

# Breast cancer research: A scientometric analysis of Indian publications during 2004–2013

## Abstract

The paper examines 5189 Indian publications on breast cancer research, as covered in Scopus database during 2005–2014, experiencing an annual average growth rate of 21.94% and citation impact of 3.38. The world breast cancer output (203,879 publications) came from several countries, of which the top 15 most productive countries (United States, U.K., China, Germany, Italy, Canada, France, Japan, etc.,) accounted for 89.89% share of the global output during 2005–2014. India's global publication share was 2.55% and hold 12<sup>th</sup> rank in global output during 2005–2014. The Indian publications on breast cancer came from several organizations, of which the top 15 most productive contributed 27.89% share in the national breast cancer output during 2005–2014. India's international collaborative publications share in breast cancer was 19.89% during 2005–2014, which increased from 19.25% to 20.11% from 2005–2009 to 2010–2014. Medicine accounted for the largest share (54.58%) of output in breast cancer, followed by biochemistry, genetics and molecular biology (38.08%), pharmacology, toxicology and pharmaceuticals (23.11%), chemistry (11.29%), agricultural and biological sciences (3.87% share) and immunology and microbiology (2.04% share) during 2005–2014. Diagnosis, chemotherapy, screening, prognosis, surgery and radiotherapy together account for 72.58% publications share among treatments methods used in Indian breast cancer research during 2005–2014. Maharashtra, Delhi, Tamil Nadu and Karnataka together accounted for 53.52% of the India's breast cancer output during 2005–2014.

**Key words:** Bibliometrics, Breast cancer, India, Publications, Scientometrics.

Ritu Gupta,  
Brij Mohan Gupta<sup>1</sup>,  
K. K. Mueen Ahmed<sup>2</sup>

<sup>1</sup>Venkateswara University,  
Department of Library &  
Information Science, Tirupathi 517  
502, Andhra Pradesh,  
<sup>2</sup>Phcog.Net and SciBiolMed.Org,  
Bengaluru, Karnataka, India

### Address for Correspondence:

Dr. Brij Mohan Gupta, 1173  
Sector 15, Panchkula - 134 113,  
Haryana, India.  
E-mail: bmgupta1@yahoo.com

### Access this article online

Website: [www.oghreports.org](http://www.oghreports.org)

DOI: 10.5530/ogh.2016.5.2.2

Quick response code:

## INTRODUCTION

Breast cancer is an uncontrolled growth of breast cells. Cancer occurs as a result of mutations, or abnormal changes, in the genes responsible for regulating the growth of cells and keeping them healthy. The genes are in each cell's nucleus, which acts as the "control room" of each cell. Normally, the cells in our bodies replace themselves through an orderly process of cell growth: Healthy new cells take over as old ones die out. However over time, mutations can "turn on" certain genes and "turn off" others in a cell. That changed cell gains the ability to keep dividing without control or order, producing more cells just like it and forming a tumor. A tumor can be benign (not considered cancerous) or malignant (has the potential to be dangerous and if left unchecked, its cells eventually can spread beyond the original tumor to other parts of the body). The term "breast cancer" refers to a malignant tumor that has developed from cells in the breast.<sup>[1]</sup>

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**How to cite this article:** Gupta R, Gupta BM, Ahmed M. Breast cancer research: A scientometric analysis of Indian publications during 2004-2013. OGH Reports, 2016; 5(2):49-56.

The female breast is made up mainly of lobules (milk-producing glands), ducts (tiny tubes that carry the milk from the lobules to the nipple), and stroma (fatty tissue and connective tissue surrounding the ducts and lobules, blood vessels, and lymphatic vessels). Most breast cancers begin in the cells that line the ducts (ductal cancers). Some begin in the cells that line the lobules (lobular cancers), while a small number start in other tissues. Breast cancer cells can enter lymphatic vessels and begin to grow in lymph nodes. Most lymphatic vessels in the breast connect to lymph nodes under the arm (axillary nodes). Some lymphatic vessels connect to lymph nodes inside the chest (internal mammary nodes) and those either above or below the collarbone (supraclavicular or infraclavicular nodes). If the cancer cells have spread to lymph nodes, there is a higher chance that the cells could have also gotten into the bloodstream and spread (metastasized) to other sites in the body.<sup>[2,3]</sup>

Breast cancer is always caused by a genetic abnormality (a “mistake” in the genetic material). However, only 5–10% of cancers are due to an abnormality inherited from your mother or father. Instead, 85–90% of breast cancers are due to genetic abnormalities that happen as a result of the aging process and the “wear and tear” of life in general.<sup>[1]</sup>

Breast cancer rates are much higher in developed nations compared to developing ones. There are several reasons for this, with possibly life-expectancy being one of the key factors - breast cancer is more common in elderly women; women in the richest countries live much longer than those in the poorest nations. The different lifestyles and eating habits of females in rich and poor countries are also contributory factors.<sup>[4]</sup>

