



Working Toward a Cure:

Examining The State of Global Breast Cancer Research

October 2011



Introduction

Breast cancer is the most frequent cancer among women worldwide, with approximately 1.38 million new cases diagnosed in 2008. Among all cancer, it ranks second overall at nearly 11% of all cancers.¹

The incidence of breast cancer is far higher in developed countries compared to the developing world, with incidence varying from 19.3 per 100,000 women in Eastern Africa to 89.7 per 100,000 women in Western Europe.² Approximately 460,000 deaths each year are caused by breast cancer.³

However, a change is underway in the global breast cancer scenario. An estimated 1.7 million women will be diagnosed with breast cancer in 2020 – a 26% increase from current levels – and most will be in the developing world.⁴ The disease is increasing rapidly in middle- and low-income countries, including Africa, much of Asia, and Latin America. Breast cancer is already the leading cause of cancer among Southeast Asian women, and is second only to cervical cancer in women in south-central Asia. Breast cancer rates also are expected to rise precipitously by 2020 in India and China, the world's most populous countries.^{5, 6}

According to the World Health Organization, the global rise in breast cancer incidence has many causative factors, including reproductive history, genetics, radiation (especially at times of breast development), and the Western lifestyle with a high caloric diet, obesity and lack of physical activity.⁷

Despite the rise of breast cancer incidence in the developing world, the incidence of breast cancer remains significantly higher in higher income countries. However, survival rates for breast cancer present an entirely different picture. Though incidence and overall mortality rates for breast cancer remain lower in lower income countries than in higher income countries, case fatality rates from breast cancer – the ratio of deaths in a designated population of women with breast cancer – are very high in lower income countries. High case fatality rates are likely due to a lack of primary health care and other facilities for detection, diagnosis and care of breast cancer, along with a lack of awareness of the benefits of detection.⁸

Improvement in breast cancer survival in higher income countries, and especially in the United States, can be attributed to improved detection and treatment technologies such as mammography, advanced surgical procedures, and adjuvant therapies. However, improved survival rates for breast cancer in some higher income countries also have been due to improved awareness leading to early detection and therefore greater success in treatment.⁹



Global expansion of research

Research into the causes, prevention and treatment of breast cancer is taking place at research institutions and medical centers throughout the world, particularly in North America and Western Europe but with notable expansion taking place in China.

According to a medical review by the American Cancer Society, new global research into breast cancer includes:

- **Causes** – studies are examining lifestyle factors including the effect of exercise, weight gain or loss and diet. Genetic factors that influence breast cancer are another important area, particularly now that the human genome has been mapped out.
- **Chemoprevention** – various types of drugs are showing promise in lowering breast cancer risk, particularly to prevent cancer recurrences.
- **Gene studies** – research are linking certain patterns of genes with aggressive forms of breast cancer.
- **Classifying breast cancer** – a newer system of grouping breast cancers based on molecular features may help predict outcomes and response to treatments.
- **Tumor cells in the blood** – Many women with breast cancer have tumor cells in the bloodstream. Research is developing tests that can detect these cells, which may be helpful in determining whether therapies are working or whether cancer has returned.
- **Oncoplastic surgery** – clinicians are developing treatments that involve reshaping the breast at the same time the patient undergoes breast-conserving surgery.
- **Breast reconstruction surgery** – advances in microvascular surgery are showing improvements in breast reconstruction.
- **Radiation treatment** – clinicians are comparing giving larger daily doses of radiation over shorter periods of time.
- **New chemo drugs** – newer classes of drugs are being developed to target advanced breast cancers.
- **Targeted therapies** – newer groups of drugs affect gene changes in cells that cause cancer and prevent new blood vessels from forming in tumors.
- **New imaging tests** – New methods are being studied to determine whether abnormalities may be tumors, including use of intravenous radioactive tracers, 3D mammography and thermal imaging.
- **Bisphosphonates** – New drugs being studied that may help systemic therapies such as chemotherapy work better.
- **Denosumab** – This new drug used to help protect bones when cancer spreads to the bone is also being tested with early breast cancer to see if it can help prevent the disease from spreading.
- **Vitamin D** – Deficiencies in this vitamin have been linked to poorer outlooks, though it hasn't been determined whether taking vitamin D supplements are helpful.



Methodology

The analysis was split into two phases: phase I looked at the breast cancer research literature landscape and phase II, which took a look at a number of well-performing nations and one of their institutions that is a highly productive contributor to the subject field.

Phase I – To construct the initial data pool, the keywords breast cancer, invasive ductal carcinoma, invasive lobular carcinoma, infiltrating ductal carcinoma, infiltrating lobular carcinoma, DCIS, ductal carcinoma, LCIS, lobular carcinoma, her2neu, her2/neu, ErbB-2, CD340, BRCA, triple negative carcinoma and basaloid cancer were used to search titles, abstracts, and keywords of original articles, reviews, and proceedings papers published in the SciVerse Scopus™ database (<http://www.info.sciverse.com>) from Elsevier between January 1, 2006 to December 31, 2010. The resulting pool of research papers related to breast cancer research was then analyzed. The data pool was used to generate a list of subject categories, institutions, and nations analyzed in three ways: according to the total number of papers, total cites, and total cites/paper.

Phase II – SciVal® Spotlight (<http://www.info.scival.com>) was used to gain deeper insights into the core strengths of these nations and the institutions that are contributing to these national strengths.

