

# Thrombosis Research in India: A Bibliometric Assessment of Publications Output during 2000-19

BM Gupta<sup>1,\*</sup>, KK Mueen Ahmed<sup>2</sup>, Madhu Bansal<sup>3</sup>, Ghose Modin Mamdapur<sup>4</sup>

## ABSTRACT

The paper presents a quantitative and qualitative profile of Thrombosis research in India, based on 4026 publications indexed in Scopus database during 2000-19. Indian research output on Thrombosis registered 11.64% annual growth, averaged 13.54 citations per paper and contributed 2.26% global share (with 13<sup>th</sup> rank) and 14.13% share devoted to international collaborative papers. Thrombosis research applications across subjects were the largest in medicine (87.93%), followed for other subjects with contribution from 5.84% to 10.08%), etc. The distribution by type revealed that Venous Thrombosis accounted for the highest share (52.36% share), followed by Arterial Thrombosis (29.01% share), Limb ischemia (1.49%) and Hepatic artery thrombosis (0.72%) during 2000-19. AIIMS- New Delhi (374 papers) and PGIMER-Chandigarh (280 papers) lead the country as the most productive organizations. Besides, GMCH-Chandigarh (66.80 and 4.93) and Fortis Healthcare Limited (47.82 and 3.53) lead the country as the most impactful organizations in terms of citation per paper and relative citation index. K. Ghosh (61 papers) and R. Saxena (51 papers) lead the country as most productive authors and K. Sarin (115.32 and 8.52) and D. Dash (44.29 and 3.27) lead as the most impactful authors. *Indian Heart Journal* (with 160 papers), *BMJ Case Reports* (133 papers) and *Neurology India* (115 papers) topped the list of most productive journals.

**Key words:** Thrombosis research, Indian publications, Scientometrics, Bibliometrics.

## INTRODUCTION

Thrombosis is a term for a blood clot (thrombus) occurring inside a blood vessel, obstructing the flow of blood through the circulatory system. A thrombus is most likely to occur: (i) in people who are immobile and in those with a genetic predisposition to blood clotting and (ii) can also form after damage occurs in an artery, vein, or surrounding tissue. When a blood vessel (a vein or an artery) is injured, the body uses platelets (thrombocytes) and fibrin to form a blood clot to prevent blood loss. Even when a blood vessel is not injured, blood clots may form in the body under certain conditions. In response to injury, the blood clot quickly forms a plug that can reduce or prevent bleeding. Such a process can cause severe health problems, as it interrupts the function of a blood vessel. A section of a blood clot that breaks free from the thrombus and circulates in the bloodstream is called an embolus. An embolus moves through the vascular system until it lodges in a different part of the body. It is especially dangerous if it reaches the heart, lungs, or brain (embolism).<sup>1,2</sup> Blood clotting or coagulation is an important process that prevents excessive bleeding when a blood vessel is injured. Platelets (a type of blood cell) and proteins in your plasma (the liquid part of blood) work together to stop the bleeding by forming a clot over the injury. Typically, your body will naturally dissolve the blood clot after the injury

has healed. Sometimes, however, clots form on the inside of vessels without an obvious injury or do not dissolve naturally. These situations can be dangerous and require accurate diagnosis and appropriate treatment.<sup>3</sup>

Clots can occur in veins or arteries, which are vessels that are part of the body's circulatory system. While both types of vessels help transport blood throughout the body, they each function differently. Veins are low-pressure vessels that carry deoxygenated blood away from the body's organs and back to the heart. An abnormal clot that forms in a vein may restrict the return of blood to the heart and can result in pain and swelling as the blood gathers behind the clot. Deep vein thrombosis (DVT) is a type of clot that forms in a major vein of the leg or, less commonly, in the arms, pelvis, or other large veins in the body. In some cases, a clot in a vein may detach from its point of origin and travel through the heart to the lungs where it becomes wedged, preventing adequate blood flow. This is called a pulmonary (lung) embolism (PE) and can be extremely dangerous.<sup>3</sup>

Arteries, on the other hand, are muscular, high-pressure vessels that carry oxygen- and nutrient-rich blood from the heart to other parts of the body. When your doctor measures your blood

**BM Gupta<sup>1,\*</sup>, KK Mueen Ahmed<sup>2</sup>, Madhu Bansal<sup>3</sup>, Ghose Modin Mamdapur<sup>4</sup>**

<sup>1</sup>Formerly with CSIR-, New Delhi, INDIA.

<sup>2</sup>Phcog.Net, Bengaluru, Karnataka, INDIA.

<sup>3</sup>Punjab University Library, Department of Mathematics, Chandigarh, INDIA.

<sup>4</sup>Synthite Industries (P) Ltd., Kerala, 682311, INDIA.

### Correspondence

**Dr. BM Gupta**

Formerly with CSIR, New Delhi-11012, INDIA.

