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Physical Activity as a Quality of Life Determinant in Breast Cancer Prevention and Survivorship: A Review

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ABSTRACT

Background. Breast cancer is the leading invasive neoplasm and a major cause of female cancer mortality. Research confirms that physical activity significantly reduces cancer risk, alleviates treatment side effects, and improves patients' quality of life.

Aim. To synthesize information regarding the protective effect of physical activity against breast cancer development and its role in alleviating treatment-related side effects and improving quality of life.

Materials and methods. The studies used in this work were identified through a keyword-based literature review of the PubMed and Google Scholar databases.

Results. Physical activity (PA) exerts strong protective and therapeutic effects at all stages of breast cancer, reducing both disease risk and mortality. Progressive resistance training safely improves muscle strength and range of motion without exacerbating lymphedema. Additionally, aerobic exercise maintains cardiorespiratory fitness during chemotherapy. Overall, PA significantly enhances quality of life and effectively reduces symptoms of depression.

Conclusions. Physical activity is a safe, effective intervention that improves clinical outcomes and patient well-being. Despite its benefits, participation remains low; thus, supervised exercise programs should be integrated into standard oncological care with active physician involvement. Future research must focus on optimizing exercise protocols in relation to specific tumor biomarkers.

KEYWORDS breast cancer; physical activity; quality of life; lymphedema; oncological rehabilitation; physical exercise

1. Introduction

Breast cancer is currently the most frequently diagnosed cancer among women worldwide. Global epidemiological data on cancer burden estimated 2.26 million cases of breast cancer in 2020, making it the primary cause of cancer-related mortality in women [1].

Lifestyle behaviors are well-established risk factors for both the development of breast cancer and the adverse outcomes following its onset. Recent findings indicate that engaging in even minimal physical activity provides a protective effect against the disease [2]. Furthermore, numerous studies have identified the critical role of exercise in the treatment of breast cancer, highlighting its ability to alleviate treatment side effects, enhance quality of life, and improve overall survival [2, 3, 9].

During breast cancer treatment, physical health often deteriorates due to the disease itself and treatment-related physiological changes. Despite the established efficacy of standard therapies, such as chemotherapy and radiotherapy, these interventions can adversely affect cardiovascular and metabolic outcomes, as well as the patients' overall quality of life (QoL) [7, 19]. Moreover, patients frequently experience depression alongside emotional and behavioral reactions. Most cancer patients begin to experience depressive symptoms upon receiving their initial diagnosis or in response to disease progression. The fear of mortality increases levels of anxiety and depression by detaching the patient from their normal life [11]. Treatment-related reductions in aerobic capacity, fatigue, and loss of muscle strength further contribute to depression and a decline in quality of life. Maintaining a healthy lifestyle, which includes regular physical activity, is essential to minimizing the psychological and physical side effects of treatment [4].

Unfortunately, few patients remain physically active due to various barriers. Physicians can play a pivotal role in encouraging patients to engage in increased activity. Further research is necessary to identify programs and approaches that assist both breast cancer patients and those at high risk in maintaining a regular exercise regimen [3].

2. Physical Activity and Its Role in Prevention

2.1. Epidemiological Evidence

Epidemiological data indicate a significant protective potential of physical activity (PA) regarding the development of breast cancer. Regular engagement in moderate-intensity exercise correlates with an approximately 13% reduction in postmenopausal breast cancer risk. In the case of vigorous activity, the risk reduction is 9% for premenopausal women and 17% for the postmenopausal group, respectively. A general comparative analysis reveals that women leading an active lifestyle have a 25% lower probability of developing the neoplasm

compared to those with the lowest activity levels [6, 7, 29]. The most profound effects are observed with regular recreational activity of moderate-to-high intensity, particularly when maintained throughout the lifespan or initiated during the postmenopausal period [7, 24].

Although scientific evidence emphasizes the particular value of long-term activity, introducing exercise later in life also yields measurable benefits—it has been demonstrated, among other things, that postmenopausal PA reduces cancer risk regardless of previous exercise habits. Importantly, the protective influence of exercise is observed across all ethnic and racial groups, establishing this preventive method as a universal intervention [1, 9].

