

**LIFESTYLE MODIFICATION AND PHARMACOTHERAPY IN
BREAST CANCER: A COMPREHENSIVE REVIEW**

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ABSTRACT

Breast cancer is the most commonly diagnosed cancer among women worldwide and remains a leading cause of cancer-related mortality despite significant advances in diagnosis and treatment. The increasing global burden of breast cancer highlights the importance of a comprehensive management approach that integrates evidence-based pharmacotherapy with healthy lifestyle modifications. Pharmacological treatment includes surgery-supported systemic therapies such as chemotherapy, endocrine therapy, targeted therapy, immunotherapy, and supportive care, each selected according to tumour subtype, stage, and individual patient characteristics. These therapies have substantially improved survival outcomes; however, they are often associated with adverse effects that may affect patients' quality of life and treatment adherence. Lifestyle modification has emerged as an important

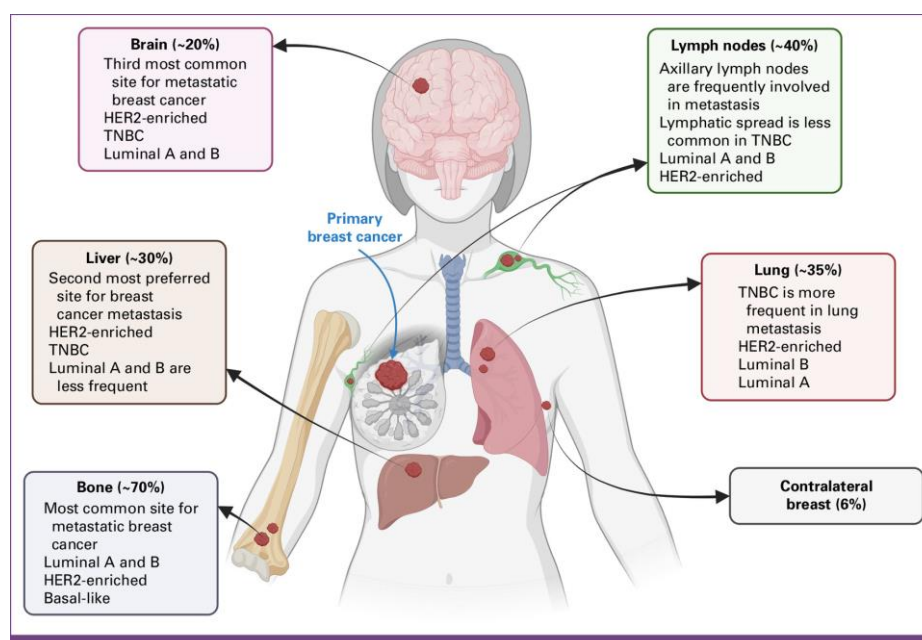
complementary strategy in breast cancer prevention, treatment, and survivorship. Regular physical activity, a balanced diet rich in fruits, vegetables, and whole grains, maintenance of a healthy body weight, smoking cessation, limited alcohol consumption, adequate sleep, stress management, and psychosocial support have been shown to reduce the risk of recurrence, improve treatment tolerance, minimise therapy-related complications, and enhance overall well-being. Growing scientific evidence also suggests that these interventions positively influence metabolic, inflammatory, and hormonal pathways involved

in breast cancer progression. This review summarises the current evidence on the role of lifestyle modification alongside pharmacotherapy in breast cancer management. It discusses the mechanisms, therapeutic benefits, limitations, and recent advances in treatment, while emphasising the importance of a multidisciplinary and patient-centred approach. Integrating pharmacological therapies with sustainable lifestyle interventions can optimise clinical outcomes, improve quality of life, and contribute to long-term survival among breast cancer patients. This review aims to provide healthcare professionals and researchers with a comprehensive overview of current strategies and future directions in breast cancer management.

KEYWORDS: Breast Cancer, Pharmacotherapy of Breast Cancer, Lifestyle Modification, Comparison of Pharmacotherapy and Lifestyle.