Mobile no: +91 9888378275

Email: bmgupta1@gmail.com

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pressure, the test results are an indicator of the pressure in your arteries. Clotting that occurs in arteries is usually associated with atherosclerosis (hardening of the arteries), a deposit of plaque that narrows the inside of the vessel. As the arterial passage narrows, the strong arterial muscles continue to force blood through the opening and the high pressure can cause the plaque to rupture. Molecules released in the rupture cause the body to overreact and form an unnecessary clot in the artery, potentially leading to a heart attack or stroke. When the blood supply to the heart or brain is completely blocked by the clot, a part of these organs can be damaged as a result of being deprived of blood and its nutrients.<sup>3</sup>

There have been many research advances that have improved the prevention and treatment of blood clots. Some current treatments include: (i) Anticoagulants - medicine that prevents clots from forming; (ii) Thrombolytics - medicine that dissolves blood clots, (iii) Catheter-directed thrombolysis - a procedure in which a long tube, called a catheter, is surgically inserted and directed toward the blood clot where it delivers clot-dissolving medication; and (iv) Thrombectomy - surgical removal of a clot.<sup>3</sup>

Thromboembolic conditions were estimated to account for 1 in 4 deaths worldwide in 2010 and are the leading cause of mortality. Thromboembolic conditions are divided into arterial and venous thrombotic conditions. Ischemic heart disease and ischemic stroke comprise the major arterial thromboses and deep-vein thrombosis and pulmonary embolism comprise venous thromboembolism. Atrial fibrillation is a major risk factor for stroke and systemic arterial thromboembolism. Estimates of the global burden of disease were obtained from Global Burden of Disease Project reports, recent systematic reviews and searching the published literature for recent studies reporting measures of incidence, burden and disability-adjusted life-years. Estimates per 100 000 of the global incidence rate (IR) for each condition are ischemic heart disease, IR=1518.7; myocardial infarction, IR=139.3; ischemic stroke, IR=114.3; atrial fibrillation, IR=77.5 in males and 59.5 in females; and venous thromboembolism, IR=115 to 269. Mortality rates (MRs) for each condition are ischemic heart disease, MR=105.5; ischemic stroke, MR=42.3; atrial fibrillation, MR=1.7; and venous thromboembolism, MR=9.4 to 32.3. Global public awareness is substantially lower for pulmonary embolism (54%) and deep-vein thrombosis (44%) than heart attack (88%) and stroke (85%).<sup>4</sup>

To increase global awareness of the thrombosis-related disease burden, starting in 2014, the International Society on Thrombosis and Haemostasis (ISTH) declared 13 October as World Thrombosis Day. As public awareness campaigns focusing on heart disease and stroke were already established through World Heart Day and World Stroke Day, a strategic decision was made to concentrate initial plans for World Thrombosis Day on VTE.<sup>5</sup>

The evaluation of researchers' work and careers, which traditionally relied on peer review, is increasingly substituted or influenced by publication output and citation impact metrics. Bibliometric indicators are more and more applied by governments and other funding organization mainly because of their large-scale applicability, lower costs and time as well as their perceived objectivity. The goal is to optimize research allocations and make funding both more efficient and effective. In the present study, bibliometric analysis has been employed to study thrombosis research. Bibliometric analyses are based on two major units: the scientific publication as an indicator of research output and citations received by them as a proxy of their scientific impact or influence on the scholarly community. Aggregation levels of bibliometric studies range from micro (author) to macro (countries) with different kinds of meso level in between such as institutions, journals or research fields.<sup>6</sup>

During the last two decades, not a single comprehensive study at national and international level is available on this theme. Under such conditions, it is deemed appropriate and necessary that a bibliometric study is undertaken to evaluate the performance of Thrombosis research in India and also focus on India's institutional and researchers performance that are driving the research within the country.

## Literature Review

No comprehensive bibliometric study on the subject, both at national and international level is available. However, only two bibliometric/scientometric studies related to analysis of "Thrombosis research" covering publications are available. Amongst the existing studies, Tian, Zhang, Zeng, Wang, Gao, Su and Li<sup>7</sup> examined 1709 publications (distributed in 58 countries and published in 790 academic journals) on VTE in children from PubMed database during 1988-June 2019 and analyzed to explain the present research hotspots. The information related to the authors, journals, journal source countries and the major medical subject headings (MeSH) terms was traced in these articles and the content, characteristics, internal relations and scientific structure of children's VTE publications were summarized. Qi, Jia, Ren, Yang and Stefano<sup>8</sup> analyzed the scientific publications (6691 and 4325) in the fields of Portal vein thrombosis (PVT) and Budd-Chiari syndrome (BCS) listed in the PubMed, EMBASE and Cochrane library databases. The publication year, country, type of paper, study design and number of citations were summarized. It was observed that the number of papers gradually increased over time, researchers from the USA published the greatest number of papers and clinical studies were the most common type of paper, but fewer than half of these observed more than 10 papers. The 5 most frequently cited original articles and guidelines/consensuses were also listed

## Objectives

The study is designed to examine qualitative and quantitative aspects of India's overall research output covered in international Scopus database during 2000-19. In particular, the study focuses on: (i) global research output in Thrombosis in terms of publications growth and contribution and global share of top 10 most productive countries, (ii) India's research output on Thrombosis in terms of publications growth, its distribution by document and source types, distribution by broad subject areas and type of research, research output in terms of citation impact and bibliographic features of highly-cited papers and identify top 30 most India's productive organizations and authors and top 20 journals for research communications.

