Impact of aerobic and heavy resistance exercise on fitness and emotions breast cancer survivors experience cancer-related tiredness

El impacto del ejercicio aeróbico y de resistencia pesada en la aptitud física y las emociones las sobrevivientes de cáncer de mama experimentan cansancio relacionado con el cáncer

Authors

Nur Azis Rohmansyah [1]
Faza Annasai [1]
Abiyyu Amajida [1]
Sunaryo Sunaryo [1]
Sumarjo Sumarjo [1]
Arisa Sespheng [2]
Sirisuda Phonthee [3]
Ashira Hiruntrakul [3]

[1] Universitas Negeri Yogyakarta (Indonesia)
[2] Walailak University (Thailand)
[3] Khon Kaen University (Thailand)

Corresponding author:
Ashira Hiruntrakul
hashir@kku.ac.th

How to cite in APA

Rohmansyah, N. A., Annasai, F., Amajida, A., Sunaryo, S., Sumarjo, S., Sespheng, A., Phonthee, S., & Hiruntrakul, A. (2025). Impact of aerobic and heavy resistance exercise on fitness and emotions breast cancer survivors experience cancer-related tiredness. *Retos*, *67*, 1–11. https://doi.org/10.47197/retos.v67.111291

Abstract

Objective: This study examined how two simultaneous supervised exercise programs affected breast cancer survivors with initial tiredness.
Methodology: Thirty two female breast cancer survivors, aged 49 ± 4 years, were randomly assigned to aerobic (n = 16) or heavy resistance exercise (n = 16) exercise programs. Both programs included eighteen weeks of resistance training, but the aerobic component in the former was more vigorous and supervised, with a perceived exertion rating of 7–8, compared to 6 for the heavy resistance exerices interventions. Most of the study addressed felt weariness. Baseline and eighteen weeks endpoints were measured. The Bonferroni correction for multiple comparisons placed the statistical significance level at 0.004.
Results: The aerobic and heavy resistance exercise program reduced waist circumference (p = 0.035) and other anthropometric parameters (p = 0.029). Elevated p values in pre- and post-intervention comparisons show that aerobic exercise did not provide these advantages. No significant differences were seen between therapies, since all p values surpassed 0.004.
Conclusions: In breast cancer survivors, further research is needed to determine if concurrent heavy resistance exercise is better than aerobic.

Keywords

Body composition; cancer; intensity training; physical activity; physical fitness.

Resumen

Objetivo: Este estudio examinó cómo dos programas de ejercicios supervisados simultáneos afectaron a las sobrevivientes de cáncer de mama con cansancio inicial.
Metodología: Treinta y dos sobrevivientes de cáncer de mama, de 49 ± 4 años de edad, fueron asignadas aleatoriamente a programas de ejercicios aeróbicos (n = 16) o de ejercicios de resistencia intensos (n = 16). Ambos programas incluyeron dieciocho semanas de entrenamiento de resistencia, pero el componente aeróbico en el primero fue más vigoroso y supervisado, con una calificación de esfuerzo percibido de 7-8, en comparación con 6 para las intervenciones de ejercicios de resistencia intensos. La mayor parte del estudio abordó el cansancio percibido. Se midieron los puntos iniciales y finales a las dieciocho semanas. La corrección de Bonferroni para comparaciones múltiples colocó el nivel de significación estadística en 0,004.
Discusión: El programa de ejercicios aeróbicos y de resistencia pesada redujo la circunferencia de la cintura (p = 0,035) y otros parámetros antropométricos (p = 0,029). Los valores de p elevados en las comparaciones previas y posteriores a la intervención muestran que el ejercicio aeróbico no proporcionó estas ventajas. No se observaron diferencias significativas entre las terapias, ya que todos los valores de p superaron 0,004.
Conclusiones: En las sobrevivientes de cáncer de mama, se necesitan más investigaciones para determinar si el ejercicio de resistencia intenso concurrente es mejor que el aeróbico.

Palabras clave

Composición corporal; cáncer; entrenamiento de intensidad; actividad física; aptitud física.

Introduction

Breast cancer represents a major factor in the rates of illness and death among women in developed countries, with its worldwide occurrence on the rise (Sung et al., 2021). Breast cancer survival is rising, therefore knowing its physical and mental impacts during and after therapy is vital. Research shows that women diagnosed with breast cancer often face the impacts and side effects of chemotherapy, especially fatigue (Montel et al., 2022; Schmidt et al., 2012; Winters-Stone et al., 2008). Cancer-related fatigue is a common symptom seen in individuals with cancer, reflecting either the disease itself or the effects of treatment. The occurrence of fatigue in cancer patients varies, with estimates ranging from 60% to 90% (Kilgour et al., 2010). Many cancer patients report that the onset of exhaustion causes them more distress than the pain linked to their illness (Schmidt et al., 2012). Weariness is characterized by a profound sensation that persists despite attempts to find relief through rest. Cancer treatments, especially chemotherapy, can diminish a patient's energy levels and lead to anemia, ultimately causing fatigue. A variety of therapeutic approaches have been implemented to address and manage Cancer-Related Fatigue; nonetheless, an effective treatment has yet to be discovered. Exercise is acknowledged as a potent strategy to prevent, reduce, or ease fatigue (Cleeland et al., 2003; Neil et al., 2013; Saligan et al., 2015).

Numerous studies indicate that the occurrence of fatigue as a side effect of chemotherapy varies between 65% and 100% (Schmidt et al., 2016; Thornton et al., 2010). Cancer-related fatigue is frequently experienced intensely by many cancer patients, leading to restrictions in their capacity to carry out everyday activities (Ruiz-Casado et al., 2014; SHA et al., 2015). Fatigue is recognized as a common negative consequence of cancer. The impact of cancer-related fatigue on quality of life is profound, severely hindering the ability to engage in daily activities and resulting in a notable decline in functional capacity for individuals receiving cancer treatment (Caan et al., 2018; Klassen et al., 2017; Peel et al., 2009).

