Effects of a Combined Physical Exercise Program on Cardiovascular Capacity in Women With Breast Cancer: a Preliminary Study

Efectos de un Programa de Ejercicio Físico Combinado en la Capacidad Cardiovascular de Mujeres con Cáncer de Mama: Estudio Preliminar

Alejandro Jiménez-Marín [1]
Evelyn Martín-Moraleda [2]
María Virginia García-Coll [2,3]
Héctor Asensio Mora [1]
Mónica Castellanos-Montealegre [3]

[1] Faculty of Sports Sciences, University of Castilla-La Mancha, Spain
[2] PAFS (Physical Activity and Health Promotion) Research Group, University of Castilla-La Mancha, Spain
[3] Motor Skills and Sport Excellence Research Group, University of Castilla-La Mancha, Spain

Correspondence:
Alejandro Jiménez Marín
alejandroj.m.01@gmail.com

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Combined Physical Exercise Program in Women With Breast Cancer

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Abstract

The aim of this study was to analyse the effect of a physical exercise program on cardiovascular capacity in women with breast cancer at any stage of the disease. A pre-experimental design based on Pre and Post-treatment was used. Nine breast cancer subjects participated for this study; the sample was divided into two groups. One group performed a combined and supervised physical exercise program, and the control group maintained their activities of daily living. Cardiovascular capacity, body composition, blood pressure, lower body functionality, hand grip strength and balance were measured both pre and post. Significant between-group differences were found at post in 6 minutes walking test distance travelled, waist-to-hip ratio, 30-seconds sit-to-stand test and balance with the non-dominant leg. Our 8-week combined and supervised physical exercise program is able to increase cardiovascular capacity, lower-body strength and non-dominant leg balance, and reduce waist-to-hip ratio of breast cancer patients at any time of the disease.

Keywords: Malignant tumour of breast, concurrent training, 6MWT, body composition, lower body strength.

Resumen

El objetivo de este estudio fue analizar el efecto de un programa de ejercicio físico en la capacidad cardiovascular de mujeres con cáncer de mama en cualquier momento de la enfermedad. Se utilizó un diseño preexperimental basado en Pre y Post- tratamiento. Participaron nueve sujetos de cáncer de mama, se dividió la muestra en dos grupos. Un grupo realizó un programa de ejercicio físico combinado y supervisado, y el grupo control mantuvo sus actividades de la vida cotidiana. Se midieron tanto en el pre como en el post, la capacidad cardiovascular, composición corporal, presión arterial, funcionalidad del tren inferior, fuerza de prensión manual y equilibrio. Se encontraron diferencias significativas entre grupos en el post, en la distancia recorrida en el test de los 6 minutos caminando, en el índice cintura-cadera, 30 segundos Sit to Stand y equilibrio con la pierna no dominante. Los principales resultados mostraron que un programa de ejercicio físico combinado y supervisado de 8 semanas es capaz de aumentar la capacidad cardiovascular, fuerza del tren inferior y equilibrio de la pierna no dominante, y de reducir el índice cintura-cadera de las pacientes de cáncer de mama en cualquier momento de la enfermedad.

Palabras clave: Cáncer de seno, entrenamiento concurrente, 6MWT, composición corporal, fuerza del tren inferior.

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Introduction

Breast cancer is one of the tumours with the highest incidence worldwide; in 2020, it was the most frequently diagnosed cancer, with 2,261,419 cases in total. In 2023, 35,000 new cases of breast cancer were estimated in Spain (Sociedad Española de Oncología Médica [SEOM], 2023).

Treatments to address this disease produce a series of side effects that reduce the quality of life of patients (Courneya, 2001), with the most frequent ones being a decrease in cardiovascular capacity (Adams et al., 2004; Hurria et al., 2016); changes in body composition, such as weight gain and body fat; loss of muscle mass and bone density (Demark-Wahnefried et al., 2018; Goodwin et al., 1999; Hojan et al., 2013; Irwin et al., 2005); joint pain (Arem et al., 2016); peripheral neuropathies (Streckmann et al., 2014); and fatigue (Berger et al., 2012; Ficarra et al., 2022).