According to GLOBOCAN (2012), breast cancer is the second most common and frequent cancer among women in the world, with an estimated 1.67 million new cases (25% of all cancer cases diagnosed in 2012). Of the total new cases, 883,000 cases were from less developed region (China, 187,000 and India, 145,000 cases) and 794,000 cases (USA, 233,000 cases) from more developed regions of the world. The breast cancer standardized incidence rates age standardized rate (ASR) vary across geographical regions, with ASR ranging from 27/100,000 in middle Africa and Eastern Asia to 96/100,000 in Western Europe. With an estimated 522,000 deaths (India, 70,000 cases and China, 48,000 cases) in 2012, breast cancer is the fifth cause of death from cancer overall. It is, however, the most frequent cause of death in women in less developed region (324,000 deaths, 14.3% of the total) and second cause of deaths in more developed region (198,000 deaths, 15.4%) after lung cancer. Mortality rates in terms of ASR between world regions vary and ranges from 6/100,000 in Eastern Asia to 20/100,000 in Western Africa. Here we notice that the mortality rates is less than that of incidence because of the more favorable survival of breast cancer in (high incidence) developed regions.<sup>[5]</sup>

India is experiencing an unprecedented rise in the number of breast cancer cases across all sections of society, as are also in other countries. Presently, India already has one of the worst survivals from breast cancer in the world and has the highest number of women dying from breast cancer in the world. India also ranks number one in the numbers of healthy life years lost (disability adjusted life years) due to breast cancer.<sup>[6]</sup>

## Literature review

Glynn *et al.*<sup>[7]</sup> made a bibliometric assessment the quantity and quality of world breast cancer literature (180,216 papers and 4,136,224 citations), contributed by 155 countries and published in more than 4000 journals. It also identified the key nations and journals involved in its production over the past half-century. Glynn *et al.*<sup>[8]</sup> investigated the relationship between malignancy and research, in order to better quantify the degree to which breast cancer is being over- or under-represented in the research world. It examined research output over a 1 year period for the 26 most commonly diagnosed cancers in the UK and elucidate changes in research output over time and then to correlate these changes with improvements in survival.

Shakhodabandeh *et al.*<sup>[9]</sup> analyzed the trend of scientific output (114 articles) in the field of breast cancer research in Iran, using MEDLINE through 1965–2008. Epidemiology and related issues was the most popular subject area investigated by Iranian scientists. Molecular based researches were in second and clinical-related issues were in third condition. About 70% of Iranian publications in this field were published in journals with impact factor between 0.396 and 5.684. Breast cancer research and treatment was the high-impact journal that published Iranian publications. The United States and England were the most prolific countries that published Iranian publications in this field.

Perez-Santos, Martin and Anaya-Ruiz<sup>[10]</sup> quantitatively assess current research trends with regard to breast cancer in Mexico from 2003 to 2012. Articles were analyzed by scientific output and research performances of individuals, institutes, and collaborative countries with Mexico. Data were retrieved from the Web of Science database from 2003 to 2012. A total of 256 articles were retrieved. The institutions with the majority of publications were the National Autonomous University of Mexico (22.3%), the National Institute of Cancerology (21.9%), and Social Security Mexican Institute (20.3%). Clinical observation studies were the dominant investigation type (64%), and the main types of research were metabolics (24.2%) and pathology (21.5%). This article address key evaluation questions and to establish priorities, define future areas of research, and develop breast cancer control strategies in Mexico.

Kotepuri, Wannaiampikul, Chupeerach, C and Duangmano<sup>[11]</sup> evaluated research publications in the field of diets and breast cancer. The impact of the economic outcome on national academic productivity was also investigated. Data were retrieved using PubMed for English-language publications. The search included all research for which articles included words relating to “diets and breast cancer.” Population and national income data were obtained from publicly available databases. Impact factors for journals were obtained from journal citation reports<sup>®</sup> (Thomson scientific). There were 2396 publications from 60 countries in 384 journals with an impact factor. Among them, 1652 (68.94%) publications were original articles. The United States had the highest quantity (51% of total) and highest of mean impact factor (8.852) for publication. Sweden had the highest productivity of publication when adjusted for number of population (6 publications per million populations). Publications from the Asian nation increased from 5.3% in 2006 to

14.6% in 2012. Diets and breast cancer-associated research output continues to increase annually worldwide including publications from Asian countries. Although the United States produced the most publications, European nations per capita were higher in publication output.

## OBJECTIVES

The main objectives of this study are to study the performance of Indian research in breast cancer during 2005–2014, based on publications covered in Scopus database. In particular, the study focuses on the following objectives:

- To study the growth of world and Indian research output and the citation pattern of the Indian research output;
- To study the global publication share of top 15 most productive countries and the place of India in global output;
- To study the international collaboration share of Indian publications and the contribution of leading foreign countries in India's collaborative output;
- To study the distribution of Indian research output by broad subject areas and study their growth and decline;
- To study the Indian breast cancer output by treatment methods and their distribution by geographical areas;
- To study the publication productivity and citation impact of 15 most productive 15 Indian institutions;
- To study the medium of communication; and
- To study the characteristics of high cited papers.