PHASE I – The breast cancer research landscape

In general, the global outlook for breast cancer research mirrors the global outlook for research in general, with most of the developed world remaining stable or declining slightly while research in China grows rapidly.

According to analysis by Battelle Memorial Institute and R&D Magazine, the global share of overall research and development spending for the United States dropped from 34.7% to 34.0% and Europe fell from 24.1% to 23.2% from 2009 to 2011, a time of recession in most developed countries. During the same period, Asia's share of global research and development spending rose from 33.6% to 35.3%, led by China, whose global share rose from 11.2% to 12.9%. As noted in the Battelle/R&D Magazine analysis, China continued to increase investments in R&D during the recession while other countries looked to cut R&D investments.



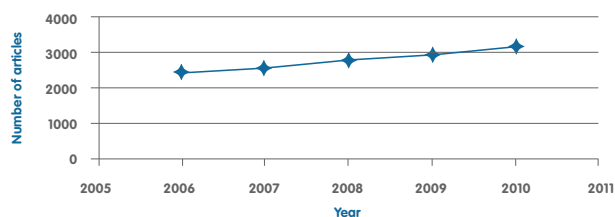
Emergence of China

An analysis of global trends in breast cancer research was conducted by Elsevier's SciVal Analytics Group using Scopus data consisting of articles, article reviews and conference papers.

The analysis of the years 2006-2010 of article output found that breast cancer research is continuing to grow worldwide, but much of that growth is being driven by an upsurge in research output in China.

Fig. 1

Global yearly research article output on breast cancer



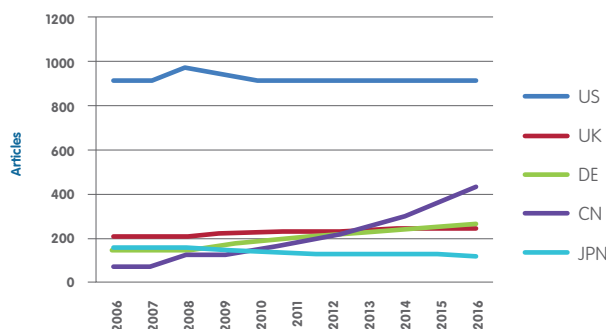
The annual global breast cancer research article output rose by 5.21% from 2006 to 2010, growing from 2,500 articles in 2006 to 3,223 articles in 2010. Analysis shows that China's growing output of research on breast cancer will result in China overtaking Germany in 2012 and the United Kingdom in 2013 to become the second leading nation in breast cancer article output, following the United States. In 2015, due to its continuing growth rate, Germany will overtake the United Kingdom. Meanwhile, breast cancer research in Japan – following that country's declining investment in science – will continue its downward trend.

International growth

The country with the greatest output of research articles on breast cancer remains the United States. However, the US level of output has been static in recent years, with approximately 913 articles published in 2006, 915 in 2010 and is expected to remain that way in the future, with a projected 917 published in 2016. In Europe, breast cancer research article output is rising slightly in the United Kingdom with an annual growth rate of 2%, from 209 articles in 2006 to 228 in 2010 and an estimated 249 in 2016. Germany is increasing at a somewhat greater rate of 6% per year, from 151 articles in 2006 to 193 articles in 2010 and a projected 267 in 2016. Breast cancer research is on the decline in France, where published articles have dropped by 4% a year and in Spain and Italy, the number of articles has dropped by 6%.

Fig. 2

Breast cancer article growth and expected growth



Breast cancer research is declining in Japan, from 155 articles published in 2006 to 138 in 2010. If this trend continues, the article output in 2016 is projected to be 121. The Scopus data analysis clearly shows one of the greatest growth rates in research articles on breast cancer has been in China, with more than 19% growth per year. This growth is demonstrated with 77 articles only in 2006 to 151 in 2010 to an estimated 434 articles in 2016. With the exception of Japan, breast cancer research rates are growing in many Asian countries. For example, in Korea, the number of articles has risen from 37 in 2006 to 56 in 2010 and to a projected 101 in 2016. This is a growth rate of 10% and that of Taiwan is at 8%.

Such rates of growth for breast cancer research output, steady in most Western nations while rising in Asia – reflect a global pattern in recent years of overall increases in investment in industrial and academic research and development in China and some other Asian countries while such funding remains static or declines in the rest of the world.

Going against the trend toward stagnation in breast cancer and general research in Western countries has been Switzerland. That country has avoided the economic recession that has plagued the rest of Europe in recent years, and robustly invested in research and development. Funding for research in Switzerland is expected to continue to increase throughout this decade. Data from the Swiss National Science Foundation shows that the number of research projects approved for funding grew from 252 in 2000 to 443 in 2009. Analysis of Scopus data shows similar growth in breast cancer article output in Switzerland with one of the highest rates of 21%. Researchers in that country published 34 articles on breast cancer research in 2006, which grew to 70 in 2010 and are projected to reach 222 by 2016.

