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# Indian contribution to breast cancer research: a bibliometric analysis

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Based on breast cancer research data obtained from Scopus multidisciplinary database, it is seen that with 6696 (1.82% global share) articles from India on breast cancer during 1975-2014, India ranks 12th in the world in terms of research paper output. About 80% of the Indian publications appeared during the period 2004-14. Hospitals are more productive with Tata Memorial Hospital publishing the highest number of papers during the period. About 30.35% Indian publications are a result of international collaboration with 94 countries.

**Keywords:** Breast Cancer; Tumor; India; Bibliometrics

## Introduction

The World Health Organization's International Agency for Research on Cancer (IARC) (http://www.iarc.fr/) has identified more than 100 types of chemical, physical, and biological carcinogens that causes cancer. Cancer research is focused on discovering new carcinogens, explaining how they cause cancer and providing insights into ways to prevent cancer. Peyton Rous discovered cancer, and the virus causing cancer came to be known as Rous sarcoma virus. Peyton Rous was awarded the Nobel Prize in 1966 for his discovery[1]. In addition to viruses, chemicals and radiations also cause cancer and sometimes cancer is found to run in families[2].

Breast cancer is one of the most common forms of cancer that manifests as a carcinoma (cancer found in the breast tissue) or as a sarcoma[3] (cancer found in the connective tissue of the breast). The symptoms of the breast cancer may include, lump formation, change in shape, dimpling and a red scaly patch of skin, and fluid oozing through the nipple, etc[4]. The breast cancer is the major cause of death among women in the United States[5] and other parts of the World. Due to increased incidences of breast cancer, it has been reported that each year, over 1.1 million cases of breast cancer in women have been diagnosed worldwide and over 410,000 women died due to breast cancer[6].

Breast cancer is classified based on the effect of carcinogens on breast tissues. Cancer developed in milk ducts are known as ductal carcinomas, while those developing from lobules are known as lobular carcinomas. Further, there are more than 18 other sub-types of breast cancer[7-8]. There are technological and medical advances that have made early diagnosis and treatment of the breast cancer possible. Mammography is routinely used method for detection of breast cancer and surgery; radiation therapy, chemotherapy, hormonal therapy and targeted therapy are used as treatment methods for treating breast cancer[9-11].

Cancer research is growing rapidly as evidenced by the increasing research publication output. Bibliometric analysis helps in studying the various facets of publication productivity in different research areas[12-13]. Several bibliometric studies have reported analysis of cancer literature[14-16]. There are bibliometric studies on cancer of specific organs such as cervical cancer[17-18], and oral cancer[19], while other bibliometric studies are on cancer in specific countries[20-22] including a study on global perspectives[23]. Specific country based cancer studies include Arab countries[24], Brazil[25], France[26], Iran[27-28],

Mexico[29] and Nigeria[30]. From the review of literature, it is seen that there are no bibliometric studies on breast cancer research from India so far. So, this paper attempts to fill this gap by presenting a bibliometric report on breast cancer research in India.

## Objectives of the study

- To analyse the contribution of India in breast cancer research
- To study the research performance of Indian institutions in the area of breast cancer;
- To identify Indian breast cancer researchers;
- To find preferred journals in which Indian breast cancer researchers publish their works; and
- To examine breast cancer research collaboration.

## Methodology

The Scopus database was searched for records on breast cancer using the keywords breast cancer, cystosarcoma phyllodes, malignant cystosarcoma phyllodes, breast invasive ductal carcinoma, infiltrating duct carcinoma, mammary ductal carcinoma, breast neoplasm, breast tumor, human mammary neoplasm, human mammary carcinoma available in title, abstract and keyword fields. The geographical location was kept as India. All these keywords used for tumors or cancer of the human breast and have been obtained from Medical Subject Heading (MeSH) for Breast Cancer available at PubMed of National Center for Biotechnological Information (NCBI). The following search string was used to retrieve data from Scopus.