Aerobic training stands out as the most effective and thoroughly examined method of exercise for reducing fatigue (Caan et al., 2018; Christensen et al., 2014; Klassen et al., 2017). Nevertheless, the effects of aerobic on cancer-related fatigue continue to be a subject of debate. There are few strategies available to address cancer related fatigue, with exercise proving to be the most effective. Aerobic has been suggested as a valuable rehabilitation approach for patients (Padilha et al., 2017; Refiani et al., 2021; Shachar et al., 2016). The aerobic strategy, has not shown effectiveness in reducing cancer related fatigue. The management of physical disorders linked to fatigue is effectively addressed through aerobic exercise advised approach for cancer patients facing fatigue, owing to its effectiveness, ease of implementation, and safety (Sweegers et al., 2019).

Engaging in heavy resistance training has the potential to enhance the immune system's ability to suppress cancer cells. Engagement in heavy resistance training can result in reductions in body weight and fat, subsequently potentially leading to decreased estrogen levels. Engaging in heavy resistance training speeds up the movement of food through the digestive system, thereby minimizing the time that harmful carcinogenic substances can affect the intestinal and colonic tissues (Toohey et al., 2018). Heavy resistance training was tested on chemotherapy-treated breast cancer patients (Chan et al., 2024; Moher et al., 2001). The exercise group demonstrated significant physical function gains and tiredness reduction. Prior studies have shown that heavy resistance training markedly improves quality of life (Borg, 1954; Harriss et al., 2019).

Aerobic and heavy resistance training is applicable to different cancer types, adhering to the limitations and contraindications established by the American College of Sports Medicine. Campbell's study on breast cancer patients receiving chemotherapy demonstrated that aerobic and heavy resistance training significantly enhanced physical functioning, improved anthropometric measures, and reduced cancer-related fatigue in the treatment group. Participating in aerobic and heavy resistance training for 3-5 days per week, lasting 12 minutes at a light effort over a duration of eighteen weeks. Exercise under supervision can help older breast cancer survivors become stronger and perform better physically. In both supervised and unsupervised settings, resistance training may provide greater gains than aerobic or flexibility training (Padilha et al., 2017; Refiani et al., 2021; Shachar et al., 2016). However, age-specific recommendations and the best training modality for particular outcomes were not included in the ACSM recommendations since there were not enough studies that explicitly compared two or more training modalities. These recommendations were not empirically derived from studies that included both aerobic and heavy resistance training cancer-related fatigue in patients undergoing chemotherapy, even though the ACSM guidelines also imply that supervised exercise may contribute to greater improvements in outcomes and be safer for higher risk populations. The aim is to examine the impact of aerobic and heavy resistance training on cancer-related fatigue in patients undergoing chemotherapy.

Method

Participants

This investigation employed a Quasi-Experimental design. In this study, data collection began after obtaining authorization from Universitas Negeri Yogyakarta and receiving approval from the Institutional Research Ethics Committee (Sosa et al., 2012). The WinPepi program was used to calculate sample size, with Pagola Javier S et al., (2020) as a reference. The study used a 5% significance level, 80% power, 95% confidence level, and 20% dropout rate, yielding a total sample size of 32 breast cancer patients. This study established the following inclusion criteria: Patients diagnosed with breast cancer who are receiving post-surgical chemotherapy, those capable of engaging in low to moderate-intensity training that results in a heart rate increase of +40% as determined by a pre-test, individuals willing to commit to 18 weeks of aerobic and heavy resistance training, participating 3-5 times per week for 12 minutes each session, and breast cancer patients classified as stages 1 and 2. The criteria for exclusion in this study included breast cancer patients who had complications from other diseases that contraindicated exercise. According to the American College of Sports Medicine, exercise is contraindicated for cancer patients who have heart disorders or diseases, including severe arterial hypertension, aneurysm, ischemia indicated by ECG results, uncontrolled dysrhythmia, and uncontrolled heart failure. Additionally, lung diseases such as pulmonary infarction and acute pulmonary embolism, neuromuscular, rheumatoid, and musculoskeletal diseases that may worsen with exercise, uncontrolled metabolic diseases like diabetes mellitus, thyrotoxicosis, and myxedema, chronic infectious diseases such as hepatitis, AIDS, and tuberculosis, as well as mental or physical disabilities that could lead to inadequate exercise, are also factors to consider.

The consent form is provided to cancer patients receiving chemotherapy who may participate in the study. The individual outlines the aims and goals of the study, as well as the potential effects throughout and following the data gathering process. If a potential participant is open to being involved in the study, they are required to complete the consent form. However, if they choose not to participate, their decision is fully respected, and no pressure is applied to compel their involvement.

Procedure

Intervention

The aerobic exercise lasted 60 minutes and comprised an aggressive warm-up, aerobic activity, and rigorous resistance training. The 15-minute warm-up comprised respiratory and mobility exercises. The aerobic portion of the exercise was 30 minutes of monitored cycling on a bicycle ergometer at an intensity graded 7–8 (extremely heavy) on the Borg 1–10 scale of perceived exertion (Mijwel et al., 2018). The supervised rigorous resistance training encompassed workouts with resistance bands, dumbbells, stability balls, suspension apparatus, and bodyweight motions aimed at main muscle groups. Participants executed 8–10 exercises per session, dictated by perceived fatigue, comprising 2–3 sets per exercise: 2 sets of 6 repetitions during weeks 1–5, 3 sets of 7 repetitions in weeks 6–11, and 2 sets of 8 repetitions in weeks 12–18, with a 5-minute rest interval between sets and 45 seconds between exercises. The Borg RPE scale necessitates an intensity score between 6 and 7, categorized as severe to extremely severe. As a result, participants elevate exercise intensity to sustain RPE levels over the 18-week intervention. A session is deemed complete when a minimum of 90% of the designated exercises are executed accurately (Mijwel et al., 2018).