2.2. Biological Mechanisms

The biological mechanisms underlying this phenomenon are complex and involve a cascade of interrelated processes. Physical activity contributes to the reduction of breast cancer risk by optimizing body composition, limiting systemic inflammation, and improving metabolic parameters. Key importance is attributed to the reduction of estrogen bioavailability, enhancement of insulin sensitivity, and regulation of adipokine levels [2, 5, 7]. While a full understanding of these molecular pathways requires further analysis, it is already established that increasing population-level physical activity should become a priority preventive strategy. This approach is justified for every woman, regardless of current body mass index (BMI) or other lifestyle factors, especially given that the majority of adults do not meet current physical activity guidelines [3, 8].

2.3. Influence on Survival After Recurrence

The influence of post-diagnosis exercise habits on recurrence rates and patient mortality was also a subject of analysis. Research findings indicate a significant correlation between high levels of physical activity and prognosis: among women exhibiting the highest commitment to exercise after their cancer diagnosis, a 29% reduction in the risk of breast

cancer-specific mortality was recorded. Furthermore, in the same group, the risk of all-cause mortality was as much as 43% lower compared to patients leading a sedentary lifestyle [9].

3. Quality of Life and Functional Deficits Following Breast Cancer Therapy

The decline in breast cancer mortality has resulted in a growing population of women living for many years after completing primary therapy. However, this group faces a range of short- and long-term adverse effects, the management of which remains a clinical priority and a public health challenge [1, 12]. The most common complications include lymphedema, cardiotoxicity, chronic fatigue, osteoporosis, and obesity. These complications, frequently occurring alongside restricted upper limb mobility and loss of muscle mass, significantly diminish health-related quality of life (HRQoL) and the overall life satisfaction of patients [4, 9, 22, 26].

4. Mental Health

A breast cancer diagnosis represents a critical moment in a woman's life, often carrying far-reaching consequences for her mental health, the course of therapy, and ultimate prognosis. The disease necessitates a radical change in daily functioning, resulting from profound uncertainty regarding treatment processes as well as painful shifts in body image perception. Consequently, patients confront numerous barriers across key spheres of life, particularly within the domains of interpersonal and social relationships [11, 13].

Compared to the healthy population, patients who have completed oncological treatment exhibit a significantly higher incidence of anxiety disorders, depression, and post-traumatic stress disorder (PTSD) [11-13]. Furthermore, sexual dysfunctions remain a significant clinical issue in this group, adversely affecting the overall psychophysical well-being of these women [14].

4.1. The Relationship Between Symptoms of Anxiety and Depression and Physical Exercise

In the clinical presentation of patients immediately following a diagnosis, symptoms of apprehension predominate and frequently evolve into intensified anxiety states. Although severe depressive episodes are diagnosed less frequently in the initial phase of the disease, this issue affects nearly 20% of the breast cancer population, making depression a significant and prevalent challenge in oncological care [11, 13].

The implementation of systematic physical exertion translates into measurable psychosomatic benefits. Improved physical fitness promotes the reduction of stress and anxiety, while alleviating depressive symptoms, which significantly enhances the psychological well-being of patients. Furthermore, physical activity allows for shorter hospital stays and positively modifies the symptom profile by reducing fatigue, sleep disturbances, and loss of appetite, among others [3, 4, 22].

Significant improvements across all domains of the WHOQOL-BREF quality of life questionnaire—including physical health, psychological health, social relationships, and environmental functioning—have been observed in patients participating in structured training programs. The combination of aerobic and resistance training has proven particularly effective in increasing quality of life indices and reducing depression among women who have completed oncological treatment [4, 30].

4.2. Perception of Body Image and Sexual Health

Mastectomy or breast deformity directly impacts female identity, sexuality, and self-esteem. It is estimated that approximately one-third of patients who have completed oncological treatment experience significant psychological distress resulting from a distorted

body image, with this issue being particularly acute among younger women [11, 13]. Statistical data indicate that sexual dysfunctions affect as many as 73.4% of patients, classifying this population as a high-risk group in the area of intimate health [14].

The etiology of sexual dysfunction in women with a history of breast cancer is multifactorial. Common iatrogenic consequences of therapy include vaginal dryness and dyspareunia, resulting from hormonally induced ovarian failure (following chemotherapy) or the use of adjuvant hormone therapy. However, it is noteworthy that a decline in the quality of sexual life is also reported by patients who underwent only surgical treatment, suggesting a significant role for psychogenic factors [12, 14].