(TITLE-ABS-KEY (breast cancer) OR TITLE-ABS-KEY (cystosarcoma phyllodes) OR TITLE-ABS-KEY (malignant cystosarcoma phyllodes) OR TITLE-ABS-KEY (breast invasive ductal carcinoma) OR TITLE-ABS-KEY (infiltrating duct carcinoma) OR TITLE-ABS-KEY (mammary ductal carcinoma) OR TITLE-ABS-KEY (breast neoplasm) OR TITLE-ABS-KEY (breast tumor) OR TITLE-ABS-KEY (human mammary neoplasm) OR TITLE-ABS-KEY (human mammary carcinoma) AND AFFIL (India) ) AND PUBYEAR > 1974 AND PUBYEAR < 2015)

The data were analyzed for tabulating the characteristics of publications, types of publications, productive countries, and then further analyzed for Indian contribution in terms of performance by institutions, journals, authors and their citation impact and Hirsch Index (*h*-Index)[31].

## Results

A total of 368,801 records were retrieved from Scopus using the query discussed in the methodology. Table 1 gives the publication productivity of the top twelve countries on breast cancer research. It was found that the USA was the most productive country with 36.63% of global share of publications on breast

Table 1—Most productive countries and their publication share on breast cancer research

| Sl. no. | Country | No. of publications | | | | | Share of publications (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1975-1984 | 1985-1994 | 1995-2004 | 2005-2014 | 1975-2014 | 1975-1984 | 1985-1994 | 1995-2004 | 2005-2014 | 1975-2014 |
| 1. | United States | 10098 | 14624 | 37325 | 73046 | 135093 | 41.86 | 29.94 | 36.97 | 37.48 | 36.63 |
| 2. | United Kingdom | 2193 | 4305 | 8852 | 15768 | 31118 | 9.09 | 8.81 | 8.77 | 8.09 | 8.44 |
| 3. | Germany | 1681 | 2438 | 6258 | 12016 | 22393 | 6.97 | 4.99 | 6.20 | 6.17 | 6.07 |
| 4. | Italy | 1375 | 2717 | 5392 | 10780 | 20264 | 5.70 | 5.56 | 5.34 | 5.53 | 5.49 |
| 5. | France | 1279 | 2643 | 5205 | 9132 | 18259 | 5.30 | 5.41 | 5.16 | 4.69 | 4.95 |
| 6. | Japan | 1296 | 2231 | 5129 | 8561 | 17217 | 5.37 | 4.57 | 5.08 | 4.39 | 4.67 |
| 7. | China | 43 | 224 | 1080 | 15680 | 17027 | 0.18 | 0.46 | 1.07 | 8.05 | 4.62 |
| 8. | Canada | 710 | 1351 | 4043 | 9428 | 15532 | 2.94 | 2.77 | 4.00 | 4.84 | 4.21 |
| 9. | Netherlands | 406 | 1118 | 2631 | 5496 | 9651 | 1.68 | 2.29 | 2.61 | 2.82 | 2.62 |
| 10. | Australia | 392 | 735 | 2326 | 5873 | 9326 | 1.63 | 1.50 | 2.30 | 3.01 | 2.53 |
| 11. | Spain | 156 | 517 | 2239 | 5954 | 8866 | 0.65 | 1.06 | 2.22 | 3.06 | 2.40 |
| 12. | India | 216 | 227 | 850 | 5403 | 6696 | 0.90 | 0.46 | 0.84 | 2.77 | 1.82 |
| | Others | 4277 | 15721 | 19622 | 17738 | 57358 | 17.73 | 32.18 | 19.44 | 9.10 | 15.55 |
| | World | 24122 | 48851 | 100952 | 194876 | 368801 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

cancer. India ranked 12th in terms of total publications with 6696 papers which is 1.82% of global literature. In terms of global share of publications during 1975-1984, it was 0.90% (216 articles of 24122 globally) that decreased further to 0.46% (227 articles of 48851 globally) during 1985-1994. Since then the research by the Indian authors is continuously increasing i.e., 0.84% (850 article of 100952 globally) in 1995-2004 to 2.77% (5403 articles of 194876 globally) of global output during 2005-2014.

The Indian contribution of 6696 records was further analyzed. It was found that most of the publications on breast cancer appeared during the last decade (80.69%). It was seen that over 12.69% publications appeared during the period 1995-2004, while the initial twenty years saw a contribution of about 6.62%. Over 73.81% of papers published during the period of 1975-2014 have been cited at least once. These 6696 papers received a total of 68247 citations with an Average Citation per Paper (ACPP) of 10.19 citations. Papers published during the period from 1995-2004 have highest ACPP (16.77).