Outcome measures

Physical Fitness

Triaxial accelerometers (GT3X monitor, Actigraph; Pensacola, FL) measured MVPA levels objectively. Previous study has validated this device (Nakagawa et al., 2023). Participants were instructed to wear the accelerometer (near the right iliac crest) for seven to ten days when awake and only remove it for swimming sports or riding. Valid MVPA evaluation required five days of observation, including two weekends, and 10 hours of accelerometry data each day. Only the last seven days of recordings, including two weekends, were included when participants supplied more than seven consecutive days. Analysis was done with ActiLife5 LITE (Actigraph). All activities, with the exception of transitions, had intraclass correlation coefficients for inter-rater reliability more than 0.95. High validity was shown by the results, which showed sensitivity and positive predictive values of over 85% for sitting and reclining and over 90% for walking and jogging (Nakagawa et al., 2023).

Cardiorespiratory

A metabolic cart (Vmax 29C; SensorMedics Corp., Yorba Linda, CA) was employed to assess cardiorespiratory fitness (peak oxygen uptake, VO2peak) during a maximal incremental cycle ergometer test (Ergometrics Ergoline 800, Jaeger, Bitz, Germany). At a consistent speed of 60–70 rpm, the load was incrementally increased by 10 watts per minute, starting with 20 watts. The participants were verbally instructed to cycle until they reached voluntary weariness, while being monitored electrocardiographically. VO2peak was the maximum value of the test (mean duration of 20 seconds). VT was computed as outlined in reference (Grote et al., 2016). According to reliability evaluation, the coefficient of variation (CV) for every instrument was noticeably higher, ranging from 4.8% to 10.9% (Grote et al., 2016).

Muscle strength

A dynamometer (TKK 5001 Grip-D; Takei, Tokyo, Japan) assessed handgrip strength in kilograms (to the closest 0.1 kg) (Kang et al., 2019). The reliability of the instrument is shown by the data obtained from the correlation value (.949), coefficient of variation (7.91%), and limits of agreement values (Kang et al., 2019). The sit-to-stand (STS) test assessed the duration (in seconds) required to sit down and stand up from a chair five times for lower-limb strength evaluation. Participants started the examination with their arms crossed over their chests and their backs against the chair. Commence and complete the work expeditiously while sitting. The FTSTS, 30-s STS, and 1-min STS tests had intraclass correlation coefficients (ICC) of 0.96, 0.95, and 0.96 for repeated assessments, respectively (Wang et al., 2022). The balance beam assessment evaluates balance and coordination, specifically body stability and movement control. Participants traverse a narrow beam continuously, and their duration is documented. The tennis ball tossing test evaluates upper body coordination and strength, specifically the ability of upper body muscles to collaborate for a powerful and precise motion. A tennis ball is propelled to its maximum distance from a designated location and documented.

Fatigue

A five-point ordinal scale was utilized to evaluate fatigue perception via the PERFORM questionnaire, which consists of 12 items distributed across three dimensions: “Physical Limitations,” “Activities of Daily Living,” and “Beliefs and Attitudes.” Reduced scores indicate increased fatigue, with 3.5 being the "minimal important difference." The PERFORM questionnaire is practical, reliable (demonstrating internal consistency and test-retest reliability), valid, and sensitive to change (Gascón et al., 2013; Perwitasari et al., 2023). The range of estimates for internal consistency was 0.67 to 0.95. The progenitor version of the FS-A has validity estimations ranging from 0.13 to 0.76 (Gascón et al., 2013; Perwitasari et al., 2023).

Emotional measures

The abridged LaFreniere and Jean's 1996 Social Competence and Behavior Evaluation Scale (SCBE-30), consisting of 30 items assessed on a 6-point Likert scale from 1 to 6, was utilized to assess participants' emotional competency (Echeverría et al., 2016). Scores for each subdomain—social competence, aggressive fury, and anxious withdrawal—were derived by aggregating the scores of individual items. Inter-rater reliability, test-retest reliability, internal consistency, and temporal stability are substantial. The scale exhibited robust internal consistency, with Cronbach's α values of 0.91 for social competence, 0.88 for anger-aggression, 0.91 for nervous retreat, and an overall α score of 0.92. The results of the SCBE-30's construct validity and internal consistency tests were similar to those of LaFreniere and Dumas' validation of the teacher version of the test (Echeverría et al., 2016).

Data analysis

Analyses were conducted using IBM SPSS version 25.0 (IBM, Armonk, NJ, USA). Supplementary descriptive data were obtained from a normality inquiry. Comparisons among groups were conducted using paired t-tests or Wilcoxon paired-sample tests, depending on data distribution or scoring criteria. The physical fitness test results were analyzed with a longitudinal mixed-effects model, incorporating factors such as gender, age, height, weight, and baseline data, with forest plots generated in R (R4.2.1). The SCBE data was examined using age and gender as variables, employing a 2 (aerobic and heavy resistance) × 2 (baseline and post 12 weeks) mixed-model ANOVA, assuming no baseline differences. Effect size (pü2) was utilized to quantify the magnitude of the effect, categorized as small (0.01), medium (0.06), and large (0.14).

Results

The study included 32 female breast cancer survivors, separated into two groups: one with 16 individuals engaging in aerobic (average age 49 ± 4 years) and the other with 16 participants in heavy resistance training (average age 48 ± 1 year). Baseline differences across groups were not significant (table 1). As shown by increased PERFORM questionnaire scores at post-intervention compared to baseline, both training programs reduced fatigue perception, particularly the heavy resistance training (p = 0.005, marginally exceeding the adjusted threshold of p = 0.006, with p = 0.011 for the heavy resistance training) (table 2). The enhancement was similar across groups (p = 0.458). Heavy resistance training reduced waist circumference (p = 0.021), while aerbobic did not (p = 0.521). Post-intervention BMI decreased with heavy resistance training (p = 0.24), but there was no significant difference between groups (p = 0.233) (table 2).

The results of the Social Competence and Behavior Evaluation Scale revealed no significant differences in the mean values of social competence [F(3, 325) = 3.652, p = 0.076], anger aggression [F(3, 345) = 3.827, p = 0.075], and anxious withdrawal [F(3, 347) = 3.245] between the two groups of BC in their baseline assessments. Further analysis of the results revealed no significant changes in the principal temporal effect across the three dimensions before and after the intervention (p>0.05). The principal effect of grouping was evident on anger aggression [F(3, 352)=3.925, p=0.025, Partial η2=0.035] and anxious-withdrawal [F(3, 358)=4.352, p=0.005, Partial η2=0.005], indicating significant score variations among the three groups post-intervention; however, the interaction between grouping and time was not statistically significant (table 3).