The intrapsychic experiences of these women encompass a range of negative phenomena, such as fear of infertility, subjective feelings of unattractiveness, loss of perceived feminine attributes, and a profound deconstruction of the sexual "self." These effects can persist for many years after remission, impacting both the somatic and emotional spheres of the patients [11, 13].

Analyses show that among sexually active patients, factors such as depression and low physical activity correlate negatively with intimate satisfaction. Conversely, women engaging in regular physical exertion achieve significantly better results in sexual function tests compared to patients leading a sedentary lifestyle [4, 14].

5. The Role of Physical Activity in Managing Treatment Side Effects and Improving Clinical Outcomes

5.1. Breast Cancer-Related Lymphedema

Lymphedema is defined as the pathological accumulation of protein-rich fluid in the interstitial space resulting from lymphatic system dysfunction. In the context of oncological patients (BCRL – Breast Cancer-Related Lymphedema), it most commonly manifests as

regional swelling of the upper limb on the ipsilateral (operated) side. This condition is accompanied by pain, a sensation of heaviness and pressure, as well as a significant restriction in joint mobility. Consequently, these changes impair both gross and fine motor skills, directly impacting performance in activities of daily living (ADL) and reducing quality of life. Currently, BCRL is classified as an incurable chronic disease, where the therapeutic process focuses on reducing lymphatic congestion and maintaining the functionality of the affected limb [15, 27].

The integration of physical activity into the standards of care for patients with BCRL represents a relatively new approach. For years, breast cancer survivors were advised to avoid strenuous or repetitive exertion involving the upper body due to fears of inducing or exacerbating the edema. However, research from the last decade has revised these views, providing evidence for the safety of progressive resistance training (PRT) [16, 18]. Current scientific consensus indicates that resistance exercise (RE) yields measurable benefits, allowing for the recovery of physical limb function, improvement in body composition, and reduction in the risk of metabolic disorders.

According to recent findings, although PRT does not demonstrate a direct prophylactic effect in preventing the onset of edema, it is crucial for maintaining muscle mass and optimizing motor functions. For this reason, strength training is increasingly integrated into rehabilitation programs for women following mastectomy. Despite the availability of numerous resistance training (RT) protocols, the literature still lacks unified guidelines regarding the optimal frequency, intensity, and duration of such interventions [17, 28].

Resistance training should be regarded as an essential component of supportive therapy, complementing standard rehabilitation. To formulate precise clinical recommendations, further research is necessary to rigorously describe muscle strength

parameters, evaluation methods, and principles for individualizing training loads for this patient population [10, 18].

5.2. Cancer Treatment-Induced Cardiotoxicity

Breast cancer patients, particularly those with the HER2-positive subtype, face a high risk of developing cardiotoxicity. This is a common side effect of standard therapeutic regimens based on anthracyclines and trastuzumab [19, 20]. Cardiovascular complications in this group may necessitate the interruption of oncological therapy and, in extreme cases, lead to the development of chronic cardiovascular diseases. Given the proven cardioprotective effects of exercise in the general population, physical activity (PA) performed during oncological treatment emerges as a significant strategy for mitigating the negative impact of therapy on the myocardium. It is suggested that aerobic training, in particular, may serve a protective role against damage induced by cytostatic and targeted drugs [19, 20].

Despite promising theoretical premises, clinical data indicate that exercise training does not statistically significantly prevent the decline in left ventricular systolic function parameters, such as left ventricular ejection fraction (LVEF) or global longitudinal strain (GLS), compared to standard medical care. Furthermore, no significant impact of exercise was observed on conventional echocardiographic indicators of cardiac structure or on the concentration of myocardial injury biomarkers (NT-proBNP, hs-TnT) [21]. Nevertheless, physical interventions proved effective in significantly improving the cardiorespiratory fitness of patients. Importantly, exercise training has been recognized as a safe supportive method, associated with no serious adverse events during exercise sessions [20, 21].

Supervised physical activity programs appear to be the optimal model for engaging patients during therapy. Currently, however, the literature provides a limited amount of data, resulting in a lack of unified clinical guidelines in this area. Designing effective training

programs requires an individualized approach that considers both physical barriers and patient motivation, which is essential for maintaining continuity of activity throughout the entire treatment process [19, 21].

