is an important trend which warrants further exploration in the output patterns of CSIR institutions. Among the most plausible reasons, this shift may be either due to decrease in research activities, hence publications from these institutions or, due to a change of nature of research outcomes from these institutes (say patents, technology transfers etc., instead of research papers).

Among the other institutions, Jawaharlal Nehru Center for Advanced Scientific Research (JNCASR) (34 to 110), Physical Research Laboratory (PRL) India (75 to 134), Inter University Accelerator Centre (79 to 203), UGC DAE Consortium for Scientific Research (81 to 128), SN Bose National Centre for Basic Science (SNBNCBS) (84 to 163), Raja Ramanna Centre for Advanced Technology (87 to 196), Maulana Azad Medical College (91 to 167), Bose Institute (92 to 161), National Institute of Pharmaceutical Education Research (NIPER) SAS Nagar Mohali

(95 to 257), ICAR National Dairy Research Institute (97 to 101), and Institute of Physics Bhubaneswar (IOPB) (99 to 155) moved to positions outside top 100. Taken together, the contribution of these 40 organisations in national output during the 1st period was 14.7% of publication in the first period, which reduced to 8.01% during the 2nd period.

Other major organisations whose position in terms of share of publications reduced were CSIR-Indian Institute of Chemical Technology (IICT), Kolkata (13 to 38), CSIR-National Chemical Laboratory (NCL), Pune (19 to 46), Indian Association for the Cultivation of Science (IACS), Jadavpur (20 to 60), Annamalai University (21 to 42), University Of Madras (22 to 52), and CSIR-National Physical Laboratory (NPL), Delhi (27 to 87). The highest CAGR over both periods among these institutions is 10.24% for Jawaharlal Nehru Technical University Hyderabad. From Table 1 it may also be noted that many of these institutions had a negative CAGR in the 2nd period indicating a slower rate of publication during the period. The movement of central and state universities out of the top 100 list raises concerns regarding their research activities and environment. The movement of central government funded R&D institutions (Bose Institute, IOPB, JNCASR, PRL, Raja Ramanna Centre for Advanced Technology, SNBNCBS), CSIR, ICAR, NIPER Institutes and UGC centres etc. out of the top 100 institutions list, may however be an indication of either a change in research agenda with higher focus on other activities such as technology development, patents, etc. or a general decline in research activity in these institutions.

New entrants in the 2013-2024 period are mainly Private universities (18), NITs (9), IITs (5), IISERs (2), many of which were newly established (Table 3). Three (3) state universities,

Table 1: Research Output of top 100 Indian Institutions during 2004-2013 and 2014-2023 (Union of two sets).

Sl. No.	Name of the Institution	2004-2013				2014-2023				CAGR3 (2004-2023)
		TP	Rank	CAGR1 (2004-2013)	% share of total	TP	Rank	CAGR2 (2014-2023)	% share of total	
1.	Indian Institute of Science (IISc) Bangalore	13,965	1	6.58	3.15	21,976	1 (-)	3.32	1.82	4.99
2.	Indian Institute of Technology (IIT) Kharagpur	10,561	2	9.23	2.38	21,349	2 (-)	7.48	1.77	8.43
3.	University of Delhi	9,456	3	12.36	2.13	21,109	3 (-)	8.21	1.75	10.51
4.	Indian Institute of Technology (IIT) Delhi	8,446	4	8.3	1.9	19,957	5 (↓)	10.77	1.66	9.65
5.	Indian Institute of Technology (IIT) Madras	8,231	5	10.92	1.86	20,465	4 (↑)	10.50	1.7	10.62
6.	Banaras Hindu University (BHU)	8,047	6	15.11	1.81	17,360	7 (↓)	8.16	1.44	11.13

