STM JOURNALS

International Journal of
Oncological Nursing and Practices

ISSN: 3049-2939
Volume 3, Issue 2, 2025
July—December
DOI (Journal): 10.37591/IJONNP

https://journals.stmjournals.com/ijonnp

Review IJONNP

A Review of Literature on Breast Cancer: Molecular Insights, Clinical Approaches, and Future Perspectives

Ritu[1,*], Anshika Rosha[2]

Abstract

Breast cancer is the leading cause of morbidity and mortality in women globally. Although both men and women can get the condition, women are more likely to get it, and its prevalence has been rising globally in recent years. The epidemiology, risk factors, pathophysiology, diagnosis, treatment options, and survival rates of breast cancer are all examined in this review of recent research. Breast cancer can show up as a lump in the breast, changes in the breast's size or form, skin dimpling, or nipple discharge, among other signs. Screening methods that can identify issues early and enhance prognosis include magnetic resonance imaging (MRI), mammography, and ultrasonography. Breast tumors can be precisely classified using histopathological investigation and molecular profiling, which informs therapy choices. The study examines the molecular subtypes of breast cancer, the genetic and environmental factors that influence risk, and developments in early detection, including the function of screening programs. With a focus on the value of personalized medicine, treatment approaches such as surgery, chemotherapy, radiation, targeted therapy, and immunotherapy are examined. There are still issues, especially with aggressive subtypes like triple-negative breast cancer, despite advancements in research and treatment. Immunotherapy and molecular profiling are two potential future research avenues that could enhance survival rates and results.

Keywords: Mammography, ultrasonography, estrogen receptor, menstruation, triple-negative breast cancer

INTRODUCTION

Breast cancer is one of the most common cancers in the world, accounting for the majority of cancer-related deaths among women. It is distinguished by the uncontrolled multiplication of cells in the breast tissue, which can invade adjacent tissues or metastasis to other organs. Over the past several decades, advances in molecular biology, imaging, and therapeutics have improved survival rates, yet breast cancer continues to pose significant challenges, particularly in aggressive subtypes such as triple-negative breast cancer (TNBC). TNBC is less susceptible to targeted hormonal or HER2 therapy because it does not express human epidermal growth factor receptor 2 (HER2), progesterone receptors (PR), or estrogen receptors (ER) [1]. The development of breast cancer is multifactorial, influenced by genetic predisposition, hormonal imbalances, reproductive history, environmental exposures, and lifestyle factors. Hereditary mutations, especially in the BRCA1 and BRCA2 genes, dramatically increase lifetime breast cancer risk, while family history remains a strong predictor. Other contributing factors include age, obesity, alcohol consumption, prolonged exposure

***Author for Correspondence**
Ritu
E-mail: ritu@galgotiasuniversity.edu.in

[1]Assistant Professor, Department of Nursing, Galgotias School of Nursing, Galgotias University, Greater Noida, Gautam Budh Nagar, Uttar Pradesh, India
[2]Nursing Tutor, Department of Nursing, Galgotias School of Nursing, Galgotias University, Greater Noida, Gautam Budh Nagar, Uttar Pradesh, India

Received Date: October 12, 2025
Accepted Date: November 05, 2025
Published Date: November 12, 2025

Citation: Ritu, Anshika Rosha. A Review of Literature on Breast Cancer: Molecular Insights, Clinical Approaches, and Future Perspectives. International Journal of Oncological Nursing and Practices. 2025; 3(2): 15–20p.

to estrogen, late menopause, and early menarche. These factors collectively affect the initiation, progression, and prognosis of breast cancer. With the advent of molecular profiling and immunotherapy, the management of breast cancer has become increasingly personalized. This review synthesizes the latest findings on the epidemiology, risk factors, pathophysiology, diagnosis, treatment, and survival outcomes of breast cancer, highlighting areas of ongoing research and future directions [2].

REVIEW OF LITERATURE

Breast cancer remains the most frequently diagnosed malignancy among women worldwide and a major cause of cancer-related mortality. According to GLOBOCAN 2020, approximately 2.3 million new cases and 685,000 deaths were reported globally, highlighting the growing burden of the disease in both developed and developing countries [1].