5.3. Fatigue

Cancer-Related Fatigue (CRF) is one of the most common complaints reported by patients, showing an increasing trend during adjuvant therapy. Statistics indicate that 41% of women with breast cancer experience moderate-to-severe fatigue during the active phase of treatment, and in nearly 30% of patients, this symptom persists for many years after the completion of therapy. In the opinion of patients, CRF is often perceived as the most burdensome symptom, which crucially reduces quality of life and represents a significant barrier to returning to professional activity [12, 22, 23].

The implementation of systematic physical exertion during adjuvant therapy exerts a protective influence on the general and physical aspects of fatigue, while also counteracting declines in motivation and overall life activity. However, analyses show that exercise interventions do not correlate significantly with fatigue in the cognitive and affective dimensions. The most pronounced improvement is observed in the somatic sphere, suggesting that the physical component of fatigue is the most susceptible to the therapeutic effects of exercise [22, 23].

According to current guidelines, performing physical activity at a level of 150 minutes per week at moderate-to-high intensity is a sufficient dose for a significant reduction in CRF. This level of activity allows for the effective recovery of physical fitness and restores an optimal level of daily functioning for patients [3, 9, 29].

5.4. Overweight and Obesity

The relationship between body mass and breast cancer risk varies depending on menopausal status. While obesity correlates with a decreased incidence in premenopausal women, excess adipose tissue in the postmenopausal period is associated with a 1.5- to 2-fold increase in the risk of developing the disease. It is estimated that every 5 kg weight gain above the lowest weight recorded in adulthood increases the risk of postmenopausal breast cancer by 4–8% [7, 9]. This correlation is particularly pronounced in women who do not use hormone replacement therapy (HRT). Furthermore, excessive body mass is a significant prognostic factor, increasing the probability of recurrence and mortality regardless of the patient's age. Simultaneously, observational data indicate that physical inactivity constitutes an independent risk factor for morbidity and mortality, exerting a negative impact regardless of the degree of obesity [9].

Physical activity (PA) plays a fundamental role in both body mass control and the direct reduction of cancer risk. Adhering to the World Health Organization (WHO) recommendations for recreational PA (at a level of ≥ 10 MET-hours/week) results in a significant reduction in breast cancer incidence [6, 24]. Importantly, the protective effect of exercise manifests regardless of smoking status, and among carriers of BRCA gene mutations, regular exertion is associated with a significant delay in the age of cancer manifestation [2, 8].

The biological mechanisms explaining these relationships include, among others, the reduction of estrogen bioavailability, the dampening of systemic inflammation, the mitigation of metabolic dysfunctions, and the optimization of body composition through the reduction of adipose tissue. In light of these data, it is crucial to develop and implement effective strategies

promoting weight control and physical activity, which is an essential prerequisite for optimizing treatment outcomes in this patient population [5, 7].

5.5. Decreased Muscle Strength and Reduced Range of Motion

Surgery can lead to unique physical impairments in breast cancer patients, such as fatigue, pain, restricted range of motion, frozen shoulder, muscle weakness, and poor body image. In women undergoing breast cancer treatment with certain chemotherapeutic agents, a decrease in lean body mass and muscle strength may occur, consequently leading to weight gain. These changes may not only result in deteriorated physical fitness but also predispose women to weight-related chronic diseases [13, 25, 26].

Resistance training and shoulder muscle stretching performed 4–6 weeks post-surgery reduce upper limb impairment in women treated for early-stage breast cancer. Such interventions improve the range of motion for flexion and abduction and contribute to increased shoulder abductor strength [25, 27].

Elderly breast cancer survivors (BCS) can safely engage in resistance exercises that improve both lower and upper body strength, thereby reducing risk factors for falls and future disability [25].

6. Quality of Life

Among the cancer patient population, quality of life is a strong predictor of mortality and morbidity. Therefore, incorporating the assessment of health-related quality of life (HRQoL) into clinical cancer research is of paramount importance and can provide better insight into significant outcomes that extend beyond tumor response and survival. A primary goal for cancer patients is to enhance their quality of life by maximizing functions affected by the disease and its therapy. Preliminary research suggests that exercise can be an effective intervention to improve quality of life in cancer survivors. Benefits include improvements in

specific symptoms such as fatigue and secondary lymphedema, as well as enhancements in physical function, emotional functioning, mental health, and global HRQoL [29, 30].