Sl. No.	Name of the Institution	2004-2013				2014-2023				CAGR3 (2004-2023)
		TP	Rank	CAGR1 (2004-2013)	% share of total	TP	Rank	CAGR2 (2014-2023)	% share of total	
7.	Indian Institute of Technology (IIT) Bombay	7,848	7	9.52	1.77	19,551	6 (↑)	8.97	1.62	9.28
8.	All India Institute of Medical Sciences (AIIMS) New Delhi	7,285	8	9.57	1.64	16,273	9 (↓)	8.50	1.35	9.18
9.	Indian Institute of Technology (IIT) Kanpur	7,104	9	6.49	1.6	13,316	14 (↓)	7.70	1.1	7.19
10.	Jadavpur University	6,742	10	10.67	1.52	12,817	15 (↓)	4.47	1.06	7.81
11.	Tata Institute of Fundamental Research (TIFR)	6,404	11	6.44	1.44	10,564	22 (↓)	2.38	0.88	4.13
12.	Indian Institute of Technology (IIT) Roorkee	5,870	12	16.21	1.32	15,997	10 (↑)	10.17	1.33	13.38
13.	CSIR-Indian Institute of Chemical Technology (IICT)	5,427	13	3.83	1.22	6,070	38 (↓)	-4.04	0.5	1.39
14.	Anna University	5,322	14	14.13	1.19	13,725	13 (↑)	5.19	1.14	9.98
15.	Panjab University	4,945	15	10.9	1.11	10,696	21 (↓)	7.44	0.89	9.01
16.	Aligarh Muslim University	4,875	16	14.12	1.1	11,244	19 (↓)	9.60	0.93	11.73
17.	University of Calcutta	4,642	17	14.42	1.05	9,793	24 (↓)	2.88	0.81	8.74
18.	Post Graduate Institute of Medical Education Research (PGIMER) Chandigarh	4,469	18	12.02	1.01	11,898	18 (-)	8.89	0.99	10.83
19.	CSIR-National Chemical Laboratory (NCL)	4,089	19	1.47	0.92	5,137	46 (↓)	-2.88	0.43	0.44
20.	Indian Association for the Cultivation of Science (IACS) Jadavpur	4,005	20	6.31	0.9	4,540	60 (↓)	-0.34	0.38	2.99
21.	Annamalai University	3,932	21	13.54	0.89	5,549	42 (↓)	1.65	0.46	7.94
22.	University of Madras	3,531	22	6.49	0.8	4,831	52 (↓)	5.11	0.4	5.36
23.	Indian Institute of Technology (IIT) Guwahati	3,517	23	23.5	0.79	12,743	16 (↑)	11.06	1.06	17.19
24.	University of Hyderabad	3,501	24	12.27	0.79	7,127	32 (↓)	5.44	0.59	8.85
25.	Manipal Academy of Higher Education (MAHE)	3,369	25	25.59	0.76	14,892	12 (↑)	17.63	1.24	20.47

Sl. No.	Name of the Institution	2004-2013				2014-2023				CAGR3 (2004-2023)
		TP	Rank	CAGR1 (2004-2013)	% share of total	TP	Rank	CAGR2 (2014-2023)	% share of total	
26.	Jawaharlal Nehru University New Delhi	2,901	26	11.11	0.65	8,539	28 (↓)	8.66	0.71	10.61
27.	CSIR-National Physical Laboratory (NPL)	2,725	27	12.21	0.61	3,694	87 (↓)	0.24	0.31	6.80
28.	Savitribai Phule Pune University	2,692	28	12.42	0.61	6,444	36 (↓)	8.84	0.53	10.61
29.	University of Mysore	2,684	29	9.8	0.6	3,105	113 (↓↓)	2.64	0.26	3.57
30.	Saha Institute of Nuclear Physics	2,640	30	9.14	0.6	4,330	68 (↓)	-2.83	0.36	3.38
31.	Indira Gandhi Centre for Atomic Research (IGCAR)	2,621	31	11.34	0.59	3,946	76 (↓)	-1.22	0.33	4.31
32.	Indian Statistical Institute Kolkata	2,492	32	7.09	0.56	3,905	79 (↓)	5.53	0.32	5.23
33.	CSIR-Central Drug Research Institute (CDRI)	2,481	33	7.02	0.56	3,218	107 (↓↓)	-0.98	0.27	3.81
34.	Jawaharlal Nehru Center for Advanced Scientific Research (JNCASR)	2,418	34	5.98	0.54	3,132	110 (↓↓)	-4.34	0.26	1.75
35.	University of Rajasthan	2,385	35	4.16	0.54	2,032	191 (↓↓)	2.39	0.17	1.03
36.	Guru Nanak Dev University	2,308	36	10.62	0.52	4,801	54 (↓)	5.96	0.4	7.94
37.	ICAR-Indian Veterinary Research Institute	2,288	37	8.01	0.52	3,581	92 (↓)	0.03	0.3	4.59
38.	Sanjay Gandhi Postgraduate Institute of Medical Sciences	2,267	38	10.03	0.51	3,744	84 (↓)	5.82	0.31	7.35
39.	Jamia Millia Islamia	2,195	39	15.09	0.49	7,537	30 (↑)	14.93	0.63	14.63
40.	Indian Institute of Technology BHU Varanasi (IIT-BHU) Varanasi	2,175	40	16.9	0.49	8,709	26 (↑)	17.78	0.72	16.50
41.	University of Allahabad	2,162	41	15.52	0.49	3,277	104 (↓↓)	7.43	0.27	10.21
42.	Institute of Chemical Technology Mumbai	2,102	42	10.46	0.47	5,052	47 (↓)	7.51	0.42	9.12
43.	Cochin University Science Technology	2,088	43	9.08	0.47	3,946	75 (↓)	10.59	0.33	9.14
44.	Sri Venkateswara University	2,069	44	11.25	0.47	2,559	142 (↓↓)	-9.15	0.21	-0.31

