A Supervised Home-Based Exercise Program to Improve Functional Performance in Women With Breast Cancer (Home-Pac): A Randomized Controlled Trial

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Background: Endocrine therapy's effects may hinder the functional performance and quality of life of women with breast cancer. Physical activity can counteract these effects, but this population does not regularly adopt it. This study aimed to test the impact of a 12-week home-based exercise intervention with a supervised component on the functional performance, quality of life, and physical activity of women with breast cancer undergoing endocrine therapy. **Methods:** Twenty-one women were initially randomized. Three participants were missing at random before the intervention started, leaving 18 with breast cancer stage I to III diagnosis, aged 18 to 75 years, receiving endocrine therapy, and reporting low to moderate activity levels. The study comprised a weekly online exercise session and, an exercise booklet intervention, and control group. Functional performance, quality of life, and physical activity were assessed. ANOVAs with repeated measures and Bonferroni-adjusted pairwise comparisons were conducted. **Results:** High adherence to program was observed (80%). Significant group-by-time interactions, favoring the intervention group, were found for functional performance—sit-to-stand ($F = 19.64$; $P < .001$; $Eta^2 = .55$), arm curl ($F = 13.01$; $P = .002$; $Eta^2 = .45$), and timed-up-go ($F = 12.22$; $P = .003$; $Eta^2 = .43$); quality of life—insomnia ($F = 6.05$; $P = 0.026$; $Eta^2 = .27$) and global health status ($F = 6.81$; $P = .020$; $Eta^2 = .31$); and total physical activity ($F = 5.95$; $P = .027$; $Eta^2 = .27$). **Conclusion:** The findings suggest that home-based exercise programs might be feasible and improve strength and overall mobility. These programs may contribute to increasing physical activity and quality of life of women with breast cancer. Further studies with larger samples are needed to confirm these findings. **(Rehab Oncol 2025;43:26–37)** *Key words: adherence, breast cancer, functional performance, home-based, physical activity*

Breast cancer affects many women worldwide.[1] Cancer treatments, such as endocrine therapy, have multiple side effects that compromise the quality of life and functional performance (ie, the person's ability to carry out daily activities that require physical effort) of women with breast cancer.[2,3] Endocrine therapy's common side effects include loss of bone density, arthralgia, muscle pain, fatigue, decline in muscle strength and cardiorespiratory fitness, and increased body fat.[3] The magnitude of the pain-related side effects may lead to low adherence and abandonment of adjuvant endocrine therapy among women with breast cancer.[4,5]

Physical activity is a feasible strategy to counteract many physiological and psychological treatment- and therapy-related side effects.[6] Boing et al[3] meta-analysis reported positive effects of exercise on increasing cardiorespiratory fitness, pain reduction, and arthralgia in women undergoing endocrine therapy. Zhu et al[6] systematic review showed positive associations between exercise and quality of life, self-esteem, attitudes toward life, reduction

Rehabilitation Oncology

The authors declare that they have no competing interests.

Online Publication date: January 8, 2025

Received: February 2, 2024; Accepted: November 13, 2024

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DOI: 10.1097/01.REO.0000000000000382

in depression and anxiety symptoms, improved body composition and muscular strength, and reduction in specific physiological markers (eg, interleukin-6). Also, physical exercise may improve adherence to endocrine therapy by reducing the magnitude of side effects (eg, arthralgia-related pain).[4]

Despite the known benefits, women with breast cancer show low compliance with physical activity guidelines.[7] Women with breast cancer often fail to comply with exercise programs due to, but not limited to, time constraints, difficulties in traveling, and conflicting commitments.[8] Home-based exercise programs (ie, performed inside or in the immediate surroundings of a subject's home) can be a feasible strategy to improve physical activity levels, quality of life, and functional performance of women with breast cancer, overcoming commonly reported barriers to physical activity practice, such as lack of time, motivation, traveling, and financial issues.[9] According to Denton et al[10] classification, these exercise programs can vary in their degree of structure (depending on the level of tailoring and individuality that goes with the exercise prescription) and extent of professional supervision (supervised, facilitated, or unsupervised). A prior systematic review found high adherence levels (71%-88%) to home-based exercise interventions in women with breast cancer and multiple physiological benefits.[11] Coughlin et al[12] showed that these interventions effectively increased physical activity levels and improved this population's functional performance, aerobic capacity, body composition, and quality of life. These outcomes appear to be more enhanced in supervised home-based interventions than unsupervised ones.[13] Another study conducting a supervised home-based exercise program reported significant improvements in quality of life and strength levels in women with breast cancer.[14] However, the number of supervised home-based exercise interventions remains limited.[11,15]

Remote technologies offer a novel delivery mode for promoting PA.[16] Remote physical activity interventions offer an opportunity to reach many people at a relatively low cost and have been shown to change physical activity behavior effectively.[17] Their relevance has increased even more since the COVID-19 pandemic, especially for more vulnerable populations like those living with chronic diseases. Still, few remote exercise interventions in cancer survivors have been identified in prior systematic reviews, showing inconsistent results.[18-20] Therefore, developing and testing novel remote exercise interventions has been recommended to evaluate their effectiveness and usefulness for clinical practice.

The current study sought to address these 2 research gaps by testing the effects of a 12-week online home-based exercise intervention, with a directly supervised and an autonomous booklet-based component, on the functional performance, quality of life, and physical activity levels of women with breast cancer undergoing endocrine therapy. Adherence to the intervention was also investigated. We hypothesized that participants from the intervention group would present better functional performance than the control group. Second, we hypothesized that the intervention group would improve quality of life more than the control group. We also expected the intervention group to present greater physical activity levels at the program's end. Finally, we hypothesized that adherence to the program would be high.

