

<https://doi.org/10.56770/jcp2025929>**REVIEW ON THE LATEST DEVELOPMENTS IN DETECTION AND TREATMENT OF BREAST CANCER****Muhammad Wasim Tasleem^{1*} , Lizza Riaz², Saba Javed³, Muhammad Shahid⁴, Uzma Bashir⁴ **¹Shandong Province Key Laboratory of Emerging Contaminants Risk Prevention and Control, College of Life Sciences, Shandong Normal University, Jinan 250014, PR-China.²Sheikh Zayed Medical College, Rahim Yar Khan, Pakistan.³Faculty of Pharmaceutical Sciences, Government College University Faisalabad, Punjab, Pakistan.⁴University College of Conventional Medicine, Faculty of Medicine and Allied Health Sciences, The Islamia University of Bahawalpur, Pakistan.

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ABSTRACT

Numerous treatments for breast cancer have emerged in recent years, influenced by genetic and environmental factors that contribute to the disease's heterogeneity. Breast cancer stem cells are a primary driver of tumor aggressiveness and pose significant challenges to effective treatment. This assessment highlights that the identification of promising therapeutic approaches has led to substantial advancements in breast cancer treatment. Brain metastases, which carry a poor prognosis, are predominantly caused by breast cancer. Management of brain metastases in breast cancer patients typically involves a combination of systemic medications and local therapies, such as radiation or surgery. The introduction of novel antibody-drug conjugates has revolutionized the treatment landscape for metastatic breast cancer. Additionally, technological advancements are being leveraged to improve patient outcomes and streamline processes in the rapidly evolving healthcare sector. Given that breast cancer is the most common cancer among women worldwide, successful management necessitates innovative strategies. This review discusses both healthy and unhealthy dietary influences, as well as preventive measures, including radiation and chemotherapy.

Keywords: Breast Cancer, Chemotherapy, Radiation Therapy, Immunotherapy.

*Corresponding Author. E-mail: 20210500295@stu.sdn.edu.cn

INTRODUCTION

One kind of cancer that manifests differently in women is breast cancer. The United States recorded 268,670 new cases of breast cancer in 2018. Breast cancer is a common cancer that primarily affects women worldwide. Based on molecular and histological features, it can be divided into three types: triple-negative breast cancer (TNBC) (ER⁻, PR⁻, HER2⁻), hormone receptor-positive (either progesterone receptor-positive (PR⁺) or estrogen receptor-positive (ER⁺)), and human epidermal growth factor receptor 2-positive (HER2⁺). The development of efficient treatment options for patients with metastatic breast cancer (MBC) has advanced significantly in recent years [1-4].

As the fourth leading cause of cancer-related deaths worldwide, breast cancer is also the leading cause of cancer mortality among women. Its high

incidence and mortality rates pose a major threat to women's health and represent a global health concern. Between 2011 and 2020, the disease exhibited a mortality rate of approximately 1%, with an estimated incidence of 138 cases per 100,000 people. Currently, bulk cell sequencing, which does not accurately analyze the differences between individual cells, is a primary focus of breast cancer research [5].

STAT3 is a crucial protein involved in various essential cellular processes related to breast cancer, including development, survival, differentiation, regeneration, immunological response, respiration, and metabolism. Upstream signaling molecules, such as Janus kinase and the epidermal growth factor receptor (EGFR), regulate STAT3 expression and subcellular localization. Surgical resection, local radiation therapy, systemic

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chemotherapy, endocrine therapy, and molecular targeted therapy are the current systemic treatments for breast cancer. Some patients develop resistance to first-line therapy medications, while others see the disease move toward more aggressive forms despite these sophisticated strategies.

