

ORIGINAL ARTICLE

Qualitative Analysis of the Most Cited Publications from Leading Indian Medical Institutions

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Abstract

Background and Objectives: The most important responsibility of physicians is research - advancement of medical knowledge is the core on which the other responsibilities, patient care and research, are based. This study was planned to conduct a qualitative analysis of the major publications from the the country's leading medical institutions.

Methods: We used Scopus to generate a list of total number of publications from the topmost institutions, the number of citations, and citations per article. We calculated the h-index, g-index, i-10 index, and h5-index for these institutions. A more detailed analysis was carried out for the top 20 most cited papers in each of the institutions. Only descriptive statistics were used.

Results: Among the top 10 medical institutions included, AIIMS, Delhi and PGIMER, Chandigarh were the top institutes, accounting for more publications and citations than the next eight institutions combined. The other institutions also managed to publish a large number of highly-cited papers. AIIMS was the leading institution when other indices were calculated. Among the most-cited articles, >80% had first/corresponding authors from outside India. A large number papers remained uncited, even after many years of publication.

Interpretation and conclusions: Uncited papers could be a result research conducted with the purpose of getting the numbers needed for promotion (NRP). Importance of collaborative research was seen to be an important factor when citations are considered. Even with the huge resource deficit, our institutes managed to publish a decent number of highly cited articles, which can be boosted if funding situation is improved.

Introduction

The word doctor is derived from the Latin word 'docere', meaning, 'to teach'. From where do we get the teaching matter?

It has recently been shown that lower levels of serum calcium, even within the normal range, increase the risk for sudden cardiac arrest.¹ These findings need to be 'taught', with the accompanying editorial stating, "Low serum calcium levels may be considered a potential risk factor for sudden cardiac arrest....." with the remark that these findings should be interpreted with caution.²

Similarly, when we choose to use a drug in the treatment of some illness, the confidence that the drug works comes only from research.

Consequently, although the World Medical Association Declaration states, "..... THE HEALTH AND WELL-BEING OF MY PATIENT will be my first consideration",³ neither healthcare, nor teaching can occur without research.

Therefore, we believe that the most important responsibility of physicians is to do research - advancement of medical knowledge forms a core component of physicians' work, as the various Codes of Ethics state.⁴

Research in India is highly dichotomized - on the one hand, more

than half of our medical institutions did not publish even a single paper over a ten-year period between 2005 to 2014,⁵ on the other hand, some institutions have continued to produce hundreds of publications annually, as seen in several studies over the last decades.⁵⁻⁸

Similar patterns were observed when we recently analyzed data in two specific areas - Clinical Pharmacology⁹ and Chemotherapy¹⁰ - as part of the International Council for Science National Committee-commissioned Status Report on Pharmacological Research in India for the past 5 years.

A preliminary analysis of publications emanating out of some of the leading institutions of the country by us showed that less than 0.5% of the publications in these top institutions were cited ≥ 100 times.¹¹ However, this was not a systematic study and we did not thoroughly analyze topmost publications from the leading institutions of the country.

This study was thus planned to conduct a qualitative analysis of the major publications from the the country's leading medical institutions.

Methods

We included medical institutions which are widely considered to be the best in India. We used Scopus to generate a list of total number of publications from each of these institutions, year-wise list in the last 5 years, the number of citations, and citations per article. We also noted the year for which Scopus has the first entries of publications from these institutions.

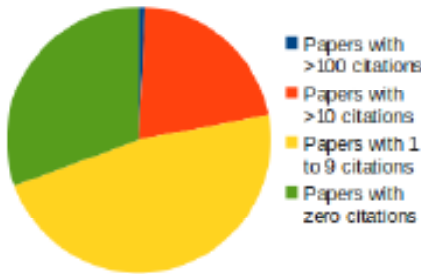
For each of the selected institutes, we calculated the h-index,¹² the g-index,¹³

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Table 1: Details of number of publications, citations and indices in the top 10 medical institutions of India