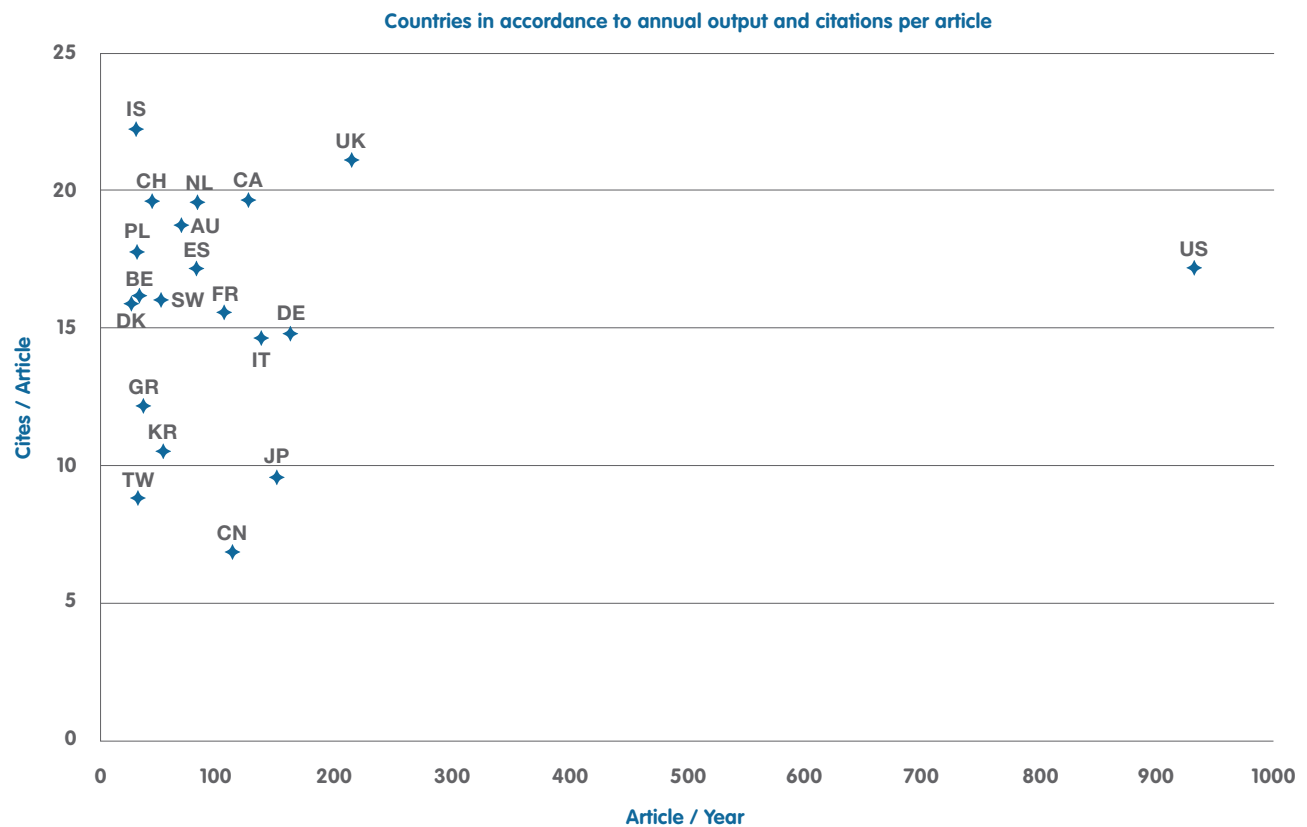


International growth

In addition to the number and growth of research articles on breast cancer published by various countries, Scopus data was used to determine the number of citations of country research used in other research papers, and the number of citations compared to the number of articles published each year. This helps to measure the level of importance of a country's overall research reports. Again, the period of measurement was 2006-2010. The United States led in the number of citations with 76,191, followed by the United Kingdom at 21,442, Canada at 11,880, Germany at 10,607 and Italy at 10,486. Among the leading countries in breast cancer research, the number of citations per article published, which further discerns the criticality of a country's individual research reports, showed Israel at 22 citations per article published, United Kingdom at 21, Canada at 20, Netherlands at 20, Switzerland at 20, Australia at 19 and the United States at 17.

Despite recent growth and decline in many countries, the United States still remains the leader in breast cancer research funding and in research and development in general.¹⁰ During 2006-2010, the amount of articles published on breast cancer research from the United States was more than four times the number of the second leading country. The United States had 76,191 citations for its breast cancer research articles, more than three times the next country. And, of the ten leading institutions conducting specific breast cancer research, gauged by articles and citations, seven of them are in the United States, including the top four: University of Texas M.D. Anderson Cancer Center in Houston; National Cancer Institute in Bethesda; Memorial Sloan-Kettering Cancer Center in New York; and Dana-Farber Cancer Institute in Boston.

Fig. 3
Citations





PHASE II – Country and institution capacity in breast cancer research

Methodology

Country and institution analysis of breast cancer research is conducted through SciVal® Spotlight, which uses co-citation analysis as its underlying methodology to map a university's research strength. Co-citation analysis has been used for many years in the field of information science, and was introduced in 1973 by Henry Small, a pioneer in bibliometrics.

Two articles are said to be co-cited if they are both cited in the reference list of an article. Co-citations for pairs of reference articles can be counted and are known as co-citation counts. Researchers co-cited within scholarly literature are deemed to be part of the same research community. This community can be defined as a very specific topic that authors are working on, writing about, researching and co-citing. The more co-citations, the more defined and specific a community becomes. For this report, a 5-year publication window was used (2006-2010).

