

Childhood Obesity: Scientometric Mapping of Indian Research During the Last Two Decades

Devi Dayal^{1,*}, Madhu Bansal², Jivesh Bansal³, Brij Mohan Gupta⁴

ABSTRACT

Background: The prevalence of childhood obesity (CHO) has gradually increased in India over the past two decades and has necessitated advanced research to address it. Assessing CHO-related research conducted so far is necessary to guide future research. However, a bibliometric assessment of Indian CHO research is unavailable. **Aim:** The study aimed to map the CHO research published in India during the last two decades. **Materials and Methods:** The publication data was retrieved from Elsevier's Scopus database using a predefined search strategy. The quality of publications was assessed using indicators such as citations per paper (CPP), relative citation index (RCI), and Hirsch index (HI). **Results:** India contributed 705 (1.8%) to a global total of 37,762 publications and is currently ranked 15th in CHO-related research; the top 3 countries are the USA, UK, and Australia with 38.1%, 9.6%, and 6.5% publication share respectively. The annual growth in India's publications was 27.4% compared to the global average of 8.7%. The research quality has declined (average CPP 50.6 during 2002-2011 and 25.4 during 2012-2021). Only 25.2% of publications were internationally collaborative. The most productive organizations were AIIMS, New Delhi, PGIMER, Chandigarh, and St. John's Research Institute, Bengaluru, whereas Amrita Institute of Medical Sciences, Sheri-Kashmir Institute of Medical Sciences, J&K, and Sitaram Bhartiya Institute of Science and Research, New Delhi were the most impactful. CS Yajnik, N Tandon, and V Khadilkar were the most prolific, whereas A Laxmaiah, HPS Sachdev, and V Mohan were the most impactful authors. Seven of the ten top productive journals were Indian, but only three were among the most impactful. **Conclusion:** India lags in CHO research behind other countries having similar current and future projections for the prevalence of CHO. Its research output, but not impact, has increased over the past two decades. India's international collaboration in CHO research is meager. Our analysis identifies the contributions of various stakeholders in addressing CHO and provides a framework for researchers, policymakers, organizations, and national government for future research to develop interventions for effective prevention and control of CHO. **Keywords:** Scientometrics, Obesity, Child obesity, Overweight, Bibliometrics, Research output.

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INTRODUCTION

Childhood obesity (CHO) is a multifactorial disorder resulting primarily from an imbalance between energy intake and expenditure and is associated with increased morbidity and mortality.¹ Several chronic health conditions, such as type 2 diabetes, dyslipidemia, hypertension, cardiovascular disease, metabolic liver disease, musculoskeletal problems, thyroid disorders, hypoferrremia, etc., occur in patients with CHO.²⁻⁷ In addition, CHO is associated with various psychological issues.⁸ CHO is also a potential harbinger of obesity during adolescence and adulthood, with a high risk of life-limiting comorbidities.² Developing effective interventions to target CHO through advanced research is therefore crucial.

Worldwide, the prevalence of CHO has been increasing at an alarming rate. According to 2016 estimates, CHO has risen by more than 10-fold in

the last 40 years, from 11 million to 124 million, with an additional 216 million children classified as overweight.⁹ The CHO epidemic is driven by low-income economies, especially in Asia and Middle-east and Latin America.⁹ The high disease burden poses enormous financial implications in developing countries. In India, CHO affects 3-4% of children younger than five years, according to current estimates representing an increase from 2-1% in 2015-16.¹⁰ Furthermore, the annual rise in CHO in Indian children between 2010-30 is projected to be very high at 10-8%, vis-a-vis the world average projection of 13%.^{9,10} The worrisome trends and patterns of CHO in India argue an urgent need for timely interventions to avoid obesity-linked morbidity and mortality.^{10,11}

One of the responses to the increasing burden of CHO is conducting advanced research to address the

