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Eric Martin
University of Notre Dame Australia, Eric.Martin@nd.edu.au

Claudio Battaglini
University of North Carolina at Chapel Hill, claudio@email.unc.edu

Dianne Groff
University of North Carolina at Chapel Hill, groff@email.unc.edu

Fiona Naumann
University of New South Wales, f.naumann@unsw.edu.au

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Original research

Improving muscular endurance with the MVe Fitness Chair™ in breast cancer survivors: A feasibility and efficacy study

Eric Martin[a,*], Claudio Battaglini[b,c], Dianne Groff[b,c], Fiona Naumann[d]

[a] School of Health Science, The University of Notre Dame Australia, Australia
[b] Department of Exercise and Sports Science, University of North Carolina at Chapel Hill, USA
[c] Lineberger Comprehensive Cancer Center, University of North Carolina at Chapel Hill, USA
[d] School of Medical Sciences, Faculty of Medicine, The University of New South Wales, Australia

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ABSTRACT

Objectives: To assess the feasibility and efficacy of delivering Pilates exercises for resistance training to breast cancer survivors using the MVe Fitness Chair™.
Design: Pilot randomized controlled trial.
Methods: Twenty-six female breast cancer survivors were randomized to use the MVe Fitness Chair™ ($n = 8$), traditional resistance training ($n = 8$), or a control group (no exercise) (CO) ($n = 10$). The MVe Fitness Chair™ and traditional resistance training groups completed 8 weeks of exercise. Muscular endurance was assessed pre and post-test for comparisons within and between groups using push ups, curl ups, and the Dynamic Muscular Endurance Test Battery for Cancer Patients of Various Ages.
Results: Feasibility of the MVe Fitness Chair™ was good, evidenced by over 80% adherence for both exercise groups and positive narrative feedback. Significant improvements in muscular endurance were observed in the MVe Fitness Chair™ ($p < 0.002$) and traditional resistance training groups ($p < 0.001$), but there were no differences in improvement between the MVe Fitness Chair™ and traditional resistance training groups ($p < 0.711$) indicating that Pilates and traditional resistance training may be equally effective at improving muscular endurance in this population.
Conclusions: The MVe Fitness Chair™ is feasible for use in breast cancer survivors. It appears to promote similar improvements in muscular endurance when compared to traditional resistance training, but has several advantages over traditional resistance training, including cost, logistics, enjoyment, and ease of learning.

1. Introduction

Breast cancer survivors (BCS) experience ongoing side effects post-treatment, such as decreased shoulder function, muscle atrophy with concurrent adiposity, and fatigue.[1–3] Several reviews have summarized the evidence that exercise can help relieve or reverse these symptoms.[4–6] Regaining muscular endurance is especially important in BCS to assist survivors regain functionality, perform activities of daily living and/or recreational activities at the same level or better than before treatment, reduce fatigue, and improve their overall quality of life.[1–3]

The American College of Sports Medicine (ACSM) Roundtable on Exercise Guidelines for Cancer Survivors stated that more detailed investigations are needed in exercise oncology programming.[7] Research suggests that cancer survivor preference for exercise varies, and catering to preferences is essential to encourage survivors to engage in and maintain physical activity.[8–10] The ACSM declared that Pilates may be an effective exercise mode, but found no evidence to support the safety or efficacy of Pilates in this population.[7]

Pilates focuses on quality, precision, and control of movement to build core strength and muscular endurance.[11–13] Pilates exercises stimulate proprioception and force the participant to control all phases of motion. This mind-body connection leads to enhanced body-awareness and motor performance, and may improve muscular endurance and uniform muscle development.[11,13,14]

A review of literature found two studies that used Pilates as an exercise intervention in BCS.[11,12] Eyigor et al.[11] randomized BCS to either a mat based Pilates and home exercise routine ($n = 15$) or home exercise routine only ($n = 27$), both lasting 8 weeks. Results indicated that the Pilates group improved significantly more on the 6 min walk test and the sit and reach test compared to the home exercise alone group. Keays et al. explored the effect of total body Pilates training on shoulder function.[12] While they used

* Corresponding author.
E-mail address: eric.martin@nd.edu.au (E. Martin).

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Fig. 1. MFC exercises.

Pictures provided by Peak Pilates®.

multiple Pilates machines in their exercise program, they did not use a Pilates chair. In their study, no adverse events occurred in the four participants, though they showed no statistically significant improvements in shoulder function after 12 weeks.