Sl. No.	Name of the Institution	2004-2013				2014-2023				CAGR3 (2004-2023)
		TP	Rank	CAGR1 (2004-2013)	% share of total	TP	Rank	CAGR2 (2014-2023)	% share of total	
45.	Vellore Institute of Technology (VIT)	2,065	45	61.02	0.46	17,272	8 (↑)	21.93	1.43	39.75
46.	Christian Medical College Hospital (CMCH) Vellore	2,041	46	12.6	0.46	4,971	48 (↓)	5.84	0.41	9.71
47.	Maharaja Sayajirao University Baroda	2,014	47	10.39	0.45	3,117	111 (↓)	2.98	0.26	5.29
48.	Mangalore University	1,979	48	6.62	0.45	2,015	193 (↓)	6.78	0.17	6.29
49.	Andhra University	1,977	49	10.43	0.45	3,228	106 (↓)	4.25	0.27	5.19
50.	Bharathidasan University	1,935	50	11.21	0.44	5,158	44 (↑)	10.83	0.43	11.23
51.	Jamia Hamdard University	1,868	51	17.34	0.42	4,483	62 (↓)	8.96	0.37	12.31
52.	CSIR-Central Food Technological Research Institute (CFTRI)	1,855	53	4.4	0.42	2,158	176 (↓)	-1.29	0.18	1.71
53.	CSIR-National Institute Interdisciplinary Science Technology (NIIST)	1,855	52	4.06	0.42	2,586	139 (↓)	1.76	0.22	3.61
54.	National Institute of Technology (NIT) Tiruchirappalli	1,852	54	25.88	0.42	6,699	34 (↑)	13.03	0.56	18.30
55.	Shivaji University	1,849	55	15.5	0.42	2,927	120 (↓)	4.07	0.24	8.35
56.	Bharathiar University	1,747	56	13.06	0.39	5,993	39 (↑)	5.61	0.5	9.84
57.	University of Mumbai	1,706	57	-4.5	0.38	2,188	172 (↓)	12.32	0.18	2.15
58.	Punjab Agricultural University	1,701	58	6.09	0.38	4,849	51 (↑)	14.36	0.4	10.87
59.	CSIR-Central Leather Research Institute (CLRI)	1,700	59	5.54	0.38	2,114	185 (↓)	-2.41	0.18	1.74
60.	Birla Institute of Technology Science Pilani (BITS) Pilani	1,678	60	18.41	0.38	9,320	25 (↑)	17.84	0.77	18.81
61.	Lucknow University	1,639	61	9.36	0.37	2,881	123 (↓)	7.26	0.24	7.36
62.	Madurai Kamaraj University	1,617	62	9	0.36	2,707	129 (↓)	1.25	0.23	4.92

Sl. No.	Name of the Institution	2004-2013				2014-2023				CAGR3 (2004-2023)
		TP	Rank	CAGR1 (2004-2013)	% share of total	TP	Rank	CAGR2 (2014-2023)	% share of total	
63.	Indian Institute of Engineering Science Technology Shibpur (IIEST)	1,611	63	13.86	0.36	4,688	58 (↑)	7.28	0.39	10.37
64.	Visva Bharati University	1,609	64	21.23	0.36	4,231	71 (↓)	4.50	0.35	12.41
65.	Kalyani University	1,559	65	13.57	0.35	3,034	117 (↓↓)	2.48	0.25	6.80
66.	University of Burdwan	1,558	66	12.2	0.35	3,423	99 (↓)	6.49	0.28	8.15
67.	Tata Memorial Centre (TMC)	1,551	67	15.26	0.35	4,656	59 (↑)	8.46	0.39	13.23
68.	Karnatak University	1,535	68	3.46	0.35	2,125	179 (↓↓)	4.81	0.18	3.41
69.	King George S Medical University	1,517	69	22.17	0.34	3,603	91 (↓)	3.69	0.30	9.07
70.	CSIR-Indian Institute of Chemical Biology (IICB)	1,512	70	8.06	0.34	2,005	194 (↓↓)	-2.89	0.17	2.74
71.	Thapar Institute of Engineering Technology	1,494	71	26.39	0.34	7,896	29 (↑)	12.69	0.65	19.29
72.	Punjabi University	1,484	72	29.91	0.33	3,562	93 (↓)	4.96	0.3	16.29
73.	CSIR-National Institute of Oceanography (NIO)	1,476	73	12.32	0.33	2,212	168 (↓↓)	0.45	0.18	6.85
74.	CSIR-Central Electrochemical Research Institute (CECRI)	1,475	76	7.59	0.33	2,593	138 (↓↓)	0.92	0.22	5.49
75.	Kurukshetra University	1,475	74	14.63	0.33	2,432	149 (↓↓)	11.08	0.20	9.50
76.	Physical Research Laboratory India	1,475	75	5.11	0.33	2,631	134 (↓↓)	4.91	0.22	5.53
77.	Bangalore University	1,472	77	7.22	0.33	1,752	218 (↓↓)	-2.17	0.15	1.30
78.	Jawaharlal Nehru Technological University Hyderabad	1,460	78	31.39	0.33	2,475	146 (↓↓)	-3.46	0.21	10.24
79.	Inter University Accelerator Centre	1,458	79	7.43	0.33	1,888	203 (↓↓)	2.46	0.16	4.81
80.	National Institute of Mental Health Neurosciences India	1,435	80	16.8	0.32	4,402	66 (↑)	7.40	0.37	11.84