INTRODUCTION

Breast cancer is the most commonly diagnosed malignancy among women and continues to represent a major public health challenge worldwide. According to recent global estimates from GLOBOCAN 2022, breast cancer accounts for a substantial proportion of newly diagnosed cancer cases and remains one of the leading causes of cancer-related mortality in women. The disease comprises a heterogeneous group of malignant tumors originating from breast tissue, characterized by uncontrolled cellular proliferation, the ability to evade normal immune surveillance and apoptosis, and the potential to metastasize through the lymphatic and circulatory systems to distant organs.^[1,2,3]



Most breast cancers arise from the epithelial lining of the milk ducts or the lobules of the breast. Tumours originating from the ducts are classified as ductal carcinomas, whereas those arising from the lobules are known as lobular carcinomas. Both histological types may occur as carcinoma in situ, where malignant cells remain confined to their site of origin, or as invasive carcinoma, in which cancer cells infiltrate the surrounding breast tissue and may subsequently spread to regional lymph nodes or distant organs. Current evidence indicates that breast carcinogenesis results from interactions among genetic susceptibility, hormonal influences, environmental exposures, and lifestyle-related factors. Furthermore, tumour progression is regulated by diverse biological mechanisms, including cancer stem cell activity, alterations in the intratumoral microbiome, and disruption of circadian rhythm, all of which have emerged as promising areas for therapeutic research. Breast cancer risk is influenced by both modifiable and non-modifiable factors. Non-modifiable determinants include female sex, increasing age, inherited genetic mutations, and a positive family history of breast cancer. Modifiable risk factors include obesity, particularly in postmenopausal women, alcohol consumption, tobacco smoking, exposure to ionizing radiation, and reproductive factors such as nulliparity or delayed first pregnancy. Addressing these modifiable factors may contribute to reducing disease incidence and improving long-term health outcomes.

Breast cancer is also recognized as a molecularly heterogeneous disease consisting of distinct biological subtypes, each demonstrating unique clinical characteristics and therapeutic responses. Advances in molecular diagnostics, imaging techniques, surgical management, radiotherapy, systemic chemotherapy, endocrine therapy, targeted therapy, and immunotherapy have substantially improved patient survival and disease control. Alongside pharmacological management, evidence supports the role of lifestyle interventions—including maintaining a healthy body weight, engaging in regular physical activity, consuming a balanced diet, limiting alcohol intake, and avoiding tobacco use—in reducing recurrence risk, enhancing treatment outcomes, and improving quality of life among breast cancer survivors.^[4,5,6,7]

Epidemiology

The global burden of breast cancer has changed considerably over the past few decades. During the 1980s and 1990s, the reported incidence increased substantially, primarily because of improvements in screening programs and greater use of mammography, which

enabled earlier detection of previously undiagnosed cases. In the United States, however, a temporary decline in incidence was observed in the early 2000s, largely associated with a reduction in the use of hormone replacement therapy (HRT) following evidence linking HRT with an increased risk of breast cancer. Currently, the incidence of breast cancer continues to rise worldwide, with the highest rates reported in high-income and industrialized countries. Nearly half of all newly diagnosed cases occur in developed nations. This pattern has been attributed to demographic changes, increased life expectancy, widespread screening practices, and lifestyle factors commonly associated with Western societies, including unhealthy dietary habits, physical inactivity, tobacco use, obesity, and chronic psychological stress. Population-based screening plays a crucial role in the early detection of breast cancer. Mammography remains the standard screening modality and has demonstrated the greatest benefit in women aged 50–69 years. Conventional mammography generally exhibits a sensitivity of approximately 75–95% and a specificity ranging from 80–95%, making it an effective tool for identifying early-stage disease. In women at high genetic risk, particularly those with suspected hereditary breast cancer syndromes, contrast-enhanced breast magnetic resonance imaging (MRI) is recommended as an additional screening technique because of its higher sensitivity. When mammographic findings are suspicious, breast ultrasonography is commonly performed for further lesion characterization. A core needle biopsy, followed by histopathological evaluation, is then used to establish a definitive diagnosis and guide subsequent treatment decisions.^[8,9]