Mitophagy, or mitochondrial autophagy, is a selective process that maintains balance within cells and mitochondria. Since its coining in 2005, the term "mitophagy" has been linked to important findings on its molecular mechanisms and consequences for both health and illness. This process, which is controlled by a complicated web of chemicals and signaling channels, entails the selective breakdown and elimination of damaged or defective mitochondria via lysosomes. On the other hand, excessive mitochondrial breakdown brought on by unchecked mitophagy can interfere with regular mitochondrial turnover [6].

Some risk factors for breast cancer, such as being female, becoming older, and having a family history of breast or ovarian cancer, are uncontrollable. Additionally, race and ethnicity play a role, with some groups demonstrating higher prevalence rates. Reproductive history, such as early menarche, late menopause, nulliparity, or an earlier first pregnancy, also contributes to increased risk. Other factors include dense breast tissue, a history of non-cancerous breast disorders, previous breast cancer diagnoses, and prior radiation therapy. Furthermore, various growth factors secreted by cancer cells, including transforming growth factor (TGF)- α , TGF- β , insulin-like growth factor (IGF)-I, IGF-II, and platelet-derived growth factor (PDGF), have been identified as stimulants for stromal cells.

The prognosis for breast cancer (BC) patients is influenced by several factors, including age, therapy type, histological classification, stage, and pathological differentiation. Notably, younger age is a distinct risk factor, with younger patients often experiencing poorer survival rates compared to older individuals. The diversity of breast cancer presents significant therapeutic challenges. In resource-limited countries, breast cancer is frequently diagnosed at advanced stages, largely due to ineffective promotion of early detection, diagnosis, and treatment despite medical advancements. To evaluate the complexities of the medical system regarding breast cancer, the Breast Health Global Initiative (BHGI) has attempted to categorize the organizational levels of healthcare across nations [7].

Breast cancer is the most common malignancy among women worldwide. Recent data indicates an approximately 1% annual increase in breast cancer incidence from 2015 to 2019. The Jordan Cancer Registry reported over 1,750 new breast cancer cases in 2022, making it responsible for

one-fifth of all cancer cases and over 40% of all malignancies in women. The study introduced the concept of a "4:1 ratio," suggesting that preventing four local recurrences by year five could potentially avert one breast cancer death by year fifteen.

Immunotherapy has become a vital component of cancer treatment, effectively targeting various solid and liquid tumors. This approach encompasses gene and cell therapies, such as customizing chimeric antigen receptor (CAR) T cells or expanding immune cell products ex vivo. It also includes vaccines and oncolytic viruses that enhance antigen presentation and activate the immune response, as well as monoclonal and bispecific antibodies that modulate inhibitory and stimulatory immune checkpoints [8].

PATHOLOGY OF BREAST CANCER

Carcinomas, which originate from breast epithelial components, account for 95% of all breast cancer cases. Breast cancer is primarily categorized into two main types: in situ carcinomas and invasive carcinomas. In situ carcinomas arise from the ductal or lobular epithelium but remain confined within that area, without invading the underlying basement membrane. As a result, they have a negligible potential for metastasis since they are localized and limited. In contrast, a ductal or lobular carcinoma is classified as invasive (or infiltrating) when it breaches the basement membrane that delineates the epithelial border [9].

TECHNOLOGY FOR SINGLE-CELL SEQUENCING (SCS)

Single-cell sequencing encompasses various fields, including proteomics, metabolomics, epigenomics, transcriptionomics, and genomics. A significant advancement in this area occurred in 2009 when Tang Fuchou developed the first highly sensitive next-generation single-cell transcriptome sequencing technology. This innovation allows for the large-scale analysis of thousands of cells at a relatively low cost, offering accurate and efficient results [10].

BREAST STRUCTURE

The parenchyma of the female breast is divided into multiple lobes by connective and adipose tissue. The mammary fat pad, composed of adipocytes, supports the network of glandular ducts formed by epithelial cells resting on the basement membrane. Adipose tissue also supplies the gland with immune cells and nutrients. Additionally, the connective tissue, characterized by fibroblasts and forming Cooper's ligaments, plays a crucial role in maintaining the breast's structural integrity while also housing the nerves and blood vessels from the chest wall.