Institute	Total number of publications	Total number of citations	Citations per paper	h index	g index	h5 index	h5 median
AIIMS	29394	304929	10.4	150	264	61	159
PGIMER	20707	197179	9.5	110	175	51	124
CMCV	8432	85547	10.1	93	147	40	64
SGPGI	6874	83627	12.2	86	168	37	59
KGMU	6424	45407	7.1	70	111	29	44
MAMC	5518	35731	6.5	62	91	22	31
KMC	5392	33368	6.2	61	86	18	25
JIPMER	4732	254094	5.4	47	70	21	26
BHU	5564	58908	10.6	88	144	33	44
KEM	4612	43779	9.5	71	120	30	42

Abbreviations: All India Institute of Medical Sciences, Delhi (AIIMS), Postgraduate Institute of Medical Education and Research, Chandigarh (PGIMER), Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry (JIPMER), Christian Medical College, Vellore (CMCV), Sanjay Gandhi Postgraduate Institute, Lucknow (SGPGI), King George Medical University, Lucknow (KGMU), Maulana Azad Medical College, Delhi (MAMC), Kasturba Medical College, Manipal (KMC), Seth GS Medical College and KEM Hospital (KEM) and Banaras Hindu University, Varanasi (BHU).

**Fig. 1: Proportion of papers among all the top institutions combined that received 100 or more, 10 or more, 1 to 9, or zero citations.**

the i-10 index,¹⁴ and the h5-index with h5-median.¹⁵ Although these indices are author level metrics, we used them for institutions. The h-index was defined as: An institute is said to have an index of h if it has published h papers each of which has been cited at least h times. The g-index was calculated as the largest number such that the top g articles of an institute received at least g² citations. The i10-index was calculated as the number of publications of an institute with 10 or more citations. We extended the concept of i-10 index to very highly cited papers using i-1000 index and i-100 index. In addition, we used another index, i-zero, to denote the number of papers that have not received any citations.

The h5-index was defined as the h-index of an institute for articles published in the last 5 years. The h5-median was estimated as the median number of citations for articles constituting the institutional h5-index.

Table 2: Various research metrics of the top 10 medical institutions of the country

Institution	i-1000 index, n (%)	i-100 index, n (%)	i-10 index, n (%)	i-zero index, n (%)
AIIMS	8 (0.027)	304 (1.03)	6990 (24)	9393 (32)
PGIMER	2 (0.001)	130 (0.63)	4223 (20)	6251 (30)
CMCV	1 (0.012)	85 (1.01)	2102 (25)	2287 (27)
SGPGI	3 (0.044)	64 (0.93)	1939 (28)	1852 (27)
KGMU	1 (0.016)	31 (0.48)	1106 (17)	2279 (35)
MAMC	0 (0)	23 (0.42)	923 (17)	1783 (32)
KMC	0 (0)	22 (0.41)	819 (15)	2017 (37)
JIPMER	0 (0)	7 (0.15)	690 (15)	1713 (36)
BHU	1 (0.018)	72 (1.29)	1319 (24)	1561 (28)
KEM	0 (0)	33 (0.71)	1012 (22)	1273 (28)

Abbreviations: All India Institute of Medical Sciences, Delhi (AIIMS), Postgraduate Institute of Medical Education and Research, Chandigarh (PGIMER), Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry (JIPMER), Christian Medical College, Vellore (CMCV), Sanjay Gandhi Postgraduate Institute, Lucknow (SGPGI), King George Medical University, Lucknow (KGMU), Maulana Azad Medical College, Delhi (MAMC), Kasturba Medical College, Manipal (KMC), Seth GS Medical College and KEM Hospital (KEM) and Banaras Hindu University, Varanasi (BHU)

Results

The top 10 medical institutions widely considered to be the best are: the three institutions of national importance, namely, All India Institute of Medical Sciences, Delhi (AIIMS), Postgraduate Institute of Medical Education and Research, Chandigarh (PGIMER), and Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry (JIPMER), along with the Christian Medical College, Vellore (CMCV), Sanjay Gandhi Postgraduate Institute, Lucknow (SGPGI), King George Medical University, Lucknow (KGMU), Maulana Azad Medical College, Delhi (MAMC), Kasturba Medical College, Manipal (KMC), Seth GS Medical College and KEM Hospital, Mumbai (KEM) and Banaras Hindu University, Varanasi (BHU).