## METHODOLOGY

The study retrieved and downloaded the publication data of the world and of 15 most productive countries in breast cancer from the Scopus database (<http://www.scopus.com>) for 10 years during 2005–2014. A number of keywords, such as “breast,” “lobul\*,” “duct\*” and “cancer or neoplasm or carcinoma” were used in “title, abstract and keyword” tag and restricting it to the period 2005–2014 in “date range tag” was used for searching the global publication data and this become the main search string. When the main search string with restricted to 15 most productive countries in “country tag,” as shown below, the publication data on 15 productive countries were obtained. When the main search string is further restricted to “subject area tag,” “country tag,” “source title tag,” “journal title name” and “affiliation tag,” we got information on distribution of publications by subject, collaborating countries and organization-wise, etc. For citation data, the 3 years, 2 years, 1 year citation window was used for publications during 2005–2012, 2013 and 2014. In addition, citations to publications was also collected from date of publication till the end of February 2015 for sections 4.1 and 4.10.

((TITLE-ABS-KEY (breast) and TITLE-ABS-KEY (cancer or neoplasm or carcinoma)) and PUBYEAR >2004 and PUBYEAR <2015) or ((TITLE-ABS-KEY(breast and lobul\*) and TITLE-ABS-KEY (cancer or neoplasm or carcinoma)) and PUBYEAR >2004 and PUBYEAR <2015) or ((TITLE-ABS-KEY (breast and duct\*) and TITLE-ABS-KEY (cancer or neoplasm or carcinoma)) and PUBYEAR >2004 and PUBYEAR <2015))

((TITLE-ABS-KEY (breast) and TITLE-ABS-KEY (cancer or neoplasm or carcinoma)) and PUBYEAR >2004 and PUBYEAR <2015) or ((TITLE-ABS-KEY (breast and lobul\*) and TITLE-ABS-KEY (cancer or neoplasm or carcinoma)) and PUBYEAR >2004 and PUBYEAR <2015) or ((TITLE-ABS-KEY (breast and duct\*) and TITLE-ABS-KEY (cancer or neoplasm or carcinoma)) and PUBYEAR >2004 and PUBYEAR <2015)) and (LIMIT-TO (AFFILCOUNTRY, “India”))

## ANALYSIS

The world and India has published 203,879 and 5189 publications on breast cancer during 2005–2014, which increased from 15,275 and 171 in 2005 to 22,853 and 955 publications in 2014, registering an annual average growth rates of 4.75% and 21.94%. The cumulative growth of world and Indian publications in breast cancer has increased from 86,766 and 1335 publications during 2006–2009 to 117,113 and 3854 publications during 2010–2014, witnessing a growth rate of 34.97% and 188.70%. India's global publications share in breast cancer was 2.55% during 2005–2014, which increased from 1.54% during 2005–2009 to 3.29% during 2010–2014. The average citation per publication registered by Indian publications in breast cancer was 3.38 during 2005–2014, which decreased from 4.02 during 2005–2009 to 3.16 during 2010–2014 [Table 1].

### Citation pattern of Indian research output

Citations of 5189 Indian publications during 2005–2014 in breast cancer were examined since the year of publication till February 2015. During this period, 37,873 citations were received by 5189 Indian publications, leading to the average citation per publication of 7.30. Only 35.40% of the total Indian publications did not get any citations (zero citation) and rest of the 64.60% publications were cited 1 or more times. Of the total cited publications, 0.62% publications (receiving more than 100 citations) contributed 13.44% citations share, 0.29% publications (receiving 81–100 citations) contributed 3.26% citations share, 0.77% publications (receiving 61–80 citations) contributed 7.13% citations share, 1.75% publications (receiving 41–60 citations) contributed 11.59% citations share, 6.38% publications (receiving 21–40 citations) contributed 24.23% citations share and 54.80% publications (receiving 1–20 citations) contributed 40.25% citations share [Table 2].

### Global publication share and citation impact of top 15 most productive countries

The global research output in breast cancer originated in more than 100 countries during 2004–2013. Table 3 lists the output of top 15 most productive countries in breast cancer that produced 89.89% of the global output in breast cancer during 2004–2013. The global publication share of the top 15 most productive countries has increased from 87.75% during 2005–2009 to 91.51% during 2010–2014. The publication share of 15 most productive countries in breast cancer varied from 1.51% to 34.75% during 2005–2014, with highest publication share (34.75%) coming from USA, followed by UK (7.54% share), China (7.40%), Germany (5.75% share), Italy (5.11% share), Canada, France and Japan