TYPES OF BREAST CANCER

There are two types of breast cancer: invasive and non-invasive. Breast cancer can be classified in a number of ways based on a number of criteria,

including cell types, histological profiles, invasiveness, and the presence or lack of the human epidermal growth factor receptor 2 (HER2) and the estrogen and progesterone receptors (ER and PR). The next part gives a quick summary of several common forms of breast cancer. Pregnancy-associated breast cancer (PABC) is the term used when breast cancer is discovered during pregnancy or within a year following childbirth.

Invasive Breast Cancer

Invasive breast cancer is characterized by cancer that has spread beyond the ducts or lobules where it originated. Ductal carcinoma in situ is a type of non-invasive breast cancer where atypical cells grow inside the milk ducts without invading surrounding tissue. The term "in situ" means "in place." Although these atypical cells remain localized, they have the potential to develop into invasive breast cancer.

A number of carefully controlled processes are involved in the invasion-metastasis cascade in breast cancer. Cancer cells first enter the circulatory system by invading adjacent blood or lymphatic arteries. They may then spread to distant metastatic locations such as the liver, brain, lungs, or bones. This metastatic process depends on connections between cancer cells and the endothelial cells that line blood arteries. These interactions allow cancer cells to spread and infiltrate other tissues. Systemic pharmacological therapy, which includes chemotherapy, targeted therapies, immunotherapeutic medications, and endocrine therapy agents, is the main treatment strategy for patients with metastatic breast cancer [11-14].

Non-Invasive Breast Cancer

When aberrant cells in the milk ducts or lobules start to proliferate and disseminate throughout the breast tissue, non-invasive breast cancer develops. When the tumor is tiny or has grown greatly over time, these cancer cells may be able to spread to other parts of the body via the immune system or systemic circulation. The most prevalent type of cancer in women is invasive breast cancer, which affects 6% of women before the age of 75 and is most common in wealthy communities in Australia and Europe [15].

BREAST CANCER WITH LAMINATION

Luminal breast cancers, which are defined as ER-positive tumors, account for over 70% of instances of breast cancer in Western countries. Luminal-like malignancies usually manifest as invasive breast cancer (IBC) without a particular subtype, while they can sometimes advance to more invasive forms such as micropapillary, lobular, cribriform, mucinous, and tubular carcinomas. Proliferation-related pathways and luminal-regulated pathways are the two main biological processes that distinguish luminal-like cancers into

luminal A and luminal B variations, each of which has unique clinical characteristics [16-18].

Luminal A

In addition to being HER2 negative, luminal A tumors are characterized by the presence of progesterone (PR) and/or estrogen (ER) receptors. The activation of genes by ER transcription factors exclusive to the luminal epithelium of the mammary ducts characterizes this subtype. Luminal A cancers also show decreased expression of genes related to cell division. They usually grow slowly, are less aggressive, and are simpler to identify.

Luminal B

The prognosis for luminal B cancers is worse than that of luminal A malignancies. In addition to being ER positive, they could also be PR-negative and HER2 positive. Proliferative genes including MKI67 and AURKA are expressed at higher levels in luminal B cancers. This subtype expresses the luminal epithelium-specific PR and FOXA1 genes and proteins less frequently than luminal A cancers. The presence of estrogen receptors, which are present in equal amounts in both A and B subtypes, distinguishes both luminal and non-luminal diseases [19].