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knowledge gaps to develop the most effective preventive interventions. This requires quantification and evaluation of research conducted so far, which is usually achieved through bibliometric studies.¹² The available bibliometric literature on CHO research is scarce. The initial studies that evaluated global obesity research did not specifically analyze publications on CHO.^{13,14} Two recent studies that assessed international CHO research focussed on the worldwide research trends but did not provide details of individual country research.^{15,16} Assessing the respective countries' research architecture and trends is crucial to help national organizations and researchers concentrate on research gaps. To our knowledge, there is a single bibliometric analysis from China on its CHO research.¹⁷ A similar bibliometric evaluation of Indian research on CHO is unavailable. The present study was thus undertaken to assess CHO-related research published in India comprehensively.

MATERIALS AND METHODS

The data for the present study were retrieved from Elsevier's Scopus database (<http://www.scopus.com>) using a defined search approach with Boolean and Proximity operators. Keywords for the search included "child* OR Kid* OR Newborn* OR Pediatric* OR Paediatric* OR Juvi* OR Teen OR Kinder* OR Adolescent" AND "Obes* OR Overweight OR Adiposit* OR Excess AND Weight". These keywords were suffixed to the "keyword" tag, and the output was confined to 2002-2021. The search strategy was identical to our previous bibliometric studies.¹⁸⁻²⁰ The leading search strategy yielded 37,762 global CHO records, further refined by countries, authors, organizations, and journals.

The publications were quantified using the complete counting technique, i.e., each contributing author or organization in multiple authorship papers was fully counted and given equal credit. The quality of publications was assessed using quality indicators such as citations per paper (CPP), relative citation index (RCI), and Hirsch index (HI). The CPP was derived from the total number of citations divided by the total number of publications. The RCI measured the influence of a publication. It was calculated by the number of sources divided by the average number of citations that a publication generally receives in the same field.²¹ The HI is the maximum value of h such that the given author or journal has published h papers that have each been cited at least h times. We also used VOSviewer and Biblioshiny apps to evaluate and visualize the interactions among countries, organizations, authors, and keywords. Highly-cited publications (HCP) were identified as receiving more than 100 citations. To understand changes in publications' growth and metrics over time, the study period was divided into two 10-year periods. Citations to publications were counted from the date of publication till June 15, 2022.

Ethical considerations

The extraction and use of secondary data do not need approval from ethics committees for human research. We, however, followed all research ethics recommended for such analysis.²²

RESULTS

Publication growth over time

From 2002 to 2021, the global and Indian publications numbered 37,762 and 705, respectively. India registered a 27.4% average annual growth compared to the world average of 8.7% in the subject (Table 1). The highest number of publications emerged from the USA (38.1%), followed by the UK (9.6%), Australia (6.5%), Canada (5.1%), and Germany (5.0%). Ten countries, namely China, Spain, Brazil, Canada, Netherlands, India, Australia, Denmark, Sweden, and Italy, showed an increase in the publication share against a decrease in five countries,

namely Germany, UK, the USA, France, and Japan. India ranked 15th in terms of the number of publications (Table 2).

The overall impact of Indian publications

The average CPP of Indian publications was 31.7 over the study period but decreased from 50.6 during 2002-2011 to 25.4 during 2012-2021 (Table 1).

Publication types

A majority of publications (547, 77.5%) appeared as articles, 78 (11.0%) as reviews, 41 (5.8%) as letters, 15 (2.1%) as editorials, 12 (1.7%) as notes and less than 1% each as others such as conference paper, short survey, etc.

International Collaboration

One-fourth (25.2%) of Indian publications were ICPs. The maximum collaboration ($n=74$, 41.5%) was with the UK, followed by the USA ($n=73$, 41.0%), Australia ($n=38$, 14.6%), Brazil ($n=25$, 14.0%), China ($n=23$, 12.9%), Italy and S. Africa ($n=17$, 9.5% each), Kenya ($n=15$, 8.4%), and Netherlands ($n=14$, 7.8%) (Figure 1).

Table 1: Comparative growth of Indian and global publications on childhood obesity, their citations, and international collaboration during 2002-2021.

