Key Fitness Variables as Predictors of Psychological Well Being in Breast Cancer Survivors

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Abstract

Enduring negative effects from breast cancer (BrCa) treatment have motivated investigators to study interventions aimed at improving survivor quality of life (QOL). Moderate to vigorous physical activity is believed to improve survivor QOL but surprisingly little is known about the direct relationship between key fitness variables and survivor QOL. This study investigated whether predictive and/or significant correlational relationships exist between VO_2 peak and/or grip strength and survivor QOL, before and after a 12 week physical activity (PA) training program. At baseline, a significant correlation was found between physical well-being and VO_2 peak ($r=0.59$, $p<0.05$) and grip strength ($r=0.55$, $p<0.05$) in breast cancer survivor PA trainees but only in those reporting low levels of BrCa symptoms. Significant positive correlations were additionally observed between emotional well being ($r=0.71$, $p<0.01$), and functional well being ($r=0.69$, $p<0.01$) with grip strength (but not VO_2 peak) in this low symptom reporting group. BrCa symptom levels for individuals reporting the highest symptoms ($\beta = -0.28$; $p = 0.007$), and grip strength ($\beta = 0.17$; $p = 0.01$) were each significant predictors of QOL at baseline while VO_2 peak was not. After 12 weeks of PA training, participants who adhered to the exercise class (>50% attendance) had significantly higher VO_2 peak and QOL than individuals who did not adhere. These results emphasize symptomology and grip strength in predicting QOL status in BrCa survivors at baseline. The importance of exercise class adherence is emphasized.

Keywords: Breast cancer survivors, physical activity, VO_2 peak, grip strength, quality of life

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Table of Contents

1.0 Introduction and Background

This thesis is divided into three parts. In part 1 I will review the literature on breast cancer incidence, physiological and psychological effects, and physical activity as an intervention. Part 2 will present the results of a systematic review comparing the effects of different types of physical activity interventions in breast cancer survivors. Part 3 presents results from a sub-analysis of data collected as part of a larger study conducted at the University Health Network (UHN) entitled "Pilot study to evaluate the feasibility of an innovative smartphone enabled health coaching intervention (iMOVE) to promote long-term maintenance of physical activity behavior in breast cancer survivors".

1.1 Breast Cancer Incidence and Survival

Amongst the chronic diseases that constitute a global problem (World Health Organization, 2005) Breast Cancer (BrCa) is an increasingly important concern (Coughlin et al. 2009). In 2012, the nearly 1.7 million *new* cases resulted in BrCa being ranked as the second most common cancer, and the most common cancer in females worldwide. This represents ~ 12% of all cancer diagnoses and ~ 25% of all cancer diagnoses in women globally (Ferlay et al. 2012). Over one million women are diagnosed with BrCa worldwide each year, while in Canada, 1 in 9 women are expected to develop the disease in their lifetime (Jemal et al. 2011; Canadian Cancer Society, 2010). In 2015, an estimated 25,000 Canadian women will be diagnosed with BrCa, accounting for 26% of all female cancer cases. Although the ratio of cancer diagnoses across Canadian provinces remains fairly stable, Ontario has the largest

proportion of BrCa in Canada with 39% of cases and an estimated 9800 women diagnosed in 2015, (Canadian Cancer Society's Advisory Committee on Cancer Statistics, 2015).

BrCa incidence has increased by more than 20% since 2008 estimates (World Health Organization, 2013). This increase in incidence and diagnosis has contributed to breast cancer currently being the most frequently diagnosed female cancer in both the developed and less developed world (140 of 184 countries) globally. (World Health Organization, 2013). Increasing incidence in the developing world is believed to be related to a combination of westernized lifestyles (characterized by excess weight and sedentariness), increases in life expectancy, and urbanization (Jemal et al. 2010; Coughlin et al. 2009; Porter, 2008). Fortunately, improvements in screening, detection, and treatment have resulted in an overall decreased mortality rate despite increasing incidence (Altekruse et al. 2010; Vainio & Bianchini, 2002; Canadian Cancer Society's Advisory Committee on Cancer Statistics, 2015; World Health Organization 2007). The majority of BrCa cases are now detected at localized stages, which have an estimated 5-year survival rate of 96% (Altekruse et al. 2010; Canadian Cancer Society's Advisory Committee on Cancer Statistics, 2015). In Canada, the BrCa mortality rate has been declining over the last 30 years and is the lowest it has been since 1950 with a 44% decreased mortality since 1986 and an estimated 5-year survival rate of 88%. Recent data indicates that there are currently more than 157,000 Canadian women living who received a diagnosis since 1999 (Canadian Cancer Society's Advisory Committee on Cancer Statistics, 2015). Health professionals have developed the term "survivors" to refer to such individuals who are believed to be cancer free (Casla et al. 2015). There will be an estimated 11 million cancer survivors in 2020, representing a 42% increase from 2010 to 2020 (Parry et al. 2011). Although such advancements are promising, with increasing incidence and survival rates come a cluster of long-term negative effects resulting

from aggressive cancer treatments that must be addressed and adjusted to throughout the survivorship phase (Miller & Triano, 2008; Camp-Sorell, 2006; Stewart et al. 2006).

1.2 Physiological Side Effects

Many BrCa survivors experience physiological side effects from cancer treatments that have lasting negative impact. Adjuvant chemotherapy has been shown to cause bone loss, weight gain, neurotoxicity, neurocognitive changes, ovarian function failure, infertility, sexual dysfunction, secondary malignancy, and cardiac toxicity (Mayer, 2013; Guise, 2006; Kroenke et al. 2005; Florescu et al. 2013, Swain & Arezzo, 2008; Janelsins et al. 2011; Praga et al. 2005). Women treated with adjuvant chemotherapy gain an average of 10 pounds, which increases their risk of recurrence (Kroenke et al. 2005). Bone density loss, a common side effect in both pre and postmenopausal survivors, can lead to osteopenia or osteoporosis and increase fracture risk (Chen et al. 2005; Guise, 2006). Peripheral, sensory, or motor neuropathies can result in paresthesias and pain, critically altering a patient's ability to function (Swain & Arezzo, 2008). Neurocognitive changes often termed "brain fog" or "chemo brain" which alter an individual's attention, memory, or concentration is reported by 75% of women who have received chemotherapy (Janelsins et al. 2011; Wefel et al. 2011). Premature ovarian failure and resulting infertility, sexual dysfunction, and permanent menopause can affect a subset of women (Letourneau et al. 2012), while secondary malignancy is a rare yet serious consequence affecting some patients (Praga et al. 2005).

The most common chemotherapy-related toxicities are cardiotoxicities, which elevate morbidity-mortality risks (Florescu et al. 2013). Anthracyclines (a class of chemotherapy drugs) have a known history of causing acute and chronic cardiotoxicities, while radiation therapy, hormonal therapy, taxanes and trastuzumab treatment (alternative chemotherapy agents) also

have cardiotoxic effects (Bird & Swain, 2008). Possible cardiovascular complications include congestive heart failure, myocardial ischemia, hypertension, arrhythmias, QT prolongation, bradycardia, pericarditis, acute coronary syndrome, and thromboembolic events (Bodai & Tuso, 2015). Pulmonary damage can also occur due to endothelial cell damage, alteration of the pulmonary parenchyma, dilation of air spaces, and changes to connective tissues and alveoli (Camp-Sorrell, 2006).

In addition to chemotherapy related toxicities, surgical treatments can have a significant impact on musculoskeletal function. Mastectomies and lymph node dissections can damage certain nerves causing muscle dysfunction, pain, and axillary paresthesia (Casla et al. 2015). The most common impairments reported following breast cancer surgery include: reduced range of motion, numbness of the axilla, numbness in the lateral chest wall, swelling, pain, stiffness, increases in arm volume, and reduced strength (Reitman et al. 2004; Thompson, et al. 1995; Yeoh et al. 1986; Swedborg & Wallgren, 1981; Tasmuth et al. 1996). An estimated 2 to 51% of BrCa survivors suffer reduced range of motion, 17 to 33% experience decreased muscle strength, 12 to 51% report chronic pain, and 50% experience stiffness in the joints (Reitman et al. 2003; DisSipio et al. 2013; Sestak et al. 2008). Radiotherapy can also cause physical limitations with chronic scarring and fibrosis often occurring in the area treated (Casla et al. 2015).

1.3 Peak Oxygen Consumption (VO_2 Peak)

Some of the treatment related declines cited above can be assessed and quantified through cardiopulmonary exercise testing, with aerobic capacity used as one measure of cardiorespiratory endurance, operationally defined as "the ability of the heart lungs, and circulatory system to supply oxygen and nutrients efficiently to working muscles" (Heyward, 2010). Maximum oxygen consumption (VO_2max) (also known as aerobic capacity) is the

maximum rate of oxygen use by muscles during exercise, and is the current gold standard for directly measuring cardiorespiratory endurance (Heyward, 2010). Peak oxygen consumption (VO_2 peak), or the maximum oxygen consumed during a cardiopulmonary exercise test, is often used in clinical populations, such as BrCa survivors, since VO_2max may not be achieved during the test due to its volitional component. Although participants are encouraged to push to a maximum exertion, the VO_2 peak attained by variously motivated subjects during the test may or may not be equal to VO_2 max; specifically, VO_2 peak is often lower when the participant does not wish to continue a test to completion or engages in less than maximal exertion levels. VO_2 peak is an especially important measure in this population, as it is associated with breast cancer specific and cardiovascular disease specific mortality, and all cause mortality (Peel et al, 2009; Keteyian et al. 2008; Myers et al. 2002).

When individuals are not able to complete direct cardiopulmonary testing, alternative tests with predictive equations are often used in substitute. The 6-minute walk test is a widely used field based assessment, which is independently predictive of morbidity and mortality (Rostagno et al. 2003; Cote et al. 2007). A generalized equation can be used to accurately estimate VO_2 Peak from 6-minute walk results among patients with diverse diseases (Ross et al. 2010).

1.31 Peak oxygen consumption in breast cancer survivors.

Physiological side effects along with deconditioning due to reduced physical activity during treatment are associated with observed declines in VO_2 peak in breast cancer patients (Neil-Sztrako et al. 2014). Peak oxygen uptake can be as much as 50% lower in BrCa survivors when compared to age-matched healthy individuals (Herrero et al. 2006; MacVicar et al. 1989; Courneya et al. 2003). In a study comparing an exercise intervention administered during

chemotherapy to a randomly selected non-participating control group of equivalent breast cancer patients, those receiving regular treatments (with no exercise intervention) were found to have a drop in VO_2 peak of 6.4% (Courneya et al. 2007). Additionally, in a recent cross sectional analysis of 248 women diagnosed with breast cancer (including women before, during, and after treatment), the women assessed had a 27% lower mean VO_2 peak than age-matched healthy sedentary women (Jones et al. 2012). Furthermore, 32% of these women had a VO_2 peak of *less than* 15.4 mL $kg^{-1} \cdot min^{-1}$ which is the suggested value required to maintain functional independence in healthy older women (Jones et al. 2012; Patterson, Cunningham, & Koval, 1999).

1.4 Grip Strength

Treatment related declines in musculoskeletal function are often presented through measures of strength. Grip strength, measured with the use of a hand held dynamometer, is often used in clinical settings as a reliable measure of global muscular strength (Neil-Sztramko et al. 2014; Innes, 1999). Grip strength has further been shown to be a predictor of functional limitations, complications following surgery, disability, and mortality (Bohannon, 2001). In breast cancer patients, grip strength can be used to objectively measure upper body impairments following surgery (Hayes et al. 2005). Impaired grip strength can be defined as a difference in grip strength between affected and non-affected sides of 5-10% (Reitman et al. 2004).

1.41 Grip strength in breast cancer survivors.

In a recent systematic review of upper limb strength for women diagnosed with breast cancer, it was found that grip strength values fall below the median reported value of 27.7kg for healthy adults aged 50 to 59 with a mean grip strength of 24.6kg in women on treatment and 22.8kg in women off treatment. The lower value reported in women *following* treatment

compared to *during* treatment suggests that declines in grip strength continue as the survivorship process progresses (Neil-Sztramko et al. 2014). Reitman et al. (2004) found the prevalence of impaired grip strength in breast cancer survivors to be 40% while Hladiuk et al. (1992) found 16% of women to have reduced grip strength one year following surgery.

1.5 Fatigue

Fatigue is one of the most common symptoms reported by cancer survivors and often persists long after treatment has been completed (Smets et al. 1993). A review by Jacobsen and Stein (1999) suggests that breast cancer patients who have previously undergone adjuvant chemotherapy, adjuvant radiotherapy, or autologous bone marrow transplantation can suffer from clinically significant levels of fatigue for months or years following treatment. Minton and Stone (2008) conducted a systematic review addressing the phenomenon of post-treatment fatigue in breast cancer survivors and concluded there is good evidence that such fatigue can occur for up to 5 years after completing adjuvant therapy. A multi-centre prospective study by Meeske et al. (2007) found forty one percent of the breast cancer survivors assessed (N=1183) to be significantly fatigued. Fatigue was associated with poorer health related quality of life, particularly in dimensions of role and social functioning. Correlates of fatigue that were significant included pain, physical inactivity, weight gain, antidepressant use, and cognitive problems. Bower et al. (2000) similarly found one third of sampled breast cancer survivors (N=1957) to report more severe fatigue, which was correlated with higher levels of depression, pain, and sleep disturbance with depression and pain being the strongest predictors of fatigue.

1.6 Psychological Side Effects

In addition to declines in physical functioning, adjusting to the diagnosis, residual treatment effects, and difficult transitions back to everyday living can cause survivors a cluster of

psychological problems leading to elevated levels of depression, anxiety, and generic distress (Spiegel, 1997; Fann et al. 2008; Lueboonthavatchai, 2007). The risk of psychiatrically diagnosable distress in cancer patients has been reported as nearly twice that of the general population (Hinz et al. 2010). In a five-year observational cohort study of early breast cancer survivors, 48% of the women confronted significantly elevated levels of depression, anxiety, or both in the year after diagnosis, about twice that of the general female population (Burgess et al. 2005). Although distress rates in years 2, 3, and 4 declined to 25% following diagnosis and up to 15% in year 5, 45% of the women who experienced recurrence experienced significantly elevated depression, anxiety, or both (Burgess et al., 2005). Alternatively, Broeckel et al. (2000) found that more elapsed time since diagnosis was associated with higher levels of self reported depression. Fann et al. (2008) found the prevalence of major depressive disorder to be around 10-25% when reviewing 20 years of literature on breast cancer patients and depression, while a recent systematic review on the prevalence of depression in breast cancer survivors found rates to vary widely, from 1% to 56% (Zainal et al. 2013). The most common symptoms associated with significantly elevated depression include fatigue, pain, cognitive impairments, sleep disturbance, functional limitations, and low sexual desire (Zainal et al., 2013).

Depression has also been found to predict disease progression and mortality in cancer patients (Satin et al. 2009). Conversely, decreased depression symptoms in breast cancer patients are associated with longer survival rates, suggesting the potential importance of treating psychological morbidity in decreasing mortality (Giese-Davis et al. 2011). There is substantial evidence that depression, fatigue, and pain may share a common biological mechanism that is one result of cancer treatment, namely increased levels of proinflammatory cytokines (Cleeland et al. 2003). In breast cancer survivors, these proinflammatory cytokines can be chronically

elevated even 3-5 years following treatment indicating a possible area to target while intervening in this population (Bower et al. 2002). In a systematic review of 59 studies on cancer related fatigue and its associations with depression and anxiety, almost all studies showed a positive correlation of fatigue with depression and anxiety although the directionality of the relationship is not well understood (Brown & Kroenke 2009).

1.7 Quality of Life

Quality of life is a particularly important measure in this population as it includes several domains that can assess both the physiological and psychological side effects experienced. The FACT-B is a commonly used self report instrument designed to measure multidimensional quality of life in breast cancer patients through the domains of: physical well being, social family well-being, emotional well being, functional well being, and additional concerns relating to breast cancer (Brady et al. 1997). Literature on the quality of life of BrCa survivors is mixed with some studies of survivors reporting lower quality of life than non-disease affected controls and some survivors reporting similar quality of life to the general population (Mols et al. 2005; Dow et al. 1996).

Dow et al. (1999) examined the continuum of quality of life outcomes in breast cancer survivors. In longer-term survivors, fatigue, aches and pains, and sleep problems were found to be of concern soon following treatment. Psychological distress from diagnosis, treatment, and fear of recurrence became more problematic over time, while family distress, sexuality, and family burden were the largest social concerns. Uncertainty over the future was also present in longer-term survivors (Dow et al. 1999). Holzner et al. (2001) found that reduced quality of life, especially in dimensions of emotional, social, and sexual functioning persisted up to and greater than 5 years following treatment. Alternatively, a review of studies examining quality of life in

long- term (diagnosed at least 5 years earlier) BrCa survivors indicated that most individuals experienced good overall quality of life (Mols et al. 2005). However, the majority of studies reported that BrCa survivors experienced specific problems, arms experienced as swelled or 'thick' and painful arms, and problems with sexual functioning. Social support, current medical condition, and income level were positive predictors of quality of life while being treated with adjuvant chemotherapy was a negative predictor (Mols et al. 2005).

1.8 Physical Activity as an Intervention

Substantial evidence has demonstrated physical activity to be a non-invasive, well tolerated, and low risk intervention with the potential to improve cancer outcomes, particularly quality of life (Schmitz et al. 2010). Systematic reviews and meta-analyses of physical activity interventions for cancer survivors have demonstrated significant improvements in a range of areas including but not limited to: VO_2 peak, peak power output, distance walked in 6 minutes, fatigue, anxiety, vigor, self esteem, psychological well being, social functioning, body composition (BMI and waist circumference), muscular strength and quality of life (Speck et al. 2010, Schmitz et al. 2005; Knols et al. 2005, Fong et al. 2012; Oldervoll et al. 2004; McMillan & Newhouse, 2011; Penedo et al. 2004). With regards to quality of life, consistent evidence indicates that physical activity interventions increase the quality of life in cancer survivors in the physical, functional and psychological areas (Courneya & Friedenreich, 1999; Cramp et al. 2010). Exercise interventions in cancer survivors have also consistently been effective in reducing cancer-related fatigue (especially in interventions of moderate intensity) (Brown et al. 2010), and depressive symptoms (Brown et al. 2012).

Similarly, physical activity, as an intervention for breast cancer patients, has been shown to be associated with significant improvements in physical functioning, VO_2 peak, muscular

strength, body composition, fatigue, quality of life, anxiety, depression, self-esteem, and body image (Battaglini et al. 2014; McNeely et al. 2006; Kirshbaum et al. 2007; Speck et al. 2010; Fong et al. 2012). In terms of quality of life, a systematic review examining the effect of exercise on quality of life in women living with breast cancer (which included all stages of disease), gave strong evidence that exercise positively influences quality of life (Bicego et al. 2009). However, reviews that are specific to other outcomes are not available in this population.

1.81 Physical activity and survival

Most recently, physical activity has been associated with reductions in breast cancer specific and all-cause mortality (Lahart et al. 2015; Ibrahim & Al-Homaidh, 2010). In a systematic review, Ballard et al. (2012) identified 27 observational studies that indicated physical activity was associated with reductions in all-cause, breast cancer-specific, and colon-cancer specific mortality. Of these 27 studies, 17 breast cancer studies were reviewed which reported reductions in mortality ranging from 13% to 51% in association with low to high physical activity levels. Although causes for these findings are not entirely clear, a number of mechanisms have been proposed to explain the protective effect of physical activity, including reduced exposures to estrogen and androgen, insulin related changes, reductions in adipokines, and inflammation (Lahart et al. 2015). However, as improved psychological outcomes have also been associated with increased survival rates (Giese-Davis et al. 2011), it is unclear what proportions of protective effects are due to either physiological factors or psychological factors, or their combination.

1.9 Relationship between Physiological and Psychological Variables

There is a general consensus that physical activity has positive effects on mood, anxiety, depression, and general well-being with multiple studies reporting anxiolytic and anti-depressive

effects (Ströhle, 2009; Guszkowska, 2003, Byrne & Byrne, 1993, Callaghan, 2004). The most frequently cited mechanisms for such findings revolve around the endorphin and monoamine hypotheses, with increased blood circulation in the brain viewed as impacting the hypothalamic-pituitary-adrenal (HPA) axis, reducing distraction and cognitive dissonance while increasing mastery achievements, self-efficacy, positive feedback, and positive social interactions (Paluska & Schwenk, 2000; Taylor et al. 1985; Arent et al. 2000; Peluso & Andrade, 2005; Deslandes et al. 2009). Yet, surprisingly few studies have examined the precise mechanisms of change.

1.91 Relationship between physiological and psychological outcomes in other populations.

Although there is consensus that physical activity can improve both physiological and psychological outcomes, the relationship between the concepts is not entirely clear. Karapolat et al. (2007) examined the relationship between depressive symptoms and anxiety with the quality of life and functional capacity of heart transplant patients and found significant negative correlations between VO_2 peak and depression (Beck Depression Inventory) ($r = - 0.39$) and between VO_2 and state and/or anxiety (State-Trait Anxiety Inventory) ($r = - 0.47$). In turn, they further found that the combination of depression and functional capacity (VO_2 peak) predicted quality of life following transplant. Koukouvou et al. (2004) found an exercise training program provided to chronic heart failure patients increased their VO_2 peak, quality of life, and decreased anxiety and depression, but improvements in psychological status were found to be independent of increases in VO_2 peak.

Huisinga et al. (2011) examined the effect of elliptical exercise training (fifteen x's 30 minute sessions over 6 weeks) on fatigue and quality of life ratings in patients with multiple sclerosis. Based on existing theory, there was a surprising independence of outcome variables.

The overall quality of life score did not correlate with the overall fatigue score, and the change in fatigue score (over time) correlated only moderately with the physical aspects of quality of life outcomes (physical function subscale: r=-0.42, p =0.043; role physical subscale: r =-0.52, p =0.009). Furthermore, the change in fatigue score did not correlate significantly with the psychosocial quality of life outcomes. In another study investigating correlations between quality of life and physical fitness in patients with cystic fibrosis, quality of life was significantly correlated with physical fitness and, more specifically, with aerobic fitness (Hebestreit et al. 2014). Peak oxygen consumption (VO_2 peak) was significantly correlated (r=0.30-0.46; p<0.001 - p<0.05) with 7 of 13 quality of life scales at baseline. Additionally, a change in VO_2 peak significantly correlated (r=0.26-0.37; p<0.01 – p <0.05) with feelings of embarrassment, health perception, and weight problems subscales, meaning that the higher VO_2 peak change score, the lesser the feelings of embarrassment and perceptions of weight problems. Muscle power (as measured by the 30 second Wingate test protocol) was also significantly correlated (r=0.25-0.32) with the quality of life scales of physical functioning, vitality, role imitations, and digestive symptoms, but no significant correlations (r=0.012-0.192; p <0.001 – p <0.05) were found between baseline-to-outcome changes in muscle power and baseline-to-outcome changes in quality of life. Aerobic power was significantly correlated (r=0.24-0.35; p <0.001 – p <0.05) with 4 quality of life scales, and change in aerobic power (baseline to outcome) correlated (r=0.31-0.34; p <0.01 – p <0.05) significantly with vitality, role limitations, and weight problems subscales. Still in another study of patients with severe COPD, Leyesnson et al. (2016) found no significant relationship between improved quality of life and changes in VO_2 peak and distance walked.