**Table 1: World and Indian literature in breast cancer: Growth, impact and international collaboration, 2005–2014**

Publication year	World TP	India				
		TP	TC	ACPP	ICP	Percentage of ICP
2005	15,275	171	537	3.14	31	18.13
2006	16,319	247	854	3.46	53	21.46
2007	17,122	257	1116	4.34	43	16.73
2008	18,374	284	1157	4.07	55	19.37
2009	19,676	376	1698	4.52	75	19.95
2010	21,269	551	1467	2.66	116	21.05
2011	22,648	671	3458	5.15	132	19.67
2012	24,764	777	4220	5.43	161	20.72
2013	25,579	900	2446	2.72	178	19.78
2014	22,853	955	583	0.61	188	19.69
2005–2009	86,766	1335	5362	4.02	257	19.25
2010–2014	117,113	3854	12,174	3.16	775	20.11
2005–2014	203,879	5189	17,536	3.38	1032	19.89

TP: Total papers, TC: Total citations, ACPP: Average citations per paper, ICP: International collaborative papers

**Table 2: Citations received by Indian publications in breast cancer, 2005–2014**

Citations range	Number of papers	Number of citations	Percentage of papers	Percentage of citations
>100	32	5092	0.62	13.44
81–100	15	1271	0.29	3.356
61–80	40	2701	0.77	7.132
41–60	91	4391	1.75	11.59
21–40	331	9175	6.38	24.23
1–20	2842	15,243	54.8	40.25
0	1838	0	35.4	0
	5189	37,873	100	100

(from 4.04% to 4.48% share), Spain, Australia, Netherlands, India and South Korea (from 2.49% to 2.80% share), and Sweden and Switzerland (from 1.51% to 1.71% share) during 2005–2014. The global publication share has increased by 5.21% in China, followed by India (1.75%), South Korea (1.17%), Australia (0.34%), Spain (0.12%) and Netherlands (0.07%), as against decrease by 2.61% in USA, followed by U.K. (1.09%), Germany (0.76%), France (0.19%), Japan (0.12%), Canada (0.09%), Sweden (0.08%), Switzerland (0.05%) and Italy (0.03%) from 2005–2009 to 2010–2014 [Table 3].

### International collaboration

The share of international collaborative publications in India's in breast cancer research output was 19.89% during 2005–2014, which decreased from 19.25% during 2005–2009 to 20.11% during 2010–2014. India has collaborated with several countries in breast cancer research during 2005–2014. Among the collaborating

**Table 3: Publication output and global publication share of top 15 most productive countries in breast cancer, 2005–2014**

Country	Number of papers			Share of papers		
	2005–2009	2010–2014	2005–2014	2005–2009	2010–2014	2005–2014
USA	31,406	39,452	70,858	36.2	33.69	34.75
UK	7083	8287	15,370	8.16	7.076	7.539
China	3823	11,263	15,086	4.41	9.62	7.399
Germany	5364	6351	11,715	6.18	5.42	5.75
Italy	4450	5972	10,422	5.13	5.10	5.11
Canada	3932	5202	9134	4.53	4.44	4.48
France	3877	5010	8887	4.47	4.28	4.36
Japan	3567	4671	8238	4.11	3.99	4.04
Spain	2370	3338	5708	2.73	2.85	2.8
Australia	2250	3440	5690	2.59	2.94	2.79
Netherlands	2243	3104	5347	2.59	2.65	2.62
India	1335	3854	5189	1.54	3.29	2.54
South Korea	1578	3500	5078	1.82	2.99	2.49
Sweden	1521	1963	3484	1.75	1.68	1.71
Switzerland	1336	1742	3078	1.54	1.49	1.51
World	86,766	117,113	203,879	100	100	100

**Table 4: Share of leading countries in India's international collaborative output in breast cancer during 2005–2014**

Name of collaborative country	Number of international collaborative publications			Share of international collaborative publications		
	2005–2009	2010–2014	2005–2014	2005–2009	2010–2014	2005–2014
USA	151	404	555	58.75	52.13	53.78
UK	17	66	83	6.61	8.52	8.04
Canada	17	53	70	6.61	6.84	6.78
Germany	18	49	67	7.00	6.32	6.49
Saudi Arabia	5	55	60	1.95	7.10	5.81
France	15	42	57	5.84	5.42	5.52
Australia	11	41	52	4.28	5.29	5.04
Japan	12	32	44	4.67	4.13	4.26
Malaysia	3	41	44	1.17	5.29	4.26
South Korea	3	40	43	1.17	5.16	4.17
Singapore	11	30	41	4.28	3.87	3.97
Italy	5	29	34	1.94	3.74	3.29
Taiwan	5	25	30	1.94	3.23	2.91
China	5	24	29	1.94	3.09	2.81
Spain	3	25	28	1.17	3.23	2.71
Total	257	775	1032	100.0	100	100