Epidemiology

Breast cancer is the most frequent cancer among women worldwide, with an estimated 2.3 million new cases expected in 2020. Its incidence has steadily risen, particularly in high-income countries, due to changes in lifestyle, reproductive patterns, and increased screening. Regions such as North America, Europe, and Australia report the highest age-standardized incidence rates (ASIR), whereas parts of Asia and Africa historically had lower rates. However, the incidence in these regions is gradually increasing, possibly due to urbanization, dietary changes, and improved cancer detection programs (Table 1) [3].

Due to a lack of awareness and a lack of screening facilities, breast cancer is frequently discovered at an advanced stage in low- and middle-income nations. Mortality rates remain disproportionately high in these regions, highlighting the need for early detection and improved access to healthcare services. Screening programs, including mammography, ultrasound, and clinical breast examination, have contributed to reduced mortality rates in developed nations, underscoring the importance of early diagnosis [4].

Table 1. Global breast cancer incidence and mortality (2020).

Region	New cases (millions)	Mortality (millions)	ASIR (per 100,000)
North America	0.28	0.07	90
Europe	0.55	0.15	85
Australia	0.14	0.03	92
Asia	0.95	0.35	45
Africa	0.38	0.25	35

Risk Factors

The etiology of breast cancer is complex, involving genetic, hormonal, reproductive, lifestyle, and environmental factors [5].

- *Genetic factors:* Mutations in tumor suppressor genes such as BRCA1 and BRCA2 significantly elevate breast cancer risk, with lifetime risks as high as 60–80% for carriers. Susceptibility to breast cancer increases with a family history, particularly among first-degree relatives. Genetic testing and counseling are critical for high-risk populations to enable early detection and preventive interventions.
- *Hormonal factors:* Long-term exposure to progesterone and estrogen is linked to a higher risk of breast cancer. Hormone replacement therapy (HRT), late menopause, and early menarche have all been associated with increased risk. Estrogen promotes cellular proliferation in breast tissue, increasing the likelihood of malignant transformation.
- *Lifestyle and environmental factors:* Obesity, sedentary behavior, and alcohol consumption are known to increase breast cancer risk, whereas regular physical activity and breastfeeding provide protective effects. Exposure to environmental toxins, endocrine disruptors, and radiation can further contribute to oncogenesis.

- *Reproductive factors:* Nulliparity or delayed childbirth raises breast cancer risk, while early childbirth and prolonged breastfeeding are protective. Cumulative reproductive hormone exposure influences cellular proliferation and susceptibility to DNA damage.

Pathophysiology

Breast cancer is caused by abnormalities in the DNA of breast cells, which result in uncontrolled proliferation. It often develops in the ducts (ductal carcinoma) or lobules (lobular carcinoma). Molecular subtypes based on receptor status dictate prognosis and therapy [6]:

- *Luminal A:* ER+/PR+, HER2-, low-grade, favorable prognosis.
- *Luminal B:* ER+/PR+, HER2+, higher grade, moderate prognosis.
- *HER2-enriched:* HER2+, ER-/PR-, aggressive behavior.
- *Triple-negative:* ER-/PR-/HER2-, highly aggressive, limited targeted therapy.

The tumor microenvironment (TME) plays a critical role in disease progression, metastasis, and therapeutic resistance. Components such as stromal fibroblasts, immune cells, and extracellular matrix interact with tumor cells to promote angiogenesis, invasion, and immune evasion (Figure 1).

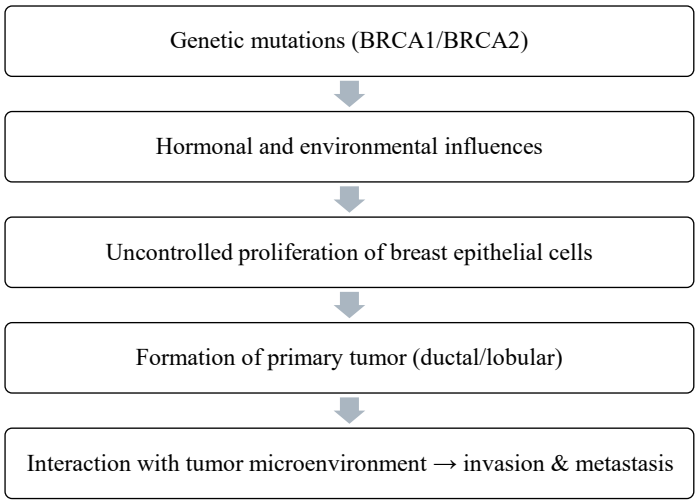

Figure 1. Breast cancer pathogenesis.