The MVe Fitness Chair™ (MFC) could be an effective tool for improving BCS' muscular endurance. The pedal can be set to four levels of tension, which either resists force applied against it or assists a person rise from a lowered position.[15] For example, a chest press would use the pedal as resistance, whereas in a step up, where one foot is placed on top of the box and one foot on the pedal, the force of the spring assists the exerciser to rise up. Each exercise has a recommended level of tension, and while the level can be changed to progressively overload the participant, the manual recommends an increase in volume and attention to technique, rather than changing the resistance, to progress the exercises. The MFC facilitates the performance of many Pilates exercises, and compared to other Pilates chairs, has the benefit of being lightweight and stackable, to take up minimum room for storage. Fig. 1 shows the MFC exercises used in this study.

The purpose of this study was to ascertain the feasibility of using the MFC for resistance training in BCS, and to pilot test its efficacy at improving muscular endurance. The secondary purpose was to compare the MFC to traditional resistance training (TRT).

2. Methods

This study used a randomized control trial design to assess the feasibility of using the MFC at the Get REAL & HEEL Breast Cancer Rehabilitation Program (GR&H) and to pilot its efficacy at increasing muscular endurance in BCS. Participants enrolled in GR&H at the University of North Carolina at Chapel Hill (UNC-CH) from January to December 2009. Participants were 26 females, age 29–69 years, diagnosed with stage I, II, or III breast cancer, who had completed all treatments within 6 months, had consent from their oncologist to participate, underwent strict health screening, and signed an informed consent form approved by the Biomedical Institutional Review Board for Human Subjects Research at UNC-CH prior to participating in the study. Exclusion criteria were: cardiorespiratory disease; bone, joint, or muscle pain or abnormalities that would compromise the participant's ability to complete the exercise training protocol; or already enrolled in a formal exercise program.

All participants underwent a baseline assessment before being randomized into three groups: exercise using the MFC ($n = 8$; mean age = 44.6 years); exercise using TRT ($n = 8$; mean age = 47.8 years); or a control group ($n = 10$; mean age = 49.5 years). Simple randomization with replacement was used to place individuals into groups. The MFC and TRT groups exercised for 8 weeks, while the control group was asked to not exercise. Participants were assessed again after 8 weeks.

Prior to testing and each exercise session, resting heart rate, blood pressure, and oxygen saturation levels were assessed via Polar heart rate monitor (Lake Success, NY), Diagnostic 700 aneroid sphygmomanometer (Hauppauge, NY) and Litmann stethoscope (St. Paul, MN), and Sport Stat finger pulse oxymeter (Plymouth, MN), respectively. At baseline and post test, muscular endurance was evaluated by the combined repetitions on a standardized push up test, partial curl up test,[16] and the Dynamic Muscular Endurance Test Battery for Cancer Patients of Various Ages presented by Schneider et al.[17] This protocol provides a table, divided into age groups, that shows what percentage of body weight participants should lift for each exercise. Exercises consisted of performing single arm dumbbell bicep curls on each arm, lateral pull-downs on a cable machine, seated machine leg extensions, and prone machine hamstring curls using resistance training machines (Magnum Fitness Retro Series Machine, South Milwaukee, WI). Participants performed repetitions at 60 beats per minute to a metronome until they could not keep up with the rhythm, could not perform any more repetitions, or chose to stop. The summed total repetitions performed on push ups, partial curl ups, both biceps curls, lateral pull-downs, leg extension, and hamstring curls created a composite score used in the analysis of muscular endurance.

The 8 week exercise intervention was delivered by trainers from the GR&H staff, who were enrolled in a Bachelors or Masters of

Table 1
Resistance training protocols for MFC and TRT.

MVe Fitness Chair™ exercises	Traditional resistance training exercises
Shoulder lateral raise with pump	Lateral raises
Single leg pump	Crunches
Mermaid	Oblique crunches
Front leg pump	Ball squats
Calf raises	Calf raises
Two arm pump	Chest press
Pelvic lift	Bridge

Week	Target intensity	Volume
Week 1	RPE 9–10	1 set of 8 reps
Weeks 2–3	RPE 10–11	1–2 sets of 8 reps
Weeks 4–6	RPE 12–13	2 sets of 8 reps
Weeks 7–8	RPE 13–14	2 sets of 8–10 reps

Table 2
Participant feedback and muscular endurance changes.

"I think it could be used as an all in one fitness and strengthening piece of equipment."
"The nice thing about it over free weights is that the arm is controlled, sort of guides you to different levels of difficulty without overdoing it."
"I love the Pilates machine. I liked how it CAN work every part of your body."
"I feel like I had a better core work out with that machine than I could from free weights. I also noticed that when done properly, the exercises had less stress on joints."
"I liked that I could get an entire workout from one machine."