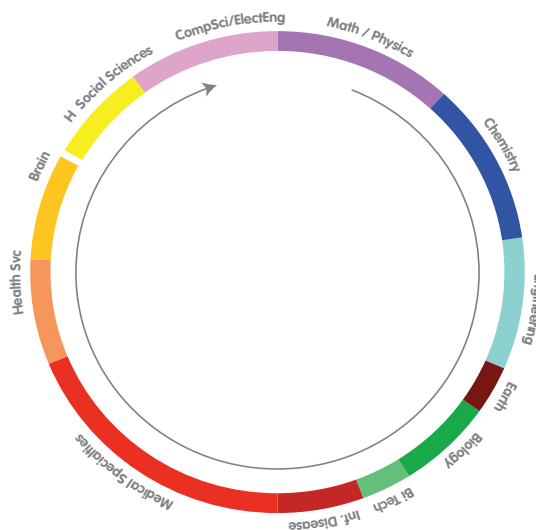
These research communities have identifying tags attached to them, which is how they are located within selected countries using the specific breast cancer search terms provided. Entering the specific search terms, 1,100 research communities were identified by having 1 or more breast cancer search term-related tags. This means that these 1,100 research communities are involved in and dedicated to very specific, concentrated forms of breast cancer research in the United States, China, the United Kingdom and Germany. Using this methodology, Harvard University, Fudan University, University College London and Heidelberg University were identified as being highly productive in article publication in the breast cancer field.

For this report on the status of breast cancer research, the research competencies were derived by first nominating research communities in which an institution and country are significantly active in the publication of articles. Competencies are then created by regrouping the selected communities where they share one or more of the same articles from selected institutions or countries. Finally, the competencies are filtered by the four chosen disciplines within an institution or country's map.

For the analysis of the ongoing breast cancer research in countries and institutions, SciVal Spotlight was used to determine the competencies in each of the disciplines of clinical cancer research, oncology, radiation therapy and radiology. Analysis of articles and citations in these subject areas together provide a significant indication of breast cancer research outlook. In addition, specific competencies in breast cancer research were examined within these disciplines.

Data for this analysis was examined through tables, circle maps and matrices, and each competency was also examined at various levels of detail regarding number of articles, top authors, journals where articles were published, main keywords and top disciplines, along with a variety of graphing for each competency. SciVal Spotlight is also used to analyze collaborations in competencies among countries, institutions and individual researchers through global interactive mapping.

Fig. 4
The Circle of Science – along which the subject areas are ordered for visualization purposes



This model can be used to identify areas where countries or institutes tend to focus their work within a unique set of related communities



United States

Research institutions in the United States and US funding agencies continue to lead the world in breast cancer research, as they do with research and development in general.¹¹ However, because of the US budget deficit and political division in Congress, the short-term outlook for federal funding for research and development may be somewhat uncertain, while the long-term outlook is generally positive. But even in lean years, federal funding for life sciences research has grown and that trend is expected to increase in the future.

The National Cancer Institute is the world's largest funder of breast cancer research, investing more than \$631 million in 2010, more than for any other type of cancer.¹² Two areas of recently targeted investment include are the Trial Assigning Individualized Options for Treatment (Rx) (TAILORx), to determine whether genes associated with breast cancer recurrence risk can help identify the most effective treatments, and the Study of Tamoxifen and Raloxifene to study the effectiveness and side effects profile of these two drugs in long-term prevention for high-risk women.

The United States remains a country with a high breast cancer rate yet declining breast cancer mortality. Breast cancer is the most common cancer among women in the United States, and one of the leading causes of cancer death among women. According to the American Cancer Society, an estimated 230,000 new cases of breast cancer will be diagnosed and nearly 40,000 deaths will be caused in 2011.

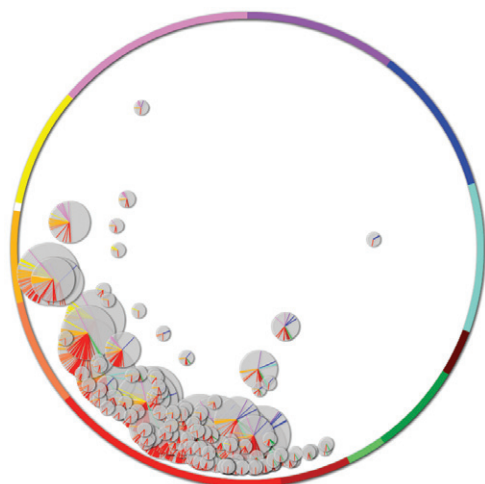
The US breast cancer rate is among the highest in the world at 76 cases per 100,000 women per year from the years 2004-2008. However, mortality rates are far lower than in many other countries, at 15 deaths per 100,000 women per year during the same years.¹³ By comparison, mortality rates are 23 per 200,000 in Nigeria, 25 per 100,000 in Jordan, 20 per 100,000 in Argentina and 20 per 100,000 in Kazakhstan.¹⁴

After rising for more than two decades, US breast cancer rates decreased by about 2% per year from 1998 to 2007. The decline, which was only seen in women aged 50 or older, is believed to be due in part to the decline in use of hormone therapy after menopause following a 2002 study linking it to increased breast cancer risk.

An examination using SciVal Spotlight clearly showed US leadership in breast cancer research through the very high global share of articles published in both medical specialties and health science research, reflecting a continuing ascendancy in both clinical and bench science regarding breast cancer.