Risk factors

Breast cancer develops through a complex interaction of genetic, hormonal, reproductive, and lifestyle-related factors. These risk factors are generally categorized as non-modifiable and modifiable.^[1] Among women, non-modifiable risk factors include female sex, increasing age, a positive family history of breast cancer, inherited pathogenic variants in BRCA1 and BRCA2, early onset of menstruation (menarche), and delayed menopause. These factors increase lifetime exposure to oestrogen and contribute to a greater risk of disease development.^[2] Several modifiable factors also influence breast cancer risk. These include having no children (nulliparity), prolonged exposure to exogenous oestrogen or hormone replacement therapy, obesity, excessive alcohol intake, smoking, physical inactivity, and unhealthy dietary habits. Reproductive characteristics such as a late first full-term pregnancy and limited duration of breastfeeding have also been associated with an elevated risk.^[3] Although breast cancer is much less common in men, it can occur and is linked to several risk

factors. Advancing age, African ancestry, inherited BRCA2 mutations (more frequently than BRCA1), obesity, elevated circulating oestrogen levels, gynecomastia, previous chest irradiation, diabetes mellitus, and inflammatory conditions of the testes, including orchitis and epididymitis, have all been associated with an increased likelihood of developing male breast cancer.^[4] The exact etiology of breast cancer remains incompletely understood. Most cases are sporadic rather than hereditary, indicating that environmental exposures and lifestyle factors play a major role in disease development. Hereditary breast cancers account for approximately 5–10% of all cases, and mutations in BRCA1 and BRCA2 are responsible for nearly 30% of inherited breast cancers. Ongoing research continues to identify additional susceptibility genes and to investigate how genetic predisposition interacts with environmental and lifestyle influences.^[10]

Pathophysiology

The majority of breast cancer cases are sporadic, accounting for approximately 90–95% of diagnoses, while hereditary breast cancers comprise only about 5–10% and are most commonly linked to inherited mutations in the BRCA1 and BRCA2 genes. Among invasive breast malignancies, invasive ductal carcinoma (IDC) is the predominant histological subtype, followed by invasive lobular carcinoma (ILC). The development of breast cancer is a multifactorial process involving interactions among genetic susceptibility, environmental exposures, hormonal influences, and individual patient characteristics. Advances in molecular profiling have identified distinct breast cancer subtypes that differ in their biological behaviour, therapeutic response, and clinical outcomes. These molecular subtypes include:

Luminal A: Oestrogen and/or progesterone receptor-positive (HR-positive) with negative HER2 expression; generally associated with a favourable prognosis.

Luminal B: Hormone receptor-positive with HER2 overexpression or increased cellular proliferation; typically demonstrates a more aggressive clinical course than Luminal A.

Basal-like (Triple-negative): Lacks expression of hormone receptors and HER2, often exhibiting aggressive behaviour and limited targeted treatment options.

HER2-enriched: Characterized by HER2 overexpression in the absence of hormone receptor expression, with treatment primarily relying on HER2-targeted therapies.^[11]

Sign and Symptoms and Diagnosis

Sign and Symptoms

1. A localized area of the breast may feel firmer, denser, or noticeably heavier than the surrounding breast tissue.
2. The skin of the nipple or areola may become discoloured, scaly, dry, or develop crust-like lesions.
3. A newly developed inversion, retraction, or abnormal deviation of the nipple may be observed.
4. Changes in the overlying breast skin, including dimpling or puckering, may occur due to underlying tissue involvement.
5. Noticeable alterations in the breast's size, shape, or overall contour may indicate disease progression.
6. The breast skin may appear erythematous and oedematous with a characteristic peau d'orange (orange-peel) appearance caused by skin thickening and prominent pores.^[12]