In cancer patients, Banzer et al. (2014) looked at change in VO_2 peak and its relationship with quality of life and fatigue. Absolute change in VO_2 peak was stratified into three tertiles and related to quality of life and fatigue scores. Patients in the upper tertile (i.e. greatest improvements in VO_2 peak) had significantly higher quality of life increases compared to the lower tertile (lowest improvements in VO_2). There was also a significant difference in fatigue reductions (baseline-to-outcome) between the upper and lower tertiles illustrating a similar kind of relationship. Point estimation indicated that patients who increased their VO_2 peak by10% or more had a 2.6 times greater chance of reducing fatigue symptoms by 20% or more.

1.92 Relationship between physiological and psychological outcomes in breast cancer survivors

With breast cancer patients specifically, various studies on physical activity have reported both physiological and psychological improvements, but most have not examined whether a predictive relationship exists between physiological and psychological variables (Battaglini et al. 2014; Bicego et al. 2009; McNeely et al. 2006; Speck et al. 2010). Herrero et al. (2006) sought to assess whether cardiorespiratory fitness is related to quality of life in survivors of breast cancer. A trend was found for a positive relationship between VO_2 peak and quality of life ($r=0.43$) although significance was not reached ($p=0.10$). Alternatively, a study undertaken by Courneya et al. (2003) investigated the relationship between VO_2 peak and quality of life in a randomized controlled trial (RCT) of breast cancer survivors. Changes in VO_2 peak in this study were significantly correlated with positive changes in quality of life ($r =0.45$, $P < .01$). Furthermore, when change in peak oxygen consumption was used as a mediator variable in a multiple regression analysis (n=50), support of statistical mediation for changes in overall quality of life was observed (peak oxygen consumption beta = 0.30, $P = .066$; experimental group beta =

0.24, *P* = .149 but not for self-esteem (peak oxygen consumption beta = 0.01, *P* = .959; experimental group beta = 0.42, *P* = .016). Despite such results, which are theoretically challenging as increased fitness should correlate with increased self esteem, further examination of the relationship is warranted with a larger sample. Furthermore, there is a specific need to investigate the relationships between VO_2 peak, quality of life, anxiety, depression, and fatigue in future research.

Similarly, impaired grip strength has been examined in relation to health related quality of life. In a study by Reitman et al. (2004) the relationships between treatment modalities, physical impairments, disabilities, and health related quality of life were examined. When impairments were used to predict disabilities, discrepancies in grip strength did, to some degree, predict physical functioning (beta =0.1, 95% CI = 0.04-0.5, r^2 change =0.06), role limitations physical (beta = 0.3, 95% CI = 0.2-0.5, r^2 change = 0.20), and role limitations emotional (beta = 0.2, 95% CI = 0.05-0.4, r^2 change= 0.11) but did **not** predict mental health. Winters-Stone et al. (2007) looked at physical fitness as a predictor of fatigue in long-term breast cancer survivors. Older age, lower extremity muscle strength, and physical activity hours per week were found to be significant and independent predictors of improved fatigue scores, while body composition and submaximal aerobic fitness did not predict fatigue. When using the handgrip strength test as a measure of function in breast cancer survivors, Cantarero-Villanueva et al. (2012) observed week to moderate relationships (some reaching significance) with Profile of Mood States subscales depression (*p* = -0.266, P =0.028), anger (*p* =-0.221, P = 0.031), tension (*p* = -0.197, P = 0.056), vigor (*p* = 0.087, P = 0.400), fatigue (*p* = -0.364, P <0.001), and confusion (*p* =-0.348, P = 0.001). Such conflicting results, which do not conform to existing theory, indicate needs for future study of the relationship between grip strength and quality of life.

2.0 Systematic Review

2.1 Introduction

Breast Cancer (BrCa) is a major health concern with over one million women diagnosed worldwide each year [1,2]. As the most common form of cancer affecting women in both the developed and developing world [3], in recent years there have been significant improvements in detection and available treatments, resulting in decreased mortality rates despite increasing BrCa incidence [4,5]. However, despite increased survival rates, available treatments often produce a cluster of negative physical and psychological effects that demand greater attention during the survivorship process [6-8].

Common physiological issues faced by BrCa patients include cardiotoxicity, pulmonary decline, reduced aerobic capacity, reduced strength, swelling, pain, fatigue, and sleep disturbances [9-11]. Psychological consequences include depression, anxiety, fear of recurrence, feelings of being alone, and body image and sexual problems [12-14]. It is estimated that as high as 90 percent of BrCa patients report at least one treatment-related adverse outcome with nearly 60 percent reporting multiple adverse outcomes [15]. Such adverse effects can substantially decrease quality of life in multiple dimensions, further indicating a need for strategies to enhance quality of life during BrCa survivorship.

Over the years, a substantial body of literature has demonstrated physical activity to be a non-invasive, well-tolerated, and low-risk intervention in enhancing negative cancer-related outcomes [16-18]. Physical exercise, in aerobic (i.e. continuous large-muscle activity elevating breathing and heart rate), resistance (i.e. activity against some form of external resistance), and combined aerobic-resistance forms has shown to benefit cancer patients across multiple physical-psychological domains [19-22]. Numerous reviews and meta-analyses on the topic (in BrCa and

other cancer types) have also found physical exercise to be an effective intervention modality in cancer patients; however, these reviews have either (a) not distinguished between patients at different stages of treatment stage (i.e. patients vs. survivors) and exercise modalities (i.e. aerobic, resistance, combined activity) [23-26], (b) focused solely on a particular exercise modality [27], or (c) included several uncontrolled trials [28].

Although multiple benefits can be derived from all three forms of physical activity, there is evidence in support of the differential impact of aerobic, resistance, and combined activities in BrCa patients. For example, one relevant meta-analysis by Ferrer et al. [29] examined the effectiveness of exercise in cancer survivors and found aerobic exercise intensity (higher METs) to be a significant predictor of quality of life improvement, while resistance activity was not found to be a predictor or moderator of quality of life. Since a direct comparison between aerobic, resistance, and combined interventions was not the sole focus, the primary objective of this paper is to systematically review randomized controlled trials (RCTs) evaluating the impact of aerobic, resistance, or combined physical activity interventions in BrCa survivors with respect to quality of life, psychosocial, and fitness measures.

2.2 Methods

2.21 Literature search

A systematic keyword search of MEDLINE, EBSCO, Scopus, and PubMed databases was conducted to identify aerobic, resistance, or combined physical activity interventions for breast cancer survivors in English language for the period of January 2000 to May 2016. Search terms included the following combinations: breast cancer, survivors, physical activity, exercise, aerobic, resistance, combined, quality of life, anxiety, depression, fatigue, VO_2 Peak, grip

strength, and randomized controlled trial(s). To identify additional citations, we further explored reference sections of selected trials and performed online web searches.

2.22 Inclusion and exclusion criteria

Inclusion was limited to randomized controlled trials (RCTs), from January 2000 to May 2016 that evaluated the effectiveness of aerobic, resistance, or combined physical activity interventions in improving quality of life, psychological status, or fitness measures in breast cancer survivors. Given these goals, inclusion was limited to RCTs that integrated a specific exercise modality (aerobic, resistance, or combined), and to trials that included breast cancer survivors (have completed treatment and/or termed cancer free [30]). Therefore, we excluded studies that did not specify intervention modality, included breast cancer patients (in treatment), or did not include quality of life, fatigue, depression, anxiety, VO_2 Peak, or grip strength as an outcome variable.

2.23 Abstraction, synthesis, and ratings of study quality

Three reviewers (KC, MP, and IA) extracted relevant study information, including participant characteristics, study characteristics and findings, using a pre-specified form. In addition, the Cochrane tool for the assessment of bias [31] was used to assess methodological rigour and potential sources of bias (e.g., selection bias, performance bias, attrition bias, reporting bias, etc.) across selected studies. Ratings were performed separately by two reviewers (KC & MP), with disagreements resolved by consultation with a third reviewer (PR).

2.3 Results

2.31 Database search and selection process

Database searches led to a total of 788 citations across MEDLINE (n= 270), EBSCO (n= 250), Scopus (n= 91), and PubMed (n= 167), along with one additional citation identified using

manual internet search [31]. After the removal of duplicate citations, of the 603 remaining citations, 572 were eliminated in the first stage (review of title and abstract), and another 11 were removed at subsequent stages, leading to a total of 21 trials selected for inclusion (Refer to Tables 1, 2, and 3). Figure 1 depicts the search and selection process flow diagram according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guideline [32].

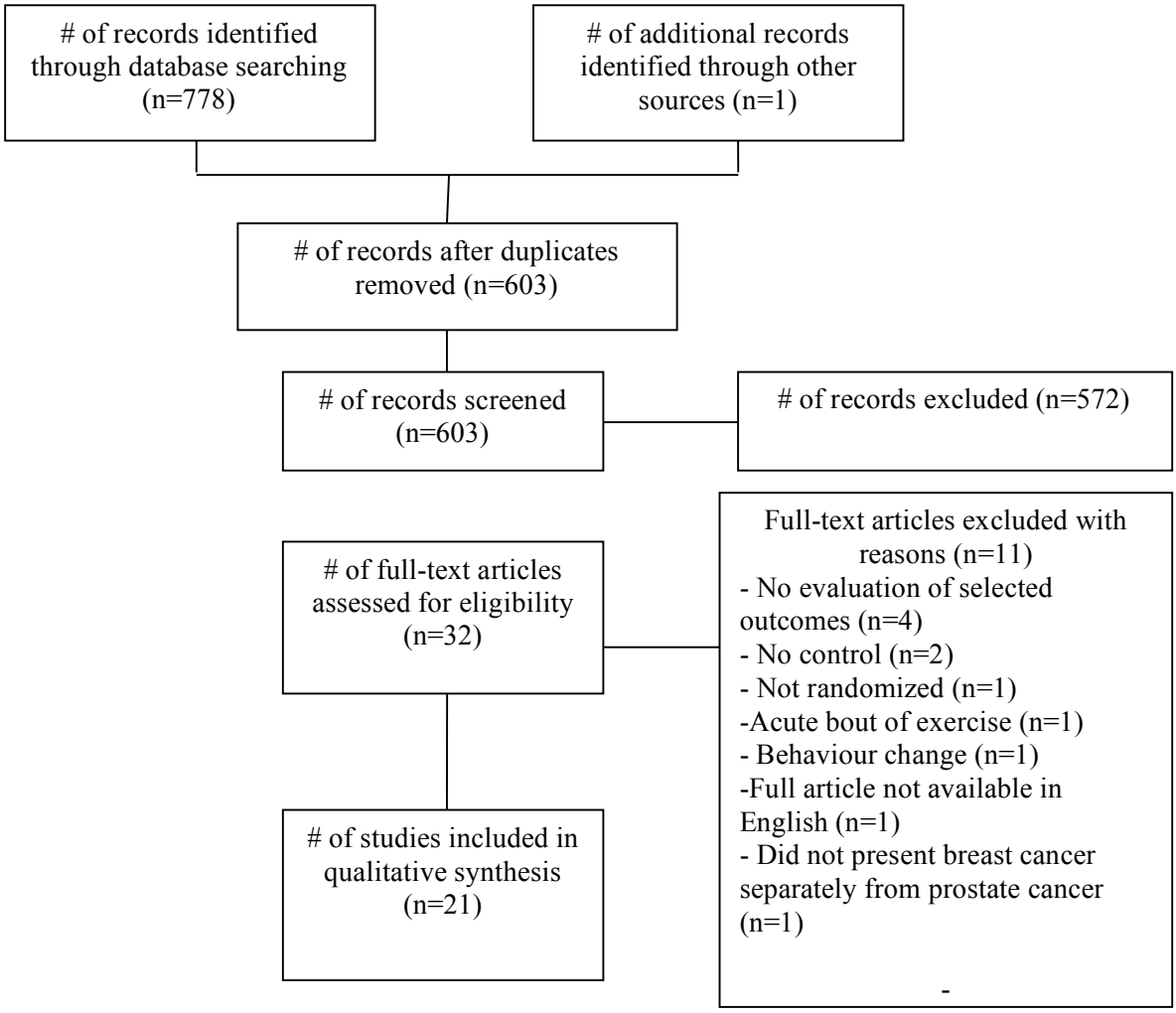

Figure 1. PRISMA Diagram for the Search and Selection Process

Table 1. Characteristics of included aerobic trials

Study	Sample	Intervention	Comparison (Control)	Outcomes	Results
Baruth et al., 2015	N = 32 postmenopausal BrCa survivors; *M* age = 56.15; *M* months since treatment = 5; 94% completion rate.	N = 20; 12 weeks of home based walking (progressing to 5 days/wk); 30-40 minutes; RPE 12-15.	N = 12; Wait list control group.	Fatigue (FACT-F); QOL (SF-36).	Improved QOL subscales: role emotional (ES=0.14), mental health (ES=0.28), vitality (ES=0.57), role physical (ES=0.60), general health (ES =0.66), and physical functioning (ES=0.69); Reduced fatigue (ES = -0.36) in intervention versus control.
Cadmus et al., 2009	N=75 postmenopausal BrCa survivors; *M* age = 55.8; *M* months since diagnosis = 45; 89% completion rate.	N = 37; 24 weeks of supervised (3 days/wk) and home based exercise (2 days/wk); 150 minutes/wk; 60-80% of predicted HR max.	N=38; Usual care.	QOL (FACT-B and SF-36)	No change in QOL in intervention and usual care group; Intervention was associated with improved FACT B social/family well-being subscale (p<0.001) and improved SF-36 social functioning subscale (p<0.05) only in those who reported low social

					functioning at baseline.
Courney a et al., 2003	N = 53 postmeno-pausal BrCa survivors; *M* age = 59; *M* months since treatment = 14; 94% completion rate.	N =24; 15 weeks of supervised (3 days/wk) exercise on cycle ergometer; 15-35 minutes; 70-75% of VO_2 max.	N = 28; Control group.	QOL (FACT-B); VO_2 Peak.	QOL increased by 9.1 points in exercise group and 0.3 points in the control group (mean difference, 8.8 points; 95% CI, 3.6 to 14.0; *p*= 0.01); VO_2 Peak increased by 0.24L /min in exercise group and decreased by 0.05L/min in control group (mean difference 0.29 L/ min; 95% CI; 0.18 to 0.40; *p*> 0.001); QOL correlated with Peak VO_2 (R=0.45; *p* <0.01).
Daley et al., 2007	N = 108 pre and post-menopausal BrCa survivors; *M* age = 51.1; *M* months since treatment =17.5; 93% completion rate.	N = 34; 8 weeks of supervised (3 days/wk) exercise; 150 minutes/wk; 65-85% of HR max; RPE 12-13.	N = 36; exercise placebo; 8 weeks of supervised light intensity body conditioning/ stretching; Below 40% HRR. N = 38; Usual care; Asked to continue normal lifestyle.	QOL (FACT-B); Fatigue (Piper Fatigue Scale); Depression (Beck Depression Inventory).	Improved FACT-G (mean difference, 9.8 points; *p*= 0.004) and FACT-B (*p* = 0.002) in exercise group compared to usual care; Improved social well being (*p*=0.32), functional well being (*p*=0.014) and

					breast cancer subscale (p = 0.038) in exercise group compared to usual care; Reduced fatigue in exercise placebo (p=0.037) compared to usual care; Improved mean depression score in exercise (p=0.001) and exercise placebo (P=0.001) compared to usual care.
Dolan et al., 2015	N = 36 postmeno-pausal BrCa survivors; *M* age = 57.2; *M* months since diagnosis = 72; 92% completion rate.	N = 11; 6 weeks of supervised (3 days/wk) continuous moderate aerobic exercise training (CMT); 60-70% VO_2 Peak. N = 12; 6 weeks of supervised (3 days/wk) aerobic interval training (AIT); 70-100% VO_2 Peak.	N=10; Control offered delayed exercise intervention.	VO_2 Peak.	Improved VO_2 Peak in AIT (11.5%) and CMT (13.0%) (p < 0.001) compared to delayed exercise group; No significant difference between exercise groups.
Murteza ni et al.,	N = 62 BrCa	N = 30, 10 weeks of	N = 32; Control asked	QOL (FACT-	Improved FACT G (9.16

2014	survivors; *M* age = 52; *M* months since treatment = 19.1; 84.9% completion rate.	supervised (3 days/wk) exercise; 15-45 minutes; 50-75% HRR.	to maintain regular activities.	B);12 minute walk test.	points, $p <$ 0.008), FACT B (13.4 points, $p <$ 0.003), functional well-being subscale ($p < 0.010$), emotional well-being subscale ($p < 0.035$) in exercise group compared to control; Improved 12MWT ($p <$ 0.009) in exercise group compared to control.
Musanti, 2012	N=42 BrCa survivors; *M* age 50.5; 3-24 months since treatment; 88% completion rate.	N = 10; 12 weeks of home-based (3 days/wk) walking; 15-30 minutes; 40-85% predicted HR max.	N=12; Flexibility program N=9; Resistance exercise program N=11 Combined aerobic & resistance exercise program .	Fatigue (Piper Fatigue Scale); Anxiety; Depression (Hospital Anxiety and Depression Scale).	Fatigue (p=0.000) and Anxiety/Depression (p=0.001) decreased significantly from baseline only in individuals who scored above the threshold of clinical significance at baseline; There were no differences between groups.
Pinto et al., 2005	N = 86 BrCa pre and postmeno-pausal survivors; *M* age	N = 43, 12 weeks of home based (progressing to 5 days/wk); 10-30 minutes;	N = 43, control group, asked not to change level of activity; Weekly	Fatigue (Linear Analog Scale for Fatigue); Rockport 1-Mile Walk	PA group significantly out performed control on Rockport Walk Test (ANCOVA $F_{1,68} = 21.12, p$

	=53.14; *M* months since treatment = 21.96; 95% completion rate.	55-65%; Weekly phone call to monitor exercise adherence.	phone call to complete symptom questionnaire (to keep contact similar between groups).	Test.	< 0.001); PA group significantly reduced fatigue (ANCOVA $F_{1,81} = 12.00, p = .001$) compared to control.
Rogers et al., 2015	N= 222 BrCa pre and postmeno-pausal survivors; *M* age = 54.4; *M* months since diagnosis = 54; 96% completion rate.	N= 110, 12 weeks of supervised (2 days/wk for first 6 weeks) and home based (eventually becoming exclusively home based) exercise; 150 minutes/wk; 40-59% HRR; Exercise counseling and group discussions	N= 112, Usual care.	QOL (FACT-B).	Improved QOL at 3 months and 6 months (M = +6.4; CI = 3.1–9.7; $p < 0.001$) and (M = +3.8; CI = 0.5–7.2; $p = 0.025$); Improved physical well being ($p = 0.003$), emotional well being ($p = 0.008$), functional well being ($p < 0.001$), FACT – G ($p < 0.001$), and trial outcome index ($p = 0.001$) at 3 months compared to control. Differences remained significant at 6 months for physical well being ($p = 0.030$) and FACT-G. ($p = 0.011$).
Saarto et	N=573 pre	N= 263; 12	N=237;	2km Walk	No significant

al., 2012	and post menopausal BrCa survivors; *M* age = 52.35; *M* months since treatment = 4; 87% completion rate.	months of supervised (one day/wk) and home based (2-3 days/wk) training; 60 minutes; RPE 14-16.	Encouraged to maintain previous physical activity levels.	Test; QOL (EORTC QLQ-C30); Fatigue (FACT-F), Depression (Finnish Modified Beck Depression Scale).	differences between groups in 2-km walking time (95% CI=–0.02 to 0.37 min, p=0.15), QOL (p =0.43), Fatigue (p = 0.95), and Depression (p =0.50). Linear relationship between higher PA and improved QOL (p=0.006), irrespective of the intervention.
Yuen & Sword, 2007	N = 29 BrCa survivors with moderate fatigue; *M* age = 53.9; 9 days-35 months since treatment; 76% completion rate.	N= 7; 12 weeks of home based (3 days/wk) walking; 20-40 minutes; RPE 10-13.	N = 7, Usual care. N = 8; Resistance exercise group.	Fatigue (Piper Fatigue Scale); 6-Minute Walk Test.	Significant reduction of fatigue for walking group but not for resistance group (Z =2.521, one tailed P=0.006). Significant improvement in 6MWT for RE group but not the AE group (Z =2.366, one tailed P =0.009).

Table 2. Characteristics of included resistance trials

Study	Sample	Intervention	Comparison (Control)	Outcomes	Results
Cormie et al., 2013	N = 62 BrCa survivors with BrCa related lymphedema; *M* age = 57.2; *M* months since diagnosis = 85.2; 92% completion rate.	N = 22; 12 weeks of supervised (2 days/wk) high load resistance exercise; 60 minutes; 75-85% of 1RM. N = 21; 12 weeks of supervised (2 days/wk) low load resistance exercise; 60 minutes;55-65% 1RM.	N = 19; Usual care.	Grip Strength; QOL (SF-36)	Trends toward greater improvement in grip strength in exercise groups (p = 0.077); No significant differences between groups at baseline for any of the QOL domains (p > 0.483); Change in physical function subscale of QOL associated with changes in symptom severity (rho = −0.298 to −0.534, p = 0.000– 0.019; DASH, BPI-severity, BPI-interference and QLQ- BR23 arm sub-scale) and muscle strength (of chest press and leg press 1RM) (r = 0.340–0.350, p = 0.007–0.006).
Musanti, 2012	N=42 BrCa survivors; *M* age 50.5; 3-24 months since	N=9; 12 weeks of home based resistance (3 days/wk; 12 exercises; 10-12 reps; RPE	N=12; Flexibility program N=11; Aerobic and Resistance exercise	Fatigue (Piper Fatigue Scale); Anxiety; Depression	Fatigue (p=0.000) and Anxiety/Depression (p=0.001) decreased significantly from baseline only in

	treatment; 88% completion rate.	3-8).	program N=10; Aerobic exercise program	(Hospital Anxiety and Depression Scale).	individuals who scored above the threshold of clinical significance at baseline; There were no differences between groups.
Ohira et al., 2006	N = 86 BrCa survivors; *M* age = 53; *M* months since treatment = 13.8; 92% completion rate.	N = 39; 26 weeks of supervised (first 13 weeks) and home based (second 13 weeks) resistance exercise (2 days/wk; 9 exercises).	N = 40, control group received intervention following the 6 months.	QOL (CARES-SF); Depression (CES-D).	Physical global QOL score (Standardized Difference = 0.62, P =0.006), and psychosocial global score (Standardized Difference = 0.52, P =0.02) improved significantly in treatment group compared to control. No significant changes in depression scores. Increases in upper body strength (r =0.30; P<0.01) and lean mass (r =0.23; P<0.05) were correlated with improved physical global score. Increases in lean mass were also correlated with improved psychosocial global score (r=0.24, P<0.05).
Sim et al., 2010	N =40 BrCa	N = 20; Active	N = 20, Non active	QOL (SF-36).	Active resistance group improved

	survivors with lymphedema; *M* age = 50.7; *M* months since treatment = 4.79; 100% completion rate.	resistance group; 8 weeks of complex decongestive physiotherapy followed by active resistance exercise (5 days/wk; 15 minutes; 6 exercises; 10 reps; 2 sets).	resistance group; Only performed complex decongestive physiotherapy.		physical functioning, role physical, body pain, general health, and mental health ($p < .05$). Non-active resistance group improved physical functioning, role physical, body pain, and mental health ($p < 05$). Between group differences favored the active group in role physical and general health ($p<.05$).
Winters-Stone et al., 2012	N = 106 postmenopausal BrCa survivors; *M* age = 62.7; *M* months since diagnosis = 60.5; 63% completion rate.	N = 52; 12 months of supervised (2 days/wk) and home based (one day/wk) resistance and impact exercise; 60 minutes; 8-10 exercises; 8-12 reps; 1-3 sets; 60-80% 1RM.	N = 54; Flexibility training control; Series of whole body stretching and relaxation exercises.	Grip strength; Fatigue (Schwartz Cancer Fatigue Scale).	No significant difference on grip strength (p =0.92 and 0.93 for right and left hand) or Fatigue (p = 0.90).

