

A comparison of the MVe Fitness Chair to traditional weight training as the resistance training portion of an exercise rehabilitation program for breast cancer survivors.

Eric Alexander Martin

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Approved by:

Dr. Claudio Battaglini

Dr. Diane Groff

Mrs. Debra Murray

ABSTRACT

Eric Alexander Martin: A Comparison of the MVe Fitness Chair to Traditional Weight Training as the Resistance Portion of a Comprehensive Rehabilitation Program for Breast Cancer Survivors

(Under the direction of Dr. Claudio Battaglini)

Resistance training has a strong research record in alleviating treatment related symptoms in cancer patients. The purpose of this study was to compare traditional weight training (TWTG) to Pilates using the MVe Fitness Chair (MVeG) as the resistance portion of the Get REAL & HEEL Breast Cancer Program on selected functionality parameters. Sixteen female breast cancer survivors were randomized into either the MVeG or TWTG group and completed 8 weeks of training. Functionality measures were taken pretest and posttest for comparisons between groups. Significant improvement in overall muscular endurance (OME) was observed in the MVeG from pretest to posttest ($p = 0.002$), however no significant difference between groups was observed for OME, balance, fatigue, or quality of life. The results suggest that for an 8 week training program, the MVeG appears to promote similar changes in functionality when compared to TWTG.

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I salute my brothers Adam and Clay and my parents for molding and supporting me. I thank Dr. Battaglini and Mrs. Murray for encouraging me and giving me a goal and purpose. I am grateful to my friends for always forcing me to toe the line.

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Chapter I

Introduction

The second most deadly cancer in women is breast cancer, but mortality rates have decreased steadily since 1990 (American Cancer Society [ACS], 2008).

Improvements in screening and treatment techniques have increased the 5 year survival rate to 85% (Monga et al, 2007). Unfortunately after 5 years the survival rate still declines and quality of life (QOL) tends to decline throughout the cancer experience. Some speculate that the body ages a decade during 1 year of treatment (O'Clair, 2008). What is the cost of surviving? It has been reported that \$219.2 billion was spent on cancer care in 2007 (ACS, 2008). Cost, lack of health insurance, and other obstacles prevent Americans from receiving the necessary care to make a successful recovery (ACS, 2008).

The three most common options to treat cancer are surgical removal, radiation therapy, and chemotherapy, with hormone therapy and biologic therapy also viable options; multiple methods are usually combined in an oncologist's prescription (ACS, 2008; Galvao and Newton, 2005). These "cures" all add to the detrimental affects of the disease on a person, the direct side effects of the treatments sometimes being greater than the cancer itself. Stage of cancer, pre-existing medical conditions, overall health, and age at time of treatment all contribute to the functional impact of the cancer and treatment (Salmon and Swank, 2002; Courneya and Karvinen, 2007). Some of the many side effects of the treatments include fatigue, nausea, decreased range of motion (ROM), cachexia, osteoporosis, depression, impaired cardiovascular and pulmonary function, and cardiotoxicity (Battaglini et al, 2007; Boyer, 1999; Courneya and Karvinen, 2007; Dimeo,

2001; Greiwe, Cheng, Rubin, Yarasheski, and Semenkovich, 2001; Keays, Harris, Lucyshyn, and MacIntyre, 2008; Newton and Galvao, 2008). Many of these side effects increase the risk of developing other chronic conditions such as diabetes or cardiovascular disease (Galvao et al, 2006). Of all the symptoms, fatigue seems to be the most common problem, and therefore often researched and used as a marker of progress post treatment (Dimeo, 2001). Pathological fatigue is ubiquitous among patients, affecting every aspect of their life, and persists for years after treatment has ended (Courneya and Mackey, 2001; De Backer et al, 2007; Dimeo, 2001). Fatigue is a good marker of the treatment process because it is often the signal to screen for cancer or other diseases, and as long as it's present a person's treatment should not be considered complete (Monga et al, 2007).

Usually, a person's first response to fatigue is rest, and chronic fatigue drives this instinct to create a sedentary lifestyle, which traditionally has been encouraged by oncologists (De Backer et al, 2007, Dimeo, Rumberger, and Keul, 1998). Long-term physical inactivity leads to major declines of fitness, energy, and function, accounting for a third of total loss of functional capacity experienced by cancer survivors (Herrero et al, 2006; Monga et al, 2007). The loss of functional capacity makes restarting exercise harder and perpetuates the fatigue cycle (Dimeo et al, 1998). In light of these new views on activity and fatigue, exercise is now usually prescribed instead of rest to help patients maintain function and combat other side effects (De Backer et al, 2007). Not only have patients in exercise groups reported less fatigue, but also patients in control groups often report increased fatigue over time (Dimeo, Fetscher, Lange, Merelsmann, and Keul, 1997; Galvao and Newton, 2005; Hamer, Stamatakis, and Saxton, 2008; Knobf, Insogna, DiPietro, Fennie, and Thompson, 2008; Kolden et al, 2002; McNeely et al, 2006; Monga et al, 2007; Vallance, Courneya, Taylor, Plotnikoff, and Mackey, 2008).

Research continues to espouse the benefits of exercise among cancer patients. The American College of Sports Medicine and the American Heart Association now recognize exercise as medicine because of how beneficial it can be in health restoration following most disease onset (Newton and Galvao 2008). An individualized exercise prescription can reduce the risk of contracting cancer, diminish most side effects, and decrease mortality rates in cancer survivors (Hayward et al, 2004; Klika, Callahan, and Golik 2008; McNeely et al, 2006; Pearce, 2008; J. Rogers, Courneya, Verhulst, Markwell, and McAulery, 2008). In addition to these physical benefits, cancer survivors often feel psychologically better and have more hope because they are actively helping themselves instead of just having treatments administered to them (Knobf et al, 2008). Testing has determined that cancer survivors respond to exercise similarly to healthy individuals or those with cardiovascular disease (Herrero et al, 2006). A review of literature in 2001 showed that exercise is a safe and feasible way to improve QOL in most cancer patients and survivors (Courneya & Mackey, 2001). Studies have found benefits of exercise to match most of the physical detriments of treatment, including improving physical function, strength, balance, and flexibility while diminishing fatigue, adiposity, chronic inflammation, depression, and chance of reoccurrence (Battaglini et al 2007; De Backer et al 2007; Dimeo 2001; Galvao et al 2006; Hamer et al, 2008; Hayward et al, 2004; Knobf et al, 2008; Monga et al, 2007; Pearce, 2008; C. Rogers, Colbert, Greiner, Perkins, and Hursting, 2008; Vallance et al, 2008). Many studies on exercise and cancer summarize that exercise improves overall QOL of cancer survivors. The strongest evidence of the protective effects of exercise in cancer survivors has been shown specifically for cancers of the breast (Newton and Galvao, 2008).

Though intensity of exercise is generally agreed upon, the best mode of exercise is yet to be determined. It has been found that both cardiovascular and resistance training

are safe and effective modes of exercise (Courneya, Mackey, and McKenzie, 2002; Galvao and Newton, 2005; Newton and Galvao, 2008). Many studies have looked at aerobic exercise only, some at resistance exercise only, and one study by Knobf and colleagues (2008) looked at loaded aerobic exercise only. Several studies have looked at a combination of aerobic and resistance training, and this combined approach seems best to combat all the problems involved with cancer and its treatment (Courneya and Mackey, 2001). In the studies incorporating resistance training, the specific mode has been traditional weight lifting emphasizing exercises using free weights or machines that incorporate larger muscle groups per American College of Sports Medicine (ACSM) guidelines. As far as the author is aware of, only one study has looked at the use of Pilates in cancer patients (Keays et al, 2008), and that study's outcome measures were only on shoulder ROM, not measures of fitness, function, and QOL.

Pilates is a form of exercise in which quality, precision, and control of movement is emphasized in order to build core strength and overall functionality (Aaronson, 2007; Keays et al, 2008; O'Clair, 2008). The mind-body connection that Pilates exercise attempts to foster can lead to enhanced body-awareness, core stability, coordination, posture, and uniform muscle development through regular practice (Keays et al, 2008). It is speculated that Pilates can have specific benefits for breast cancer survivors, including lymphatic drainage; shoulder girdle (scapula-humeral rhythm) improvement; restoring ROM, posture, and balance; increased local and global stabilizing muscle strength and function; improved core strength and endurance; and re-establishment of proper muscular firing patterns (Aaronson, 2007; O'Clair, 2008). Pilates is generally a low intensity form of exercise and because of its focuses could be a perfect mode for increasing functional capacity after completion of cancer treatments (Keays et al, 2008).

A new piece of equipment, the MVe Fitness Chair, made by Peak Pilates, could be a great tool for rehabilitating breast cancer survivors. A picture of the MVe Fitness Chair is below.



The pedal can be set to four different levels of tension, with Level 1 being the least tension and Level 4 being the most tension. The pedal can either provide resistance to force applied against it or assist a person rise from a lowered position. The constant resistance challenges a participant to remain under control in a proprioceptively enriched environment. The MVe Fitness Chair facilitates the performance of many Pilates exercises. Compared to a home gym system or a full weight training room and equipment, the MVe Fitness Chair is small, portable, and affordable. If the results of this study are favorable, the MVe Fitness Chair could become another option for use in both inpatient and outpatient treatment and be more cost effective.

The Get REAL & HEEL Breast Cancer Program is a comprehensive exercise and recreation therapy program. Both aerobic and resistance exercises make up the exercise therapy portion of the program, with the aerobic exercises being treadmill walking, elliptical use, or cycle ergometry. The resistance exercises follow the aforementioned moderate guidelines, and before have always used free weights and machines to work major muscle groups. In this study, the efficacy of the MVe Fitness Chair as a complete piece of resistance equipment is compared to traditional resistance training apparatuses.

Statement of Purpose

The purpose of this study was to compare two different resistance training modalities (traditional weight training vs. Pilates using the MVe Fitness Chair) as the resistance training portion of the Get REAL & HEEL Breast Cancer Program on selected measurements of overall functionality. The secondary purpose explored the impact of these two training modalities on fatigue and overall QOL.

Research Questions

1. Will patients assigned to participate in the Pilates exercise group (MVeG group) using the MVe Fitness Chair improve overall muscular endurance (OME)?
2. Will subjects in the MVeG improve muscular endurance as much as subjects in the traditional weight training group (TWTG)?
3. Will subjects in the MVeG have better static and dynamic balance than subjects in the TWTG?
4. Will subjects in the MVeG experience greater psychosocial gains than subjects in the TWTG?

Hypotheses

- H1. Subjects in the MVeG will significantly improve overall muscular endurance from pretest to posttest.
- H2. There will be no significant difference in improvements on repetitions lifted during the muscular endurance test between subjects in the MVeG and subjects in the TWTG at posttest.
- H3. Subjects in the MVeG will significantly improve static balance as measured by time in the single-foot stance test compared to subjects in the TWTG at posttest.
- H4. Subjects in the MVeG will have a significantly lower combined time on the 360° turn test and four square step test than the TWTG at posttest.

H5. Subjects in the MVeG will have a significantly higher score on the QOL Scale than the TWTG at posttest.

H6. Subjects in the MVeG will have a significantly lower score on the Piper Revised Fatigue Scale than the TWTG at posttest.

Definition of Terms

Get REAL & HEEL Breast Cancer Program: a rehabilitation program for breast cancer survivors, offered through UNC-CH's EXSS department, which provides exercise and recreation therapy at no charge to participants.

Pilates: a method of exercise developed by Joseph Pilates, focusing on the conscious awareness and engagement of the core muscles during all movements

Traditional weight training: resistance training using dumbbells and selecterized weight machines

Overall Muscular Endurance (OME): the sum of the maximal number of repetitions obtained during the assessment of muscular endurance for the following exercises: modified push-up, partial curl-ups, biceps curls (sum of the results for right and left arm), lat pull down, leg extension, and leg curl.

MVe Fitness Chair: a piece of exercise equipment developed by Peak Pilates, which is a stool with a spring-loaded t-bar attached to the base.

Assumptions

- All subjects strictly followed the pretest guidelines before being measured at pretest and at posttest.
- All subjects adhered to and completed all training sessions as conducted by their trainer.