METHODS

Study Design

The Home-PAC was a 2-arm randomized controlled trial comprising a 12-week structured and supervised home-based exercise program, according to Denton et al[10] classification. This intervention was supported by an exercise booklet and involved a supervised component consisting of one online group exercise session per week and an unsupervised exercise component during the rest of the week, compared to a waiting-list control group following usual care. There was no blinding of outcome assessors or intervention providers to the participant's group.

This study used resources from another trial[21] to apply and test its exercise booklet tool, which was developed to support and guide participants in unsupervised physical activities at home or in other contexts. The study was conducted in collaboration with the University Hospital Centre from Algarve (CHUA), whose medical team helped screen and refer potential participants. Figure 1 presents the CONSORT diagram flow.

Participants

Women were recruited by medical referral from a convenience sample and contacted by one of the researchers to gauge their interest in participating in the study.

The inclusion criteria for entering the study were: (1) women aged between 18 and 75 years old; (2) breast cancer stage I to III diagnosis; (3) undergoing adjuvant endocrine therapy after completing all other treatments (eg, surgery, chemotherapy, radiotherapy, immunotherapy); (4) reporting low to moderate levels of physical activity on the International Physical Activity Questionnaire (IPAQ) (ie not engaging on 3 or more days of vigorous activities for at least 20 minutes per day on 5 or more days of moderate activities or walking for at least 30 minutes each day[22]); (5) having access to a device with the internet; (6) providing written informed consent; 6) available for online sessions (intervention) or to be contacted (control).

The exclusion criteria were: (1) medical contraindications to exercise (determined by their primary physician); (2) medically diagnosed physical or psychiatric illnesses or conditions that enabled them to perform the assessments and/or the intervention (eg, pregnancy or non-medically controlled conditions); (3) presenting high levels

of physical activity on IPAQ; (4) evidence of stage IV cancer, new or recurrent tumors; (5) already on an exercise program.

Sample Calculation

Considering the study design, sample size calculations were performed for the primary outcome, with a factorial variance analysis and repeated measures as the reference statistical analysis. Based on previous research findings,[23,24] the target sample size was estimated at 34 participants to obtain a medium effect size ($\alpha = 0.05$; statistical power = 0.80) using G*Power 3.1. Considering an estimated dropout ratio of 20%, the final estimated sample size was 41.

Participant selection and randomization. Medical professionals from CHUA selected potential participants who were contacted by the hospital between January and February 2023 to assess whether they were interested in being contacted by the research team. One researcher contacted interested participants and invited them for an in-person or online meeting. After the initial contact, a flyer with general information about the study was sent through email. In the initial meetings, project details were explained, doubts cleared, and interested participants signed the written informed consent.

After baseline assessments, participants were randomly assigned to 1 of 2 groups (intervention group or waiting-list control group), with an allocation ratio 1:1, using GraphPad (https://www.graphpad.com/quickcalcs/randomize1/). No stratification factors were used in the randomization process, and randomization was not concealed from the interventionist member of the research team.

Intervention

Home-based exercise intervention group. Participants in this group were provided with an exercise booklet for their home workout sessions and also attended an online instruction session to learn the exercises in the booklet.[21] The researcher explained how to use the perceived exertion scale (Borg's scale) and demonstrated examples for each intensity level. All activities were performed under the researcher's supervision to ensure correct execution.

A certified exercise professional with specific training in exercise for oncologic populations conducted a weekly 60-minute online exercise group session using Zoom software. The primary goal of these sessions was to instruct participants on the effective use of the exercise booklet, proper exercise performance, and attainment of the appropriate volume and intensity during unsupervised training sessions. Second, these sessions aimed to enhance participants' motivation, enjoyment, and dedication to training. This was achieved through positive feedback and encouragement from the supervising professional and by teaching different methods for combining and customizing their training sessions or modifying booklet exercises to reduce or increase complexity during their autonomous training. During group sessions, exercises and progressions were tailored to each participant's physical fitness and health conditions. Also, participants were encouraged to stop if they were excessively fatigued, having trouble breathing, or feeling pain or uncomfortable. This also helped keep their motivation levels.

Each session involved a maximum of 10 women and comprised a 10-minute warm-up with 3 to 5 mobility, activation, and balance exercises, a 40-minute block comprising aerobic and resistance exercises, and a 10-minute cooldown involving breathing and stretching exercises. For resistance training, participants were instructed to use no equipment, use equipment already available at their home (eg, dumbbells or resistance bands), or any objects with some weight (eg, rice packets, water bottles, or backpacks with added weight), and asked to perform 3 to 5 exercises in the first 6 weeks, progressing to 5 to 6 exercises, 2 to 3 sets of 6 to 15 repetitions, with 30 to 60 seconds rest between sets. The aerobic portion of the training started with circuits consisting of 3 exercises performed in sets of 1 to 2 minutes with 30 to 60 seconds rest between sets. Participants were instructed to work with a perceived effort level between 12 and 15 (moderate to vigorous). The supervising instructor provided exercise adaptations for participants unable to achieve the desired intensity or having difficulties performing certain exercises due to limited range of motion, joint pain, or discomfort. Cooldown comprised breathing exercises and light stretches, followed by 5 to 10 minutes for participant questions and reminders to fill out and send their exercise logs.

Participants were encouraged to complete 2 unsupervised training sessions each week using the exercise booklet and engage in brisk walks or other self-selected aerobic activities at a moderate to vigorous intensity, aiming to accumulate 150 minutes per week.[25] Finally, participants who had difficulty accessing the online exercise sessions received step-by-step guidance from a researcher via video call. Also, an email contact was provided to motivate and keep the program on track and address the participant's questions or concerns throughout the study.

