

# Top 100 Cited Classic Articles in Breast Cancer Research

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## ABSTRACT

**Objective:** This study aimed to analyze 100 most cited articles in breast cancer research.

**Materials and Methods:** The data in this study were obtained by a search conducted on the Web of Science (WOS). In brief, the term “breast cancer” was typed in the search box of WOS basic research including all the years and the data. The analysis was carried out by compiling the top 100 cited articles in the shortlist as sorted by the journals, categories of the studies, the countries, the centers, the authors and the publication date. No statistical methods were used in the study. All data were reported as percentages, numbers and bar charts on tables.

**Results:** Our findings showed that the most frequently cited article received 7609 citations to date. Most articles were published in the New England Journal of Medicine. 81% of the studies originated from the USA. The National Institutes of Health (NIH USA) was ranked the first with 21% and it was followed by Harvard University in terms of number of published articles. 42% of the articles were published under the category of medicine and general internal medicine.

**Conclusion:** Top 100 most cited articles originated from the United States. The highest number of articles among the top 100 articles were published in New England Journal of Medicine and National Institutes of Health NIH USA was the leading institutes published the most articles.

**Keywords:** Breast cancer, citation, research

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## Introduction

There has been a growing increase in the incidence of breast cancer (1), which is still the most significant cancer-related cause of female mortality (2). In spite of significant progress in the management of breast cancer, the search for a curative treatment is still ongoing. Although a number of crucial studies and clinical trials have significantly contributed to the improvement of breast cancer care, many often remain unknown to the majority of clinicians, suggesting a need to identify at least the top 100 most cited studies in the field. Actually, in the past, there were a couple of studies which identified the most cited articles in several fields such as digestive disease and psychology (3, 4), which helped the researchers in this field to easily access them. This identification is important because the decisions made by the clinicians are generally based on the evidence and the studies with a high impact (5). The most significant component of the methodological qualities of studies is associated with an increase of citation and a high impact factor of the journal where it is published (6). The object of this study was to identify and analyze the qualities of the top 100 cited papers in breast cancer-related studies.

## Materials and Methods

The data in this study were obtained by a search conducted on the Web of Science (WOS) (Clarivate Analytics, United States). The journals indexed in the Science Citation Index Expanded were included. There were no restrictions on the journals. The Science Citation Index Expanded in WOS covers more than 8,500 notable and major journals encompassing 150 disciplines. The coverage time extends from 1900 to the present (7). The term “Breast cancer” was typed into the search box of WOS basic research with the selection of all the years and the data were searched in Title setting. Our search produced 189.235 published articles between 1978-2017. Thereafter, they were listed based on the citation frequency-from the highest to the lowest. The analysis was carried out by compiling the Top 100 cited classical articles in a shortlist as sorted by the journals, categories of the studies, countries, centers where the studies were published, authors and publication date. Since this was not invasive study, an approval from the ethical committee was not requested. The study was conducted in accordance with the Declaration of Helsinki.

## Statistical analysis

No statistical methods were used in the study. All the data were given in percentages, numbers and bar charts.

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Table 1. The top 100 cited articles in breast cancer research