Delimitations

- All subjects have been diagnosed with stage I, II, or III breast cancer and have completed their cancer treatment(s) within 6 months.

Limitations

- All testing of muscular endurance was done using weights, so the weight lifting group had more practice doing the specific motions required of them in the testing, and therefore may have developed better motor patterns for the exercises at post test than the Pilates group, reflecting neuromuscular rather than physiological improvement.
- Different stages of disease and different types of treatment could potentially compromise the subjects' ability to respond similarly to the interventions administered.
- Different trainers could present the exercises differently, although all trainers participated in training workshops to learn to present the exercises in a uniform fashion.

Significance of the Study

Exercise benefits survivors of all forms of cancer; however, no exact prescription has been developed for this group. Recent literature reviews have concluded with guidelines concerning modes of cardiovascular exercise as well as frequency, volume, and intensity of resistance exercise. Most studies look at traditional weight lifting using gross movement exercises as the mode of resistance training. The traditional weight training has been found effective in improving all physiological parameters, however, the large (both physically and in number of pieces) equipment and expense could make it unfeasible for a small clinic or hospitals to provide patients with the opportunity to engage in weight training. More importantly, hospitals may not have the extra funding or

space to house their own weight room. The MVe Fitness Chair is a small, easily storable, and relatively inexpensive piece of exercise equipment that could replace a whole weight room and would be perfect for a small clinic, a patient's hospital room, or at a patient's home. Easy access would give patients the ability to start physical rehabilitation in the hospital as the patient received adjuvant therapy and continue their rehabilitation at home. Even though this study does not have the ability to generalize its results to other cancer populations, including in-hospital and in-treatment patients, it may serve as a foundation for future studies interested in administering interventions with more affordable and compact pieces of equipment. If the results of this study demonstrate that the MVe Fitness Chair promotes similar or greater improvements in physical function and psychosocial health of post-treated breast cancer survivors when compared to traditional weight training programs, the reproduction of this study protocol may be explored in other cancer populations including those undergoing in-hospital treatments.

Chapter II

Review of Literature

Many studies have looked at the benefits of different combinations of exercise and almost universal improvement has been found regardless of mode. This review will give a brief overview of the pathology of breast cancer and its common side effects and treatments, then describe the overall impact of exercise in the breast cancer population by examining studies that have used aerobic training only, resistance training only, and a combination of aerobic and resistance training. Next, the review will cover issues of balance and how cancer can change balance, and finally the review will conclude with a brief look at Pilates exercise in breast cancer patients.

Cancer Pathology and Treatment

Breast cancer is the form of cancer that develops in the milk glands and ducts of the breast. From these tissues, the cancer can metastasize into the local lymph nodes or blood vessels. While breast cancer can occur in men, it is very rare, with less than 2,000 cases per year. The National Cancer Institute (NCI) estimates that in 2009 there will be 192,370 cases in females and another 40,170 deaths in females in the United States. The most common treatments for breast cancer are surgery, radiation therapy, chemotherapy, and hormone therapy and can be used independently, though they are frequently used in combination (NCI, 2009).

Surgeries range from lumpectomies, which target the tumor and a small amount of normal tissue around it, to full mastectomies, where the entire breast is removed. Axillary lymph nodes may also have to be removed. Surgery often leads to decreased range of

motion, soreness, and higher risk of tearing the tissues surrounding the surgery site.

Radiation therapy is used to kill cancer cells or keep them from growing, and can be done internally via brachytherapy (implant radiation) or externally via external beam radiation.

Radiation therapy can burn the tissue surrounding the target site, and lead to nausea, fatigue, and other symptoms. Chemotherapy can be administered orally or intravenously and uses drugs to kill the cancer cells or prevent their division. Like radiation therapy, chemotherapy can lead to nausea, fatigue, and other symptoms. Hormone therapy tries to stop cancer cells from growing by removing or blocking hormones that may cause certain cancers to grow. Hormone therapy can lead to early menopause, osteoporosis, nausea, fatigue, and other symptoms (NCI, 2009).

As discussed previously, fatigue is a major side effect of both breast cancer and its treatment. Fatigue is a major factor in decreased QOL and affects 75% - 96% of patients treated with chemotherapy and 75% - 100% of patients treated with both radiation and chemotherapy (De Backer 2007). Patients experiencing chronic fatigue often decrease their amount of physical activity, which can lead to cachexia and loss of functionality (Herrero et al, 2006, Monga et al, 2007). These losses tend to create a cycle, where the patient continually decreases their ability to exercise and responds by exercising even less (Dimeo et al, 1998). Exercise training can boost energy levels by increasing cardiovascular endurance and muscular strength and endurance. Resistance training can increase lean muscle mass, which allows individuals to complete activities of daily living with less effort and participate in greater levels of physical activity, which will allow them to exercise more and combat fatigue further (Hamer et al, 2008; Knobf et al, 2008; Kolden et al, 2002; Vallance et al, 2008).

Reviews of Exercise Studies in Cancer Survivors

Courneya and Mackey wrote a paper in 2001 to attempt to create guidelines for exercise in breast cancer survivors based on the research done at the time, which mostly consisted of aerobic endurance exercise only. They recommended walking or cycling three to five times per week at 50% - 75% VO_2 max, for 20-30 minutes, but cautioned that much less may be necessary for some patients.

In 2003, Courneya wrote a summary literature review of 47 research studies looking at either aerobic or resistance exercise in breast and non-breast cancers both during and after treatment. He also included four trials he personally had completed at the University of Alberta, Canada, before publishing his review. The review supported that a myriad of exercise programs benefit QOL.

Galvao and Newton (2005) published a review of exercise intervention studies in cancer patients. The 26 studies that were reviewed ranged from cardiovascular training only to resistance training only to combined cardiovascular and resistance training programs. In summary, they came up with the following guidelines for each mode of training: Cardiovascular exercise: three to five times per week, 20-60 minutes per session continuous or intermittent, at 55-90% max heart rate; Resistance exercise: one to three times per week, one to four sets per major muscle group, 6-12 repetitions of 50-80% of one repetition maximum (1RM); Flexibility exercise: two to three times per week, two to four sets per major muscle group, holding stretches 10-30 seconds.

In 2008 Newton and Galvao wrote a review in which they made specific recommendations for exercise in most cancer patients. This new paper refined and updated the recommendations they made in 2005. Their recommendations were for 20-60 minutes of continuous or intermittent exercise, three to five times per week at 55% to 90% maximal heart rate (estimated as $220 - \text{age}$). For resistance exercise, they

recommended 6-12 repetitions (50%-85% or 1RM) and one to four sets of each exercise for major muscle groups one to three times per week. They also recommended two to four sets of flexibility exercises for major muscle groups two to three times per week.

All of the authors of the reviewed studies agreed on the use of moderate exercise for treatment protocols and that the most beneficial exercise programs should include aerobic, resistance, and flexibility training. One problem every review pointed out was that no study had compared different modes of resistance training.

Brief Review of Impact of Aerobic Based Exercise Protocols in Cancer Survivors

A randomized controlled trial by Dimeo and colleagues (1997) examined the effects of aerobic exercise on 70 patients with solid tumors treated with high dose chemotherapy. The training group performed 16 bed cycle ergometry intervals of 1 minute on, 1 minute rest, each day for the duration of hospitalization. The control group decreased 27% more in performance than the training group. Other results included a significantly higher maximal physical performance at discharge in trained patients, and significant reductions in duration of neutropenia and thrombopenia, severity of diarrhea and pain, and duration of hospitalization in trained patients.

To determine the effects of exercise on blood immune function on postmenopausal breast cancer, Fairey and colleagues (2005) set up a year long randomized controlled trial examining the changes in natural killer cell cytotoxic activity in isolated peripheral blood mononuclear cells. Patients cycled on upright ergometers at 70-75% peak oxygen consumption, of progressively longer durations throughout the 15 week training period, three times each week. A non-exercising control group was also measured on dependant variables. Natural killer cell cytotoxic activity exhibited significant increases in the exercise group compared to the control group.

A randomized control group of prostate cancer survivors, with pre and posttest measurements taken around a cardiovascular exercise intervention during radiotherapy, was studied by Monga and colleagues (2007). Twelve variables, including cardiovascular fitness, flexibility, fatigue, and strength (as measured by how long it takes to stand up and sit down five times from an armless chair) were recorded pre and posttest. The intervention group walked on a treadmill for 50 minutes in the morning before daily radiation therapy, three times a week for 8 weeks. The exercise group significantly improved on cardiovascular fitness, the stand-and-sit test, flexibility, fatigue, physical well-being, social well-being, and QOL. The control group significantly worsened in fatigue and social well-being scores, with eight other scores changing in a negative direction after the intervention.

A case study giving a breast cancer survivor an aerobic training program was carried out by de Paleville and colleagues (2007) prior to and during 8 weeks of chemotherapy. Measures of functional ability and fatigue were measured before and after the intervention. The patient completed five exercise sessions per week, but only one was supervised. Exercise was recorded by a pedometer and self-reported in a training log. Exercise started at 15 minutes of walking and increased to 35 minutes. The subject improved in all tests of functionality, and rated every item on the Revised Piper Fatigue Scale at zero. The authors concluded that extended prehabilitation could result in even greater outcomes.

In another breast cancer study, conducted by Knobf and colleagues (2008), a one-group pre-posttest design was implemented to test a 16-24 week supervised walking exercise intervention among women who were diagnosed with stage one or two breast cancer, had completed chemotherapy and/or radiation therapy within 3 years of enrollment, at diagnosis were premenopausal or perimenopausal and either

perimenopausal or postmenopausal when enrolled in the study. Twenty-six subjects completed an intervention of walking on a treadmill with a weighted backpack and belt. After 12 weeks, the backpack was eliminated due to worries of lymphedema. Women reported feelings of empowerment and control in their recovery. Bone mass and density were maintained with no significant change in weight or body composition.

Courneya and colleagues (2008) conducted a prospective, randomized, controlled trial in 55 mild-to-moderately anemic patients with non myeloid solid tumors. Patients were randomized to either a darbepoetin alfa alone group [DAL] or darbepoetin alfa plus aerobic exercise training group [DEX]. The DEX group performed aerobic exercise training three times per week at 60%-100% of baseline exercise capacity for 12 weeks. Both groups increased scores of QOL and decreased levels of fatigue. The DEX group had a significantly greater VO_{2peak} than the DAL group, and the DEX group had borderline increased hemoglobin response over the DAL group.

In 2008, Klika and colleagues conducted a case study with a woman who was highly self motivated to contribute to her rehabilitation. Their subject was measured on body composition, pulmonary function testing, lactate threshold, and maximal oxygen consumption. During chemotherapy and radiation therapy, the subject was instructed to exercise 6 days a week at or below her lactate threshold. She self-controlled all of her own exercise, and recorded her activity in a log from August 2005 to October 2006, completing 424 exercise sessions. Body weight, percentage of fat, and pulmonary function remained stable for the entire period, and VO_{2max} decreased from 56.4 to only 52.0 ml/kg/min, a small drop considering the subject was undergoing both chemotherapy and radiation therapy. This study showed how long term exercise can maintain physiological function during cancer treatment.

Resistance Training in Exercise Prescription

Resistance training is important for improving two major areas of fitness: muscular strength and muscular endurance. These attributes make functional movements and activities of daily living easier. Improving muscular strength and endurance allows people to perform activities of daily living with less physiological stress and to maintain functional independence throughout life. Resistance training may also provide health related benefits, such as a lower risk of osteoporosis, low back pain, hypertension, diabetes, and obesity. Resistance training is particularly beneficial for postmenopausal women who are at risk for rapid loss of bone mineral density (ACSM, 2006). In studies specifically studying cancer survivors, resistance training has been shown to improve muscular strength, endurance, coordination, and function; maintain weight and percent body fat; improve physical functioning, antioxidant defense mechanisms, bone mineral density, development of lean tissue, psychological adjustments, body image, sleeping, mood, and feelings of control, independence, and self-esteem. Potentially concurrent with those are decreased anxiety, depression, fatigue, adiposity, chronic inflammation, cachexia, risk of osteoporosis, cancer-specific mortality, and all-cause mortality (Galvao et al, 2006; Hamer et al, 2008; Hayward et al, 2004; Pearce, 2008; C. Rogers et al, 2008).