Sl. No.	Name of the Institution	2004-2013				2014-2023				CAGR3 (2004-2023)
		TP	Rank	CAGR1 (2004-2013)	% share of total	TP	Rank	CAGR2 (2014-2023)	% share of total	
81.	UGC DAE Consortium for Scientific Research	1,433	81	8.01	0.32	2,716	128 (↓)	4.96	0.23	7.12
82.	CSIR-Central Salt Marine Chemical Research Institute (CSMCRI)	1,428	82	13.68	0.32	2,333	156 (↓)	4.03	0.19	8.56
83.	National Institute of Technology Rourkela	1,417	83	33.44	0.32	8,556	27 (↑)	15.77	0.71	24.17
84.	SN Bose National Centre for Basic Science (SNBNCBS)	1,393	84	9.16	0.31	2,257	163 (↓)	3.76	0.19	6.36
85.	Tata Memorial Hospital	1,389	85	14.48	0.31	3,703	86 (↓)	7.00	0.31	11.86
86.	CSIR-Centre for Cellular Molecular Biology (CCMB)	1,386	86	6.87	0.31	1,494	255 (↓)	-1.88	0.12	1.09
87.	Raja Ramanna Centre for Advanced Technology	1,361	87	9.02	0.31	1,959	196 (↓)	-1.64	0.16	4.39
88.	CSIR-National Geophysical Research Institute (NGRI)	1,352	88	9.22	0.3	1,860	206 (↓)	0.76	0.15	4.42
89.	Govind Ballabh Pant University of Agriculture Technology	1,344	89	6.78	0.3	2,270	162 (↓)	9.63	0.19	6.32
90.	Pondicherry University	1,319	90	19.05	0.3	4,826	53 (↑)	7.96	0.4	13.96
91.	Maulana Azad Medical College	1,317	91	14.77	0.3	2,223	167 (↓)	3.63	0.18	5.72
92.	Bose Institute	1,307	92	8.81	0.29	2,286	161 (↓)	1.08	0.19	4.93
93.	Kasturba Medical College Manipal	1,275	93	18.43	0.29	3,945	77 (↑)	12.47	0.33	15.04
94.	Birla Institute of Technology Mesra	1,264	94	24.78	0.28	4,036	74 (↑)	12.64	0.33	18.58
95.	National Institute of Pharmaceutical Education Research SAS Nagar Mohali	1,186	95	6.22	0.27	1,481	257 (↓)	-0.12	0.12	3.37
96.	Dr Hari Singh Gour University	1,173	96	7	0.26	1,481	256 (↓)	5.29	0.12	4.84
97.	ICAR-National Dairy Research Institute	1,148	97	13.71	0.26	3,397	101 (↓)	4.56	0.28	9.79
98.	Tezpur University	1,148	98	31.2	0.26	3,741	85 (↑)	4.91	0.31	18.16

Sl. No.	Name of the Institution	2004-2013				2014-2023				CAGR3 (2004-2023)
		TP	Rank	CAGR1 (2004-2013)	% share of total	TP	Rank	CAGR2 (2014-2023)	% share of total	
99.	Institute of Physics Bhubaneswar (IOPB)	1,111	99	-2.32	0.25	2,336	155 (↓)	6.56	0.19	3.63
100.	CSIR-Central Glass Ceramic Research Institute CGCRI	1,107	100	10.57	0.25	1,749	220 (↓)	-2.43	0.15	4.38
101.	Alagappa University	1,092	103	14.4	0.25	3,488	97 (↑)	9.89	0.29	10.63
102.	National Institute of Technology (NIT) Karnataka	1,018	112	25.84	0.23	4,904	50 (↑)	16.65	0.41	19.09
103.	SRM Institute of Science Technology Chennai	987	119	69.15	0.22	12,742	17 (↑)	28.38	1.06	43.36
104.	Indian Institute of Technology (IIT) Indian School of Mines Dhanbad	982	120	26.16	0.22	10,135	23 (↑)	18.02	0.84	21.58
105.	Jawaharlal Institute of Postgraduate Medical Education Research	841	140	23.16	0.19	3,818	82 (↑)	10.30	0.32	14.01
106.	National Institute of Technology (NIT) Durgapur	835	141	27.81	0.19	3,864	80 (↑)	13.87	0.32	18.99
107.	University of Kashmir	783	149	28.91	0.18	4,323	69 (↑)	15.70	0.36	20.71
108.	Indian Institute of Science Education Research (IISER) Kolkata	742	163	66.06	0.17	4,085	72 (↑)	9.25	0.34	34.40
109.	Shanmugha Arts Science Technology Research Academy (SASTRA)	728	167	40.58	0.16	5,683	41 (↑)	8.75	0.47	25.40
110.	Motilal Nehru National Institute of Technology (NIT)	707	171	26.54	0.16	3,431	98 (↑)	14.81	0.28	17.86
111.	Sardar Vallabhbhai National Institute of Technology (NIT)	703	173	65.67	0.16	3,804	83 (↑)	12.81	0.32	34.77
112.	National Institute of Technology (NIT) Warangal	679	181	17.76	0.15	4,749	57 (↑)	21.05	0.39	18.64
113.	National Institute of Technology (NIT) Calicut	624	193	37.55	0.14	3,407	100 (↑)	20.16	0.28	25.10
114.	Delhi Technological University	610	197	27.56	0.14	4,786	55 (↑)	25.67	0.4	23.70