No	Author	Title	Journal	No of Cite
1	Slamon DJ.	Human breast cancer: correlation of relapse and.	Science. 1987;3798106(177):235	7609
2	Slamon, Dennis J., et al.	"Use of chemotherapy plus a monoclonal antibody against HER2 for metastatic breast cancer that overexpresses HER2."	New England Journal of Medicine 344.11 (2001): 783-792.	5760
3	Slamon, Dennis J., et al.	"Studies of the HER2/neu proto-oncogene in human breast and ovarian cancer."	Science 244.4905 (1989): 707.	5300
4	Al-Hajj, Muhammad, et al.	"Prospective identification of tumorigenic breast cancer cells."	Proceedings of the National Academy of Sciences 100.7 (2003): 3983-3988.	5087
5	Van't Veer, Laura J., et al.	"Gene expression profiling predicts clinical outcome of breast cancer."	Nature 415.6871 (2002): 530-536.	4798
6	Miki Y1, Swensen J, et al.	A strong candidate for the breast and ovarian cancer susceptibility gene BRCA1.	Science 266 (1994): 7.	3948
7	Early Breast Cancer Trialists' Collaborative Group.	"Effects of chemotherapy and hormonal therapy for early breast cancer on recurrence and 15-year survival: an overview of the randomised trials."	The Lancet 365.9472 (2005): 1687-1717.	3643
8	Van De Vijver, Marc J., et al.	"A gene-expression signature as a predictor of survival in breast cancer."	New England Journal of Medicine 347.25 (2002): 1999-2009.	3599
9	Fisher, Bernard, et al.	"Tamoxifen for prevention of breast cancer: report of the National Surgical Adjuvant Breast and Bowel Project P-1 Study."	Journal of the National Cancer Institute 90.18 (1998): 1371-1388	3548
10	Elston, Christopher W., and Ian O. Ellis.	"Pathological prognostic factors in breast cancer. I. The value of histological grade in breast cancer: experience from a large study with long-term follow-up."	Histopathology 19.5 (1991): 403-410.	3330
11	Li, Jing, et al.	"PTEN, a putative protein tyrosine phosphatase gene mutated in human brain, breast, and prostate cancer."	Science 275.5308 (1997): 1943-1947.	3210
12	Müller, Anja, et al	"Involvement of chemokine receptors in breast cancer metastasis."	Nature 410.6824 (2001):50-56.	3139
13	Romond, Edward H., et al.	"Trastuzumab plus adjuvant chemotherapy for operable HER2-positive breast cancer."	New England Journal of Medicine 353.16 (2005): 1673-1684.	2903
14	Paik, Soonmyung et al.	"A multigene assay to predict recurrence of tamoxifen-treated, node-negative breast cancer."	New England Journal of Medicine 351.27 (2004): 2817-2826.	2826
15	Early Breast Cancer Trialists' Collaborative Group.	"Tamoxifen for early breast cancer: an overview of the randomised trials."	The Lancet 351.9114 (1998): 1451-1467.	2665
16	Malkin, David, et al.	"Germ line p53 mutations in a familial syndrome of breast cancer, sarcomas, and other neoplasms."	Science 250.4985 (1990): 1233.	2636
17	Piccatt-Gebhart, Martine J., et al.	"Trastuzumab after adjuvant chemotherapy in HER2-positive breast cancer."	New England Journal of Medicine 353.16 (2005): 1659-1672.	2605
18	Fisher, Bernard, et al.	"Twenty-year follow-up of a randomized trial comparing total mastectomy, lumpectomy, and lumpectomy plus irradiation for the treatment of invasive breast cancer."	New England Journal of Medicine 347.16 (2002): 1233-1241.	2450
19	Early Breast Cancer Trialists' Collaborative Group.	"Effects of radiotherapy and of differences in the extent of surgery for early breast cancer on local recurrence and 15-year survival: an overview of the randomised trials." The	Lancet 366.9503 (2006): 2087-2106.	2223
20	Wooster, Richard, et al.	"Identification of the breast cancer susceptibility gene BRCA2."	Nature 378.6559 (1995): 789.	2085
21	Sjöblom, Tobias, et al.	"The consensus coding sequences of human breast and colorectal cancers."	science 314.5797 (2006): 268-274.	2034
22	Iorio, Marilena V., et al.	"MicroRNA gene expression deregulation in human breast cancer."	Cancer research 65.16 (2005): 7065-7070.	2028
23	Wolff, Antonio C., et al.	"American Society of Clinical Oncology/College of American Pathologists guideline recommendations for human epidermal growth factor receptor 2 testing in breast cancer."	Journal of clinical oncology 25.1 (2006): 118-145.	1967
24	Vogel, Charles L., et al.	"Efficacy and safety of trastuzumab as a single agent in first-line treatment of HER2-overexpressing metastatic breast cancer."	Journal of Clinical Oncology 20.3 (2002): 719-726.	1901
25	Cristofanilli, Massimo, et al.	"Circulating tumor cells, disease progression, and survival in metastatic breast cancer."	New England Journal of Medicine 351.8 (2004): 781-791	1849
26	Ford, Deborah, et al.	"Genetic heterogeneity and penetrance analysis of the BRCA1 and BRCA2 genes in breast cancer families."	The American Journal of Human Genetics 62.3 (1998): 676-689.	1824