The most important principle in exercise training is that the body will adapt to the specific demands that are placed upon it (Folland and Williams, 2007; NASM, 2004). There are three phases of response to a specific demand that the body undergoes: alarm reaction, resistance development, and exhaustion. The alarm reaction is the body's first response to a stress in which sympathetic nervous, endocrine, and metabolic reactions occur to create a heightened physical state for action. In the resistance development phase, the body recruits more muscle fibers and delivers more oxygen to the working muscles so they can overcome the load placed upon them. Exhaustion arises when

prolonged stress exceeds a person's capability and he/she is forced to quit activity or becomes injured (NASM, 2004).

Some adaptations to resistance training are increases in (a) lean muscle mass, (b) muscular strength, and (c) muscular endurance. While all three attributes generally increase with any resistance training, the protocol of resistance training tends to favor increases in either muscular strength or endurance (ACSM, 2006). Protocols are defined by their mixture of acute variables. The specific mixture of acute variables determines the specific adaptation in the body. Some of the main acute variables manipulated to create a workout are intensity, volume, rest, and duration. Strength training uses high intensities, low volumes, medium to long rest periods, and are short to medium in duration. Accepted ranges for each variable are 70-100% 1RM, three to six sets of 1-12 repetitions, with 45 seconds to 5 minutes of rest between sets. Endurance training uses low intensities, high volumes, short to medium rest periods, and are medium to long in duration. Accepted ranges for each variable are 40-70% 1RM, one to three sets of 12 - 25 repetitions, with 0 – 90 seconds of rest between sets (National Academy of Sports Medicine [NASM], 2004). For each protocol, duration is prescribed based upon the individual's current training status, with untrained individuals generally doing shorter workouts than trained individuals (ACSM, 2006).

The specific manipulation of the above discussed variables elicits different and specific responses. Type 1 and/or Type 2 muscle fibers are recruited as needed to meet the specific demands. The ranges described above that are typical of endurance training tend to target more Type 1 muscle fibers. Type 1 muscle fibers have a greater oxidative capacity and fatigue slowly. By recruiting them more often, the body can increase its neuromuscular efficiency with these fibers so that more muscle fibers are incorporated into each motor unit. Type 1 muscle fibers can hypertrophy, but to a lesser extent than

Type 2 fibers. The ranges described above that are typical of strength training tend to target more Type 2 muscle fibers. Type 2 muscle fibers have a greater cross sectional area and can generate more force but fatigue easily. The body can up-regulate its Type 2 motor unit activity also, though preferential hypertrophy is also a common and prodigious adaptation seen in Type 2 muscle fibers (Brooks, Fahey, White, and Baldwin, 2000). For both types of fibers, hypertrophy creates more sarcomeres, which allows more tension to be developed in the muscle (Folland and Williams, 2007). It is important to understand that all muscles have both types of muscle fibers, and that function and training determine which type of muscle fiber dominates within a muscle (Brooks et al, 2000).

Neurological adaptation, rather than muscle fiber adaptation, can account for a large percentage of early increases in strength and endurance in an untrained individual (Galvao and Newton, 2005). Enhanced firing frequency and synchronization of muscle efforts can allow an individual to resist a greater load without having any change of the myofibrils (Folland and Williams, 2007). The acute variables of the training protocols in the present study fall within the ranges of endurance training, which is why overall muscular endurance, rather than strength, is used as the dependent variable in the study.

A study not looking specifically at cancer patients, but still pertinent to the topic, is Greiwe and colleagues' (2001) examination of resistance exercise in frail elderly adults. The side effects of cancer and its treatment produce a physiological state similar to the studied population. The subjects underwent three months of pretraining. They met 3 days a week to work on flexibility and joint range of motion. The training program also lasted 3 months, with exercises performed 3 days per week. The training program consisted of a 5 minute warm up and 50-90 minutes of supervised resistance exercise, initially using machines and later progressing to incorporate free weights. Acute variables were one to two sets of six to eight repetitions using 65-75% of the initial 1RM,

progressed to three sets of 8-12 repetitions using 85-100% of the initial 1RM. The subjects significantly improved in strength results for all exercises except biceps curl. The study shows the efficacy and, more importantly, safety of resistance training in frail individuals.

Kolden and colleagues (2002) chose to look at the efficacy of group exercise training on sedentary female breast cancer survivors. The patients exercised three times per week for 16 weeks. Workouts consisted of a 10 minute warm up, 20 minute aerobic training, 20 minutes resistance training, and a cool down. Blood pressure, heart rate, weight, skin fold thickness, aerobic capacity by submaximal treadmill test, flexibility, and estimated 1RM on Cybex machines were all measured pretest and posttest, with HR and BP measured throughout the intervention. Instruments measuring mood, distress, and QOL were also administered. Significant improvements were found for resting systolic blood pressure, flexibility, aerobic capacity, bench press, and leg press, as well as many of the scores of well being from the aforementioned instruments. This study is typical of interventions nationwide, follows the guidelines set forth in the reviews discussed earlier in this chapter, and is a good model for what exercise interventions with breast cancer survivors should look like.

In an effort to reduce treatment side effects, Galvao and colleagues (2006) provided prostate cancer survivors with a progressive resistance training program. Their exercise intervention was similar to the one used by Kolden and colleagues (2002). Their program lasted 20 weeks, and measured strength and performance in a number of different functional tests. Significant improvements were found in muscle strength, endurance, and most tests of function, with a preservation of lean and fat mass. They concluded that resistance training is very beneficial in reducing treatment side effects.

Obesity is a risk factor for breast cancer, but resistance training can reduce adiposity. Battaglini and colleagues (2007) used a randomized controlled trial to compare an exercise and control group of breast cancer survivors on scores of body composition and fitness. The exercise intervention combined cardiovascular, resistance, and flexibility training. This is one of few studies to have a 100% adherence rate. Ten volunteers were assigned into each group, and measured on percent lean body mass and overall muscle strength. Only a significant interaction effect was found on both dependant variables, creating positive trends between exercise, body composition, and strength. These results are important from both a prevention of first occurrence and reoccurrence standpoint.

While high intensity training is generally considered too taxing on already weakened systems, Quist and colleagues (2006) attempted training cancer patients at high intensities. The study enrolled 70 patients of mixed gender and diagnoses into a 6 week program. Patients were randomly assigned to a high or low intensity training group. The high intensity group met in groups three times a week for 90 minute long sessions to lift weights at 85-95% of their 1RM and cycle on an ergometer for 10 minutes at 85-95% of their maximum heart rate. The low intensity group worked in groups for 30 minute sessions four times a week. Their activities consisted of relaxation or massage and body awareness training. One repetition maximum tests, VO_{2max} tests, and weight and body composition by skin-fold were compared pre and postintervention. Highly significant improvements were found for strength, significant improvements in fitness were found in the majority of patients in both groups, and there was an average increase in weight with reduction in percent body fat. It should be noted that throughout the program seven patients were excluded from the exercise component due to fever, infection requiring treatment, and/or risk of bleeding. Patients were not allowed to participate if their thrombocytes were below 50 billions/L and/or leukocytes below 1 billion/L. Also, two

patients pulled their hamstring muscles. In the end, 75.2% of patients completed the whole program. At this time, this kind of training is not recommended in cancer survivors, however, this study shows that it could be beneficial. More research is needed to conclude if high intensity resistance training will be appropriate in this population.

Balance and Resistance Training

One of the major side effects of chemotherapy is the loss of balance. Wampler and colleagues (2007) examined the effect of a common chemotherapy treatment on balance in breast cancer survivors. They tested 20 breast cancer survivors who had completed taxane treatment and twenty healthy matched controls on measures of static and dynamic postural control and balance. They found that the breast cancer survivors performed significantly worse on all measures of posture and balance. Three mechanisms contribute to balance: somatosensory perception, vision, and the vestibular system. In their discussion, they reported that taxane chemotherapy can negatively effect somatosensory perception and lead to instability. By matching their subjects and controlling for many other factors including pre-existing disease or injury, height, weight, and age they were able to attribute the majority of the differences in their groups to the taxane treatment alone. They also found significant differences in low contrast vision between the two groups. As vision is one of the three mechanisms that allow humans to balance, they concluded that changes in vision, possibly resulting from the taxane treatment, could contribute to the breast cancer groups' imbalance. While they had not found any published reports linking taxane to vestibular toxicity, other chemotherapy agents have been linked to vestibular toxicity. Wampler and colleagues concluded that taxane would also have a similarly detrimental affect on the vestibular system, and therefore a person's ability to balance. All of the factors reported in Wampler and colleagues' study indicate that breast cancer survivors who have undergone chemotherapy have an impaired ability

to maintain posture and stability, and could therefore also have an impaired ability to improve their balance.

One of the benefits of Pilates exercises is the mind-body connection they foster. Pilates movements are not unique in this regard. Larkey and colleagues (2009) describe the groups of movements that facilitate this mind-body connection as meditative movement forms. They reviewed studies looking at Tai Chi and Qigong to find any common outcomes. All studies reviewed looked at healthy adult populations of ages ranging from 20s to 70s. One outcome they looked for was balance, and cited 11 studies using Tai Chi that all found significant improvements among factors relating to balance. Larkey and colleagues (2009) examined two randomized control trials that showed significant improvement in balance after 12-15 weeks of practicing Tai Chi. They reviewed three randomized control trials using Qigong that also found significant balance improvements, one specifically using the single leg stance test as a measure. These studies looking at exercise modes with similar paradigms confirm that Pilates can improve balance, and they may indicate that at least 12 weeks is needed for these improvements to be seen in healthy individuals.

A randomized control trial was implemented to find if exercise could improve balance in community dwelling osteopenic women ages 41-78 (Hourigan, Nitz, Brauer, O'Neil, Wong, and Anderson, 2008). The exercise group met twice a week for 1 hour of exercise each session; the intervention lasted 20 weeks. At the end of 20 weeks, the exercise group significantly improved on 9 of 11 balance measures compared to the control group. Two of those nine balance measures were single leg stance on the left and right leg, respectively.

Judge and colleagues (1993) administered a 6 month intervention to women ages 62 to 75 years. Their trial had a combined exercise group and a flexibility only group. The

combined group performed resistance, cardiovascular, and Tai Chi exercises three times a week. The flexibility only group's treatment was delayed until week 13, and for the remainder of the time they performed Tai Chi exercises weekly. This trial's balance measure was amount of sway on single leg stance test. At the end of the intervention, the combined group significantly improved on the single leg stance test, while the flexibility only group did not significantly improve. The disparity in time of exercise between the groups indicates that combined exercise modes may help improve balance better than just balance exercises alone, and that more than 12 weeks is needed to see improvements in balance.

To treat women who had completed treatment for breast cancer, Waltman and colleagues (2003) used a multicomponent intervention that included a home based resistance training program. This was a pilot study using only 21 subjects. The resistance training program consisted of performing eight exercises with hand and ankle free weights twice weekly. The exercises were all traditional weight training exercises. To work on balance, the subjects were specifically prescribed toe stand and heel stand exercises. The intervention lasted 12 months, with assessments conducted at baseline, 6 months, and 12 months. To test dynamic balance, subjects performed the Timed Backward Tandem Walk. They found significant improvement from baseline to 6 months, and baseline to 12 months, but no further statistically significant improvement from 6 months to 12 months. This study indicates that traditional resistance exercises that include balance specific exercises are effective at improving dynamic balance after 6 months.

A much larger study, using 223 postmenopausal breast cancer survivors from four sites, assessed the effects of 24 months of strength training on muscle strength and balance (Twiss, Waltman, Berg, Ott, Gross, and Lindsey, 2009). The women were

randomly assigned into either an exercise group (n = 110) or a control group (n = 113). Women in the exercise group performed their exercise either at home or at investigator approved fitness centers. Both home and fitness center exercises were exactly prescribed, and followed moderate guidelines for an endurance protocol. All assessments were conducted by physical therapists at either hospitals or rehabilitation centers at the four sites. Assessments were conducted at baseline, 6 months, 12 months, and 24 months into the intervention. Twiss and colleagues assessed dynamic balance via the Timed Backward Tandem Walk. They found that the both groups significantly improved dynamic balance by 6 months, and continued to improve through the whole intervention. They also found significantly greater improvement on dynamic balance in the exercise group compared to the control group 24 months into the intervention. This indicates that resistance exercise training can augment improvements in balance.