Harvard University

Fig. 5
The 2010 circle of science for Harvard University



Each grey circle represents an institutional competency, with location determined by its primary subject area

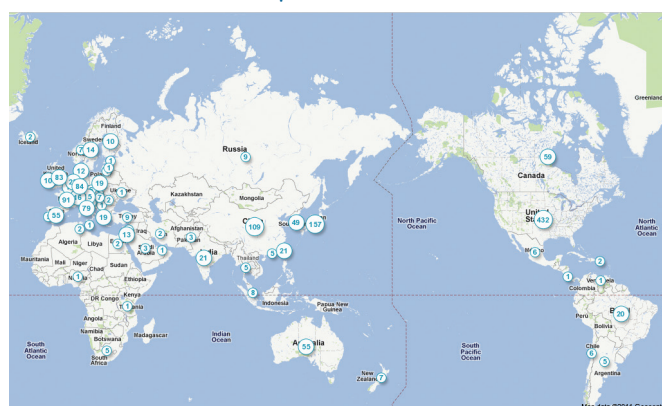
The oldest university in the United States and one of the most prestigious universities in the world, Harvard University is home to one of the top ranked medical schools in education and research in the United States. Harvard is home to medical research institutions such as the Harvard Clinical Research Institute, but it also has established many joint research programs with other prestigious institutions, such as the Broad Institute of MIT and Harvard in genomic medicine and the Laboratory for Nanomedicine with Brigham and Women’s Hospital.

A SciVal Spotlight analysis of research competencies at Harvard University related to breast cancer found 163 competencies clustered around medical specialties and health sciences, a very high number for any institution, showing a balance of research in both clinical care and bench science.

Among them was a competency in the field of breast cancer and body mass index within the disciplines of clinical cancer research, human molecular genetics and medical screening and epidemiology. In this burgeoning area of research, more than 38,000 articles were published from 2006-2010, growing 6.6% year. A total of 2,296 articles were published by Harvard researchers, leading the world in research articles published in this area.

Another research competency is in the field of breast cancer, lymph nodes and radiation therapy, where 10,958 articles were published worldwide, of which 494 articles were published by Harvard researchers within the five-year period. Again, Harvard University leads all other institutions in research articles published in this field. In the field of breast reconstruction among breast cancer patients in the disciplines of dermatology and plastic surgery, 5,874 articles were published worldwide in the five-year span, growing at a rate of nearly 12% a year, with Harvard as a publication leader with 272 articles. Harvard University’s collaborative efforts in this field are likewise prodigious. In subject areas that together create a significant indication of breast cancer research outlook, Harvard University researchers collaborated with 60 researchers at Fudan University in Shanghai, co-authoring 25 papers, from 2006 to 2010. Harvard researchers also worked with 170 researchers in this field at Peter MacCallum Cancer Centre in Melbourne, Australia, producing 41 co-authored articles.

Fig. 5.1
Global collaboration map



Harvard researchers worked with 84 institutions in Germany in the competencies related to breast cancer research, including Heidelberg University, the University of Cologne and the Hannover Medical School. In collaboration with institutions in the United Kingdom, Harvard researchers worked with 83 institutions in the competencies related to breast cancer research, including University College London, Wellcome Research Laboratories and University of Oxford. Harvard researchers worked with 109 institutions in China in the areas of breast cancer research-related competencies, including Fudan University, Chinese Academy of Medical Sciences and Sichuan University.

China

China's investment in overall research is growing at an annual rate of 9%-10%, about the same as its economic growth, both of which are about four times US growth. In absolute dollars, however, the US and China remain at parity in growth. If research investment continues at the same pace in both countries, China would reach the US level in about 20 years, but analysts believe that is unlikely because US growth is at an unusually low level and China's high rate may not be sustainable.¹⁵

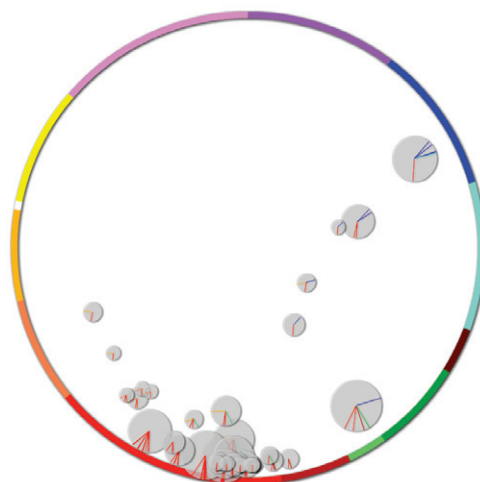
One issue driving the growth in biomedical R&D in China is the global industry recognition that China's massive and aging population may eventually constitute the world's biggest pharmaceuticals market. An analysis by Reuters¹⁶ said that large global pharmaceutical companies such as Novartis and Pfizer are dramatically expanding R&D in China to help cope with an aging population with less healthy dietary habits and an increasingly sedentary lifestyle. These same issues, among women, are expected to contribute to a growing incidence of breast cancer.

In fact, breast cancer is on the rise in China, with at least one study¹⁷ published in 2008 in the Journal of the National Cancer Institute stating that "China is on the cusp of a breast cancer epidemic." Results showed that breast cancer incidence in China is expected to increase substantially from current rates, estimated at 10–60 cases per 100,000 women, to more than 100 new cases per 100,000 women aged 55–69 years by 2021. That would rank higher than today's rates in some Western European countries, where the highest rates in the world are currently found.