**Table 5: Subject-wise break-up of India's publications in breast cancer, 2005–2014**

Subject areas	TP			Activity index		TC	ACPP	HI	HCP	Percentage of HCP
	2005–2009	2010–2014	2005–2014	2005–2009	2010–2014					
Medicine	849	1983	2832	54.58	116.5	94.28	3.33	52	18	0.64
Biochemistry, Genetics and molecular biology	511	1465	1976	38.08	100.5	99.82	5.02	54	17	0.86
Pharmacology, toxicology and pharmaceuticals	223	976	1199	23.11	72.29	109.6	4.89	47	9	0.75
Chemistry	92	494	586	11.29	61.02	113.5	5.02	33	5	0.85
Agricultural and biological sciences	39	162	201	3.874	75.42	108.5	2.75	22	1	0.5
Immunology and microbiology	22	84	106	2.043	80.67	106.7	3.85	12	0	0
Total of the country	1335	3854	5189	54.58	116.5	94.28	3.33	52	18	0.64

\*There is a duplication of publications under various subject areas, as some journals covered are common in different subject areas. TP: Total publications, TC: Total citations, ACPP: Average citations per publication, ICP: International collaborative publications, HCP: High cited papers, HI: H-index

**Table 6: Distribution of India's breast cancer publications by treatment methods, 2005–2014**

Treatment methods	Number of publications			Share of publications		
	2005–2009	2010–2014	2005–2014	2005–2009	2010–2014	2005–2014
Diagnosis	254	667	921	19.00	17.31	17.75
Chemotherapy	217	548	765	16.30	14.22	14.74
Screening	160	528	688	12.00	13.70	13.26
Prognosis	144	341	485	10.80	8.85	9.35
Surgery	152	329	481	11.40	8.54	9.27
Radiotherapy	162	264	426	12.10	6.85	8.21
Pathology	128	232	360	9.59	6.02	6.94
Genetics	76	130	206	5.69	3.37	3.97
Quality of life	36	81	117	2.70	2.10	2.25
Epidemiology	25	44	69	1.87	1.14	1.33
Palliative care	13	20	33	0.97	0.52	0.64
Total	1335	3854	5189	100	100	100

countries, the largest share (53.78%) was contributed by United States, followed by UK (8.04%), Canada (6.78%), Germany (6.49%), Saudi Arabia (5.81%), France (5.52%), Australia (5.04%), Japan and Malaysia (4.26% each), Singapore (3.97%), Italy (3.29%), Taiwan (2.91%), China (2.81%), and Spain (2.71%) during 2005–2014. The international collaborative publications share of foreign countries in India's publications output increased by 5.15% in Saudi Arabia, followed by Malaysia (4.12%), South Korea (3.99%), Spain (2.06%), U.K. (1.90%), Italy (1.80%), Taiwan (1.28%), China (1.15%), Australia (1.01%) and Canada (0.22%), as against decrease by 6.63% in United States, followed by Germany (0.68%), France (0.42%), and Singapore (0.41%) from 2005–2009 to 2010–2014 [Table 4].

### Subject-wise distribution of research output

India's breast cancer research output during 2005–2014 has been published in the context of six sub-fields (as reflected in Scopus database classification), with highest publications share (54.58%) coming from medicine, followed by biochemistry, genetics and

**Table 7: Geographical distribution of breast cancer research publications in India, 2005–2014**

Name of geographical area	Number of publications			Share of publications		
	2005–2009	2010–2014	2005–2009	2010–2014	2005–2009	2010–2014
Maharashtra	253	546	799	19.00	14.17	15.4
Delhi	271	481	752	20.30	12.48	14.49
Tamil Nadu	142	515	657	10.60	13.36	12.66
Karnataka	155	414	569	11.60	10.74	10.97
Uttar Pradesh	129	377	506	9.66	9.78	9.75
Telangana	60	296	356	4.49	7.68	6.86
Kerala	61	139	200	4.57	3.61	3.85
Chandigarh	51	116	167	3.82	3.01	3.22
Punjab	25	128	153	1.87	3.32	2.95
Gujarat	34	101	135	2.55	2.62	2.60
Andhra Pradesh	14	102	116	1.05	2.65	2.23
Haryana	16	91	107	1.20	2.36	2.06
West Bengal	11	94	105	0.82	2.44	2.02
Rajasthan	10	78	88	0.75	2.02	1.70
Orissa	10	46	56	0.75	1.19	1.08
Madhya Pradesh	3	24	27	0.22	0.62	0.52
Pondicherry	10	17	27	0.75	0.441	0.52
Chattisgarh	2	10	12	0.15	0.259	0.231
Bihar	0	6	6	0	0.16	0.12
Total of the country	1335	3854	5189	100	100	100

molecular biology (38.08%), pharmacology, toxicology and pharmaceuticals (23.11%), chemistry (11.29% share), agricultural and biological sciences (3.87% share) and immunology and microbiology (2.04% share). The research activity, as reflected in activity index, has witnessed increase in, pharmacology, toxicology and pharmaceuticals (from 72.29 to 109.60), chemistry (from 61.02 to 113.50), agricultural and biological sciences (from 75.42 to 108.50) and immunology and microbiology (from 80.67% to 106.70%) in contrast to decrease in medicine (from 116.50 to 94.28) and biochemistry, genetics, and molecular biology (from

100.50 to 99.82) from 2005–2009 to 2010–2014. Among these six subjects, the largest citation impact per publication (5.02 each) was registered by biochemistry, genetics and molecular biology and chemistry, followed by pharmacology, toxicology and pharmaceuticals (4.89), immunology and microbiology (3.85), medicine (3.33) and agricultural and biological; sciences (2.75) during 2005–2014 [Table 5].