Period	World		India				
	TP	TP	TC	CPP	TP%	ICP	%ICP
2002	594	4	654	163.50	0.67	1	25.00
2003	738	14	961	68.64	1.90	3	21.43
2004	865	13	1361	104.69	1.50	3	23.08
2005	1037	13	633	48.69	1.25	5	38.46
2006	1169	11	311	28.27	0.94	1	9.09
2007	1233	20	485	24.25	1.62	2	10.00
2008	1431	20	2439	121.95	1.40	3	15.00
2009	1571	25	532	21.28	1.59	7	28.00
2010	1638	19	689	36.26	1.16	2	10.53
2011	2046	37	842	22.76	1.81	15	40.54
2012	2092	60	1433	23.88	2.87	14	23.33
2013	2499	47	1036	22.04	1.88	9	19.15
2014	2514	63	1196	18.98	2.51	20	31.75
2015	2595	38	492	12.95	1.46	9	23.68
2016	2500	56	4138	73.89	2.24	15	26.79
2017	2423	30	3366	112.20	1.24	10	33.33
2018	2514	45	538	11.96	1.79	9	20.00
2019	2706	64	782	12.22	2.37	18	28.13
2020	2866	71	427	6.01	2.48	20	28.17
2021	2731	55	73	1.33	2.01	12	21.82
2002-2011	12322	176	8907	50.61	1.43	42	23.86
2012-2021	25440	529	13481	25.48	2.08	136	25.71
2002-2021	37762	705	22388	31.76	1.87	178	25.25

Abbreviations: TP: Total Papers; TC: Total Citations; CPP: Citation per Paper; ICP: International Collaborative Papers.

Table 2: Output and share of top 15 countries in childhood obesity research during 2002-2021.

Sl.no.	Country	Number (% share) of publications		
		2002-2011	2012-2021	2002-2021
1	United States	4769 (38.7)	9632 (38.1)	14401 (38.1)
2	United Kingdom	1256 (10.1)	2388 (9.4)	3644 (9.6)
3	Australia	754 (6.1)	1707 (6.7)	2461 (6.5)
4	Canada	544 (4.4)	1402 (5.5)	1946 (5.1)
5	Germany	690 (5.6)	1217 (4.8)	1907 (5.0)
6	Italy	514 (4.1)	1163 (4.6)	1677 (4.4)
7	China	222 (1.8)	1422 (5.6)	1644 (4.3)
8	Spain	398 (3.2)	1200 (4.7)	1598 (4.2)
9	Brazil	382 (3.1)	1154 (4.5)	1536 (4.0)
10	Netherlands	318 (2.5)	898 (3.5)	1216 (3.2)
11	France	398 (3.2)	750 (2.9)	1148 (3.0)
12	Sweden	287 (2.3)	724 (2.8)	1011 (2.6)
13	Japan	264 (2.1)	523 (2.0)	787 (2.0)
14	Denmark	193 (1.5)	541 (2.1)	734 (1.9)
15	India	176 (1.4)	529 (2.1)	705 (1.8)
16	Total	11165	25250	36415
17	World	12322	25440	37757

Research trends and hot-spots

We identified 3494 significant keywords that reflect the focus areas and trends in Indian childhood obesity research during 2002-2021 (Figure 2).

Top research organizations

A total of 156 organizations were engaged in childhood obesity research; 71 contributed 1-5 papers each, 66 contributed 6-10 articles each, and 19 organizations contributed more than ten publications each. Eight organizations registered their publication output above the group average (13.6) of all organizations, while six had CPP and RCI above the group average (154.6 and 5.1, respectively) (Table 3).

Top authors

Two thousand five hundred and eighty-three authors participated in Indian CHO research. Table 4 shows the top 10 most prolific and most impactful authors.

Top journals

Most Indian research (703 papers, 99.2%) in CHO was communicated through journals. Seven of the ten top productive journals were Indian, but only 3 of these were among the most impactful (Table 5).

