The Effects of a Ten-Week Multifaceted Exercise Program on Muscle Strength and Aerobic Capacity in Women with Breast Cancer

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ABSTRACT

Objectives: The objective of this pilot study was to determine the benefits of participation in a multifaceted exercise program for women in breast cancer survivorship and then to assess physical adaptations to training. Background: Inactivity in the breast cancer population has been shown to have potentially negative consequences. Evidence suggests regular participation in exercise promotes improved cardiopulmonary function, strength, and flexibility among women in breast cancer survivorship. However, previous studies of exercise programs often reflect only one regimen of exercise for subjects to complete. Methods and Measures: A quasi-experimental research design, using a pre-test and post-test, was utilized for this ten-week study. Twelve females diagnosed with breast cancer within the last eight years met the inclusion criteria for enrollment in a bi-weekly multifaceted exercise intervention program. This program consisted of aerobic (i.e. bike, treadmill, elliptical, walking track, stair climbing); flexibility (i.e. yoga, active joint motion stretching, foam roller); and strengthening (i.e. free weights, pilates, tai chi, stability ball, BOSU ball, circuit training, theraband routine) The study, in part, assessed aerobic capacity and upper extremity muscle strength. Measurement tools used included the YMCA bike protocol and manual muscle testing. The means and standard deviations were used to determine the descriptive analysis of all data collected. Inferential statistics were analyzed using Wilcoxon Sign Rank test for pre-test and post-test measures due to a small sample size. Statistical significance was determined at p <0.05. SPSS version 11.5 was used to analyze the data. Results: Nine of the twelve participants completed the testing for analyses. Upon study completion, two participants improved aerobically, two aerobically decreased, and five participants had no change in their aerobic capacity. All participants experienced muscle strength gains of a minimum of 1/3 grade in at least one muscle group. An increase in lower trapezius muscle strength was achieved by all subjects. The two participants with improved aerobic capacity experienced strength gains in every muscle category. Conclusion: A multifaceted exercise program has the potential to increase scapular muscle strength and is a consideration for increasing activity levels in women one to eight years post breast cancer diagnosis.

Introduction

Disease pathology of cancer and its treatments, which may include surgery, radiation, chemotherapy, hormonal, and/or biological therapies, cause side effects that can negatively affect the integrity of the body at a functional level.\(^1\) Research\(^2\)\(^-\)\(^4\) suggests that upper extremity functional limitations and decreased aerobic capacity occurs in women during treatment for breast cancer and may exist for two or more years in women after treatment for breast cancer. Jones\(^4\) reported that women diagnosed with breast cancer demonstrated values of aerobic capacity and upper extremity strength lower than reported normative values of women in similar age groups. Women with a breast cancer diagnosis had an average of 30% less aerobic fitness compared to the normative values. These significant impairments in cardiopulmonary function were evidenced...
across the continuum of survivorship compared to age-matched healthy women. The research suggests that the decline in aerobic capacity may be due, whether directly or indirectly, to the effects of the treatment for cancer. The decreased physical activity, associated with the side effects of treatment, could lead to deconditioning. The most significant strength deficits in the breast cancer population post-treatment have commonly been identified in scapular abduction, adduction, upward rotation, and depression, as well as shoulder flexion, external rotation, internal rotation, scaption, and adduction movements.

Additionally, studies show that physical activity is a core element for the rehabilitation of the disease by improving overall quality of life and decreasing mortality rates. Research has demonstrated that regular participation in exercise can improve areas of noted functional deficits including aerobic capacity, strength, and flexibility in women diagnosed with breast cancer post-treatment.

De Backer and colleagues reported evidence of significant improvements in cardiopulmonary function (from 6% to 39%) following an exercise intervention. A randomized controlled trial (RCT) by Winters-Stone et al. studied 106 post-menopausal breast cancer survivors. The women assigned to the one-year resistance exercise program significantly improved in upper and lower body strength in comparison to the stretching group. Lee et al. conducted a randomized controlled trial of thirty-two women diagnosed with breast cancer. The scapula-oriented exercise group demonstrated increased strength, improved quality of life, and decreased pain when compared to a general exercise group or control group.