Diagnosis

1. Screening

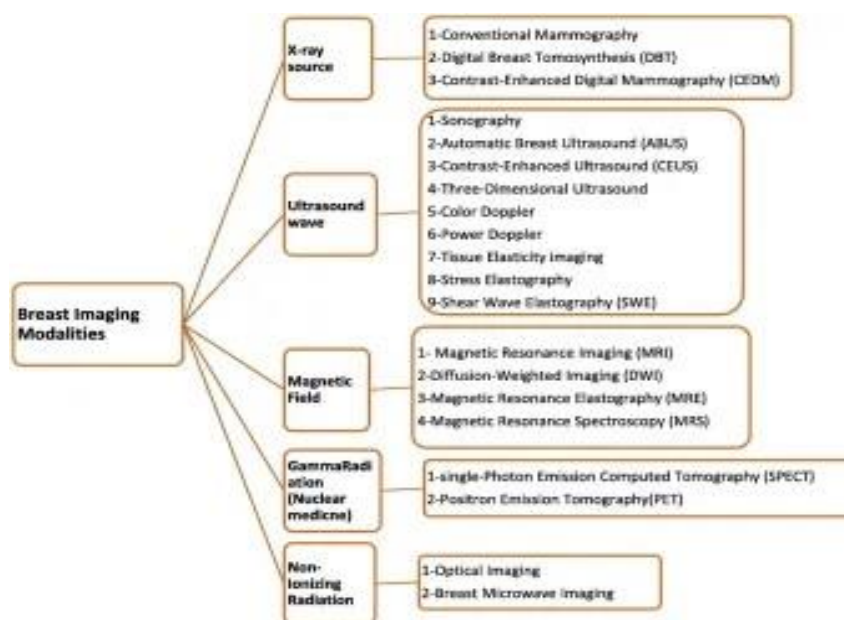
Breast cancer is commonly identified either during routine screening examinations or after the onset of clinical symptoms, such as breast pain, a palpable lump, or other suspicious changes that necessitate further diagnostic evaluation. Early detection through screening programs enables the diagnosis of tumors at an earlier stage, when they are typically smaller and less likely to have spread to regional lymph nodes or distant organs. Early-stage detection also increases the likelihood of breast-conserving surgery and less extensive axillary procedures while reducing the need for systemic chemotherapy. Consequently, screening contributes to lower treatment-related complications, improved quality of life, and enhanced long-term survival outcomes for patients.^[13]

2. IMAGING

2.1. Mammography

The American Cancer Society (ACS) recommends that women begin annual mammographic screening at 40 years of age, with the greatest benefit observed among women aged 40–74 years. Mammography remains the standard imaging modality for the early detection of breast cancer; however, its diagnostic accuracy varies according to several factors, including patient age, breast density, ethnicity, previous breast disease, image quality, and the radiologist's

expertise. In women with dense breast tissue, particularly younger and premenopausal individuals, the sensitivity of mammography is reduced, resulting in a greater likelihood of both false-positive and false-negative findings. Despite its established role in breast cancer screening, conventional mammography has certain limitations. These include exposure to low-dose ionizing radiation, decreased effectiveness in dense breasts, patient discomfort during image acquisition, and the possibility of inaccurate results that may lead to unnecessary investigations or delayed diagnosis. Although mammography has contributed to a reduction in breast cancer mortality through earlier detection, its overall effectiveness may be limited in specific patient populations. To address these limitations, contrast-enhanced digital mammography (CEDM) has emerged as a valuable adjunct imaging technique. This method utilizes intravenous iodinated contrast agents to highlight tumor-associated angiogenesis, thereby improving the visualization of malignant lesions. Although CEDM involves a slightly higher radiation dose than conventional mammography, studies have demonstrated that it provides superior sensitivity and diagnostic performance, particularly in women with dense breast tissue. Furthermore, CEDM has shown improved detection accuracy compared with conventional mammography and breast ultrasonography, making it a promising tool for selected patients.^[14]



3. Tissue Biopsy

When imaging studies reveal a suspicious breast lesion, a core needle biopsy performed under imaging guidance, such as stereotactic, ultrasound, or magnetic resonance imaging (MRI) guidance, is the preferred method for obtaining tissue for histopathological evaluation.

Compared with fine-needle aspiration (FNA), core needle biopsy provides larger tissue samples, allowing for a more accurate diagnosis and better assessment of tumor characteristics; therefore, it is generally considered the diagnostic technique of choice whenever feasible. In patients with clinically or radiologically suspicious regional lymph nodes, ultrasound-guided core needle biopsy is recommended to confirm nodal involvement. During the biopsy procedure, radiopaque marker clips are commonly placed within the primary breast lesion and, when appropriate, in the biopsied lymph node. These markers facilitate accurate localization of the biopsy site during subsequent imaging, surgery, or neoadjuvant therapy. The collected tissue specimens are then submitted for comprehensive histopathological examination. In addition to confirming the diagnosis, laboratory analysis includes the assessment of key predictive and prognostic biomarkers, such as oestrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER2) status, which are essential for determining prognosis and guiding individualized treatment strategies.^[15]