These studies all indicate that both traditional and nontraditional exercise programs can help improve balance in cancer survivors. They also indicate that 3 to 6 months are needed to improve both static and dynamic balance in this population.

Pilates and Breast Cancer

To the author's knowledge, Keays and colleagues' (2008) pilot study was the first to employ Pilates training with breast cancer survivors. They chose to use Pilates as an intervention because it is low impact and trains body control, awareness, and function. They used a generic total body program for their intervention, because they felt it would be more accessible to their patients. Patients participated in three 1 hour long exercise sessions per week for 12 weeks. The intervention began with pre-Pilates exercises and stretching, progressed to beginner level exercises, and, if appropriate for the patient, progressed to intermediate level exercises. Their outcome variables were shoulder ROM, pain, mood state, upper extremity function, and upper extremity circumference. This

study only recruited four subjects, so statistical significance was hard to find. Keays and colleagues concluded that their results did have clinical significance however, and their study showed that Pilates is safe for breast cancer survivors to participate in. They also recommended Pilates as a good starting point for women to return to exercise after completing treatments.

Conclusion

Research demonstrates that exercise benefits cancer survivors. No consensus on proper activity has been reached, nor have any studies found in this search compared different training modes in the same population. This study will compare two resistance programs—Pilates and traditional weight lifting such as described in the literature—to see if one is more effective than the other.

Chapter III

Methodology

The purpose of this study was to compare two different resistance training modalities (traditional weight training vs. Pilates) as the resistance training portion of the Get REAL & HEEL Breast Cancer Program on selected measurements of overall functionality. The secondary purpose explored the impact of these two training modalities on fatigue and overall QOL.

Subjects

Volunteers for this study consisted of 16 females, age 25 to 75 years, who were diagnosed with breast cancer and completed their major cancer treatment including surgery, chemotherapy and/or radiation within 6 months of enrollment. All subjects were recruited from the Get REAL & HEEL Breast Cancer Program, at the University of North Carolina at Chapel Hill, Department of Exercise and Sport Science. The criteria for participation in the Get REAL & HEEL Breast Cancer Program include:

1. Confirmed diagnosis of stage I, II, or III invasive breast cancer;
2. Within 6 months of completion of all planned surgery, radiation therapy and chemotherapy;
3. Ages ranging from 25-75 years old;
4. Be consented by their medical oncologist to participate in the study;
5. Not be enrolled in the UNC Can-Thrive couples intervention study;

Any potential subject willing to enroll in the Get REAL & HEEL Breast Cancer Program is excluded from participation in the program if they have:

1. Confirmed diagnosis of stage IV invasive breast cancer;
2. Cardiovascular or respiratory disease, bone, joint, or muscle pain or abnormalities that would compromise the patient's ability to complete the exercise training protocol.

General Procedures

If the criteria for participation in the Get REAL & HEEL Breast Cancer Program are met, and volunteers have signed the informed consent form approved by the University of North Carolina Biomedical IRB #05-2785 to participate in the Get REAL & HEEL Breast Cancer Program, they are automatically randomized into one of four groups. The four groups are: an exercise only group, a recreation therapy only group, a combined exercise and recreation therapy group, or a delayed intervention group. The Get REAL & HEEL Breast Cancer Program lasts for 5 months. Volunteers participate in their randomized group receiving the intervention assigned for the first 2 months then receive a combined exercise and recreation therapy intervention for the last 3 months. Subjects assigned to the delayed treatment group don't receive any intervention until the first 2 months of the program have passed, but then receive a full 5 months of the combined exercise and recreation therapy intervention. For this traditional weight training vs. Pilates study, a subset of the Get REAL & HEEL Breast Cancer Program participants were used.

Subjects assigned to the exercise only group were recruited to participate in the study. Within the exercise only group, subjects were randomly assigned into one of the protocol groups, either the traditional weight training [TWTG] or Pilates [MVeG] groups. Both protocols deliver exercise matched for volume of work and sequence of activity of aerobic, resistance, and flexibility training. The only difference between groups was the

type of resistance training administered; traditional weight training or Pilates MVe Fitness Chair training program.

The MVe Fitness Chair came with a manual and DVD that described proper exercise technique, illustrated the execution of many exercises, outlined proper sequencing of exercises in the chair, and gave sample workouts. To become adept at teaching Pilates to subjects, the author read the manual and practiced the techniques and sample workouts on his own to become familiar with them, and participated in three separate training sessions with a Master Pilates Instructor, who specialized in the use of the MVe Fitness Chair,. After concluding training with the Master Pilates Instructor, the author crafted a total body workout using the exercises from the MVe Fitness Chair manual and his knowledge of personal training. The Pilates workout was designed to follow the manual's guidelines while mimicking standard workouts that had been previously prescribed at the Get REAL & HEEL Breast Cancer Program clinic. After the Pilates workout was set, exercises that recruited the same muscles were selected to be used in the traditional weight lifting protocol.

Assessment

A series of physical assessments, a QOL assessment questionnaire, and fatigue assessment questionnaire were administered before and after the exercise intervention; the same tester performed all physical assessments. While a full battery of tests were performed on each subject, only the assessments that were investigated in this study are described here. Brady and colleagues (1997) have developed a series of QOL assessment tools to be used in cancer survivors. For this study, the Functional Assessment of Cancer Therapy-Breast (FACT-B) was used to measure QOL in the subjects. Specifically, the dependent variable assessed was the FACT-B Total Score. The FACT-B covers physical, emotional, social, and functional well being as well as asking questions about a patient's

relationship with their doctor and specific questions about additional symptoms and concerns specific to breast cancer over other cancers. Brady and colleagues (1997) conducted a study to determine the reliability and validity of the FACT-B scale. Two samples were used in this study. For the first sample, 47 breast cancer survivors completed the FACT-B at baseline and 2 months later for the sensitivity to change analysis. The second sample consisted of 295 breast cancer patients who completed the FACT-B multiple times over 3 years to validate the questionnaire and test reliability. The two samples were combined for analyses of the data. They found a test-retest correlation coefficient of 0.85 for the FACT-B, which indicates that the tool is highly reliable over time. Using multivariate analysis, they found that the FACT-B was also significantly sensitive to change ($p = 0.006$), indicating that it's valid for measuring QOL as it reflects performance status (Brady et al, 1997). The FACT-B and how to score it can be seen in Appendix A.

The Revised Piper Fatigue Scale (RPFS) is a self report questionnaire for patients to quantify how fatigued they feel and how it affects their life. The original Piper Fatigue Scale consisted of questions in four categories of subjective questions that can be scored to quantify a patient's level of fatigue. There were 40 questions in the Piper Fatigue Scale. These categories cover the temporal, sensory, affective, and intensity/severity dimensions of fatigue. When originally tested for reliability, the Piper Fatigue Scale scored over 0.80 on the Cronbach's alpha test. Piper and colleagues (1992) determined validity of their scale via a literature review and a review by an 11 member national panel of experts on fatigue. In 1998, Piper and colleagues conducted a methodological study of their questionnaire by mailing it and instructions out to women with breast cancer, asking them to complete it and return it. Of the over 2,000 women the Piper Fatigue Scale was mailed to, 382 returned it fully complete. The purpose of the study was to revise and

shorten their scale without losing the reliability and validity of the original version. To determine this, they ran a principal factor analysis with oblique rotation on all the items of the returned Piper Fatigue Scales. After analyzing their results, Piper and colleagues (1998) decided to cut 18 questions, and so the Revised Piper Fatigue Scale is a 22 question survey that is just as reliable and valid as the original (see Appendix B for questions and scoring directions).

Overall muscular endurance was evaluated by the combined measures of a standardized push up test, partial curl up test (Heyward, 2006), and a submaximal muscular testing protocol. The OME testing protocol can be seen in Appendix C. Static and dynamic balance were assessed by a single leg stance test (Berg, Wood-Dauphinee, Williams, and Maki, 1992), 360° turn test (Reuben and Siu, 1990; Lipsitz et al, 1991), and the four square step test (Dite and Temple, 2002). The procedures for these balance tests can be seen in Appendix D. Neither these tests nor any other balance test have been validated for use in breast cancer populations. However, they have been validated for use in frail elderly adults. Berg and colleagues (1992) validated their Balance Scale, which included the single leg stance test, among stroke patients, elderly residents of an assisted living home, and elderly citizens of Toronto who came into the testers' lab. They correlated their tests' scores with ratings from caregivers and self report questionnaires, and found their tests to be statistically significantly correlated, ergo valid. Reuben and Siu (1990) found that the 360° turn test was both reliable (Cronbach's $\alpha = 0.87$) and valid in elderly adults. To check for validity, they performed several correlations tests between their measure and three different all ready accepted scales. Dite and Temple (2002) found that the four square step test was reliable ($ICC = 0.99$) and valid ($p < 0.01$) for use in community dwelling adults over 65 years old. To determine reliability and validity, correlations were run between the results of the four square step test and the results of the

timed up and go test, functional reach test, and step test. Breast cancer survivors exhibit similar physical functionality as frail elderly adults, and since there are no tests that have been validated for breast cancer survivors, these tests were deemed appropriate for use in this study.

Intervention

The exercise intervention for this study lasted 8 weeks. The interventions were designed to match each other in volume of work and sequence of muscles exercised. Each subject's program was modified to track the individual subject's abilities and progress. For both interventions, patients' exercise sessions started with approximately 15 minutes of moderate aerobic exercise on either a treadmill, elliptical, or cycle ergometer, followed by 5 minutes of total body stretching, including a standing press and pump on the MVe Fitness Chair to warm up the spine. The resistance exercises for each group are presented in Table 1. After performing the resistance exercises, patients cooled down and stretched for 5 minutes.

Table 1
Resistance Exercises for MVeG and TWTG

| MVe Fitness Chair | Traditional |
|--------------------------------|--------------------|
| Shoulder lateral raise w/ pump | Lateral raises |
| Single leg pump | Crunches |
| Mermaid | Oblique Crunches |
| Front leg pump | Squats w/ ball |
| Calf raises | Calf raises |
| Two arm pump | Chest press |
| Pelvic lift | Bridge |

Intensity of exercise was quantified on the Borg Rate of Perceived Exertion scale (RPE) from 6-20. The progression of the target intensity and the volume throughout the intervention is presented in Table 2. RPE is a subjective measure and can be influenced by factors such as if a subject is tired, sore, or distracted. Volumes were adhered to regardless of RPE. The amount of resistance, technique in exercise, and tempo of exercise

were manipulated to attempt to reach the target intensity as indicated by RPE. Subjects were asked to report their RPE for each exercise upon completion of the set, and any of the aforementioned adjustments were made if needed.

Table 2
Weekly Target Intensity and Volume of Resistance Training

| 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 |

To help decrease differences of delivery of the intervention between trainers, all trainers had to attend training sessions to make sure they understood the methods and cues of delivering the exercise modes. A master Pilates instructor came to the clinic to teach all trainers the Pilates exercises on the MVe Fitness Chair, and the lead investigator led a workshop on the use of the MVe Fitness Chair for this protocol. Every trainer was supervised by the lead investigator on their first training session using the MVe Fitness Chair to insure they understood the methods and were teaching the protocols to their subjects properly.

Statistical Analysis

All gathered data was analyzed using SPSS version 17.0, a statistical software package. Significance was set apriori at an alpha level ≤ 0.05 . The independent variables of this study were the two different groups: TWTG and MVeG. The dependent variables were OME (total repetitions), static balance (time on single-foot stance test), dynamic balance (combined time of 360° turn test and four-square step test), fatigue score, and QOL score. Confidence intervals of the means were provided, as well as an analysis of effect size. Specifically, the effect size of each t-test analysis was computed via the Cohen's d method (small effect size, $d = 0.2 - 0.5$: medium effect size, $d = 0.5 - 0.8$: large effect size, $d > 0.8$).