Various types of physical activity interventions have been tested in different studies, including aerobic exercise, resistance exercise, combined aerobic and resistance exercise, walking, yoga, stretching, Tai Chi, and Qigong [18, 29]. Additional research is essential to clarify whether total physical activity or specific types and combinations of activity are particularly beneficial for improving HRQoL in breast cancer patients, which is necessary for developing superior physical activity recommendations for this patient group [3, 18].

Regarding specific types of physical activity, combined aerobic and resistance interventions appeared to result in a greater improvement in quality of life compared to other types of activity [10, 29].

7. Discussion

Breast cancer remains a major global health challenge, generating numerous unmet medical needs. Achieving a sustained and equitable improvement in treatment outcomes for this potentially curable disease requires elevating standards of care and prioritizing the physical fitness and quality of life of the growing population of patients living many years after completing therapy [1, 3, 29].

Research indicates that systematic physical activity contributes to improvements in overall fitness, aerobic capacity, muscle strength, and body flexibility [29], while also supporting immune system function [7] in cancer patients. Furthermore, increased physical capacity translates into enhanced psychological well-being by reducing levels of stress, depression, and anxiety [4]. Exercise may also shorten hospital stays by improving bone mineral density and alleviating symptoms such as nausea, pain, sleep disturbances, and diarrhea [29].

In the future, it is advisable to conduct prospective epidemiological studies to link proposed biomarkers with the risk of developing breast cancer, as well as randomized controlled trials analyzing the impact of physical activity on these indicators. Interventional studies utilizing physical exercise will help to more accurately define the optimal type, intensity, and duration of activity conducive to reducing the risk of breast cancer incidence [5, 18].

8. Conclusions

Breast cancer is the most frequently diagnosed malignancy among women in approximately 140 countries worldwide. It is estimated that the lifetime risk of developing the disease affects roughly one in eight women. Achieving a sustained and equitable improvement in treatment outcomes for this often-curable disease requires not only elevating standards of care but also prioritizing the physical fitness and quality of life of the growing population of patients living many years after completing therapy.

Research indicates that even modest levels of physical activity can exert a protective effect against the development of breast cancer. Nevertheless, many patients remain inactive due to various barriers. Physicians can play a pivotal role in motivating patients to engage in movement. However, further research is essential to develop effective programs that support both diagnosed individuals and those in high-risk groups in undertaking regular exercise. Among women leading an active lifestyle, the risk of developing the disease is, on average, approximately 25% lower compared to less active women. Thus, regular physical activity represents a simple, accessible, and relatively low-cost preventive method in both developed and developing countries. It is also noteworthy that for individuals already diagnosed with breast cancer, exercise can reduce the risk of recurrence.

Furthermore, it has been demonstrated that both aerobic training and resistance exercise contribute to improving quality of life and reducing symptoms of depression among women following breast cancer treatment.

Disclosure

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REFERENCES

1. Wilkinson L, Gathani T. Understanding breast cancer as a global health concern. *Br J Radiol.* 2022;95(1130):20211033. doi:10.1259/bjr.20211033
2. 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;13(11):1387-1397. doi:10.7150/ijbs.21635
3. Kraschnewski JL, Schmitz KH. Exercise in the Prevention and Treatment of Breast Cancer: What Clinicians Need to Tell Their Patients. *Curr Sports Med Rep.* 2017;16(4):263-267. doi:10.1249/JSR.0000000000000388
4. Aydin M, Kose E, Odabas I, Meric Bingul B, Demirci D, Aydin Z. The Effect of Exercise on Life Quality and Depression Levels of Breast Cancer Patients. *Asian Pac J Cancer Prev.* 2021;22(3):725-732. doi:10.31557/APJCP.2021.22.3.725
5. Lynch BM, Milne RL, English DR, Brown KA, Drummond AE, Swain CTV, van Roekel EH, Moore MM, Gaunt TR, Martin RM, Lewis SJ. Linking Physical Activity to Breast Cancer: Text Mining Results and a Protocol for Systematically Reviewing Three Potential Mechanistic Pathways. *Cancer Epidemiol Biomarkers Prev.* 2022;31(1):11-15. doi:10.1158/1055-9965.EPI-21-0435
6. Friedenreich CM. Physical activity and breast cancer: review of the epidemiologic evidence and biologic mechanisms. *Recent Results Cancer Res.* 2011;188:125-39. doi:10.1007/978-3-642-10858-7_11
7. Friedenreich CM, Ryder-Burbidge C, McNeil J. Physical activity, obesity and sedentary behavior in cancer etiology: epidemiologic evidence and biologic mechanisms. *Mol Oncol.* 2021;15(3):790-800. doi:10.1002/1878-0261.12772