The Exercise Booklet

The exercise booklet used in this study comprised 6 groups of exercises: (1) breathing (diaphragmatic breathing); (2) mobility (cat-camel, butterfly, pullover, floor angels, thoracic mobility, chest stretch, wall slides); (3) activation (glute bridge, toe taps, bear plank, superwoman); (4) Balance exercises (alternating knee raises, line walking, single-leg stand with eyes closed); (5) cardiorespiratory (knee elevation, leg curls, jumping jacks); and (6) resistance using bodyweight or external resistance (chair sit-to-stand, static lunges, hip abduction, chest press, chest flies, wall push-ups, back rows, back flies,

bicep curls). All the exercises were provided with a QR code directly linked to a demonstration video. The booklet also provided information about physical activity guidelines for cancer survivors, health benefits of exercising, safety considerations for training, equipment, and accessories needed, and Borg's scale of subjective effort perception, explaining how to use it to monitor and control the intensity of the exercises. Finally, the booklet provided practical instructions on structuring a training session, with examples, including the number of exercises to select per group, the number of sets and repetitions, and the rest between sets and activities.

Exercise logs. The exercise logs were used to register and self-monitor the frequency, volume, perceived intensity, and type of activities performed in the unsupervised training sessions and control any exercise-related adverse events. Participants were also asked to send their weekly logs for tailored feedback, and advice from the exercise professional returned by email.

Control group. Participants in this group were asked to maintain their usual care and current daily routines. After the intervention, participants were offered the exercise booklet and the Home-PAC intervention. During the 12-week intervention period, participants received 6 phone calls lasting 6 to 10 minutes or a text message if they could not answer once every 2 weeks to maintain motivation and interest in the study. No discussion, encouragement, or counselling on physical activity was provided.[26] A log was filled in, including the length of the calls, the participant's health status, motivational status, dropout reasons (if applicable), and other relevant information.

Assessments

All assessments were performed at baseline and intervention's end (12 weeks) in standardized conditions at a local sports center in a calm and comfortable environment. Both assessments were conducted in the same place, at the same time of day, and by the same assessor.

Demographics, physical activity history, and clinical information. A general information questionnaire collected data regarding the participant's age, education level, and physical activity history. Clinical information (ie, breast cancer stage, dates and types of primary treatments, starting date, and kind of endocrine therapy currently being received) was collected from participants' medical records.

Functional performance (primary outcome). Functional performance was assessed by measuring strength (sit-to-stand and arm curl), agility (Timed Up and Go), aerobic capacity (6-minute walk), and flexibility (chair sit-and-reach and back scratch).[27,28]

Quality of life (secondary outcome). The European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 (EORTC QLQ-C30) and breast cancer module (EORTC QLQ-BR23) assessed the cancer-related quality of life.[29,30] EORTC QLQ C-30 is a 30-item questionnaire consisting of 8 multi-item functional (physical, role, emotional, cognitive, and social) and symptom (fatigue, pain, and nausea) subscales, 1 global health status and quality of life subscales, and 6 single items (dyspnoea, insomnia, appetite loss, constipation, diarrhea, and financial difficulties). The breast cancer module QLQ-BR23 includes 23 questions grouped into 6 subscales (ie, body image, sexual functioning, sexual enjoyment, systematic therapy side effects, breast symptoms, and arm symptoms). High scores on functional scales show better functioning, and high scores on the symptoms scale and body image represent higher issues.[31]

Physical activity levels (secondary outcome). The short version of the IPAQ (IPAQ-SF)[32] assessed physical activity levels. The IPAQ-SF is a 9-item questionnaire that measures the weekly time spent on various intensities of physical activity (ie, light, moderate, and vigorous) and sitting time during the week and weekend days. Total physical activity scores and discrimination by intensity were derived from the data collected (min/week) and total sitting time (hours/week).[32]

Adherence to the intervention (secondary outcome). Adherence was assessed through inspection of exercise logs, which included the duration, frequency, type of activity, and rate of perceived exertion, using the Borg CR-10 scale.[33,34] Adherence to the supervised sessions was assessed through presence calculations and a registry.

Statistical Procedures

All statistical analyses were performed using the SPSS Statistics (IBM, version 26.0). The significance level was determined at 5%. Three participants left the study before the intervention started for reasons unrelated to the study (ie, lack of time, personal matters, and non-exercise-related health issues). Therefore, they were assumed to be missing completely at random, and a complete case analysis was performed. There was no missing data for the remaining participants. Descriptive statistics were used to characterize sample features and levels of adherence to the intervention. Independent sample t-tests were used to compare groups at baseline. ANOVAs with repeated measures were conducted. Eta squared effect sizes were calculated. According to Cohen,[23] an Eta^2 of .01 is classified as a small effect, an Eta^2 of .06 as a medium effect, and an Eta^2 of .14 as a large effect. Post-hoc pairwise comparisons, using Bonferroni adjustment for multiple comparisons, were conducted, and mean differences (MD) and 95% confidence intervals (95% CI) were calculated to further explore differences between groups across different time points.

Ethics

Ethics approval was obtained before the study was implemented from the Ethics Committee of Sports and Physical Education Faculty (FEFD) and the Investigation Support Unit of the University Hospital Centre from Algarve (ref. 216.22). The trial was conducted under the Declaration of Helsinki for Human Studies from the World Medical Association.[35]

RESULTS

Participant Characteristics

Of the 110 potential participants in the initial list, 89 declined or failed to meet the eligible criteria, and 21 signed the informed consent (recruitment rate ≈ 19%) and were randomly assigned into intervention (n = 11) or control (n = 10) groups. The included participants were spread across the Algarve region. Most women were considered ineligible to enter the study because they reported considerable levels of exercise, were already engaged in an exercise program, or had conflicting commitments. Of these, 18 participants completed the program and all assessments. Three women left the study before the intervention started for personal reasons that were not related to the study, namely time management issues (n = 1), personal matters (n = 1), and unspecified health issues (n = 1). The participants' flowchart is presented in Figure. Baseline characteristics are shown in Table 1.