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No	Author	Title	Journal	No of Cite
27	Cobleigh, Melody A., et al.	"Multinational study of the efficacy and safety of humanized anti-HER2 monoclonal antibody in women who have HER2-overexpressing metastatic breast cancer that has progressed after chemotherapy for metastatic disease."	Journal of Clinical Oncology 17.9 (1999): 2639-2639.	1812
28	Miller, Kathy, et al.	"Paclitaxel plus bevacizumab versus paclitaxel alone for metastatic breast cancer."	New England Journal of Medicine 357.26 (2007): 2666-2676.	1773
29	Wood, Laura D., et al.	"The genomic landscapes of human breast and colorectal cancers."	Science 318.5853 (2007): 1108-1113.	1746
30	Million Women Study Collaborators.	"Breast cancer and hormone-replacement therapy in the Million Women Study."	The Lancet 362.9382 (2003): 419-427.	1707
31	Veronesi, Umberto, et al.	"Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer."	New England Journal of Medicine 347.16 (2002): 1227-1232.	1704
32	Gail, Mitchell H., et al.	"Projecting individualized probabilities of developing breast cancer for white females who are being examined annually."	Journal of the National Cancer Institute 81.24 (1989): 1879-1886.	1688
33	Carey, Lisa A., et al.	"Race, breast cancer subtypes, and survival in the Carolina Breast Cancer Study."	Jama 295.21 (2006): 2492-2502.	1684
34	Wang, Yixin, et al.	"Gene-expression profiles to predict distant metastasis of lymph-node-negative primary breast cancer."	The Lancet 365.9460 (2005): 671-679.	1668
35	Giuliano, Armando E., et al.	"Lymphatic mapping and sentinel lymphadenectomy for breast cancer."	Annals of surgery 220.3 (1994): 391.	1660
36	Collaborative Group on Hormonal Factors in Breast Cancer.	"Breast cancer and hormone replacement therapy: collaborative reanalysis of data from 51 epidemiological studies of 52 705 women with breast cancer and 108 411 women without breast cancer."	The Lancet 350.9084 (1997): 1047-1059.	1657
37	Geyer, Charles E., et al.	"Lapatinib plus capecitabine for HER2-positive advanced breast cancer."	New England Journal of Medicine 355.26 (2006): 2733-2743.	1623
38	Hall, Jeff M., et al.	"Linkage of early-onset familial breast cancer to chromosome 17q21."	Science 250.4988 (1990): 1684.	1623
39	Overgaard, Marie, et al.	"Postoperative radiotherapy in high-risk premenopausal women with breast cancer who receive adjuvant chemotherapy."	New England Journal of Medicine 337.14 (1997): 949-	1570
40	Antoniou, Anthony, et al.	"Average risks of breast and ovarian cancer associated with BRCA1 or BRCA2 mutations detected in case series unselected for family history: a combined analysis of 22 studies"	The American Journal of Human Genetics 72.5 (2003): 1117-1130	1539
41	Neve, Richard M., et al..	"A collection of breast cancer cell lines for the study of functionally distinct cancer subtypes."	Cancer cell 10.6 (2006): 515-527	1486
42	Karnoub, Antoine E., et al.	"Mesenchymal stem cells within tumour stroma promote breast cancer metastasis."	Nature 449.7162 (2007): 557-563.	1473
43	Early Breast Cancer Trialists' Collaborative Group.	"Polychemotherapy for early breast cancer: an overview of the randomised trials."	The Lancet 352.9132 (1998): 930-942.	1442
44	Carter, Christine L., Carol Allen, and Donald E. Henson.	"Relation of tumor size, lymph node status, and survival in 24,740 breast cancer cases."	Cancer 63.1 (1989): 181-187.	1417
45	Easton, Douglas F., et al.	"Genome-wide association study identifies novel breast cancer susceptibility loci."	Nature 447.7148 (2007): 1087-1093.	1416
46	Ma, Li, Julie Teruya-Feldstein, and Robert A. Weinberg.	"Tumour invasion and metastasis initiated by microRNA-10b in breast cancer."	Nature 449.7163 (2007): 682-688.	1413
47	Minn, Andy J., et al.	"Genes that mediate breast cancer metastasis to lung."	Nature 436.7050 (2005): 518-524.	1409
48	Doyle, L. Austin, et al.	"A multidrug resistance transporter from human MCF-7 breast cancer cells."	Proceedings of the National Academy of Sciences 95.26 (1998): 15665-15670.	1394
49	Tabar, Lazio, et al.	"Reduction in mortality from breast cancer after mass screening with mammography: randomised trial from the Breast Cancer Screening Working Group of the Swedish National Board of Health and Welfare."	The Lancet 325.8433 (1985): 829-832.	1371
50	Krag, David, et al.	"The sentinel node in breast cancer—a multicenter validation study."	New England Journal of Medicine 339.14 (1998): 941-946	1356
51	Howell, Anthony.	"Results of the ATAC (Arimidex, Tamoxifen, Alone or in Combination) trial after completion of 5 years' adjuvant treatment for breast cancer."	Lancet 365.9453 (2005): 60.	1350