- 8.Khalifa A, Guijarro A, Nencioni A. Advances in Diet and Physical Activity in Breast Cancer Prevention and Treatment. *Nutrients*. 2024;16(14):2262. doi:10.3390/nu16142262
- 9.Ligibel JA, Basen-Engquist K, Bea JW. Weight Management and Physical Activity for Breast Cancer Prevention and Control. *Am Soc Clin Oncol Educ Book*. 2019;39:e22-e33. doi:10.1200/EDBK_237423
- 10.Soriano-Maldonado A, Díez-Fernández DM, Esteban-Simón A, Rodríguez-Pérez MA, Artés-Rodríguez E, Casimiro-Artés MA, Moreno-Martos H, Toro-de-Federico A, Hachem-Salas N, Bartholdy C, Henriksen M, Casimiro-Andújar AJ. Effects of a 12-week supervised resistance training program, combined with home-based physical activity, on physical fitness and quality of life in female breast cancer survivors: the EFICAN randomized controlled trial. *J Cancer Surviv*. 2023;17(5):1371-1385. doi:10.1007/s11764-022-01192-1
- 11.Fortin J, Leblanc M, Elgbeili G, Cordova MJ, Marin MF, Brunet A. The mental health impacts of receiving a breast cancer diagnosis: A meta-analysis. *Br J Cancer*. 2021;125(11):1582-1592. doi:10.1038/s41416-021-01542-3
- 12.Carreira H, Williams R, Müller M, Harewood R, Stanway S, Bhaskaran K. Associations Between Breast Cancer Survivorship and Adverse Mental Health Outcomes: A Systematic Review. *J Natl Cancer Inst*. 2018;110(12):1311-1327. doi:10.1093/jnci/djy177
- 13.Dinapoli L, Colloca G, Di Capua B, Valentini V. Psychological Aspects to Consider in Breast Cancer Diagnosis and Treatment. *Curr Oncol Rep*. 2021;23(3):38. doi:10.1007/s11912-021-01049-3
- 14.Smedsland SK, Vandraas KF, Bøhn SK, Dahl AA, Kiserud CE, Brekke M, Falk RS, Reinertsen KV. Sexual activity and functioning in long-term breast cancer survivors;

- exploring associated factors in a nationwide survey. *Breast Cancer Res Treat.* 2022;193(1):139-149. doi:10.1007/s10549-022-06544-0
15. Donahue PMC, MacKenzie A, Filipovic A, Koelmeyer L. Advances in the prevention and treatment of breast cancer-related lymphedema. *Breast Cancer Res Treat.* 2023;200(1):1-14. doi:10.1007/s10549-023-06947-7
 16. Hasenoehrl T, Palma S, Ramazanov D, Kölbl H, Dorner TE, Keilani M, Crevenna R. Resistance exercise and breast cancer-related lymphedema-a systematic review update and meta-analysis. *Support Care Cancer.* 2020;28(8):3593-3603. doi:10.1007/s00520-020-05521-x
 17. Ammitzbøll G, Johansen C, Lanng C, Andersen EW, Kroman N, Zerahn B, Hyldegaard O, Wittenkamp MC, Dalton SO. Progressive resistance training to prevent arm lymphedema in the first year after breast cancer surgery: Results of a randomized controlled trial. *Cancer.* 2019;125(10):1683-1692. doi:10.1002/cncr.31962
 18. Montaña-Rojas LS, Romero-Pérez EM, Medina-Pérez C, Reguera-García MM, de Paz JA. Resistance Training in Breast Cancer Survivors: A Systematic Review of Exercise Programs. *Int J Environ Res Public Health.* 2020;17(18):6511. doi:10.3390/ijerph17186511
 19. Ginzac A, Passildas J, Gadéa E, Abrial C, Molnar I, Trésorier R, Duclos M, Thivat E, Durando X. Treatment-Induced Cardiotoxicity in Breast Cancer: A Review of the Interest of Practicing a Physical Activity. *Oncology.* 2019;96(5):223-234. doi:10.1159/000499383
 20. Tranchita E, Murri A, Grazioli E, Cerulli C, Emerenziani GP, Ceci R, Caporossi D, Dimauro I, Parisi A. The Beneficial Role of Physical Exercise on Anthracyclines Induced Cardiotoxicity in Breast Cancer Patients. *Cancers (Basel).* 2022;14(9):2288. doi:10.3390/cancers14092288