Diagnosis

Early detection is essential for improving outcomes. Diagnostic modalities include imaging, biopsy, and genetic testing [7].

- *Imaging:* Mammography remains the gold standard for women over 50, while ultrasound is useful for dense breasts. MRI is indicated in high-risk populations and for evaluating tumor extent.
- *Biopsy:* Core needle biopsy and fine needle aspiration confirm malignancy, providing histopathological information on subtype and grade.
- *Genetic testing:* Screening for BRCA1/2 mutations is recommended for patients with a strong family history or early-onset breast cancer.

Treatment

Management of breast cancer is multimodal, depending on tumor stage, molecular subtype, and patient characteristics (Table 2).

Surgical interventions: Lumpectomy and mastectomy are primary surgical approaches, often combined with sentinel lymph node biopsy to assess metastasis.

Radiotherapy: Postoperative radiotherapy targets residual cancer cells and reduces recurrence, particularly after breast-conserving surgery.

Chemotherapy: Utilized for high-risk, early-stage, or metastatic disease, chemotherapy may be administered before surgery (neoadjuvant) to shrink tumors.

Targeted therapy: HER2-positive cancers benefit from agents like trastuzumab, while PARP inhibitors are emerging for BRCA-mutated cancers.

Hormonal therapy: Tamoxifen and aromatase inhibitors block estrogen effects in ER-positive tumors, reducing recurrence risk.

Immunotherapy: Immune checkpoint inhibitors are increasingly used for TNBC, showing promising results in clinical trials.

Table 2. Summary of breast cancer treatment modalities.

Treatment type	Indication	Mechanism of action
Surgery	Localized tumors	Physical removal of the tumor
Radiotherapy	Post-surgical, high-risk recurrence	DNA damage to cancer cells
Chemotherapy	High-risk or metastatic disease	Cytotoxic agents target dividing cells
Hormonal Therapy	ER+/PR+ tumors	Blocks estrogen signaling
Targeted Therapy	HER2+ or BRCA-mutated tumors	Blocks specific oncogenic proteins
Immunotherapy	TNBC, metastatic disease	Enhances immune response

Survival and Prognosis

Tumor stage and subtype at diagnosis affect survival. Early-stage disease has favorable outcomes, with 5-year survival rates approaching 99% for localized tumors. Metastatic breast cancer has a 5-year survival rate of about 27%, whereas regional disease has an 85–90% survival rate. Improvements in survival are largely attributable to early detection, molecularly guided therapy, and targeted treatment strategies [8, 9].

Challenges and Future Directions

Despite advancements, obstacles remain, notably in treating TNBC. Chemoresistance, recurrence, and limited targeted therapeutic alternatives provide continuous challenges. Future directions focus on personalized medicine, including molecular profiling, immunotherapy, liquid biopsies, and novel drug delivery systems such as nanomedicine. The incorporation of artificial intelligence into imaging and diagnostics has the potential to improve early detection and treatment planning [10].

DISCUSSION AND CONCLUSION

One of the main causes of cancer-related morbidity and mortality among women, breast cancer remains a significant global health concern. Despite considerable advances in medical research, the disease remains complex due to its multifactorial etiology, diverse molecular subtypes, and variations in clinical presentation and response to therapy. The global burden of breast cancer is rising steadily, especially in developing countries, largely due to delayed diagnosis, limited access to screening, and unequal availability of advanced treatment facilities. This highlights the critical need for effective prevention methods, early identification, and equal access to contemporary healthcare systems.

Over the last few decades, there has been substantial progress in understanding the molecular mechanisms and genetic basis of breast cancer. The identification of hormone receptors and HER2 expression has transformed the therapeutic landscape, leading to more precise, targeted treatments. The development of hormonal therapies such as tamoxifen and aromatase inhibitors, as well as targeted

agents like trastuzumab, has substantially improved survival outcomes in receptor-positive cases. Furthermore, the growing field of immunotherapy has shown promise in treating aggressive and previously refractory subtypes, including triple-negative breast cancer, by harnessing the body's immune system to combat tumor growth.