Cardiovascular capacity is one of the parameters most affected by treatments such as chemotherapy, radiotherapy, or some targeted therapies. The reduction in maximum oxygen consumption (VO_2max) in these patients can be between 5% and 22% (Hurria et al., 2016). The damage generated in the cells of the cardiovascular system and the toxicity produced by these treatments are some of the causes (Jones et al., 2011). A reduction in cardiovascular capacity linked to cardiotoxicity can increase the risk of various heart diseases, such as coronary artery diseases, myocardial infarction, and cardiomyopathies, among other conditions (Nikovia et al., 2023). In addition, it can affect the functional capacity of patients, their tolerance of daily activities and their daily performance (Aykol et al., 2023; Mera-Mamián et al., 2021), resulting in a decrease in quality of life and increased risk of mortality (Tranchita et al., 2023).

Moderate- and vigorous-intensity physical exercise has been shown to be safe, effective and feasible in women with breast cancer at any time during the disease (Gil-Herrero, McNeely, et al., 2022; Maginador et al., 2020; Schmitz et al., 2010). In addition, it reduces toxicity related to treatments, which helps restrict tumour growth (Maginador et al., 2020). Physical exercise, specifically resistance training, has been shown to be effective for increasing VO_2max. during and after treatment in patients with breast cancer (Kirkham et al., 2016). Increasing VO_2max increases quality of life and functionality and decreases cancer-related fatigue (Ficarra et al., 2022; Hojan et al., 2013; Lamkin & Garland, 2020). In addition, physical exercise improves the metabolic flexibility, number, density, content and oxidative capacity of mitochondria, thus improving the functionality of the cells (San-Millán, 2023).

There are numerous benefits of combined physical exercise (those interventions that combine strength and resistance training) for breast cancer patients (Malveiro et al., 2023; Martínez-Vizcaíno et al., 2023). Therefore, it has been proposed to analyse the impact of a combined physical exercise program on the cardiovascular capacity of this population. In addition, as secondary objectives, the effects of this program on parameters such as body composition, blood pressure, hand grip strength, lower body functionality and balance in women with breast cancer have been investigated.

Methods

Design

This research was carried out via an experimental methodology with a preexperimental design that was based on two small groups pre and post treatment (Thomas et al., 2004), owing to the difficulty of obtaining a large sample for this specific population.

Participants

This study included a sample of nine women with breast cancer belonging to the Asociación de Prevención y atención de Afectadas de Cáncer de Mama (APACAMA) of Toledo. The inclusion criterion in this study was women older than 18 years with a diagnosis of breast cancer at any stage of the disease (survivors with active treatment or advanced disease). The exclusion criteria were the presence of chronic obstructive pulmonary disease (COPD) and the contraindication to physical exercise by the referring physician. The samples were divided into an experimental group (n = 5) and a control group (n = 4). The groups were assigned according to the availability of the participants and not randomly.

Before starting the study, all participants who met the criteria and were interested in participating signed an informed consent form specifying that the study was conducted in accordance with the Declaration of Helsinki.

Procedure

First, an online meeting was organized with all the participants, where they reported on the benefits of physical exercise in patients with breast cancer. In addition, at this meeting, the procedure to be followed throughout the study was detailed, as were the physical exercise programme and assessment tests. Informed consent was subsequently obtained from all participants, and they were summoned to the facilities of the Toledo School of Sports Sciences. Prior to the evaluations, the

participants fasted for a minimum of 4 hours to ensure the correct evaluation of the body composition tests. The tests were carried out in the following order: anthropometric evaluation, body composition, blood pressure measurement, evaluation of hand grip strength, static balance, lower body functionality and, finally, the 6-minute walking test [6MWT] (But-Hadzic et al., 2021).