### Distribution of publications by treatment methods

In terms of treatment methods used in breast cancer research in India during 2005–2014, the largest publication share (17.75%) was registered by diagnosis, followed by chemotherapy (14.74%), screening (13.26%), prognosis (9.35%), surgery (9.27%), radiotherapy (8.21%), pathology (6.94%), genetics (3.97%), quality of life (2.25%), epidemiology (1.33%), and palliative care (0.64%) during 2004–2013. The publication share has increased by 1.71% in screening, as against decrease by 5.28% in radiotherapy, pathology (3.57%), surgery (2.85%), genetics (2.32%), chemotherapy (2.04%), prognosis (1.94%), diagnosis (1.72%), screening (1.71%), epidemiology (0.73%), quality of life (0.59%), and palliative care (0.45%) from 2005–2009 to 2010–2014 [Table 6].

### Distribution of research output by geographical areas

Among India states and union territories contributing to breast cancer research during 2005–2014, the largest publication share (15.40%) came from Maharashtra, followed by Delhi (14.49%), Tamil Nadu (12.66%), Karnataka (10.97%), Uttar Pradesh (9.75%), Telangana (6.86%), etc. during 2005–2014. Together the first four states account for 53.52% share of the Indian output in breast cancer during 2005–2014. The share of breast cancer publications have increased in Telangana (3.19%), Tamil Nadu (2.73%), Andhra Pradesh (1.60%), Punjab (1.45%), Rajasthan (1.27%), Haryana (1.16%), Madhya Pradesh (0.40%), Uttar Pradesh (0.12%), Bihar (0.16%), Chattisgarh (0.11%) and Gujarat (0.07%), as against decrease in Delhi (7.82%), Maharashtra (4.78%), Kerala (0.96%), Karnataka (0.87%), Chandigarh (0.81%) and Pondicherry (0.31%) from 2005–2009 to 2010–2014 [Table 7].

### Profile of top 15 most productive organizations

The productivity of 15 most productive Indian organizations in breast cancer varied from 50 to 270 publications and together contributed 27.89% (1447 publications) share in the cumulative publications output of India in breast cancer research during 2005–2014. The scientometric profile of these 15 Indian organizations is presented in Table 8. Five organizations have registered higher publications output than the group average of 96.47: Tata Memorial Hospital (TMC), Mumbai (270 publications), All India Institute of Medical Sciences (AIIMS), New Delhi (243 publications), University of Madras (112 publications), Indian Institute of Chemical Technology (IICT), Hyderabad (110 publications) and Postgraduate Institute of Medical Education and Research, Chandigarh. Nine organizations have registered more than the average citation per publication (4.52) among the 15 organizations during 2004–2015: National Institute of Pharmaceutical Education and Research (NIPER), Mohali (8.20), Jadavpur University,

Kolkata (6.54), National Centre for Cell Science (NCSS), Pune (6.44), Central Drug Research Institute (CDRI), Lucknow (6.00), Indian Institute of Science (IISc), Bengaluru (5.78), Institute of Rotary Cancer Hospital, New Delhi (5.47), Chittranjan National Cancer Institute (CNCI), Kolkata (4.98), Indian Institute of Technology (IIT), Kharagpur (4.98) and IICT, Hyderabad (4.65). Seven organizations have registered more than the average h-index (15.73) of all 15 organizations during 2004–2013: AIIMS-New Delhi (24), TMC-Mumbai (22), NIPER-Mohali, IISc-Bengaluru and IICT-Hyderabad (18 each), CDRI-Lucknow and University of Madras (17 each). Seven organizations have achieved more than the average share of international collaborative publications (18.66%) of all 15 organizations: IIT-Kharagpur (36.54%), Jadavpur University-Kolkata (36.00%), CNCI-Kolkata (26.79%), AIIMS-Delhi (23.05%), NCSS-Pune (21.15%), TMH-Mumbai (20.00%) and IISc-Bengaluru (18.99%) during 2005–2014. Eight organizations have achieved more than the average share of national collaborative publications (30.82%) of all 15 organizations: CDRI-Lucknow (55.84%), Jadavpur University, Jodhpur (54.00%), Varadman Mahavirj Medical College and Safdarjang Hospital, New Delhi (50.84%), SGPGIMS-Lucknow (46.15%), IICT-Hyderabad (42.73%), NCSS-Pune (42.31%), NIPER-Mohali (37.88%) and AIIMS-Delhi (31.28%) during 2004–2015.