## MATERIALS AND METHODS

In order to undertake a study of India's contribution in Thrombosis research, Scopus database (<http://www.scopus.com>) was used as the main source of indexed publications covering 20-year period 1999-2018. Single keyword "Thrombosis" was searched in "Keyword tag" as well as in "Article Title tag" (joined by Boolean operator "OR") simultaneously and restricted the output to period "2000-19" in the "period tag", to get global publication data (consisting of 178462 records). The above mentioned search strategy was refined by country of publication (including India) to get publication output data on top 10 countries. India's publication output comprised of 4260 records. The search strategy for obtaining India's output was further refined to get statistics on India's output as required in the study. Citations to publications were obtained and searched from date of their publication till 20 May 2019. Separate search strategies were formulated to get data on various types of Thrombosis. All type of publications have been used in this study.

KEY(thrombosis\*) AND PUBYEAR > 1999 AND PUBYEAR < 2020 AND (LIMIT-TO (AFFILCOUNTRY, "India"))

## Analysis

### Publication Growth

The global publications in field of Thrombosis research was 178462 during 2000-19, an average of 8923.1 publications per year. India accumulated 4026 publications during the period, with an average of 201.3 publications per year. India registered 11.64% growth compared to 4.18% by the world. India's absolute growth between 2000-09 and 2010-19 was 173.12% compared to 39.70% by the world. India contributed 2.26% share to global output in 20 years; its 10-year global publications share surged from 1.45% to 2.83% during 2000-09 to 2010-19. India's citation impact on a 20-year window averaged to 13.54 citations per paper (CPP) and its 10-year citation impact dropped from 15.60 CPP to 12.78 CPP during 2000-09 to 2010-19. The 206 (5.12%) papers in India's output received funding support from more than 100 national and international funding agencies. The funded papers increased from 29 during 2000-09 to 177 during 2010-19 (Table 1).

Of the total publications, 68.38% appeared as articles, 12.77% as reviews, 10.58% as letters, 3.45% as notes, 1.84% as editorials, 1.79% as conference papers, 0.75% as notes, 0.32% as book chapters, erratum and retracted (0.02% each) and undefined (0.07%).

### Top 15 Countries in Thrombosis Research

157 countries unevenly participated in global Thrombosis research: 47 countries published 1-10 papers, 33 published 11-50 papers, 17 published 51-100 papers, 35 published 101-1000 papers, 15 published 1001-5000, 9 published 5001-15,000 papers and 1 published 58268 papers.

Bulk of the global research output (95.28%) in the field was contributed by top 15 most productive countries alone. USA accounted for the largest share of 32.651%, U.K., Italy, Germany, France, China and Japan (from 5.31% to 8.13%) and Canada, Spain, Netherlands, Turkey, Australia, India, Switzerland and South Korea (from 1.80% to 4.57%) during 2000-19. The global publication share decreased in 3 countries, namely U.K., France and Germany (from 0.60% to 0.95%), while it increased in other 12 countries (from 0.13% to 5.32%) from 2000-09 to 2010-19 (Table 2).

### India's International Collaboration

The share of India's international collaborative papers (ICP) in its national output was 14.13% during 2000-19, which increased from 11.68% (2000-09) to 15.03% (2010-19). India's 569 ICPs have received 32445 citations, registering 57.02 citations per paper. India's collaboration with the USA was the largest (49.74% of India's ICP output), followed by U.K. (22.32%), Canada(14.41%), Germany (11.25%), France (10.72%) and by 5 other collaborative countries its international collaborative publications (ICP) share was between 7.38% and 9.49% (Table 3).

**Table 1: Growth of Publications on Thrombosis Research in India during 2000-19.**

2 Publication Year	Global Publications (TP)	Indian Publications						
		TP	%TP	TC	CPP	ICP	%ICP	FP
2000	4765	44	0.92	417	9.48	1	2.27	1
2001	5389	47	0.87	2449	52.11	4	8.51	2
2002	6129	73	1.19	1199	16.42	6	8.22	3
2003	6937	113	1.63	1069	9.46	7	6.19	1
2004	7186	87	1.21	1173	13.48	10	11.49	1
2005	7979	92	1.15	1256	13.65	14	15.22	4
2006	8486	130	1.53	2116	16.28	13	10.00	2
2007	8720	138	1.58	1713	12.41	18	13.04	4
2008	9118	162	1.78	2520	15.56	21	12.96	8
2009	9742	193	1.98	2919	15.12	32	16.58	3
2010	9757	208	2.13	4260	20.48	25	12.02	5
2011	9735	267	2.74	4296	16.09	47	17.60	13
2012	10426	272	2.61	2975	10.94	35	12.87	12
2013	10735	312	2.91	11116	35.63	35	11.22	12
2014	10363	316	3.05	4757	15.05	51	16.14	18
2015	10683	308	2.88	3211	10.43	43	13.96	14
2016	10886	351	3.22	1938	5.52	52	14.81	19
2017	10784	319	2.96	3852	12.08	56	17.55	22
2018	10535	340	3.23	738	2.17	49	14.41	32
2019	10107	254	2.51	529	2.08	50	19.69	30
2000-09	74451	1079	1.45	16831	15.60	126	11.68	29
2010-19	104011	2947	2.83	37672	12.78	443	15.03	177
2000-19	178462	4026	2.26	54503	13.54	569	14.13	206

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; ICP=International Collaborative Papers

### Subject-Wise Distribution of India's Research Output

Thrombosis research in India is classified in 5 major disciplines (as identified in Scopus database classification). Of these, medicine have been the most favored subject areas (with 87.93% national publications share) and for other 4 disciplines national publications share ranged between 1.09% and 10.08%.