Unlike other countries examined through SciVal Spotlight for this report, which show greatest strengths in medical specialties in the field of breast cancer research, China also publishes a large number of articles in chemistry in this field. This may be due to China's search for improved clinical treatment through pharmaceutical research in order to confront its incipient breast cancer epidemic.

Fudan University

Fig. 6
The 2010 circle of science for Fudan University



Each grey circle represents an institutional competency, with location determined by its primary subject area

Fudan University is one of the oldest and most selective universities in China. Located in Shanghai, Fudan University is a major medical research institution and one of the top medical schools in China, with 10 teaching and research hospitals. The Shanghai Medical College at Fudan University has established cooperative and exchange programs with prominent medical schools throughout the world. A SciVal Spotlight analysis of research competencies related to breast cancer research found 46 competencies tightly clustered on medical specialties, which is in keeping with Fudan University Shanghai Cancer Center's emphasis on clinical research. Research competencies in this area include the field of breast cancer and clinical cancer care within the disciplines of clinical cancer research, oncology, neuroscience and molecular and cellular research, with a group of researchers at Fudan University publishing 80 papers from 2006-2010. Worldwide in these disciplines, there were 3,333 articles published in those years, growing by 1.2% a year. At Fudan University, articles in these disciplines grew at .3% a year. Fudan University is a global publication leader in this area of research.

Another area of strength is breast cancer and odds ratios among cancer patients within the disciplines of clinical cancer research, oncology and human molecular genetics, also with 80 papers published over the same five-year period. Worldwide, there were 2,185 articles published from 2006-2010, declining at a rate of 3.4% per year. Fudan University's rate of publishing articles in this area was growing by .7% a year. The university also is a global publication leader in this area.

China's focus on clinical treatment for its growing breast cancer rate may be reflected in Fudan University's publication leadership in the area of drug and gene delivery and the blood-brain barrier within the disciplines of pharmaceutical and clinical cancer research. Globally, 862 articles were published in this area, growing at a rate of 8.8% a year. Fudan University published 46 articles at a 1.1% annual growth rate.

Fig. 6.1
Global collaboration map



In the disciplines of clinical cancer research, oncology, radiation therapy and radiology, which together create a significant indication of breast cancer research outlook, Fudan University engages in global collaboration with many countries and institutions. In the United States, 83 institutions are collaborating with Fudan University in the competencies related to breast cancer research, institutions including the University of Texas, University of California Los Angeles and the National Cancer Institute. Fudan researchers collaborate with 11 institutions in the United Kingdom in breast cancer-related competencies, including University College London, Mount Vernon Hospital and University of Leeds. In Germany, Fudan researchers collaborate with five institutions in competencies related to breast cancer research, including Heidelberg University, and the Max Planck Institutes, Brandenburg and Berlin.

Examples of institutional collaborations include 35 researchers at University of Texas M.D. Anderson Cancer Center who co-authored articles with Fudan University researchers in the specific breast-cancer related subject areas, co-authoring 33 articles within the specific subject areas/disciplines, from 2006-2010.



United Kingdom

Like many other developed countries, the United Kingdom is undergoing budget cuts for general research, including medical research, due to the economic downturn that is particularly pronounced in Europe. But the UK has traditionally invested a lower percentage of its gross domestic product to research and development compared to wealthy western nations, including the United States, Germany, France, Sweden and Switzerland, and compared to industrialized Asian nations such as Japan and South Korea.¹⁸

Breast cancer is the most common cancer in the United Kingdom despite that it is rare in men.¹⁹ From 1979-2008 in Britain, the breast cancer incidence rate for women increased by 65% from 75 per 100,000 in 1979 to 124 per 100,000 in 2008. Over the same period, the annual number of new breast cancer cases almost doubled from 23,876 to 46,537 in the UK.²⁰ The increase in hormone replacement therapy is thought to have also contributed to the increase, particularly in the 1990s.²¹ An analysis of breast cancer incidence and hormone replacement therapy in Scotland among women aged 50-64 showed that a decrease in hormone replace therapy coincided with declining breast cancer incidence.²² An estimated 1,400 fewer cases of breast cancer in women ages 50-59 occurred in 2005 in the UK in 2005 due to the reduction in hormone replacement therapy.²³ However, the reduction in hormone replacement therapy is not expected to retard the long-range increase in breast cancer. Future projections for breast cancer in the UK predict a continued increase from a rate of 119 per 100,000 women in 2000-04 to 124 per 100,000 in 2020-24.²⁴ This trend may be due to high rates of later first pregnancies and fewer pregnancies, which are linked to increased breast cancer incidence. This trend is much more prominent among affluent female populations, and is believed to be an important factor in higher breast cancer rates in high income countries.²⁵

While breast cancer incidence may rise, breast cancer mortality rates are expected to continue falling in the UK and other countries in Western Europe and North America. From 1989 to 2006, the UK had the second highest drop in breast cancer deaths in Europe. Decreases in England and Wales, Northern Ireland and Scotland were 35%, 29%, and 30%, respectively.²⁶

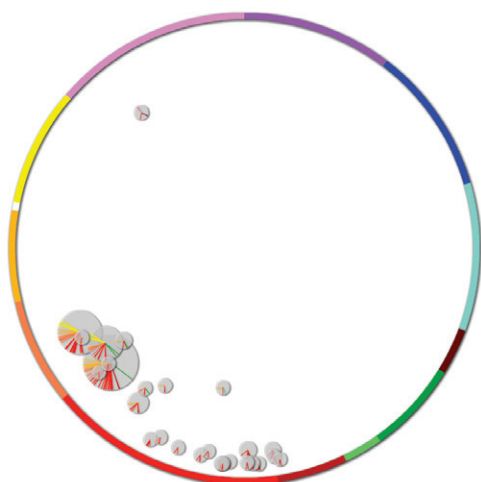
The reduction in breast cancer mortality rates is likely to have several different causes including increased screening, increasing specialization of care, and improvements in radiation therapy, surgery and chemotherapy, including the widespread adoption of Tamoxifen treatment since 1992.