Sl. No.	Name of the Institution	2004-2013				2014-2023				CAGR3 (2004-2023)
		TP	Rank	CAGR1 (2004-2013)	% share of total	TP	Rank	CAGR2 (2014-2023)	% share of total	
115.	Indian Institute of Science Education Research (IISER) Pune	536	213	64.46	0.12	4,487	61 (↑↑)	11.17	0.37	34.12
116.	Siksha O Anusandhan University	501	222	78.93	0.11	4,929	49 (↑↑)	19.60	0.41	41.54
117.	Gandhi Institute of Technology Management (GITAM)	500	223	27.78	0.11	4,082	73 (↑↑)	29.40	0.34	23.97
118.	Amity University NOIDA	491	227	73.84	0.11	6,873	33 (↑↑)	26.16	0.57	43.30
119.	Visvesvaraya National Institute of Technology (NIT) Nagpur	433	243	25.64	0.10	3,529	95 (↑↑)	21.12	0.29	23.41
120.	SSN College of Engineering	431	244	48.68	0.10	3,561	94 (↑↑)	21.47	0.3	35.27
121.	Malaviya National Institute of Technology (NIT) Jaipur	415	252	26.39	0.09	4,384	67 (↑↑)	26.44	0.36	23.59
122.	Indian Institute of Technology (IIT) Hyderabad	377	266	74.5	0.09	6,071	37 (↑↑)	19.61	0.5	43.94
123.	Sathyabama Institute of Science Technology	337	282	31.8	0.08	4,253	70 (↑↑)	25.33	0.35	27.63
124.	Datta Meghe Institute of Higher Education Research (Deemed to be University)	329	288	58.74	0.07	4,763	56 (↑↑)	29.26	0.4	29.25
125.	Kalinga Institute of Industrial Technology (KIIT)	315	296	70.69	0.07	5,141	45 (↑↑)	22.78	0.43	41.66
126.	Indian Institute of Technology (IIT) Bhubaneswar	273	333	71.74	0.06	3,613	90 (↑↑)	16.77	0.3	39.21
127.	Indian Institute of Technology (IIT) Patna	230	387	65.07	0.05	3,625	89 (↑↑)	24.06	0.3	41.13
128.	Indian Institute of Technology (IIT) Indore	222	397	44.22	0.05	5,741	40 (↑↑)	19.60	0.48	31.81
129.	Saveetha Institute of Medical Technical Science	198	420	57.01	0.05	10,777	20 (↑↑)	61.02	0.89	53.29

Sl. No.	Name of the Institution	2004-2013				2014-2023				CAGR3 (2004-2023)
		TP	Rank	CAGR1 (2004-2013)	% share of total	TP	Rank	CAGR2 (2014-2023)	% share of total	
130.	Lovely Professional University	187	442	32.69	0.04	6,481	35 (↑↑)	43.57	0.54	36.75
131.	Koneru Lakshmaiah Education Foundation K L (Deemed to be University)	180	461	56.4	0.04	4,447	64 (↑↑)	42.40	0.37	43.56
132.	National Institute of Technology (NIT) Silchar	168	480	26.34	0.04	3,926	78 (↑↑)	32.31	0.33	30.25
133.	Homi Bhabha National Institute	152	519	38.7	0.03	14,993	11 (↑↑)	48.56	1.24	41.82
134.	University of Petroleum Energy Studies (UPES)	84	752	49.81	0.02	4,458	63 (↑↑)	44.99	0.37	46.03
135.	Saveetha Dental College Hospital	78	788	43	0.02	5,510	43 (↑↑)	65.65	0.46	45.93
136.	GLA University	76	806	22.76	0.02	3,645	88 (↑↑)	70.38	0.3	37.82
137.	Symbiosis International University	49	1,092	25.99	0.01	3,504	96 (↑↑)	48.39	0.29	32.08
138.	Chandigarh University	-	-	0	-	4,440	65 (↑↑)	97.99	0.37	48.66
139.	ICAR-Indian Agricultural Research Institute	-	-	11.03	-	7,393	31 (↑↑)	10.45	0.61	9.88
140.	Saveetha School of Engineering	-	-	8.01	-	3,852	81 (↑↑)	65.91	0.32	37.57

Alagappa University (97), Delhi Technical University (55) and University of Kashmir (69) also entered the top-100 institutions. The most notable pattern is in the case of the private universities, where a major change can be observed in the total number of publications, rising from only a few hundred publications to thousands of publications in the period, indicating a major focus on research activities and outputs in these institutions.