MECHANISMS OF BREAST CANCER DEVELOPMENT AND METASTASIS

A variety of complex cyto-biological processes contribute to the development and metastasis of breast cancer, transforming healthy breast cells into malignant ones that grow, invade, and spread to other locations. Understanding these mechanisms is crucial for developing tailored treatments and improving patient outcomes. Approximately 70% of breast cancer metastases occur in the bone, making it the most common site of metastasis. This is often associated with osteolytic metastatic lesions due to hyperactive osteoclast-mediated bone resorption. While all subtypes of breast cancer can develop bone metastases, the risk is significantly higher for luminal subtype tumors (80.5%) compared to HER2-like tumors (55.6%) and basal-like tumors (41.7%). Additionally, patients with non-metastatic breast cancer may eventually develop distant metastases, even if their initial therapy was effective. Therefore, it is essential to understand the mechanisms behind the metastatic process and the complex interactions between the tumor and host that drive disease progression [20].

CHEMOTHERAPY

More research is needed to determine how chemotherapy-induced menopause affects cognitive performance, particularly as the use of chemotherapy to treat early-stage breast cancer rises. Chemotherapy has a wide range of effects, and the majority of evidence suggests that the impact of estrogen is at least somewhat specific to verbal memory. Menopausal state and

chemotherapy may interact significantly in the verbal memory domain since verbal memory function, measured by comparable neuropsychological tests, is impacted by both estrogen levels and chemotherapy [21-24].

There is growing evidence that anticancer treatments can alter the microbiome in breast cancer patients. Neoadjuvant chemotherapy, which typically includes anthracyclines, alkylating agents, and taxanes, is often administered to shrink tumors before surgery. Given the lack of effective inhibitors and the progressive upregulation of specific proteins with continued chemotherapy treatment, evaluating multidrug resistance (MDR) expression may eventually serve as an additional stratification method for identifying high-risk malignancies, though its application may be limited. The chemotherapy regimen a patient receives will depend on the grade and severity of their breast cancer. The most common signs and symptoms have been examined in relation to the connection between adjuvant chemotherapy side effects and outcomes in elderly patients with breast cancer [25].

Common side effects of chemotherapy include mucositis, diarrhea, nausea, vomiting, and infections due to low white blood cell counts. These symptoms can significantly affect both the patient's quality of life and that of their family and support system. Before starting chemotherapy, patients often experience fear and anxiety, particularly if they have previously encountered these side effects. Most breast cancer patients receive chemotherapy as adjuvant treatment following surgery, but it can also be given as neoadjuvant therapy before surgery. Terms like "primary medical therapy" and "induction chemotherapy" are synonymous with this approach. Neoadjuvant chemotherapy was initially used to treat locally advanced and incurable breast cancer. In the case of inflammatory breast cancer, primary chemotherapy is crucial; many centers opt for cytotoxic drugs and radiation therapy rather than surgery.

Certain chemotherapeutic agents directly affect natural killer (NK) cells. Research shows that pretreatment with epirubicin significantly enhances NK cell-mediated cytotoxicity against tumor cells, suggesting that combining NK cell-based immunotherapy with anthracycline chemotherapy may be an effective strategy for breast cancer. While cytotoxic chemotherapy initially compromises NK cell responses in breast cancer patients, NK cell counts (CD56) typically return to normal after adjuvant treatment. Neoadjuvant systemic treatment has become the standard of care when primary breast conservation is not an option due to tumor size or its relationship with breast size, provided there is a sound chemotherapeutic rationale.

Chemotherapy is "the use of pharmacologic or natural agents that inhibit the development of invasive breast cancer either by blocking the DNA damage that initiates carcinogenesis or by arresting or reversing the progression of premalignant cells." Chemotherapy primarily targets the estrogen receptor since more than 70% of breast cancers are estrogen receptor-positive (ER+). About 70% of instances of breast cancer are hormone receptor-positive (HR+), and the two primary classes of anti-estrogen drugs are aromatase inhibitors (AIs) and selective estrogen receptor modulators (SERMs). Standard fractionation is still used for radiotherapy, and long-term chemotherapy regimens that combine taxanes and anthracyclines represent common treatment protocols. Given the high number of breast cancer survivors, further understanding of the long-term effects of anticancer therapies is essential. Each anticancer treatment has distinct side effects, some of which may overlap.