- H1. Subjects in the MVeG will significantly improve OME from pre to posttest. Mean total repetitions from pre to post-intervention will be compared by a dependent samples t-test within the MVeG.
- H2. There will be no significant difference in improvements on repetitions performed during the muscular endurance tests between TWTG and MVeG at the end of the intervention. A delta score ($\Delta = \text{Post intervention \# of reps} - \text{Pre intervention \# of reps}$) will be calculated for each group and used for the analysis. The delta scores will be compared between the TWTG and MVeG by independent samples t-test.
- H3. Subjects in the MVeG will improve significantly more on the single-foot stance test than subjects in the TWTG at the end of the intervention. A delta score ($\Delta = \text{Post time on SL stance} - \text{Pre time on SL stance}$) will be calculated for each group and used for the analysis. The delta scores will be compared between the TWTG and MVeG by independent samples t-test.
- H4. Subjects in the MVeG will improve their dynamic balance more than the TWTG. Dynamic balance improvement will be calculated by the summation of the time of the 360° turn test and four-square step tests. A delta score ($\Delta = \text{baseline assessment time for 360}^\circ \text{ turn test} + \text{baseline assessment time for four-square step test} - (\text{final assessment baseline time for 360}^\circ \text{ turn test} + \text{final assessment time for four-square step test})$) will be calculated for each group and used for the analysis. The delta scores will be compared between the TWTG and MVeG by independent samples t-test.
- H5. Subjects in the MVeG will have a significantly higher score on the QOL Scale than the weight lifting group at the end of the intervention. Mean scores will be compared between groups by ANOVA.

H6. Subjects in the MVeG will have a significantly lower score on the Piper Revised Fatigue Scale than the weight lifting group at the end of the intervention. Mean scores will be compared between groups by ANOVA.

Chapter IV

Results

The purpose of this study was to compare two different resistance training modalities (traditional weight training vs. Pilates) as the resistance training portion of the Get REAL & HEEL Breast Cancer Program on selected measurements of overall functionality. The secondary purpose explored the impact of these two training modalities on fatigue and overall QOL.

All data were entered into an electronic database for analyses. All data were analyzed using SPSS version 17.0 for Windows, a statistical software program. Statistical significance was set apriori at an alpha level ≤ 0.05 . Descriptive statistics are presented in the form of means and standard deviations.

Subjects

Volunteers for this study consisted of 16 females, age 25 to 75 years, who were diagnosed with breast cancer and had completed their major cancer treatment including surgery, chemotherapy and/or radiation within 6 months of enrollment. All subjects were recruited from the Get REAL & HEEL Breast Cancer Program, at the University of North Carolina at Chapel Hill, Department of Exercise and Sport Science. Subject characteristics for both groups (MVeG and TWTG) are presented in Table 3. Table 4 describes the treatments undergone by subjects in each group.

Table 3
Subject Characteristics

| | Age (years) | | Height (centimeters) | | Weight (kilograms) | | Body Composition (% Body Fat) | |
|---------------|----------------|------|-------------------------|-----|-----------------------|------|----------------------------------|-----|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| MVeG n = 8 | 44.6 | 8.0 | 168.4 | 7.7 | 76.5 | 15.4 | 28.5 | 5.6 |
| TWTG n = 8 | 47.8 | 11.5 | 166.4 | 5.9 | 66.5 | 11.4 | 28.7 | 3.8 |

Table 4
Number of Subjects Receiving Each Kind of Treatment

| | Chemotherapy | Radiation Therapy | Surgery |
|---------------|--------------|-------------------|---------|
| MVeG n = 8 | 6 | 7 | 8 |
| TWTG n = 8 | 8 | 6 | 8 |

Most subjects in both groups received all treatments. In the MVeG, one subject had surgery only, and one subject had surgery and radiation therapy only.

Hypothesis One

Subjects in the MVeG will significantly improve OME from pre to posttest. The dependent variable of this analysis was the mean sum of the number of repetitions performed for the following exercises: modified push up, partial curl ups, biceps curls (sum of the results for right and left arm), lat pull down, leg extension, and leg curl during the 8 week protocol. The descriptive statistics of the analysis of hypothesis one are presented below in Table 5.

Table 5
Descriptive Statistics of Hypothesis One

| | Delta Score Mean | SD | Std. Error Mean | 95% CI of lower | Mean upper |
|---------------|---------------------|-------|--------------------|--------------------|---------------|
| MVeG n = 8 | 36.75 | 22.46 | 7.94 | 17.97 | 55.53 |

Using a dependent samples t-test, a significant difference in OME was found from pretest to posttest within the MVeG ($p = 0.002$). The Cohen's d score for this analysis was 1.32, indicating a large effect size.

Hypothesis Two

There will be no significant difference in improvements on repetitions performed during the muscular endurance tests between TWTG and MVeG at the end of the intervention. The dependent variable of this analysis was the delta score of OME from pretest to posttest. The descriptive statistics of the analysis of hypothesis two are presented below in Table 6.

Table 6
Descriptive Statistics of Hypothesis Two (OME)

| | Delta Score Mean | SD | Std. Error Mean | 95% CI of lower | Mean upper |
|---------------|-----------------------------|-----------|----------------------------|----------------------------|-----------------------|
| MVeG n = 8 | 36.75 | 22.46 | 7.94 | -32.37 | 16.87 |
| TWTG n = 8 | 44.50 | 23.45 | 8.29 | -32.38 | 16.88 |

Using an independent samples t-test, no significant difference was found between delta scores for OME of the two groups ($p = 0.511$). The Cohen's d score for this analysis was -0.47, which indicates a small effect size.

Hypothesis Three

Subjects in the MVeG will improve significantly more on the single-foot stance test than subjects in the TWTG at the end of the intervention. The dependent variable of this analysis was the delta score of static balance from pretest to posttest. The descriptive statistics of the analysis of hypothesis three are presented below in Table 7.

Table 7
Descriptive Statistics of Hypothesis Three (Static Balance)

| | Delta Score Mean | SD | Std. Error Mean | 95% CI of lower | Mean upper |
|---------------|-----------------------------|-----------|----------------------------|----------------------------|-----------------------|
| MVeG n = 8 | 1.04 | 2.90 | 1.02 | -1.91 | 3.70 |
| TWTG n = 8 | 0.15 | 2.31 | 0.81 | -1.93 | 3.72 |

Using an independent samples t-test, no significant difference was found between delta scores for static balance of the two groups ($p = 0.505$). The Cohen's d score for this analysis was 0.34, which indicates a small effect size.

Hypothesis Four

Subjects in the MVeG will improve their dynamic balance more than the TWTG. The dependent variable of this analysis was the delta score of dynamic balance from pretest to posttest. The descriptive statistics of the analysis of hypothesis four are presented below in Table 8.

Table 8
Descriptive Statistics of Hypothesis Four (Dynamic Balance)

| | Delta Score Mean | SD | Std. Error Mean | 95% CI of lower | Mean upper |
|---------------|-----------------------------|-----------|----------------------------|----------------------------|-----------------------|
| MVeG n = 8 | 0.25 | 2.36 | 0.83 | -1.97 | 3.22 |
| TWTG n = 8 | -0.37 | 2.49 | 0.88 | -1.97 | 3.22 |

Using an independent samples t-test, no significant difference was found between delta scores for dynamic balance for the two groups ($p = 0.614$). The Cohen's d score for this analysis was 0.26, which indicates a small effect size.

Hypothesis Five

Subjects in the MVeG will have a significantly higher score on the QOL Scale than the TWTG at the end of the intervention. The dependent variables of this analysis

were pretest QOL score and posttest QOL score. The descriptive statistics of the analysis of hypothesis five are presented below in Table 9.

Table 9
Descriptive Statistics of Hypothesis Five (QOL)

| | QOL Mean Score | SD | Std. Error Mean | 95% CI of Mean | |
|------------------------|----------------|-------|-----------------|----------------|--------|
| | | | | Lower | Upper |
| MVeG Pretest n = 8 | 107.00 | 15.50 | 6.75 | 92.51 | 121.49 |
| MVeG Posttest n = 8 | 114.73 | 14.06 | 4.91 | 104.20 | 125.25 |
| TWTG Pretest n = 8 | 98.88 | 22.13 | 6.75 | 84.39 | 113.36 |
| TWTG Posttest n = 8 | 112.63 | 13.7 | 4.91 | 102.10 | 123.15 |

Using a repeated measures ANOVA, both groups significantly improved from pretest to posttest ($p = 0.012$), but no significant interaction effect was found between group and time ($p = 0.434$).

Hypothesis Six

Subjects in the MVeG will have a significantly lower score on the Piper Revised Fatigue Scale than the TWTG at the end of the intervention. The dependent variables of this analysis were pretest fatigue score and posttest fatigue score. The descriptive statistics of the analysis of hypothesis six are presented below in Table 10.

Table 10

Descriptive Statistics of Hypothesis Six (Fatigue)

| | Fatigue Mean Score | SD | Std. Error Mean | 95% CI of Mean | |
|---------------------------|-------------------------------|-----------|----------------------------|-----------------------|--------------|
| | | | | Lower | Upper |
| MVeG Pretest n = 8 | 4.44 | 1.53 | 0.66 | 3.03 | 5.85 |
| MVeG Posttest n = 8 | 2.98 | 1.70 | 0.69 | 1.51 | 4.45 |
| TWTG Pretest n = 8 | 4.26 | 2.14 | 0.66 | 2.85 | 5.67 |
| TWTG Posttest n = 8 | 3.17 | 2.15 | 0.69 | 1.70 | 4.64 |

Using a repeated measures ANOVA, both groups significantly decreased their fatigue scores from pretest to posttest ($p = 0.009$), but no significant interaction effect was found between group and time ($p = 0.670$).

Chapter V

Discussion, Conclusion, and Recommendations

Introduction

Previous research has shown that exercise has a strong record in helping breast cancer patients to improve their physical and psychosocial function during and after treatment (Courneya, 2003; Galvao and Newton, 2005). Resistance training has been used in this population as part of exercise routines, with most studies using traditional weight lifting for their resistance training. Weight lifting has been shown to improve muscular strength and endurance significantly (Galvao et al 2006; Newton and Galvao, 2008). Very few studies have used other modes of resistance exercise, such as Pilates, as the means of improving muscular fitness in breast cancer patients (Courneya and Mackey, 2001; Newton and Galvao, 2008). If there were other modes of resistance training that could also be efficient in improving muscular strength and endurance, researchers and clinicians would have more options to help treat their patients.

The MVe Fitness Chair is a new piece of exercise equipment made by Peak Pilates, Boulder CO. It facilitates the performance of many Pilates exercises that are similar to traditional exercise moves used in weight lifting, but may place a greater demand on core stabilizer muscles than their counterparts done with traditional resistance equipment. Exercises with extra emphasis on core stability may help improve patients' overall functionality and increase their ability to perform activities of daily living similarly or perhaps better than exercises that are focused primarily on increasing muscular endurance of the limbs (Aaronson, 2007; O'Clair, 2008). Ergo, the purpose of

this study was to compare traditional weight lifting to Pilates as the mode of resistance training in the comprehensive exercise routine of the Get REAL & HEEL Breast Cancer Program on selected measurements of overall functionality. The secondary purpose explored the impact of these two training modalities on QOL and fatigue.

Overall Muscular Endurance

Hypothesis one assessed if Pilates exercises could improve OME. Results from a paired samples t-test showed a significant increase in OME from pretest to posttest, indicating that Pilates exercises using the MVe Fitness Chair are effective for improving OME. This result agrees with the general body of work that breast cancer survivors can adapt positively to resistance exercises. Galvao and colleagues (2006) reported that subjects who performed moderate intensity resistance exercise training three times per week significantly improved muscular endurance, by the 10th week of their program, as measured by number of repetitions on chest press and leg press. Kolden and colleagues (2002) also administered an exercise intervention that incorporated cardiovascular and resistance training. Their subjects exercised three times per week, performing 20 minutes of both cardiovascular and resistance exercises. Kolden and colleagues reported that by week 16, subjects significantly improved muscular strength, as measured by estimated 1RM tests of bench press and leg press. Similarly, Quist and colleagues (2006) used estimated 1RM tests of chest press, leg press, and lateral pull down to assess muscular strength. Their subjects significantly improved muscular strength in only 6 weeks of high intensity resistance training, undergoing three sessions per week that lasted 90 minutes each.