Schmitz et al. completed a systematic review of fifty-four (RCTs) women during and after breast cancer treatment. Twenty of twenty-two studies noted statistically significant improvements when examining aerobic fitness. Eleven studies found statistically significant improvements in muscular strength. Lastly, Rogers et al. studied forty-one sedentary women on hormone therapy post breast cancer diagnosis and demonstrated statistically significant increases in accelerometer physical activity, aerobic fitness, and muscle strength in the legs and back after a twelve-week multidisciplinary physical activity behavior change intervention.

The development of an exercise protocol tailored to the needs, interests, and preferences of women with breast cancer may promote adherence to regular exercise participation. Therefore, this part of a larger study sought to develop a variety of exercise interventions in order to expose the women to an assortment of physical activities, provide information on safe and effective exercise practices, and use feedback provided by the subjects to guide subsequent sessions. The purpose of this study, in part, is to determine if a multifaceted exercise program positively influences aerobic capacity and strength in women diagnosed with breast cancer. The significance of this study is to promote long-term healthy behaviors in women diagnosed with breast cancer.

Methods

The research design is a quasi-experimental pilot cohort study. Institutional Review Board approval was obtained through Oakland University. The data obtained was from a larger study that assessed physiological, anthropometric, and musculoskeletal changes during exercise training in females diagnosed with breast cancer.
Forty breast cancer survivors aimed to be recruited via personal contacts, pamphlets, websites, and other advertisements through local cancer centers, local university, the surrounding community, and a local mindfulness program for breast cancer survivors. Inclusion criteria was met if females were diagnosed with breast cancer, between the ages of eighteen and seventy, no more than eight years post cancer diagnosis, and received physician clearance. Participants were excluded if they did not receive physician clearance; if they experienced abnormal responses identified during baseline tests, such as abnormal increase in heart rate, blood pressure or oxygen saturation, difficulty breathing, and dizziness; and/or were greater than eight years post cancer diagnosis.

Informed consent and physician clearance was obtained from each participant and the rights of the subjects were protected. Data was de-identified and numerically coded to preserve confidentiality. A physician was present during all pre-post testing procedures. This study focuses on two components of a larger study, specifically aerobic capacity and scapular muscle strength. Each participant completed aerobic capacity testing based on a modified YMCA Bike Protocol. Unlike a maximal stress test where a person is commonly taken to their maximal heart rate without complication, this is a sub-maximal test. This physical test was completed on a stationary bike (Monark Ergomedic 828) while examiners monitored blood pressure manually using a blood pressure cuff (blood pressure was taken periodically while on the bike, therefore subjects were wearing the blood pressure cuff during testing). Heart rate and oxygen saturation data were collected from a pulse oximeter monitor (John Bunn finger pulse oximeter) which was placed upon the index finger of the participant. Exertion rates were obtained utilizing the six to twenty Rate of Perceived Exertion (RPE) Scale.

Although it is a common assessment tool for research, several studies report that sub-maximal tests generally under-predict one’s max VO2 when compared to the gold standard of a maximal VO2 test. The Standard Error of Measure for the bike protocol is 4.2-5.7 milliliters/kilogram/minute and the minimal clinically important difference (MCID) is 3.5 milliliters/kilogram/minute. Association with the gold standard is: an R2 value of .56 -.94. Manual muscle testing per Daniels and Worthingham protocol was completed for strength of rhomboids, middle trapezius, lower trapezius, and serratus anterior. These muscles were targeted due to being commonly weak within the breast cancer population. Muscular tests may have been modified or eliminated based on the participant’s current physical status. If the test position was modified, it was noted in the subject’s file. The tests were completed by the primary investigator. The exercise position determined for each participant at baseline was repeated for post-test measures. According to Cuthbert and Goodheart, manual muscle test-retest reliability is between .96 -.98. The MCID has not yet been established. Participants completed the pre-test followed by a ten week, bi-weekly multifaceted exercise program. A multifaceted exercise program is characterized as a variety of exercise interventions including flexibility, strength, and aerobic training. All exercise sessions consisted of five to ten minute cardio warm-ups utilizing a stationary exercise bike, treadmill, rowing machine, walking on an inside track or stair climbing. This warm-up was followed by cardio exercise and strength training ranging from twenty to sixty minutes. The multifaceted exercise sessions were purposely developed to provide a variety of exercise options for the participants so they could understand that aerobic, flexibility and strengthening exercise can be achieved in a variety of
formats. This allowed for each individual participant to find what exercise program they enjoyed the most to encourage sustainability of a long-term commitment to exercise. Strengthening exercises in the fitness center consisted of: free weights for shoulder flexion, abduction, scapular retraction; lat pulldown; shoulder press/overhead press; seated rows; upper extremity pullover (extensions and core stability); lateral raise; prone glut; seated hamstring (knee flexion); and seated quads (knee extension). Several other exercise routines were experienced one time each including: yoga, pilates, Zumba, tai chi, routines with the BOSU ball, stability ball, foam roller, and theraband as well as a circuit training routine.