4. Radioimmunosциntigraphy

Radioimmunosциntigraphy (RIS) is a molecular imaging technique that employs radiolabelled antibodies or other radiopharmaceuticals to selectively bind to tumor-associated antigens expressed on breast cancer cells. The diagnostic principle is based on differences in antigen expression between malignant and normal tissues, allowing targeted visualization of cancerous lesions. Commonly targeted antigens include carcinoembryonic antigen (CEA), polymorphic epithelial mucin (PEM/MUC1), and tumor-associated glycoprotein-72 (TAG-72). In addition to antigen-based imaging, RIS can also be applied for receptor imaging, particularly in tumors expressing somatostatin receptors. Several radiotracers and perfusion agents, including thallium-201 (^{201}Tl), technetium-99m sestamibi ($^{99\text{m}}\text{Tc}$ -sestamibi), technetium-99m tetrofosmin ($^{99\text{m}}\text{Tc}$ -tetrofosmin), technetium-99m methylene diphosphonate ($^{99\text{m}}\text{Tc}$ -MDP), and technetium-99m diethylenetriamine pentaacetic acid ($^{99\text{m}}\text{Tc}$ -DTPA), may be used to enhance lesion detection and evaluate tumor perfusion. Despite its ability to provide functional and molecular information, the routine clinical application of RIS is limited because of its relatively high cost, moderate diagnostic sensitivity and specificity, and limited suitability as a population-based breast cancer screening modality.^[16]

Pharmacotherapy of Breast Cancer

Breast cancer outcomes have improved considerably over the past few decades because of advances in early detection and treatment. Although breast cancer remains one of the leading causes of cancer-related mortality among women, the majority of individuals diagnosed with the disease survive long term, particularly when it is detected at an early stage. Patient prognosis and therapeutic decisions are primarily determined by the tumor stage at diagnosis, histological characteristics, and molecular subtype.^[17] For women at increased risk of developing hormone receptor-positive breast cancer, pharmacological risk-reduction strategies have demonstrated significant clinical benefit. The most extensively investigated preventive agents are selective oestrogen receptor modulators (SERMs), including tamoxifen and raloxifene, and aromatase inhibitors (AIs) such as anastrozole, letrozole, and exemestane. These medications reduce estrogen-mediated stimulation of breast tissue and lower the incidence of hormone-dependent breast cancer in high-risk populations.^[17] The management of breast cancer requires a multidisciplinary approach that combines local and systemic therapies according to the patient's clinical condition and tumor biology. Chemotherapy remains an important treatment modality, particularly for patients with high-risk, locally advanced, or metastatic disease. Commonly used cytotoxic drugs include anthracyclines (e.g., doxorubicin), taxanes (e.g., paclitaxel and docetaxel), and cyclophosphamide, which inhibit cancer cell proliferation through different mechanisms.^[18] For tumors that overexpress the human epidermal growth factor receptor 2 (HER2), targeted biological therapies have substantially improved survival outcomes. Monoclonal antibodies such as trastuzumab and pertuzumab selectively inhibit HER2 signalling pathways, thereby suppressing tumor growth and reducing disease recurrence. These agents are frequently combined with chemotherapy to achieve greater therapeutic efficacy.^[18]

Patients with hormone receptor-positive breast cancer benefit from endocrine therapy, which interferes with estrogen signalling. Tamoxifen, a selective estrogen receptor modulator, blocks estrogen receptors in breast tissue, whereas aromatase inhibitors, including letrozole, anastrozole, and exemestane, decrease estrogen synthesis in postmenopausal women. In advanced hormone receptor-positive, HER2-negative disease, endocrine therapy is commonly combined with cyclin-dependent kinase 4/6 (CDK4/6) inhibitors, such as palbociclib, ribociclib, and abemaciclib, resulting in prolonged progression-free survival.^[19]

Immunotherapy has recently emerged as an important treatment option for selected patients, particularly those with triple-negative breast cancer (TNBC). Immune checkpoint inhibitors, including pembrolizumab and atezolizumab, enhance antitumor immune responses by inhibiting immune regulatory pathways, thereby enabling the immune system to recognize and eliminate malignant cells more effectively.^[19]