Figure 1 presents the progression of Indian publication output and citedness of Indian publication on breast cancer research during the period of 1975-2014. It is evident that till 1995, the publication output was very low. During 1995-2008, there was a moderate growth of publications but thereafter a steep growth of scientific output is seen.

Out of the 6696 Indian breast cancer research records in Scopus, 4853 are articles (73.55%), 754 are reviews (11.43%), and remaining appeared as conference papers (434; 6.58%), letters (234; 3.55%) and editorials (90; 1.6%). Notes, short surveys, books and book chapters were lower than one percent each.

***Research performance of Indian institutions on breast cancer***

It was found that twelve institutes published seventy seven or more papers on breast cancer during 1975-2014. Table 2 provides publication output of top 12 Indian institutions and their citation impact along with *h*-index values[32]. Unlike other bibliometric measures, the *h*-index takes into account the lifetime achievement of a scholar's work and *h*-index can give a fairer measure of an overall academic impact[33-34]. These 12 institutes have contributed 26.63% of the total Indian publications on breast cancer. The highest contribution came from Tata Memorial Hospital (428 papers), followed by All India Institute of Medical Sciences (330 papers) and PGIMER, Chandigarh (164 papers). In terms of citation count, Tata Memorial Hospital tops the list with 4745 citations with an Average Citations Per Paper (ACPP) of 11.09. Indian Institute of Science has highest ACPP of 17.66 followed by Regional Cancer Center (17.31) and Central Drug Research Institute (13.58). Five institutes have more publications than group average

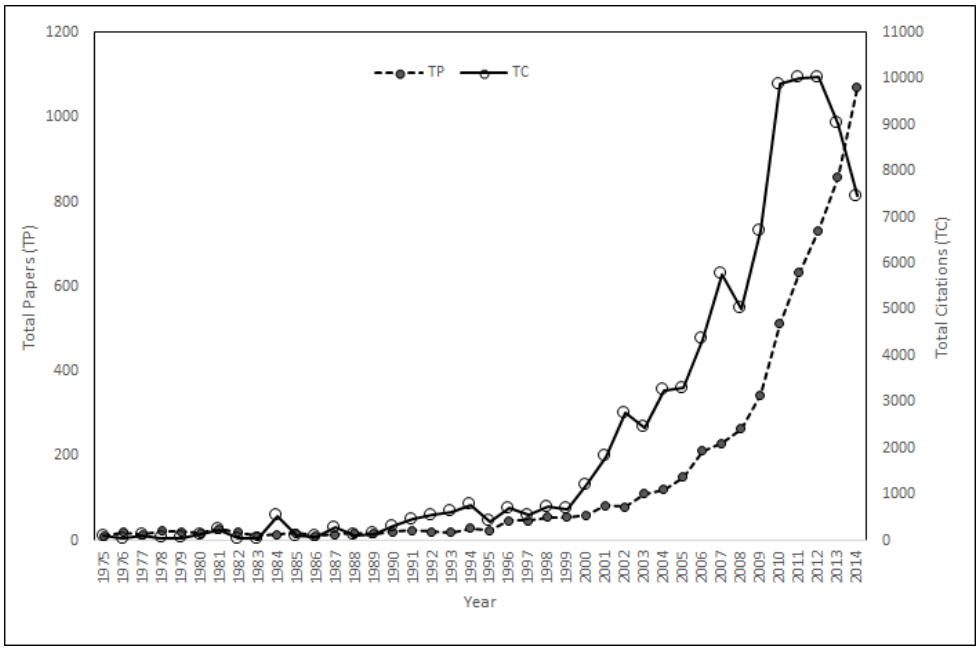


Fig. 1—Publication growth and citedness of Indian publication on breast cancer

(21) while six have fewer *h*-index values than group average (Table 2).