### Medium of communication

The 15 most productive journals contributed from 35 to 134 papers and together contributed 13.63% share (182 papers) to the total journal publication output in breast cancer during 2005–2014. The publication share of these top 15 most productive journals increased from 13.63% to 22.18% from 2005–2009 to 2010–2014. Of these 15 journals, the highest IF (2013) was of PLOS One (3.534), followed by European Journal of Medicinal Chemistry (3.432), International Journal of Pharma and Bio Sciences (2.968), bioorganic and medicinal chemistry letters (2.331), International Journal of Pharmacy and Pharmaceutical Sciences (1.590), Asia Pacific Journal of Cancer Prevention (1.50), Indian Journal of Cancer (1.13), etc., [Table 9].

### High cited papers

There were 33 papers (22 articles, 10 reviews and 1 short survey) in Indian breast cancer research, which have received 100 or more citations from the date of their publication till February 2015. These 33 papers together received 5026 citations, with an average citation per paper of 152.30. Of 33 papers, 27 received citations from 100 to 199, 5 from 200 to 299 and 1 from 300 to 399. Of the 33 high cited papers, 14 papers were zero collaborative (single institution papers), 2 national collaborative and 17 international collaborative (9 bilateral and 8 multinational collaborative). Among the 17 international collaborative publications, USA authors had both first and corresponding authorship in 9 papers, Belgium in two papers, India in two papers (in one paper only corresponding authorship), U.K., Japan and France (only first author) in one paper each. Twenty-seven Indian organizations are involved in these 31 high cited papers, of which the largest number of papers<sup>[5]</sup> came from Institute of Life Sciences, Bhubaneswar, followed by TMC, Mumbai, AIIMS, New Delhi, IIT, Madras and Birla Institute of Technology and Science, Pilani (2 papers

**Table 8: Scientometric profile of top 15 most productive Indian organizations in breast cancer, 2005–2014**

Name of the organization	TP	TC	ACPP	HI	ICP	Percentage of ICP	NCP	Percentage of NCP	HCP
Tata Memorial Hospital, Bombay	270	1165	4.31	22	54	20	32	11.85	2
All India Institute of Medical Sciences, New Delhi	243	914	3.76	24	56	23.05	76	31.28	2
University of Madras	112	318	2.84	17	13	11.61	29	25.89	0
Indian Institute of Chemical Technology, Hyderabad	110	512	4.65	18	14	12.73	47	42.73	0
Postgraduate Institute of Medical Education and Research, Chandigarh	107	279	2.61	12	13	12.15	18	16.82	0
Indian Institute of Science, Bengaluru	79	457	5.78	18	15	18.99	24	30.38	1
Central Drug Research Institute, Lucknow	77	462	6.00	17	12	15.58	43	55.84	0
National Institute of Pharmaceutical Education and Research, Mohali	66	541	8.20	18	7	10.61	25	37.88	1
Sanjay Gandhi Postgraduate Institute of Medical Education and Research, Lucknow	65	206	3.17	11	7	10.77	30	46.15	1
Chittranjan National Cancer Institute, Kolkata	56	279	4.98	13	15	26.79	17	30.36	1
Institute of Rotary Cancer Hospital, New Delhi	55	301	5.47	11	10	18.18	15	27.27	1
Varadman Mahavir Medical College and Safdarjang Hospital, New Delhi	53	184	3.47	14	6	11.32	27	50.94	0
Indian Institute of Technology, Kharagpur	52	259	4.98	12	19	36.54	14	26.92	0
National Centre for Cell Science, Pune	52	335	6.44	15	11	21.15	22	42.31	1
Jadavpur University, Kolkata	50	327	6.54	14	18	36	27	54	1
Total of 15 organizations	1447	6539	4.52	15.73	270	18.66	446	30.82	11
Total of the country	5189								
Share of total 15 organizations in country output	27.89								

TP: Total publications, TC: Total citations, ACPP: Average citations per publication, ICP: International collaborative publications, HCP: High cited papers, HI: H-index, NCP: National collaborative papers

**Table 9: List of most productive journals in Indian in breast cancer during 2005–2014**

Name of the journal	Number of publications			Share of publications			IF 2013
	2005–2009	2010–2014	2005–2014	2005–2009	2010–2014	2005–2014	
Asia Pacific Journal of Cancer Prevention	27	107	134	2.02	2.78	2.58	1.50
Indian Journal of Cancer	27	81	108	2.02	2.1	2.08	1.13
Journal of Cancer Research and Therapy	39	63	102	2.92	1.63	1.97	0.761
Indian Journal of Pathology and Microbiology	42	45	87	3.15	1.17	1.68	0.642
European Journal of Medicinal Chemistry	8	70	78	0.6	1.82	1.5	3.432
Public Library of Science One	6	59	65	0.45	1.53	1.25	3.534
Bioorganic and Medicinal Chemistry letters	10	54	64	0.75	1.4	1.23	2.331
Medicinal Chemistry Research	2	60	62	0.15	1.56	1.19	1.612
Journal of Clinical and Diagnostic Research	3	58	61	0.22	1.5	1.18	0.140
Indian Journal of Surgical Oncology	0	61	61	0	1.58	1.18	NA
International Journal of Pharma and Bio Sciences	0	54	54	0	1.4	1.04	2.968
International Journal of Pharmacy and Pharmaceutical Sciences	0	52	52	0	1.35	1.00	1.590
Indian Journal of Surgery	8	31	39	0.6	0.8	0.75	0.270
Journal of the Indian Medical Association	10	25	35	0.75	0.65	0.67	NA
International Journal of Pharmaceutical Sciences Review and Research	0	35	35	0	0.91	0.67	2.190
Total of 15 journals	182	855	1037				
Total of the country	1335	3854	5189				
Share of 15 journals in country output	13.63	22.18	20				