Instruments and Variables

To assess cardiovascular capacity, the 6MWT was used. It was done outside, on a hard and flat surface. A distance of 30 m was marked, with marks every 3 m, and two points were placed where the participant had to turn around when reaching them. The participant was asked to walk as much distance as possible on this trail for 6 minutes. The distance reached after 6 minutes was recorded, and VO_2max was estimated via the following formula: 22.506-0.271 × weight + 0.051 × distance (6MWT) - 0.065 × age (Mänttäri et al., 2018).

Anthropometric measurements were obtained via a standardized methodology, following the recommendations of the International Society for the Advancement of Kinanthropometry (ISAK). The participants were barefoot, without socks or stockings and with light clothing. A Seca 217 portable height rod (Seca, Ltd., Hamburg, Germany) was used for the height measurement. Waist and hip perimeters were measured with a tape measure, making two consecutive measurements, and if the difference was greater than 1 cm, a third measurement was performed, and the result was averaged over the other measurements.

For body composition, electrical bioimpedance was used (Tanita® Body Composition Monitor model MC 780-S MA, Tokyo, Japan). All the data were processed via DIETOWIN 2023 software, version 11.0 (Dietowin SL). An automatic arm blood pressure monitor (Walson HL888FA, Taipei, Taiwan) was used to assess blood pressure. Manual grip strength was measured via a dynamometer to obtain the grip strength of the dominant and nondominant hands (Takei TKK5401 GRIP-D handgrip dynamometer, Tokyo, Japan). It was measured three times with each arm, without rest, and the arms were alternated with each attempt. For each measurement, the participant was asked to press the dynamometer for 3 seconds. The highest force achieved in each of the arms was recorded.

Lower body functionality was measured with the 30-second sit-to-stand test [30STS] (Gavala-González et al., 2020). The participant was asked to stand up and sit down as many times as possible for 30 seconds. The total number of times the participant rose was recorded.

To evaluate the static balance of the participants, the one-leg standing test was used (Michikawa et al., 2009), where the participant stood with her eyes open. One leg was subsequently lifted at a 90° angle with respect to the hip and held for one minute or as long as possible. Two attempts were made with each leg, and the longest time reached in seconds was recorded.

After the initial assessment, the participants were divided according to their availability into two groups: an exercise group (n = 5) and a control group (n = 4). The interventions are summarized in Table 1, which uses the checklist template and the replication of interventions (Hoffmann et al., 2014).

Before starting the study, descriptive, demographic and medical history data were collected from the participants. After the 8-week intervention period, both groups were sent to the laboratory to perform all the assessments except for the those on the forms with which descriptive data were collected.

Statistical Analysis

The statistical package SPSS® V. 28.0 for Windows 10 (SPSS Inc., Chicago, IL, USA) was used. The Shapiro-Wilk test was performed because the sample size was less than 30 (n = 9) to analyse the distribution and normality of the data. For the variables of age, height, and demographic data and medical history, descriptive statistics (mean, standard deviation and standard error of the mean) were calculated. All the variables, except those referring to the one-way standing test, followed a normal distribution, so Student's t test was applied for related samples (with a 95% confidence interval) to observe the changes between the pre- and postintervention values of each group. Student's t test was used for between-group comparisons of independent samples, establishing a level of significance of $p \leq .05$. Cohen's d was used to study the effect size, in which values less than 0.2 were considered small effects, values between 0.5 and 0.7 were considered medium effects, and values greater than 0.8 were considered large effects (Dominguez-Lara, 2018).

For the variables related to the one-leg standing test, which is nonparametric, the Wilcoxon test was used to observe the differences between the pre- and postintervention values of each group. The Mann-Whitney U test was applied to analyse the differences between both groups, establishing a level of significance of $p \leq .05$. The effect size was studied via biserial correlation, considering values lower than .3 for a small effect, between .3 and .5 for a medium effect, and greater than .5 for a large effect (Dominguez-Lara, 2018).