The private universities that improved in ranking are, SRM Institute of Science Technology Chennai (119 to 17), Shanmugha Arts Science Technology Research Academy SASTRA (170 to 40), Sardar Vallabhbhai National Institute of Technology (173 to 83), Siksha O Anusandhan University (222 to 49), Gandhi Institute of Technology Management (GITAM) (223 to 73), Amity University NOIDA (227 to 33), SSN College of Engineering (244 to 94), Sathyabama Institute of Science Technology (282 to 70), Datta Meghe Institute of Higher Education Research Deemed To Be University (288 to 56), Kalunga Institute of Industrial Technology (KIIT) (296 to 45), Lovely Professional University (442 to 35),

Koneru Lakshmaiah Education Foundation K L Deemed To Be University (461 to 64), Saveetha Dental College Hospital (788 to 43), GLA University (806 to 88), Symbiosis International University (1092 to 96), and, Chandigarh University which was established in 2012 and is placed at 65th position in the 2014-2023 period. A closer look at the newly entering private universities suggests that many of them are large universities with more than 500 faculty members (QS Top University Profiles-<https://www.to.puniversities.com/universities/>).

Among the NITs, the nine institutes that gained are Malaviya NIT Jaipur (252 to 67), Motilal Nehru NIT in Prayagraj (171 to 98), NIT Calicut (193 to 100), NIT Durgapur (141 to 80), NIT Karnataka (112 to 50), NIT Silchar (480 to 78), NIT Warangal (181 to 57), Sardar Vallabhbhai NIT (173 to 83), and Visvesvaraya NIT Nagpur (243 to 95). Five IITs are four newly established institutes, namely IIT Bhubaneswar (333 to 90), IIT Hyderabad (266 to 37), IIT Indore (397 to 40), IIT Patna (387 to 89), and IIT-ISM Dhanbad (120 to 23), entered the top 100 list in the

Table 2: Institutions which went out of top 100 list in 2014-23 period.

Sl. No.	Institution name	Type
1.	Andhra University	State
2.	Bangalore University	State
3.	Bose Institute	DST
4.	CSIR-Central Drug Research Institute (CDRI)	CSIR
5.	CSIR-Central Electrochemical Research Institute (CECRI)	CSIR
6.	CSIR-Central Food Technological Research Institute (CFTRI)	CSIR
7.	CSIR-Central Glass Ceramic Research Institute (CGCRI)	CSIR
8.	CSIR-Central Leather Research Institute (CLRI)	CSIR
9.	CSIR-Central Salt Marine Chemical Research Institute (CSMCRI)	CSIR
10.	CSIR-Centre for Cellular Molecular Biology (CCMB)	CSIR
11.	CSIR-Indian Institute of Chemical Biology (IICB)	CSIR
12.	CSIR-National Geophysical Research Institute (NGRI)	CSIR
13.	CSIR-National Institute Interdisciplinary Science Technology (NIIST)	CSIR
14.	CSIR-National Institute of Oceanography (NIO)	CSIR
15.	Dr Hari Singh Gour University	Central
16.	Govind Ballabh Pant University of Agriculture Technology	State
17.	ICAR-National Dairy Research Institute (NDRI)	ICAR
18.	Institute of Physics Bhubaneswar (IOPB)	DAE
19.	Inter University Accelerator Centre	UGC
20.	Jawaharlal Nehru Center for Advanced Scientific Research (JNCASR)	DST
21.	Jawaharlal Nehru Technological University, Hyderabad	State
22.	Kalyani University	State
23.	Karnatak University	State
24.	Kurukshetra University	State
25.	Lucknow University (University of Lucknow)	State
26.	Madurai Kamaraj University	State
27.	Maharaja Sayajirao University Baroda	State
28.	Mangalore University	State
29.	Maulana Azad Medical College	State
30.	National Institute of Pharmaceutical Education Research, SAS Nagar Mohali	NIPER

Sl. No.	Institution name	Type
31.	Physical Research Laboratory India	DoS
32.	Raja Ramanna Centre for Advanced Technology	DAE
33.	Shivaji University	State
34.	Sn Bose National Centre for Basic Science Snnbncbs	DST
35.	Sri Venkateswara University	State
36.	UGC DAE Consortium for Scientific Research	UGC
37.	University of Allahabad	Central
38.	University of Mumbai	State
39.	University of Mysore	State
40.	University of Rajasthan	State

second period. JIPMER (140 to 82), and two IISERs Pune (213 to 62) and Kolkata (163 to 72), also entered the list. These 40 new entrant institutions taken together account for 17.57% of the total research publications in the 2nd period.