***Research output of Indian authors on breast cancer***

Figure 2 illustrates output and impact of India's most productive authors on breast cancer research. There are 15 Indian authors who have published thirty or more papers during 1975-2014. It was found that these 15 authors belong to 12 institutions of India. These 15 authors contributed 534 papers, which accounts for 7.98% of the total Indian publications output. Five authors have published more number of papers than the group average (35.6 papers), of which the most productive author is P. Sachdanandam, from the University of Madras, Chennai who has published the highest number of 50 publications followed N.K. Shukla with 43 papers, R. Sarin with 37 papers and V. Raina and I. Mitra each having published 36 papers each.

Going by citation count, the highest number of citations (1289 citations) were received by S. Padhey's papers who had an average citation per paper (ACPP) of 39.06, followed by I. Mitra of Tata Memorial Hospital, Mumbai with 938 citations (ACPP=26.06) and V. Raina of Fortis Hospital, Gurgaon with 829 citations (ACPP=23.03). Considering *h*-index as a factor of qualitative measure, it was found that S. Padhey has highest *h*-Index with a value of 20, followed by P. Sachdanandam (*h*-Index=16) and A. Kamal (*h*-Index=14). The average *h*-Index value is found to be 11.6, where seven authors have higher *h*-index value than group average while eight have a lower value than group average (Figure 2).

***Journal productivity in terms of Indian contribution***

The Indian papers on breast cancer research were published in 1351 national and international journals. Table 3 presents the list of journals in which 50 or more papers on breast cancer were published. The publication share of these eighteen journals was 31.37% of total Indian research output. Many Indian authors preferred *Indian Journal of Cancer* for publishing breast cancer research. It has Impact Factor (IF) of 0.802 for the year 2014. Other journals were *Indian Journal of Pathology and Microbiology* (146 papers; IF=0.642), *Asian Pacific Journal of Cancer Prevention* (144 articles; IF=1.5) and *Journal of Cancer Research and Therapeutics* (103 articles; IF=0.949). As far as the Impact Factor (IF) is concerned, the Indian authors have published 65 papers in *PLoS One* which has IF 3.534, followed by *European Journal of Medicinal Chemistry* (84 papers) with IF of 3.432 and *Journal of Surgical Oncology* (51 papers) with IF of 2.843 (Table 3).

***Indian breast cancer research collaboration***

Of these 6696 papers published from India, 2032 were collaborative papers (30.35%) with authors from as many as 94 countries. Most of the collaborative research was with USA (653; 9.75%) followed by UK (116; 1.73%), Germany (84; 1.25%), Canada (75; 1.16%) and France (74; 1.11%). Other countries have lower than one percent share of collaborative research with India. The research collaboration trend with top 5 countries since 1986 has been depicted in Fig. 3.

Table 2—Most productive institutions in India working on breast cancer (1975-2014)

| Sl. no. | Institution | TP | TC | ACPP | *h*-Index |
|---|---|---|---|---|---|
| 1. | Tata Memorial Hospital, Mumbai | 428 | 4745 | 11.09 | 33 |
| 2. | All India Institute of Medical Sciences, New Delhi | 330 | 4429 | 13.42 | 32 |
| 3. | Postgraduate Institute of Medical Education and Research, Chandigarh | 164 | 1215 | 7.41 | 19 |
| 4. | University of Madras, Chennai | 142 | 1348 | 9.49 | 19 |
| 5. | Indian Institute of Chemical Technology, Hyderabad | 118 | 1433 | 12.14 | 23 |
| 6. | Central Drug Research Institute, Lucknow | 92 | 1249 | 13.58 | 20 |
| 7. | Indian Institute of Science, Bangalore | 91 | 1607 | 17.66 | 23 |
| 8. | Chittaranjan National Cancer Institute, West Bengal | 90 | 1161 | 12.90 | 18 |
| 9. | Institute Rotary Cancer Hospital, New Delhi | 90 | 1021 | 11.34 | 15 |
| 10. | Banaras Hindu University Institute of Medical Sciences, Varanasi | 83 | 850 | 10.24 | 15 |
| 11. | Regional Cancer Centre, Trivendrum | 78 | 1350 | 17.31 | 21 |
| 12. | Sanjay Gandhi Postgraduate Institute of Medical Sciences Lucknow | 77 | 878 | 11.40 | 14 |