Increases in muscular strength can translate into increases in muscular endurance, and vice versa. This is due to the adaptations that muscle undergoes in response to resistance training. One adaptation that increases muscular strength is an increase in

motor unit size, i.e. more muscle fibers are innervated per alpha motor neuron. If a motor unit can recruit more fibers, it can generate more force, and therefore a muscle will be stronger. Every muscle has many motor units, and they do not all activate at the same time. Rather, motor units within a muscle take turns innervating so that the muscle doesn't fatigue. If one motor unit is able to generate more force, then other motor units in the muscle can rest and be innervated later to maintain the same amount of force. This gives the initial motor unit time to recover before firing again. In this manner, a muscle is able to exhibit greater endurance by having an increased strength. Similarly, the increase in force generation potential in a muscle due to hypertrophy allows other motor units to rest, therefore allowing the muscle to exhibit greater endurance. Though one adaptation can be trained preferentially over the other, any resistance training increases both muscular strength and endurance. Thus any increase in muscular strength can be equated to at least some increase in muscular endurance, and vice versa (ACSM, 2006; Brooks et al, 2000; NASM, 2004). Even though two of the above studies used muscular strength instead of muscular endurance as their dependent variable, and the results are not directly comparable to the present study, they all show a clinical improvement in muscular function. This confirms that cancer survivors can quickly improve OME with resistance training, including Pilates.

Hypothesis two assessed if the MVeG would improve OME as much or more than the TWTG. Results showed no significant difference in change in OME between the groups, indicating that neither group improved significantly more than the other. This could indicate that Pilates exercises are just as effective as weight lifting exercises at improving OME. If that is true, it could be more cost and space effective to train patients using the MVe Fitness Chair than with traditional weight lifting equipment. More research is needed to see if other forms of nontraditional resistance training would also

improve OME in this population, but the present study indicates that other modes could be effective. The MVeG improved an average of 37 reps, which was a 57% improvement, while the TWTG group improved an average of 46 reps, which was a 70% improvement. Since the two training protocols were designed to use exercises that worked the same muscles in similar motion patterns, it would be expected that the muscles would improve similarly. The difference in the mean improvement on reps can be accounted for by the principle of specificity. The testing protocol used traditional weight lifting exercises, so the TWTG may have performed better on the test because of familiarity with the equipment and types of exercises. The improvement in both groups on total reps is clinically significant, and may translate to greater functionality and ease of performing activities of daily living.

The main theoretical advantage of performing exercises on the MVe Fitness Chair is that the core stabilizer muscles would be better trained. However, the MVeG increased 10 reps more on average on the partial crunch test while the TWTG increased 15 reps more on average on the partial crunch test. It should be noted that the TWTG did regular crunches as an exercise, while the MVeG equivalent did not put the spine through flexion and extension. These results indicate that while the TWTG was statistically no better than the MVeG, the practice they had on the tested exercises helped their performance. The differences in number of repetitions, both overall and for the crunch by itself, are not clinically significant, and should be viewed as similar between the groups. The small sample sizes, and therefore low statistical power, may have hindered any of these results from being statistically significant. Another important factor that must be taken into consideration is the duration of the study protocol. Even though previous research has shown improvements in muscular fitness using a 6 week protocol, the intensity of training was higher than the present study (Quist et al, 2006). If the present study lasted longer

than 8 weeks with a larger sample size, perhaps the results could have been different. More comparative studies are needed to confirm and extend these results.

Balance

Hypothesis three assessed if the MVeG would improve static balance as much or more than the TWTG. Results showed no significant difference in change in static balance between the groups, however, the MVeG had a mean increase of 1.04 seconds on the single leg stand test, while the TWTG had a mean increase of 0.15 seconds on the single leg stand test. As an exploratory analysis, an ANOVA was run to determine if there was any improvement over time, and it was found that there was no significant improvement in static balance in either group from pretest to posttest. With increased training of the core stabilizer muscles and the focus on mind-body connection, it would be expected that Pilates training would help improve balance (Larkey, Johnke, Etnier, and Gonzalez, 2009). Balance is the ability to maintain control of one's center of gravity as it moves through space. Core stabilizer muscles work to keep the body's center of mass over its base of support, thus helping to maintain balance and posture (NASM 2004). Therefore, an increase in core stability may help improve balance. Since there was no significant difference between groups on the measure of core strength (partial curl up), it could not be expected that in this study this attribute helped either group's static balance more than the other.

The expectation of this study was that both groups would significantly improve balance, with the Pilates group having even greater gains than the traditional group. Many factors may help explain the results of this study. The first issue that must be addressed is the effects of the subjects' treatments on their ability to balance. Wampler and colleagues (2007) described how chemotherapy negatively impacts all three balance mechanisms. As all except two subjects in the present study underwent chemotherapy, the lack of

significant improvement in balance could partially be attributed to the lasting side effects of chemotherapy. A major factor found in the literature was length of intervention. In healthy populations, static balance was seen to improve in 12 weeks to 6 months (Judge, Lindsey, Underwood, and Winsemsius, 1993; Hourigan et al, 2008; Larkey et al, 2009). Since breast cancer survivors receiving chemotherapy have an even harder time improving balance than healthy individuals, it's possible that even more than 12 weeks or 6 months would be needed to see improvements in this population. Previous research suggests that the present protocol may not have lasted long enough for significant improvements in balance to be made by either group. If this study were reproduced with a larger sample size and was conducted over 6 months with multiple assessments throughout, the significant improvement in balance may be found using the current protocol.

Hypothesis four assessed if the MVeG would improve dynamic balance as much or more than the TWTG. Results showed no significant difference in change in dynamic balance between the groups ($p = 0.614$). An exploratory ANOVA showed no significant improvement in dynamic balance for either group ($p = 0.938$). Like with static balance, previous research indicates that more than 8 weeks is necessary to see significant improvements in dynamic balance.

A common test used to assess dynamic balance is the Timed Backward Tandem Walk Test (Waltman, Twiss, Ott, Gross, Lindsey, Moore, et al., 2003; Galvao et al., 2006; Twiss et al, 2009). The present study utilized both the 360° turn test and the four square step test to assess dynamic balance, so the results are not directly comparable. However, in three experimental studies using the Timed Backward Tandem Walk Test to assess dynamic balance in breast cancer survivors after resistance training, significant improvements were found in dynamic balance (Waltman et al., 2003; Galvao et al., 2006;

Twiss et al., 2009). These studies found significant improvements at 5 months, 6 months, 12 months, and 24 months. One study took a measure at 10 weeks and did not find significance that early on. These results confirm the trend found among static balance that 8 weeks may not be long enough for balance to improve, and that with more time dynamic balance could also improve. Another possible explanation for the lack of improvement is that the subjects recruited to this study might have all ready had superior balance ability for their population, and that significant improvement beyond their baseline was not possible. There are no normative values for balance among breast cancer survivors, but it has been shown that this population performs physically similar to elderly adults. Gill and colleagues (1995) created quartiles of performance for the 360° turn test using 548 elderly independent adults. Their most superior quartile performed the test in 1.1 – 2.4 seconds. The average time to complete the 360° turn test for all subjects in this study was 1.7 seconds, so if these breast cancer survivors' balance really was similar to those of healthy older adults, they all ready possessed superior balancing abilities, and would have had less room to improve. Normative values and ranges for performance tests need to be developed among breast cancer survivors so that proper comparisons within and between studies can be made.

Research has shown that exercise can improve both static and dynamic balance. However, when comparing the results of this study to the published literature, it seems that more than the 8 weeks used in this study are needed to improve balance significantly. The other studies that did find significance had a minimum of at least four more weeks of training than the present study. If this study were carried out for another month, perhaps significant improvement would be found. In order to conduct a valid study, the two protocols in this study were matched for volume and exercises used. The exercises selected covered both upper body, lower body, and core muscles, and in both groups, the

matched exercises worked the same target muscles in similar motions. While the traditional exercises selected together formed a proper weight lifting routine, the exercises selected to match them in the Pilates workout were constrained by the need for comparability. The MVe Fitness Chair allows for the creation of a more specific exercise protocol that focuses on balance, however, there would not have been any good matches for them with the traditional weight training equipment available to use in this study. The MVe Fitness Chair system is designed to use a wide range of exercises that all challenge balance and core control. To match the traditional weight training protocol, the Pilates protocol used in this study focused more on limb movement. Perhaps a Pilates routine that used more of the exercises that focused on balance and core control would elicit significant balance gains better than the current Pilates protocol. If the MVe Fitness Chair were more fully taken advantage of, it is very likely it could also elicit greater gains on all physical function measures than seen in this study. Further research is needed to confirm or refute this possibility.

Quality of Life and Fatigue

Hypothesis five assessed if the MVeG would differ from the TWTG on QOL score. Results showed that both groups significantly improved their QOL, but that there was no significant interaction effect between group and time. These results agree with the published literature that exercise is an effective means of improving QOL among cancer patients. Monga and colleagues (2007) implemented an 8 week exercise intervention in prostate cancer survivors, and measured QOL via the FACT-P, which is directed specifically toward prostate cancer patients as compared to this study using the FACT-B, which is directed specifically toward breast cancer patients. The intervention demonstrated that QOL significantly improved with 8 weeks of exercise, confirming the results of the present study. A review by Courneya and Mackey (2001) established that

exercise is an effective way to improve QOL in cancer survivors, and the present study agreed with their conclusion. The increase in OME seen in this study would allow the subjects to perform functional activities with greater ease (ACSM, 2006; Hamer et al, 2008; Knobf et al, 2008; Vallance et al, 2008). This could contribute to better and less stressful performance of activities of daily living, as well as being able to participate in recreational activities longer and without tiring as much. By being able to do more things with less effort, the subjects in this study would have a higher QOL. Aside from improving their physical quality of life, subjects had the opportunity to improve their mental quality of life. A major factor, which has been commented on by Knobf and colleagues (2008), is the sense of empowerment and hope derived from participating in a personalized exercise program. During treatments, patients are passively undergoing operations that make them feel physically worse. An exercise program is a chance for them to actively help themselves, and often the act of exercising creates acute physical and mental feelings of betterment. Seeing oneself progress over time creates the sense of hope and empowerment which allows people to continue with their exercise program after leaving the clinical setting. In exit interviews conducted with the patients at the end of the program, a frequent comment was that the interaction with a personal trainer and with other patients greatly contributed to their QOL. Patients often said that spending time with their trainer was an enjoyable experience they looked forward to each week. The social interactions fostered at the Get REAL & HEEL Breast Cancer Program were beneficial to the subject's mental and emotional improvements in QOL.

Hypothesis six assessed if the MVeG would differ from the TWTG on fatigue score. Results showed that both groups significantly decreased their fatigue, but that there was no significant interaction effect between group and time. These results agree with the published literature that exercise is an effective means of decreasing fatigue in cancer

patients. Monga and colleagues (2007) also measured fatigue in their 8 week study, and like the present study used the RPFS. They found a significant decrease in fatigue at 8 weeks within their exercise group, confirming the results of the present study. Newton and Galvao (2005) wrote a review of the benefits of exercise on physical and psychosocial factors in cancer survivors. All the studies they reviewed that used fatigue as an outcome found that exercise significantly decreases fatigue in this population, confirming the results of the present study. Fatigue as measured by a questionnaire is a subjective measure, and therefore dependent on a patient's perception. In the present study, the subjects increased their tolerance to exercise, specifically their OME. Throughout the 8 weeks, the volume of training increased three times. Fatigue must have lessened in the subjects for them to tolerate the greater volume and improve over the 8 weeks, due to the adaptations to the training. As they adapted, they felt less fatigued, and were able to train more, and further improved their OME which helped them decrease fatigue. Consistent training can create a cycle that decreases fatigue and allows for more training, and this was exhibited in this study by the concurrent significant increase in OME with decrease in fatigue score. In addition to the resistance training, all subjects in this study participated in aerobic exercise training. Adaptations to the total exercise done could help improve subject's perceived energy levels. If a subject felt they had more energy, they would perceive a lessening of fatigue, lowering their score on the RPFS. The RPFS is a good tool for assessing fatigue levels in this population, however, by its nature it's subject to many physical, mental, and emotional factors, and it is difficult to determine how much of each factor contributes to the overall perception a subject may have of fatigue.