Equally important is the emphasis on early detection through screening programs such as mammography, ultrasound, and genetic testing for high-risk individuals. In addition to improving treatment effectiveness, early diagnosis also improves quality of life and long-term prognosis. Genetic counseling for individuals with BRCA1 and BRCA2 mutations allows for informed decision-making regarding preventive strategies, including prophylactic surgery or chemoprevention.

As research continues to evolve, the integration of molecular profiling, precision medicine, and artificial intelligence into breast cancer care is expected to revolutionize diagnosis, prognosis, and therapeutic planning. Personalized treatment based on individual tumor biology will likely replace the traditional "one-size-fits-all" approach, minimizing toxicity while maximizing efficacy. Additionally, public health initiatives aimed at lifestyle modification, such as reducing alcohol consumption, promoting physical activity, and encouraging breastfeeding, can contribute to lowering disease incidence.

In conclusion, breast cancer research stands at a pivotal juncture where scientific innovation, clinical expertise, and public health interventions must converge. The combination of early detection, genetic understanding, and advanced therapeutic modalities offers hope for reducing global breast cancer mortality and improving the lives of millions of women worldwide.

REFERENCES

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. 2021 May; 71(3): 209–249. doi: 10.3322/caac.21660. Epub 2021 Feb 4. PMID: 33538338.
2. Miki Y, Swensen J, Shattuck-Eidens D, Futreal PA, Harshman K, Tavtigian S, Liu Q, Cochran C, Bennett LM, Ding W, *et al*. A strong candidate for the breast and ovarian cancer susceptibility gene BRCA1. Science. 1994 Oct 7; 266(5182): 66–71. doi: 10.1126/science.7545954. PMID: 7545954.
3. Hong R, Xu B. Breast cancer: an up-to-date review and future perspectives. Cancer Commun (Lond). 2022 Oct; 42(10): 913–936. doi: 10.1002/cac2.12358. Epub 2022 Sep 8. PMID: 36074908; PMCID: PMC9558690.
4. Zheng R, Zhang S, Zeng H, Wang S, Sun K, Chen R, Li L, Wei W, He J. Cancer incidence and mortality in China, 2016. J Natl Cancer Cent. 2022 Feb 27; 2(1): 1–9. doi: 10.1016/j.jncc.2022.02.002. PMID: 39035212; PMCID: PMC11256658.
5. Autier P, Boniol M, La Vecchia C, Vatten L, Gavin A, Héry C, Heanue M. Disparities in breast cancer mortality trends between 30 European countries: retrospective trend analysis of WHO mortality database. BMJ. 2010 Aug 11; 341: c3620. doi: 10.1136/bmj.c3620. Erratum in: BMJ. 2010;341:c4480. LaVecchia, Carlo [corrected to La Vecchia, Carlo]. PMID: 20702548; PMCID: PMC2920378.
6. Cirak Y, Furuncuoglu Y, Yapicier O, Alici S, Argon A. Predictive and prognostic values of BubR1 and synuclein-gamma expression in breast cancer. Int J Clin Exp Pathol. 2015 May 1; 8(5): 5345–53. PMID: 26191236; PMCID: PMC4503107.
7. Botha JL, Bray F, Sankila R, Parkin DM. Breast cancer incidence and mortality trends in 16 European countries. Eur J Cancer. 2003 Aug; 39(12): 1718–29. doi: 10.1016/s0959-8049(03)00118–7. PMID: 12888367.
8. Sant M, Francisci S, Capocaccia R, Verdecchia A, Allemani C, Berrino F. Time trends of breast cancer survival in Europe in relation to incidence and mortality. Int J Cancer. 2006 Nov 15; 119(10): 2417–22. doi: 10.1002/ijc.22160. PMID: 16964611.

9. Sant M, Francisci S, Capocaccia R, Verdecchia A, Allemani C, Berrino F. Should we use incidence, survival or mortality to assess breast cancer trends in European women? Nat Clin Pract Oncol. 2006 May; 3(5): 228–9. doi: 10.1038/ncponc0489. PMID: 16682983.
10. Frischbier HJ. Die Screening-Mammographie und ihre Bedeutung für die Senkung der Brustkrebsmortalität [Screening mammography and its significance for decreasing breast cancer mortality]. Z Arztl Fortbild (Jena). 1991 Oct 25; 85(20): 995–9. German. PMID: 1776292.