(TP – Total Publications, TC-Total Citations, ACPP – Average citation per paper)

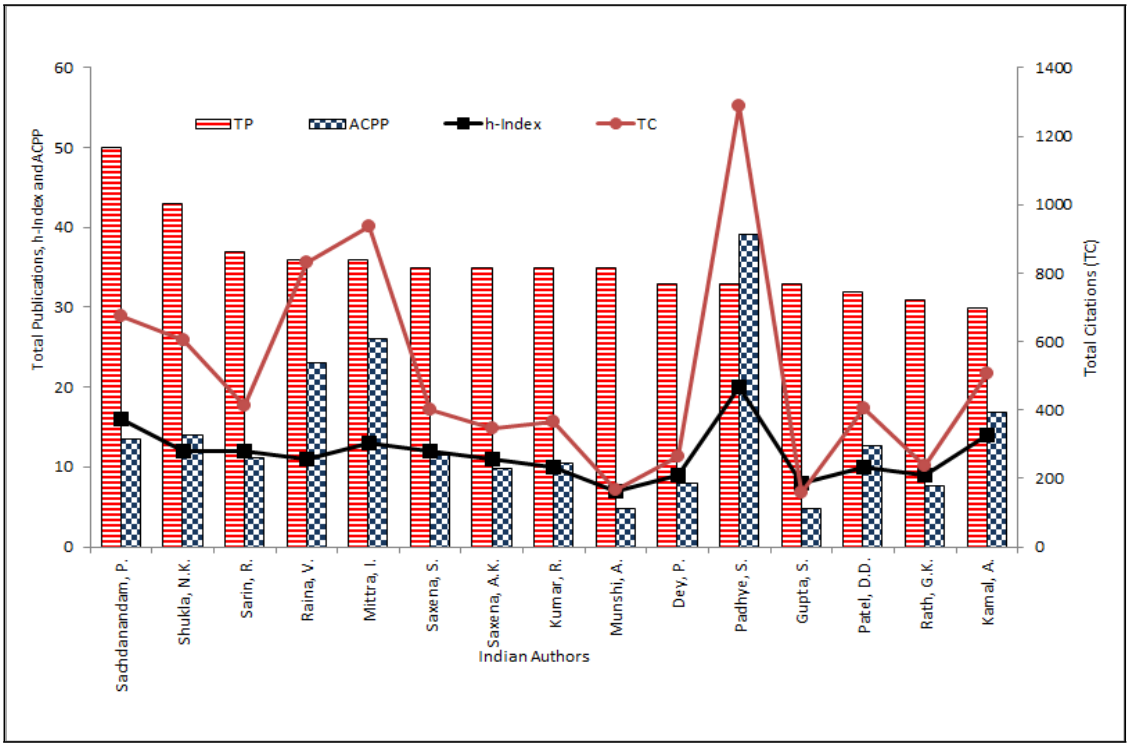


Fig. 2—Prolific Indian authors engaged in breast cancer research

Table 3—Top journals preferred for publishing Indian breast cancer research

| Sl. no. | Journal | TP | % | IF |
|---|---|---|---|---|
| 1. | *Indian Journal of Cancer* | 205 | 3.06 | 0.802 |
| 2. | *Indian Journal of Pathology and Microbiology* | 146 | 2.18 | 0.642 |
| 3. | *Asian Pacific Journal of Cancer Prevention* | 144 | 2.15 | 1.5 |
| 4. | *Journal of Cancer Research and Therapeutics* | 103 | 1.54 | 0.949 |
| 5. | *European Journal of Medicinal Chemistry* | 84 | 1.25 | 3.432 |
| 6. | *Bioorganic and Medicinal Chemistry Letters* | 66 | 0.99 | 2.331 |
| 7. | *Acta Cytologica* | 65 | 0.97 | 1.562 |
| 8. | *PLOS One* | 65 | 0.97 | 3.534 |
| 9. | *Indian Journal of Surgery* | 62 | 0.93 | 0.273 |
| 10. | *Indian Journal of Surgical Oncology* | 62 | 0.93 | - |
| 11. | *Journal of Clinical and Diagnostic Research* | 61 | 0.91 | - |
| 12. | *Medicinal Chemistry Research* | 56 | 0.84 | 1.402 |
| 13. | *International Journal of Pharma and Bio Sciences* | 54 | 0.81 | - |
| 14. | *Journal of the Indian Medical Association* | 54 | 0.81 | - |
| 15. | *Diagnostic Cytopathology* | 53 | 0.79 | 1.52 |
| 16. | *Journal of Surgical Oncology* | 51 | 0.76 | 2.843 |
| 17. | *Indian Journal of Medical Research* | 50 | 0.75 | 1.661 |
| 18. | *International Journal of Pharmacy and Pharmaceutical Sciences* | 50 | 0.75 | - |