Table 1
Intervention description using template for intervention and replication (TIDier) checklist

Item number	Item
Brief name	
1	Effects of a combined physical exercise program on cardiovascular capacity in women with breast cancer: A Preliminary study
Why	
2	Analyse the effect of a combined physical exercise program on cardiovascular capacity, body composition, blood pressure, handgrip strength, lower body functionality and balance in women with breast cancer at any stage of the disease.
What	
3	Exercise group had access to the following materials: • Dumbbells from 2 to14 kg • 20 kg Olympic bar • Mats • 1, 2.5, 5 and 10 kg plates • Low, medium and high intensity elastic bands Both groups received general physical activity recommendations.
4	8 weeks combined physical exercise program with strength and resistance exercises.
Who provided	
5	Two fourth year Physical Activity and Sport Sciences students, with previous experience in personal training in oncology patients.
How	
6	Supervised face-to-face sessions in groups of two to three people.
Where	
7	• Strength exercises: Multipurpose gymnasium of the Faculty of Sports Sciences of the University of Castilla-La Mancha in Toledo for strength training. • Resistance exercises: At Senda Ecológica in Toledo.
When and how much	
8	Two weekly sessions of 1 hour, with 48 hours between sessions, for 8 weeks. **Resistance exercises** • **Weeks 1 to 4**: Interval training of 5 x 20 s at moderate intensity (RPE 3-6) and increasing 5 s in intervals each week. Rest 2 to 3 minutes. • **Weeks 5 to 8**: Interval training of 5 x 20 s at vigorous intensity (RPE 7-8) and increasing 5 s intervals each week. Rest 2 to 3 minutes. **Strength exercises** Full-body workouts with the main movement patterns, performing two sets of 8-10 repetitions. • **Weeks 1 to 2**, "Isometric exercises" (30 seconds per repetition): Isometric floor press, Isometric band row, Isometric military press, Isometric pull down, Isometric wall squat, Isometric Romanian deadlift. • **Weeks 3 to 4**, "Exercises with self-loading": Floor press with elastic band, Rowing with elastic band, Military press with elastic band, Pull down with elastic band, Squat, Romanian deadlift with elastic band. • **Weeks 5 to 6**, "Exercises with light external loads" (RPE 4-5): Floor press with dumbbells, Rowing with dumbbells, Military press with dumbbells, Biceps curl with dumbbells, Back squat with barbell, Romanian deadlift with barbell. • **Weeks 7 to 8,** "Exercises with heavy external loads" (RPE 7-8): Floor press with dumbbells, Rowing with dumbbells, Military press with dumbbells, Biceps curl with dumbbells, Back squat with barbell, Romanian deadlift with barbell.
Tailoring	
9	Endurance training could be done walking or walking, depending on the subject's capabilities.
Modifications	
10	A third strength set was added from week 3 to meet the session duration.
How well	
11	Trainers trained in physical exercise in oncology patients.
12	Attendance to the exercise program (%) was 90.00 ± 12.96.

Results

Table 2
Characteristics of the sample

	Total
Age in years, *M* (*SD*)	51 (11.48)
Height in meters, *M* (*SD*)	156.73 (5.9)
Medical history, *n* (%)	
Cancer diagnosis	
LUMINAL A	3 (33.3)
LUMINAL B	3 (33.3)
TRIPLE NEGATIVE	1 (11.1)
HER2+	2 (22.2)
Type of patient	
Under treatment	7 (77.8)
Survivor	2 (22.2)
Menopause	
Premenopausal	7 (77.8)
Postmenopausal	2 (22.2)
Stage of cancer	
I	1 (11.1)
II	5 (55.5)
III	3 (33.3)
Metastasis	
No	6 (66.7)
Nodes	1 (11.1)
Bones	1 (11.1)
Multiple	1 (11.1)
Surgery	
Yes	8 (88.9)
No	1 (11.1)
Type of surgery	
No	1 (11.1)
Breast-sparing	4 (44.4)
Partial mastectomy	1 (11.1)
Total mastectomy	1 (11.1)
Double mastectomy	2 (22.2)
Chemotherapy	
Yes	7 (77.8)
No	2 (22.2)
Active chemotherapy	
Yes	3 (33.3)
No	6 (66.7)
Radiotherapy	
Yes	7 (77.8)
No	2 (22.2)
Hormonal treatment	
Yes	7 (77.8)
No	2 (22.2)

Characteristics of the Sample

As shown in Table 2, in this study, nine participants were recruited, and eight of them completed the final evaluation after the exercise program. The average age of the participants was 51 ± 11.4 years.