Table 1. Baseline demographic categorized by group

	Aerobic	Heavy Resistance
Age (years)	49 ± 4	48 ± 1
Time since diagnosis (median IQR, in years)	2 (2)	2 (2)
Time since treatment ended (median IQR, in years)	2 (1)	2 (1)
Radiotherapy (%)	30%	26%
Hormonotherapy (%)	95 %	93 %
Surgery (%)	100 %	100 %
Chemotherapy (%)	88 %	86 %

Table 2. Impact of the exercise interventions on the study outcomes

Variable	Group	Baseline	Post	Change post minus baseline within groups (95% CI)	ES (Hedges' d)	p-value within groups	Between-group (high *vs.* moderate-intensity) difference in change *post* minus baseline (95 % CI)	*p*-value between groups
Body mass (kg)	Aerobic	57.8 ± 6.0	59.3 ± 7.7	1.5 (−1.5, 1.7)	0.01	0.357	−0.8 (−1.5, 0.5)	0.235
	Heavy resistance	58.4 ± 12.4	57.5 ± 11.6	−0.9 (−1.6, 0.9)	0.05	0.257		
BMI ($kg \cdot m^{-2}$)	Aerobic	26.4 ± 4.7	27.4 ± 4.9	-1.0 (−0.4, 0.5)	0.1	0.747	−0.8 (−0.5, 3.0)	0.233
	Heavy resistance	26.8 ± 6.8	26.5 ± 6.3	−0.3 (−1.7, 0.4)	0.24	0.071		
BMD ($g \cdot cm^{-2}$)	Aerobic	2.3 ± 0.3	2.1 ± 0.3	0.2 (−1.2, 1.2)	0.89	0.389	0.2 (0.2, 0.2)	0.034
	Heavy resistance	2.4 ± 0.3	2.1 ± 0.3	0.0 (−0.1, 0.0)	0.96	0.055		
Fat mass (% of total body mass)	Aerobic	45.3 ± 3	45.3 ± 3	−0.1 (−2, −2)	0.23	0.664	−2 (−4, 2)	0.327
	Heavy resistance	45.4 ± 4	44.7 ± 4	0.6 (−1, 1)	0.1	0.032		

Waist circumference (cm)	Aerobic	94.3 ± 6	94.5 ± 8	0.2 (−3, 2)	0.23	0.521	−3 (−4, 1)	0.035
	Heavy resistance	94.5 ± 7	94.4 ± 6	−0.1 (−3, −2)	0.24	0.021		
LBM (% of total body mass)	Aerobic	55 ± 6	56 ± 6	1 (−0, 3)	0.15	0.075	1 (−1, 2)	0.260
	Heavy resistance	54 ± 3	54 ± 3	0 (−1, 2)	0.4	0.575		
MVPA (min/week)	Aerobic	332 ± 163	301 ± 102	−31 (−108, 25)	0.14	0.114	21 (−100, 172)	0.103
	Heavy resistance	315 ± 121	321 ± 101	−6 (−164, 141)	0.07	0.743		
CRF (MET)	Aerobic	4.2 ± 1.2	4.5 ± 1.2	0.3 (0, 1.2)	0.56	0.032	0 (−2.3, 2.6)	0.415
	Heavy resistance	4.5 ± 1.2	5.1 ± 1.4	0.6 (−0, 1.3)	0.46	0.145		
STS test (seconds)	Aerobic	4.6 ± 1.1	4.2 ± 0.7	−0.4 (−1.1, −1.1)	1.06	0.005	0.1 (−0.6 1.1)	0.247
	Heavy resistance	4.6 ± 1.2	4.2 ± 0.7	−0.4 (−2.1, −0.6)	1.24	0.003		
Handgrip (kg)	Aerobic	23 ± 4	21 ± 6	-0.2 (−3, 1)	0	0.812	0 (−4, 6)	0.568
	Heavy resistance	23 ± 3	20 ± 3	-0.3 (−3, 0)	0	0.720		
NLR	Aerobic	2.6 ± 0.7	2.4 ± 1.5	−0.2 (−0.6, 0.8)	1.11	0.646	−0.4 (−1.0, 0.8)	0.586
	Heavy resistance	2.4 ± 0.9	2.1 ± 0.7	−0.3 (−0.9, −0.1)	0.57	0.027		
Balance beam walking (s)	Aerobic	7.47 ± 4.53	6.43 ± 3.41	-1.04 (-3.13, -0.62)	0.003	0.532	−0.3 (−1.1, 0.6)	0.547
	Heavy resistance	7.43 ± 4.63	6.14 ± 2.14	-1.29 (-3.23, -1.43)	0.002	0.034		
Tennis ball throwing (m)	Aerobic	4.35 ± 1.45	5.12 ± 1.21	0.77 (0.13, 0.73)	0.005	0.516	−0.2 (−1.6, 0.8)	0.512
	Heavy resistance	4.59 ± 1.44	5.24 ± 1.21	0.65 (-0.33, 0.42)	0.572	0.047		
Fatigue (PERFORM questionnaire score	Aerobic	27.5 ± 8	48 ± 10	20.5 (3, 2)	1.13	0.011	5 (−7, 14)	0.458
	Heavy resistance	27.4 ± 7	38.1 ± 6	10.7 (1, 1)	1.57	0.005		

Diferencias significativas, p<.05.