These institutions published the highest number of papers, with AIIMS and PGIMER leading by a fairly large margin, accounting for more publications and citations than the next eight institutions combined (Table 1). We excluded Tata Memorial Hospital, Mumbai because it runs a few courses only, 4 superspeciality and 6 postgraduate courses¹⁶ although it had more publications (6072, about 400 per year) than some of those included, with the top paper being highly cited (4682 citations),

AIIMS was the leading institution when other indices were calculated. The i-1000 index for all institutions combined was 16, and the i-100 index was >700 (Table 2). Overall, nearly a

Year-wise number of publications in the last 5 completed years from 2012 to 2016 was also noted.

A more detailed analysis was carried out for the top 20 most cited papers in each of the institutions. We estimated the total number of citations for the top 20 articles, calculated number of citations per paper, and noted the maximum/minimum citations received. A cumulative impact factor of the institutes was calculated by summing up the journal impact factors in which the top 20 most cited papers were published. The median and range of the cumulative impact factor were also estimated.

In addition, for the top 20 articles, we looked at who was the first/ corresponding author, how many of them were research/review articles and checked whether the papers were part of collaborative research or single-institutional.

For the sake of comparison, we chose one of the top international medical institutions (Harvard Medical School) and a few Indian medical colleges that can be considered to somewhere in-between the top-most and the bottom ones.

Statistical analysis: We presented the data as numbers, percentages, means or medians. Only descriptive statistics was used. Figures were made using MS Excel.

Table 3: Detailed analysis of the 20 most cited publications of the top 10 medical institutions of the country

Institute	Citations	Citations per paper	Max.	Min.	Impact factor total	Median (Range)
AIIMS	25436	1272	4625	472	711.085	47.831 (2.644-72.406)
PGI	10269	513	1511	294	606.471	43.984 (1.803-47.831)
CMCV	7559	378	1083	214	404.199	12.509 (1.976-47.831)
SGPGI	14764	738	4625	183	372.712	7.975 (1.557-47.831)
KGMU	5513	176	1511	123	405.667	11.862 (0.88-47.831)
BHU	7984	399	1454	198	307.441	5.396 (0.38-72.406)
KMC	2977	149	314	105	45.046	2.210 (0-5.606)
MAMC	3469	173	629	104	155.219	2.831 (0.79-72.406)
JIPMER	2314	116	279	73	154.955	2.319 (0.25-72.406)
KEM	6841	342	921	135	244.573	5.471 (0.638-47.831)

Abbreviations: All India Institute of Medical Sciences, Delhi (AIIMS), Postgraduate Institute of Medical Education and Research, Chandigarh (PGIMER), Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry (JIPMER), Christian Medical College, Vellore (CMCV), Sanjay Gandhi Postgraduate Institute, Lucknow (SGPGI), King George Medical University, Lucknow (KGMU), Maulana Azad Medical College, Delhi (MAMC), Kasturba Medical College, Manipal (KMC), Seth GS Medical College and KEM Hospital (KEM) and Banaras Hindu University, Varanasi (BHU)

Table 5: Number of publications and year-wise publications on some of the medical colleges of India

Institute	Total number of publications	Citation count of the most cited paper	Year-wise publications					Record since, year
			62	60	75	50	55	
St. John’s Medical College, Bangalore	1158	3408	62	60	75	50	55	1967
Madras Medical College	1595	2126	74	94	75	79	113	1879
GMCH Amritsar	557	410	72	39	41	63	47	1975
Goa Medical College	755	198	35	32	41	23	40	1968
Calcutta School of Tropical Medicine	1100	324	67	71	50	51	77	1921
S.N. Medical College Agra	675	207	31	29	30	21	23	1950
J.J. Medical College, Davangere	509	115	63	47	57	46	22	1978
Rajendra Medical College Ranchi	197	46	9	14	12	29	24	1967

third of all publications did not receive a single citation and the single largest category of citations was between 1 to 9 (Figure 1).