In the past decade, significant progress has been made in the use of cytotoxic chemotherapy for both advanced and early-stage breast cancer, with landmark studies demonstrating clear survival benefits from newer therapies. However, determining the optimal approach for any specific patient cannot rely solely on literature reviews or decision-making algorithms. The first combined adjuvant chemotherapy treatment studied was CMF (cyclophosphamide, methotrexate, and 5-fluorouracil). A National Institutes of Health consensus group recommends that most women with localized breast cancer should receive adjuvant polychemotherapy, regardless of lymph node, menopausal, or hormone receptor status, as these factors ultimately influence prognosis. The National Comprehensive Cancer Network recommends combination therapies that include taxanes, anthracyclines, cyclophosphamide, cisplatin, and fluorouracil [26].

RADIATION THERAPY

Because the breasts are located on the chest wall while the patient is lying supine, individuals with larger breasts may receive higher doses of radiation to vital organs such as the heart and lungs. One approach to mitigate the toxicities associated with radiotherapy in patients with larger breasts and/or a higher BMI is the use of prone whole-breast radiation, which has demonstrated favorable toxicity profiles.

VACCINES

Bivalent vaccines containing the immunologic adjuvant OPT-821, along with the neuroblastoma-associated antigens GD2 and GD3, are currently in phase II trials. In patients with neuroblastoma (NB), these vaccinations have elicited anti-GD2 and anti-GD3 IgG antibody responses [27].

BREAST CANCER STEM CELLS

Although breast cancer stem cells (CSCs) constitute a small fraction of the tumor, they are

thought to play a critical role due to their ability to proliferate indefinitely. Elevated levels of progesterone in the blood can trigger pluripotent stem cells in immature breast tissue to undergo terminal differentiation, and having a full-term pregnancy before the age of 20 is known to provide protection against breast cancer. Malignant stem cells are resistant to conventional treatments and are either quiescent or proliferate slowly. Their self-renewal capacity poses a risk for clinical recurrence and tumor regeneration. Identifying the biochemical mechanisms specific to cancer stem cells will enable selective targeting of this important subgroup of tumor cells. It is crucial to anticipate the cellular response to treatments and to co-target escape mechanisms.

MAMMARY GLAND INFLAMMATION

Increased inflammation in breast tissue can result from both obesity and sudden involution. Obesity itself is characterized by chronic systemic inflammation, which elevates local inflammation and increases the risk of developing cancer. Abrupt involution in the mammary gland causes acute inflammation that can persist over time. Research indicates that the inflammatory cells and cytokines found in tumors are more likely to promote immunosuppression rather than eliciting strong antitumor responses. Interestingly, women with weakened immune systems have a lower relative risk of developing common epithelial malignancies, such as breast adenocarcinoma.

A previous study found that women who took NSAIDs at least twice a week for a minimum of five years had a lower body mass index (BMI), greater life satisfaction, and improved cognitive function. Through the nuclear factor kappa-light-chain-enhancer of activated B cells (NF- κ B) and mitogen-activated protein kinase (MAPK) signaling pathways, several compounds in pomegranate extract, such as ellagitannins, anthocyanins, and phenols, have shown anti-inflammatory and anticancer properties. These substances lower cyclooxygenase-2 (COX-2) expression, which in turn lowers pro-inflammatory prostaglandin synthesis and cell proliferation. Moreover, suppression of phosphatidylinositol 3-kinases (PI3K), protein kinase B (Akt), or NF- κ B itself increases the downregulation of inflammatory gene transcription [28].

UNHEALTHY DIETS

While a pro-inflammatory diet heavy in red and processed meat and alcohol has been associated with an increased risk of breast cancer recurrence (BCR), a long-term anti-inflammatory diet can prolong the life of breast cancer patients. Elevated BCR is also linked to unhealthy eating habits, such as consuming large amounts of sweets, processed juices, soft drinks, potato chips, mayonnaise, desserts, solid oils, red and processed meats, and too much salt. This risk is further increased by the

Western dietary pattern, which is high in animal fats, soft drinks, hydrogenated fats, fast food, refined cereals, sweets, and processed meats.