A SciVal Spotlight examination of research competencies related to breast cancer research in the United Kingdom shows them clustered around the subject areas of medical specialties and health sciences, signifying strengths in clinical and bench research. There also are breast cancer research-related competencies in the subject areas to math and physics, which include the disciplines of data mining and systems software.

UK investment includes genetic research into new treatments for breast cancer. UK scientists from the Breakthrough Breast Cancer Research Centre at the Institute of Cancer Research recently discovered three new genes involved in the development and growth of breast cancer.²⁷ The discovery could lead to new ways to treat and prevent the disease. Researchers at the Centre also have compiled an encyclopedia of genes associated with different types of breast cancer in the hope that it will help in the development of specifically targeted treatments.²⁸ They used a lab technique called high-throughput RNA interference screening to identify genetic faults that drive the various forms of breast cancer. Researchers at Cancer Research UK have identified a gene which can cause a particularly aggressive form of breast cancer to develop.²⁹ The gene was called a "prime candidate" for the development of new breast cancer drugs.

University College London

Fig. 7
2010 circle of science for University College London



Each grey circle represents an institutional competency, with location determined by its primary subject area

University College London is one of the two founding colleges of the University of London, and the first in England to be established on an entirely secular basis. University College London, or UCL, as it is known, is developing into a major global biomedical research center, with one of the top clinical medicine research programs in Europe. Together with other public and private institutions, University College London is building the Francis Crick Institute, a new £600 million medical research center slated to open in 2015. One of the world's largest medical research centers, the Francis Crick Institute will house 1,250 scientists.³⁰ In August 2008, University College London formed UCL Partners, the largest academic health science center in Europe, with several National Health Service trusts. The UCL Cancer Institute, which opened in 2007, is a state-of-the-art institute that will eventually house over 300 scientists, consolidating cancer research at University College London. The institute has particular expertise in breast cancer genetics.

A SciVal Spotlight analysis of research competencies at University College London related to breast cancer found a strong position in health sciences and a lesser emphasis on medical specialties, which relates to strengths in bench science and somewhat less in clinical research. Among them is a research competency in the field of metastatic breast cancer and aromatase inhibitors within the discipline of oncology. Globally, 276 articles were published in this field of research from 2006 to 2010, with eight articles by researchers at University College London, at a growth rate of 1% over that period.

In the breast cancer-related competencies, University College London collaborated with 91 institutions in the United States, including Harvard University, Stanford University and Johns Hopkins University. It collaborated with six institutions in China, including the University of Hong Kong, Chinese Academy of Sciences and Hong Kong Polytechnic University. London College University researchers collaborated with 22 institutions in Germany in competencies related to breast cancer research, including the German Cancer Research Center, University of Erlangen-Nuremberg and Charite – Universitätsmedizin Berlin.

Fig. 7.1
Global collaboration map



For example, researchers at University College London collaborated with researchers around the world, including work with 16 co-authors at Stanford University in California in competencies related to breast cancer, which resulted in 25 articles from 2006 to 2010, and 17 collaborations with INSERM in France, resulting in 6 articles.



Germany

In overall research and development, Germany is the fourth largest investor in the world. Germany contributes about a quarter of the European Union's total gross domestic expenditure on R&D. There are approximately 750 publicly funded research institutions in Germany, plus research centers run by industry.³¹

Like other countries in Western Europe and North America, and for likely the same reasons, breast cancer incidence in Germany rose until 2002, and thereafter declined by approximately 6.8% through 2005, with the largest reductions among women in the age group 50-59 years old. Mortality declined from 1996 to 2005 by 19%.³²

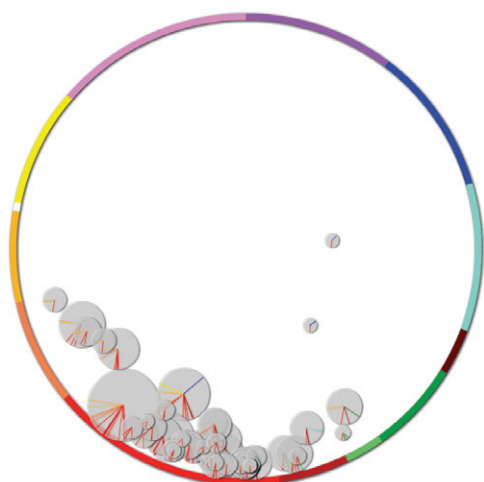
Regional patterns of breast cancer in Germany are highly relevant to the causes and prevention of the disease. Variation in breast cancer incidence and mortality between the former regions of West and East Germany is high. Incidence and mortality are about 35% lower in East Germany than in West Germany. Preventive factors for breast cancer include higher number of pregnancies at younger ages and breast feeding. In the years 1975-1990, women in the former East Germany had higher pregnancy numbers than women in West Germany, and women in the eastern part of Germany have been younger at the time of their first pregnancy. Also, hormone replacement therapy was much lower in East Germany than in West Germany.³³

An examination using SciVal Spotlight of breast cancer research-related competencies in Germany reveals most activity in medical specialties, which focuses on clinical research.