A detailed analysis of the top 20 papers with respect to the number of citations (number, maximum/minimum), total impact factor of the journals, and median (range) of impact factor followed a pattern similar to that seen for the overall publication scenario with AIIMS and PGIMER leading followed by the other institutions (Table 3).

In most of the top papers, the corresponding authors and the first authors matched belonged to the same institutions, but for the top 5 among the selected 10 institutions more than 80% of the papers had first/corresponding authors from outside, in most cases USA or UK (Table 4). These were also the institutions whose papers received the highest numbers of citations and were published in high impact factor journals. On the other hand, in general, the lower placed institutions had less of

collaborative articles, and also received less number of citations (Table 4). Less than a quarter of all papers were review articles, others being research papers primarily (Table 4).

We looked at the research output of some of the established, older medical colleges of India (Table 5). These institutions produced nearly 50 papers per year per institute. In contrast, one of the newer institutions, namely, GMCH, Chandigarh, to which one of the authors belongs, publishes more than 100 papers per year (Table 5). When the number of publications over the last five years from these institutions was combined, there was a trend towards decline (Figure 2). The top institutions, barring BHU, had very few publications listed in Scopus in their earlier years (Table 6).

The Medical Council of India website¹⁷ lists 477 colleges out of which 218 are Government and 218 are managed by Trusts, most of which are old colleges. The MCI list shows that in the last few years three new categories

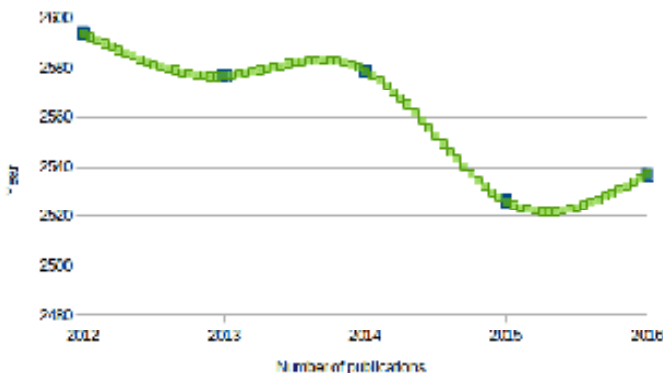


Fig. 2: Cumulative number of publications in the last five years for the different institutions including St. John’s Medical College, Bengalore, Madras Medical College, GMCH Amritsar, Goa Medical College, Calcutta School of Tropical Medicine, S.N. Medical College Agra, J.J.M. Medical College, Davangere, Rajendra Medical College Ranchi and GMCH, Chandigarh

Table 4: Analysis of top 20 citations of the leading medical institutions of the country with respect to authorship and type of article

Institution	First author	Corresponding author	Review author
AIIMS	2	2	3
PGIMER	3	3	3
CMCV	4	3	5
SGPGI	4	3	6
KGMU	4	4	7
BHU	7	7	5
KMC	15	15	2
MAMC	10	11	7
JIPMER	17	18	6
KEM	3	3	2

Abbreviations: All India Institute of Medical Sciences, Delhi (AIIMS), Postgraduate Institute of Medical Education and Research, Chandigarh (PGIMER), Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry (JIPMER), Christian Medical College, Vellore (CMCV), Sanjay Gandhi Postgraduate Institute, Lucknow (SGPGI), King George Medical University, Lucknow (KGMU), Maulana Azad Medical College, Delhi (MAMC), Kasturba Medical College, Manipal (KMC), Seth GS Medical College and KEM Hospital (KEM) and Banaras Hindu University, Varanasi (BHU)

of medical colleges have come up – ‘Private’, 10 colleges; ‘Society’, 22 colleges and ‘Govt-Society’, 9 colleges (Table 7). We did not analyze research output from these newer institutions. Among the top ten institutions that we evaluated, nine are government institutions.