ROLE OF P53 IN BREAST CANCER

One crucial tumor suppressor protein that maintains genomic stability is p53. Various stressors, including replication stress, oxidative stress, hypoxia, DNA damage, food deprivation, and telomere shortening, are known to activate p53, the primary regulatory transcription factor. Mutations in the p53 gene, which are common in breast cancer, are associated with a loss of tumor suppressive activity and an increase in carcinogenic properties. These mutations contribute to metastasis, tumor growth, and treatment resistance.

When cancer cells block lymphatic vessels or channels in the skin of the breast, it results in swelling, warmth, redness, dimpling, and/or broad ridges of the breast tissue, a condition known as inflammatory breast cancer. Although rare, inflammatory breast cancer is characterized by rapid growth. Treatment requires careful coordination of multidisciplinary approaches, including radiation therapy, surgery, chemotherapy, and imaging [29].

HEALTHY DIETS

Breast cancer has been associated with healthy circadian dietary practices, and disturbances in these practices can contribute to breast cancer recurrence (BCR). Biomarkers of inflammation and BCR can be downregulated by eating more frequently, consuming less calories in the evening, and fasting for extended periods of time. Often referred to as "the most important meal of the day," breakfast is essential for good health. A healthy breakfast and nutrient-dense foods may help prevent breast cancer, according to research. Mammography and MRI screening, chemoprevention (using aromatase inhibitors [AIs] and selective estrogen receptor modulators [SERMs]), and biological prevention (using drugs like Herceptin and epratuzumab) are examples of current preventive approaches. Triple-negative breast cancer (TNBC) may also be effectively treated with immunotherapy drugs called PD-1/PD-L1 inhibitors [30, 31].

CONCLUSION

This review emphasizes that the implementation of innovative treatment strategies has significantly advanced breast cancer management. Traditional hormone therapies and standard treatments have been found lacking in effectiveness. Ongoing research and education are vital for the diagnosis and treatment of phyllodes tumors. As one of the most prevalent cancers among women globally, breast cancer is marked by various genetic and epigenetic changes and poses a serious threat to public health. A comprehensive understanding of its classification, molecular causes, and treatment options is essential. Moreover, obese breast cancer patients represent a distinct group, as they face a higher risk of developing the disease and may

encounter increased complications from radiation and surgery. Additionally, obese women are more prone to local recurrence, even when appropriately treated for localized disease, compared to their normal-weight peers.