Research activity index in all of 5 disciplines witnessed fluctuations between 2000-09 and 2010-19. Compared to world average index of 100, three disciplines registered significant rise in their activity index: Biochemistry, Genetics and Molecular Biology (from 57.90 to 115.41), Pharmacology, Toxicology and Pharmaceutics (from 82.38 to 106.45) and Immunology and Microbiology (from 59.36 to 14.88). In two other disciplines it registered significant decline: Medicine (from 107.51 to 97.25) and Neurosciences (from 117.49 to 93.59). Immunology and

Microbiology recorded the highest citation impact per paper of 21.55 and Neurosciences the least (9.46) during 2000-19 (Table 4)

### Types of Thrombosis

On classifying thrombosis papers by its various types, it was observed that Venous Thrombosis contributed the largest share (52.36%) of papers, followed by Arterial Thrombosis (29.01% share), Limb ischemia (1.49%) and Hepatic artery thrombosis (.72%) during 2000-19. In terms of citation impact, Arterial Thrombosis registered the highest number of citations per paper (18.56), followed by Venous Thrombosis (13.60), Hepatic artery thrombosis (7.38) and Limb ischemia (5.88).

Within Venous Thrombosis, the largest publication share (25.34%) is contributed by Pulmonary Embolism, followed by Deep Vein Thrombosis (20.96%), Portal Vein Thrombosis (7.58%), Cerebral Venous Sinus Thrombosis (4.64%), Jugular Vein Thrombosis (3.10%), Budd-Chiari syndrome, Cavernous sinus thrombosis and Renal Vein

**Table 2: Global Thrombosis Research: Top 15 Most Productive Countries during 2000-19.**

S.No	Name of the Country	Number of Papers			Share of Papers		
		2000-09	2010-19	2000-19	2000-09	2010-19	2000-19
1	USA	23437	34831	58268	31.48	33.49	32.65
2	U.K.	6317	8196	14513	8.48	7.88	8.13
3	Italy	5013	8146	13159	6.73	7.83	7.37
4	Germany	5781	7087	12868	7.76	6.81	7.21
5	France	4565	5546	10111	6.13	5.33	5.67
6	China	1696	7905	9601	2.28	7.60	5.38
7	Japan	3866	5610	9476	5.19	5.39	5.31
8	Canada	3176	4984	8160	4.27	4.79	4.57
9	Spain	2753	3985	6738	3.70	3.83	3.78
10	Netherlands	2663	4064	6727	3.58	3.91	3.77
11	Turkey	1831	3008	4839	2.46	2.89	2.71
12	Australia	1829	2715	4544	2.46	2.61	2.55
13	India	1079	2947	4026	1.45	2.83	2.26
14	Switzerland	1382	2421	3803	1.86	2.33	2.13
15	South Korea	759	2447	3206	1.02	2.35	1.80
	Total	66147	103892	170039	88.85	99.89	95.28
	World	74451	104011	178462			

**Table 3: India's International Collaboration in Thrombosis Research during 2000-19.**

S.No.	Collaborative Country	International Collaborative Papers (ICP)			Share of ICP		
		2000-09	2010-19	2000-19	2000-09	2010-19	2000-19
1	USA	61	222	283	48.41	50.11	49.74
2	U.K.	21	106	127	16.67	23.93	22.32
3	Canada	14	68	82	11.11	15.35	14.41
4	Germany	9	55	64	7.14	12.42	11.25
5	France	13	48	61	10.32	10.84	10.72
6	Japan	7	47	54	5.56	10.61	9.49
7	Australia	10	42	52	7.94	9.48	9.14
8	Italy	3	49	52	2.38	11.06	9.14
9	Netherlands	5	43	48	3.97	9.71	8.44
10	Brazil	6	36	42	4.76	8.13	7.38
	Total India's ICP output	126	443	569			

Thrombosis (2.48%, 2.38% and 2.36%), Femoral Vein Thrombosis (1.89%) and other types contributing less than 1.0%. In terms of impact, Budd-Chiari syndrome registered the highest (18.29) citations per paper, followed by Deep Vein Thrombosis (16.46), Portal Vein Thrombosis (14.45), Pulmonary Embolism (11.40), etc. Among Arterial Thrombosis, Thrombotic stroke and Myocardial infarction contributed 11.95% and 11.95% share each with citation per paper of 24.65 and 18.99 (Table 5).

### India's Top 30 Most Productive Organizations

425 organizations participated in Indian research on Thrombosis during 2000-19, of which 238 organizations published 1-5 paper each, 102 organizations published 6-10 papers each, 37 organizations 11-20 papers each, 30 organizations 21-50 papers each, 13 organizations 51-100 papers each and 5 organizations 101-374 papers each. The productivity of top

30 most productive organizations varied from 30 to 374 publications per organization; together they contributed 55.46% (2233) Indian publications share and 59.69% (32535) Indian citations share during 2000-19. The productivity count of the 30 top organizations is shown in Table 6.