In terms of medical history, 66.6% of the participants had been diagnosed with luminal A (33.3%) or luminal B (33.3%) cancer. The majority (77.8%) were receiving treatment at the time of the study, and 77.8% had been diagnosed with cancer before menopause. A total of 55.5% of the participants had been diagnosed with stage II disease, and 66.7% did not have metastases. A total of 88.9% had surgery. Chemotherapy was administered to 77.8% of the participants, but currently, only 33% of them continue with the treatment. A total of 77.8% had received radiotherapy, and a similar number (77.8%) continued with hormonal treatment.

Comparison Before and After the Program

According to the data presented in Table 3, differences in fat-free mass (kg) and percentage were detected in the control group. In addition, differences were found in the systolic pressure values.

Regarding the exercise group, differences were found in the distance covered in the 6MWT, as well as in the number of repetitions performed in the 30STS.

Table 3
Changes in the variables evaluated pre-post combined physical exercise intervention

	CG (*n* = 4), *M* ± *SD*				EG (*n* = 5), *M* ± *SD*					
Variables	**Pre**	**Post**	**Δ**	***p*[a]**	**Pre**	**Post**	**Δ**	***p*[a]**	***p*[b]**	***ES***
Cardiovascular capacity										
6MWT distance travelled (m)	530.63 ± 70.54	574.75 ± 42.23	44.13	.192	645.75 ± 76.86	769.25 ± 134.73	123.5	**.024***	**.033***	-1.948[e]
VO2max estimated (ml/kg/min)	26.15 ± 3.85	28.43 ± 2.32	2.28	.196	32.97 ± 7.76	36.80 ± 12.93	3.83	.197	.248	**-0.846**[e]
Body composition										
Weight (kg)	70.60 ± 17.28	70.50 ± 17.49	-0.10	.572	62.60 ± 14.14	63.38 ± 12.65	0.77	.383	.534	0.467
Fat mass (kg)	25.90 ±10.33	26.90 ± 9.79	1.00	.088	20.85 ± 8.81	20.20 ± 8.66	-0.65	.102	.345	0.725[d]
Fat mass (%)	35.85 ± 6.91	37.53 ± 5.50	1.68	.144	32.40 ± 5.64	30.95 ± 6.50	-1.45	.071	.173	**1.092**[e]
Fat-free mass (kg)	44.18 ± 8.47	43.60 ± 8.62	-0.57	**.019***	41.75 ± 5.47	43.18 ± 4.32	1.43	.127	.933	0.062
Fat-free mass (%)	63.20 ± 5.33	62.48 ±5.50	-0.73	**.024***	67.63 ± 5.66	69.05 ± 6.50	1.43	.070	.173	**-1.092**[e]
Bone mass (kg)	2.333 ± 0.47	2.333 ± 0.47	0.00	-[c]	2.13 ± 0.26	2.20 ± 0.22	0.08	.058	.839	0.150
BMI	28.88 ± 4.82	28.80 ± 4.92	-0.07	.391	24.93 ± 4.30	25.25 ± 3.73	0.32	.340	.294	**0.813**[e]
Hip circumference (cm)	108.67 ± 7.57	103.25 ± 7.64	-5.42	**.001***	98.75 ± 4.19	105.38 ± 11.26	6.63	.204	.765	0.221
Waist circumference (cm)	101.04 ± 12.51	95.75 ± 15.58	-5.29	.051	78.38 ± 8.75	77.00 ± 11.30	-1.38	.740	.099	**1.378**[e]
WHR	0.93 ± 0.05	0.92 ± 0.08	0.00	.836	0.79 ± 0.09	0.73 ± 0.04	-0.06	.166	**.006***	**2.902**[e]
Blood pressure										
Systolic (mmHg)	125.75 ± 10.37	114.00 ± 5.60	-11.75	**.023***	114.75 ± 4.27	112.00 ± 4.83	-2.75	.382	.608	0.383
Diastolic (mmHg)	78.75 ± 6.24	82.25 ± 9.14	3.50	.544	76.25 ± 4.27	74.75 ± 3.30	-1.50	.620	.174	**1.091**[e]
Lower body functionality										
30STS	15.25 ± 1.71	18.25 ± 5.06	3.00	.199	16.25 ± 2.21	24.75 ± 5.05	8.5	**.014***	.119	-1.285[e]
Handgrip strength										
Dominant hand (kg)	23.10 ± 5.84	25.63 ± 7.82	2.53	.276	21.65 ± 4.94	23.75 ± 4.66	2.1	.391	.695	0.291
Nondominant hand (kg)	22.43 ± 9.54	23.38 ± 8.44	0.95	.586	22.4 ± 4.16	24.62 ± 4.60	2.22	.236	.804	-0.184
Balance										
Dominant leg (s)	50.75 ± 18.5	51.75 ± 16.5	1	.655	42.80 ± 19.15	60.00 ± 0.00	17.20	.180	.317	0.353[d]
Nondominant leg (s)	45.5 ±22.51	40.75 ± 16.68	-4.75	.593	54.00 ± 5.52	60.00 ± 0.00	6.00	.180	**.047***	**0.701**[e]