Each participant had her blood pressure taken pre and post exercise by one of the researchers. Participants were instructed in the use of the RPE scale (never exceeding thirteen) as a guide for their endurance and safety. In addition, research assistants were constantly monitoring each individual participant’s form during the exercises. Subjects were educated in the importance of good form to prevent injury and fatigue. Decreasing intensity of exercise was mandatory when good form was unable to be maintained.

Each session concluded with a five to ten minute cardio cool-down with a flexibility activity. In addition to the weekly exercise programs, participants attended three presentations on the following topics: mindfulness, nutrition, and emotional wellness. A post-test session was then conducted following the final intervention.

Statistical analysis was completed using SPSS version 11.5. For the primary analysis, a Wilcoxon sign rank was used due to a small sample size. The means and standard deviations were reported for adequate clinical relevance.

This study’s hypothesis is - a multifaceted exercise program will increase aerobic fitness and strength in women diagnosed with breast cancer.

Results

This study began with sixteen participants. Four participants dropped out due to personal reasons and twelve participants finished the study. Complete data sets were available on nine individuals. Nineteen sessions were scheduled over a ten-week period, with an average participant attendance of 13.6 sessions. Participants’ ages ranged from thirty-five to sixty-six years old, with the average age being fifty-five years old.

The primary analysis of this study evaluated aerobic capacity changes. The results were compiled into three categories defined as metabolic equivalents (METs). A MET reflects the energy expended by the body at rest. MET values for various physical activities reflect the ratio of energy expended during that particular activity to the energy expended for an equal time at rest. The estimated metabolic cost of rest is equivalent to a VO2 of 3.5 mL·kg⁻¹·min⁻¹. Those participants who increased aerobically experienced a metabolic increase greater than or equal to one MET. The participants who decreased aerobically experienced a metabolic decrease greater than or equal to one MET. Finally, those who had no change aerobically had a metabolic change of less than one MET in either a positive or negative direction.

The secondary analysis was configured based on the percent of participants who experienced change in scapular muscle strength. Rhomboids, middle trapezius, lower trapezius, and serratus anterior were assessed on the right and left sides of the body. Following evaluation of our primary analysis, muscle strength changes were
analyzed and compared between and within aerobic capacity categories of those who increased, decreased, or had no change aerobically.

The “gold standard” zero to five manual muscle testing scale was used. A score of five is considered normal and the patient is able to resist maximal force. Zero means that no visible or palpable contraction of the muscle tested is present.

Figure 1, titled “Percent of Participants with Strength Gains in Key Muscles”, depicts the percent of participants who achieved strength gains in key muscles. Strength in the right lower trapezius muscle was gained by 100% of participants - demonstrated by the lower trapezius column (purple bar) in the graph. Strength of the right and left rhomboid muscles (pink and gold bar columns) was increased by 70% of participants.

Figure 2, titled “Grades of MMT change per participant in all muscles pre-testing/post-testing” depicts the muscle strength changes in each individual participant in each muscle tested at the pre-testing and after the post-testing. The colors signify the overall change in aerobic capacity. The green color highlights those subjects who had a decreased aerobic capacity; the purple signifies those who had an increased aerobic capacity; and those who had no change in aerobic capacity are highlighted in blue.

Figure 3, titled “Percent of Participants, Categorized by Aerobic Capacity Changes, with Strength Gains in Key Muscles”, highlights that 100% of participants demonstrated strength improvements in their right lower trapezius muscle. This was the weakest muscle in participants at baseline testing and achieved the greatest strength gains regardless of aerobic capacity category.