- Six organizations registered their publications output above their group average (74.43): AIIMS- New Delhi (374 papers), PGIMER-Chandigarh (280 papers), SGPGIMS-Lucknow (142 papers), KEMH-Pune (116 papers), CMC- Vellore (105 papers) and NIMHANS-Bangalore (76 papers);
- Ten organizations registered their citations per paper and relative citation index above the group average (14.57 and 1.08) of all organizations: GMCH-Chandigarh (66.80 and 4.93), Fortis Healthcare Limited (47.82 and 3.53), NIMS-Hyderabad (37.07 and

**Table 4: Subject-Wise Breakup of Indian Publications in Thrombosis Research during 2000-19**

S.No	Subject*	Number of Papers (TP)			Activity Index		TC	CPP	%TP
		2000-09	2010-19	2000-19	2000-09	2010-19			
1	Medicine	1020	2520	3540	107.51	97.25	47869	13.52	87.93
2	Biochemistry, Genetics and Molecular Biology	63	343	406	57.90	115.41	5178	12.75	10.08
3	Pharmacology, Toxicology and Pharmaceutics	68	240	308	82.38	106.45	3328	10.81	7.65
4	Neurosciences	74	161	235	117.49	93.59	2224	9.46	5.84
5	Immunology and Microbiology	7	37	44	59.36	114.88	948	21.55	1.09
	Indian Output	1079	2947	4026					

There is overlapping of literature covered under various subjects

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper

**Table 5: Break-up of papers by type of Thrombosis during 2000-19.**

S.No	Type of Thrombosis	Number of Papers			% TP	TC	CPP
		2000-09	2010-19	2000-19			
1	Venous Thrombosis	565	1543	2108	52.36	28672	13.60
	Deep Vein Thrombosis	181	663	844	20.96	13893	16.46
	Portal Vein Thrombosis	79	226	305	7.58	4407	14.45
	Renal Vein Thrombosis	22	73	95	2.36	438	4.61
	Retinal Vein Occlusion	1	12	13	0.32	27	2.08
	Femoral Vein Thrombosis	15	61	76	1.89	499	6.57
	Super Vein Cava Thrombosis	11	14	25	0.62	87	3.48
	Juglar Vein Thrombosis	28	97	125	3.10	254	2.03
	Cerebral Venous Sinus Thrombosis	40	147	187	4.64	1270	6.79
	Cavernous sinus thrombosis	28	68	96	2.38	642	6.69
	Pulmonary Embolism	243	777	1020	25.34	11628	11.40
	Paget-Schroetter disease	1	2	3	0.07	3	1.00
	May-Thurnes Syndrome	3	4	7	0.17	19	2.71
Budd-Chiari syndrome	29	71	100	2.48	1829	18.29	
2	Arterial Thrombosis	267	901	1168	29.01	21678	18.56
	Thrombotic stroke	136	345	481	11.95	11857	24.65
	Myocardial infarction	91	313	404	10.03	7673	18.99
3	Limb ischemia	10	50	60	1.49	353	5.88
4	Hepatic artery thrombosis	0	29	29	0.72	214	7.38
		1079	2947	4026			

2.74), TMH-Mumbai (30.43 and 2.25), GBPH-Delhi (30.08 and 2.22), CMC- Vellore (23.37 and 1.73), AIIMS- New Delhi (20.08 and 1.48), ILBS-New Delhi (18.85 and 1.39), MAMC- Delhi (16.69 and 1.23) and GSMC-Mumbai (14.69 and 1.08).

### India's Top 30 Most Productive Authors

646 authors participated in Indian research on Thrombosis during 2000-19, of which 437 authors published 1-5 paper each, 156 authors 5-10 papers each, 41 authors 11-20 papers each, 10 authors 21-50 papers each

and 2 authors 51-61 papers each. The research productivity of top 30 most productive authors varied from 13 to 61 publications per author. Together they contributed 16.27% (655) Indian publications share and 17.68% (9634) Indian citations share during 2000-19. Their detailed scientometric profile is presented in Table 7.

- Eleven of top 30 authors registered their publications output above the group average of 21.83: K. Ghosh (61 papers), R. Saxena (51 papers), S. Shetty (48 papers), U. Kaul (31 papers), J. Kalita (29 papers), U.K. Misra (27 papers), N. Khandelwal (24 papers), G.