Group	Baseline		Post intervention		Change score	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
MFC $n = 8$	64.1	(18.4)	100.9[a]	(34.7)	36.8[b]	(22.5)
TRT $n = 8$	63.1	(24.2)	107.6[a]	(35.7)	44.5[b]	(23.5)
Control $n = 10$	61.7	(27.7)	61.9	(25.2)	0.20	(12.5)

[a] Significantly different from baseline ($p < 0.002$).
[b] Significantly different from control ($p < 0.002$).

Exercise and Sport Science and had been trained in exercise principles with BCS by the program director. The interventions were designed by the principal investigator. Given the focus on muscular endurance, the resistance training portion of the exercise routine for the MFC group was designed first, using recommendations and guidelines presented in the manual accompanying the MFC[15] and the ACSM.[7,16] The TRT protocol was then selected using exercises that targeted the same muscle groups in motions similar to the exercises performed for the MFC protocol. The two protocols matched in volume of work and sequence of muscles exercised. For both interventions, exercise sessions started with 15 min of aerobic exercise at 65–75% heart rate reserve, using a treadmill, elliptical, or stationary cycle, followed by 5 min of total body stretching, then 25 min of resistance training (Table 1). After performing the resistance exercises, participants cooled down and stretched for 5 min.

Intensity of resistance exercise was quantified on the Borg Rating of Perceived Exertion (RPE) scale from 6 to 20. The RPE scale is a valid way of quantifying intensity of resistance training.[18] All attempts were made to adhere to the prescribed volume so a training effect could be achieved. The amount of resistance, technique in exercise, and tempo of exercise were manipulated to attempt to reach the target intensity as indicated by RPE. Trainers monitored participants and asked for feedback on the challenge of each exercise, and made adjustments during the exercise as needed to reach the desired RPE. Additionally, participants reported their RPE for each exercise upon completion of the first set, with adjustments being made to the second set if needed.

To help decrease differences in delivery of the intervention between trainers, all trainers attended two workshops to ensure they understood the methods and cues of delivering the exercise modes. The lead investigator led a workshop on the protocols for both exercise groups and supervised trainers throughout the study to ensure accuracy of instruction and delivery.

All data were analyzed using SPSS version 17.0 (SPSS, Inc., Chicago, IL). Significance was set a priori at an alpha level ≤ 0.05. Feasibility was assessed through participant attendance to the program and narrative feedback. Attendance rates were compared between the MFC and TRT groups by ANOVA. Based upon the 82% adherence seen in the study by Schneider et al.,[19] feasibility was determined by an attendance rate of over 80%. Narrative feedback about the MFC was gathered from participants during exit interviews, which were conducted by the same member of the research team, who was not involved in delivering the exercise program. The interviewer took detailed notes regarding participants' answers, which included asking questions about their experiences using the MFC and how it compared to their other exercise experiences.

The efficacy of the MFC for improving muscular endurance was analyzed using a repeated measures ANOVA, comparing all groups from pre-test to post-test to see if their muscular endurance changed throughout the study period. Change scores in muscular endurance were calculated from baseline to post test for each group and analyzed using a univariate ANOVA.

3. Results

The MFC was found to be feasible with all participants completing the intervention and reporting enjoying using the MFC. The MFC group had a mean adherence rate of 83.3%. This was similar to the TRT group ($p = 0.705$), who had an average adherence rate of 81.2%. Table 2 displays some of the comments made by participants. The feedback was all positive on the MFC's use, with major themes being that participants enjoyed the feeling of total body work and that its design helped them follow the staff's instruction because the pedal gave them a control point to fixate upon. From the primary investigator's perspective, the MFC was feasible as it improved muscular endurance in the participants, the novelty of the chair motivated the participants, and it was easy to instruct participants on the MFC's use.

Using the MFC for resistance training proved efficacious at improving muscular endurance, as seen in Table 2. The MFC group increased their muscular endurance score by 36.8 (57%) ($p < 0.002$) and the TRT improved by 44.5 (71%) ($p < 0.001$), while the control group showed almost no change ($p < 0.961$). A comparison of the change scores showed that the MFC and TRT groups were significantly different than the control group ($p < 0.002$ and $p < 0.000$, respectively). While the TRT group showed a larger total gain than the MFC group, this difference was not statistically significant ($p < 0.711$).