(TP Total publication, IF – Impact factor)

## Conclusion

Cancer has become one of the deadliest and life-threatening diseases for the global population. Majority of research in the area of cancer is focused on discovering new carcinogens, causes, and discovery of drugs. In India, out of every two women diagnosed with breast cancer, one woman dies due to it[35]. The present study presents a forty-year

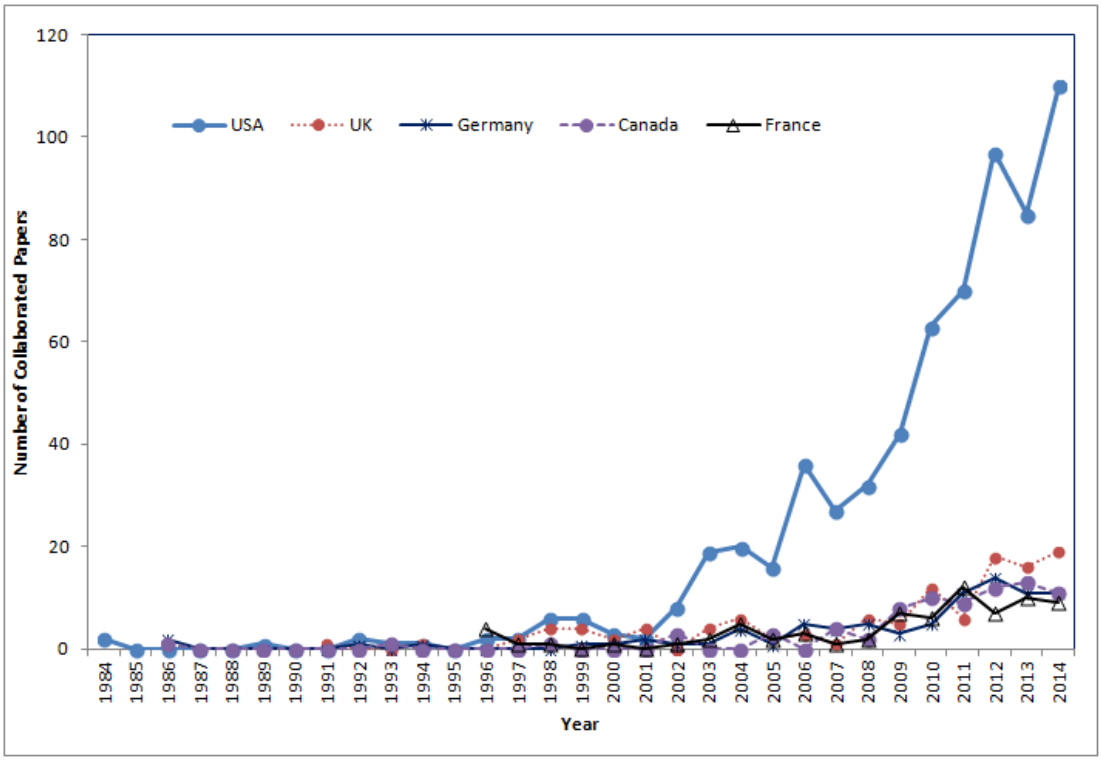


Fig. 3—Indian breast cancer research collaboration trend with top 5 counties

perspective of Indian breast cancer research. The study reveals that the Indian breast cancer research is continuously increasing. Initially the research trend was low but the largest number (80%) of publications appeared during the last decade of the study. This is one of the few studies that may have found that a hospital (Tata Memorial Hospital) has a very active research programme as compared to universities or research institutes.

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