**Table 6: Scientometric Profile of Top 30 Indian Organizations in Thrombosis Research during 2000-19.**

S.No	Name of the Organization	TP	TC	CPP	HI	ICP	%ICP	RCI
1	All India Institute of Medical Sciences (AIIMS), New Delhi	374	7511	20.08	29	48	12.83	1.48
2	Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh	280	2925	10.45	25	16	5.71	0.77
3	Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGIMS), Lucknow,	142	1066	7.51	17	8	5.63	0.55
4	King Edward Memorial Hospital (KEMH), Pune	116	1450	12.50	21	13	11.21	0.92
5	Christian Medical College (CMC), Vellore	105	2454	23.37	16	28	26.67	1.73
6	The National Institute of Mental Health and Neuro-Sciences (NIMHANS), Bangalore	76	497	6.54	18	6	7.89	0.48
7	The Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Pondicherry	71	225	3.17	8	2	2.82	0.23
8	Sree Chitra Tirunal Institute for Medical Sciences and Technolog (SCTIMST), Thiruvananthapuram	65	869	13.37	14	8	12.31	0.99
9	Fortis Escorts Heart Institute (FEHI), New Delhi	64	628	9.81	12	14	21.88	0.72
10	Sir Ganga Ram Hospital (SGRH), New Delhi	62	494	7.97	11	6	9.68	0.59
11	King George's Medical University (KGMU), Lucknow	61	592	9.70	10	8	13.11	0.72
12	G.P.Pant Hospital (GBPH), Delhi	59	1775	30.08	15	7	11.86	2.22
13	Nizam's Institute of Medical Sciences (NIMS), Hyderabad	54	2002	37.07	11	12	22.22	2.74
14	Amrita Institute of Medical Sciences (AIMS), Kochi	54	279	5.17	10	4	7.41	0.38
15	Kasturba Medical College (KMC), Manipal	54	204	3.78	6	3	5.56	0.28
16	National Institute of Immunohaematology (NIIH), Mumbai	54	512	9.48	13	3	5.56	0.70
17	Sri Jayadeva Institute of Cardiovascular Sciences and Research (SJICSR), Bangalore	54	162	3.00	7	1	1.85	0.22
18	Maulana Azad Medical College (MAMC), Delhi	52	868	16.69	10	8	15.38	1.23
19	Tata Memorial Hospital (TMH), Mumbai	44	1339	30.43	10	10	22.73	2.25
20	Manipal Academy of Higher Education (MAHE), Manipal	43	273	6.35	6	3	6.98	0.47
21	Armed Forces Medical College (AFMC), Pune	43	320	7.44	8	0	0.00	0.55
22	Seth Gordhandas Sunderdas Medical College (SGSMC), Mumbai	42	617	14.69	12	5	11.90	1.08
23	Fortis Healthcare Limited	39	1865	47.82	9	6	15.38	3.53
24	Army Hospital Research and Referral (AHRR), New Delhi	38	343	9.03	11	3	7.89	0.67
25	Institute of Liver and Billiary Sciences (ILBS), New Delhi	34	641	18.85	10	6	17.65	1.39
26	Medical College and Hospital (MCH), Kolkata	31	195	6.29	5	1	3.23	0.46
27	VMMC and Safdarjang Hospital, New Delhi	31	113	3.65	6	3	9.68	0.27
28	Command Hospital Air Force, Bangalore	31	189	6.10	8	1	3.23	0.45
29	Government Medical College and Hospital (GMCH), Chandigarh	30	2004	66.80	9	2	6.67	4.93
30	Bombay Hospital and Medical Research Centre (BHMRC), Mumbai	30	123	4.10	7	3	10.00	0.30
	Total of 30 organizations	2233	32535	14.57	11.8	238	10.66	1.08
	Total of India	4026	54503	13.54				
	Share of 30 organizations in India's total	55.46	59.69					

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; HI=h-index; ICP=International Collaborative Papers; RCI=Relative Citation Index

Karthikeyan and A. Seth (23 papers each), J. Ahluwalia and S.K. Sarin (22 papers each);

- Six of top 30 authors registered their citation per paper and relative citation index above the group average (14.71 and 1.09) of all authors: S.K. Sarin (115.32 and 8.52), D. Dash (44.29 and 3.27), A. Seth (31.04 and 2.29), M. Dikshit (21.36 and 1.58), R.K. Dhiman (16.31 and 1.20) and G. Karthikeyan (15.22 and 1.12)

### Medium of Research Communication

Nearly 99.16% (3992) of Thrombosis research in India appeared in 463 journals, 0.27% (7) each in books and conference proceedings, 0.12% (5) in book series and 0.17% (7) as undefined. Of the 463 journals (reporting 3992 articles), 313 published 1-5 papers each, 80 published 6-10 papers

each, 44 published 11-20 papers each, 19 published 21-50 papers each, 4 published 51-100 papers each and 3 published 101-160 papers each during 2000-19.

The top 30 most productive journals accounted for 34.24% of total Indian output in journals (covering Thrombosis research) during 2000-19. The 10-year output in journals increased from 31.44% to 35.27% between 2000-09 and 2010-19. Indian Heart Journal was the top most productive journal (with 160 papers) in reporting Indian research in the field of Thrombosis research, followed by BMJ Case Reports (133 papers), Neurology India (115 papers), Journal of Clinical and Diagnostic Research (92 papers), etc. during 2000-19. Similarly, Thrombosis Research registered the highest (17.58) citation impact per paper, followed by Journal of Clinical and Experimental Hepatology