Functional Performance (Primary Outcome)

Table 2 shows the results for all functional performance measures. Significant group-by-time interaction effects, favoring the intervention group, were found for 3 functional performance measures, namely sit-to-stand ($F = 19.64$; $P < .001$; $Eta^2 = .55$), arm curl ($F = 13.01$; $P = .002$; $Eta^2 = .45$), and timed-up-go ($F = 12.22$; $P = .003$; $Eta^2 = .43$). These effects were large following Cohen's classification (ie, $Eta^2 > .14$ is considered large). Significant main effects of time were observed for these 3 measures ($P < .01$), with post-hoc pairwise comparisons showing significant improvements in the intervention group from baseline to post-intervention (MD [95% CI])—sit-to-stand: 8.4 [6.2, 10.6] repetitions; arm curl: 9.9 [7.3, 12.5] repetitions, timed-up-go: –.8 [–1.1, –.5]

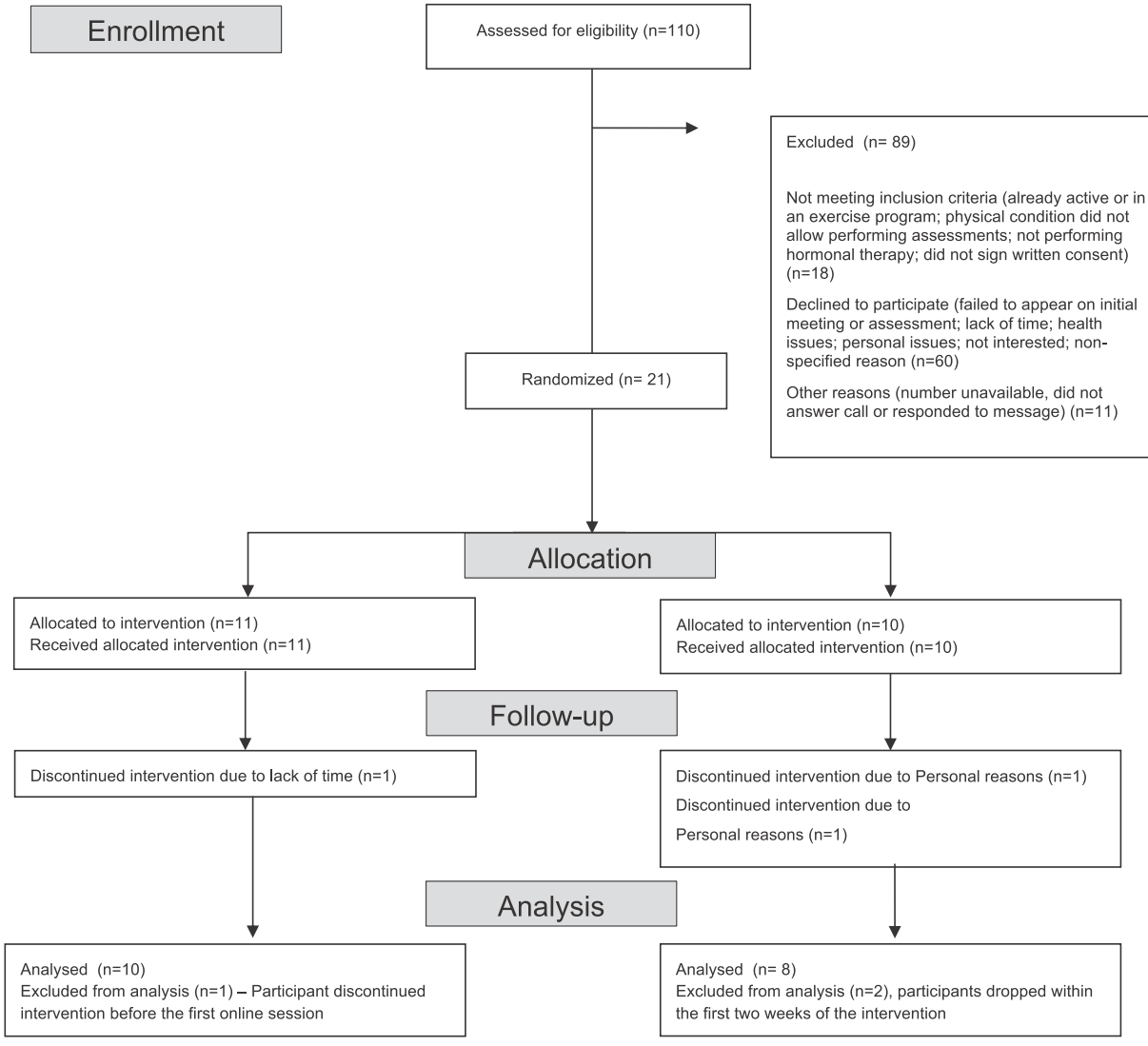

Fig. Study's diagram flow.