21. Antunes P, Joaquim A, Sampaio F, Nunes C, Ascensão A, Vilela E, Teixeira M, Capela A, Amarelo A, Marques C, Viamonte S, Alves A, Esteves D. Effects of exercise training on cardiac toxicity markers in women with breast cancer undergoing chemotherapy with anthracyclines: a randomized controlled trial. *Eur J Prev Cardiol.* 2023;30(9):844-855. doi:10.1093/eurjpc/zwad063
22. van Vulpen JK, Peeters PH, Velthuis MJ, van der Wall E, May AM. Effects of physical exercise during adjuvant breast cancer treatment on physical and psychosocial dimensions of cancer-related fatigue: A meta-analysis. *Maturitas.* 2016;85:104-11. doi:10.1016/j.maturitas.2015.12.007
23. Husebø AM, Dyrstad SM, Mjaaland I, Søreide JA, Bru E. Effects of scheduled exercise on cancer-related fatigue in women with early breast cancer. *ScientificWorldJournal.* 2014;2014:271828. doi:10.1155/2014/271828
24. Maliniak ML, Patel AV, McCullough ML, Campbell PT, Leach CR, Gapstur SM, Gaudet MM. Obesity, physical activity, and breast cancer survival among older breast cancer survivors in the Cancer Prevention Study-II Nutrition Cohort. *Breast Cancer Res Treat.* 2018;167(1):133-145. doi:10.1007/s10549-017-4470-7
25. Wilson DJ. Exercise for the Patient after Breast Cancer Surgery. *Semin Oncol Nurs.* 2017;33(1):98-105. doi:10.1016/j.soncn.2016.11.010
26. Visovsky C. Muscle strength, body composition, and physical activity in women receiving chemotherapy for breast cancer. *Integr Cancer Ther.* 2006;5(3):183-91. doi:10.1177/1534735406291962
27. Kilbreath SL, Refshauge KM, Beith JM, Ward LC, Lee M, Simpson JM, Hansen R. Upper limb progressive resistance training and stretching exercises following surgery for early breast cancer: a randomized controlled trial. *Breast Cancer Res Treat.* 2012;133(2):667-76. doi:10.1007/s10549-012-1964-1

28. Winters-Stone KM, Dobek J, Bennett JA, Nail LM, Leo MC, Schwartz A. The effect of resistance training on muscle strength and physical function in older, postmenopausal breast cancer survivors: a randomized controlled trial. *J Cancer Surviv.* 2012;6(2):189-99. doi:10.1007/s11764-011-0210-x
29. Aune D, Markozannes G, Abar L, Balducci K, Cariolou M, Nanu N, Vieira R, Anifowoshe YO, Greenwood DC, Clinton SK, Giovannucci EL, Gunter MJ, Jackson A, Kampman E, Lund V, McTiernan A, Riboli E, Allen K, Brockton NT, Croker H, Katsikioti D, McGinley-Gieser D, Mitrou P, Wiseman M, Velikova G, Demark-Wahnefried W, Norat T, Tsilidis KK, Chan DSM. Physical Activity and Health-Related Quality of Life in Women With Breast Cancer: A Meta-Analysis. *JNCI Cancer Spectr.* 2022;6(6):pkac072. doi:10.1093/jncics/pkac072
30. Shin WK, Song S, Jung SY, Lee E, Kim Z, Moon HG, Noh DY, Lee JE. The association between physical activity and health-related quality of life among breast cancer survivors. *Health Qual Life Outcomes.* 2017;15(1):132. doi:10.1186/s12955-017-0706-9