Table 3. Characteristics of included combined trials

Study	Sample	Intervention	Comparison (Control)	Outcomes	Results
Casla et al., 2015	N= 94 pre and postmenopausal BrCa survivors; *M* age= 49.6; *M* months since treatment = 10.44; 95% completion rate.	N = 44, 12 weeks of supervised (two days/wk) exercise combining aerobic (30 minutes; 55-85% HRR) and resistance (30 minutes; 8-15 reps; 2 sets; Borg Scale 10-20) exercise.	N=45; Control group asked to maintain regular behavior.	VO_2max ; QOL (SF36).	Significant improvements in VO_2max (p =0.001, effect size d= 0.94) and QOL (p =0.002, effect size d = 0.53), compared to control.
Hayes et al., 2012	N = 194 pre and postmenopausal BrCa survivors; *M* age = 52.4; 6 weeks since surgery; 93% completion rate.	N = 67, face to face delivered exercise intervention. N =67, telephone delivered exercise intervention. 8 months of aerobic (progressing to 4days/wk; 45 minutes) and strength based (2 days/wk) exercise; progressing from low to moderate to moderate to	N =60; Usual care.	QOL (FACT-B); Fatigue (Functional Assessment of Chronic Illness Therapy – Fatigue Subscale); Anxiety and Depression (The Greene Climacteric Scale).	Significant and clinically relevant improvements in QOL (p =0.030) and Fatigue (p = 0.032) in both treatment groups. Change in QOL only differed significantly (p < 0.05) from usual care in the telephone delivered group. There were no clinically relevant improvements in Anxiety and Depression in

		high intensity.			either group (p = 0.284).
Herrero et al., 2005	N=20 postmenopausal BrCa survivors; *M* age = 50.5; *M* months since treatment = 35.8; 80% completion rate.	N=8; 8 weeks of supervised aerobic (3 days/wk; 20-30 minutes; 70-80% predicted HR max) and resistance (2 days/wk ; 11 exercises; 8-15 reps; 2-3 sets).	N=8; Non-exercising control group: Followed usual sedentary lifestyle.	VO_2 Peak; QOL (EORTC QLQ-C30).	Significant improvements (p<0.05) in global QOL (p=0.002), physical QOL (p=0.04), and VO_2 Peak (mean 3.9ml/kg/min; 95% CI, 0.93, 6.90) compared to control.
McKenzie & Kalda, 2003	N=14 BrCa survivors with unilateral upper extremity lymphedema; *M* age =56.6; > 6 months since treatment; 100% completion rate.	N=7, 8 weeks of upper body aerobic (3 days/wk; 5-20 minutes; 8.3-25W) and resistance (3 days/wk; 2-10 reps; 2-3 sets) exercise.	N=7; Control group.	QOL (SF-36).	Three of the QOL domains showed trends toward improvement for the exercise group: physical functioning (p = 0.050), general health (p =0.048) and vitality (p=0.023). The mental health domain increased for all subjects (p= .019).
Milne et al., 2008	N = 58 pre and postmenopausal BrCa survivors; *M* age =55.1; *M* months since treatment = 13; 98% completion rate.	N= 29; Immediate Exercise Group (IEG); 12 weeks of supervised aerobic (3 days/wk; 20 minutes) and resistance (3 days/wk;12	N = 29; Delayed Exercise Group (DEG), completed the program during the next 12 weeks. DEG served as	QOL (FACT-B); Fatigue (Schwartz Cancer Fatigue Scale).	From baseline to 12 weeks QOL increased in the IEG by 20.8 while decreasing in the DEG by 5.3 points (mean group difference = 26.1; 95% CI = 18.3–32.7; P

		exercises;10-15 reps).	control group.		< 0.001). From 12 to 24 weeks, QOL increased in the DEG by 29.5 points, while increasing by 6.5 points in the IEG (mean group difference = 23.0; 95% CI = 16.3–29.1; P < 0.001). Significant time by group interaction was found for Fatigue (F=8.8 P<0.001).
Musanti, 2012	N=42 BrCa survivors; *M* age 50.5; 3-24 months since treatment; 88% completion rate.	N=11; 12 weeks of home based aerobic (4-5 days; 15-30 minutes; 40-85% predicted HR max) and resistance (2 days/wk; 12 exercises; 10-12 reps; RPE 3-8).	N=12; Flexibility program N=9; Resistance exercise program N=10; Aerobic exercise program	Fatigue (Piper Fatigue Scale); Anxiety; Depression (Hospital Anxiety and Depression Scale).	Fatigue (*p*=0.000) and Anxiety/Depression (*p*=0.001) decreased significantly from baseline only in individuals who scored above the threshold of clinical significance at baseline; There were no differences between groups.
Nikander et al., 2012	N=86 pre and postmenopausal BrCa survivors; *M* age = 53.15; < 4 months since treatment; 78% completion	N = 30; 12 months of supervised (1 day/wk) and home based (3 days/wk) aerobic (30-40 minutes; RPE 11-16) and	N=37; Advised to continue daily routine activities.	Grip strength; 2km Walk Test.	Improved grip strength (~4% between-group difference, p=0.01). No significant improvement in 2km Walk Test (*p*=0.90).

	rate.	resistance (1 day/wk; dumbbell exercises) exercise.

2.32 Ratings of study quality

Table 4 presents the assessment of risk of bias for the RCTs reviewed according to Cochrane Collaboration criteria (Higgins et al., 2011). Two reviewers (KC and MP) rated individual RCTs according to their provision of information on randomization methodology, allocation sequence, blinding, incomplete outcome data, and possible selective reporting. 13 RCTS (62 percent) provided information on their specific randomization methodology and 9 (42 percent) employed a concealed allocation sequence. None of the included RCTS blinded participants to their group assignment, given the nature of the exercise intervention. However, two programs (Hayes et al., 2013; Nikander et al., 2012) blinded exercise therapists to participant group assignments. All studies provided a complete presentation of analyses set forth. In terms of other biases, except in 3 RCTs with a high rating on other biases (e.g. use of a self-referred convenience sample in Musanti , 2012, incorporation of nutritional counseling without assessing its respective impact in Casla et al., 2013, heterogeneity in study population in terms of treatment stage in Nikander et al., 2012), it remained unclear the extent to which individual study limitations could negatively impact their reported conclusions.

Table 4. Risk of bias assessment using Cochrane risk of bias tool

Study	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding (performance bias and detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Aerobic						
Cadmus et al., 2009	Low	Low	NA	Low	Low	Unclear
Daley et al., 2007	Low	Unclear	NA	Low	Low	Unclear
Dolan et al., 2015	Unclear	Unclear	NA	Low	Low	Unclear
Murtezani et al., 2014	Low	Low	NA	Low	Low	Unclear
Rogers et al., 2015	Low	Low	NA	Low	Low	Unclear
Saarto at al., 2012	Low	Unclear	NA	Low	Low	Unclear
Baruth et al., 2015	Unclear	Unclear	NA	Low	Low	Unclear
Yuen & Sword, 2007	Low	Unclear	NA	Low	Low	Unclear
Courneya et al., 2003	Low	Low	NA	Low	Low	Unclear
Pinto et al., 2005	Unclear	Unclear	NA	Low	Low	Unclear
Resistance						
Cormie et al., 2013	Low	Low	NA	Low	Low	Unclear
Winters-Stone et al., 2012	Low	Low	NA	Low	Low	Unclear
Ohira et al., 2006	Low	Unclear	NA	Low	Low	Unclear
Sim et al., 2010	Unclear	Unclear	NA	Unclear	Low	Unclear
Combined						
Casla et al., 2015	Low	Unclear	NA	Low	Low	High
Musanti, 2012	Unclear	Unclear	NA	Low	Low	High
Herrero et al., 2005	Unclear	Low	NA	Low	Low	Unclear

Milne et al., 2008	Low	Low	NA	Unclear	Low	Unclear
McKenzie & Kalda, 2003	Unclear	Unclear	NA	Low	Low	Unclear
Hayes er al., 2013	Low	Low	Low	Low	Low	Unclear
Nikander et al., 2012	Unclear	Unclear	Low	Low	Low	High

2.33 Program characteristics

Of the 21 RCT's, 9 of the interventions were solely aerobic programs [31-41], 4 of the interventions were solely resistance programs [42-45], 6 of the interventions were combined aerobic and resistance programs [46-51], one intervention compared aerobic, resistance, and combined programs [52], and one intervention compared aerobic and resistance programs [53]. For the aerobic exercise interventions, 4 of the programs were supervised [35-38], 4 were home-based [33, 39, 52-53], and 3 were a combination of supervised and home-based [34, 40-41]. The resistance exercise interventions included one supervised program [42], 2 home based programs [52-53], and 3 combination programs [43-45]. For the combined exercise interventions, 5 of the programs were supervised [46-50], one was home based [52], and one was a combination of supervised and home based [51].

The aerobic interventions ranged from 6 weeks [37] to 12 months [41] in duration, the resistance interventions ranged from 8 weeks [44] to 12 months [45] in duration, and the combined aerobic and resistance interventions ranged from 8 weeks [48-49] to 12 months [51] in duration. Weekly physical activity ranged from 75 minutes [35] to 180 minutes [41] in the aerobic interventions and 60minutes [46] to 180 minutes [47] of aerobic activity in the combined interventions. Aerobic exercise interventions and the aerobic portion of the combined

interventions included activities such as walking, jogging, cycling, swimming, step aerobics, circuits, and intervals. Duration of the resistance interventions and resistance portions of the combined interventions were not given in minutes but in sets and repetitions. Resistance exercise included ranges from 6 to 10 exercises, 1-4 sets, and 8-12 repetitions, using resistance bands, weights, or machines. Intensity of interventions varied throughout all types of interventions as well as description of intensity (i.e. percentage of predicted heart rate maximum, percentage of heart rate reserve, percentage of VO2 Peak, METs, and RPE). However, most trials progressively intensified throughout resulting in moderate to vigorous levels of intensity by the end of the program. (See Table 1 for detailed summaries).

2.34 Participant characteristics

Study participants include breast cancer survivors with some studies focusing solely on post-menopausal survivors [33-35, 37, 45, 48] and some including both pre and post-menopausal survivors [36, 39-41, 46-47, 50-51]. Length of survivorship is reported in various ways (if reported) throughout all studies (i.e. time since treatment, time since diagnosis, or within a certain time frame since treatment). Studies range in length of survivorship from 6 weeks since surgery [47] to a mean of 7.1 years post diagnosis [42]. Participants ranged in mean age from 50.5 [52] to 59 [35] in aerobic interventions, from 50.5 [52] to 62.7 [45] in resistance interventions, from 49.06 [46] to 55.1 [50] and had a mean age of 56.1 across all studies.

2.35 Program outcomes

2.351 Quality of life

Seven aerobic interventions [33-36, 38, 40-41], three resistance interventions [36, 38, 40], and five combined interventions [46-50] evaluated improvements to quality of life. Of the seven aerobic interventions measuring quality of life, five programs saw improvements [33, 35-

36, 38, 40]. One such successful program implemented a 12- week home based walking intervention [33] in breast cancer survivors who had completed adjuvant therapy within the last 12 months. Compared to a weight list control, walkers saw greater improvements in quality of life (SF-36) subscales: role emotional, mental health, vitality, role physical, general heath, and physical functioning. When looking at supervised interventions, 8 weeks of supervised aerobic exercise [36] resulted in a significant mean difference of 9.8 points in general quality of life (FACT-B) compared to a usual care group. The aerobic exercise group also saw significant improvements in breast cancer specific quality of life compared to usual care. A 10-week supervised moderate intensity aerobic exercise intervention [38] also produced significant improvements in general quality of life (FACT-G) by 9.16 points and breast cancer specific quality of life (FACT-B) by 13.4 points compared to controls. The exercise group also improved their scores on the functional well-being subscale and the emotional well being subscales. Similarly, a 15 week supervised aerobic exercise intervention [35] indicated significant quality of life (FACT-B) increases by 9.1 points in the exercise group and only 0.3 points in the control group. In addition, changes in peak oxygen consumption were significantly correlated ($r=0.45$, $p<0.01$) with changes in quality of life. Some programs added further components to the aerobic intervention. A 12 week program that included both supervised and home based aerobic exercise with exercise counseling and group discussions [40] was successful in significantly improving general quality of life (FACT-G), breast cancer specific quality of life (FACT-B), the physical well being subscale, the emotional well being subscale, and the functional well being subscale immediately following the intervention (12 weeks) compared to controls. At follow up (24 weeks) between group differences were still present for general quality of life, breast cancer specific quality of life, and the physical well being subscale. In contrast, a twelve-month

supervised and home based aerobic intervention [41] indicated no significant differences between groups in quality of life (EORTC QLQ-C30), although there was a linear relationship between increased physical activity and improved quality of life. In line with these findings, results from a 6-month supervised and home based aerobic exercise intervention [34] indicated no changes in quality of life (FACT-B and SF-36) between the exercise group and usual care group. However, the intervention was associated with improvements in the social functioning subscale in those who reported low social functioning at baseline.

Two out of three of the resistance programs evaluating quality of life demonstrated improvements. A 13 week supervised full body resistance training program followed by 13 weeks of home based training [43] was successful in significantly improving physical global and psychosocial global quality of life (CARES-SF) scores compared to a control group. Increases in upper body strength ($r=0.30$) and lean mass ($r=0.23$) were further correlated with improved physical global quality of life while increased lean mass also correlated ($r=0.24$) with improved psychosocial global quality of life. Similarly, 3 months of high load resistance training and 3 months of low load resistance training [42] both significantly improved quality of life (SF-36) compared to a usual care group. Furthermore, the change in the physical function dimension of quality of life was associated with changes in symptom severity ($rho = -0.298$ to -0.534) and muscle strength ($r=0.340$-0.350). Alternatively, 8 weeks of complex decongestive physiotherapy followed by active resistance exercise [44] resulted in no differences between the resistance group and the control group (only performed decongestive therapy), although both groups significantly improved quality of life (SF-36).

Five combined interventions measured quality of life, with four finding improvements

[46-48, 50]. Twelve weeks of supervised aerobic and resistance exercise [50] resulted in a significant time by group interaction for overall quality of life (FACT-B) with an immediate exercise group improving by 20.8 points while a delayed exercise group decreased by 5.3 points in the first 12 weeks. When the delayed exercise group completed the intervention they too improved quality of life by 29.5 points while the immediate exercise group improved by another 6.5 points. Similarly, an 8-week combined aerobic and resistance exercise program [48] was successful in significantly improving global and physical quality of life (EORTC QLQ-C30) compared to non exercise controls, while another 12-week combined aerobic and resistance intervention [46] significantly improved quality of life (SF-36) compared to controls who were asked to maintain their regular behaviours. When comparing a face to face delivered exercise intervention and a telephone delivered exercise intervention [47] with a usual care group, both groups who received the 8-week aerobic and resistance intervention (regardless of delivery) saw clinically relevant improved quality of life (FACT-B). Interestingly, only the telephone delivered exercise intervention differed significantly from the usual care group. In contrast, an eight-week upper body program [49] with combined aerobic and resistance exercise did not reach significance in terms of quality of life (SF-36) improvement. However, 3 domains of quality of life trended towards significance for the intervention group compared to the control group: physical functioning, general health, and vitality.

2.352 Fatigue

Six aerobic interventions [33, 36, 39, 41, 52-53], three resistance interventions [45, 52-53], and three combined interventions [47, 40, 52] examined effects on fatigue. Of the six aerobic interventions evaluating fatigue, three saw reductions [33, 39, 53]. Twelve weeks of

home based walking [33] resulted in larger reductions in fatigue (FACT-F) in the exercise group than the control group, while another home based aerobic program [39] also significantly reduced fatigue (Linear Analog Scale for Fatigue compared to controls. Interestingly, when comparing an aerobic exercise group to a resistance exercise group, and a usual care group [53], the aerobic group saw a significant reduction in fatigue (Piper Fatigue Scale) that the resistance group and usual care group did not. In line with these findings, two resistance interventions that evaluated fatigue (Schwartz Cancer Fatigue Scale, Piper Fatigue Scale) did not see significant improvements when compared to controls [45,52]. Similarly, three of the aerobic interventions failed to improve fatigue (Piper Fatigue Scale; FACT-F; Piper Fatigue Scale) compared to controls [36,41,52]. Interestingly, one of these interventions [36] did see a significant reduction in fatigue (Piper Fatigue Scale) in the exercise placebo group (light intensity body conditioning/stretching) compared to usual care that was not found in the aerobic exercise group.

Of the three combined interventions that examined fatigue two saw improvements [47,50]. Twelve weeks of supervised combined aerobic and resistance exercise [50] significantly reduced fatigue (Schwartz Cancer Fatigue Scale) compared to a delayed exercise group. Similarly a face to face delivered or telephone delivered aerobic and resistance exercise intervention [47] (regardless of delivery) resulted in clinically relevant reductions in fatigue (Functional Assessment of Chronic Illness Therapy – Fatigue Subscale) compared to usual care. The combined intervention that did not improve fatigue (Piper Fatigue Scale) [52] also did not see fatigue reductions in the other comparison groups (aerobic, resistance, and flexibility). Fatigue reductions were only seen in individuals who scored above the threshold of clinical significance at baseline.

2.353 Depression and anxiety

Three aerobic [36,41,52], two resistance [43, 52], and two combined [47,52] studies assessed depression while one aerobic [53], one resistance [53], and two combined [47, 52] interventions measured anxiety. One [36] of three of the aerobic intervention saw improvements in depressive symptoms (Beck Depression Inventory). Eight weeks of supervised aerobic exercise resulted in a significant difference in mean depression scores between the exercise and usual care group. Alternatively, a twelve-month supervised and home based aerobic program [41] and a 12-week home based aerobic program [52] both found no significant between group differences in depression scores (Finnish Modified Beck Depression Scale; Hospital Anxiety and Depression Scale). The aerobic intervention that assessed anxiety (Hospital Anxiety and Depression Scale) (52) found no significant improvements, but also found no improvements in the other comparison groups (resistance, combined and flexibility). Of the two resistance and two combined interventions that assessed depression and anxiety, none saw significant improvements in either outcome [43,52, 47, 52] (CES-D; Hospital Anxiety and Depression Scale; The Greene Climacteric Scale; Hospital Anxiety and Depression Scale).

2.354 VO_2 peak and walk tests

Two aerobic interventions [35, 37], two combined interventions [46, 48], and no resistance interventions directly measured VO_2 peak, while four aerobic interventions [38-39, 41, 53], one resistance intervention [53], and one combined intervention [51] indirectly measured aerobic capacity through distance walked. Both aerobic interventions [35,37] were successful in significantly improving VO_2 peak compared to controls. Fifteen weeks of supervised aerobic exercise on cycle ergometers [35] increased VO_2 peak by 0.24L/min in the exercise group while

decreasing by 0.05L/min in the control group. Both combined interventions [46, 48] were also successful in significantly improving VO_2 peak compared to controls. Twelve weeks of supervised exercise sessions combining aerobic and resistance exercise [46] significantly improved VO_2 max by 5.35ml/kg/min in the exercise group with changes being maintained at 6 months follow up. An 8-week combined aerobic and resistance exercise program [48] was also successful in significantly increasing VO_2 peak by 3.9ml/kg/min compared to control.

Four aerobic interventions [38-39, 41, 53] indirectly assessed aerobic capacity through distance walked with two [38-39] seeing improvements. Ten weeks of supervised moderate intensity aerobic exercise [38] was successful in significantly improving performance on distance walked in twelve minutes compared to control. Similarly, twelve weeks of home based moderate intensity aerobic exercise [39] resulted in the exercise group significantly out performing control on a one mile walking test. In contrast, a twelve-month supervised and home based training program [41] saw no differences between groups in 2km walking time. Interestingly, in a study that compared 12 weeks of home based walking and 12 weeks of resistance training to a usual care group [53], there were significant reductions in fatigue in the aerobic group but not in the resistance group or in usual care controls; there were significant improvements in distance walked in 6 minutes in the resistance group but not in the aerobic group and not in usual care. The one combined intervention that used a walking test, 4 months of supervised and home based aerobic and dumbbell training [51], was not effective in improving 2km walk time.

2.355 Grip strength

Two resistance interventions [42, 45] and one combined intervention [51] measured grip

strength. In a 3 month intervention of high load or low load resistance training [42], trends toward greater improvement in grip strength in the experimental groups was observed ($p = 0.077$). This intervention also observed that change in the physical dimension of quality of life was associated with change in muscle strength (chest press and leg press 1RM) $r = 0.340–0.350$). A one-year resistance and impact exercise program [45] was also not successful in improving grip strength. In contrast, the combined intervention [51], 4 months of supervised and home based aerobic and dumbbell training, was successful in significantly improving grip strength by about 1 kg, while it decreased by a similar degree in the control group.

2.36 Conclusions

All three types of intervention have the ability to improve physiological and psychological outcomes in breast cancer survivors. In terms of quality of life, interventions that yielded greater improvements tended to be supervised. Additionally, studies that saw peak VO_2 improvements often had individuals exercising on site with exercise intensity being monitored. No obvious trends in terms of grip strength improvements emerged, except that no solely aerobic interventions assessed this measure. It is not clear that any type of intervention is superior with regard to quality of life, aerobic, or strength improvements – however solely aerobic interventions rarely measure strength, and resistance interventions rarely measure aerobic capacity. Furthermore, few studies examine the interrelation among physiological and psychological measure. Future research is warranted with a focus on home based interventions and their ability to improve such measures and the interrelation among physiological and psychological variables.

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3.0 The Current Study

The current study involves a sub-analysis of data collected as part of a larger study conducted at the University Health Network (UHN) entitled "Pilot study to evaluate the feasibility of an innovative smartphone enabled health coaching intervention (iMOVE) to promote long-term maintenance of physical activity behaviour in breast cancer survivors". The proposed analyses will examine whether significant predictive and/or correlational relationships exist between VO_2 peak and/or grip strength and quality of life in breast cancer survivors. Specifically, we will assess whether there is a relationship between VO_2 peak and/or grip strength with overall quality of life, as well as with specific subscales of quality of life, and depression to determine which fitness variable is most relevant to quality of life status in this population under what circumstances. Additional analyses will assess the intervention effects on VO_2 peak, grip strength, and quality of life, and determine whether significant correlations exist between improved fitness and QOL within an exercise intervention period of 12 weeks. It is hypothesized that VO_2 peak and grip strength will be significantly associated with higher quality

of life scores at baseline (with the FACT-B as an outcome measure). Furthermore, it is hypothesized that the intervention group will significantly improve VO_2 peak, grip strength, and quality of life status at 12 weeks assessment, and that improved VO_2 peak and grip strength will significantly correlate with quality of life scores, as assessed at 12 weeks post-intervention. For the purpose of the current study, participants in the intervention and control groups will be combined together for some baseline analysis. The main research question does not depend on whether the participant received iMOVE or not, rationalizing the combination of the two groups.