Table 3. Evaluation of Social Competence and Behavior Evaluation Scale scores across three groups pre- and post-intervention

Variable	Group	Baseline	Post	Time effect			Group effect			A group by time interaction effect		
				F	p	Partial n^2	F	P	Partial n^2	F	P	Partial n^2
Social Competence	Aerobic	6.25 ± 0.06	5.36 ± 0.06	0.89	0.435	0.005	4.237	0.05	0.03	0.363	0.822	0.003
	Heavy resistance	6.75 ± 0.06	5.16 ± 0.06									
Anger Aggression	Aerobic	3.54 ± 0.06	2.45 ± 0.05	1.09	0.078	0.025	4.61	0.033	0.035	1.362	0.322	0.024
	Heavy resistance	3.24 ± 0.06	2.24 ± 0.05									
Anxious-withdrawal	Aerobic	3.57 ± 0.07	2.63 ± 0.06	0.94	0.75	0.001	5.347	0.005	0.005	6.524	0.005	0.072
	Heavy resistance	3.47 ± 0.07	2.53± 0.06									

Discussion

A quasi-experiment found that an 18-week training program for breast cancer survivors with fatigue (PERFORM score < 0.458) and aerobic and heavy resistance training significantly improved central adiposity measurements (waist circumference). However, no intergroup differences met the modified p-value criterion. An earlier study evaluated how moderate-intensity exercise affected fatigued breast cancer survivors (Fayers et al., 2002; Ruiz-Ruiz et al., 2002). Overall, only the heavy resistance training reduced fatigue, resulting in PERFORM ratings that matched those of both the aerobic and heavy resistance training groups.

The integration of aerobic and heavy resistance training to mitigate cancer-related fatigue in breast cancer patients has been emphasized, it has been observed that heavy resistance training alone or aerobic interventions did not produce notable improvements in fatigue levels within this group. The findings from our study suggest that heavy resistance training may have a positive impact on specific outcomes, which is consistent with previous studies involving breast cancer patients that incorporated both resistance training and moderate-intensity aerobic exercise (Chan et al., 2024).

We observed significant benefits from moderate intensity therapies, which showed positive effects on anthropometric measures, as evidenced by a trend towards reduced waist circumference. This highlights the importance of establishing long-term heavy resistance training within this group, given that the average value of this variable remained consistent, even after its recent recognition as an independent predictor of breast cancer mortality, particularly the hazard ratio for waist circumference surpassing 88 cm (Adams et al., 2018; Cella et al., 2001; Gadisa et al., 2019; Lipsett et al., 2017; Mijwel et al., 2018; Rogers et al., 2014).33–38 Furthermore, our results are consistent with a recent systematic investigation that established heavy resistance training provides greater advantages compared to aerobic in cancer survivors (Azab et al., 2012; Dibaba et al., 2019). Additionally, prior studies indicate that inflammation may adversely affect the positive outcomes of exercise training on fatigue in breast cancer survivors, potentially explaining the failure to achieve the stringent p threshold concerning the impact of heavy resistance training on fatigue (Azab et al., 2012; Mijwel et al., 2018; Moher et al., 2001; Molmen-Hansen et al., 2012). Further investigation is warranted; however, heavy resistance training combined with resistance training may offer significant health benefits for breast cancer survivors.

The two groups did not exhibit any significant effects in social competence, wrath aggression, and anxiety withdrawal after the intervention when compared to the baseline, as indicated by intragroup comparisons. Nevertheless, the intervention resulted in a substantially lower level of wrath aggression in the heavy resistance group than in the aerobic group. Additionally, the anxiety withdrawal scores of the two groups were substantially different, with both the aerobic and heavy resistance groups exhibiting substantial decreases. The impact of interventions on the social and social-emotional competence of young children has been the subject of previous research (Hwang, 2019).

Our results are in line with the most recent ACSM exercise guidelines for cancer survivors, which indicate that this is sufficient to enhance a number of health outcomes associated with cancer. According to recent guidelines, most cancer survivors can improve their self-reported physical functioning by engaging in aerobic and/or resistance exercise for 30 minutes at a moderately intense level two to three times a week for at least 12 weeks. The only women who self-reported gains in physical function that differed from losses in controls were those who engaged in aerobic or resistance exercise. However, these improvements fell short of what was deemed clinically relevant, raising concerns about whether the changes were significant enough for women. Including measures of physical functioning and comparing aerobic and resistance training were two of our study's strong points. We believed that completely excluding exercise was unethical because it is now advised for all cancer survivors. Studies have shown that flexibility exercises can increase physical activity and mobility in older persons without cancer.

The present study did not identify any substantial changes in social competence. This may be attributed to the short amount of intervention time or the overemphasis on secure social distancing in teaching strategies and everyday health care settings, which have an impact on social development. A systematic review that revealed a lack of research evidence regarding the impact of exercise on anxiety/withdrawal and anger/aggression (Molmen-Hansen et al., 2012; Scott et al., 2018). The review also emphasized that exercise programs are the most researched and effective body-oriented interventions in fostering social-emotional development.

Therefore, we might not be fully appreciating the advantages of aerobic, resistance, and perhaps even stretching exercises for those who have survived breast cancer. Trends were similar between subjective and objective measures, and some of our results came close to reaching significance. In order to account for the variation in effort and response among breast cancer survivors, we could have been underpowered and required a bigger sample, although statistical adjustment for multiple testing lost significance. On the other hand, given our lower initial intensity, it's also feasible that adjustments took longer. Despite our conservative exercise recommendations in this initial research, the women's excellent tolerance to training implies that future trials may begin at a higher level or increase intensity more quickly. The difficulty to extrapolate our results to breast cancer survivors who reside far from an academic health institution is another drawback. Future research should examine if other circumstances could be used when participants experience a health setback, as attrition was mostly caused by health-related factors that prohibited women from starting exercise again.

Nevertheless, there are certain constraints that must be considered, specifically concerning the small sample size and the absence of a non-exercise control group. Meta-analytic findings indicate that exercise provides significant benefits compared to non-exercise controls in cancer survivors (Fu et al., 2013;

Scott et al., 2018; Shachar et al., 2016). The subjective scale (SCBE-30) may be influenced by inaccurate perceptions or social desirability bias, Additionally, a significant limitation is the insufficient control over nutritional factors, which may substantially affect body composition. This study is strongest in its unique methodology, which evaluates the benefits of an exercise intervention for cancer patients with baseline fatigue, followed by a thorough outcome analysis and careful multiple comparison adjustment.