Highly cited publications

Only 30 (4.2%) publications were widely cited, averaging 484.4 CPP; 22, 5, and 3 publications accumulated 101-344, 404-796, and 2178-3264 CPP, respectively. Twenty-two HCPs were published as articles, six as review papers, and one each as a conference paper and editorial. AIIMS contributed the highest numbers (7 publications), N. Delhi followed by Sita Ram Bhartia Institute of Science and Research (6 articles) and Sunder Lal Jain Hospital (4 pieces). SK Bhargava and HPS Sachdev contributed 7 HCPs each, A Laxmaiah (5 documents), and M Raj and A Ramachandra (4 papers each). The 30 HCPs appeared in different national and international journals; 5 in the Lancet, two each in Indian

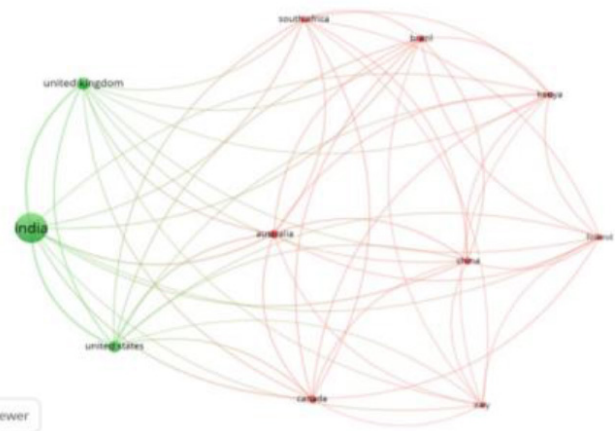


Figure 1: India's international collaboration in childhood obesity research during 2002 to 2021.

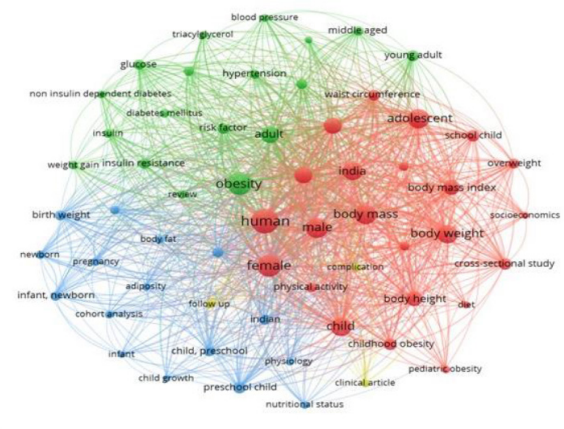


Figure 2: Network visualization of prominent keywords. The significance is displayed by node size and text dimension.

Pediatrics and Journal of Clinical Endocrinology and Metabolism, and 1 in 21 other journals.

DISCUSSION

Our analysis suggests that India has contributed significantly to global publication growth over the past two decades and is ranked amongst the top 15 countries in CHO research. However, even as India's productivity has increased, the research impact has decreased, as indicated by CPP during the second half of the study period. One of the reasons could be a general decline in the quality of scientific research over the last few decades. It is believed that lower research quality is related to factors such as an increase in the number of researchers and linking the number of publications to academic promotions and professional development, resulting in competitive pressure to publish at all costs that may compromise the research quality.²³ The non-impressive increase in international collaboration may also have contributed to the lower quality of Indian publications during the past decade. It is worth mentioning that recent bibliometric studies have consistently demonstrated an increase in India's international collaboration in other areas of research.²⁴⁻²⁶ It is well known that collaborative research improves its quality and impact.^{27,28} Furthermore, improving the long-term impact and sustainability of global research in any field needs strengthening collaborations between high- and low-income countries.²⁹

Table 3: The most productive and most impactful Indian organizations in childhood obesity research during 2002-2021.