4.0 Methods

4.1 Patient Population and Eligibility

Inclusion criteria for recruitment were: 18-75 years of age, within 2 years of completed adjuvant therapy (excluding hormone therapy), baseline physical activity participation of less than 60 minutes of pre-planned physical activity per week, physician clearance to participate in moderate physical activity, ability to read and write in English, and ability and willingness to attend weekly exercise training sessions and assessments at particular time points throughout the study. Exclusion criteria were: plans to join a physical activity or weight loss program within the next 9 months, metastatic or recurrent disease, pregnancy or planned pregnancy within the next 9 months, planned surgery within the next 9 months, and unwilling to be randomized.

4.2 Sample Size

Sample size calculations were conducted as part of the larger pilot study that resulted in an estimated sample size of 35-40 participants per study arm. *There were no existing RCT to base sample size calculations on for the larger envisioned RCT study* which was a major reason for conducting the pilot study. Consequently, a simulation was conducted over a range of sample

sizes, and different values of SD for the precision of treatment effect estimate. The precision of the estimate is represented by the inverse of the margin of error. Type I error was set at α=0.05 and power at 80%. From the simulation result, a sample size of 35-40 was at the elbow point of the curves; meaning the precision does not proportionally increase with a larger sample size beyond this point. Therefore, with an anticipated dropout rate of 25% (White et al. 2009), the aim is to recruit 107 participants to obtain a sample size of 80 participants (40 per arm). Since the study is ongoing and has involved a slower than expected recruitment, for the current analyses there is a predetermined sample size of 41 participants. Analyses will be rerun with the full sample size once the study is completed for publication purposes.

4.3 Recruitment

Participants were recruited through the Princess Margaret Hospital, a cancer hospital that is a member of the UHN. Identified potential participants from clinic lists and chart reviews were approached by a member of the clinical team in person or by phone. Additional recruitment included posting flyers in various locations throughout the UHN (Refer to Appendix 1), tweeting and posting on the ELLICSR (Electronic Living Laboratory for Interdisciplinary Cancer Survivorship Research) Twitter and Facebook pages and recruiting from Breast Cancer and survivorship clinics at UHN. Eligible women willing to participate were asked to provide consent (Refer to Appendix 2) and contact information and were contacted to schedule a baseline assessment. All assessments were completed at the ELLICSR (part of the UHN) state of art testing facilities. Both the UHN Research Ethics Board and the Human Participants Review Subcommittee at York University approved all study procedures.

4.4 Randomization

After completing the baseline assessment, participants were randomized into the health coaching (iMOVE) intervention group or the exercise intervention without health coaching group (the comparison control group). Staff from the Department of Biostatistics at Princess Margaret Hospital stratified participants by age and treatment with adjuvant hormone therapy (AHT) (or no AHT) and randomly assigned in a 1:1 ratio using a SAS generated computerized randomization process. The research coordinator telephoned Biostatistics staff to receive the participant's assignment, and did not have access to the randomization sequence.

4.5 Confidentiality

Patient confidentiality was ensured with study ID numbers being used on data collection forms with all links between study ID and patient name secure and locked (in filing cabinets within locked offices) at all times. More specifically, all information collected throughout the study was stored in password protected files on the UHN network, in password protected computers, and/or in secure locked cabinets and remained confidential with all identifying information deleted. Only the research team had access to such information. No information regarding subjects was shared with healthcare professionals not associated with the study. Publications arising from the research will not contain any patient names.

4.6 Description of Intervention Arms

4.61 Exercise training program

Participants in both intervention and control groups received a 12 week physical activity program. The program included a weekly group exercise class and a progressive home-based exercise prescription. The group exercise class was 60 minutes in length and instructed by a certified exercise physiologist and registered kinesiologist. The class consisted of a warm up,

aerobic exercise (i.e jogging on place, high knees, grapevine), resistance exercise with the use of resistance bands (i.e bicep curl, standing row), and a cool down. Participants were encouraged to work at a moderate to vigorous pace based on self-monitored rating of perceived exertion (RPE) scale (Borg, 1998). The class cycled through 4 different class layouts: 1) half aerobic, half resistance (refer to Appendix 3) 2) alternating aerobic and resistance for legs, chest, and back (refer to Appendix 4) 3) alternating aerobic and resistance for arms, shoulders, and core (refer to Appendix 5) 4) circuit (refer to Appendix 6). Each participant attended each class type 3 times for a total of 12 classes. Participants began the program with a rolling start so classes were kept identical to ensure each participant attended every exercise class type in equal proportion. Classes took place at the ELLICSR gym. The 12-week exercise prescription was based on the American College of Sports Medicine (ACSM) guidelines with the goal of achieving a minimum of 150 minutes per week of moderate intensity aerobic activity and 2 sessions per week of resistance exercise (Schmitz, 2010). Participants were given an exercise manual that included exercise descriptions with pictures, other exercise information and resources, (Refer to Appendix 7) and 3 resistance bands (red = light resistance, green = medium resistance, blue = strong resistance) for their home-based exercise prescriptions. Weekly home-based exercise was prescribed by the certified exercise physiologist and registered kinesiologist at the end of each exercise class on a prescription sheet (see Appendix 8). Participants were asked to provide the certified exercise physiologist and registered kinesiologist with the exercise they performed within the previous week, the difficulty of such exercise based on the RPE scale, and if they experienced any pain or discomfort during the exercise (Refer to Appendix 9). The home-based exercise prescriptions combine aerobic and resistance exercise and progressively intensify each week in volume (Refer to Appendix 7).

4.62 iMOVE intervention

In addition to the exercise training program, individuals randomized into the iMOVE intervention group received telephone based health coaching and supportive technology software. The telephone based health coaching included 10 x 30 minute one-on-one phone calls with a trained health-coach that focused on motivation, promotion of self-efficacy, and collaborative problem solving. The supportive technology included a HealthCoach software app (the NexJ Healh Coach mobile app) via a smartphone that included the ability to track physical activity, nutrition, pain, psychological well being, and goal setting. Entries into the app allowed for the creation of graphs giving participants and health coaches indicators of change. Participants were also provided with a wearable fitness technology (the Fitbit Flex) that tracks movement and sleep patterns 24 hours a day. The Fitbit provides lights indicating the number of steps taken per day and will buzz when a participant reaches the goal of 10,000 steps. It further tracks distance walked, calories burned, activity duration and intensity, and sleep quality.

4.6 Data Collection

The current study examined the first two time-points of assessment data: baseline (T0), and following completion of the 12 week exercise program (T1). Assessments were conducted by a certified exercise physiologist and a registered kinesiologist. Assessments were conducted in the following order: 1) Participants complete patient report outcomes (Refer to Appendix 10), 2) Participants are administered a PAR Q + by the certified exercise physiologist (Refer to Appendix 11), 3) resting heart rate, oxygen saturation, and blood pressure are assessed, 4) Weight, height, and waist circumference are measured, 5) Grip strength is assessed, 6) A

cardiopulmonary exercise test is performed, 7) Resting heart rate, oxygen saturation, and blood pressure are assessed.

4.61 Patient reported outcomes

Demographic data were recorded (Refer to Appendix 10.1) including age, country of birth, languages spoken, highest level of education completed, marital status, employment status, and number of children.

4.611 Leisure- time exercise questionnaire

Exercise frequency and intensity were assessed with a 3 item questionnaire, the Leisure-Time Exercise Questionnaire (LTEQ) (Refer to Appendix 10.2), which asks individuals to report on their weekly exercise habits (Godin & Shephard, 1997). This questionnaire has been validated ($p<0.05$) through relationships between leisure score and VO_2 max ($r=0.56$-0.69), body fat percentage ($r=0.43$-0.66), treadmill time ($r = 0.57$), and Caltrac activity monitors ($r = 0.32$-0.45) (Godin and Shephard 1997; Jacobs et al. 1993; Sallis et al. 1993; Miller et al. 1994). Correlational analyses have also found the questionnaire to be reliable ($p<0.05$) ($r = 0.24$-0.96) (Godin and Shephard, 1997; Sallis et al. 1993; Jacobs et al. 1993).

4.612 Quality of life

Quality of life was measured using the validated 44-item Functional Assessment of Cancer Therapy Breast- (FACT-B) (Refer to Appendix 10.3) which measures subscales of physical well being, social/family well being, emotional well being, functional well being, and additional concerns related to breast cancer specially (Cella et al. 1993). Convergent validity was tested by looking at associations between scores on the FACT and scores on other similar measures completed at the same time which yielded strong correlations ($r = 0.58$-0.79) while divergent validity (looking at associations between scores with dissimilar measures) saw weak

correlations (r=0.22) (Cella et al. 1993). Coefficients of reliability were also high for the overall scale (r = 0.86) and specific subscales (r =0.82-0.92).

4.613 Fatigue

Fatigue was assessed by the 13- item Functional Assessment of Cancer Therapy-Fatigue (FACT-F) subscale (Refer to Appendix 10.4) (Yellen et al. 1997). Test- retest correlations found this scale to be reliable (r=0.87). Convergent and discriminant validity testing found a significant positive relationship with other known measures of fatigue (r = 0.74-0.75), a significant negative relationship with vigor (r=0.66), and an expected lack of relationship with social desirability (r=0.04) (Yellen et al. 1997).

4.614 Anxiety

The 20-item Spielberger's State-Trait Anxiety Inventory-State (STAI-S) (Refer to Appendix 10.5) (Spielberger, 1983) was applied in the assessment of anxiety. Internal consistency coefficients for the scale range from (r=0.86-0.95) with test-retest correlations of (r=0.65-0.89). The inventory has been found to be valid with overall correlations between the STAI and other measures of anxiety (the Taylor Manifest Anxiety Scale and Cattell and Scheier's Anxiety Scale Questionnaire) being 0.73 and 0.85, respectively (Julian, 2011).

4.615 Depression

Depression was measured using the Center for Epidemiological Studies-Depression Scale Short form (CESD-SF) (Refer to Appendix 10.6) (Radloff, 1977). Validity of the scale was established through correlations with other self-report measures (r=0.83), with clinical ratings of depression (r=0.69-0.75), and with other variables that support construct validity (r =0.0.54-0.56). Test-retest correlations showed acceptable reliability (r=0.51-0.67) (Radloff, 1977).

4.616 Breast Cancer Symptoms

Physical symptoms were measured using the Breast Cancer Prevention Trial (BCPT) Symptoms Scale (Refer to Appendix 10.7) (Stanton et al. 2005). To test whether the scales were distinct from measures of quality of life (i.e., whether they had discriminant validity), BCPT scores were correlated with quality of life with only 2 scales exceeding r=0.30. Reliability was also found to be acceptable (r=0.70) (Stanton et al. 2005).

4.62 Anthropometrics

Body composition assessments utilized body mass index (BMI) and waist circumference (WC) evaluations. Participants' height and weight was also assessed to calculate BMI (BMI = weight [kg]/height $[m]^2$. Waist circumference was specifically measured by placing the tape horizontally halfway between the top of the iliac crest and the bottom of the rib cage, which is the protocol defined by the World Health Organization (Heyward, 2010).

4.63 Fitness measures

4.631 Resting measures

Resting heart rate, blood pressure, and oxygen saturation were measured after the participant had been seated for 5 minutes.

4.632 Musculoskeletal function

Grip strength was measured using a Jamar Dynamometer according to the Canadian Society for Exercise Physiology protocol (CSEP 2004).

4.633 Cardiopulmonary exercise test

Cardiorespiratory fitness was assessed with a maximal exercise test using the Modified Bruce Treadmill protocol, which is a protocol suitable for high risk or elderly individuals

(Heyward, 2010). VO2 peak (mlO2/kg/min) was measured using a metabolic cart with continuous gas exchange analysis during the incremental exercise test. Resting blood pressure, heart rate, and arterial oxygen saturations were measured at rest and during exercise. Subjects performed an incremental ramp test to their tolerance limit defined as the point at which subjects could not exert themselves any further, or signaled a wish to stop despite encouragement from the technician. Absolute and relative test termination criteria were based on standardized guidelines (Heyward, 2010). Participants who had contraindications for the maximal protocol (i.e severe arthritis in knees) completed the 6 minute walk test which measures the distance an individual can walk as quickly as possible in 6 minutes. This test has been used as a proxy measure of aerobic fitness in breast cancer survivors (Campbell et al. 2012) and is positively related (r =0.78) to the time it takes to reach 85% of heart rate max on the Bruce protocol (Heyward, 2010).

4.7 Hypotheses

In relation to evaluating associations between VO_2 peak, grip strength, and quality of life, it is hypothesized that:

4.71 Hypothesis 1

VO_2 peak and grip strength will be significantly and positively associated with quality of life scores at baseline (with the FACT-B as an outcome measure) and that the extent of these associations will vary according to existing residual breast cancer symptoms. Accordingly, participants will be divided into tertiles on the basis of their self reported breast cancer-related symptoms with the rationale that participants with more severe symptoms would experience weaker associations between VO_2 peak, grip strength, and quality of life than those with lower levels of residual symptoms.

4.72 Hypothesis 2

Peak VO_2 and grip strength will be strong predictors of quality of life at baseline within a linear regression model.

In relation to the evaluation of changes in VO_2 peak, grip strength, and quality of life levels from baseline to 3 month post-intervention, it is hypothesized that:

4.73 Hypothesis 3

The intervention group (i.e. iMOVE) compared to the control group (exercise-alone) will have significantly higher VO_2 peak, grip strength, and quality of life status at 12 weeks assessment within a one-way analysis of covariance (ANCOVA) model adjusted for age, breast cancer symptoms, and baseline levels of VO_2 peak, grip strength, and quality of life as covariates.

4.74 Hypothesis 4

Participants that participate in the group class (i.e attend > 50% of exercises classes) will have significantly higher VO_2 peak, grip strength, and quality of life (at 12 weeks), compared to individuals who do not adhere to the group class (attend < 50% of classes) regardless of group allocation.

4.75 Hypothesis 5

Improved VO_2 peak and grip strength will significantly correlate with quality of life scores, as assessed at 12 weeks post-intervention.

4.8 Statistical Analyses

Statistical analysis was performed using SPSS version 20 (SPSS, 2011). Broadly, statistical analyses are divided into the evaluation of: associations between VO_2 peak and grip strength with quality of life at baseline within each tertile of breast cancer symptom scores

(**Hypothesis 1**), VO_2 peak and grip strength as predictors of quality of life at baseline within linear regression models (**Hypothesis 2**), the evaluation of changes in VO_2 peak, grip strength, and total quality of life from baseline to 3 month post-intervention between the iMOVE intervention and the exercise only control group (**Hypothesis 3**), the evaluation of changes in VO_2 peak, grip strength, and total quality of life from baseline to 3 month post-intervention between individuals who adhered to the group class (> 50% attendance) and individuals who did not adhere (<50% attendance) (**Hypothesis 4**), and associations between changes in VO_2 peak and grip strength with changes in quality of life (**Hypothesis 5**).

4.81 Statistical analyses for hypothesis 1 and 2

First, Chi square test of independence and one-way analysis of variance (ANOVA) were conducted to evaluate potential differences at baseline in demographic, physical, and psychological characteristics between study participants stratified by tertiles according to their breast cancer symptom scores. In addition, Pearson correlations were calculated at baseline to evaluate biivariate associations between VO_2 peak with quality of life and depressive symptoms scores, and grip strength with quality of life and depressive symptoms scores within each tertile of breast cancer symptom (i.e. low, moderate, high levels) scores. Then, separate multiple linear regression analyses were employed to model the relationship between VO_2 peak, grip strength, and total quality of life score at baseline, adjusted for other relevant covariates, including age, leisure time physical activity, depression, and breast cancer symptoms (again, separated into tertiles). All models were examined for normality, colinearity, and possible outlying influences (e.g. tolerance and VIF statistics).

4.82 Statistical analyses for hypothesis 3, 4, and 5

Next, these cross-sectional analyses at baseline were followed by the evaluation of changes from baseline to 3 month post-intervention in mean quality of life scores (i.e. FACT-B), VO_2 peak, and grip strength between intervention (i.e., iMOVE) and control (i.e. exercise alone) groups. First, Chi square test of independence and independent samples t-test were employed to evaluate potential differences at baseline in categorical and continuous demographic and clinical variables between intervention (i.e., iMOVE) and control (i.e. exercise alone) groups. These were followed by separate one way analyses of covariance (ANCOVA) models to evaluate differences between groups (i.e. iMOVE intervention and exercise-alone control) in quality of life scores (i.e. FACT-B), VO_2 peak, and grip strength adjusted for age, breast cancer symptoms, and baseline scores of quality of life, VO_2 peak, and grip strength within respective models. Similar comparisons were also evaluated for individuals with less than 50% and more than 50% of attendance to the group exercise class, regardless of group allocation. To account for multiple comparisons, all p values are Bonferroni adjusted.

5.0 Results

5.1 Associations between VO_2 peak, Grip strength, and Quality of Life at Baseline

5.11 Participant characteristics

Forty-one female breast cancer survivors, regardless of their group allocation, (within 2 years of completing adjuvant therapy) (mean age of 57.03 ± years) were included in this part of the study. Tables 1 and 2 present the demographic and clinical characteristics of study participants overall and when grouped into tertiles according to self reported BrCa Symptom

Scores at baseline (lowest tertile = lowest symptom level, middle tertile = mid level symptoms, highest tertile = highest symptom level).

Table 1. Demographic characteristics according to BrCa symptom scores at baseline

Variable	Overall	Lowest symptoms[a] (LS) (N= 14)	Mid level symptoms[a] (MS) (N= 14)	Highest Symptoms[a] (HS) (N= 13)	P
Country of Origin					
Canada	24(58.5)	10.0 (71.4)	7.0 (50.0)	7.0 (53.8)	0.47
Other	17(41.5)	4.0 (28.6)	7.0 (50.0)	6.0 (46.2)	
Education					
Some high school	5(12.2)	3.0 (21.4)	2.0 (14.3)	0.0 (0.0)	
Some college or university	24(58.5)	9.0 (64.3)	7.0 (50.0)	8.0 (61.5)	0.34
Some post-graduate	12(29.3)	2.0 (14.3)	5.0 (35.7)	5.0 (38.5)	
Employment Status					
Full-time	16(39)	7.0 (50.0)	4.0 (28.6)	5.0 (38.5)	
Part-time	8(19.5)	2.0 (14.3)	4.0 (28.6)	2.0 (15.4)	
Homemaker	2(4.9)	1.0 (7.1)	0.0 (0.0)	1.0 (7.7)	0.71
Unemployed	5(12.2)	1.0 (7.1)	1.0 (7.1)	3.0 (23.1)	
Retired	8(19.5)	3.0 (21.4)	4.0 (28.6)	1.0 (7.7)	
Marital Status					
Married or common law	24(58.5)	8.0 (57.1)	9.0 (64.3)	7.0 (53.8)	
Divorced or separated	5(12.2)	1.0 (7.1)	1.0 (7.1)	3.0 (23.1)	0.68
Single or never married	11(26.8)	4.0 (28.6)	4.0 (28.6)	3.0 (23.1)	
Widowed	1(2.4)	1.0 (7.1)	0.0 (0.0)	0.0 (0.0)	
Physical Health Comorbidities					
Cardiovascular Disease	14(34.1)	8.0 (57.1)	2.0 (14.3)	4.0 (30.8)	0.06
Cerebrovascular Disease	1(2.4)	0.0 (0.0)	0.0 (0.0)	1.0 (7.7)	0.33
Metabolic Disease	5(12.2)	3.0 (21.4)	1.0 (7.1)	1.0 (7.7)	0.43

Musculoskeletal Conditions	22(53.1)	8.0 (57.1)	10.0 (71.4)	4.0 (30.8)	0.09
Respiratory Disease	8(19.6)	2.0 (14.3)	3.0 (21.4)	3.0 (23.1)	0.66
Mental Health Comorbidities					
Self-reported depression	6(14.6)	2.0 (14.3)	0.0 (0.0)	4.0 (30.8)	0.08
Medications					
Blood Pressure Medications	11(26.77)	6.0 (42.9)	2.0 (14.3)	3.0 (23.1)	0.37
Cholesterol Medications	1(2.37)	1.0 (7.1)	0.0 (0.0)	0.0 (0.0)	0.21
Tamoxifen or Letrozole	11(26.93)	5.0 (35.7)	2.0 (14.3)	4.0 (30.8)	0.41

a: grouped into tertiles according to self reported BrCa Symptom Scores at baseline (lowest tertile = lowest symptom level, middle tertile = mid level symptoms, highest tertile = highest symptom level)

In relation to demographic characteristics, no differences between groups were observed in any demographic characteristic (Table 2). From lowest to highest symptom level (per lowest prevalence level of BrCa symptoms to highest prevalence level of BrCa symptoms), 23.1% (lowest), 14.3% (mid level), and 42% (highest) were taking blood pressure medications, 0% (lowest), 0 % (mid level), and 7.1% (highest), were taking cholesterol medications, and 30.8% (lowest), 14.3% (mid level), and 35.7% (highest) were taking Tamoxifen or Letrzole.