**Table 7: Scientometric Profile of Top 30 Most Productive Indian Authors in Thrombosis Research during 2000-19.**

S.No	Name of the Author	Affiliation of the Author	TP	TC	CPP	HI	ICP	%ICP	RCI
1	K. Ghosh	NIIH-Bombay	61	521	8.54	13	13	21.31	0.63
2	R. Saxena	AIIMS – New Delhi	51	439	8.61	12	10	19.61	0.64
3	S. Shetty	NIIH-Bombay	48	461	9.60	12	2	4.17	0.71
4	U. Kaul	Fortis Escorts Heart Institute (FEHI), Delhi	31	354	11.42	10	11	35.48	0.84
5	J. Kalita	SGPGIMS-Lucknow	29	382	13.17	11	1	3.45	0.97
6	U.K. Misra	SGPGIMS-Lucknow	27	372	13.78	11	1	3.70	1.02
7	N. Khandelwal	PGIMER-Chandigarh	24	201	8.38	6	2	8.33	0.62
8	G.Karthikeyan	AIIMS-New Delhi	23	350	15.22	9	7	30.43	1.12
9	A. Seth	FEHI-Delhi	23	714	31.04	9	12	52.17	2.29
10	J. Ahluwalia	PGIMER-Chandigarh	22	137	6.23	7	0	0.00	0.46
11	S.K. Sarin	ILBS-New Delhi	22	2537	115.32	13	5	22.73	8.52
12	C.N.Manjunath	SJICSR-Bangalore	21	88	4.19	6	0	0.00	0.31
13	V.K.Bahl	AIIMS-New Delhi	20	255	12.75	7	3	15.00	0.94
14	D.Nagaraja	NIMHANS-Bangalore	20	181	9.05	7	1	5.00	0.67
15	P. Singh	PGIMER-Chandigarh	19	232	12.21	4	1	5.26	0.90
16	R. Christopher	NIMHANS-Bangalore	18	143	7.94	7	0	0.00	0.59
17	S.S. Kothari	AIIMS-New Delhi	16	202	12.63	5	1	6.25	0.93
18	A.Biswas	AIIMS-New Delhi	15	134	8.93	6	7	46.67	0.66
19	M.Kannan	AIIMS-New Delhi	15	198	13.20	8	3	20.00	0.97
20	M.Mahapatra	AIIMS-New Delhi	15	77	5.13	5	2	13.33	0.38
21	D.Dash	BHU-IMS-Varanasi	14	620	44.29	9	3	21.43	3.27
22	M.Dikshit	CDRI-Lucknow	14	299	21.36	8	2	14.29	1.58
23	R.B.Singh	Halberg Hospital and Research Institute (HHRI), Moradabad	14	10	0.71	2	14	100.00	0.05
24	S. Singh	PGIMER-Chandigarh	14	119	8.50	5	2	14.29	0.63
25	S. Varma	PGIMER-Chandigarh	14	85	6.07	5	1	7.14	0.45
26	V.P.Choudhry	AIIMS-New Delhi	13	88	6.77	6	0	0.00	0.50
27	R.K.Dhiman	PGIMER-Chandigarh	13	212	16.31	7	1	7.69	1.20
28	B.Kulkarni	KEMH-Pune	13	98	7.54	5	0	0.00	0.56
29	Y.Mehta	FEHI-Delhi	13	81	6.23	5	5	38.46	0.46
30	M.C.Nanjappa	SJICSR-Bangalore	13	44	3.38	4	1	7.69	0.25
	Total		655	9634	14.71	7.47	111	16.95	1.09
	Total of World		4026	54503	13.54				
	Share of 30 Authors in World Total Output		16.27	17.68					

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; HI=h-index; ICP=International Collaborative Papers; RCI=Relative Citation Index

**Table 8: Top 30 Most Productive Journals in Thrombosis Research during 2000-19.**

S.No	Name of the Journal	Number of Papers			TC	CPP
		2000-09	2010-19	2000-19	2000-19	
1	Indian Heart Journal	62	98	160	488	3.05
2	BMJ Case Reports	0	133	133	161	1.21
3	Neurology India	45	70	115	703	6.11
4	Journal of Clinical and Diagnostic Research	0	92	92	169	1.84
5	Journal of Association of Physicians of India	36	51	87	235	2.70
6	Indian Journal of Pediatrics	15	39	54	323	5.98
7	Indian Journal of Gastroenterology	20	33	53	282	5.32
8	Indian Journal of Critical Care Medicine	10	36	46	181	3.93
9	Annals of Cardiac Anaesthesia	2	42	44	105	2.39
10	Indian Pediatrics	12	29	41	257	6.27
11	Indian Journal of Anaesthesia	0	39	39	307	7.87
12	Medical Journal Armed Forces India	19	20	39	54	1.38
13	Annals of the Indian Academy of Neurology	4	34	38	148	3.89
14	Indian Journal of Radiology and Imaging	17	17	34	93	2.74
15	Journal of Indian Academy of Clinical Medicine	8	23	31	17	0.55
16	Indian Journal of Haematology and Blood Transfusion	4	26	30	49	1.63
17	Indian Journal of Anaesthesia Clinical Pharmacology	7	22	29	30	1.03
18	Asian Cardiovascular and Thoracic Annals	12	16	28	151	5.39
19	Indian Journal of Cancer	3	24	27	85	3.15
20	Journal of Clinical and Experimental Hepatology	0	27	27	264	9.78
21	Indian Journal of Nephrology	0	26	26	22	0.85
22	Journal of Postgraduate Medicine	15	10	25	230	9.20
23	Clinical and Applied Thrombosis Hemotasis	8	17	25	207	8.28
24	Journal of Neurosciences in Rural Practice	0	25	25	95	3.80
25	Journal of the Indian Medical Association	11	13	24	52	2.17
26	Indian Journal of Pathology and Microbiology	8	12	20	76	3.80
27	Catheterization and Cardiovascular Interventions	7	12	19	117	6.16
28	Journal of Obstetrics and Gynecology of India	1	18	19	27	1.42
29	Thrombosis Research	7	12	19	334	17.58
30	Indian Journal of Dermatology, Venereology and Leprology	4	14	18	127	7.06
	Total of 30 journals	337	1030	1367		
	Total global journal output	1072	2920	3992		
	Share of top 30 journals in global journal output	31.44	35.27	34.24		

(9.78), Journal of Postgraduate Medicine (9.20), Clinical and Applied Thrombosis Hemotasis (8.28), Indian Journal of Anaesthesia (7.87) and Indian Journal of Dermatology, Venereology and Leprology (7.06). In terms of total citations received, Neurology India tops the list with 703 citations, followed by Indian Heart Journal (488 citations), Thrombosis Research (334 citations), Indian Journal of Pediatrics (323 citations) and Indian Journal of Anaesthesia (307 citations) (Table 8).