NA: Not available

each) and 22 other organizations (3 Hospitals-Institute of Rotary Cancer Hospital, New Delhi, Sterling Hospital, Ahmedabad and Dr. Jilla Hospital Aurangabad; 3 medical colleges-medical college, Jaipur, Amtita Institute of Medical Sciences, Coimbatore and SGPIMS, Lucknow; 7 research institutes - Regional Cancer Center, Trivandrum, Amala Cancer Research Center, Trissur, ITRC-Lucknow, Bose Institute, Kolkata, INMAS, Delhi, NII-New Delhi and Institute of Bioinformatics, Bengaluru; 6 Universities-Delhi, Pune, Baroda, Banaras and Jamia Hamdard and 3 institutes of national importance-IISc-Bengaluru, IIT-Bombay and NIPER, Mohali) with one paper each. The 33 high cited papers were published in 27 peer reviewed journals, of which the largest number of papers (3 each) were published in cancer research and biomaterials, followed by 2 papers each in cancer letters and New England Journal of Medicine, and one paper each in 23 journals (AAPS Journal, Advanced Drug Delivery Review, American Journal of Transplantation, biology of the cell, cancer, Chinese medicine, current drug delivery, current problems in cancer, European journal of medicinal chemistry, food and medicinal chemistry, histopathology, journal of biological chemistry, journal of the American Chemical Society, Molecular pharmaceuticals, nanomedicine, nanotechnology, NMR in biomedicine, oxidative medicine and cellular longevity, pharmacological reports, proceedings of the National Academy of Sciences of United States, the lancet, World Journal of Surgery and World Psychiatry).

## SUMMARY AND CONCLUSIONS

India had published 5,189 publications in breast cancer research during 2005–2014, which increased from 171 publications in 2005 to 955 publications in 2014, witnessing a growth rate of 4.75%. India's publication share in global output was 2.55% during 2005–2014, which increased from 1.54% during 2005–2009 to 3.29% during 2010–2014. The citation impact registered by Indian publications in breast cancer was 3.38 during 2005–2014, which decreased from 4.02 during 2005–2009 to 3.16 during 2010–2014. The international collaborative publications share in India's output was 19.89% during 2005–2014, which decreased from 19.25% during 2005–2009 to 20.11% during 2010–2014. Among various subject fields, medicine contributed the highest publication share (54.58%), followed by biochemistry, genetics and molecular biology (38.08%), pharmacology, toxicology and pharmaceuticals (23.11%), chemistry (11.29% share), agricultural and biological sciences (3.87% share) and immunology and microbiology (2.04% share). The research activity showed increasing trend in pharmacology, toxicology and pharmaceuticals, chemistry, agricultural and biological sciences and immunology and microbiology, as against decreasing trend in medicine and biochemistry, genetics and molecular biology from 2005–2009 to 2010–2014. Biochemistry, genetics and molecular biology and chemistry registered the highest citation impact (5.02), followed by pharmacology, toxicology and pharmaceuticals (4.89), immunology and microbiology (3.85), medicine (3.33) and agricultural and biological sciences (2.75) during 2005–2014. The four treatment methods, namely diagnosis, chemotherapy, screening and prognosis together accounted for

55.10% share in India's breast cancer output during 2005–2014. In terms of geographical distribution, the four states namely Maharashtra, Delhi, Tamil Nadu and Karnataka accounted for 53.52% of the India's breast cancer output during 2005–2014. The top 15 most productive Indian organizations together accounted for 27.89% share in India's breast publication output and had an average publication productivity per organization of 96.47, average citation impact per paper of 4.52, average h-index of 15.73 and average international collaborative publication share of 18.66% during 2005–2014. The 15 most productive Indian and foreign journals together contributed 13.63% share in India's breast cancer output, which increased from 13.63% to 22.18% from 2005–2009 to 2010–2014.

The authors indicate that cancer prevention is still not a priority in India as the emphasis remains on treatment of cancer and strengthening of tertiary cancer hospitals, rather than prevention via screening or early detection of cancer in India. Therefore, there is a need for educating the population about breast self-awareness and advice to seek medical attention earlier for breast concerns, as well as ensuring healthy lifestyle choices to reduce risk can potentially have a significant impact in managing the problem of breast cancer in India. Furthermore, the government programs on cancer require several organizational, budgetary and human resources, and the accessibility of breast cancer diagnostic, referral, treatment and palliative care facilities should be improved simultaneously.

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