Note: CG = Control group; EG = Exercise group; 6MWT = six-minute walking test; 30STS = 30 seconds sit to stand; Δ = difference between pre and post.

a = Comparison between base and post.

b = Differences between groups at post.

c = T cannot be calculated because the standard error of the difference is 0.

d = Medium ES.

e = Large ES.

* = $p \leq .05$.

Comparison Between Groups

Significant differences in the distance travelled (m) in the 6MWT, in the waist-to-hip ratio (WHR) and in the time spent in balance with the nondominant leg were detected between the two groups.

In addition, a large effect size was observed for the variables referring to cardiovascular capacity, the percentage of fat mass and fat-free mass, BMI, waist circumference and the WHR. Similarly, a large effect size was observed for systolic pressure, 30STS repetitions, and nondominant leg balance. A medium effect size was observed for fat mass (kg).

Discussion

The objective of this study was to analyse the effect of a combined physical exercise program on the cardiovascular capacity of women with breast cancer at any time during the disease course.

Our findings revealed that, after 8 weeks of combined physical exercise, the exercise group was able to cover a greater distance in the 6MWT than the control group, with this increase being greater than 50 m, which is considered a significant clinical difference in most populations (Kirkham et al., 2016). The distance reached by the exercise group was similar to that reached by the group of active women with breast cancer in the cross-sectional study by Gil-Herrero, Pollán, et al. (2022). The increase in distance is not influenced by the stage of the cancer, type of surgery or hormonal treatment (But-Hadzic et al., 2021), so it allows us to compare the population of interest in this study, despite being at different stages of the disease.

In line with the above findings, the differences observed between the groups could be related to the inclusion of moderate-to-high intensity cardiovascular exercise. In agreement with other studies, physical exercise interventions with a duration of 8-14 weeks a training frequency of 2-3 times per week, which include between 20 and 45 minutes of moderate-to high-intensity aerobic exercise are effective in improving the cardiovascular capacity of patients with breast cancer during and after treatment (Kirkham et al., 2016).

Another objective of this study was to evaluate the impact of the combined physical exercise program on the body composition and blood pressure of this population. Our results showed that an 8-week physical exercise program is effective in reducing WHR in women with breast cancer, in accordance with the results of other interventions, such as those carried out by Nuri et al. (2012) and Rogers et al. (2009). A reduction in the WHR to less than 0.85 is essential in this population, since high WHR values increase the risk of death from any cause, metabolic complications, and increased risk of recurrence (Chan & Norat, 2015).