Organization Name	TP	TC	CPP	HI	ICP	%ICP	RCI
Most productive organizations							
AIIMS, New Delhi	65	3352	51.5	23	16	24.6	1.6
PGIMER, Chandigarh	38	398	10.4	10	4	10.5	0.3
St John's Research Institute, Bengaluru	25	699	27.9	14	19	76.0	0.8
KEM Hospital, Mumbai	24	1399	58.2	17	13	54.1	0.1
Jehangir Hospital, Pune	18	488	27.1	10	5	27.7	0.8
Public Health Foundation of India, Gurugram	16	229	14.3	8	13	81.2	0.4
Maulana Azad Medical College, New Delhi	15	1155	77.0	7	7	46.6	2.4
University of Delhi, Delhi	15	84	5.6	3	3	20.0	0.2
St. John's National Academy of Health Sciences	12	261	21.7	10	7	58.3	0.6
University of Calcutta	12	150	12.5	8	1	8.3	0.4
Most impactful organizations							
Amrita Institute of Medical Sciences India	6	6282	1047.0	5	6	100.0	32.9
Sher-I-Kashmir Institute of Medical Sciences	6	6161	1026.8	4	6	100.0	32.3
Sitaram Bhartia Institute of Science and Research	12	8986	748.8	8	10	83.3	23.5
Madras Diabetes Research Foundation, Chennai	11	6361	578.2	8	7	63.6	18.2
National Institute of Nutrition India	10	4029	402.9	9	6	60.0	12.6
Sunder Lal Jain Hospital, New Delhi	6	1464	244.0	6	6	100.0	7.6
Fortis Healthcare Ltd.	11	885	80.4	10	4	36.3	2.5
Maulana Azad Medical College, New Delhi	15	1155	77.0	7	7	46.6	2.4
KEM Hospital, Mumbai	24	1399	58.2	17	13	54.1	1.8
AIIMS, New Delhi	65	3352	51.5	23	16	24.6	1.6

Abbreviations: TP: Total papers; TC: Total citations; CPP: Citations per paper; ICP: International collaborative papers; HI: H-Index; RCI: Relative citation index.

Table 4: Leading authors in Indian research on childhood obesity during 2002-21.

Author	Affiliation	TP	TC	CPP	HI	ICP	RCI
Most productive authors							
CS Yajnik	KEM Hospital, Pune	18	988	54.8	14	9	1.7
N Tandon	AIIMS, New Delhi	14	397	28.3	9	5	0.8
V Khadilkar	Jehangir Hospital, Pune	12	312	26.0	6	3	0.8
SK Bhargava	Sunder Lal Jain Hospital, New Delhi	11	7472	679.2	9	10	21.3
GV Krishnaveni	Holdsworth Memorial Hospital, Mysore	11	353	32.0	7	11	1.0
A Misra	Diabetes Foundation India	11	915	83.1	10	4	2.6
A Khadilkar	Jehangir Hospital, Pune	10	318	31.8	7	2	0.9
R Kuriyan	St. John's Research Institute, Bengaluru	10	442	44.2	8	8	1.3
RK Marwaha	Society for Endocrine Health, New Delhi	10	233	23.3	8	0	0.7
SR Veena	Holdsworth Memorial Hospital, Mysore	10	352	35.2	7	10	1.1
Most impactful authors							
A Laxmaiah	National Institute of Nutrition India	6	6738	1123.0	6	4	35.3
HS Sachdev	Sitaram Bhartia Institute of Science and Research, New Delhi	9	9736	1081.7	8	9	34.0
V Mohan	Madras Diabetes Research Foundation, Chennai	8	6288	786.0	7	4	24.7
RM Anjana	Madras Diabetes Research Foundation, Chennai	8	6229	778.6	7	6	24.5
SK Bhargava	Sunder Lal Jain Hospital, New Delhi	11	7472	679.2	9	10	21.3
KS Reddy	Public health Foundation of India, Gurugram	8	1833	229.1	7	8	7.2
D Prabhakaran	Public Health Foundation of India, New Delhi	6	924	154.0	5	6	4.8
M Vaz	St John's Research Institute, Bengaluru	1	117	117.0	7	3	3.6
A Misra	Diabetes Foundation India	11	915	83.1	10	4	2.6
N Gupta	AIIMS, New Delhi	7	538	76.8	7	3	2.4

Abbreviations: TP: Total papers; TC: Total citations; CPP: Citations per paper; ICP: International collaborative papers; RCI: Relative citation index.