Table 2. Physical and psychological characteristics according to BrCa symptom scores at baseline

Variable	Overall	Lowest symptoms[a] (LS) (N= 14)	Mid level symptoms[a] (MS) (N= 14)	Highest symptoms[a] (HS) (N= 13)	Post-hoc Comparisons
Physical					
Age (years)	57.12(8.38)	58.7 (8.0)	58.4 (9.8)	54.0 (6.8)	-
BMI (kg/m^2)	28.65(6.33)	27.7 (7.7)	27.7 (5.3)	30.7 (5.7)	-
WC (cm)	91.96(15.56)	88.0 (16.2)	87.2 (13.3)	101.3 (13.7)	HS>LS*; HS>MS*
Grip Strength (kg)	42.88(10.06)	44.1 (11.5)	42.6 (11.7)	41.8 (6.5)	-
Vo_2 peak (ml/min/kg)	20.89(4.92)	20.7 (4.9)	21.4 (5.6)	20.5 (4.5)	-
Psychological					
FACT- PWB	22.81(4.51)	24.9 (3.2)	24.0 (2.4)	19.3 (5.5)	LS>HS**; MS>HS**
FACT-SFWB	21.61(5.34)	23.3 (4.5)	20.9 (5.3)	20.7 (6.0)	-
FACT- EWB	18.27(4.69)	20.7 (3.0)	18.4 (3.9)	15.6 (5.7)	LS>HS**
FACT- FWB	20.58(5.62)	22.4 (4.5)	21.4 (4.6)	17.7 (6.7)	-
FACT-Additional concerns	21.66(5.80)	25.9 (3.9)	22.6 (3.9)	16.0 (4.8)	LS>HS***; MS>HS***
FACT- B	104.94(18.57)	117.2 (12.6)	107.3 (13.5)	89.2 (18.3)	LS>HS***; MS>HS**
FACIT-F	35.9 (11.7)	44.4 (6.6)	36.6 (9.1)	26.7 (11.4)	LS>HS***; MS>HS*** LS>MS*
CESD	7.91(6.09)	4.9 (3.4)	6.7 (4.9)	12.5 (7.1)	HS>LS***; HS>MS**

*p<0.05 ** p<0.01 *** p<0.001

a: grouped into tertiles according to self reported BrCa Symptom Scores at baseline (lowest tertile = lowest symptom level, middle tertile = mid level symptoms, highest tertile = highest symptom level)

5.12. Mean values for VO_2 peak, grip strength, and quality of life according to tertiles of breast cancer symptoms

In relation to physical characteristics, mean peak oxygen consumption was 20.7ml/kg/min, 21.4ml/kg/min, and 20.5 ml/kg/min from lowest to highest symptoms and mean grip strength was 44.1kg, 42.6kg, and 41.8kg from lowest to highest symptoms (i.e. lowest to highest prevalence of BrCa symptoms), with no differences between intervention and control groups. Waist circumference (WC) was significantly lower in the lowest symptoms (i.e. lowest prevalence of BrCa symptoms) than in the mid level and highest symptom group (i.e. highest prevalence of BrCa symptoms). The physical well-being and breast cancer concerns subscales of the FACT-B were significantly lower in the highest symptoms than in the lowest symptoms and in the mid level symptoms when compared to the highest tertile. The emotional well being subscale of the FACT-B was significantly lower in the highest symptoms than in the lowest symptoms. Overall FACT-B quality of life scores were higher and depression scores (CESD-SF) were significantly lower in the lowest and mid level symptoms (than in the highest symptoms). No differences between intervention and control groups were observed in all other physiological or psychological variables.

5.13 Baseline associations

5.131 Hypothesis 1 results - Associations between VO_2 peak and grip strength with QOL at baseline according to tertiles of breast cancer symptoms

A significant positive correlation was observed between the physical well being subscale of the FACT-B and VO_2 peak ($r=0.59$, $p<0.05$) and grip strength ($r=0.55$, $p<0.05$) in only the lowest (tertile) symptoms group. Significant positive correlations were observed between the emotional well being subscale ($r=0.71$, $p<0.01$), and the functional well being subscale ($r=0.69$, $p<0.01$) with grip strength (but not VO_2 peak) but, again, only in the lowest symptom group. A

significant negative correlation was observed between the CESD and VO2 Peak (r = -0.57, p <0.05), but only again in the lowest symptom group. A significant positive correlation was detected between the social and family well being subscale and VO_2 peak (r =0.57, p <0.05) but only in the highest symptom (tertile) group.

Table 3. Baseline Correlations

			Age	FACT-PWB	FACT-SFWB	FACT-EWB	FACT-FWB	FACT-Breast	CESD-SF
BCPT Score	**Lowest symptoms[a] (LS)**	**VO_2 peak**	-0.37	0.59*	0.16	0.46	0.30	0.12	-0.57*
		Grip strength	-0.31	0.55*	0.45	0.71**	0.69**	0.22	-0.48
	Mid level symptoms[a] (MS)	**Vo2 peak**	-0.34	-0.16	-0.50	-0.14	-0.20	0.17	0.36
		Grip strength	-0.18	0.06	0.26	0.21	0.29	-0.21	-0.18
	Highest Symptoms[a] (HS)	**Vo2 peak**	-0.19	0.10	0.57*	0.13	-0.01	-0.01	-0.36
		Grip strength	0.31	0.29	-0.03	0.47	0.02	-0.03	-0.09

*p<0.05 ** p<0.01 *** p<0.001

a: a: grouped into tertiles according to self reported BrCa Symptom Scores at baseline (lowest tertile = lowest symptom level, middle tertile = mid level symptoms, highest tertile = highest symptom level)

5.132 Hypothesis 2 results - VO_2 peak and grip strength as predictors

Within the first multiple regression model (see model 1), evaluating the relationship between VO_2 peak, depression scores, and breast cancer symptoms at baseline, depression scores (β = - 0.78; p = 0.001) and BCa symptom levels for individuals in the highest symptoms (β = - 0.28; p = 0.007) each significantly predicted quality of life at baseline. However, VO_2 peak failed to attain statistical significance as a predictor of quality of life at baseline (β = - 0.11; p = 0.70). Within a second regression model (see model 2), seeking to evaluate the relationship

between grip strength, depression scores, and breast cancer symptoms at baseline, depression scores (β = - 0.74; p = 0.001) and grip strength (β = 0.17; p = 0.01) were each significant predictors of quality of life at baseline. BrCa symptoms levels for individuals in the highest symptoms (β = - 0.27; p = 0.05) were marginally significant.

Table 4. Grip strength and VO_2 Peak as predictors of quality of life at baseline

	Variables		**b(SE)**	**β**	**p**	**Adj. R2**
Model 1						0.81
	Age		- 0.12 (0.17)	- 0.56	0.47	
	Leisure time Physical Activity		0.04 (0.07)	0.05	0.53	
	CESD		- 2.38 (0.27)	- 0.78	0.001**	
	BCa Symptoms	Mid level symptoms	- 0.54 (3.08)	- 0.14	0.08	
		Highest symptoms	- 10.92 (3.77)	- 0.28	0.007**	
	Vo_2 peak		- 0.11 (0.29)	- 0.03	0.70	
Model 2						0.84
	Age		- 0.03 (0.15)	-0.01	0.83	
	Leisure time Physical Activity		0.01 (0.06)	0.02	0.78	
	CESD		- 2.26 (0.25)	-0.74	0.001**	
	BCa Symptoms	Mid level symptoms	- 5.35 (2.82)	-0.14	0.06	
		Highest symptoms	- 10.46 (3.45)	-0.27	0.05	
	Grip strength		0.31(0.12)	0.17	0.01*	

*p<0.05 ** p<0.01 *** p<0.001

5.2 Evaluation of changes in Vo2 peak, Grip strength, and Quality of Life levels from Baseline to 3 month Post-Intervention

5.21 Participant characteristics: Intervention versus control group

First, in relation to differences in demographic, physical and psychological characteristics at baseline between intervention and control group, according to independent sample t-tests, no

differences were observed between groups in any participant characteristics with the exception of depression, where a greater number of individuals in the intervention group reported depression as a co-morbid condition (p=0.02) (Table 5). Similarly, potential differences in demographic, physical and psychological characteristics at baseline were also explored in relation to the amount of attendance in group exercise classes (i.e. <50 % attendance versus > 50 % attendance regardless of group allocation) using independent samples t-tests. Similar to above, this evaluation indicated again no statistically significant differences between participants with greater than 50 percent attendance and participants with less than 50 percent attendance in group exercise classes on all physical and psychological variables at baseline.

Table 5. Baseline demographic and clinical characteristics of the intervention and comparison groups; values are presented as count (percentage); P values refer to between group differences.

Variable	Intervention (N= 23)	Control (N= 18)	P
Age (years)	56.1(8.0)	58.4(8.9)	0.40
Country of Origin			
Canada	14(60.9)	10(55.6)	0.73
Other	9(39.1)	8(44.4)	
Education			
Some high school	4(17.4)	1(5.6)	0.26
Some college or university	11(47.8)	13(72.2)	
Some post-graduate	8(34.8)	4(22.2)	
Employment Status			
Full-time	11(47.8)	5(27.8)	0.23
Part-time	3(13.0)	5(27.8)	
Homemaker	2(8.7)	0(0)	
Unemployed	2(8.7)	3(16.7)	
Retired	3(13)	5(27.8)	
Other	2(8.7)	0(0.0)	
Marital Status			
Married or common law	14(60.9)	10(55.6)	0.71
Divorced or separated	2(8.7)	3(16.7)	
Single or never married	6(26.1)	5(27.8)	

Widowed	1(2.4)	0(0)	
Physical Health Comorbidities			
Cardiovascular Disease	8(34.8)	6(33.3)	0.92
Cerebrovascular Disease	0(0)	1(5.6)	0.25
Metabolic Disease	2(8.7)	3(16.7)	0.44
Musculoskeletal Conditions	9(39.1)	13(72.2)	0.09
Respiratory Disease	4(17.4)	4(22.2)	0.52
Mental Health Comorbidities			
Depression (self reported)	6(26.1)	0(0)	0.02
Medications			
Blood Pressure Medications	6(26.1)	5(27.8)	0.90
Cholesterol Medications	1(4.3)	0(0)	0.37
Tamoxifen or Letrozole	5(21.7)	6(33.3)	0.41

5.22 Changes in VO_2 peak, grip strength, and quality of life scores from baseline to 12 weeks (3 months)

5.221 Hypothesis 3 results - iMOVE vs. control

Separate one-way analyses of covariance (ANCOVA) were conducted to evaluate potential differences between groups (i.e. intervention versus control) in VO_2 Peak, Grip Strength and Quality of Life Scores at 3 month post- intervention, adjusted for age, breast cancer symptom levels and baseline levels of the respective outcome variables (e.g. VO_2 Peak, Grip Strength and Quality of Life Scores) as covariates. Overall, there were no statistically significant differences between groups at 3 month post-intervention in VO_2 peak (mean difference = -0.3ml/min/kg, p = 0.60) and grip strength (mean difference = 2.2kg, p =0.25), although over the course of the intervention, grip strength improved slightly in the intervention group and decreased in the control group (Figure 3). Similarly, although the pattern of quality of life results indicated increases in FACT-B scores in the intervention group at 12 weeks, scores at 3 month

follow-up in the intervention group were not significantly different when compared to the control group (p= 0.30) (mean difference = 3.6 points, p = 0.30) (Table 6 and Figure 1). Except baseline levels of the covariate attaining statistical significance, none of the other covariates reached statistical significance within the ANCOVA models.

Table 6. Body composition, fitness and psychological characteristics before and after intervention (at 12 weeks); Values are presented as mean (standard deviations)

Variables	**Intervention Group (N= 23)**		**Control Group (N= 18)**		**Difference between groups (Adjusted)[a]**	**Between group P value**
	Baseline	**Post-treatment**	**Baseline**	**Post-treatment**		
Physical						
BMI (kg/m^2)	28.8 (7.0)	28.6(6.9)	28.4(5.5)	28.4(5.3)	-0.2	0.42
WC (cm)	92.1(16.7)	90.0 (15.7)	91.7(14.5)	91.7(14.1)	-1.8	0.06
Grip Strength (kg)	44.0(9.5)	44.8(10.6)	41.4(10.9)	40.4(10.5)	2.2	0.25
Vo_2 peak (ml/min/kg)	20.7(4.9)	20.5(4.0)	21.1(5.0)	20.9(4.6)	-0.3	0.60
Psychological						
FACT- PWB	22.7(5.3)	23.0(3.9)	22.9(3.4)	23.2(4.5)	0.1	0.99
FACT- SFWB	22.6(4.3)	21.7(5.7)	20.4(6.3)	19.4(5.8)	0.7	0.55
FACT- EWB	18.4(5.2)	19.2(4.4)	18.0(4.0)	18.3(4.4)	0.9	0.26
FACT- FWB	20.3(5.7)	20.5(5.3)	20.9(5.6)	19.0(4.8)	1.8	0.10
FACT- Additional concerns	22.0(6.6)	23.6(5.7)	21.1(4.7)	22.4(4.2)	0.9	0.43
FACT- B	106.1(20.3)	108.0(20.8)	103.4(16.5)	102.4(19.0)	3.6	0.30
FACIT-F	37.3(11.3)	39.0(10.0)	35.7(9.6)	36.4(9.6)	1.3	0.51
CESD	7.3(6.3)	7.8(5.1)	8.7(5.8)	8.5(6.0)	0.1	0.91

[a] Differences between groups adjusted for age, breast cancer symptoms and baseline levels of the respective covariate.

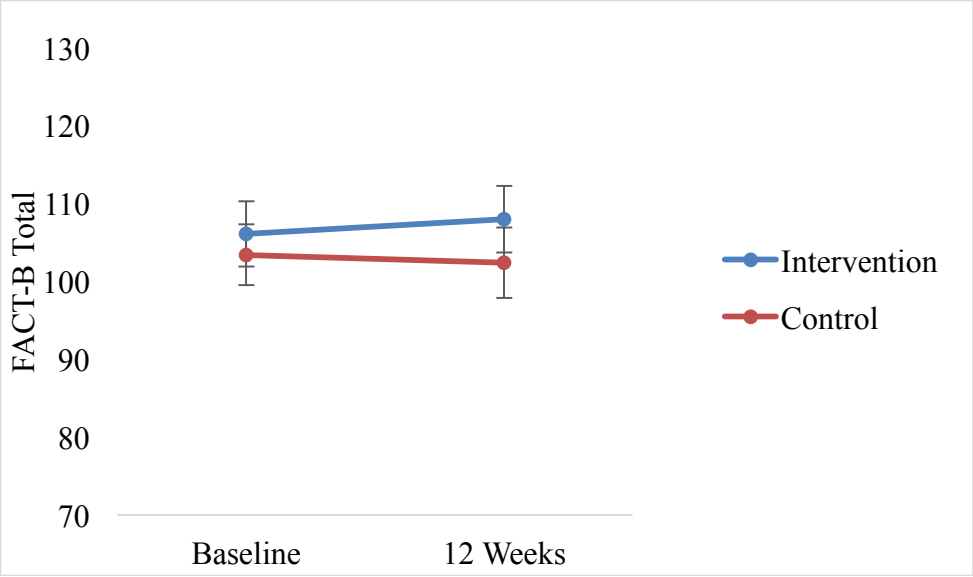

Figure 1. FACT-B total scores at baseline and 12 Weeks in intervention and control groups
*error bars represent standard error of the mean

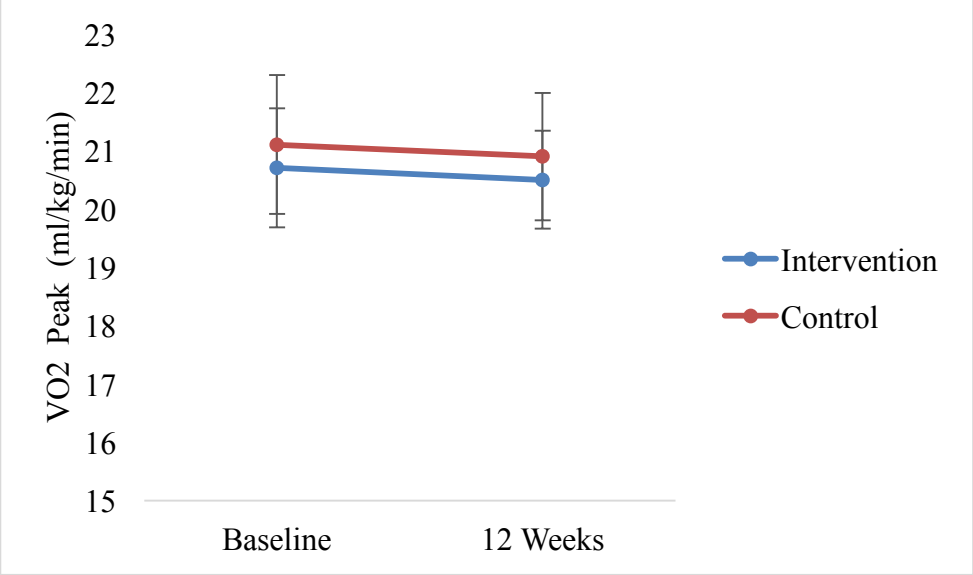

Figure 2. VO_2 peak at baseline and 12 weeks in intervention and control groups
*error bars represent standard error of the mean

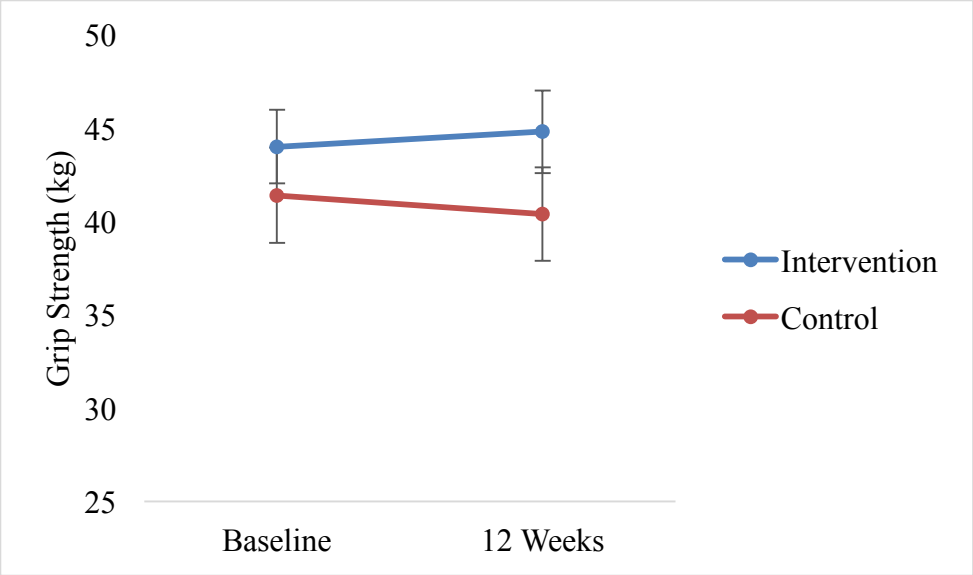

Figure 3. Grip strength at baseline and 12 Weeks in intervention and control groups
*error bars represent standard error of the mean

5.222 Hypothesis 4 results - >50% attendance vs. <50% attendance

Similar to analyses in the preceding section (i.e. 5.221), separate one-way analyses of covariance (ANCOVA) were conducted to evaluate potential differences between participants who attended greater than 50 percent of weekly exercise sessions versus participants who attended less than 50 percent of these sessions. Scores at 3 month post- intervention were compared between these groups in VO_2 Peak, Grip Strength and Quality of Life Scores, adjusted for age, breast cancer symptom levels and baseline levels of the respective outcome variables (e.g. VO_2 Peak, Grip Strength and Quality of Life Scores) as covariates. Table 7 depicts mean scores in physical and psychological characteristics in participants when they were stratified by their attendance to the weekly group exercise classes (i.e. <50 % versus > 50 % attendance regardless of group allocation). In contrast to results in the preceding section, there were statistically significant differences in between groups in VO_2 Peak at 3 months (mean difference

=1.4ml/kg/min, p=0.01; ηp^2 = 0.16), FACT-B emotional wellbeing subscale (mean difference =2.0 points, p= 0.01; ηp^2 = 0.15), FACT-B total score (mean difference = 7.7 points, p = 0.03; ηp^2 = 0.12), and FACT-F scores (mean difference = 5.7 points, p= 0.005; ηp^2 = 0.13). In contrast, differences in grip strength between groups did not reach significance (mean difference = 1.8kg, p =0.40). Among covariates, all baseline levels of respective covariates reached statistical significance, while age and breast cancer scores did not reach statistical significance.

Table 7. Body composition, fitness and psychological characteristics before and after intervention (at 12 weeks) when participants are stratified by exercise class attendance; Values are presented as mean (standard deviations)

Variables	**Greater than 50% attendance (N= 28)**		**Less than 50% attendance (N= 13)**		**Difference between groups (Adjusted)[a]**	**Between group P value**
	Baseline	**Post-treatment**	**Baseline**	**Post-treatment**		
Physical						
BMI (kg/m^2)	28.3(6.0)	28.2(5.7)	29.3(7.2)	29.2(7.4)	-0.4	0.88
WC (cm)	90.7(14.7)	89.7(14.5)	94.6(17.6)	93.0(15.9)	0.3	0.73
Grip Strength (kg)	43.9(10.7)	44.2(10.9)	40.7(8.5)	39.8(9.9)	1.8	0.40
Vo_2 peak (ml/min/kg)	21.3(5.1)	21.5(4.5)	20.0(4.4)	19.0(3.1)	1.4	0.01
Psychological						
FACT- PWB	23.5(3.0)	23.6(3.5)	21.3(6.7)	21.9(5.1)	0.1	0.84
FACT- SFWB	21.9(5.2)	21.5(5.6)	21.0(5.6)	18.9(6.0)	1.9	0.13
FACT- EWB	18.5(4.5)	19.6(3.4)	17.8(5.1)	17.1(5.7)	2.0	0.01
FACT- FWB	20.8(5.6)	20.7(5.0)	20.0(5.9)	18.0(4.8)	2.3	0.06
FACT- Additional concerns	22.0(5.4)	24.0(4.4)	20.7(6.7)	21.0(6.2)	2.3	0.06
FACT- B	106.8(16.1)	109.5(17.4)	100.9(23.1)	97.0(23.0)	7.7	0.03
FACT-F	36.7(8.6)	39.7(8.5)	36.3(14.0)	34.0(11.6)	5.7	0.005
CESD	7.3(5.6)	7.1(4.7)	9.1(7.0)	10.1(6.5)	-1.8	0.16

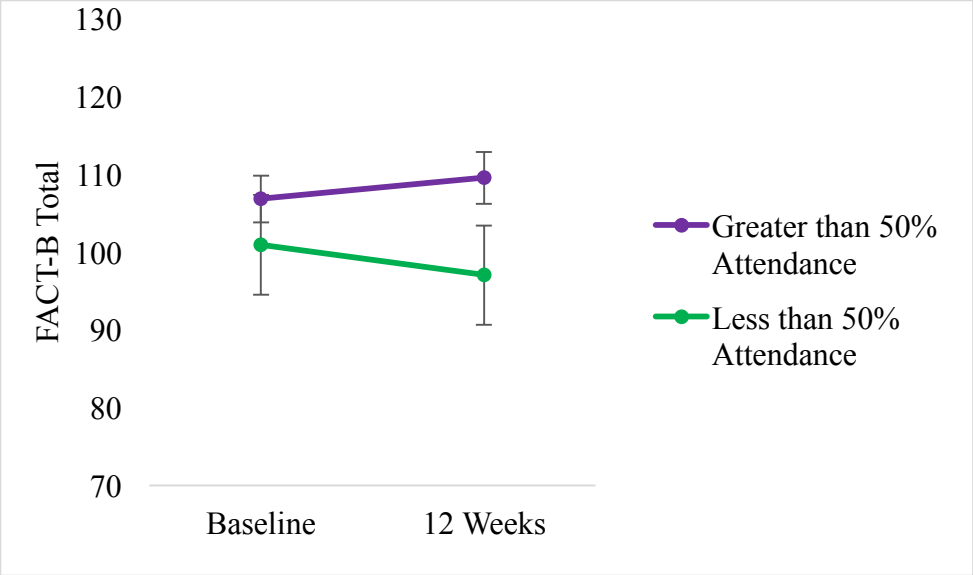

Figure 4. FACT-B scores of participants who attended less than 50% and more than 50% of exercise classes at baseline and 12 weeks
*error bars represent standard error of the mean