Discussion

The purpose of this study was to determine if a multifaceted exercise program positively influences aerobic capacity and strength in women diagnosed with breast cancer. Even though the research protocols varied in all studies reviewed in the literature, the sample population was consistent and the outcomes were similar to other findings. Aerobic capacity and muscular strength improvements were observed in all the previous studies, which used a variety of exercise training protocols. Key results of this study demonstrate three categories of completion: 1) aerobic capacity increased in two participants, 2) aerobic capacity decreased in two individuals, and 3) five participants had no change aerobically. All women demonstrated some increase in muscle strength with all of them achieving strength gains in the right lower trapezius muscle. In addition, all subjects who improved aerobically also experienced strength gains in every muscle category. Anecdotally, improvements gained in overall posture and body awareness were observed although no formal evaluation was included in this study.

Qualitatively, participants documented in their exercise session forms the value of this experience. One participant stated, “I have started to try to challenge my body a bit more and have modified some of the exercises to make them harder to do.” Another expressed, “I feel like I have
**Figure 1:** Percent of participants with strength gains in key muscles

![Bar chart showing percent of participants with strength gains in key muscles.](chart)

**Figure 2:** Grades of MMT change per participant in all muscles pre/post

Green = decreased aerobic capacity  Purple = increased aerobic capacity and  Blue = no change in aerobic capacity

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Figure 3: Percent of participants, categorized by aerobic capacity changes, with strength gains in key muscles

![Bar chart showing aerobic capacity changes and strength gains in key muscles](image)

Figure 4: Participant MET changes from pre-test to post-test

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learned a lot about good form when exercising and listening to my body.” Still another participant commented, “I really enjoyed being here. I may have not lost the weight I wanted to, but I have become more aware of my posture and of my core. I do make the effort to pay attention to how I am doing things.”

Limitations of this study are well recognized and need further explanation. One issue is the small sample size, which resulted from an inability to recruit more participants as well as subjects needing to quit the study for personal issues. As a result, these results cannot be generalized to any population. Variations had to be made in testing techniques due to a participant’s lack of function. For example, one woman could not lay prone due to breast implants from reconstruction after mastectomy so scapular muscle testing was completed in a semi-prone, planti-grade position by standing and flexing at her trunk using support from the non-testing arm on the plinth. The primary investigators were involved in data collection due to lack of personnel and there was no blinding of subjects or investigators, which could be considered a possible bias. The program was of short duration, only ten weeks. Perhaps results of the study would have differed if the exercise training was for a longer period of time. The research team did not include any evidence-based testing of posture. Upon witnessing changes and based on the qualitative statements from participants regarding the postural changes that occurred, it would be advised that in future studies, posture is included in measurement testing due to its impact on patients’ perception, awareness and increased self-esteem.

Although this makes comparison of each session more difficult, a multifaceted exercise program, consisting of a variety of exercises throughout the duration of the program, was intentional. It was one of the purposes of the study to assist the participants in finding an exercise regimen that would be sustainable long after completion of the study.

This study provides multiple opportunities for future research, including: a larger sample size, a longer duration, a structured home exercise program for each participant between sessions, a longitudinal study, as well as pre and post postural analyses.

**Conclusion**

Inactivity in the breast cancer population has been shown to have potentially negative consequences including but not limited to aerobic deconditioning and muscle weakness. Due to the lack of recruitment and subsequent small sample size, the hypothesis was only able to be partially proven. This study aims to promote healthy behaviors in women diagnosed with breast cancer. A multifaceted exercise program involving a variety of strengthening, flexibility and aerobic conditioning exercises, has the potential to improve scapular muscle strength in women diagnosed with breast cancer, less than or equal to 8 years post-treatment and is a consideration for increasing aerobic fitness levels. Further studies are suggested to expand upon the findings. This research demonstrates that a positive impact was made on the participants of this study, which could result in future promotion of similar programs for the community at large. Qualitatively, the participants enjoyed the variety and individualized exercise sessions, which included continuous assessment and correction of their form during exercise to prevent injury.
References


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