Table 5: Leading journals in childhood obesity research in India during 2002-2021.

Journal	No. of publications			Total citations
	2002-11	2012-21	2002-21	
Most productive journals				
Indian Pediatrics	19	19	38	699
Indian Journal of Pediatrics	9	24	33	302
Indian Journal of Public Health Research and Development	0	23	23	2
Obesity Surgery	1	14	15	349
PLOS One	2	13	15	388
Indian Journal of Medical Research	7	7	14	398
Journal of Clinical and Diagnostic Research	1	10	11	104
Journal of Pediatric Endocrinology and Metabolism	2	9	11	33
Indian Journal of Physiology and Pharmacology	5	5	10	94
Indian Journal of Endocrinology and Metabolism	0	9	9	53
Most impactful journals				
Lancet	1	4	5	9023
New England Journal of Medicine	3	2	5	903
Indian Pediatrics	19	19	38	699
Indian Journal of Medical Research	7	7	14	398
PLOS One	2	13	15	388
Obesity Surgery	1	14	15	349
American Journal of Clinical Nutrition	1	3	4	318
Indian Journal of Pediatrics	9	24	33	302
Diabetes Care	3	2	5	257
European Journal of Clinical Nutrition	3	3	6	226

It is, therefore, crucial for high-income countries to support capacity-building initiatives in low and middle-income countries to find global solutions to CHO.

We also found that the CHO research is dominated by high-income countries of Western Europe and North America, similar to previous global mapping studies.¹⁸⁻²⁰ This reflects the governmental commitment, the availability of infrastructure, and funding in high-income countries that enables conducting highly organized research endeavors in any field of science.³⁰ In contrast, research in low- and middle-income countries remains disorganized and poorly funded, resulting in low-impact publications.³¹ In India, although the projection for the annual increase in CHO between 2010–30 is very high, it is not yet a policy or research priority. Consequently, there is a lack of governmental and organizational commitment to research.¹¹ The CHO research is thus mainly driven by individual researchers affiliated with national institutions.³²⁻³⁴ There is a need for prioritization of research on CHO in countries where the projected rates of CHO are high, including India.⁹⁻¹¹

There are a few limitations of our study. Some publications may have been missed due to synonyms or homonyms in authors' names, even though we tried to minimize this limitation by using other fields such as affiliations. Additionally, some data could have remained uncaptured owing to single database use. Although Scopus is the most authoritative and widely-used medical bibliographic database due to its more comprehensive content coverage, search analysis tools, citation accuracy, and funding information, it does not cover all published research.³⁵ Nevertheless, most bibliometric studies use single databases.^{12,36} Despite the limitations, we could achieve the stated objectives within our study protocol and provide an architecture of Indian CHO research. Our study also provides a framework for researchers and policymakers to conduct advanced CHO research, urgently required to formulate guidelines for managing the rising burden of CHO.

CONCLUSION

Indian CHO research output has consistently increased over the past two decades. The research impact has, however, decreased. There is a need to augment international collaboration in CHO research to improve its quality and enable knowledge sharing and transfer. Our study also identifies the contributions of authors, institutions, and journals in addressing CHO. It thus provides a framework for authors, policymakers, organizations, and national government to focus on CHO research to better understand its increasing burden and prepare a roadmap for mitigating the imminent CHO epidemic.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

DD: Data interpretation and preparation of the final draft of the manuscript; **MB and JB:** Data interpretation and inputs in manuscript preparation; **BMG:** Data collection and analysis, preparation of the initial manuscript draft.

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