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No	Author	Title	Journal	No of Cite
52	Veronesi, Umberto, et al.	"Sentinel-node biopsy to avoid axillary dissection in breast cancer with clinically negative lymph-nodes."	The Lancet 349.9069 (1997): 1864-1867.	1342
53	Kang, Yibin, et al.	"A multigenic program mediating breast cancer metastasis to bone."	Cancer cell 3.6 (2003): 537-549.	1327
54	Liaw, Danny, et al.	"Germline mutations of the PTEN gene in Cowden disease, an inherited breast and thyroid cancer syndrome."	Nature genetics 16.1 (1997): 64-67.	1302
55	Spiegel, David, et al.	"Effect of psychosocial treatment on survival of patients with metastatic breast cancer."	The Lancet 334.8668 (1989): 888-891.	1296
56	Hankinson, Susan E., et al.	"Circulating concentrations of insulin-like growth factor I and risk of breast cancer."	The Lancet 351.9113 (1998): 1393-1396.	1286
57	Fisher, Bernard, et al.	"Five-year results of a randomized clinical trial comparing total mastectomy and segmental mastectomy with or without radiation in the treatment of breast cancer."	New England Journal of Medicine 312.11 (1985): 665-673	1264
58	Fisher, Bernard, et al.	"Effect of preoperative chemotherapy on the outcome of women with operable breast cancer."	Journal of Clinical Oncology 16.8 (1998): 2672-2685.	1261
59	Cummings, Steven R., et al.	"The effect of raloxifene on risk of breast cancer in postmenopausal women: results from the MORE randomized trial."	Jama 281.23 (1999): 2189-2197.	1259
60	Baum, M., et al.	"For the ATAC (Arimidex, Tamoxifen Alone or in Combination) Trialists' Group (2002) Anastrozole alone or in combination with tamoxifen versus tamoxifen alone for adjuvant treatment of postmenopausal women with early breast cancer: first results of the ATAC randomised trial."	Lancet 359: 2131-2139.	1257
61	Anzick, Sarah L., et al.	"AIB1, a steroid receptor coactivator amplified in breast and ovarian cancer."	Science 277.5328 (1997): 965-968.	1242
62	Dupont, William D., and David L. Page.	"Risk factors for breast cancer in women with proliferative breast disease."	New England Journal of Medicine 312.3 (1985): 146-151.	1232
63	Dent, Rebecca, et al.	"Triple-negative breast cancer: clinical features and patterns of recurrence."	Clinical cancer research 13.15 (2007): 4429-4434.	1217
64	Wooster, Richard, et al.	"Localization of a breast cancer susceptibility gene, BRCA2, to chromosome 13q12-13."	Science 265.5181 (1994): 2088-2091.	1214
65	Parker, Joel S., et al.	"Supervised risk predictor of breast cancer based on intrinsic subtypes."	Journal of clinical oncology 27.8 (2009): 1160-1167.	1207
66	Colditz, Graham A., et al.	"The use of estrogens and progestins and the risk of breast cancer in postmenopausal women."	New England Journal of Medicine 332.24 (1995): 1589-1593.	1200
67	Fisher, Bernard, et al.	"Eight-year results of a randomized clinical trial comparing total mastectomy and lumpectomy with or without irradiation in the treatment of breast cancer."	New England Journal of Medicine 320.13 (1989): 822-828.	1197
68	Harris, Lyndsay, et al.	"American Society of Clinical Oncology 2007 update of recommendations for the use of tumor markers in breast cancer."	Journal of clinical oncology 25.33 (2007): 5287-5312.	1194
69	Harvey, Jenet M., et al.	"Estrogen receptor status by immunohistochemistry is superior to the ligand-binding assay for predicting response to adjuvant endocrine therapy in breast cancer."	Journal of clinical oncology 17.5 (1999): 1474-1474.	1159
70	Allred, D. C., et al.	"Prognostic and predictive factors in breast cancer by immunohistochemical analysis." Modern pathology: an official journal of the United States and Canadian	Academy of Pathology, Inc 11.2 (1998): 155-168.	1151
71	Goldhirsch, A. 2011 et al.	"Strategies for subtypes—dealing with the diversity of breast cancer: highlights of the St Gallen International Expert Consensus on the Primary Therapy of Early Breast Cancer 2011."	Annals of oncology (2011): mdr304.	1149
72	Coombes, R. Charles, et al.	"A randomized trial of exemestane after two to three years of tamoxifen therapy in postmenopausal women with primary breast cancer."	New England Journal of Medicine 350.11 (2004): 1081-1092.	1143
73	Fisher, Bernard, et al.	"A randomized clinical trial evaluating tamoxifen in the treatment of patients with node-negative breast cancer who have estrogen-receptor-positive tumors."	New England Journal of Medicine 320.8 (1989): 479-484.	1137
74	Sotiriou, Christos, et al.	"Breast cancer classification and prognosis based on gene expression profiles from a population-based study."	Proceedings of the National Academy of Sciences 100.18(2003): 10393-98	1124
75	Sotiriou, Christos, et al.	"Breast cancer classification and prognosis based on gene expression profiles from a population-based study."	Proceedings of the National Academy of Sciences 100.18 (2003): 10393-10398.	1112