### Highly - Cited Papers

Of the total India's output in Thrombosis research in India (4026 publications), only 66 (1.64% share) accumulated 100 to 4199 citations per paper (cumulative total 28701 citations) since their publication during 2000-19, averaging to 434.86 citations per paper. The distribution of these 66 highly cited papers is skewed. Thirty seven papers accumulated citations in the range 100-188 per paper, 9 papers

were in citation range 2107 - 299, 8 papers in citation range 301-479, 3 papers in citation range 624-949, 6 papers in citation range 1028-1871 and 2 papers were in citation range 3793-4199.

- Of the 66 highly cited papers, 16 resulted from contribution by single organizations per paper (non-collaborative papers) and 50 from two or more organizations per paper (3 national collaborative and 47 international collaborative papers).
- Among 47 international collaborative highly cited papers, USA collaborated in the largest number of papers (34 papers), followed by U.K. (23 papers), Australia and Canada (20 papers each), France (19 papers), Italy (17 papers), Germany (16 papers), Brazil, Belgium, Japan and Netherlands (15 papers each), China (10 papers), etc.
- The 66 highly cited papers involved 98 authors and 63 Indian organizations.



- The leading Indian organizations participating in highly-cited papers were: AIIMS-New Delhi (11 papers), G.B. Pant Hospital, Delhi (5 papers), Maulana Azad Medical College, Delhi, Tata Memorial Hospital, Mumbai and St John's Medical College, Bangalore (3 papers each), PGIMER-Chandigarh, Seth Gordhandas Sunderdas Medical College, Institute of Biliary and Liver Sciences, New Delhi, Jupiter Hospital, Thane, Care Hospital, Hyderabad, IIT-New Delhi, BHU-IMS, Varanasi, Sahyadri Hospital, Maharashtra and GMCH-Chandigarh (2 papers each).
- The leading authors participating in highly cited papers were: S.K. Sarin (IBLS-New Delhi)(5 papers), A. Seth (AIIMS-New Delhi) and D. Dash (IMS-BHU))(2 papers each), etc.,
- Of the 66 highly cited papers, 42 were published as articles, 20 as review papers and 1 as editorial;
- These 66 highly cited papers appeared across 48 journals, of which 8 papers were published in the *Lancet*, 6 papers in *New England Journal of Medicine*, 4 papers in *Blood*, 3 papers in *Circulation*, 2 papers in *ACS Nano* and 25 other journals with 1 paper each.

## CONCLUSION

This paper focuses on India's research in the domain of Thrombosis research on select bibliometric indicators covering 20-year research (2000-19). During the period, Thrombosis research by India registered a 11.64% average annual growth, contributed 2.26% share to global output, averaged citation impact of 13.545 citations per paper and registered 66 papers (1.64% share of national output) as highly cited papers. In all, 157 countries contributed to global Thrombosis research (178462 publications). The top 15 most productive countries in the world alone accounted for 95.28% bulk share to global publications output in the subject. USA is in the leadership position in the world ranking, with 32.65% global publications share respectively The global publication share of other 9 amongst top 10 countries has been ranging between 1.80% and 8.13%. India ranks 13<sup>th</sup> most productive country in the world with 2.36% share. Medicine, among 5 leading subjects, has been the most preferred subject in Thrombosis research (with 87.93% publications share) and other 4 disciplines national publications share ranged between 1.09% and 10.08%.

The distribution of India research by participating 425 organizations is skewed. The top 30 organizations contributed 55.46% publications share and 59.69% citations share respectively during the period. AIIMS- New Delhi (374 papers), PGIMER-Chandigarh (280 papers) and SGPGIMS-Lucknow (142 papers) have been the most productive research organizations in the country. The organizations leading in terms of citation per paper and relative citation index were: GMCH-Chandigarh

(66.80 and 4.93), Fortis Healthcare Limited (47.82 and 3.53), NIMS-Hyderabad (37.07 and 2.74), TMH-Mumbai (30.43 and 2.25), etc. The distribution of India research by 646 participating authors is highly scattered. The top 30 authors across India contributed merely 16.27% publications share and 17.68% citations share respectively during the period. Indian Heart Journal, BMJ Case Reports and Neurology India are the top two most popular journals in the subject that published 160, 133 and 115 papers respectively.

In order to improve its research performance, India need to increase its output and improve quality by employing more qualified and trained research personal and also improve international collaboration with significant partner countries. Its must also prioritise its areas of research in blood related research, identify the core organizations and authors and increase its research funding in priority areas. Public awareness about thrombosis overall and VTE in particular, is low. Campaigns to increase public awareness about VTE are needed to reduce the burden from this largely preventable thrombotic disorder. More detailed data on the burden caused by VTE through surveys should be obtained to inform public health policy and resource allocation in health systems, especially in regions where evidence is now limited or lacking and to evaluate whether the broader and improved implementation of preventive measures will reduce the disease burden. Public health efforts to measure disease burden and increase awareness of symptoms and risk factors need to improve, particularly in low- and middle-income regions to address this leading cause of morbidity and mortality.

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