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REFERENCES

1. Zhang H, Hussin H, Hoh CC, Cheong SH, Lee WK, Yahaya BH. Big data in breast cancer: Towards precision treatment. *Digit Health*. 2024 Nov 3;10:20552076241293695. 10.1177/20552076241293695.
2. Chen M, Feng M, Lei H, Dan Mo, Ren S, Yang D. The development of the occurrence and metastasis of breast cancer by single-cell sequencing. *Cancer Cell Int*. 2024 Oct 26;24(1):349. 10.1186/s12935-024-03531-x.
3. Walker RA. The complexities of breast cancer desmoplasia. *Breast Cancer Res*. 2001;3(3):143-5. 10.1186/bcr287. Epub 2001 Feb 1.
4. Jiang RY, Zhu JY, Zhang HP, Yu Y, Dong ZX, Zhou HH, Wang X. STAT3: Key targets of growth-promoting receptor positive breast cancer. *Cancer Cell Int*. 2024 Oct 28;24(1):356. 10.1186/s12935-024-03541-9.
5. Li Y, Tao X, Ye Y, Tang Y, Xu Z, Tian Y, Liu Z, Zhao J. Prognostic nomograms for young breast cancer: A retrospective study based on the SEER and METABRIC databases. *Cancer Innov*. 2024 Oct 25;3(6):e152. 10.1002/cai2.15.
6. Kang C, LeRoith D, Gallagher EJ. Diabetes, Obesity, and Breast Cancer. *Endocrinology*. 2018 Nov 1;159(11):3801-3812. 10.1210/en.2018-00574.
7. Ahles TA, Saykin AJ. Breast cancer chemotherapy-related cognitive dysfunction. *Clin Breast Cancer*. 2002 Dec;3 Suppl 3:S84-90. 10.3816/cbc.2002.s.018.
8. Surdacka LM, Jakubas A, Jagiełło J, Daniłowska K, Picheta N, Gil-Kulik P. Epigenetic and Immune Mechanisms Linking Breastfeeding to Lower Abdel-Razeq H, Sharaf B, Tamimi F, Hani HB, Alsmadi O, Khalil H, Abunasser M, Edaily S, Mansour A. Establishment of a clinical cancer genetics program for breast cancer in a resource-limited country; challenges and opportunities. *Front Oncol*. 2024 Oct 23;14:1431985. 10.3389/fonc.2024.1431985.
9. Alzibdeh A, Abuhijlih R, Abuhijla F. Breast cancer radiobiology: The renaissance of whole breast radiation fractionation (Review). *Mol Clin Oncol*. 2024 Oct 22;21(6):97. doi: 10.3892/mco.2024.2795.
10. Hrubesz G, Leigh J, Ng TL. Understanding the relationship between breast cancer, immune checkpoint inhibitors, and gut microbiota: a narrative review. *Transl Breast Cancer Res*. 2024 Oct 21;5:31. 10.21037/tbcr-24-14.
11. Tang Z, Tian X. *Astragalus membranaceus*: A Traditional Chinese Medicine with Multifaceted Impacts on Breast Cancer Treatment. *Biomolecules*. 2024 Oct 21;14(10):1339. 10.3390/biom14101339.
12. Akl MM, Ahmed A. Cytobiological Alterations Induced by Celecoxib as an Anticancer Agent for Breast and Metastatic Breast Cancer. *Adv Pharm Bull*. 2024 Oct;14(3):604-612. 10.34172/apb.2024.055. Epub 2024 Jun 29.
13. Jang JY, Kim D, Im E, Kim ND. Therapeutic Potential of Pomegranate Extract for Women's Reproductive Health and Breast Cancer. *Life (Basel)*. 2024 Oct 3;14(10):1264.
14. Liaqat A, Mahmood A, Muhammad NA, Muhammad Usman M, Hassan HS and Muhammad Ajmal S. Cross-linked pH-sensitive pectin and acrylic acid based hydrogels for controlled delivery of metformin. *Pakistan Journal of Pharmaceutical Sciences*, 33 (4), 1483-91, 2020. <https://doi.org/10.36721/PJPS.2020.33.4.REG.1483-1491.1>
15. Anam A, Muhammad NA, Muhammad Ajmal S, Shahzada KS and Rabia M. Development, characterization and evaluation of in vitro anti-inflammatory activity of Withania coagulans extract and extract loaded microemulsion. *Pakistan Journal of Pharmaceutical Sciences* 34(1), 473-47, 2021. <https://pubmed.ncbi.nlm.nih.gov/34275796/>
16. Khizar A, Ghazala HR, Muhammad Imran Q, Muhammad Y, Muhammad NQ, Faheem AS, Aamir MN, Asif W, Talal S. Herbal Formulation Comprised of Methanol Extracts of Tribulus terrestris L. and Zingiber officinale Roscoe Has Antihypertensive Effects. *Alternative Therapy*, 18, 2021. <https://pubmed.ncbi.nlm.nih.gov/34144527/>
17. Noor AM, Muhammad I, Muhammad NA. In Silico Approaches for Novel Drug Discovery Against Coronavirus by Employing the Hybrid Molecular Technique: A Review. *Journal of*