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No	Author	Title	Journal	No of Cite
76	Easton, Douglas F., Deborah Ford, and D. Timothy Bishop.	"Breast and ovarian cancer incidence in BRCA1-mutation carriers. Breast Cancer Linkage Consortium."	American journal of human genetics 56.1 (1995): 265.	1109
77	Ragaz, Joseph, et al.	"Adjuvant radiotherapy and chemotherapy in node-positive premenopausal women with breast cancer."	New England Journal of Medicine 337.14 (1997): 956-962.	1101
78	Easton, D. F., et al.	"Genetic linkage analysis in familial breast and ovarian cancer: results from 214 families. The Breast Cancer Linkage Consortium."	American journal of human genetics 52.4 (1993): 678.	1097
79	Veronesi, Umberto, et al.	"Comparing radical mastectomy with quadrantectomy, axillary dissection, and radiotherapy in patients with small cancers of the breast."	New England Journal of Medicine 305.1 (1981): 6-11.	1096
80	Goss, Paul E., et al.	A randomized trial of letrozole in postmenopausal women after five years of tamoxifen therapy for early-stage breast cancer."	New England Journal of Medicine 349.19 (2003): 1793-1802.	1095
81	Berry, Donald A., et al.	"Effect of screening and adjuvant therapy on mortality from breast cancer."	New England Journal of Medicine 353.17 (2005): 1784-1792.	1091
82	Chlebowski, Rowan T., et al.	"Influence of estrogen plus progestin on breast cancer and mammography in healthy postmenopausal women: the Women's Health Initiative Randomized Trial."	Jama 289.24 (2003): 3243-3253.	1086
83	Tavazoie, Sohail F., et al.	"Endogenous human microRNAs that suppress breast cancer metastasis."	nature 451.7175 (2008): 147-152.	1083
84	Hedenfalk, Ingrid, et al.	"Gene-expression profiles in hereditary breast cancer."	New England Journal of Medicine 344.8 (2001): 539-548.	1083
85	Remmele, W., and H. E. Stegner.	"Recommendation for uniform definition of an immunoreactive score (IRS) for immunohistochemical estrogen receptor detection (ER-ICA) in breast cancer tissue."	Der Pathologe 8.3 (1987): 138.	1080
86	Veronesi, Umberto, et al.	"A randomized comparison of sentinel-node biopsy with routine axillary dissection in breast cancer."	New England Journal of Medicine 349.6 (2003): 546-553.	1077
87	Skobe, Mihaela, et al.	"Induction of tumor lymphangiogenesis by VEGF-C promotes breast cancer metastasis."	Nature medicine 7.2 (2001): 192-198.	1074
88	Yu, Fengyan, et al.	"let-7 regulates self renewal and tumorigenicity of breast cancer cells."	Cell 131.6 (2007): 1109-1123.	1057
89	King, Mary-Claire, Joan H. Marks, and Jessica B., et al.	"Breast and ovarian cancer risks due to inherited mutations in BRCA1 and BRCA2."	Science 302.5645 (2003): 643-64	1028
90	Ritchie, Marylyn D., et al.	"Multifactor-dimensionality reduction reveals high-order interactions among estrogen-metabolism genes in sporadic breast cancer."	The American Journal of Human Genetics 69.1 (2001): 138-147.	1027
91	Ponti, Dario, et al.	"Isolation and in vitro propagation of tumorigenic breast cancer cells with stem/progenitor cell properties."	Cancer research 65.13 (2005): 5506-5511.	1007
92	Sotiriou, Christos, et al.	"Gene expression profiling in breast cancer: understanding the molecular basis of histologic grade to improve prognosis."	Journal of the National Cancer Institute 984 (2006): 262-272	1006
93	Saslow, Debbie, et al.	"American Cancer Society guidelines for breast screening with MRI as an adjunct to mammography."	CA: a cancer journal for clinicians 57.2 (2007): 75-89.	1004
94	Krag, D. N., et al.	"Surgical resection and radiolocalization of the sentinel lymph node in breast cancer using a gamma probe."	Surgical oncology 2.6 (1993): 335-340.	1000
95	Giuliano, Armando E., et al.	"Axillary dissection vs no axillary dissection in women with invasive breast cancer and sentinel node metastasis: a randomized clinical trial."	Jama 305.6 (2011): 569-575.	981
96	Lehmann, Brian D., et al.	"Identification of human triple-negative breast cancer subtypes and preclinical models for selection of targeted therapies."	The Journal of clinical investigation 121.7 (2011): 2750-2767.	973
97	Thurlimann, B., et al.	"Goldhirsch Breast International Group (BIG) 1-98 Collaborative Group, A, et al. A comparison of letrozole and tamoxifen in postmenopausal women with early breast cancer."	N Engl J Med 353 (2005): 2747-57.	962
98	Carver, Charles S., et al.	"How coping mediates the effect of optimism on distress: a study of women with early stage breast cancer."	Journal of Personality and social psychology 65.2 (1993): 375.	962
99	Knabbe, Cornelius, et al.	"Evidence that transforming growth factor- $\beta$ is a hormonally regulated negative growth factor in human breast cancer cells."	Cell 48.3 (1987): 417-428.	962
100	Rouzier, Roman, et al.	"Breast cancer molecular subtypes respond differently to preoperative chemotherapy."	Clinical Cancer Research 11.16 (2005): 5678-5685.	960

Table 2. Distribution of articles by publication date

Publication Years	Record Count	% of 100	Bar Chart
2005	12	12.000 %	██████
2007	11	11.000 %	██████
1998	9	9.000 %	██████
2003	9	9.000 %	██████
1997	7	7.000 %	██████
1989	6	6.000 %	██████
2002	6	6.000 %	██████
2006	6	6.000 %	██████
2001	5	5.000 %	██████
1985	3	3.000 %	██████
1987	3	3.000 %	██████
1994	3	3.000 %	██████
1995	3	3.000 %	██████
1999	3	3.000 %	██████
2004	3	3.000 %	██████
2011	3	3.000 %	██████
1990	2	2.000 %	██████
1993	2	2.000 %	██████

Table 3. Journals in which the top 100 cited articles were published

Source Titles	Record Count	% of 100	Bar Chart
New England Journal of Medicine	25	25.000 %	██████
Lancet	13	13.000 %	██████
Science	11	11.000 %	██████
Journal of Clinical Oncology	8	8.000 %	██████
Nature	8	8.000 %	██████
American Journal of Human Genetics	5	5.000 %	██████
Jama Journal of The American Medical Association	4	4.000 %	██████
Journal of The National Cancer Institute	3	3.000 %	██████
Proceedings of The National Academy of Sciences of The United States of America	3	3.000 %	██████
Cancer Cell	2	2.000 %	██████
Cancer Research	2	2.000 %	██████
Cell	2	2.000 %	██████
Clinical Cancer Research	2	2.000 %	██████
Nature Genetics	2	2.000 %	██████

## Results

The articles included in the study were ranked according to the frequency of citation (Table 1). Our search demonstrated that among the top 100 articles, the most frequently cited article received 7609 citations while the least cited article received 960 citations. We found that 93 of the articles received more than 1000 citations and determined that the top 100 articles were published between 1985 and 2011 (Table 2). The number of most cited articles peaked in 2005 with 12 publications, while the number of least cited in articles peaked in 1990 and 1993 with only two publications.