TABLE 1
Participant Characteristics at Baseline

Demographics	Intervention Group (n = 10)	Control Group (n = 8)
Age (years)	54.4 ± 9.14	53.0 ± 6.78
Diagnosis stage		
I	4	5
II	5	3
III	1	0
Surgery		
Breast conservative surgeries	5	7
Total mastectomy	5	1
Sentinel node removal		
Yes	8	7
No	2	1
Chemotherapy		
Yes	3	1
No	7	7
Radiotherapy		
Yes	6	7
No	4	1
Time since diagnosis (years)		
≤1	1	0
1-2	5	5
2-3	2	0
3-4	1	2
≥5	1	1
Hormone therapy		
Aromatase inhibitors (anastrozole)	6	5
Selective estrogen receptor modulators (tamoxifen)	4	3
Ovarian function suppressors (goserelin)	4	1
Time since beginning HT (years)		
≤1	4	2
1-2	3	3
2-3	1	0
3-4	1	2
≥5	1	1

Abbreviation: HT, hormonal therapy.
Breast-conserving surgeries: lumpectomy and partial mastectomy.

seconds). Significant between-group differences were found only for the arm curl test (P = .036), favoring the intervention group (MD [95% CI] = 5.9 [2.5, 9.3] at post-intervention). There was a significant main effect of time for aerobic capacity in the intervention group (MD [95% CI] = 140 [57, 224]), but no significant interaction or between-group differences.

Quality of Life

Table 3 presents the results for each quality of life functional and symptom dimension. Significant group-by-time interaction effects were found for insomnia (F = 6.05; P = .026; Eta^2 = .27) and global health status (F = 6.81; P = .020; Eta^2 = .31), favoring the intervention group. The magnitude of these effects was large according to Cohen's cut-off values. Post-hoc pairwise comparisons showed significant improvements in the intervention group from baseline to post-intervention in insomnia scores (MD [95% CI]: –33.3 [–54.9, –11.8]). Although not significant, pairwise comparisons showed a trend toward an improvement in global health status in the intervention group (MD [95% CI]) = 11.7 [–1.3, 24.6]; P = .075) versus deterioration in the control group (MD [95% CI] = –13.1 [–28.6, 2.4]; P = .092]). Significant main effects of time (P < .05) were found in the intervention group for body image (MD [95% CI]) = 15.8 [4.8, 26.9]) and breast symptoms (MD [95% CI] = –12.5 [–21.8, –3.2]), but no significant interaction or between-group effects were found.

Physical Activity Levels

ANOVAs results for physical activity and sitting can be found in Table 4. Significant group-by-time interaction effects, favoring the intervention group, were found for total physical activity (F = 5.95; P = .027; Eta^2 = .27). This effect was of large magnitude based on the Eta squared value. Main effects of time were found for total (P = .003), vigorous (P = .013) and moderate physical activity (P = .044), with post-hoc pairwise comparisons showing significant improvements in the intervention group from baseline to post-intervention total physical activity (MD [95% CI]) = 373 min/week [194; 552]) vigorous-intensity activity (MD [95] = 104 min/week [42; 165]), moderate-intensity activity (MD [95%] = 177 min/week [21; 333]). Main effects of group were found only for total physical activity (P = .005), with significant between-group (intervention vs control) differences at intervention's end (MD [95% CI])—360 min/week [137; 582]).

Adherence to the Program

Participants from the intervention group participated in an average of 9.6 ± 2.0 out of 12 online sessions, corresponding to an average 80% adherence rate. An average of 7.7 ± 4.1 out of 12 weekly logs were retrieved from the participants.

Exercise logs showed a weekly average of 2.2 ± 1.6 days of aerobic activities (ie, brisk walking or other self-chosen activity) for 82.4 ± 44.8 minutes and 1.7 ± 1.4 training sessions, with a duration of 33.8 ± 17.3 minutes per session, performed by the intervention group participants in the unsupervised component.

Exercise-related Self-reported Adverse Events

During the intervention, participants from the intervention group reported pain in the shoulder (n = 4), knee discomfort during sit-to-stand exercises or walking (n = 5), dizziness during walking (n = 4), arm discomfort during unsupervised training sessions (n = 1), joint and muscle pain (n = 2), and back pain (n = 2). However, some adverse effects were felt due to a pre-existing condition or old injury (n = 4). In many cases, the adverse effects were reduced or eliminated across the intervention period

TABLE 2

ANOVA With Repeated Measures for Functional Performance Measured With Seniors Fitness Tests

	Baseline		Post-intervention				
	Mean ± SD		Mean ± SD				
Variable	Intervention (n = 10)	Control (n = 8)	Intervention (n = 10)	Control (n = 8)	Time Effects (p1)	Group Effects (p2)	Group/Time Interaction (p3)
Sit-to-stand (reps)	12.9 ± 4.0	13.62	21.3 ± 5.3	15.1 ± 2.9	<.001	.152	<.001
Arm curl (reps)	14.5 ± 3.1	15.12 ± 2.5	24.4 ± 3.8	18.5 ± 2.6	<.001	.036	.002
Sit-and-reach (cm)	–1.3 ± 10.2	.4 ± 7.4	–1.1 ± 8.9	1.7 ± 8.7	.900	.588	.723
Back scratch (cm)	–6.4 ± 12.7	–2.6 ± 6.8	–3.3 ± 12.2	–.2 ± 6.9	.103	.477	.056
Timed up & go (sec)	5.2 ± .8	4.8 ± .5	4.4 ± .7	4.8 ± .5	.001	.936	.003
6-Min Walk Test (meters)	417.1 ± 146.3	477.2 ± 41.8	557.4 ± 40.0	507.4 ± 109.2	.003	.891	.011

p1, ANOVA within-group effects; p2, ANOVA between-group effects; p3, ANOVA within-between group effects. Significance at $P < .05$.

(n = 8), particularly dizziness during walking, knee discomfort at sit-to-stand exercises, and joint and muscle pain. None of the adverse effects was reported as being aggravated by the exercise performance, and with the correct adaptations, the participants continued the program, and none of them dropped out.