Conclusions

Breast cancer survivors with fatigue lost waist circumference after 18 weeks of supervised strength training and moderate-intensity aerobics. This should guide future efforts to create successful and individualized exercise regimens for cancer survivors. Diverse exercise stimuli, such as changes in kind, intensity, or volume, may improve results in these people. More study is needed.

Acknowledgements

The author would like to thank those who have helped and provided support in this research.

Financing

This research was funded through research activities from DIPA funds from Universitas Negeri Yogyakarta.

References

Adams, S. C., Delorey, D. S., Davenport, M. H., Fairey, A. S., North, S., & Courneya, K. S. (2018). Effects of high-intensity interval training on fatigue and quality of life in testicular cancer survivors. British Journal of Cancer, 118(10). https://doi.org/10.1038/s41416-018-0044-7

Azab, B., Bhatt, V. R., Phookan, J., Murukutla, S., Kohn, N., Terjanian, T., & Widmann, W. D. (2012). Usefulness of the neutrophil-to-lymphocyte ratio in predicting short- and long-term mortality in breast cancer patients. Annals of Surgical Oncology, 19(1). https://doi.org/10.1245/s10434-011-1814-0

Borg, G. A. V. (1954). Psychophysical bases of perceived exertion. Plastic and Reconstructive Surgery, 14(5).

Caan, B. J., Cespedes Feliciano, E. M., Prado, C. M., Alexeeff, S., Kroenke, C. H., Bradshaw, P., Quesenberry, C. P., Weltzien, E. K., Castillo, A. L., Olobatuyi, T. A., & Chen, W. Y. (2018). Association of muscle and adiposity measured by computed tomography with survival in patients with nonmetastatic breast cancer. JAMA Oncology, 4(6). https://doi.org/10.1001/jamaoncol.2018.0137

Cella, D., Davis, K., Breitbart, W., & Curt, G. (2001). Cancer-related fatigue: Prevalence of proposed diagnostic criteria in a United States sample of cancer survivors. Journal of Clinical Oncology, 19(14). https://doi.org/10.1200/JCO.2001.19.14.3385

Chan, A. W., Tetzlaff, J. M., Gøtzsche, P. C., Altman, D. G., Mann, H., Berlin, J. A., Dickersin, K., Hróbjartsson, A., Schulz, K. F., Parulekar, W. R., Krleža-Jerić, K., Laupacis, A., & Moher, D. (2024). SPIRIT 2013 explanation and elaboration: guidance for protocols of clinical trials. BMJ. https://doi.org/10.1136/bmj.e7586

Christensen, J. F., Jones, L. W., Andersen, J. L., Daugaard, G., Rorth, M., & Hojman, P. (2014). Muscle dysfunction in cancer patients. In Annals of Oncology (Vol. 25, Issue 5). https://doi.org/10.1093/annonc/mdt551

Cleeland, C. S., Bennett, G. J., Dantzer, R., Dougherty, P. M., Dunn, A. J., Meyers, C. A., Miller, A. H., Payne, R., Reuben, J. M., Wang, X. S., & Lee, B. N. (2003). Are the symptoms of cancer and cancer treatment due to a shared biologic mechanism? A cytokine-immunologic model of cancer symptoms. Cancer, 97(11). https://doi.org/10.1002/cncr.11382

Dibaba, D. T., Ogunsina, K., Braithwaite, D., & Akinyemiju, T. (2019). Metabolic syndrome and risk of breast cancer mortality by menopause, obesity, and subtype. Breast Cancer Research and Treatment, 174(1). https://doi.org/10.1007/s10549-018-5056-8

Echeverría, A. V., Rocha, T., Leite, J. C., Teixeira, P., & Cruz, O. (2016). Portuguese validation of the social competence and behavior evaluation scale (SCBE-30). Psicologia: Reflexao e Critica, 29(1). https://doi.org/10.1186/s41155-016-0014-z

Fayers, P., Bottomley, A., EORTC Quality of Life Group, & Quality of Life Unit. (2002). Quality of life research within the EORTC-the EORTC QLQ-C30. European Organisation for Research and Treatment of Cancer. European Journal of Cancer (Oxford, England : 1990), 38 Suppl 4.

Fu, T. C., Wang, C. H., Lin, P. S., Hsu, C. C., Cherng, W. J., Huang, S. C., Liu, M. H., Chiang, C. L., & Wang, J. S. (2013). Aerobic interval training improves oxygen uptake efficiency by enhancing cerebral and muscular hemodynamics in patients with heart failure. International Journal of Cardiology. https://doi.org/10.1016/j.ijcard.2011.11.086

Gadisa, D. A., Gebremariam, E. T., & Ali, G. Y. (2019). Reliability and validity of Amharic version of EORTC QLQ-C30 and QLQ-BR23 modules for assessing health-related quality of life among breast cancer patients in Ethiopia. Health and Quality of Life Outcomes, 17(1). https://doi.org/10.1186/s12955-019-1257-z

Gascón, P., Rodríguez, C. A., Valentín, V., Mata, J. G., Carulla, J., Cassinello, J., Colomer, R., & Baró, E. (2013). Usefulness of the PERFORM questionnaire to measure fatigue in cancer patients with anemia: A prospective, observational study. Supportive Care in Cancer, 21(11). https://doi.org/10.1007/s00520-013-1862-z

Grote, S., Almstedt, H. C., & Tarleton, H. P. (2016). Cardiometabolic health among cancer survivors: A 13-week pilot study of a combined aerobic and resistance training program. Oncology Nursing Forum, 43(3). https://doi.org/10.1188/16.ONF.306-315

Harriss, D. J., Macsween, A., & Atkinson, G. (2019). Ethical Standards in Sport and Exercise Science Research: 2020 Update. In International Journal of Sports Medicine (Vol. 40, Issue 13). https://doi.org/10.1055/a-1015-3123

Hwang, H. (2019). Influence of social cognitive factors on physical activity among breast cancer survivors. Korean Journal of Adult Nursing, 31(2). https://doi.org/10.7475/kjan.2019.31.2.211