These top 100 articles were published in 14 high-impact journals where 25 out of 100 articles were published in the New England Journal of Medicine (Table 3).

81% of the studies originated from the USA while the rest originated from the UK, Canada and Italy (Table 4). These top 100 articles

Table 4. Countries of origin of the top 100 cited article

Source Titles	Record Count	% of 100	Bar Chart
United States Of America	81	81.000 %	
England	26	26.000 %	
Canada	18	18.000 %	
Italy	13	13.000 %	
France	12	12.000 %	
Netherlands	12	12.000 %	
Australia	11	11.000 %	
Switzerland	9	9.000 %	
Belgium	7	7.000 %	
Denmark	7	7.000 %	
Germany	7	7.000 %	
Sweden	7	7.000 %	
Scotland	6	6.000 %	
Finland	5	5.000 %	
Poland	5	5.000 %	
Iceland	4	4.000 %	
Spain	4	4.000 %	
Ireland	3	3.000 %	
Israel	3	3.000 %	
Peoples R China	3	3.000 %	
Russia	3	3.000 %	
Austria	2	22.000 %	█
Greece	2	2.000 %	█
Hungary	2	2.000 %	█
Japan	2	2.000 %	█
Mexico	2	2.000 %	█



Table 5. Institutions of origin

Institutions	Record Count	% of 100	Bar Chart
National Institutes of Health Nih Usa	21	21.000 %	██████████
Harvard University	18	18.000 %	██████████
National Cancer Institute Nci	18	18.000 %	██████████
University of California System	14	14.000 %	██████████
Memorial Sloan Kettering Cancer Center	13	13.000 %	██████████
University of London	13	13.000 %	██████████
Va Boston Healthcare System	13	13.000 %	██████████
Institute of Cancer Research Uk	11	11.000 %	██████████
Dana Farber Cancer Institute	10	10.000 %	██████████
Utmd Anderson Cancer Center	9	9.000 %	██████████
European Institute of Oncology	8	8.000 %	██████████
Fondazione Irccs Istituto Nazionale Tumori Milan	8	8.000 %	██████████
Pennsylvania Commonwealth System of Higher Education	8	8.000 %	██████████
Roche Holding	8	8.000 %	██████████
Unicancer	8	8.000 %	██████████
University of Oxford	8	8.000 %	██████████
University of Pittsburgh	8	8.000 %	██████████
Mcgill University	7	7.000 %	██████████
University of California Los Angeles	7	7.000 %	██████████
International Agency For Research On Cancer	6	6.000 %	██████████
Johns Hopkins Oncology Center	6	6.000 %	██████████
Johns Hopkins University	6	6.000 %	██████████
Mayo Clinic	6	6.000 %	██████████
National Surgical Adjuvant Breast Bowel Project	6	6.000 %	██████████
University of California San Francisco	6	6.000 %	██████████
University of Cambridge	6	6.000 %	██████████
University of Toronto	6	6.000 %	██████████
University of Utah	6	6.000 %	██████████
Utah System of Higher Education	6	6.000 %	██████████
World Health Organization	6	6.000 %	██████████
British Columbia Canc Agcy	5	5.000 %	██████████
Duke University	5	5.000 %	██████████
Howard Hughes Medical Institute	5	5.000 %	██████████
Leiden University	5	5.000 %	██████████
Northshore University Health System	5	5.000 %	██████████
Northwestern University	5	5.000 %	██████████
University of Michigan	5	5.000 %	██████████
University of Michigan System	5	5.000 %	██████████
Erasmus University Rotterdam	4	4.000 %	██████████
Karolinska Institutet	4	4.000 %	██████████
Rush University	4	4.000 %	██████████
University of British Columbia	4	4.000 %	██████████
University of Copenhagen	4	4.000 %	██████████
University of Edinburgh	4	4.000 %	██████████
University of Helsinki	4	4.000 %	██████████
University of North Carolina	4	4.000 %	██████████
University of North Carolina Chapel Hill	4	4.000 %	██████████
University of Texas Health Science Center San Antonio	4	4.000 %	██████████

NIH: National Institutes of Health; UK: United Kingdom; CANC AGCY: Cancer Agency; IARC: International Agency for Research on Cancer; NCI: National Cancer Institute; USA: The United States of America

that originated from 50 different centers and National Institutes of Health (NIH USA) ranked as the first with 21% of total articles followed by Harvard University and NIH National Cancer Institute (NCI). The University of Washington ranked the last with 4% (Table 5).