DISCUSSION

This small-scale randomized controlled trial suggests that a structured home-based exercise intervention, comprising a directly supervised digital component, may improve strength (sit-to-stand and arm curl), functional mobility (timed-up and go), and some facets of cancer-

TABLE 3

ANOVA With Repeated Measures for Quality of Life Measured With EORTC-QLQ C30 and BR23

	Baseline		Post-intervention				
	Mean ± SD		Mean ± SD				
Variable	Intervention (n = 10)	Control (n = 8)	Intervention (n = 10)	Control (n = 8)	Time Effects (p1)	Group Effects (p2)	Group/Time Interaction (p3)
EORTC-QLQ C30 (0-100)							
Physical functioning	82.0 ± 13.7	80.8 ± 15.7	86.7 ± 10.9	83.3 ± 16.7	.373	.687	.785
Role functioning	80.0 ± 21.9	81.3 ± 35.0	86.7 ± 13.2	83.3 ± 35.6	.206	.934	.500
Cognitive functioning	73.3 ± 32.6	75.0 ± 26.7	76.7 ± 11.7	83.3 ± 15.4	.242	.682	.610
Emotional functioning	67.5 ± 23.7	75.0 ± 31.8	74.2 ± 22.4	68.8 ± 28.8	.956	.932	.103
Social functioning	86.7 ± 15.3	81.3 ± 27.4	85.0 ± 16.6	89.6 ± 19.8	.471	.960	.285
Dyspnea	7.4 ± 14.7	8.3 ± 15.4	3.3 ± 10.5	12.5 ± 17.3	.955	.420	.347
Pain	33.3 ± 29.4	22.9 ± 33.3	33.3 ± 22.2	20.8 ± 35.4	.861	.390	.861
Appetite loss	13.3 ± 32.2	12.5 ± 35.4	3.3 ± 10.5	16.7 ± 35.6	.518	.645	.128
Fatigue	31.1 ± 26.1	25.0 ± 26.4	22.2 ± 16.6	36.1 ± 30.7	.840	.718	.083
Insomnia	46.7 ± 39.1	25.0 ± 23.6	13.3 ± 17.2	29.2 ± 37.5	.074	.817	.026
Constipation	20.0 ± 42.2	12.5 ± 24.8	3.3 ± 10.5	12.5 ± 24.8	.250	.943	.250
Nausea and vomiting	5.0 ± 11.3	4.2 ± 7.7	1.7 ± 5.3	10.4 ± 23.5	.669	.470	.172
Diarrhea	3.33 ± 10.5	.00 ± .00	.00 ± .00	.00 ± .00	.420	.420	.420
Financial difficulties	10.0 ± 16.1	25.0 ± 38.8	6.7 ± 14.1	33.3 ± 43.6	.624	.132	.260
Global health status	65.8 ± 22.7	70.8 ± 26.0	77.5 ± 11.8	60.7 ± 30.7	.882	.674	.020
QLQ BR23 (0-100)							
Therapy side effects	16.2 ± 17.4	18.1 ± 16.1	13.8 ± 11.0	19.1 ± 15.5	.276	.579	.683
Hair loss	33.3 ± .00	41.6 ± 16.7	26.7 ± 27.9	25.0 ± 31.9	N/A	N/A	N/A
Body image	67.5 ± 34.4	74.1 ± 28.3	83.3 ± 25.5	77.1 ± 24.3	.028	.994	.124
Future perspective	56.7 ± 31.6	41.7 ± 34.5	51.9 ± 44.4	45.8 ± 35.4	.982	.517	.705
Sexual function	66.1 ± 22.8	59.0 ± 24.3	66.7 ± 25.0	70.8 ± 23.2	.184	.896	.229
Sexual enjoyment	40.0 ± 27.9	27.8 ± 25.1	61.1 ± 25.1	33.3 ± 21.1	N/A	N/A	N/A
Arm symptoms	16.7 ± 13.1	20.8 ± 18.3	23.3 ± 14.3	19.4 ± 18.6	.454	.984	.259
Breast symptoms	22.5 ± 15.7	25.0 ± 19.4	10.0 ± 11.7	21.9 ± 16.0	.030	.298	.174

N/A: not applicable (insufficient data to allow ANOVA analysis).

p1, ANOVA within-group effects; p2, ANOVA between-group effects; p3, ANOVA within-between group effects. Significance at $P < .05$.

TABLE 4
Anova With Repeated Measures for Physical Activity Levels Measured With IPAQ-SF

	Baseline		Post-intervention				
	Mean ± SD		Mean ± SD				
Variable	Intervention (n = 10)	Control (n = 8)	Intervention (n = 10)	Control (n = 8)	Time Effects (p1)	Group Effects (p2)	Group/Time Interaction (p3)
Physical activity (min/week)							
VPA	9 ± .28	15 ± 42	113 ± 89	33 ± 55	.013	.195	.064
MPA	144 ± 111	68 ± 83	321 ± 235	134 ± 181	.044	.329	.329
Walking	78 ± 78	98 ± 97	171 ± 86	78 ± 61	.190	.212	.053
Total PA	231 ± 166	181 ± 124	604 ± 241	244 ± 194	.003	.005	.027
Sitting time (hours/week)							
	6.7 ± 3.3	5.2 ± 2.9	4.7 ± 3.6	4.3 ± 2.5	.137	.436	.539

p1, ANOVA within-group effects; p2, ANOVA between-group effects; p3, ANOVA within-between group effects. Significance at $P < .05$.

related quality of life (global health status and insomnia) compared to a waiting-list control. These findings corroborate previous studies suggesting additional benefits of including direct supervision in home-based interventions, particularly when involving resistance training, as it may provide a sense of confidence and safety to breast cancer survivors.[36] These results also suggest that direct supervision can be digitally delivered and still produce benefits, as observed in a previous study.[14]