Successful breast cancer management also depends on timely initiation of therapy and adherence to the prescribed treatment regimen. Surgery remains the cornerstone of treatment for localized disease and may involve breast-conserving surgery (lumpectomy) or mastectomy, depending on tumor characteristics and patient preference. Evaluation of regional lymph nodes is an essential component of surgical staging. Sentinel lymph node biopsy has largely replaced routine axillary lymph node dissection in clinically node-negative patients because it provides accurate staging while reducing postoperative complications such as lymphedema and shoulder dysfunction.^[20] Radiotherapy is an integral component of breast cancer treatment and is routinely administered following breast-conserving surgery to reduce the risk of local recurrence. It may also be recommended after mastectomy in patients with high-risk pathological features, including large primary tumors or extensive lymph node involvement. Radiation therapy improves local disease control and contributes to better long-term survival in appropriately selected patients.^[21] Emerging therapeutic strategies are expanding the future landscape of breast cancer management. Gene therapy aims to modify or replace defective genes by delivering genetic material into cancer cells through specialized vectors, thereby altering gene expression to inhibit tumor progression. Another promising approach involves microRNA (miRNA)-based therapy, which regulates gene expression associated with cancer growth and metastasis. Among these agents, MRX34, a synthetic miR-34a replacement therapy, was one of the earliest miRNA therapeutics to enter clinical evaluation. Although gene- and miRNA-based therapies remain largely investigational, ongoing clinical trials suggest that they may become valuable additions to precision medicine strategies for breast cancer in the future.^[22]

Lifestyle Modification

Lifestyle modification is recognized as an important strategy for reducing the risk of breast cancer and improving overall health. Evidence suggests that a substantial proportion of cancer cases can be prevented through the adoption of healthy behavioural practices. According to the World Health Organization (WHO), approximately 30–50% of cancers may

be preventable by minimizing exposure to modifiable risk factors and maintaining a healthy lifestyle. Unlike pharmacological interventions, lifestyle-based preventive measures are generally safe, cost-effective, and provide additional health benefits beyond cancer prevention, including improved cardiovascular health, metabolic function, and overall quality of life. Among the various modifiable lifestyle factors, dietary habits and regular physical activity have consistently been identified as key determinants influencing the development, progression, and prognosis of breast cancer. Maintaining a balanced diet, achieving a healthy body weight, and engaging in routine exercise can reduce breast cancer risk by regulating hormone levels, decreasing chronic inflammation, enhancing immune function, and improving metabolic health. Consequently, nutrition and physical activity remain central components of breast cancer prevention strategies and continue to be major areas of clinical and research interest.^[23]

1. Regular Physical Activity

Regular physical activity is widely recognized as a key lifestyle strategy for reducing the risk of breast cancer recurrence and improving long-term survival among breast cancer survivors. Exercise exerts beneficial effects through multiple biological mechanisms, including lowering circulating estrogen and insulin concentrations, reducing chronic inflammation, strengthening immune function, and enhancing overall physical and psychological well-being. Current clinical recommendations advise adults to engage in 150–300 minutes of moderate-intensity aerobic exercise or 75–150 minutes of vigorous-intensity aerobic activity each week. In addition, resistance or strength-training exercises are recommended 2–3 times per week to improve muscle strength, physical function, and overall health.^[24] Evidence from a meta-analysis of 22 prospective cohort studies demonstrated that women who participated in recreational physical activity after a breast cancer diagnosis experienced a significantly lower risk of breast cancer-related mortality compared with physically inactive women. The survival benefit was most pronounced among individuals who achieved the recommended levels of physical activity, postmenopausal women, and those with a body mass index (BMI) greater than 25 kg/m². Although variations existed among the included studies, the overall findings strongly support regular exercise as an important component of comprehensive breast cancer management and survivorship care.^[25]

2. Weight Management

Achieving and maintaining an appropriate body weight is an important component of breast

cancer prevention and survivorship care. Excess body weight, particularly obesity, has been associated with increased breast cancer risk and poorer clinical outcomes. Obesity may contribute to disease development and progression through several biological mechanisms, including enhanced estrogen production from adipose tissue, persistent low-grade inflammation, insulin resistance, and alterations in metabolic pathways. Therefore, weight management strategies involving a balanced diet, regular physical activity, and long-term lifestyle modifications are recommended, especially for overweight and obese women, to reduce the risk of breast cancer recurrence and improve overall health outcomes.^[26]