Discussion

We conducted a qualitative analysis of the most cited papers of the top institutions of the country. It is interesting to note that although

Table 6: Number of publications in the first 5 years of the top medical institutions of India

Institute	Total number of publications in the first five years	Year since record shown in Scopus
AIIMS	1	1950
PGIMER	20	1963
CMCV	0	1886
SGPGI	37	1986
KGMU	1	1914
KMC	6	1963
MAMC	17	1959
JIPMER	40	1966
KEM	7	1934
BHU	319	1971

these institutions are ranked at the top based on their medical education and patientcare strengths, they were top performers in research too, denoting the inseparableness of the three major roles. This study adds to the earlier work⁵ showing more than half of the medical colleges did not publish a single paper in a year by looking in more details at the other extreme of the spectrum – the best performers.

As expected, and as seen previously, AIIMS and PGIMER retained their two top positions, managing to keep the wide gap between them and the next-placed institutions. We used several metrics to evaluate the research impact, namely, number of publications, total number of citations, number of citations for the most cited paper, impact factor of the journals in which research was published, h-index, the g-index, the i-10 index, and the h5-index with h5-median. We extended the concept of i-10 index to i-100 and i-1000 to look at the heavily cited articles. Although some of these metrics are author or journal level metrics, we used them to calculate institutional indices, which we believe is a reasonable way to make comparisons nationally as well as internationally.

The reason for using a number of metrics is that none of them is perfect and all are prone to misuse, keeping in mind the Goodhart's law which states that "when a feature of the economy is picked as an indicator of the economy, then it inexorably ceases to function as that indicator because people start to game it".¹⁸

The most-cited paper of the country in the medical field received 4625 citations. To gain some perspective, the all time most cited paper is by Lowry et al which describes how to

Table 7: State-wise distribution and year of MCI inspection of the three newer categories of management of the medical colleges as per the MCI website

State	Year of inspection
Management: Private	
Rajasthan	2016
Chattisgarh	2013
Andhra Pradesh	2015
Uttar Pradesh	2015
Uttar Pradesh	2013
Rajasthan	2016
Telangana	2013
Gujarat	2016
Uttar Pradesh	2016
Maharashtra	2017
Management: Society	
Haryana	2017
Madhya Pradesh	2016
Madhya Pradesh	2016
Rajasthan	2016
Andhra Pradesh	2016
Andhra Pradesh	2016
West Bengal	2016
Delhi	2012
Uttar Pradesh	2015
Uttar Pradesh	2016
Telangana	2016
Telangana	2013
Madhya Pradesh	2015
Kerala	2014
Andhra Pradesh	2016
Rajasthan	2015
Chattisgarh	2016
Madhya Pradesh	2014
Andhra Pradesh	2016
Madhya Pradesh	2016
Telangana	2005
Uttarakhand	2006
Management: Govt-Society	
Gujarat	2012
Gujarat	2011
Gujarat	2012
Gujarat	2015
Gujarat	2017
Gujarat	2011
Gujarat	2015
Assam	2012
Gujarat	2012

measure protein concentration¹⁹ with more than 200,000 citations. Also, the top 10 most cited papers in the world have been cited 40,000 times whereas the top hundred are cited more than 12,000 times.²⁰

About 0.016% articles from the top institutions received more than 1000 citations, which appears to be a small figure, but compares with the worldwide data (~0.026%)²⁰. The i-1000 index which we obtained can

be considered to be the national i-1000 index in medicine as it is doubtful there will be publications with more than 1000 citations from other institutions.

Journal impact factors represent the number of citations per article in the last two years and has been commonly used as a measure of quality of a journal. The sum total of the impact factors of journals in which the top 20 publications of AIIMS were published was more than 700. In contrast, Harvard Medical School, considered the world's topmost medical institute, had impact factor totaling 661, less than that of AIIMS, and impact factor median of 37.205 as against 47.831 for AIIMS, although on other parameters it scored much higher. For example, the total number of publications is 261,006 (AIIMS – 29394), the most cited paper has 15960 citations (AIIMS – 4625) and the top 20 articles were cited 1,41,111 times (AIIMS – 25,436).