In Germany, investment in breast cancer research has included translational research that has led to new treatments, including studies suggesting that hormone-like plant compounds called phytoestrogens are useful in treating breast cancer. Scientists at the German Cancer Research Center in Heidelberg were the first to show that these substances lower the risk of developing metastasis and dying by up to 40 percent in postmenopausal breast cancer patients.³⁴ Heidelberg is the national center for a growing network of translational research regarding cancer, including breast cancer. Heidelberg is home to the National Center for Tumor Diseases, which is supported by the Heidelberg University Medical Center, German Cancer Research Center, Hospital for Thoracic Diseases and German Cancer Aid. The National Center's mission is to translate cancer research into diagnostic, therapeutic and preventive clinical trials for maximum patient benefit.

Heidelberg University

Fig. 8
2010 circle of science for Heidelberg University



Each grey circle represents an institutional competency, with location determined by its primary subject area

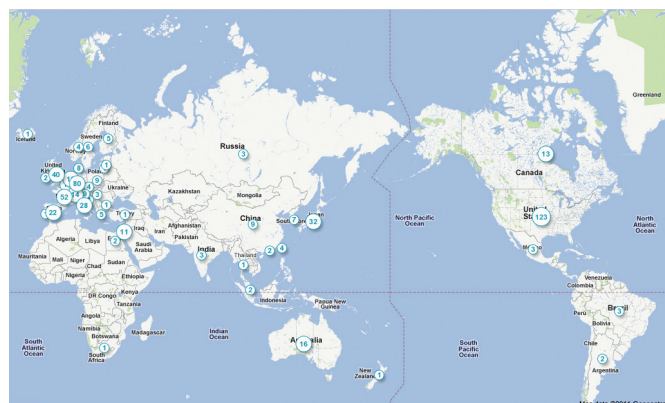
Heidelberg University, founded in 1386, is the oldest university in Germany. One of the top European centers for research, Heidelberg University emphasizes life sciences and medicine, and two fields are closely linked in research. Heidelberg's university hospital, which is made up of 12 hospitals, and the Heidelberg University Medical School, are the largest and most renowned medical facilities in Germany. Together, they constitute one of the most active biomedical research centers in the country. Heidelberg University is a founding member of the League of European Research Universities, and has close ties with the European Molecular Biology Laboratory, the German Cancer Research Center and the Max Planck Institute for Medical Research. The National Center for Tumor Diseases, a cooperative project among Heidelberg University, the German Cancer Research Center and other partners, was opened on the Heidelberg University campus in 2010.

In a SciVal Spotlight analysis of breast cancer research at Heidelberg University, 54 competencies were found in subject areas which, when examined together, provide an accurate depiction of breast cancer research. The competencies were clustered tightly around medical specialties, which indicate a focus on clinical research. Among the research competencies is work in the fields of breast cancer, susceptibility and single

nucleotides in the disciplines of clinical cancer research and oncology, in which 2,384 research articles were published from 2006 to 2010. Heidelberg University, where researchers published 78 articles of those articles, is a global publication leader in this area.

Another area where Heidelberg is a publication leader is in the combined fields of breast cancer, radiation therapy and breast-conserving surgery, in the disciplines of radiation therapy, oncology and clinical cancer research. Heidelberg researchers published 46 of the 1,100 articles over the five-year period. The number of articles in their area grew at 3.3% a year worldwide. Heidelberg researchers also are global publication leaders in the field of breast cancer, liver metastases and liver resection in the disciplines of clinical rehabilitation, transplantation and oncology, where they have published 27 of 1,029 articles worldwide.

Fig. 8.1
Global collaboration map



Heidelberg University researchers engaged in significant collaboration in areas related to breast cancer research. A total of 123 institutions in the United States collaborated with Heidelberg researchers, including Duke and Harvard Universities and the Mayo Clinic. In the United Kingdom, 49 institutions collaborated with Heidelberg University in this area of research, including London College University, Institute of Cancer Research and University of Cambridge. Heidelberg researchers collaborated with 11 institutions in China in this research area, including with Huazhong University of Science and Technology, Nanjing Medical University and Chinese University of Hong Kong.



Conclusion

The global expansion of breast cancer research reflects the changing scenario for breast cancer itself, and the rising threat it poses to women in both developed and developing countries. At the same time, the expansion of breast cancer research and greater collaboration among researchers on the global level may be a harbinger of greater worldwide awareness paid to the leading cancer killer of women.

In that regard, the global expansion of breast cancer research can only be seen as a very positive trend. Greater collaboration on a global scale means that both clinical and basic research can be carried out on a far greater diversity of populations, which is critical as interventions and treatments become increasingly targeted. Large numbers of patients can be enrolled in clinical trials and greater swaths of populations can be studied for public health interventions. With global sharing of knowledge and data, important scientific questions can be answered more quickly and efficiently and breakthrough treatments will become ever more likely.



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