- Computational Biophysics and Chemistry. 20 (7), 667–674, 2021.
<https://doi.org/10.1142/S2737416521300017>
18. Rubab A, Naeem MA, Nayab K, Muhammad B. Gastroretentive floating microspheres for the management hypertension based on drug combination of amlodipine /losartan. *Journal of Contemporary Pharmacy*, 5, 2, 40-52, 2021.
<https://doi.org/10.56770/jcp2021521>
 19. Catalano O, Fusco R, Carriero S, Tamburrini S, Granata V. Ultrasound Findings After Breast Cancer Radiation Therapy: Cutaneous, Pleural, Pulmonary, and Cardiac Changes. *Korean J Radiol.* 2024 Nov;25(11):982-991.
10.3348/kjr.2024.0672.
 20. Hassan MS, Ansari J, Spooner D, Hussain SA. Chemotherapy for breast cancer (Review). *Oncol Rep.* 2010 Nov;24(5):1121-31. 10.3892/or_00000963.
 21. Marquette C, Nabell L. Chemotherapy-resistant metastatic breast cancer. *Curr Treat Options Oncol.* 2012 Jun;13(2):263-75.10.1007/s11864-012-0184-6.
 22. Graham J. Breast Cancer: The Psychological Impact of Diagnosis, Treatment, and Remission. *Cureus.* 2024 Oct 4;16(10):e70814.
doi: 10.7759/cureus.70814.
 23. Cleator S, Parton M, Dowsett M. The biology of neoadjuvant chemotherapy for breast cancer. *Endocr Relat Cancer.* 2002 Sep;9(3):183-95. doi: 10.1677/erc.0.0090183.
 24. Harbeck N, Gnant M, Thomssen C. Breast Cancer Is Our Global Responsibility. *Breast Care (Basel).* 2015 Dec;10(6):360. 10.1159/000443159. Epub 2015 Dec 16.
 25. Sun YS, Zhao Z, Yang ZN, Xu F, Lu HJ, Zhu ZY, Shi W, Jiang J, Yao PP, Zhu HP. Risk Factors and Preventions of Breast Cancer. *Int J Biol Sci.* 2017 Nov 1;13(11):1387-1397. 10.7150/ijbs.21635.
 26. Lazzari G, Montagna A, D'Andrea B, Bianculli A, Calice G, Tucciariello R, Castaldo G, Metallo V, De Marco G, Benevento I. Breast Cancer Adjuvant Radiotherapy and Chemotherapy Sequencing: Sequential, Concomitant, or What Else? A Comprehensive Review of the Adjuvant Combinations Journey. *J Clin Med.* 2024 Oct 19;13(20):6251. 10.3390/jcm13206251.
 27. Liu S. Self-assembled lipid-based nanoparticles for chemotherapy against breast cancer. *Front Bioeng Biotechnol.* 2024 Oct 29;12:1482637.
10.3389/fbioe.2024.1482637.
 28. Akram M, Iqbal M, Daniyal M, Khan AU. Awareness and current knowledge of breast cancer. *Biol Res.* 2017 Oct 2;50(1):33. doi: 10.1186/s40659-017-0140-9.
 29. Xu X, Zhang M, Xu F, Jiang S. Wnt signaling in breast cancer: biological mechanisms, challenges and opportunities. *Mol Cancer.* 2020 Nov 24;19(1):165. doi: 10.1186/s12943-020-01276-5.
 30. Yin L, Duan JJ, Bian XW, Yu SC. Triple-negative breast cancer molecular subtyping and treatment progress. *Breast Cancer Res.* 2020 Jun 9;22(1):61. doi: 10.1186/s13058-020-01296-5.
 31. Lee K, Kruper L, Dieli-Conwright CM, Mortimer JE. The Impact of Obesity on Breast Cancer Diagnosis and Treatment. *Curr Oncol Rep.* 2019 Mar 27;21(5):41. 10.1007/s11912-019-0787-1.