We expected that participants from the intervention group would present better functional performance compared to the control group at post-intervention, but our hypothesis was confirmed only for upper body strength. Nevertheless, significant main effects of time were found for lower body strength, functional mobility, and aerobic capacity, which also indicate a potential benefit of the program on these variables. These results are corroborated by previous studies that also conducted directly supervised home-based exercise programs.[14] Improvements in strength are crucial, as many women with breast cancer report decreased strength and increased weakness after treatment.[37] The improvement in upper limb function, in particular, is extremely relevant in this population since surgical procedures may create functional and symptomatic disturbances that negatively impact women's quality of life and upper limb activity, especially if an axillary lymph node dissection is performed.[38,39] Also, strength improvements might attenuate hormone therapy discontinuation mostly due to osteoporosis, and previously associated with lower muscle strength levels.[40,41] However, further studies are needed to investigate and confirm this potential mechanism and its beneficial impact on bone protection in postmenopausal women with breast cancer undergoing hormonal therapy.

Contradicting previous findings, which show consistent improvements in aerobic capacity,[42] we could only find significant differences across time within the intervention group, but no significant main effects of group or group-by-time interaction. This might be related to the small sample size. Still, some improvements observed in the control group can have attenuated between-group and interaction effects. Improvements in controls are not uncommon in experimental studies and can be related to a greater level of awareness and possible lifestyle changes caused by merely enrolling in a trial and performing baseline assessments.[43]

Results did not confirm our second hypothesis suggesting that the intervention group would have better quality of life than the control group at post-intervention. Still, group-by-time interaction effects, favoring the intervention group, were found for insomnia and global health status. Furthermore, positive main effects of time were observed for body image and breast symptoms in the intervention group. Improvements in sleep quality resulting from physical activity interventions have been previously shown, and recent evidence suggests that poorer quality of life may contribute to worsening functional well-being, stronger fatigue symptoms, and a greater likelihood of experiencing psychological disorders and higher pain.[44,45] When delving further into the potential physiological and psychological mechanisms that could account for the improvement in sleep quality due to the intervention, it seems plausible to establish a link with a potentially improved management of specific menopausal symptoms (eg, hot flashes) according to previous literature.[46-48] Observed improvements in breast symptoms might thus have also led to reduced insomnia levels. Also, sleep quality may have improved due to the benefits of physical exercise on the reduction of potential symptoms of anxiety or depression among participants.[49] Further research could explore these variables to better understand how exercise affects sleep in menopausal women with breast cancer. Regarding body image, it is possible that exercise attenuates the negative body changes induced by breast cancer treatments, as well as the associated psychological distress, which are often associated with a poorer body image.[50,51] Prior research has identified the weight loss prompted by exercise as an important contributor to improved body image.[52,53] Still, other mechanisms like increased self-efficacy or attenuated depressive and anxiety symptoms should

not be discarded.[54] This improvement is extremely relevant for this population, since body image is a major concern for all women with breast cancer, regardless of age. It is marked by psychosocial suffering and fear of negative social repercussions, which may ultimately result in poorer mental health, and a bigger propensity toward psychological problems (eg, depression).[51,55] Future studies would do well to explore the mediating role of these factors onto exercise-induced changes in body image.

The third and fourth hypotheses of this study were confirmed. Adherence to the online group sessions was high (80%), which aligns with other home-based interventions' results.[11,56] The high adherence levels verified in home-based exercise interventions show the potential of these interventions in reducing the participation barriers among this population.[9,57] Participants reported an average of 2 days of moderate aerobic exercise, for a mean total of 82 minutes, and 2 resistance training sessions, with a mean total of 68 minutes per week in the autonomous practice part of the program. The combination of both activities performed in the unsupervised component resulted in an average of 150 minutes of physical activity per week, which shows that the intervention was effective in helping participants meet the recommendations. The high adherence rates and overall increase in physical activity found in this study, suggest the potential effectiveness of this type of intervention for improving active lifestyles among women with a history of breast cancer. This is particularly important, considering that women with breast cancer typically exhibit low levels of compliance with physical activity guidelines,[58,59] and meeting these recommendations significantly reduces risks of cancer recurrence and cancer-related mortality.[60] On the other hand, no significant changes were registered in self-reported sedentary behavior, suggesting the relevance of developing interventions that effectively reduce sedentary behavior in populations with breast cancer at various stages.[61]

Strengths and Limitations

This study is one of the few that performed a home-based exercise intervention with a direct supervision component and used the Denton et al's[10] domains to classify the intervention more accurately and consistently with the literature. Future studies may follow this classification to describe their intervention, facilitating congruence among the different home-based exercise interventions. The accurate classification of the interventions might help to understand whether certain home-based exercise programs are more suitable for specific cancer populations and treatment phases.

This study is not without limitations, and caution is recommended when interpreting and extrapolating the results of this study. The reduced number of participants in each group limited statistical power to detect significant changes/differences and precluded more complex statistical analysis (eg, ANCOVAs). Therefore, it prevented us from drawing robust conclusions or generalizing our findings. Future researchers seeking to replicate this intervention with larger samples would do well to extend the number of recruiting units (eg, collaborating hospitals) and consider less strict inclusion criteria regarding physical activity levels at the entrance. Baseline activity levels could then be considered in primary analyses as a covariate while allowing the inclusion of women who are already physically active to some extent but are not integrated into a structured exercise program. Also, an intent-to-treat analysis was not conducted, as the 3 participants who dropped out of the study were assumed to be missing completely at random, ie, for personal reasons independent of the data. Still, future studies would do well to plan and implement strategies to prevent or minimize dropout throughout the trial and to reduce the length of time between randomization and the intervention's start.