Among top 100 authors in these articles, Wolmark N. was determined to be the mostly cited common author with 12% followed by Fisher

Table 6. Most common the first 20 authors

Source Titles	Record Count	% of 100	Bar Chart
Wolmark N	12	12.000 %	██████████
Fisher B	9	9.000 %	██████████
Bryant J	8	8.000 %	██████████
Easton DF	7	7.000 %	██████████
Norton L	7	7.000 %	██████████
Peto J	7	7.000 %	██████████
Veronesi U	7	7.000 %	██████████
Cuzick J	6	6.000 %	██████████
Davidson NE	6	6.000 %	██████████
Ford D	6	6.000 %	██████████
Gelber RD	6	6.000 %	██████████
Goldhirsch A	6	6.000 %	██████████
Klijn Jgm	6	6.000 %	██████████
Peto R	6	6.000 %	██████████
Redmond C	6	6.000 %	██████████
Baum M	5	5.000 %	██████████
Brown A	5	5.000 %	██████████
Collins R	5	5.000 %	██████████
Costa A	5	5.000 %	██████████
Devilee P	5	5.000 %	██████████

Table 7. Most common the first 20 authors

Categories of articles	Record Count	% of 100	Bar Chart
Medicine General Internal	42	42.000 %	██████████
Multidisciplinary Sciences	22	22.000 %	██████████
Oncology	21	21.000 %	██████████
Genetics Heredity	7	7.000 %	██████████
Cell Biology	6	6.000 %	██████████
Biochemistry Molecular Biology	3	3.000 %	██████████
Pathology	3	3.000 %	██████████
Medicine Research Experimental	2	2.000 %	██████████
Surgery	2	2.000 %	██████████

B. and Bryant J., respectively (Table 6). Furthermore, 42% of these articles were categorized under the title of medicine and general internal medicine followed by studies under the category of multidisciplinary sciences, oncology and genetic hereditary diseases, respectively. The rate of studies under the surgery category was found to be the lowest with 2% (Table 7).

## Discussion and Conclusion

Bibliometric analysis can be conducted in many areas for different purposes (8, 9) and can be used to reveal the historical development in a field (9). In this study, we aimed to identify the top 100 most cited articles in breast cancer research to help researchers easily access and analyze them. In that respect, this study is one of the early studies under the title of breast cancer.

Although analyzing the top 100 most cited articles was relatively difficult, we identified that the top 100 articles were published between 1985 and 2011 thanks to systems such as WOS. The citations mostly peaked between 2005 and 2007. The number of citations to the studies conducted in the areas of orthopedics and neurosurgery peaked between 1965 and 1980 (10, 11). However, the citation frequency of studies in the field of cardiology peaked between 2001 and 2010 (12). This result may suggest that the development and progression in the area of breast cancer may have occurred within a short period of time. In parallel with the technological advances that have occurred in the last two decades, a significant progress in breast cancer research has been also achieved.

The number of citations is closely associated with the publishing date, and has been increasing with time (9). For this reason, the vast majority of articles with a high number of citations consisted of early-published articles. No papers published after 2011 appeared in our list. However, the number of citations is not solely depended on publication date. For example, one article in our list published in 2005 received more citations than other articles published between 1985 and 1995.

Another interesting point of our analysis is that all the articles were published in journals with a high impact factor. The New England Journal of Medicine, Lancet and Science were the journals which mostly published top 100 articles, indicating that the vast majority of the studies were published in the best-known general medical journals rather than specific journals in this field. It may be speculated that the audience of a general medical journal may be closely interested in the issue of breast cancer or it is possible to consider that the authors of studies on breast cancer preferentially choose the journals with a high impact.

Another point of our study is that the top 100 articles most often originated from the United States. The bibliometric analyses in other areas also showed that the United States ranked high on the list (13, 14). These findings clearly show that the United States is at the forefront of studies on breast cancer. A wide range of patient population and a substantial amount of financial support to researchers can be the main reason behind this.

The authors who have received the highest number of citations are the people who are prominent in their field. For example, Wolmark N. authored 12 articles in the top 100 articles whereas Slamon Dennis J. was not in the list of the first 20 authors who have the highest number of articles although he was the first author in the first 3 articles that received the highest number of citations.

Breast cancer research has progressed historically and gone through milestones in various areas in this process. These areas include breast cancer gene associations, breast cancer treatment modalities, hormonal therapies, HER2 and breast cancer involvement, sentinel lymphadenectomy, breast conserving surgery, breast cancer metastasis, survival, neoadjuvant chemotherapy and breast screening.

Slamon Dennis J. was observed as the first author in first 3 articles with the highest number of citations. All three articles were about the oncogene HER2 / neu. It has been emphasized that HER2 / neu amplification gene has a high prognostic value and this gene may play a role in the pathogenesis of breast cancer. The first three articles with the highest number of citations are very important in terms of revealing the correlation between HER2 / neu and breast cancer. Prognosis is very low in patients with HER2 / neu positive breast cancer. For this reason, HER2-targeting therapies are thought to have positive effects on outcomes. Romond, Edward H., et al. showed an improvement in the outcomes of women with HER2-positive breast cancer treated with trastuzumab, a monoclonal antibody targeting the extracellular domain of HER2. Piccart-Gebhart, Martine J. et al also demonstrated the efficacy of trastuzumab in HER2-positive breast cancer patients after adjuvant chemotherapy. Vogel, Charles L., et al., showed that trastuzumab is safe and effective as a single agent in the first-line treatment of HER2-positive metastatic breast cancer patients. Seven of the top 100 articles are related to HER2 and trastuzumab and they are an important milestone in this field.