Research Questions

1. Will Pilates exercises using the MVe Fitness Chair improve muscular endurance?

Pilates exercises using the MVe Fitness Chair can improve muscular endurance.

2. Will subjects in the Pilates group improve muscular endurance as much as subjects in the weight lifting group?

Subjects in the Pilates group improved muscular endurance as much as subjects in the weight lifting group.

3. Will subjects in the Pilates group have better static and dynamic balance than subjects in the weight lifting group?

Subjects in the Pilates group had static and dynamic balance similar to subjects in the weight lifting group, but neither group significantly improved either aspect of their balance.

4. Will subjects in the Pilates group experience greater psychosocial gains than subjects in the weight lifting group?

Subjects in the Pilates groups had psychosocial gains similar to subjects in the weight lifting group, and both groups significantly improved on both the QOL and fatigue measures.

Conclusion

The results of this study suggest that Pilates using the MVe Fitness Chair promotes similar gains in OME when compared to traditional weight lifting. Also, no significant differences between groups on improving QOL and decreasing fatigue in breast cancer survivors were observed in this study; this suggests that these two modes of exercises, focusing on improving OME, promote similar psychosocial gains. The results of this study indicated that neither protocol was effective at significantly impacting balance in only 8 weeks. According to previous literature, 8 weeks of training may not be enough for significant improvements in balance to occur; more so in patients that have undergone chemotherapy and radiation therapy. Since the MVe Fitness Chair is more cost

and space effective than many other pieces of resistance equipment, and according to the results of this experiment elicited similar gains when compared to traditional weight training, clinicians looking at improving muscular endurance, decreasing fatigue, and improving quality of life of their patients should consider the use of the MVe Fitness Chair in their practices. However, due to the low number of subjects in each group and the apparently short duration protocol, the results of this study should be interpreted cautiously. Further research is needed to confirm or refute the preliminary findings presented by this study.

Recommendations

According to the results of this study, the following recommendations can be made for continued research into the area of exercise and cancer and the use of the MVe Fitness Chair:

Implications for Research

1. Larger sample size to increase statistical power.
2. Longer intervention time with repeated tests at 6 month intervals post treatment to see extended training effect.
3. Use multi-site studies to confirm and expand these results.
4. Stratify the patients by exact treatments received if enough numbers can be recruited for each group.
5. Perform studies with patients who are pretreatment or in treatment to see if it is safe and effective at any time during the whole cancer treatment process.

Implications for Practice

1. Utilize the MVe Fitness Chair in the hospital setting by trained personnel as a means to improve physical activity levels in hospitalized cancer patients.

2. From initial assessments, stratify patients into fitness categories so that patients who all ready have a high level of fitness are not working below their capabilities.
3. The present study used a Pilates workout that matched the weight training workout. The MVe Fitness Chair is capable of delivering workouts that challenge people more, especially on balance. A study implementing a Pilates workout that used a wider range of exercises, and more exercises that focused on core control may be more effective in improving all measures of fitness.
4. All exercise interventions in this population should include a portion specifically working on balance training outside of resistance training.
5. Pilates exercises require great attention to technique. Some of the checkpoints are hard to self assess, making learning Pilates by oneself hard to do. It is important to have a master Pilates instructor train a clinic's/study's staff on how to perform and teach Pilates exercises to patients to insure they are properly done. Even if a master Pilates instructor is not specifically familiar with the MVe Fitness Chair, the principles of all Pilates exercises can be taught and applied to the exercises on the MVe Fitness Chair.
6. There are a wide array of exercises that can be done on the MVe Fitness Chair. There are many exercises that can be sequenced as progressions to continue to challenge patients. There are many techniques and modifications that can be made to exercises to make them easier for a patient. The manual that comes with the MVe Fitness Chair describes many of these progressions and modifications, but there are other things that can be done with a patient is working with a trainer, such as light contact with the trainer, that can help guide a patient safely into the proper exercise technique.

Appendix A

FACT-B Quality of Life Scale



FACT-B (version 2)

Name: _____

Date: _____

| | | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Below is a list of statements that other people with your illness have said are important. By filling in one circle per line, please indicate how true each statement has been for you during the past 7 days.



During the past 7 days:

PHYSICAL WELL-BEING

| | not at all | a little bit | some-what | quite a bit | very much | | | | | | | |
|--|------------|--------------|-----------|-------------|-----------|---|---|---|---|---|----|--------------|
| 1. I have a lack of energy..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 2. I have nausea..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 3. I have trouble meeting the needs of my family..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 4. I have pain..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 5. I am bothered by side effects of treatment..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 6. In general, I feel sick..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 7. I am forced to spend time in bed..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 8. How much does your PHYSICAL WELL-BEING affect your quality of life? | | | | | | | | | | | | |
| Not at all | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Very much so |

During the past 7 days:

SOCIAL/FAMILY WELL-BEING

| | not at all | a little bit | some-what | quite a bit | very much | | | | | | | |
|---|------------|--------------|-----------|-------------|-----------|---|---|---|---|---|----|--------------|
| 9. I feel distant from my friends..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 10. I get emotional support from my family..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 11. I get support from my friends and neighbors..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 12. My family has accepted my illness..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 13. Family communication about my illness is poor..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| If you have a spouse/partner, or are sexually active, please answer # 14-15. Otherwise, go to # 16. | | | | | | | | | | | | |
| 14. I feel close to my partner (or main support)..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 15. I am satisfied with my sex life..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 16. How much does your SOCIAL/FAMILY WELL-BEING affect your quality of life? | | | | | | | | | | | | |
| Not at all | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Very much so |

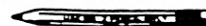
During the past 7 days:

RELATIONSHIP WITH DOCTOR

| | not at all | a little bit | some-what | quite a bit | very much | | | | | | | |
|--|------------|--------------|-----------|-------------|-----------|---|---|---|---|---|----|--------------|
| 17. I have confidence in my doctor(s)..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 18. My doctor is available to answer my questions..... | 0 | 1 | 2 | 3 | 4 | | | | | | | |
| 19. How much does your RELATIONSHIP WITH THE DOCTOR affect your quality of life? | | | | | | | | | | | | |
| Not at all | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Very much so |

Please turn to the next page.

FACT-B (version 2)



During the past 7 days:

EMOTIONAL WELL-BEING

| | not at all | a little bit | some- what | quite a bit | very much |
|--|---------------|-----------------|---------------|----------------|--------------|
| 20. I feel sad..... | ① | ② | ③ | ④ | ⑤ |
| 21. I am proud of how I'm coping with my illness..... | ① | ② | ③ | ④ | ⑤ |
| 22. I am losing hope in the fight against my illness..... | ① | ② | ③ | ④ | ⑤ |
| 23. I feel nervous..... | ① | ② | ③ | ④ | ⑤ |
| 24. I worry about dying..... | ① | ② | ③ | ④ | ⑤ |
| 25. How much does your EMOTIONAL WELL-BEING affect your quality of life? | ① | ② | ③ | ④ | ⑤ |
| Not at all | ① | ② | ③ | ④ | ⑤ |
| Very much so | | | | | |

During the past 7 days:

FUNCTIONAL WELL-BEING

| | not at all | a little bit | some- what | quite a bit | very much |
|---|---------------|-----------------|---------------|----------------|--------------|
| 26. I am able to work (include work in home)..... | ① | ② | ③ | ④ | ⑤ |
| 27. My work (include work in home) is fulfilling..... | ① | ② | ③ | ④ | ⑤ |
| 28. I am able to enjoy life "in the moment"..... | ① | ② | ③ | ④ | ⑤ |
| 29. I have accepted my illness..... | ① | ② | ③ | ④ | ⑤ |
| 30. I am sleeping well..... | ① | ② | ③ | ④ | ⑤ |
| 31. I am enjoying my usual leisure pursuits..... | ① | ② | ③ | ④ | ⑤ |
| 32. I am content with the quality of my life right now..... | ① | ② | ③ | ④ | ⑤ |
| 33. How much does your FUNCTIONAL WELL-BEING affect your quality of life? | ① | ② | ③ | ④ | ⑤ |
| Not at all | ① | ② | ③ | ④ | ⑤ |
| Very much so | | | | | |

During the past 7 days:

ADDITIONAL CONCERNS

| | not at all | a little bit | some- what | quite a bit | very much |
|--|---------------|-----------------|---------------|----------------|--------------|
| 34. I have been short of breath..... | ① | ② | ③ | ④ | ⑤ |
| 35. I am self-conscious about the way I dress..... | ① | ② | ③ | ④ | ⑤ |
| 36. My arms are swollen or tender..... | ① | ② | ③ | ④ | ⑤ |
| 37. I feel sexually attractive..... | ① | ② | ③ | ④ | ⑤ |
| 38. I have been bothered by hair loss..... | ① | ② | ③ | ④ | ⑤ |
| 39. I worry about the risk of cancer in other family members..... | ① | ② | ③ | ④ | ⑤ |
| 40. I worry about the effect of stress on my illness..... | ① | ② | ③ | ④ | ⑤ |
| 41. I am bothered by a change in weight..... | ① | ② | ③ | ④ | ⑤ |
| 42. I am able to feel like a woman..... | ① | ② | ③ | ④ | ⑤ |
| 43. How much do these ADDITIONAL CONCERNS affect your quality of life? | ① | ② | ③ | ④ | ⑤ |
| Not at all | ① | ② | ③ | ④ | ⑤ |
| Very much so | | | | | |

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To get the FACT-B total score, follow these directions.

In the Physical Well-Being section, score items 1-7 in reverse of what is filled in. For example, if an item is filled in as a 0, score it 4 points; if an item is filled in as a 1, score it 3 points.

In the Social/Family Well-Being section, score items 9 and 13 in reverse of what is filled in. Give items 10-12 and 14-15 the points for the number filled in.

In the Relationships with Doctor section, give 17 and 18 the points for the number filled in.

In the Emotional Well-Being section, score items 20 and 22-24 in reverse of what is filled in. Give item 21 the points for the number filled in.

In the Functional Well-Being section, give items 26-32 points for the number filled in.

In the Additional Concerns section, score items 34-36 and 38-41 in reverse of what is filled in. Give items 37 and 42 the points for the number filled in.

Note that items 8, 16, 19, 25, 33, and 43 are not used to calculate points.

Add all of the points together. The summation of these points is the FACT-B total score. A higher total score on the FACT-B indicates a higher overall quality of life.

Revised Piper Fatigue Scale



Name: _____ Date: _____

Revised Piper Fatigue Scale

Directions: For each of the following questions, circle the number that best describes the fatigue you are experiencing now. Please make every effort to answer each question to the best of your ability. Thank you very much.