Kang, S., Yoo, S., Baek, H., Lee, J., Choi, Y., Kim, H., Yi, H., & Yang, E. J. (2019). Potentials of Smart dynamometer use for clinical and self-management of rehabilitation in breast cancer survivors: a feasibility study. Biomedical Engineering Letters, 9(2). https://doi.org/10.1007/s13534-019-00101-3

Kilgour, R. D., Vigano, A., Trutschnigg, B., Hornby, L., Lucar, E., Bacon, S. L., & Morais, J. A. (2010). Cancer-related fatigue: The impact of skeletal muscle mass and strength in patients with advanced cancer. Journal of Cachexia, Sarcopenia and Muscle, 1(2). https://doi.org/10.1007/s13539-010-0016-0

Klassen, O., Schmidt, M. E., Ulrich, C. M., Schneeweiss, A., Potthoff, K., Steindorf, K., & Wiskemann, J. (2017). Muscle strength in breast cancer patients receiving different treatment regimes. Journal of Cachexia, Sarcopenia and Muscle, 8(2). https://doi.org/10.1002/jcsm.12165

Lipsett, A., Barrett, S., Haruna, F., Mustian, K., & O'Donovan, A. (2017). The impact of exercise during adjuvant radiotherapy for breast cancer on fatigue and quality of life: A systematic review and meta-analysis. In Breast (Vol. 32). https://doi.org/10.1016/j.breast.2017.02.002

Mijwel, S., Backman, M., Bolam, K. A., Jervaeus, A., Sundberg, C. J., Margolin, S., Browall, M., Rundqvist, H., & Wengström, Y. (2018). Adding high-intensity interval training to conventional training modalities: optimizing health-related outcomes during chemotherapy for breast cancer: the OptiTrain randomized controlled trial. Breast Cancer Research and Treatment, 168(1). https://doi.org/10.1007/s10549-017-4571-3

Moher, D., Schulz, K. F., Altman, D. G., & Lepage, L. (2001). The CONSORT statement: Revised recommendations for improving the quality of reports of parallel group randomized trials. In BMC Medical Research Methodology (Vol. 1). https://doi.org/10.1186/1471-2288-1-2

Molmen-Hansen, H. E., Stolen, T., Tjonna, A. E., Aamot, I. L., Ekeberg, I. S., Tyldum, G. A., Wisloff, U., Ingul, C. B., & Stoylen, A. (2012). Aerobic interval training reduces blood pressure and improves myocardial function in hypertensive patients. European Journal of Preventive Cardiology. https://doi.org/10.1177/1741826711400512

Montel, L., Ssenyonga, N., Coleman, M. P., & Allemani, C. (2022). How should implementation of the human right to health be assessed? A scoping review of the public health literature from 2000 to 2021. In International Journal for Equity in Health (Vol. 21, Issue 1). https://doi.org/10.1186/s12939-022-01742-0

Nakagawa, T., Fukui, T., Ohsumi, Y., Miyamoto, E., & Gotoh, M. (2023). Association between oxygen consumption and stepping exercise standardized with a triaxial accelerometer. General Thoracic and Cardiovascular Surgery, 71(1). https://doi.org/10.1007/s11748-022-01860-0

Neil, S. E., Klika, R. J., Garland, S. J., McKenzie, D. C., & Campbell, K. L. (2013). Cardiorespiratory and neuromuscular deconditioning in fatigued and non-fatigued breast cancer survivors. Supportive Care in Cancer, 21(3). https://doi.org/10.1007/s00520-012-1600-y

Padilha, C. S., Marinello, P. C., Galvão, D. A., Newton, R. U., Borges, F. H., Frajacomo, F., & Deminice, R. (2017). Evaluation of resistance training to improve muscular strength and body composition in cancer patients undergoing neoadjuvant and adjuvant therapy: a meta-analysis. In Journal of Cancer Survivorship (Vol. 11, Issue 3). https://doi.org/10.1007/s11764-016-0592-x

Pagola Javier S.; Alejo Lidia B; Barcelo Olga; Montil Marta; Oliván Jesús; Alvarez-Bustos Alejandro; Cantos Blanca; Maximiano Constanza; Hidalgo Francisco; Valenzuela Pedro L.; Fiuza-Luces Carmen; Lucia Alejandro; Ruiz-Casado Ana, I. M. (2020). Concurrent Exercise Interventions in Breast Cancer Survivors with Cancer-related Fatigue. International Journal of Sports Medicine, 41(11), 790–797. https://doi.org/10.1055/a-1147-1513

Peel, J. B., Sui, X., Adams, S. A., HIbert, J. R., Hardin, J. W., & Blair, S. N. (2009). A prospective study of cardiorespiratory fitness and breast cancer mortality. Medicine and Science in Sports and Exercise, 41(4). https://doi.org/10.1249/MSS.0b013e31818edac7

Perwitasari, D. A., Purba, F. D., Candradewi, S. F., Dania, H., Muhammad Irham, L., Noor Faridah, I., & Septiantoro, B. P. (2023). Quality of Life of Cancer Patients during Chemotherapy in Indonesia: A Comparison of EORTC QLQ-C30 and EQ-5D-5L, Based on Patients' Characteristics. International Journal of Clinical Practice, 2023. https://doi.org/10.1155/2023/9357299

Refiani, E., Maliza, R., Fitri, H., & Lestari, P. (2021). Therapeutic Effects of Medicinal Plants on Diabetic Foot Ulcers: A Systematic Review. Journal of Agromedicine and Medical Sciences, 7(3). https://doi.org/10.19184/ams.v7i3.24244

Rogers, L. Q., Vicari, S., Trammell, R., Hopkins-Price, P., Fogleman, A., Spenner, A., Rao, K., Courneya, K. S., Hoelzer, K. S., Robbs, R., & Verhulst, S. (2014). Biobehavioral factors mediate exercise effects on fatigue in breast cancer survivors. Medicine and Science in Sports and Exercise, 46(6). https://doi.org/10.1249/MSS.0000000000000210