4. Discussion

This is the first study to examine the use of the MFC. Based on the results of this study, the MFC seems feasible for use in a cancer rehabilitation clinic. Adherence to the exercise program exceeded 80%.[19] The participants enjoyed the MFC, and when comparing it to their other experiences of exercising, found that it was better at working core muscles and getting a "total body workout" compared to other forms of exercise, like resistance training. At the GR&H clinic, which had a very small floor space, the MFC provided a practical means of completing the resistance training portion of the exercise program. The MFC took up less room than the equipment used for the TRT group (fitness balls, bench, and rack of dumbbells), was easy to move, and multiple MFCs can stack onto each other, conserving more floor space when not being utilized. The principal investigator found it was easier to teach participants, with no resistance training experience, how to perform the exercises with good technique using the MFC compared to free weights, as the design of the chair guides users into the appropriate motions. From the participants' comments both throughout the program and during the exit interviews, the participants perceived that the MFC was able to improve flexibility, balance, and core strength as well as improve muscular endurance. Though this provides only anecdotal evidence as to the potential of the MFC to improve these other outcomes, it would suggest that future trials, using sophisticated measures of these fitness areas, should be conducted to test if these participants' perceptions were correct.

The MFC appears to be effective at improving muscular endurance when used 3 times per week for approximately 25 min a day, over an 8 week period. Both the MFC and TRT groups exhibited a greater increase in muscular endurance in 2 months, at 57% and 71% respectively, than the 48% improvement seen in a 6 month trial conducted by Schneider et al.,[19] which incorporated most of the same exercise prescription elements, including mode (resistance training using free weights, like the resistance training group in this study), workload (moderate to high volumes with low to moderate intensity), and frequency (a target of 3 days per week). When results between the groups in the present study were compared, the MFC was statistically as good at improving muscular endurance as TRT, though the TRT group had a higher improvement score. One likely explanation for this difference is that the testing protocol used traditional resistance training exercises, so the TRT group would have had specific practice at some of the tests. A larger trial would be needed to determine if there is a true difference between using the MFC and TRT on improving muscular endurance. However, even if the MFC cannot produce the same magnitude of long-term muscular endurance increases as TRT, it may elicit enough muscular adaptation to meet the fitness and rehabilitation goals of BCS. This idea is supported by the MFC group resulting in clinically significant gains in muscular endurance, which were even greater than those reported by Schneider et al.[19] The MFC may be easier for patients to access due to its relatively low cost and small physical size, and could become the superior choice for resistance training modality in this population.

In reviewing the literature, only two studies were found that used any form of Pilates in BCS. Both of these studies support the safety of using many forms of Pilates in BCS, but they were not directly comparable to our study's results, as they measured different aspects of fitness.[11,12] The first study, by Eyigor et al.,[11] compared home exercise plus a Pilates routine to the home exercise only. The combined group improved more than the home exercise only group, and this is most likely due to the increased volume of weekly exercise. The Pilates routine used was mat based, focusing on core stability rather than total body muscular endurance. Keays et al.[12] did use some Pilates machines, though not a chair, but in doing so demonstrated that Pilates equipment in general is safe to use in BCS. Together, these two studies[11,12] and the present one demonstrate that different forms of Pilates can be safely performed by BCS, with benefits to functional capacity, flexibility, and muscular endurance.

5. Conclusion

The MFC is a relatively inexpensive piece of exercise equipment that can provide a full body workout without needing any other equipment. Being lightweight, portable, and stackable, it could be ideal for use in a patient's home or in a hospital or clinic setting. Because it provides for a low intensity workout, oncologists may consider having one or more MFCs at the hospital oncology ward, for patients to use on the days they come in for treatment, perhaps while waiting for the results of their blood tests to determine if they will be able to take their chemotherapy or radiation dose that day. The MFC might also be a better option for equipping a new outpatient rehabilitation clinic with a small floor space, where large resistance training machines or racks of free weights would not fit.

The ACSM identified the need to determine the safety and efficacy of all forms of exercise for cancer survivors.[7] From participant reports in this study, the MFC would have been a desirable piece of equipment to have access to or even own in order to maintain an exercise routine after formal instruction on proper technique had been given in a structured setting. The main benefit of the MFC is that it guides users through the exercises because of the continuous resistance and fixed pedal motion. The MFC may be appropriate for an exercise physiologist, physiotherapist, or nurse who is seeking a rehabilitation mode appropriate for BCS they work with. Its ease of use, both in performing and learning the exercises, and ability to work all different body parts safely and gently, make it a good option to incorporate into, or stand alone to create, an exercise program in this population.

6. Practical implications

- The MFC provides an efficient, effective, and safe mode of resistance training for BCS.
- The MFC may be a superior choice than TRT for BCS based upon cost, logistics, enjoyment, and ease of instruction.
- The MFC accommodates a range of exercise intensities, from gentle to very vigorous.
- The design of the MFC facilitates learning correct exercise technique.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jsams.2012.08.012.

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