Harvard Medical School publishes more than 12,000 papers a year, ten times more than our leading institutions. This comparison was done to highlight several important aspects. The Scopus database shows the first entry of Harvard as 1884 whereas in case of AIIMS it is 1950. Second, Harvard Medical School has 2,900 faculty members and more than 5,000 instructors²¹ whereas AIIMS has about 500 faculty members.²² Thirdly, the majority of the top research publications in Harvard and the Indian institutions are outcomes of public-funded research. In this regard, some perspective can be obtained by the following figures: the annual budget of National Institutes of Health (NIH, USA) is nearly US\$ 32 billion whereas the budget of ICMR for the year 2017-18 was US\$232 million, a multiplicative factor of nearly 140.²³

Government funding for research is critical – even in fields considered to be typically industry-based, that is new drug discovery/development, it has been estimated that a large proportion of drugs and almost all the vaccines in the past few decades were created with public funding.²⁴

This aspect is probably the most important reason why India has not been able to make an impact in the field of medical research of which it is capable of. The abundant skilled manpower, well versed in the intricacies

of research, places India in a unique position to be among the world leaders in research if research fund allocation is substantially enhanced.²⁵

Another area of concern is that nearly a third of all papers from even the topmost institutions remained uncited, even after many years of publication. While the contribution of discipline-dependence²⁶ and inherent shortcomings of the databases,²⁷ cannot be ruled out, this can also be due to conduct of “me-too” type of research, or research that is not answering a relevant question and is conducted just for the sake of gaining a publication, most likely with the purpose of getting the numbers needed for promotion (NNP).

On the positive side, many of the papers, at least from the topmost institutions, were highly cited, gaining thousands of citations. When we analyzed these publications we noticed that nearly 80% were a result of collaboration, especially with international organization. As a result the first and the corresponding authors were from outside India. It is widely believed that collaborations are important in research and our data provides direct evidence of the same. The institutions among the lower half of the top 10 did not manage to get much collaborations going, and as a result, their papers did not receive a large number of citations.

Review articles are known to receive many citations²⁸ but our data show that less than a quarter of the most highly cited papers were reviews.

We also looked at some of the older medical colleges to have some assessment of their status of research. Prior to looking at the data, we were under the impression, based on the earlier papers, that the number of publications from these institutions will be very few. However, that was not the case and most of these colleges were publishing and were getting cited. There was a worrying trend of fall in the number of publications from these institutions over the past five years, which probably requires further detailed evaluation to see if there is a systematic feature so that some intervention can be planned. We did not look at the least performing colleges, as had been recently done,⁵ and there was no reason to suspect a dramatic change in that situation.

We also did not look at data from some of the newer colleges, specifically whose managements are mentioned in the MCI website as “Private”, “Society”, or “Government-Society”. Although we suspect that their research output would be insubstantial, it may be too early to expect more. Even the institutions which are now leading, had published very few papers during their initial years. It would be interesting to follow-up on this work, say 5-10 years later, and look at the research output from these newly established colleges under novel management categories and may be compare with the government ones.

Another limitation of the study is that some of the metrics used are actually meant for individual researchers and we used them for institutions. We hope this kind of compilation does convey the message regarding research output of the institutions evaluated.

Our comparison with other institutions was also not a randomized comparison, nor did we age-match institutions. However, we did not cherry pick the institutions for comparison just to prove a point and believe that they present a fairly representative picture of the medical research scenario in the country.

Some of the landmark medical research carried in India in the fields of iodine deficiency, cholera, other diarrheal disorders, tuberculosis, poliomyelitis, and leprosy has been described previously.¹¹ To this can be added the important work in the field of malaria from Osmania University, Hyderabad,²⁹ and heart valves from Sree Chitra, Trivandrum,³⁰ besides others. It would be a good idea to conduct a thorough review of such qualitatively important research from India in future.

In conclusion, our analysis of the best publications from the topmost institutions shows that these institutions are capable of competing with the best in the world, as even with the huge resource deficit, they managed to publish a decent number of highly cited articles. The study also highlights the importance of research collaboration, with collaborative papers being the most cited ones. Lastly, several of the middle-rung colleges that we looked at, did not point to a dismal picture, which allows us to end with hope, especially if funding situation is improved.

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INnOvative GLiπin for All T2DM patients



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Robust Glycemic Control¹



Minimal Hypoglycemia¹



Weight neutral¹



No dosage adjustment needed in renal impairment¹

¹ Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy 2016;9:347-363

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