This program was not entirely supervised and had a self-practice component, which might have led to discrepancies in the adopted physical activity levels and, therefore, to the attenuation of differences between groups. Nevertheless, exercise doses were somewhat controlled by using the exercise logs. Also, only 1 group session was conducted per week, and outcome assessments and intervention implementation were not blinded, which could have influenced the magnitude of improvements and the strength of the findings in the study. This mainly occurred due to a lack of financial and human resources. Future studies with a stronger methodology and blinded assessment of at least the primary outcomes will be necessary to confirm the results of this study. Additionally, interventions with higher frequency of weekly exercise sessions should be implemented to better align with physical activity guidelines. This will allow for a comprehensive analysis of the effects of guideline compliance and enable comparisons across different frequencies to establish a minimum dose required for achieving the desired results. In addition, physical activity was assessed through self-reported measures, which relied on participants' memory and interpretation, leading to potential overestimation or underestimation compared to objective measurement methods.[62,63] Future studies might use objective physical activity measurement tools (eg, accelerometers, pedometers, or activity monitors) to estimate participants' physical activity levels more accurately, allowing more solid conclusions on the effectiveness of home-based exercise programs on this outcome.[64] Body composition, a known risk factor for breast cancer development and recurrence, was not measured or controlled, not allowing for verification if the intervention resulted in increased lean mass and reduced fat mass.[65,66] Future studies should consider including and assessing body composition when conducting these programs. Finally, the control group was followed through phone calls or motivational messages to increase their maintenance in the study and monitor their physical activity. Some participants were already performing some physical activity (ie, walking), which might have improved their functional performance

and quality of life, further attenuating group differences. Furthermore, adverse events were not monitored in the control group, preventing exploration and stronger conclusions regarding the effective influence of the intervention in reducing these events.

Despite these limitations, our results suggest a potential positive effect of the intervention on breast cancer survivors' functional performance, physical activity levels, and some aspects of their quality of life, further supporting the limited research available in this field.

Practical Implications

Our findings present an opportunity to explore home-based exercise programs in a mixed supervision format, with both supervised and unsupervised components. Exercise professionals working with these populations may benefit from using this format, since it allows them to broaden their client spectrum and work with women from remote, long-distance locations, or who are immunosuppressed and contraindicated to exercise in a face-to-face context due to the potential development of health complications. This method also guarantees that, even though the training sessions are performed remotely, the exercise professional can supervise, provide feedback, and correct clients, allowing greater safety and confidence, and more sound progresses. It is important to emphasize the importance of exercise selection considering the context, the client's needs, and available equipment.

The positive trends found in our results, along with previous evidence, suggest that home-based exercise programs may be a potentially effective and convenient way for women with breast cancer undergoing hormone therapy to exercise with professional supervision. Therefore, primary care physicians may present this alternative to their patients so they can be more active and benefit from the positive effects of exercise, especially if they live in remote areas without close access to exercise facilities and services or are unable to drive due to certain symptoms or conditions.

Future investigation would do well to continue exploring the potential of home-based exercise programs as a convenient, flexible, and potentially less expensive intervention to enable more robust conclusions. A cost-effectiveness study would be relevant to compare these programs with other exercise programs conducted in different contexts (eg, community, in-person). Also, it is important to investigate the effects of such programs on different disease stages (eg, stage IV breast cancer) and treatment phases (ie, neoadjuvant/prehabilitation, adjuvant/rehabilitation settings) to further explore the potential of remotely supervised interventions at each stage of the patient's journey across the cancer diagnosis. More studies exploring the effects of this type of program in larger samples (to increase statistical power), using more sophisticated methodologies (eg, blinding), investigating different ratios of supervised/unsupervised components, other endocrine therapy drugs, are also needed.

CONCLUSIONS

This small-scale study suggested that home-based exercise interventions, with a directly supervised digital component, might be able to improve strength, functional mobility, quality of life, and physical activity levels of breast cancer survivors. Future studies are needed to explore different types of home-based exercise programs with supervised components, using larger samples, exploring different ratios of supervised/unsupervised settings, and applying these programs in other stages (eg, pre-habilitation, during neoadjuvant and adjuvant therapies).

STUDY DETAILS

Author Contributions

Role	Author
Conceptualization	PGFR, PBJ, GV, AB, EVC
Formal analysis	PGFR
Investigation	PGFR
Project administration	EVC
Resources	PGFR, GV, AB, IN, BR
Supervision	PBJ, GV, EVC
Validation	EVC
Writing—original draft	PGFR
Writing—review & editing	PBJ, EVC

Funding Sources

This study used resources from another trial funded by Fundação para a Ciência e Tecnologia (Grant number: PTDC/SAU-DES/2865/2020). The Municipal Sports Department of Portimão provided space and materials for the measurements and insurance for the participants.

Ethics Approval

This study was conducted after ethical approval from all the institutions was obtained. The participants participated voluntarily and provided written informed consent to participate in this study. Insurance also covered participants and allowed them to receive medical assistance if any accident occurred during the study's intervention. The trial was conducted under the Declaration of Helsinki for Human Studies from the World Medical Association.

Trial Registration

This study and materials are registered in OSF (DOI: 10.17605/OSF.IO/NT24W) and available publicly.

Data Sharing Statement

Anonymized trial data will be available from the corresponding author upon reasonable request for non-commercial research purposes.

ACKNOWLEDGMENTS

The authors would like to thank the Algarve Oncology Association (AOA), which assisted the project by landing volunteers to call the control group participants during the intervention.

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