DISCUSSION

The research publications from Indian Institutions during two periods 2004-2013 and 2014-2023 were analysed and the major contribution institutions during the two periods were identified. The Total Publications (TP), share in national TP and the CAGR of publications of the top 100 institutions were computed and their respective management and funding types were found out and presented. Top 3 institutions remained the same during both periods, namely, IISc, IIT Kharagpur and University of Delhi, indicating their continued emphasis on research activities and possibly the researcher base. In the Top 10 list, 2 institutions in the first period, IIT Kanpur (9) and Jadavpur University (10) moved out in the second period. In the top 100 list of 2004-13, there are eight (8) IITs, eleven (11) central universities, thirty-two (32) state universities, fourteen (14) CSIR labs, seven (7) private universities and 28 others. However, during the 2014-23 period, this list changes to include a total of thirteen (13) IITs, nine (9) central universities, nineteen (19) state universities, three (3) CSIR labs, twenty-four (24) private universities and 32 others. A total of 40 institutions were replaced in the second period by other institutions. Among the institutions which lost their position there were eighteen (18) state universities, and eleven (11) CSIR labs. In the second time period several private universities (18), NITs (9), IITs (5), IISERs (2), state universities (3), and some centrally funded institutions entered the top-100 institutions list. These patterns are a major indicator of an overall decline in research activity and output of state universities. Similarly, a drop in number of CSIR Labs in the top 100 list also needs a detailed

Table 3: Institutions which entered the top 100 list in 2014-23 period.

Sl. No.	Institution Name	Type
1.	Alagappa University	State
2.	Amity University NOIDA	Private
3.	Chandigarh University	Private
4.	Datta Meghe Institute of Higher Education Research (Deemed to be University)	Private
5.	Delhi Technological University (DTU)	State
6.	Gandhi Institute of Technology Management (GITAM)	Private
7.	GLA University	Private
8.	Homi Bhabha National Institute	DAE
9.	ICAR-Indian Agricultural Research Institute	ICAR
10.	Indian Institute of Science Education Research (IISER) Kolkata	IISER
11.	Indian Institute of Science Education Research (IISER) Pune	IISER
12.	Indian Institute of Technology (IIT) Bhubaneswar	IIT
13.	Indian Institute of Technology (IIT) Hyderabad	IIT
14.	Indian Institute of Technology (IIT) Indore	IIT
15.	Indian Institute of Technology (IIT) Patna	IIT
16.	Indian Institute of Technology (IIT) Indian School of Mines Dhanbad	IIT
17.	Jawaharlal Institute of Postgraduate Medical Education Research	JIPMER
18.	Kalinga Institute of Industrial Technology (KIIT)	Private
19.	Koneru Lakshmaiah Education Foundation K L (Deemed to be University)	Private
20.	Lovely Professional University	Private
21.	Malaviya National Institute of Technology (NIT) Jaipur	NIT
22.	Motilal Nehru National Institute of Technology (NIT)	NIT
23.	National Institute of Technology (NIT) Calicut	NIT
24.	National Institute of Technology (NIT) Durgapur	NIT
25.	National Institute of Technology (NIT) Karnataka	NIT
26.	National Institute of Technology (NIT) Silchar	NIT
27.	National Institute of Technology (NIT) Warangal	NIT

Sl. No.	Institution Name	Type
28.	Sardar Vallabhbhai National Institute of Technology (NIT)	NIT
29.	Sathyabama Institute of Science Technology	Private
30.	Saveetha Dental College Hospital	Private
31.	Saveetha Institute of Medical Technical Science	Private
32.	Saveetha School of Engineering	Private
33.	Shanmugha Arts Science Technology Research Academy (SASTRA)	Private
34.	Siksha O Anusandhan University	Private
35.	SRM Institute of Science Technology Chennai	Private
36.	SSN College of Engineering	Private
37.	Symbiosis International University	Private
38.	University of Kashmir	State
39.	University of Petroleum Energy Studies (UPES)	Private
40.	Visvesvaraya National Institute of Technology (NIT) Nagpur	NIT

exploration as to whether this indicates towards lesser research intensity or perhaps a change in research focus with higher emphasis on technologies and products rather than publications.

It is to be noted that, in 2003, the government introduced regulation for establishment and maintenance of standards in private universities (UGC 2003), and in 2008 the recommendations of National Knowledge Commission (NKC) report "Towards a Knowledge Society: Three Years of the National Knowledge Commission" were released which also made the case for increasing private investment in education. These paved the way for establishment of new large private universities which are multidisciplinary and focus on research in addition to regular education activities (Sengupta, 2020). It is observed that in terms of research publications, several established government-funded institutions have been overtaken by private universities and the newly established Institutions of National Importance (INIs), such as newly formed IITs and IISERs, having express focus on research along with good funding support. The NITs which were formed from the Regional Engineering Centres in the early 2000s have also moved into the list, indicating a clear pattern of increased research intensity in these institutions.