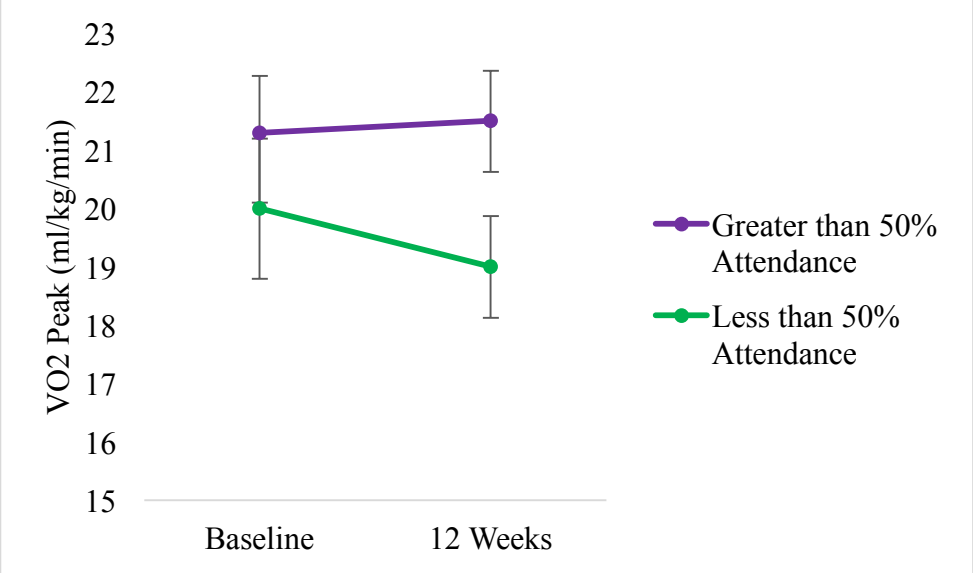

Figure 5. VO_2 Peak of participants who attended less than 50% and more than 50% of exercise classes at baseline and 12 weeks
*error bars represent standard error of the mean

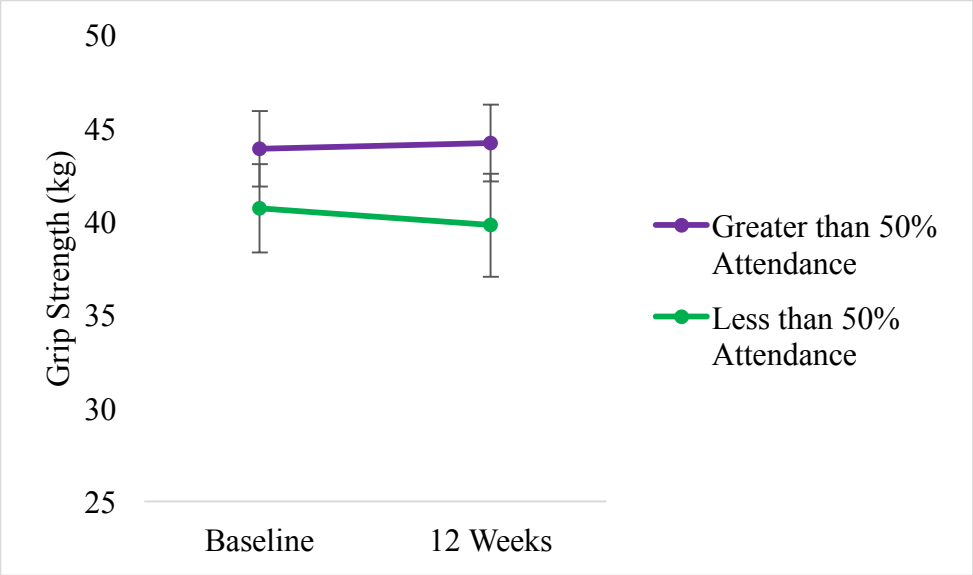

Figure 6. Grip strength of participants who attended less than 50% and more than 50% of exercise classes at baseline and 12 weeks
*error bars represent standard error of the mean

5.24 Hypothesis 5 results - Correlations between changes in VO_2 peak, grip strength and QOL

In addition, to evaluate the extent of association between changes in VO_2 peak, grip strength, and quality of life scores (FACT-B), we assessed correlations between change scores from baseline in VO_2 peak, grip strength, and quality of life scores (FACT-B). Overall, there were no statistically significant correlations between changes in VO_2 peak and FACT-B scores ($r = 0.07$, $p = 0.62$) and total grip strength and FACT-B scores ($r = 0.25$, $p = 0.11$). These correlations also showed similar patterns when participants were stratified by group class attendance (i.e. <50 % versus > 50 % attendance regardless of group allocation) with no statistically significant correlations between changes in VO_2 peak and FACT-B scores (<50 % attendance: $r = -0.42$, $p = 0.15$; > 50 % attendance: $r = 0.30$, $p = 0.11$) and total grip strength and FACT-B scores (<50 % attendance: $r = 0.29$, $p = 0.33$; > 50 % attendance: $r = 0.16$, $p = 0.40$).

6.0 Discussion

While it is an important goal to improve the physical fitness of breast cancer survivors (BrCaS) to decrease the risk of recurrence (Ballard et al. 2012; Lahart et al. 2015), it has been broadly assumed that improved fitness is also a major contributing factor to improvements in health-related quality of life (Courneya & Friedenreich, 1999; Cramp et al. 2010; Bicego et al. 2009). This thesis was aimed at testing that assumption, utilizing data from a RCT that assessed different methods of promoting exercise to BrCaS. While the analyses undertaken focused on baseline and 3 month measurements, in a study where the primary outcomes were assessed after 6 months of intervention, our results arguably address critical periods in intervention response.

For the most part, our findings suggest that associations between quality of life and physical fitness in the intervention periods addressed, as defined by peak VO_2 and grip strength measures, may not be as consistent or robust as previously believed. First, our baseline measures indicate that in sedentary Breast Cancer Survivors (BrCaS) (albeit survivors interested in attending a physical training program), stronger associations were found between grip strength and quality of life than between peak VO_2 and quality of life. Furthermore, we did *not* find a significant positive correlation between quality of life and VO_2 peak and grip strength in the baseline indices of the entire RCT participant group. Accordingly, the participants were divided into tertiles on the basis of their levels of self reported breast cancer-related symptoms with the rationale that participants whose symptoms were more severe would be least likely to experience associations between fitness and quality of life.

Our first hypothesis was confirmed in the observations of significant positive correlations between the physical well being subscale and VO_2 peak ($r=0.59$, $p<0.05$) and the physical well being subscale and grip strength ($r=0.55$, $p<0.05$) in the lowest symptoms group only, i.e those

patients reporting the most mild symptoms. Further correlations were observed between the emotional well being subscale ($r = 0.71$, $p < 0.01$), and the functional well being subscale ($r = 0.69$, $p < 0.01$) with grip strength (but not VO_2 peak) in the lowest symptoms group. Such results suggest that both peak VO_2 and grip strength are related to physical well being, but that grip strength may be a more important variable when looking at emotional status as well as functional abilities in this population. Additionally, when modeling the relationship to look at predictive ability, grip strength was found to be a significant predictor of quality of life ($\beta = 0.27$; $p = 0.01$) while VO_2 peak was not ($\beta = 0.03$; $p = 0.70$) which disputed our second hypothesis that both fitness measures would be strong predictors. While these findings may seem surprising, given the priorities assigned to aerobic fitness, they logically follow the perspective that inactive women may purposely minimize experiences where aerobic fitness (or fitness deficiencies) are acutely experienced. For example, if a woman mostly takes elevators, she rarely experiences the aerobic challenge of climbing stairs. In contrast, grip strength is central to most tasks. Whether opening a jar, carrying a package, or moving objects, generally, from place to place, a deficiency of grip strength is more noticeable. This finding is relevant to future programming as grip strength may indeed be an important outcome for physical training by itself (in contrast to functioning as a proxy measure). Furthermore, when people are motivated to exercise, it may be that grip strength training will have a more practical impact on daily living than general physical training. Therefore, it may serve as a metaphor of the benefits of exercise training, as it provides a directly observable result of effective training. It is possible that promoting exercise through appealing to sedentary individuals via the metaphor of grip strength may be more effective than previously considered. In other words, the phrase 'get a grip' may be frequently used in our culture because it reflects daily experiences of strength or weakness that register on people

significantly, perhaps even more significantly than aerobic fitness. As such, it may be an appealing approach for promoting exercise in ways that feature practical, observable impact.

Alternatively, only VO_2 peak had a significant negative correlation with depression scores (CESD) in only the lowest symptoms group (again) ($r = -0.57$, $p < 0.05$), suggesting that aerobic fitness could have a protective effect on depression, although findings on this phenomenon have been mixed with the majority of studies on various populations (college students, cardiac rehabilitation patients, breast cancer survivors) finding no relationship between depression and cardiorespiratory fitness (Carmack et al. 1999; Swardfager et al. 2008; Saarto et al. 2012; Taylor, 2012). The use of tertiles in this study is important as the majority of correlations were only observed in the lowest symptom (tertile) group even though the groups did not differ from one another at baseline. Additionally, being in the highest tertile of self-reported breast cancer symptoms ($\beta = -0.28$; $p = 0.007$), and depression (CESD) scores ($\beta = -0.78$; $p = 0.001$) were significant predictors of QOL at baseline in model 1, highlighting other potential areas to target in terms of QOL improvement in this population. In model 2 depression ($\beta = -0.74$; $p = 0.001$) was a significant predictor or QOL at baseline while being in the highest tertile of self-reported breast cancer symptoms ($\beta = -0.27$; $p = 0.05$) was reaching significance. In exception to this trend, in only the highest symptoms group was VO_2 peak found to be significantly correlated with social family well being ($r = 0.57$, $p < 0.05$).

Our second finding of potential practical importance in BrCaS exercise training, is that even after 3 months of training, *the majority of* subjects did *not* experience significant QOL or fitness improvements. These results are surprising as it is widely accepted that exercise leads to significant increases in fitness, health-related quality of life, and mental health in women affected by breast cancer (Battaglini et al. 2014; Bicego et al. 2009; McNeely et al. 2006; Speck

et al.). Additionally, contrasting our third hypothesis, the intervention group did *not* differ significantly from the control group at 12 weeks post intervention which could arise from the similarity of the two groups with regard to the exercise program (both groups received the same exercise program while one group received and additional smartphone-based program). However, this evaluation is part of an ongoing RCT and does not represent final outcomes. Furthermore, as a majority of the program was home based it is difficult to determine to what extent participants adhered to their home-based program, as we only assessed their adherence to the on-site exercise classes.

Given the above findings, participants were again split but this time according to their group exercise class attendance (as a proxy measure of adherence) and then assessed for exercise intervention effects (Hypothesis 4). Despite the lack of an overall effect for the intervention, when stratified by level of adherence (attendance) to the group exercise class (less than 50%, more than 50%), we saw statistically significant differences between groups in VO_2 peak and quality of life but not in grip strength, which may be related to the use of resistance band exercises and the absence of an intensive resistance exercise program. This effect persisted after adjusting for age, breast cancer symptoms, and baseline levels of VO_2 peak, grip strength, and quality of life as covariates. Given the difficulties of adhering to exercise (Dishman, Sallis, & Orenstein, 1985), and adopting moderate to high physical activity levels over the long term (Marcus et al. 2000; White et al. 2005), such results stress the importance of emphasizing adherence, as even the approximate measure used appeared to be significantly associated with outcome improvements.

When evaluating the correlations *between* improved fitness measures and quality of life, in contrast to our fifth hypothesis, there was a notable lack of significant associations. Overall,

there were no statistically significant correlations between changes in VO_2 peak and FACT-B scores (r =0.07, p= 0.62) and total grip strength and FACT-B scores (r =0.25, p= 0.11). Similarly, Herrero et al. (2006), Buffart et al. (2013), Travier et al. (2015), Leyesnson et al. (2016), and Koukouvou et al. (2004) did not find significant relationships between peak VO_2 and quality of life (in cancer survivors, breast cancer survivors, COPD patients, and chronic heart failure patients) although two other investigative groups did find such associations (Courneya et al., 2003; Hebestreit et al. 2014). Comparatively little research has been done regarding grip strength, but lower grip strength has been found in two studies to correlate with lower quality of life (Harman et al. 2015; Sayer et al. 2006). A similar lack of significant associative patterns were found when participants were stratified by group class attendance (i.e. <50 % versus > 50 % attendance across intervention and control groups) as there were no statistically significant correlations between changes in Vo2 peak and FACT-B scores (<50 % attendance: r =-0.42, p= 0.15; > 50 % attendance: r =0.30, p= 0.11) and between total grip strength and FACT-B scores (<50 % attendance: r =0.29, p= 0.33; > 50 % attendance: r =0.16, p= 0.40).

Such findings are interesting as it appears there is some additional factor about the group class other than fitness improvements that is leading to quality of life enhancements in this population. Possible explanations include short term exercise effects that are not reflected in either peak VO_2 or grip strength (e.g. the endorphin and monoamine hypotheses), cognitive dissonance, increasing mastery achievements, self-efficacy, positive feedback, and positive social interactions (Paluska & Schwenk, 2000; Taylor et al. 1985; Arent et al. 2000; Peluso & Andrade, 2005; Deslandes et al. 2009). In this population, especially, the group dynamic could have contributed to quality of life improvements as there are unique aspects of treatment (i.e loss of hair, weight gain) that commonly lead to body image issues (Fobair et al. 2006; Helms et al.

2008; Pelusi, 2006) that could deter participants from exercising in other environments and lead to mutual (supportive) identification. Another ready explanation for this finding is that those subjects who are more exercise-adherent have invested more significant cognitive and emotional resources into beliefs that exercise activity will improve quality of life. According to cognitive dissonance theory and the closely related self attribution theory therefore, the more the personal investment in a defined activity, the stronger the beliefs re: that activity furthering related goals. In this day and age when exercise related physical and psychological benefits are commonly circulated and promoted beliefs, we must recognize that actual quality of life benefits may be cognitively mediated. In other words, believing it's going to help results in experiences and self-reports that these benefits are being experienced. However, it should be noted that VO_2 peak (r= 0.30) had a stronger change relationship with quality of life than grip strength (r = 0.16) even if neither relationship reached statistical significance. Logically this makes sense, as the more fit an individual becomes, the more important aerobic fitness will become in everyday activities and in the choosing of such activities. However the change correlations found in this study were lower than reported by others with Courneya et al. (2003) finding a correlation of r = 0.45 between VO_2 peak and quality of life, and Cantarero-Villanuev et al. (2012) finding a correlation of r = 0.36 between grip strength and profile of mood states.

Particularly because the study is still ongoing, there are several limitations to note. We did not have an adherence measure for participants in the home based portion of the program which could have affected our results. In addition, the control group is similar to the intervention group with a similar exercise program being administered to both groups making it possibly difficult to see differences between the groups. As the study is ongoing, our sample size is limited to detect relationships, although the analyses will be rerun once all participants finish the

trial. No measures of group cohesion, and no measures of motivation or cognitive dissonance are included which limits our ability to explain the relationships found. Additionally, participants were not blinded to their group allocation leading to bias as participants may not have fully invested into the study if they felt they were not receiving the full intervention. Furthermore, it is difficult to determine whether attendance is the factor leading to differences between groups, or some other factor related to those who attended that is driving the differences found. Lastly, the relationships found in the study are correlational not causal and therefore conclusions should be made with caution.

Nonetheless, this study is still currently informative as it shows that individuals who adhered to the group exercise class significantly differed in VO_2 peak and quality of life from those who did not adhere. Furthermore, it gives us insight into the importance of grip strength as a predictor of quality of life at baseline, and the importance of breast cancer symptoms in quality of life status. Future studies could tailor exercise interventions around the amount of symptomatology experienced and focus particular attention on ways to support participant adherence.

7.0 Conclusion

When investigating predictive and/or correlational relationships between VO_2 peak and/or grip strength and QOL in BrCa survivors, significant positive correlations were observed between physical well being and VO_2 peak and grip strength in only individuals with the lowest level of reported BrCa symptoms at baseline. Significant positive correlations were also observed between emotional well being and functional well with grip strength (but not VO_2 peak) in the lowest symptoms group. BrCa symptom levels for individuals with the highest symptoms and grip strength were each significant predictors of QOL at baseline while VO_2 peak

was not. Although overall intervention effects were not observed, participants who adhered to the group exercise class (>50% attendance) had significantly higher VO_2 peak and QOL at 12-weeks post intervention than those who did not adhere (<50% attendance). These results highlight the importance of symptomology and grip strength in predicting QOL status of BrCa survivors at baseline, and stress the importance of adherence.

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9.0 Appendices

9.1 Appendix 1 – Recruitment Poster

UHN Princess Margaret Cancer Centre

Funded by
The Canadian Breast Cancer Foundation

Are you a Breast Cancer survivor who wants to become more active?

Have you completed your treatment for **Breast Cancer?**
Are you currently inactive and are looking to **get more active?**
Are you comfortable with using a **SmartPhone?** (Ex. Android, iPhone)

If so, you might be eligible for the **iMOVE** research study that looks at helping inactive Breast Cancer survivors become more active.

You will have the opportunity to work with health professionals who
are not part of your medical team to help you become and stay more active.

WHAT'S INVOLVED?

All Participants will be asked to

- Attend a weekly (1 hour) exercise session for 12 weeks
- Participate in exercise testing 3 times (1 hour each time) over the 9 month study period
- Commit to taking part in physical activity(walking) 3-5 other times per week

Some participants will be asked to:

- Complete 7, 30–min phone call sessions with a Health Coach
- Use a Smart Phone (ex. Blackberry, android, iPhone) application to track physical activity (phones may be provided for use for this study only)
- Wear an activity tracker for the duration of the program (9 months)
- Participate in interviews after the completion of this study

To participate, or to learn more about this study please call:

Dr. Maya Obadia 416.581.8460

9.2 Appendix 2 – Consent Form

UHN Toronto General Toronto Western Princess Margaret Toronto Rehab

iMOVE

CONSENT FORM TO PARTICIPATE IN A RESEARCH STUDY

Study Title:	Pilot study to evaluate the feasibility of an innovative smartphone enabled health coaching intervention (iMOVE) to promote long-term maintenance of physical activity behavior in breast cancer survivors.
Principal Investigator:	Dr. Jennifer Jones Director of Research, Cancer Survivorship Program 416-581-8603

Introduction

You are being asked to take part in a research study. Before agreeing to participate in this study, please read the following explanation about the study purpose as well as the risks and benefits associate with this study in order to make an informed decision. Please take your as much time as you need to make your decision and feel free to talk about this study with anyone you wish. Make sure that all of your questions have been answered. You should ask study staff to explain anything that you do not understand. Participation in this study is voluntary.

Background

Studies have shown that increasing physical activity has significant effects of disease prevention. Even though physical activity appears to play an important role in disease control and the promotion of long-term health and well-being of cancer survivors, the large majority of Canadian breast cancer survivors are not physically active. To date, research has primarily focused on the specific components of exercise that would result in clinical benefits for cancer survivors and much less attention has been place in measuring long-term maintenance of physical activity after the completion of structured exercise programs thus limiting their translation into practice. This study was developed with an innovative health counselling intervention which uses mobile technology (iMOVE) to promote long-term exercise behaviour change. This innovative pilot study will be the first step in the evaluation of iMOVE and the results will be use to inform the design and implementation of a larger pragmatic RCT.

Purpose

You have been asked to take part in this randomized study because you are a patient at Princess Margaret Hospital (PMH) who has recently completed treatment for breast cancer.

This study is being conducted to see if an exercise-based intervention supported by telephone and mobile (Smartphone) health coaching (iMOVE) will help to support women with early stage breast cancer to develop and sustain a regular exercise regimen.

Procedure

You will be asked to complete three separate assessments (at the start of the study, at the end of the exercise program, and 6 months after the end of exercise program) over the course of this study. These will take place at ELLICSR at Toronto General Hospital and will take approximately 90 minutes. At these assessments you will be asked to 1) complete a brief questionnaires package assessing your physical activity, quality of life, mood and physical symptoms, and 2) take part in a series of fitness tests which will be supervised by a physician and conducted by a certified exercise physiologist. These tests involve measuring your height, weight, grip strength, and a treadmill test during which a mask will be placed over your mouth. You will have an opportunity to rest and eat/drink between each of these components.
Following the baseline assessment and your registration with the study you will be 'randomized' into one of the study groups (exercise program alone or the exercise program plus health coaching) described below. Randomization means that you are put into a group by chance. It is like flipping a coin. You will have an equal chance of being placed in either group. Following this, you will begin a 12 week exercise program of moderate intensity which will be supervised by a certified exercise physiologist. This program will consist of weekly, 1 hour group sessions with the exercise physiologist as well as individualized prescriptions for at home exercises. Participants will be asked to keep a weekly log to review at each face-to-face meeting with the exercise physiologist.

Participants who are put into the health coaching group (randomization) will also be provided with a 30 minute, one-on-one telephone-based health counselling at 8 time points (week 1, 2, 3, 4, 5, 6, 8, 12,) during the course of the exercise program. These sessions will be audio-recorded. The participants who receive the telephone based sessions will also receive supporting software on their existing Smartphone devices with data plans. At the end of the exercise program 2 additional telephone health counseling booster sessions will be offered (end of month 2 and 4). Participants who are put into the health coaching intervention group will also be provided with access to the mobile phone app: the HealthCoach and be asked to wear a wrist band that collects information about how many steps you take called the Fitbit. A data plan is required for this study and no reimbursement for the data plan will be provided. In order to enhance the confidentiality of the use of this app we highly suggest that you password protect your smartphone. In the event of a medical emergency, please visit the closest emergency department. Conversation with the Health Coach over the phone or through the app should not replace seeing urgent medical care.

The app (application) used in the iMOVE intervention is called the HealthCoach and uses the platform (online version) called Connected Wellness. When using both of

these parts of the technology you will create a password that is known only to you. The password should be one that is easy for you to remember but not so easy for others to figure out. Using capitals and lower case letters as well as numbers make it more secure. However, regardless of how secure your password is, the password its-self is a weak link. This means that there is a minimal risk that your password may be figured out.

At the end of the study, you MAY also be invited to take part in a post-study telephone interview with a member of the research team. This telephone based post-study assessment will take 45 – 60 minutes and will entail talking about your experience in the study. The purpose is to select equal number of participants who report having increased, decreased or maintained exercise behaviour after the program. In order to prepare for this possibility we will also be asking you to complete another consent form allowing us to interview you over the phone. We anticipate that 24-30 participants will be selected. All telephone conversations will be audio-recorded.

Risks to being in the Study

There are very minimal risks involved in completing the physical assessments, questionnaires, and exercise program. All physical assessments will be conducted by a certified exercise physiologist using standardized protocols and all equipment will be sanitized prior to use. The fitness program employed in this study is within the parameters of recommended exercise frequency, duration, and intensity for breast cancer patients and has been used in previous studies. The certified exercise physiologist will provide you with the appropriate training necessary for exercise techniques, intensity monitoring practice, and safety guidelines for your exercise program. You will also be asked to complete a short questionnaire package. There are minimal risks associated with answering these questions. You may refuse to answer any questions that you do not feel comfortable with.

The app used for the iMove Intervention is called HealthCoach. Healthcoach also has a web based version called Connected Wellness. When using these combined technologies to ensure the safeguard of your data, the strength of the password you chose must be easy for you to remember, yet not something that others can figure out. Using a combination of both lower and upper case letters as well as numbers increases the strength of your password. Ensuring that you create a strong password that others will not be able to guess (example adding capitals or numbers in the middle of your password vs the ends) will reduce the risk of your account being compromised. By creating a more secure password and **not allowing** the app and the website to remember your information you are reducing this risk.