Although our results revealed an increase in the percentage of muscle mass and a decrease in the fat mass of the participants in the exercise group, this difference was not significant, but a large effect size was observed for these variables. This could be due to the duration of the program, since some studies have not shown improvements in body composition and body weight until week 20 of the intervention (Kirkham et al., 2016). However, multiple studies have shown differences in these variables with only 12 weeks of intervention (Casla-Barrio et al., 2021; Gil-Herrero, Courneya, et al., 2022; Lee & An, 2022). These improvements are important since the loss of muscle mass in cancer patients is associated with a worse quality of life and greater toxicity during chemotherapy, and the increase in fat mass increases the risk of metabolic and cardiovascular diseases in the long term (Gil-Herrero, Courneya, et al., 2022). In the control group, there were significant differences in fat-free mass and fat percentage. This is because both a sedentary lifestyle (Shur et al., 2021) and treatment (Hojan et al., 2013; Mijwel, Cardinale, et al., 2018; Tram et al., 2022) reduce muscle mass.

With respect to blood pressure, no significant differences were found, but a large effect size was observed for diastolic pressure, such as a decrease in systolic pressure (2.75 mmHg) and diastolic pressure (1.50 mmHg), which agrees with the results obtained in the review by Kirkham et al. (2016) in breast cancer patients during and after finishing the treatments.

Another objective of this study was to observe the impact of a combined physical exercise program on hand grip strength and lower body functionality in this population. After the program, the participants in the exercise group were able to perform a higher number of repetitions in the 30STS than were those in the control group. These results are consistent with those of multiple studies conducted with this group (Gavala-González et al., 2020; Herrero et al., 2006; Santagnello et al., 2020). These strength improvements are related to a better quality of life for patients because these patients show greater satisfaction with their physical condition (Hojan et al., 2013), better functionality and ease of performing activities of daily living.

With respect to hand grip strength, no differences were observed between the two groups. As we have commented previously, one of the main limitations of these differences is the duration of the program, since numerous studies show differences in these variables as the program lasts longer (Lee & An, 2022; Mijwel, Backman, et al., 2018). In turn, this could be because our participants had greater manual grip strength than the expected values for their age, as occurred in the study by Parkinson et al. (2023), where there was no improvement after one year of intervention.

Finally, another objective of the study was to examine the effect of a combined physical exercise program on balance in breast cancer patients at any time during the disease course. Our results revealed a significant improvement in the balance of the nondominant leg in the exercise group compared with the control group. Although we do not perform specific balance exercises in the program, the gain in strength obtained in the lower body contributes to balance in a keyway (McLay et al., 2019).

Limitations

One of the main limitations of this study is the sample size, due to the specificity of the population, in addition to being a group with little interest in practising physical exercise. Another limitation is the heterogeneity of the sample, due both to the types of breast cancer and to the time in which the disease was found in each one of them, which could affect the results obtained. Another limitation of the study is the division between groups, since it was not randomized because it was based on the availability of the participants to carry out the program. On the other hand, the duration of the exercise program was a limiting factor, since with a longer program, more differences could have been observed in the variables evaluated.

Conclusions

The findings of this study indicate that an 8-week supervised and combined physical exercise program improves the cardiovascular capacity, strength and functionality of the lower body, as well as the balance of the nondominant leg, in patients with breast cancer at any time of illness. In addition, this type of intervention has been shown to reduce the waist-hip ratio in this population.

Ethics Committee Statement

The study was conducted in accordance with the Declaration of Helsinki and participants signed an informed consent form prior to participation in the study.

Conflict of Interest Statement

The authors declare that they have no conflicts of interest.

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This research received no funding due to it being not necessary.

Authors' Contribution

Conceptualization: A.J. & M.C.; Data curation: A.J. & H.A.; Formal analysis A.J.; Investigation: A.J., E.M., H.A., & M.V.G.; Methodology: A.J., E.M., H.A. & M.C.; Project administration: M.C.; Resources: M.V.G.; Supervision: M.C. & M.V.G.; Validation: M.C. & M.V.G.; Visualization: A.J.; Writing – Original draft: A.J. & M.C; Writing – review & editing: A.J., E.M., H.A., M.C. & M.V.G. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author alejandroj.m.01@gmail.com.

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