The results also indicate that several state universities and CSIR labs have moved out of the top 100 list during the 2nd time period. A closer analysis shows that, in most cases, the total number of publications from them did not increase much during the period. The low growth in the number of publications of universities may

indicate increasing problems in the research ecosystem in these institutions and possibly also a sign of the research infrastructure becoming outdated. In the case of CSIR, a major systemic change happened with the establishment of Academy of Scientific and Innovative Research (AcSIR), a national university with CSIR labs as its campus hubs and scientists as professors. This injected a large number of new research students in the CSIR system and may have led to changes in productivity profiles of the institutes. However, despite this increase in the number of researchers, the growth of the number of publications from various CSIR labs has been low. The slower growth in number of publications from CSIR labs despite the significant systemic changes is an aspect which demands further exploration. For instance, there may be a change in focus of laboratory research, such as activities other than research publication. These may include, technology development, incubation, technology transfer, patents, educational programmes, strategic international partnerships etc. Alternatively, there may be a change in performance assessment criteria or other administrative requirements affecting the publication output.

When the patterns of growth in number of publications of certain institutions are seen along with the increase in the number of Institutes of National Importance and private universities; one inference may be that the several newly formed institutes have started contributing to the national research output in a short span of time and possibly some more such institutions may enter in this list in the next few years. The several private institutions which have entered the top 100 indicate a significant shift in the outlook and the role of the private sector in education and research in India. A good number of well-known state universities going out of the top 100 list is, however, a very disturbing observation that needs a serious and detailed examination and subsequent corrective actions.

CONCLUSION

This study looked at the research output from Indian universities, and research institutions across two periods 2004-13 and 2014-23 and identified the ones which had the highest number of publications. It looked for changes in the composition of the top 100 list and tried to identify the type of institutions which entered the top 100 list in the 2nd period and also those institutions which moved out of the top 100 list in the 2nd period.

The two most notable observations are: (a) the growth in the number of private universities and newly established INIs which have made their entry in the top 100 list, and (b) a decline in the number of state universities from the top 100 research producers list. The new entrant institutions in the top 100 have replaced several state universities, and centrally funded research institutions such as the CSIR laboratories, ICAR and NIPER institutes. Thus, these observations indicate a possible institutional shift in contribution to the research publications of

India. The state universities and certain CSIR labs going out of the top 100 list is, however, a disturbing observation that needs to be examined in more detail to concretely identify the probable reasons.

While this work presents a very interesting and useful analysis of institutional shifts in contribution to Indian research output, it may be noted that these findings are based on the research publications data only and does not include patents or technologies developed. Additionally, as the research publication data is drawn from Web of Science, any publication in other journals not listed in the Web of Science database are not accounted for. One may, therefore, like to explore with data drawn from other scholarly databases like Scopus, to see if similar patterns of institutional shifts are observed.

ABBREVIATIONS

AIIMS: All India Institute of Medical Sciences; **AISHE:** All India Survey on Higher Education; **ARIIA:** Atal Ranking of Institutions on Innovation Achievements; **BHU:** Banaras Hindu University; **CAGR:** Compound Annual Growth Rate; **CCMB:** Centre for Cellular and Molecular Biology; **CDRI:** Central Drug Research Institute; **CECRI:** Central Electrochemical Research Institute; **CFTRI:** Central Food Technological Research Institute; **CGCRI:** Central Glass and Ceramic Research Institute; **CLRI:** Central Leather Research Institute; **CSIR:** Council of Scientific and Industrial Research; **DAE:** Department of Atomic Energy; **DST:** Department of Science and Technology; **DTU:** Delhi Technological University; **IACS:** Indian Association for the Cultivation of Science; **ICAR:** Indian Council of Agricultural Research; **IIMs:** Indian Institutes of Management; **IISc:** Indian Institute of Science; **IISER:** Indian Institute of Science Education and Research; **IITs:** Indian Institutes of Technology; **IICT:** Indian Institute of Chemical Technology; **INIs:** Institutes of National Importance; **JIPMER:** Jawaharlal Institute of Postgraduate Medical Education and Research; **JNCASR:** Jawaharlal Nehru Centre for Advanced Scientific Research; **KIIT:** Kalinga Institute of Industrial Technology; **MAHE:** Manipal Academy of Higher Education; **MHRD:** Ministry of Human Resource Development; **NCL:** National Chemical Laboratory; **NGRI:** National Geophysical Research Institute; **NIIST:** National Institute for Interdisciplinary Science and Technology; **NIO:** National Institute of Oceanography; **NIRF:** National Institutional Ranking Framework; **NITs:** National Institutes of Technology; **NPL:** National Physical Laboratory; **NUS:** National University of Singapore; **PRL:** Physical Research Laboratory; **QS:** Quacquarelli Symonds; **R&D:** Research and Development; **RQ:** Research Question; **SASTRA:** Shanmugha Arts Science Technology and Research Academy; **SNBNCBS:** S.N. Bose National Centre for Basic Sciences; **TIFR:** Tata Institute of Fundamental Research; **TP:** Total Publications; **UGC:** University Grants Commission; **UPES:** University of Petroleum and Energy Studies; **USA:** United

States of America; **VIT**: Vellore Institute of Technology; **WoS**: Web of Science.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

DECLARATION

A pre-print of this work is available at: <https://arxiv.org/abs/2412.06652>.

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