3. Healthy Dietary Pattern

Adopting a nutrient-rich dietary pattern that emphasizes the consumption of vegetables, fruits, whole grains, legumes, nuts, and fiber-containing foods may contribute to improved health outcomes in breast cancer patients. In contrast, reducing the intake of highly processed foods, refined carbohydrates, and foods high in saturated fats is recommended to support metabolic health and potentially lower the risk of breast cancer recurrence and mortality. Plant-focused dietary approaches, particularly the Mediterranean diet, have demonstrated potential protective effects due to their high content of antioxidants, phytochemicals, fiber, and anti-inflammatory nutrients. Such dietary patterns may influence breast cancer outcomes by improving body weight regulation, reducing inflammation, and supporting favorable metabolic profiles.^[27]

4. Alcohol Avoidance

Alcohol intake is recognized as a modifiable risk factor associated with an increased likelihood of developing breast cancer. The risk appears to rise proportionally with increasing levels of alcohol consumption. Several mechanisms have been proposed, including alcohol-induced elevation of circulating estrogen levels, generation of oxidative stress, and accumulation of DNA damage, which may contribute to breast carcinogenesis. Therefore, reducing alcohol consumption or complete avoidance is recommended as part of breast cancer prevention strategies and lifestyle management for breast cancer survivors.^[28]

5. Smoking Cessation

Tobacco smoking is considered an important modifiable risk factor that may negatively influence breast cancer development and clinical outcomes. Evidence suggests that smoking is associated with an increased risk of breast cancer, decreased effectiveness of certain treatments, and poorer overall survival among affected individuals. Quitting smoking can

reduce systemic inflammation, improve physiological function, enhance treatment tolerance, and contribute to better long-term health outcomes in breast cancer patients.^[29]

6. Behaviour Change to Increase Physical Activity

Interventions that incorporate established behaviour change frameworks have been shown to enhance adherence to physical activity programs among breast cancer survivors. These structured approaches help individuals develop sustainable exercise habits, improve motivation, and overcome barriers to regular activity. Improved participation in exercise programs through such behavioural strategies may contribute to better physical functioning, quality of life, and long-term health outcomes in breast cancer survivors.^[30]

7. Physical Activity Behaviour Techniques

The use of evidence-based behaviour modification strategies can significantly enhance participation and long-term adherence to exercise programs among breast cancer survivors. Techniques such as establishing personalized goals, tracking individual progress, providing regular feedback, and using motivational interviewing approaches help improve motivation, overcome barriers, and encourage sustained engagement in physical activity. These interventions may contribute to better functional outcomes, improved quality of life, and enhanced overall health among breast cancer survivors.^[31]

8. Exercise During and After Treatment

Engaging in structured physical activity during different phases of breast cancer treatment, including chemotherapy, radiotherapy, and endocrine therapy, has been shown to provide significant benefits without interfering with treatment safety or effectiveness. Exercise interventions can improve cardiorespiratory fitness, muscular strength, treatment-related fatigue, psychological well-being, anxiety symptoms, and overall quality of life in breast cancer patients.^[32] Exercise programs commonly include moderate-intensity aerobic activities, such as cycling on a recumbent bike. Participants are often encouraged to gradually progress toward approximately 30 minutes of moderate-intensity exercise per session. Exercise intensity can be monitored using subjective and objective measures, including the Rating of Perceived Exertion (RPE) scale, with moderate intensity generally corresponding to an RPE of 4–6 on a 10-point scale, along with maintaining approximately 50–70% of the age-predicted maximum heart rate. These approaches help ensure safe and effective exercise participation during cancer treatment.^[32]

Comparison of Pharmacotherapy and Lifestyle:

Parameter	Pharmacotherapy	Lifestyle Modification
1. Primary treatment objective	Pharmacological approaches aim to control breast cancer by eliminating or inhibiting malignant cells through modalities such as chemotherapy, endocrine therapy, targeted biological therapy, immunotherapy, and other systemic treatments.	Lifestyle interventions focus on improving general health status, minimizing the risk of disease recurrence, reducing treatment-associated complications, and supporting long-term survival outcomes. ^[33]
2. Mechanism of action	Anticancer drugs act directly on tumor-related pathways by inhibiting cell division, blocking hormonal stimulation (e.g., tamoxifen and aromatase inhibitors), suppressing HER2-mediated signaling (e.g., trastuzumab), or enhancing immune-mediated tumor destruction.	Lifestyle measures, including regular exercise, weight control, and dietary improvement, influence cancer-related biological pathways by reducing insulin resistance, chronic inflammation, excessive estrogen exposure, and oxidative stress. ^[34]
3. Impact on survival outcomes	Pharmacological therapies significantly improve disease-free survival and overall survival, with effectiveness varying according to tumor characteristics and molecular subtype.	Maintaining an active lifestyle and achieving a healthy body weight have been associated with reduced breast cancer-specific mortality and improved survival outcomes. ^[35]
4. Influence on cancer recurrence	Adjuvant treatments, particularly endocrine therapy and HER2-directed therapies, play an important role in lowering the probability of tumor recurrence.	Physical activity and healthy dietary patterns may decrease recurrence risk by promoting favorable metabolic regulation, maintaining hormonal balance, and reducing inflammatory processes. ^[36]
5. Adverse effects	Systemic anticancer treatments may produce treatment-related toxicities. Chemotherapy-associated effects include nausea, hair loss, peripheral neuropathy, and bone marrow suppression, while endocrine therapies may contribute to joint symptoms and reduced bone mineral density.	Lifestyle interventions generally have minimal adverse effects and can help counteract treatment-related problems by reducing fatigue, improving physical strength, and enhancing functional capacity during and after therapy. ^[37]
6. Role in weight management	Certain anticancer therapies may be associated with metabolic alterations and unintended weight gain, which can negatively affect long-term health outcomes.	Lifestyle strategies involving balanced nutrition and regular physical activity promote weight control, decrease adipose tissue-related estrogen production, reduce inflammation, and improve insulin sensitivity. ^[38]
7. Contribution of dietary factors	Pharmacological treatments target cancer biology but cannot substitute for the beneficial effects of appropriate nutritional practices.	Dietary patterns emphasizing vegetables, fruits, whole grains, legumes, and minimally processed foods, such as the

		Mediterranean diet, support metabolic health and may improve treatment tolerance and overall outcomes. ^[39]
8. Effect on quality of life	Although pharmacotherapy provides significant therapeutic benefits, adverse effects associated with treatment may temporarily affect physical, emotional, and social well-being.	Lifestyle-based interventions have demonstrated positive effects on fatigue reduction, psychological health, sleep quality, emotional well-being, and overall quality of life among breast cancer patients and survivors. ^[40]

CONCLUSION

Breast cancer remains one of the leading causes of cancer-related morbidity and mortality among women worldwide. Advances in early detection, molecular classification, and targeted therapeutic approaches have significantly improved patient survival and quality of life. Pharmacotherapy continues to play a central role in breast cancer management, encompassing endocrine therapy, chemotherapy, targeted therapy, immunotherapy, and supportive care. The selection of treatment is increasingly based on tumor biology, disease stage, molecular biomarkers, and patient-specific factors, allowing for a more personalized therapeutic approach.

In addition to pharmacological treatment, lifestyle modification has emerged as an essential component of comprehensive breast cancer care. Regular physical activity, maintenance of a healthy body weight, adherence to a balanced diet rich in fruits, vegetables, and whole grains, avoidance of tobacco, limitation of alcohol consumption, adequate sleep, stress management, and psychosocial support have been associated with improved treatment tolerance, reduced recurrence risk, enhanced quality of life, and better long-term survival. The integration of evidence-based lifestyle interventions with standard pharmacotherapy offers a holistic strategy that addresses both disease control and overall patient well-being. Despite substantial progress, challenges such as drug resistance, treatment-related toxicities, disparities in healthcare access, and variability in patient adherence continue to affect treatment outcomes. Ongoing research in precision medicine, biomarker-guided therapy, novel targeted agents, immunotherapeutic strategies, and digital health interventions is expected to further optimize breast cancer management.

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