Today, hormonal treatments in breast cancer have an important place in therapy. Remmele, W., and H.E. Stegner identified estrogen receptors immunohistochemically from breast cancer tissues in 1987. Fisher, Bernard, et al. published a paper in 1989, showing a randomized clinical trial which demonstrated the efficacy of tamoxifen on breast cancer in patients that are estrogen- and progesterone-receptor-positive. This study provided significant progress in breast cancer treatment. The Early Breast Cancer Trialists' Collaborative Group investigated the efficacy of tamoxifen in early breast cancers in 1998. Fisher, Bernard et al. explained the protective effects of tamoxifen on breast cancer in 1998.

Gene-based studies have been conducted on breast cancer through the demonstration of the effects of genetic factors in many types of cancer. Miki Y, Swensen J, et al. reported the association of the BRCA-1 gene with breast cancer and ovarian cancer in 1994. Wooster, Richard, et al, showed a relationship between BRCA-2 gene and breast cancer in 1995. Easton, Douglas F. et al. investigated the incidence of breast and over-cancer in BRCA-1 gene mutation carriers. Ford, Deborah et al. showed that families with breast cancer have BRCA-1 and BRCA-2 identified in their gene analysis in relation to breast cancer in 1998. Antoniou, Anthony et al. published a study entitled "Average risks of breast and ovarian cancer associated with BRCA1 or BRCA2 mutations detected in case series unselected for family history: a combined analysis of 22 studies" in 2003. Today, BRCA1 and 2 genes can be examined and prophylactic mastectomy can be decided upon (Table 1).

Veronesi, Umberto et al. showed that using sentinel-node biopsy can help avoid axillary dissection in breast cancer patients with clinical negative lymph-nodes. Krag, David et al. emphasized the importance of sentinel node in breast cancer. In another study by Krag, D. N., et al., they showed that sentinel-node can be found by radiocalization with gamma probe. In 1994, Giuliano, Armando E. et al. described sentinel lymphadenectomy by lymphatic mapping. In 2003, Veronesi, Umberto



et al. published a paper entitled “A randomized comparison of sentinel-node biopsy with routine axillary dissection in breast cancer”, and stated that sentinel-node biopsy was a safe and reliable method. All these papers constituted the milestones for avoiding unnecessary axillary dissection in breast cancer patients, and helped reduce morbidity associated with breast surgery (Table 1).

While radical mastectomy surgery was commonly used as the conventional breast cancer treatment, modified radical mastectomy and especially preventive breast surgery are generally chosen as a curative treatment at the present time. The reason behind this change in treatment method actually is rooted in the findings of the following milestone papers: in 1981, the paper published by Veronesi, Umberto et al. compared radical mastectomy to quadrantectomy, and they found that there were no differences between these groups in terms of disease-free or overall survival rate. Fisher, Bernard et al. published a paper in 1985 entitled “Five-year results of a randomized clinical trial comparing total mastectomy and segmental mastectomy with or without radiation in the treatment of breast cancer.” and they determined that segmental mastectomy with breast irradiation and adjuvant chemotherapy was the appropriate treatment method in stage I and II breast cancer (less than 4 cm).

The rest of the top 100 cited articles were associated with adjuvant and neoadjuvant treatments, survival, breast cancer metastasis, and breast screening. These studies contribute to breast research by providing significant improvements.

In this bibliometric analysis, the vast majority of the top 100 articles were in the category of general internal medicine. It was followed by multi-disciplinary sciences, and the third in rank was oncology research. Surgery was at the bottom of the list. However, surgeons have significantly contributed to the area of breast cancer. The effects of significant studies which have been conducted in recent years will be seen during the upcoming years.

There are some limitations to our study. Only the studies having breast cancer in their title were included in the study. However, breast cancer as the topic of the studies was not taken into consideration. The studies on the topic of breast cancer with a high number of citations can also be separately analyzed. The results which have been found by typing ‘breast, breast neoplasm’ in the search box of WOS can be separately added to the analysis. In order to ensure homogenization in our study, analyses have been conducted under only one title and search.

As a result, it was found that top 100 most cited publications predominantly originated from the United States. The largest part of top 100 articles was published in New England Journal of Medicine. Most articles were published under the category of general internal medicine. The highest number of publications was in 2005. The articles about HER2 / neu were listed as the first three articles. It was determined that National Institutes of Health NIH USA and Harvard University were the institutes which published the highest number of articles.

Analysis of highly cited articles with ‘breast cancer’ in their title provided the opportunity to recognize the progress made in studies on breast cancer. It also provides a historical perspective on the development of breast cancer studies.

**Ethics Committee Approval:** Ethics committee approval was not requested for this study.

**Informed Consent:** Informed consent is not necessary as our work is a retrospective international data study.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept - EU.; Design - EU.; Supervision - EU.; Resources - EU.; Materials - EU.; Data Collection and/or Processing - EU.; Analysis and/or Interpretation - EU.; Literature Search - EU.; Writing Manuscript - EU.; Critical Review - EU.; Other - EU.

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