1. How long have you been feeling fatigued? (*check one response only*)

- a. Minutes _____
- b. Hours _____
- c. Days _____
- d. Weeks _____
- e. Months _____
- f. Other (*please describe*): _____

2. To what degree is the fatigue you are feeling now causing you distress?

| | | | | | | | | | | |
|--------------------|---|---------------------------------|---|---|---|---|---|---|---|----|
| No distress | | A great deal of distress | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

3. To what degree is the fatigue you are feeling now interfering with your ability to complete work or school activities?

| | | | | | | | | | | |
|-------------|---|---------------------|---|---|---|---|---|---|---|----|
| None | | A great deal | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

4. To what degree is the fatigue you are feeling now interfering with your ability to visit or socialize with your friends?

| | | | | | | | | | | |
|-------------|---|---------------------|---|---|---|---|---|---|---|----|
| None | | A great deal | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

5. To what degree is the fatigue you are feeling now interfering with your ability to engage in sexual activity?

| | | | | | | | | | | |
|-------------|---|---------------------|---|---|---|---|---|---|---|----|
| None | | A great deal | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

6. Overall how much is the fatigue, which you are experiencing now, interfering with your ability to engage in the kind of activities you enjoy doing?

| | | | | | | | | | | |
|-------------|---|---------------------|---|---|---|---|---|---|---|----|
| None | | A great deal | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

7. How would you describe the degree of intensity or severity of the fatigue which you are experiencing now?

| | | | | | | | | | | |
|-------------|---|---------------|---|---|---|---|---|---|---|----|
| Mild | | Severe | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

To what degree would you describe the fatigue which you are experiencing now as being:

- | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|--------------|---|----|
| 8. Pleasant | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Unpleasant | 9 | 10 |
| 9. Agreeable | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Disagreeable | 9 | 10 |
| 10. Protective | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Destructive | 9 | 10 |
| 11. Positive | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Negative | 9 | 10 |
| 12. Normal | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Abnormal | 9 | 10 |
| 13. To what degree are you now feeling: | | | | | | | | | | | | |
| Strong | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Weak | 9 | 10 |
| 14. To what degree are you now feeling: | | | | | | | | | | | | |
| Awake | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Sleepy | 9 | 10 |
| 15. To what degree are you now feeling: | | | | | | | | | | | | |
| Lively | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Listless | 9 | 10 |
| 16. To what degree are you now feeling: | | | | | | | | | | | | |
| Refreshed | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Tired | 9 | 10 |
| 17. To what degree are you now feeling: | | | | | | | | | | | | |
| Energetic | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Unenergetic | 9 | 10 |
| 18. To what degree are you now feeling: | | | | | | | | | | | | |
| Patient | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Impatient | 9 | 10 |
| 19. To what degree are you now feeling: | | | | | | | | | | | | |
| Relaxed | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Tense | 9 | 10 |

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20. To what degree are you now feeling:
- | | | | | | | | | | | | |
|--------------------|---|---|---|---|---|---|---|---|---|----|------------------|
| Exhilarated | | | | | | | | | | | Depressed |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
21. To what degree are you now feeling:
- | | | | | | | | | | | | |
|----------------------------|---|---|---|---|---|---|---|---|---|----|------------------------------|
| Able to concentrate | | | | | | | | | | | Unable to concentrate |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
22. To what degree are you now feeling:
- | | | | | | | | | | | | |
|-------------------------|---|---|---|---|---|---|---|---|---|----|---------------------------|
| Able to remember | | | | | | | | | | | Unable to remember |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
23. To what degree are you now feeling:
- | | | | | | | | | | | | |
|------------------------------|---|---|---|---|---|---|---|---|---|----|--------------------------------|
| Able to think clearly | | | | | | | | | | | Unable to think clearly |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
24. Overall, what do you believe is most directly contributing to or causing your fatigue?
- _____
- _____
25. Overall, the best thing you have found to relieve your fatigue is: _____
- _____
26. Is there anything else you would like to add that would describe your fatigue better to us? _____
- _____
27. Are you experiencing any other symptoms right now?
- No _____
- Yes Please describe: _____
- _____

Revised Piper Fatigue Scale Calculations

Calculate each section separately. The answer should be between 0 and 10.
Add each of the total numbers and divide by 22 to get overall score of 0 to 10.

Missing Data

Follow this procedure if patient answered at least 75%-80% of the questions in each section.

1. add the values of the questions answered in that section
2. divide by the number of questions answered in that section
3. substitute that number for the missing number
4. calculate total score for that section by using the substituted number

Example:

#5 is commonly not answered

| Behavioral/Severity | Score |
|---------------------|------------------------------|
| #2 - distress | 6 |
| #3 - work/school | 5 |
| #4 - socialize | 7 |
| #5 - sex | |
| #6 - activities | 8 |
| #7 - severity | 5 |
| Total | $\text{ } \div 6 = \text{ }$ |

Add $6+5+7+8+5 = 31 \div 5 = 6.2$ Substitute 6.2 for #5

| Behavioral/Severity | Score |
|---------------------|---------------------|
| #2 - distress | 6 |
| #3 - work/school | 5 |
| #4 - socialize | 7 |
| #5 - sex | 6.2 |
| #6 - activities | 8 |
| #7 - severity | 5 |
| Total | $37.2 \div 6 = 6.2$ |

Patient Name: _____

Revised Piper Fatigue Scale Calculations

| Date: _____ | | Date: _____ | | Date: _____ | |
|----------------------------|---------------------------|----------------------------|---------------------------|----------------------------|---------------------------|
| Behavioral/Severity | Score | Behavioral/Severity | Score | Behavioral/Severity | Score |
| #2 - distress----- | _____ | #2 - distress----- | _____ | #2 - distress----- | _____ |
| #3 - work/school----- | _____ | #3 - work/school----- | _____ | #3 - work/school----- | _____ |
| #4 - socialize----- | _____ | #4 - socialize----- | _____ | #4 - socialize----- | _____ |
| #5 - sex----- | _____ | #5 - sex----- | _____ | #5 - sex----- | _____ |
| #6 - activities----- | _____ | #6 - activities----- | _____ | #6 - activities----- | _____ |
| #7 - severity----- | _____ | #7 - severity----- | _____ | #7 - severity----- | _____ |
| Total | _____ ÷ 6 = _____ | Total | _____ ÷ 6 = _____ | Total | _____ ÷ 6 = _____ |
| | | | | | |
| Affective | Score | Affective | Score | Affective | Score |
| #8 - pleasant/un----- | _____ | #8 - pleasant/un----- | _____ | #8 - pleasant/un----- | _____ |
| #9 - agreeable/dis----- | _____ | #9 - agreeable/dis----- | _____ | #9 - agreeable/dis----- | _____ |
| #10 - protect/desir----- | _____ | #10 - protect/desir----- | _____ | #10 - protect/desir----- | _____ |
| #11 - positive/neg----- | _____ | #11 - positive/neg----- | _____ | #11 - positive/neg----- | _____ |
| #12 - normal/abn----- | _____ | #12 - normal/abn----- | _____ | #12 - normal/abn----- | _____ |
| Total | _____ ÷ 5 = _____ | Total | _____ ÷ 5 = _____ | Total | _____ ÷ 5 = _____ |
| | | | | | |
| Sensory | Score | Sensory | Score | Sensory | Score |
| #13 - strong/weak----- | _____ | #13 - strong/weak----- | _____ | #13 - strong/weak----- | _____ |
| #14 - awake/sleepy----- | _____ | #14 - awake/sleepy----- | _____ | #14 - awake/sleepy----- | _____ |
| #15 - lively/listless----- | _____ | #15 - lively/listless----- | _____ | #15 - lively/listless----- | _____ |
| #16 - fresh/tired----- | _____ | #16 - fresh/tired----- | _____ | #16 - fresh/tired----- | _____ |
| #17 - energy/un----- | _____ | #17 - energy/un----- | _____ | #17 - energy/un----- | _____ |
| Total | _____ ÷ 5 = _____ | Total | _____ ÷ 5 = _____ | Total | _____ ÷ 5 = _____ |
| | | | | | |
| Cognitive/Mood | Score | Cognitive/Mood | Score | Cognitive/Mood | Score |
| #18 - patient/imp----- | _____ | #18 - patient/imp----- | _____ | #18 - patient/imp----- | _____ |
| #19 - relax/tense----- | _____ | #19 - relax/tense----- | _____ | #19 - relax/tense----- | _____ |
| #20 - exhilar/depr----- | _____ | #20 - exhilar/depr----- | _____ | #20 - exhilar/depr----- | _____ |
| #21 - concentr/not----- | _____ | #21 - concentr/not----- | _____ | #21 - concentr/not----- | _____ |
| #22 - memory/not----- | _____ | #22 - memory/not----- | _____ | #22 - memory/not----- | _____ |
| #23 - think/not----- | _____ | #23 - think/not----- | _____ | #23 - think/not----- | _____ |
| Total | _____ ÷ 6 = _____ | Total | _____ ÷ 6 = _____ | Total | _____ ÷ 6 = _____ |
| | | | | | |
| Total Score | _____ ÷ 22 = _____ | Total Score | _____ ÷ 22 = _____ | Total Score | _____ ÷ 22 = _____ |

Overall Muscular Endurance Protocol

Muscular Endurance Test

(Push-up and partial curl-up)

Push-ups: Count to three seconds when pushing up and another three going down to control rhythm of exercise. Stop exercise when positioning or rhythm changes due to fatigue.

of push-ups performed: _____ *RPE* _____

Partial Curl-up (crunch): Patient lies supine on a mat with knees in 90 degrees flexion and arms at the sides. Count to 3 for flexion of trunk and another count to 3 for extension of trunk. Stop exercise when positioning or rhythm changes due to fatigue.

of curl-ups performed: _____ *RPE* _____

Exercise Specific Endurance Tests

Patients will execute repetitions until RPE of 7 is reached during the exercise using a predetermined % of their body weight calculated according to their age and sex.

% BODY WEIGHT TO BE LIFTED

| Exercise | Age<45 | Age 45-60 | Age 60-70 | Age>70 |
|-------------------|------------------|------------------|------------------|------------------|
| | Women | Women | Women | Women |
| Biceps curl L arm | .065 | .061 | .058 | .055 |
| Biceps curl R arm | .065 | .061 | .058 | .055 |
| Lat pull-down | .375 | .350 | .330 | .310 |
| Leg Extension | .375 | .350 | .330 | .310 |
| Leg Curl | .375 | .350 | .330 | .310 |

Important Considerations:

1. Ensure that subjects are properly "warmed-up" before initiation of the test protocol.
2. Patients should perform as many complete repetitions as possible, until an RPE of 7 is reached.
3. Compute "weight to be lifted" according to age and body weight specifications outlined.
4. Assist the client with the 1st repetition and then continue to "spot" throughout the test.
5. Repetitions should be performed at a controlled cadence ("1, 2, 3" – Up, "1, 2, 3" – Down).
6. Stop participant at 25 repetitions if RPE has not reached 7.

| Exercise | Body Weight | % | Machine weight Setting | Weight to be lifted | # of Reps |
|------------------------------|--------------------|----------|-------------------------------|----------------------------|------------------|
| Bicep Curls Right Arm | | | | | |
| Bicep Curls Left Arm | | | | | |
| Lat Pulldown | | | | | |
| Leg Extension | | | | | |
| Leg Curl | | | | | |

Leg Ext/Leg Curl- each plate = 12.5 lbs

Appendix D

Balance Tests Protocols

Static & Dynamic Balance Assessment

Single Limb Stance: Participant must be barefoot while testing. Ask participant to stand on one leg (participant preference of which lower extremity to use) for 30 seconds with arms folded across chest and eyes closed. Use a digital stopwatch to measure to the nearest one-hundredth of a second the time participant is able to maintain single leg stance. Start the stopwatch when participant achieves single leg stance. Stop the watch when the lifted ankle touches the supporting leg, the supporting leg moves on the floor, the lifted foot touches down, either arm moves from the start position, or the eyes open. Participant should perform three trials. Record the mean.

Trial 1_____sec.
Trial 2_____sec.
Trial 3_____sec.
Mean_____sec.

Time 360° turn: Use a digital stopwatch to measure to the nearest one hundredth of a second the time required for the participant to turn 360° in her preferred direction while standing. Ask participant to turn as quickly as possible. (Start stopwatch when examiner says “go” and stop when last foot is facing straight forward at the completion of the turn.) Record for two trials.

Trial 1_____sec.
Trial 2 _____sec.
Mean_____sec.

Four Square Step Test: Participant will rapidly change direction while stepping forward, backward, and sideways over canes which create 4 squares on the floor. Ask participant to face forward and to step as fast as possible into each square in the sequence of square 2 – 3 – 4 – 1 – 4 – 3 – 2 – 1. (“Try to complete the sequence as fast as possible without touching the sticks. Both feet must make contact with the floor in each square.”) Use a digital stopwatch to measure to the nearest one hundredth of a second the time required to complete the sequence. (Start stopwatch when 1st foot contacts floor in square 2 and stop when last foot comes back to touch floor in square 1). Participant should perform two trials. Record the best time. Repeat the trial if participant is unable to complete the sequence successfully, loses balance, or makes contact with a cane during stepping.

Trial 1_____sec.
Trial 2_____sec.
Best_____sec.

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