Benefits to being in the Study

This study is designed to introduce an individualized exercise program to increase physical activity levels and motivate the individuals to maintain a healthy activity level. You may or may not receive any medical benefit from your participation in this study, although previous studies have indicated positive outcomes for patients with exercise. Information learned from this study may benefit other patients who are facing similar circumstances to your own.

Participation

Your decision to participate in this study is completely voluntary. You may decide not to be in this study, or to be in the study now, and change your mind later. You may leave the study at any time. Your decision will not affect the current or future care you receive from Princess Margaret Hospital, Toronto General Hospital or the University Health Network.

Confidentiality

All information collected during the study will be held in strict confidence and stored in a secure cabinet in a locked office. The form that will be used to collect your information will not have your name, initials or health card number on it. Only your study ID number will be used, and the list that links your name to your code will be kept locked and secured at all times. Once recordings have been transcribed, the audiotapes will be destroyed. All of your answers will remain confidential. All identifying information will be deleted from the transcripts so that they are anonymous. You will be identified with a study number only. No names or identifying information will be used in any publication or presentations. No information identifying you will be transferred outside this hospital or to anyone besides the investigators in this study. The information collected during this study will be destroyed securely 25 years after the end of the study is complete.

Compensation

There is no compensation for participating in this study.

Compensation Clause for non-industry studies

If you become ill or are physically injured as a result of participation in this study, medical treatment will be provided. The reasonable costs of such treatment will be covered by your health insurance for any injury or illness that is directly a result of participation in this study. In no way does signing this consent form waive your legal rights nor does it relieve the investigators, sponsors, or involved institutions from their legal and professional responsibilities.

Questions about the Study

If you have any general questions about the study, please call Dr. Maya Obadia (Study Coordinator) at 416-581-8640 or maya.obadia@uhnresearch.ca or Dr. Jennifer Jones (Principal Investigator) at 416-581-8603 or jennifer.jones@uhn.on.ca. Please note that email may not be a secure method of communication or correspondence and medical or private information should be communicated through more secure channels.

If you have any questions about your rights as a research participant or have concerns about this study, call the University Health Network Research Ethics Board (REB) or the

Research Ethics office number at 416-581-7849. The REB is a group of people who oversee the ethical conduct of research studies. These people are not part of the study team. Everything that you discuss will be kept confidential.

Consent

This study has been explained to me and any questions I had have been answered. I know that I may leave the study at any time. I agree to take part in this study.

Name of Participant (Print)	Signature of Participant	Date

(You will be given a signed copy of this consent form)

My signature means that I have explained the study to the participant named above. I have answered all questions.

Name of Person Obtaining Consent	Signature	Date

If you choose to consent to participate in this study we will contact you on the phone for your first study visit. In order to do so we ask you to provide us with your contact information. If you agree, kindly enter your information below.

Cell phone number: _____
Work phone number: _____
Best time of day to call: _____
Email address: _____

In the event that we are unable to contact you for your follow-up session, is there someone else we can contact to help reach you? If so, kindly enter their information below.

Contact information for follow-up period

Name of Contact _____
Connection to participant _____
Phone number (home) _____
Phone number (cell) _____
E-mail address _____

9.3 Appendix 3 – Group Class - ½ Aerobic, ½ Resistance

Group Class- ½ Cardio, ½ Resistance

Warm up- 5 min

Marching on the spot – 1 min
Hamstring curls (butt kicks side to side with arms)- 1 min
Speed bag while tapping side to side- 1 min
V step- 1 min
Leg swings – 30 sec each side

Cardio 20 minutes

Light jumping side to side (option marching_) – 1 minute
Standing mountain climbers (option add a hop) – 1 minute
Alternating toe taps – 1 minute
Marching with high knees- 1 minute
Skiing – (option add a hop) – 1 minute
Tap and reach – 1 minute
Jumping jacks – 1 minute (low impact option)
Butt kicks – 1 minute
Pull the rope – 1 minute
Water break – 1 minute
Side shuffle – 1 minute
Paddling- 30 seconds each side
Jump rope (marching as option) – 1 minute
Elbow to knee – 1 minute
Twist and reach – 1 minute
High knee to heel touch – 1 minute
Cross country skier – 1 minute
Front crawl swimming – 1 minute
Dancing – 1 minute
Water break – 1 minute

Resistance 20 minutes 50 sec exercise 10 sec rest- Repeat 2x

Wide leg squat – 50 sec
Chest fly – 50 sec
Standing row
Leg extension Right leg – 50 sec
Leg extension Left leg – 50 sec
Band pull aparts – 50 sec
Chair bicycle – 50 sec
Lateral raise – 50 sec
Bicep curls – 50 sec
Bird dogs- 50 sec

****2 min Rest**

Cool Down- 5 min

Marching- 30 sec

Shoulder circles – 30 sec
Reach for toes alternating – 30 sec
Butt kicks - 30 sec
Pivot and reach- 30 sec

Stretches

Standing Quad Stretch- 30 sec
Toe touch – 30 sec
Chest Stretch- 30 sec
Hamstring Stretch - 30 sec
Back stretch – 30 sec

9.4 Appendix 4 – Group Class – Alternating Aerobic & Resistance for Legs, Chest, & Back

Group Class- Cardio alternating Resistance Legs, Chest, Back

Warm up- 5 min

Marching on the spot – 1 min
Step touch (side to side)- 1 min
Toe taps to the back with arms- 1 min
Grape vine- 1 min
Trunk rotation with arms reaching to the side- 1 min

Cardio/ Resistance- 30-35 min – 50 sec exercise 10 sec rest- Repeat 2x

Squats- 50 sec
Marching with high knees- 50 sec
Chest Press- 50 sec
V-step- 50 sec
Seated row- 50 sec
Pivot a reach- 50 sec
Hamstring Curl- 50 sec (25 sec each side)
Jumping jacks (low impact)- 50 sec
Bent over row- 50 sec
Skipping- 50 sec
Glute Bridge - 50 sec

****2 min Rest**

Cool Down- 5 min

Marching- 30 sec
Hamstring Curl- 30 sec
Grapevine- 30 sec
Heel digs- 30 sec
Pivot and reach- 30 sec

Stretches

Standing Quad Stretch- 30 sec
Standing Calf stretch
Chest Stretch- 30 sec
Back stretch- 30 sec

9.5 Appendix 5 – Group Class – Alternating Aerobic & Resistance for Arms, Shoulders, & Core

Group Class- Cardio alternating Resistance Arms Shoulders Core

Warm up- 5 min

Marching on the spot – 1 min
Step touch (side to side)- 1 min
Toe taps to the back with arms- 1 min
Grape vine- 1 min
Trunk rotation with arms reaching to the side- 1 min

Cardio/ Resistance- 30-35 min – 50 sec exercise 10 sec rest- Repeat 2x

Bicep curl- 50 sec
Marching with high knees- 50 sec
Upright Row- 50 sec
V-step- 50 sec
Triceps Extension- 50 sec
Pivot a reach- 50 sec
Lateral Raise- 50 sec
Jumping jacks (low impact)- 50 sec
Upright Row - 50 sec
Skipping- 50 sec
Dead Bug- 50 sec

****2 min Rest**

Cool Down- 5 min

Marching- 30 sec
Hamstring Curl- 30 sec
Grapevine- 30 sec
Heel digs- 30 sec
Pivot and reach- 30 sec

Stretches

Standing Quad Stretch- 30 sec
Standing Calf stretch
Chest Stretch- 30 sec
Back stretch- 30 sec

9.6 Appendix 6 – Group Class – Circuit

Group Class- Circuit Class

Warm Up- 5 min

March on spot
Side step
V-step
Hamstring curl
Heel digs

Circuit 30-40 min 50 sec, 10 sec transition, 1 min rest station, 2 min rest in between circuit

Stations- resistance

Squats
Lunges
Lateral raise
Front raise
Upright row
Chest press
Push up
Anti -rotational press
Dead Bug
Biceps
Triceps
Shoulder external rotation
Seated/standing row
Glute bridges
Hip Extension
Hip Abduction

Cardio Moves

skipping
marching
high knees
jumping jacks
step ups
skater
jogging on spot
mountain Climbers (standing/on mat)

Cool Down- 5 min

Toe Taps
Pivot and reach
Hamstring curl
Side steps
Marching

Stretches

** Stretches appropriate for the muscles worked that day

9.7 Appendix 7 – Exercise Manual

Home-Based Exercise Program Manual

Why will I exercise?

To feel better and more confident
To have more energy
To reduce stress

For weight control
To increase survival and decrease cancer re-occurrence
Fill in your own reason and motivations:_____
_____
_____
_____

This Manual Belongs to:
_____

Table of Contents

Introduction

Welcome to the ELLICSR Health, Wellness, and Cancer Survivorship Centre. ELLICSR is committed to supporting you throughout your treatment with a comprehensive healthy lifestyle program, including health coaching and a personalized exercise program. The program was initiated in response to the overwhelming scientific evidence indicating numerous physical and psychosocial benefits associated with exercise in patients before, during, and after treatment for cancer. Specifically for women with breast cancer, the benefits of exercise may include: increased physical fitness and energy, decreased body fat, and improved fatigue, quality of life, increased functional capacity and decreased cancer re-occurance. However, to derive these benefits, a physically active lifestyle must be maintained. Health Canada recommends a minimum 30 minutes of moderate physical activity during most days of the week. **This manual has been developed to assist you in maintaining or increasing the amount of physical activity you do on a regular basis and to address some of the side effects associated with any treatment you may have received.**

Many questions regarding exercise and breast cancer remain to be addressed. ELLICSR is dedicated towards advancing research in this area with studies that contribute to the understanding of how exercise affects women with breast cancer. Throughout your participation in the program, your physical fitness test results, exercise logs, and questionnaires will be used for research purposes. The information you provide is valued greatly by us and we will protect your confidentiality and maintain your anonymity in any scientific publications or presentations. **You will always have the opportunity to withdraw from this program and refuse to contribute your test results for research purposes**

Your exercise program is a protocol created by a CSEP-Certified Exercise Physiologist ™ (CEP) and consists of **12 weeks of exercises**. You will also have fitness assessments upon study initiation and after the 12 weeks is complete. Your CEP will guide you through these exercises and assessments and will also instruct you on when and how to perform safe progression. Please inform your CEP if you are having any difficulties with any of the exercises or have any questions regarding your exercise program.

How to Use This Manual

This manual outlines your exercise program, provides the exercise prescription, and gives you space to record your exercise activities. It will also guide you through the successful integration of exercise into your lifestyle. This manual has been developed using several fitness and motivational principles to maximize your enjoyment, adherence, and success.

In order to monitor your progress and modify your program if necessary, we have included an exercise log for you to complete during each exercise session. If you have any questions regarding the exercise log, please discuss with your CEP. Please fill in all the necessary information for each exercise session. The next section of the manual will describe some basic information about exercise that will ensure an effective and safe program.

Acknowledgments

This manual was developed with the assistance of several individuals who have generously contributed their time, effort, talents and other invaluable resources. It is with great gratitude that we acknowledge the contributions of Karla and Tyler Schlombs, Dr. Nicole Culos-Reed, Dr. Shabbir Alibhai, Dr. Paul Ritvo, Dr. Andrew Matthew, Dr. Daniel Santa Mina, Dr. Leslie Stefanyk, and Mr. William Hilton.
The Survivorship Exercise Program is made possible through the generous donations made to the Princess Margaret Foundation.

The Princess Margaret Hospital Foundation

University Health Network

Chapter 1: Exercise and You!

What is exercise and why is it important?

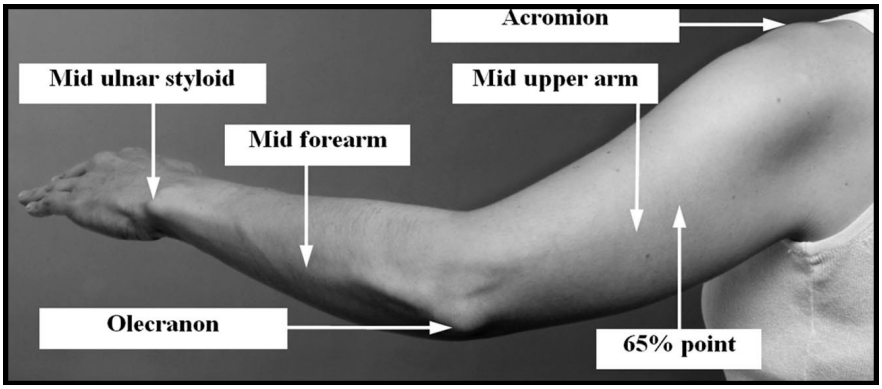
Exercise improves muscular strength, cardiovascular function, psychological wellbeing and functional capacity.

Advancements in the diagnosis and treatment of breast cancer has significantly increased the survival of women with breast cancer. Improved survival of woman with breast cancer has stimulated research now into the management of the physical challenges that warrant rehabilitation. These physical challenges include fatigue, cardiotoxicity, changes in body composition, restricted mobility, and lymphedemia. An exercise program will assist in the restoration or range or motion at your joints, strengthen your muscles, especially those of the back, and help you maintain a healthy body weight and health maintenance

Exercise: The fundamentals

Here is a list of safety guidelines that must be followed:

Train with a Friend: Training with a friend or partner can be useful for motivation, but it is important for there to be someone to provide assistance if an injury occurs.
Train in a well lit area: Always train during the day or in a lighted facility. Most activities are difficult in the dark and darkness raises the risk of fall and injury.
Carry Water: Always carry (or have access to) water or drinks that replenish water lost through perspiration. It is important to drink fluids before, during and after exercise. Try to consume about 1-2 cups of water in the hour before you start exercise.
Inspect equipment before using it: Make sure the equipment used is in good working order (e.g., bands are not torn). If you are securing resistance bands to a fixed object, ensure the object is stationary and will not move. Also, ensure the band is well secured.
Clean up: Put your equipment away after use. Poorly placed equipment can cause someone to trip.
Monitor Lymphademia: Lymphademia refers to swelling as a result of fluid build up, and generally occurs in the upper body or legs. If this is something you have experienced or if you have had lymph nodes removed, it is important to monitor this and decrease activity if needed. Below in the figure are landmarks where the circumference of the arm can be measured before and after exercise in order to track swelling.



Safety guidelines continued

Breath when exercising: Holding your breath during exercise increases blood pressure. To prevent unnecessary and potentially dangerous increases in blood pressure, it's important to breathe rhythmically during training exercises. When engaging in resistance training, breathing out (exhaling) should occur during the 'work' phase of the exercise while breathing in (inhaling) should occur during the 'relaxing' phase of the exercise. Proper breathing follows a simple 4-count pattern: lift -"exhale 1-2", lower- "inhale 1-2". Never hold your breath since this can cause a sudden rise in blood pressure.

Do
Exhale and Inhale Rhythmically
Keep a Neutral Spine
Keep You Joints Slightly Bent

Do Not
Hold your breath
Round the upper back
Lock your joints

Exercise Training Principles: Overload, Progression, and Specificity

Get F.I.T.T

The FITT Principle

It is very important to be educated about the guiding principles or exercise training and exercise types, the next step is to understand how an exercise program is developed and how it can be altered as you progress. The principle often followed is the FITT principle, which stand for *Frequency, Intensity, Time, and Type*. The FITT principle can be used to develop appropriate guidelines for all three types of exercise training: aerobic, resistance, and flexibility.

F Frequency

The frequency of exercise refers to how often one should exercise. It is important to be exercising enough to provide the body proper amounts of healthy physical stress for the body to adapt. It is equally important to allow enough rest time for healing and adaptation to occur.

I Intensity

Intensity is how hard you exercise. In aerobic exercise, it is usually measured by your heart rate response to exercise. For most people, a moderate intensity is recommended, somewhere between 50-70% of the maximum capacity of your body to deliver oxygen. It is sometimes difficult to find what is enough intensity. Fitness testing will determine a heart rate zone that corresponds with this percentage of your peak. capacity (*See "Monitoring Your Intensity" below for instructions about your heart rate monitor and how to*

gauge intensity). In resistance training, the intensity usually refers to a combination of the weight you lift (the resistance, e.g. 10 lbs or using the purple band) and the number of repetitions you can do at one time. The resistance used is often described as a percentage of how much you can maximally lift once, like 60-70% of 1 repetition maximum (RM; the weight you can lift only once or the length of the band at which you can only do one repetition of an exercise). Your exercise physiologist will assist you in determining how to adjust your resistance and instruct you on progression.

T Type

The type of exercise refers to the kind of exercise you choose. For example, brisk walking or jogging will build cardiorespiratory fitness, whereas lifting free weights or using resistance bands will improve muscular strength and endurance.

T Time

Time refers to the amount of time you spend doing your exercises during each session. This program was designed to be completed in approximately one hour.

Types of Training and different Exercise Modes for Improving Physical Fitness

Physical Fitness Component	Training Type	Exercise Mode
Cardiorespiratory Endurance	Aerobic exercise	Walking, jogging, cycling, rowing, stairclimbing, skiing, dance, aerobics, and elliptical activity
Muscular Strength and Muscular Endurance	Resistance exercise	Free weights, exercise bands, exercise machines, and body weight exercises
Bone Strength	Weight bearing aerobic exercises and resistance exercise	Walking, jogging, stairclimbing, dance, step aerobics, free weights, bands, and exercise machines.
Body Compositions	Aerobic exercise and resistance exercise	*All of the above
Flexibility	Stretching	Static stretches, PNF stretches, yoga, tai chi, palates.

(Heyward VH, 2006)

Progress of intensity

As individuals practice various exercises, their bodies adapt. As their cardiovascular profile improves and strength is gained, exercisers will require higher intensity exercises to maintain interest and optimize benefits. Although sedentary people should begin slowly, gradual progression to more intensive exercise is recommended.

Higher intensity can be achieved by:
Integrating faster and larger movements for aerobic exercises
Increasing repetitions or utilizing more resistance
Slowing movements during resistance training

Warm-ups and Cool-downs

Each exercise session should include the following phases:
Warm-up
Conditioning/Training;
Cool-down
Stretching

Warm-Up

The warm-up is an essential component of every exercise session and should consist of 5-10 minutes of low intensity activity. The warm up is designed to increase body temperature and reduce the potential for post-exercise muscle soreness. The warm-up increases blood flow to the working muscles and prepares your muscles and joints for activity. Your warm-up exercise type should correspond to the exercise you plan to condition with. For example, warm-up with a light walk if you plan to exercise with a brisk walk.

Conditioning/Training

Your conditioning/training phase will include your aerobic, resistance, or group exercise sessions. The prescription details are outlined below for each week. You will notice the intensity and duration of these sessions will gradually increase.

Aerobic/cardiovascular Exercise

Your heart and vascular system deliver oxygen and nutrients to working tissues. Aerobic exercise, also known as ‘cardio’, improves stamina and endurance, which is the ability to repeatedly use muscles over long durations, like during running and dancing, and usually refers to moderately intense activity that raises your heart rate to around 70% of your maximum rate. Aerobic exercise is key to maintaining a healthy heart and lungs. Cardio reduces risk of, and helps manage many chronic diseases, such as heart disease and diabetes, and has demonstrated positive effects in cancer patients undergoing treatment. Benefits of this kind of training include greater energy levels during and after activities, decreases in cholesterol, decreases in blood pressure, increases in insulin sensitivity, better sleep, and aids in weight loss. With less endurance, your muscles tire easier, resulting in fatigue and discomfort or pain.

Resistance/strength Training

Resistance training is a popular method of building strong, healthy muscles that are needed to perform many of the activities of daily living. Including a regular resistance training program into any routine is important to maintain strength, balance and helps ensure healthy aging. This manual will provide you with information on how to perform a number of resistance exercises in safe and effective ways, at a number of intensity and functional levels. The benefits of resistance training include increased strength, increased balance, increased insulin sensitivity, and decreased chance of injury from falls.

Cool-Down

Following the conditioning phase is the cool-down. This gradual decrease in activity will reduce the risk of complications caused by stopping an exercise too suddenly. Similar to the warm-up phase, the cool-down consists of a minimum 5-10 minutes of low intensity activity. The purpose of the cool-down is to allow for a gradual recovery of heart rate and blood pressure. Stretching can be incorporated into your warm-up and cool-down phases to maintain and improve flexibility and prevent muscle cramps and muscle soreness.

Flexibility

The stretching phase is distinct from the warm-up and cool-down phase. This involves **20-30 seconds** of static stretching after the cool-down. This should involve major muscle groups that were involved during exercise.

A generalized flexibility routine after aerobic and resistance may include:
Aerobic: quadriceps, hamstrings, hip flexors, and chest
Resistance: quadriceps, hamstrings, hip flexors, back, chest, triceps, and biceps

Your exercise physiologist will instruct you on how to complete your stretching routine.

Chapter 2: Motivation

"Obstacles are those frightful things you see when you take your eyes off your goal."
~*Henry Ford*

You Can Do It!

Unlike Buckley's Cough Syrup's famous slogan ("it tastes awful, but it works!"), exercise doesn't have to be 'awful' for it to 'work'. Exercise *can* be fun, and in the least it should be bearable. However, for it to work, you must do it! Finding the right motivation to make exercise worthwhile to you is as important as the exercise itself. Remember: goals are the reasons you dedicate your time and energy to a specific behavior, in this case – Exercise!
Your dedication and *motivation* come from the goals you set for yourself. Maybe you want to become more independent with your gardening, be able to walk comfortably without fatiguing, or return to your tennis

club. Identifying your goals are the first steps to committing yourself to a positive outcome. Unfortunately, all goals are NOT created equal. Goals that are effective at motivating you towards success are SMART!

SMART Goals are:

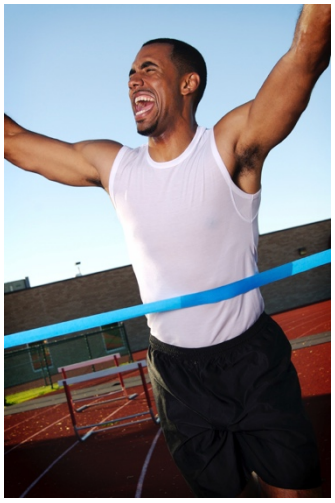
Specific: Do you know exactly what you want to accomplish? Who? What? Where? When? Why? How much?

Measurable: Are you able to assess your progress?

Attainable: Is your goal within your reach given your current situation?

Realistic: Are you are both *willing* and *able* to work towards your goal?

Timely: What is the deadline for completing your goal?



Here's an example of a SMART goal:
"For the next month, I will walk for 30 minutes every other day at a moderate pace (just enough to break a light sweat).
Consider these points when developing your **SMART** goals

Challenge yourself: Make your goals ambitious enough so that you are proud of the accomplishment when you meet your goals.

Focus on the process: look forward to the participation and not simply getting it over with. Goals should embrace the process that work towards the outcome.

Re-evaluate your goals regularly: Goals need to be adjusted when they've been attained. In order to continually improve, you need to continually set higher goals.

Set mini-goals within your bigger goals: Sometimes the most important part about exercising is simply putting on your shoes or picking up the weights. Starting the workout is the hardest part. Set simple goals for exercising such as

leaving the house or starting your warm-up at a particular time. Worry about completing the workout after you've started, not before.