Ruiz-Casado, A., Verdugo, A. S., Solano, M. J. O., Aldazabal, I. P., Fiuza-Luces, C., Alejo, L. B., Del Hierro, J. R. P., Palomo, I., Aguado-Arroyo, O., Garatachea, N., Cebolla, H., & Lucia, A. (2014). Objectively assessed physical activity levels in Spanish cancer survivors. Oncology Nursing Forum, 41(1). https://doi.org/10.1188/14.ONF.E12-E20

Ruiz-Ruiz, J., Mesa, J. L. M., Gutiérrez, A., & Castillo, M. J. (2002). Hand size influences optimal grip span in women but not in men. Journal of Hand Surgery, 27(5). https://doi.org/10.1053/jhsu.2002.34315

Saligan, L. N., Olson, K., Filler, K., Larkin, D., Cramp, F., Sriram, Y., Escalante, C. P., del Giglio, A., Kober, K. M., Kamath, J., Palesh, O., & Mustian, K. (2015). The biology of cancer-related fatigue: a review of the literature. In Supportive Care in Cancer (Vol. 23, Issue 8). https://doi.org/10.1007/s00520-015-2763-0

Schmidt, M. E., Chang-Claude, J., Vrieling, A., Heinz, J., Flesch-Janys, D., & Steindorf, K. (2012). Fatigue and quality of life in breast cancer survivors: Temporal courses and long-term pattern. Journal of Cancer Survivorship, 6(1). https://doi.org/10.1007/s11764-011-0197-3

Schmidt, M. E., Semik, J., Habermann, N., Wiskemann, J., Ulrich, C. M., & Steindorf, K. (2016). Cancer-related fatigue shows a stable association with diurnal cortisol dysregulation in breast cancer patients. Brain, Behavior, and Immunity, 52. https://doi.org/10.1016/j.bbi.2015.10.005

Scott, J. M., Zabor, E. C., Schwitzer, E., Koelwyn, G. J., Adams, S. C., Nilsen, T. S., Moskowitz, C. S., Matsoukas, K., Iyengar, N. M., Dang, C. T., & Jones, L. W. (2018). Efficacy of exercise therapy on cardiorespiratory fitness in patients with cancer: A systematic review and meta-analysis. In Journal of Clinical Oncology (Vol. 36, Issue 22). https://doi.org/10.1200/JCO.2017.77.5809

Sha, F., Zhuang, S., Zhou, L., Zhang, L., Yang, Y., Zhang, S., Jiang, Y., Qiu, G., Chen, C., Zheng, J., & Zhang, S. (2015). Biomarkers for cancer-related fatigue and adverse reactions to chemotherapy in lung cancer patients. Molecular and Clinical Oncology, 3(1). https://doi.org/10.3892/mco.2014.439

Shachar, S. S., Williams, G. R., Muss, H. B., & Nishijima, T. F. (2016). Prognostic value of sarcopenia in adults with solid tumours: A meta-analysis and systematic review. In European Journal of Cancer (Vol. 57). https://doi.org/10.1016/j.ejca.2015.12.030

Sosa, E. S., Groeneveld, I. F., Gonzalez-Saiz, L., López-Mojares, L. M., Villa-Asensi, J. R., Gonzalez, M. I. B., Fleck, S. J., PIrez, M., & Lucia, A. (2012). Intrahospital weight and aerobic training in children with cystic fibrosis: A randomized controlled trial. Medicine and Science in Sports and Exercise, 44(1). https://doi.org/10.1249/MSS.0b013e318228c302

Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA: A Cancer Journal for Clinicians, 71(3). https://doi.org/10.3322/caac.21660

Sweegers, M. G., Altenburg, T. M., Brug, J., May, A. M., Van Vulpen, J. K., Aaronson, N. K., Arbane, G., Bohus, M., Courneya, K. S., Daley, A. J., Galvao, D. A., Garrod, R., Griffith, K. A., Van Harten, W. H., Hayes, S. C., Herrero-Román, F., Kersten, M. J., Lucia, A., McConnachie, A., … Buffart, L. M. (2019). Effects and moderators of exercise on muscle strength, muscle function and aerobic fitness in patients with cancer: A meta-analysis of individual patient data. In British Journal of Sports Medicine (Vol. 53, Issue 13). https://doi.org/10.1136/bjsports-2018-099191

Thornton, L. M., Andersen, B. L., & Blakely, W. P. (2010). The Pain, Depression, and Fatigue Symptom Cluster in Advanced Breast Cancer: Covariation With the Hypothalamic-Pituitary-Adrenal Axis and the Sympathetic Nervous System. Health Psychology, 29(3). https://doi.org/10.1037/a0018836

Toohey, K., Pumpa, K., McKune, A., Cooke, J., & Semple, S. (2018). High-intensity exercise interventions in cancer survivors: a systematic review exploring the impact on health outcomes. In Journal of Cancer Research and Clinical Oncology (Vol. 144, Issue 1). https://doi.org/10.1007/s00432-017-2552-x

Wang, Z., Yan, J., Meng, S., Li, J., Yu, Y., Zhang, T., Tsang, R. C. C., El-Ansary, D., Han, J., & Jones, A. Y. M. (2022). Reliability and validity of sit-to-stand test protocols in patients with coronary artery disease. Frontiers in Cardiovascular Medicine, 9. https://doi.org/10.3389/fcvm.2022.841453

Winters-Stone, K. M., Bennett, J. A., Nail, L., & Schwartz, A. (2008). Strength, physical activity, and age predict fatigue in older breast cancer survivors. Oncology Nursing Forum, 35(5). https://doi.org/10.1188/08.ONF.815-821

Authors' and translators' details:

Nur Azis Rohmansyah	nurazisrohmansyah@uny.ac.id	Author
Faza Annasai	fazaannasai@uny.ac.id	Author
Abiyyu Amajida	abiyyuamajida@uny.ac.id	Author
Sunaryo Sunaryo	naryo1982@uny.ac.id	Author
Sumarjo Sumarjo	sumarjofik@uny.ac.id	Author & Translator
Arisa Sespheng	arisa.se@wu.ac.th	Author
Sirisuda Phonthee	sirisupho@kku.ac.th	Author
Ashira Hiruntrakul	hashir@kku.ac.th	Author