Goal-Setting Worksheet

Use this page to write a few goals down and refer to them occasionally to remind you why you're working so hard. Don't forget to make them **Specific, Measurable, Attainable, Realistic,** and have a **Time** frame for completion.

Goal #1:

_____

Benefits of the Change:

_____

Action Steps:

1. _____
2. _____
3. _____

Goal #2:

_____

Benefits of the Change:

_____

Action Steps:

1. _____
2. _____
3. _____

Goal #3:

_____

Benefits of the Change:

_____

Action Steps:

1. _____

2.

_____

3.

_____

Success Indicators:
Success indicators are things you notice about yourself that demonstrate you are getting closer to achieving your goals. It may be as simple as feeling less tired, dropping a pant size, or being able to open tight pickle jars.

1.

_____

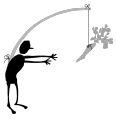
2.

_____

3.

_____

(Adapted from the CPAFLA, CSEP)



Making Your Goals Work For You: The Right Motivation

To be successful in attaining your goals, you must first find the motivation to get started and persist until your goals are reached, even in the face of obstacles. Sometimes the biggest hurdle can be getting out of your chair or bed and putting on your running shoes to go for a walk or to head to the gym.
Here are some tips on how to stay motivated throughout your exercise program:

Do start with small steps. Motivate yourself from the chair, to the shoes, and to the exercise (starting to exercise is the most difficult part!)

Do focus on enjoying the experience—the people, the movements, the environments, and the feelings.

Do reward yourself for a job well done. It may be as simple as occasionally enjoying a decadent dessert or taking a day off to recuperate after several heavy days of exercise.

Do surround yourself with people that are supportive of your exercise program and may be willing to exercise with you.

Do visualize success by creating an image of success in your mind. It can be a powerful tool for getting through the rough times and building motivation, self-confidence, and commitment. Take a quiet moment to close your eyes and see yourself engaged in new, more positive health habits (such as walking and enjoying the weather). Picture yourself reaching your goals and enjoying the rewards of a healthier, more active lifestyle.

Do monitor your progress. When you first start making changes, you may progress rapidly. Although motivating, this also can be misleading and just plain discouraging when the pace levels off. Use the exercise log at the end of this book to chart your progress and identify areas that you excelling in and areas that could use a little more effort.

Don't push yourself too hard. You may rob yourself of the enjoyment that you might normally experience when you are simply being active.

Don't "should" yourself! Instead of saying "I should exercise," say ***"It would be better for me if*** I went for a walk today because I could use some fresh air".

We All Need A Little Help From Our Friends

Even making small, positive changes to your lifestyle can be difficult. You shouldn't have to do it alone. Social support is an important component of successfully adding exercise to your routines. Invite your family, friends, and co-workers to partake in your exercise. Maybe they've been waiting for someone to

exercise with, too! Social support comes in many forms and may be as simple as some encouragement and reinforcement of your attempts to change your habits.

Spouse or Partner Support

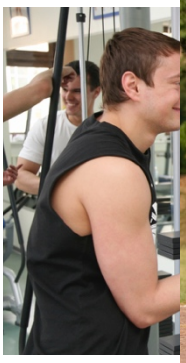
Your spouse or partner is likely to be one of the most significant people in your life. To gain support, try to include them in your change plan, for example, an exercise break.

Children

Look for opportunities to play with children in your family. This opportunity also allows you time to chat with them and get to know more about them.

Friends or Neighbours

Some people find it easier to make exercise changes if they make a commitment to another person. Arrange to take your early morning walk with a neighbour, or meet a friend and walk to lunch.



Role Model for Exercise

We are influenced by those around us, especially by people we admire. Be realistic in choosing a physically active person as a role model - are they similar to you, at an activity level you inspire to reach, or doing an activity you want to try? Use your role model as motivation for staying active!

To Infinity And Beyond!
Integrating Physical Activity Into Your Lifestyle

Exercise shouldn't be a chore. In fact, "exercise" doesn't even have to be "exercise", as long as it elicits the desired physiological response (usually an increase in your heart rate or sufficient stress on your muscles). Physical activity comes in many forms, all of which contribute to better physical fitness and health. Physical activity can include walking to local destinations (including work or the grocery store), gardening, shoveling snow, and taking the stairs. Even modest levels of physical activity have a positive effect on health. Take some time each day to do a little physical activity as a part of your commute, house-work, or social interactions.
Here are a few suggestions on how to integrate physical activity into your lifestyle:

Devise a simple routine. Set aside some time every day to do something active, whether it's a short walk around the office to stretch your legs, or waking up early to do an exercise program. Once exercise is integrated into your routine, it becomes difficult to stop!

Make some simple traveling rules. Take the stairs whenever you need to travel 2 or 3 floors up or down or walk whenever your drive takes less than 10 minutes.

Choose active hobbies. During your leisure time plan to **enjoy** a walk or a bike ride around your neighbourhood or maybe join a sports team or walking club. Make it a family and friend affair! Active living involves integrating the things you find useful, pleasurable, and satisfying with some physical activity. It's a collection of pleasant habits that burn some calories along the way.

Partner Up! Find an exercise buddy. It could be a spouse, sibling, neighbour, child, or pet! Find someone that enjoys (and maybe needs) the exercise just as much as you do. You will motivate each other towards your respective goals.

Turn It Up – music is a great motivator and helps pass the time during exercise. Just put in your favourite music, get up and move (whether it's exercise, dancing, housework, or gardening!)

Running Past the Hurdles: Overcoming Obstacles to Your Exercise Program

Nobody said exercise was easy. Exercising can be challenging, but at the same time, it can be enjoyable. Even professional athletes get tired of training, so it's easy to understand that sometimes you may find it difficult to stick with your exercise program. Especially during the course of cancer treatment, exercise may feel like the last thing you want to do. However, it is often one of the most important things you can do to ensure your speedy and *full* recovery. Remember, the more you do, the more you are able to do. When patients stop moving, they lose their capacity to move, which results in reduced physical, psychological, and social well-being.

Consider the following tips on how to maintain an active lifestyle amidst the days when you just don't feel like it.

Re-define the word exercise:

All movement is considered physical activity - take a dog (yours or your neighbours') for a walk; bike to the store; take five-minute stretch breaks; use the stairs at work… Remember – just because you're not wearing your headband and running shoes doesn't mean you aren't exercising! Routinely do a little more activity than you usually do (we just won't call it 'exercise') and you'll find you're able to do a little more each time.

More is Not Better

Think small steps. "No pain, no gain" is not the way to think of your exercise program. Not every workout has to be grueling. Take a day off if you think your body needs it. Injuring yourself will set you back further than taking one or two days to rest.

Brand New, You!

Sometimes a change of pace is all you need to become re-motivated towards your goals. Choose different activities to get you stimulated for exercise again. A new sport, different exercises, a different walking route, or even a different time of day might be all you need to get re-vitalized!

Use a Distraction

If you're new to exercise, listening to music, watching TV or playing computer games may help you stick with it; but stay aware of sensations that could signal injury or overdoing it. As you become more experienced, start focusing on your breath or concentrating on the movement of your body to help you enjoy exercise more.

Get an Accountability Partner

Find a friend, mentor or coach to keep you honest. You can either exercise *with* your partner, or simply check in with him or her to report your progress.

Plan to Stay Active

Plan to park farther from the office and put your walking shoes in the car the night before. Plan to take that new yoga class next week, and sign up *now.*

Face Your Fitness Foes

Does vacation throw your exercising schedule out of whack? Do projects at work overtake your activity time? Boredom? Fear of success? Fitness foes can be beaten once they've been identified. You can change your vacation style, set work limits, find new challenges, or face your fears with counseling and support.

Chapter 3: Exercise Safety

When completing all of your exercises, it is important to work at an appropriate intensity to prevent injuries and maximize benefits. It is important to gauge your exercise intensity using the Rating of Perceived Exertion (RPE) Scale below. You will notice in your exercise prescription provided to you by the exercise physiologist that there is a target RPE. Please strive for that number and record your actual intensity within your exercise prescription sheets. This will ensure your safety and will facilitate the communication with the team around your exercise exertion.

RPE Scale

RPE	Intensity Level	Description
6	20%	
7	30%	Very, very light
8	40%	
9	50%	Very light
10	55%	
11	60%	Fairly light
12	65%	
13	70%	Somewhat hard
14	75%	
15	80%	Hard
16	85%	
17	90%	Very hard
18	95%	
19	100%	Very, very hard
20	-	Exhaustion

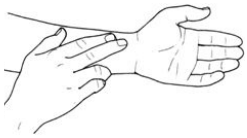
Checking your Heart Rate

If a heart rate monitor is unavailable, you can take your heart rate manually. The two most common places to do so are the carotid artery and the radial artery.

Instructions for Carotid Pulse Check:

The carotid artery is in your neck. You can find it just below your jaw and on either side of your windpipe. Take your index and middle finger and align them right under your earlobe, then slide them down the jaw line until you hit the windpipe. Feel next to the windpipe until you feel a pulsing. Use the flat parts of your fingers rather than the finger tips.

Instructions for Radial Pulse Check:



Radial

The radial artery is in your wrist just below where your thumb meets your arm. Place your index and middle finger on top of the in the small pocket where your thumb attaches to your wrist. Feel your wrist in this area until you find the steady beat. When you find your pulse, count the number of beats you feel within a fifteen second period. Multiply the number of beats you feel in fifteen seconds by 4 to get your heart rate in beats per minute (bpm). Encourage clients to self monitor their heart rate through their exercise session.

Talk Test

How hard someone is working can also be determined by whether or not they can carry on a conversation during exercise. If they are too out of breath to talk, it may be that they are working too hard. But if they can carry on a full conversation during the class, perhaps they could be working a bit harder.

It is important to continue to challenge yourself while performing resistance exercises. To do this, make sure that the resistance tubing is taut before performing the exercise so that resistance is present throughout the entire range of motion of the exercise. To increase the resistance level, shorten the distance between the hand and the anchor point of the band, to decrease the resistance level, hold the tubing farther away from the anchor point.

Using Resistance Bands

Always inspect your equipment before use
Always perform an equal number of repetitions on each side of the body
Perform each exercise through the full range of motion of the joint
Use slow, controlled movements
Be sure to exhale during the work phase of the exercise and inhale during the relaxing phase

Body Alignment

Keep the weight of the body evenly distributed over both your feet
Keep your joints 'soft' or slightly bent, never locked
Keep your chest open, allowing the shoulders to fall back and down
Keep the torso stabilized by pulling your navel in towards your spine
Your head and neck should be aligned with your spine in a neutral position
Keep your wrists neutral while performing exercises

Do
Make sure that the tubing is not ripped
Ensure that the tubing is secured to the attachment (e.g. under your feet or attached to a door attachment)
Clean tubing with a soft cloth and warm, soapy water and let dry before using (lay flat to dry)
Perform exercises slowly and in a controlled manner to prevent tubing from ‘snapping’ back at you

Do Not
Use the tubing with any sharp objects: this increases the risk of tearing
Point the tubing toward the face in case of unintended slipping of the tube
Overstretch the tubing: never pull them more than three times their resting length
Keep your tubing in direct sunlight or heat
Leave them in an area where they could be tripped over

Chapter 4: Exercise Program

Your exercise program has been designed to target the major muscle groups of the body and provide options for you to select exercises that you feel most comfortable with and gradually integrate newer exercises. You will notice that this exercise program will progressively intensify over the next 12 weeks and your exercise physiologist will support you through the entire process. This manual, in addition to exercise videos which you will have access to, will provide the essential instructions to complete a safe and effective exercise routine.
You are in control of your exercise program. Below, you'll find a 'menu' of 10 exercises. From this menu, you can choose which exercises you want to insert into your resistance training portion of your exercise program. The type of exercises and the days you exercise will be up to you, and gradually your exercise sessions will include ALL of the exercises.

Exercise Menu

Exercise	Targeted Muscle Groups
Squat	Front of thighs (quadriceps) and buttocks (gluteal region)
Hamstring Curl	Back of thighs (hamstrings)
Seated/Standing Row	Upper back and triceps
Upright Row	Shoulders (deltoids) and upper back (trapezius)
Shoulder External Rotation	Scapula stabolization
Straight Arm Lowers	Chest (pectorals) and Middle/lower trap
Standing Bicep Curls	Front of upper arms (bicep)
Standing Tricep Extension	Back of upper arm (triceps)
Lateral Arm Raise	Shoulders (deltoids)
Pallof Press (Anti-Rotation)	Core (abdominals)

Use this exercise menu to complete your exercise prescription sheets

Warm-up

Ankle Pumps

Move your foot up and down as if pushing a gas pedal in a car. Complete this exercise one foot at a time while sitting or in a standing position.

Fist Clench

Make a fist, hold for 5 seconds, then slowly open your hand and straighten your fingers. *Do not hold your breath as you hold the fist.

Shoulder Shrugs

Inhale and lift both shoulders towards your ears. Exhale as you return back to a relaxed position.

Shoulder rolls

Roll your shoulders back baking a continuous circle.

Shoulder Blade Squeeze

Squeeze your shoulder blades together by pulling them backwards towards the centre of your body.

Elbow Bend

Standing tall with your arms at your sides, bring one hand towards your shoulder on the same side, return the arm to your side, repeat. Complete this exercise one arm at a time.

Chapter 5: Exercise Log

Exercise Prescription for Week 1:
The goal for this week is for you to complete **two** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Other women have suggested that brisk walking, cycling, swimming, or even our program's exercise videos were a good place to start. Aim for **30 minutes** each session. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 1: **Aerobic Training and Group Exercise**				
Session	**Intensity** **RPE range 10-11**	**Time** **(30 min)**	**Type** **(e.g. program exercise video, walking, cycling, etc.)**	**Notes:**
1. **Aerobic** ____/__/____ (mm/dd/yy)				
2. **Aerobic** ____/__/____ (mm/dd/yy)				
Group Exercise ____/__/____ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Exercise Prescription for Week 2:

The goal for this week is for you to complete **two** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Other women have suggested that brisk walking, cycling, swimming, or even our program's exercise videos were a good place to start. Aim for **30 minutes** each session. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 2: **Aerobic Training and Group Exercise**				
Session	**Intensity** **RPE range 10-11**	**Time** **(30 min)**	**Type** **(e.g. program exercise video, walking, cycling, etc.)**	**Notes:**
1. **Aerobic** ____/__/___ (mm/dd/yy)				
2. **Aerobic** ____/__/___ (mm/dd/yy)				
Group Exercise ____/__/___ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Exercise Prescription for Week 3:

The goal for this week is for you to complete **two** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Aim for **45 minutes** each session. Please record what you have accomplished in the table below.

For the resistance training portion of this week's exercise prescription, you will complete **one 30 minute** session Please select 4 or 5 exercises from the exercise menu (pg 21) that you would like to try. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 3:

Aerobic Training and Group Exercise

Session	**Intensity RPE range 11-12**	**Time (45 min)**	**Type (e.g. program exercise video, walking, cycling, etc.)**	**Notes:**
1. **Aerobic** ___/___/___ (mm/dd/yy)				
2. **Aerobic** ___/___/___ (mm/dd/yy)				
Group Exercise ___/___/___ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Resistance Training

Do *NOT* hold your breath during exercises

Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes (soreness, easily completed, etc):**
1. **Resistance** ___/___/___ (mm/dd/yy) **Time (30 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			

Exercise Prescription for Week 4:

The goal for this week is for you to complete **two** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Aim for **45 minutes** each session. Please record what you have accomplished in the table below.

For the resistance training portion of this week's exercise prescription, you will complete **one 30 minute** session Please select 4 or 5 exercises from the exercise menu (pg 21) that you would like to try. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 4:

Aerobic Training and Group Exercise

Session	**Intensity RPE range 11-12**	**Time (45 min)**	**Type (e.g. program exercise video, walking, cycling, etc.)**	**Notes:**
1. **Aerobic** ___/___/___ (mm/dd/yy)				
2. **Aerobic** ___/___/___ (mm/dd/yy)				
Group Exercise ___/___/___ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Resistance Training

Do *NOT* hold your breath during exercises

Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes (soreness, easily completed, etc):**
1. **Resistance** ___/___/___ (mm/dd/yy) **Time (30 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			

Exercise Prescription for Week 5:

The goal for this week is for you to complete **two** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Aim for **60 minutes** each session. Please record what you have accomplished in the table below.

For the resistance training portion of this week's exercise prescription, you will complete **one 45 minute** session Please select 7 to 8 exercises from the exercise menu (pg 21) that you would like to try. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 5:

Aerobic Training and Group Exercise

Session	Intensity RPE range 12-13	Time (60 min)	Type (e.g. program exercise video, walking, cycling, etc.)	Notes:
1. **Aerobic** ___/___/___ (mm/dd/yy)				
2. **Aerobic** ___/___/___ (mm/dd/yy)				
Group Exercise ___/___/___ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Resistance Training

Do *NOT* hold your breath during exercises

Session	Exercise & Stage	Sets	Reps	Notes:
1. **Resistance** ___/___/___ (mm/dd/yy)	1.			
	2.			
	3.			
Time (60 min): _____to_____	4.			
	5.			
	6.			
	7.			
	8.			

Exercise Prescription for Week 6:

The goal for this week is for you to complete **two** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Aim for **60 minutes** each session. Please record what you have accomplished in the table below.

For the resistance training portion of this week's exercise prescription, you will complete **one 45 minute** session Please select 7 to 8 exercises from the exercise menu (pg 21) that you would like to try. Please record what you have accomplished in the table below

Don't forget to warm-up, cool-down, and stretch for each session

Week 6:

Aerobic Training and Group Exercise

Session	Intensity RPE range 12-13	Time (60 min)	Type (e.g. program exercise video, walking, cycling, etc.)	Notes:
1. **Aerobic** ___/___/___ (mm/dd/yy)				
2. **Aerobic** ___/___/___ (mm/dd/yy)				
Group Exercise ___/___/___ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Resistance Training

Do *NOT* hold your breath during exercises

Session	Exercise & Stage	Sets	Reps	Notes:
1. **Resistance** ___/___/___ (mm/dd/yy)	1.			
	2.			
	3.			
Time (60 min): _____to_____	4.			
	5.			
	6.			
	7.			
	8.			

Exercise Prescription for Week 7:

The goal for this week is for you to complete **two** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Aim for **60 minutes** each session. Please record what you have accomplished in the table below.

For the resistance training portion of this week's exercise prescription, you will complete **two 60 minute** sessions on non-consecutive days. Please select 8 to 10 exercises from the exercise menu (pg 21) that you would like to try. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 7:
Aerobic Training and Group Exercise

Session	**Intensity RPE range 13-14**	**Time (60 min)**	**Type (e.g. program exercise video, walking, cycling, etc.)**	**Notes:**
1. **Aerobic** ___/___/___ (mm/dd/yy)				
2. **Aerobic** ___/___/___ (mm/dd/yy)				
Group Exercise ___/___/___ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Continue to next page for resistance training

Don't forget to warm-up, cool-down, and stretch for each session

Week 7: Resistance Training				
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
1. **Resistance** ____/___/____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
2. **Resistance** ____/___/____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			

Exercise Prescription for Week 8:

The goal for this week is for you to complete **two** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Aim for **60 minutes** each session. Please record what you have accomplished in the table below.

For the resistance training portion of this week's exercise prescription, you will complete **two 60 minute** sessions on non-consecutive days. Please select 8 to 10 exercises from the exercise menu (pg 21) that you would like to try. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 8:
Aerobic Training and Group Exercise

Session	**Intensity RPE range 13-14**	**Time (60 min)**	**Type (e.g. program exercise video, walking, cycling, etc.)**	**Notes:**
1. **Aerobic** ___/___/___ (mm/dd/yy)				
2. **Aerobic** ___/___/___ (mm/dd/yy)				
Group Exercise ___/___/___ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Continue to next page for resistance training

Don't forget to warm-up, cool-down, and stretch for each session

Week 8: Resistance Training:				
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
1. **Resistance** ____/___/____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
2. **Resistance** ____/___/____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			

Exercise Prescription for Week 9:

The goal for this week is for you to complete **three** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Aim for **60 minutes** each session. Please record what you have accomplished in the table below.

For the resistance training portion of this week's exercise prescription, you will complete **two 60 minute** sessions on non-consecutive days. Please select 8 to 10 exercises from the exercise menu (pg 21) that you would like to try. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 9:

Aerobic Training and Group Exercise:

Session	**Intensity RPE range 14-15**	**Time (60 min)**	**Type (e.g. program exercise video, walking, cycling, etc.)**	**Notes:**
1. **Aerobic** ___/__/__ (mm/dd/yy)				
2. **Aerobic** ___/__/__ (mm/dd/yy)				
3. **Aerobic** ___/__/__ (mm/dd/yy)				
Group Exercise ___/__/__ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	
Continue to next page for resistance training				

Don't forget to warm-up, cool-down, and stretch for each session

Week 9: Resistance Training				
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
1. **Resistance** ____/___/____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
2. **Resistance** ____/___/____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			

Exercise Prescription for Week 10:

The goal for this week is for you to complete **three** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Aim for **60 minutes** each session. Please record what you have accomplished in the table below.

For the resistance training portion of this week's exercise prescription, you will complete **two 60 minute** sessions on non-consecutive days. Please select 8 to 10 exercises from the exercise menu (pg 21) that you would like to try. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 10:

Aerobic Training and Group Exercise:

Session	Intensity RPE range 14-15	Time (60 min)	Type (e.g. program exercise video, walking, cycling, etc.)	Notes:
1. **Aerobic** ___/___/___ (mm/dd/yy)				
2. **Aerobic** ___/___/___ (mm/dd/yy)				
3. **Aerobic** ___/___/___ (mm/dd/yy)				
Group Exercise ___/___/___ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Continue to next page for resistance training

Don't forget to warm-up, cool-down, and stretch for each session

Week 10: Resistance Training				
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
1. **Resistance** ____/ __/ ____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
2. **Resistance** ____/ __/ ____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			

Exercise Prescription for Week 11:

The goal for this week is for you to complete **three** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Aim for **60 minutes** each session. Please record what you have accomplished in the table below.

For the resistance training portion of this week's exercise prescription, you will complete **two 60 minute** sessions on non-consecutive days. Please select 8 to 10 exercises from the exercise menu (pg 21) that you would like to try. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 11:

Aerobic Training and Group Exercise:

Session	**Intensity RPE range 14-15**	**Time (60 min)**	**Type (e.g. program exercise video, walking, cycling, etc.)**	**Notes:**
1. **Aerobic** ___/__/___ (mm/dd/yy)				
2. **Aerobic** ___/__/___ (mm/dd/yy)				
3. **Aerobic** ___/__/___ (mm/dd/yy)				
Group Exercise ___/__/___ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Continue to next page for resistance training

Don't forget to warm-up, cool-down, and stretch for each session

Week 11: Resistance Training				
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
1. **Resistance** ____/___/____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
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	9.			
	10.			
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
2. **Resistance** ____/___/____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			

Exercise Prescription for Week 12:

The goal for this week is for you to complete **three** home-based aerobic exercise sessions in addition to the **one** group workout that you do with our team. On the days you workout at home, you can choose which type of exercise you want to engage in. Aim for **60 minutes** each session. Please record what you have accomplished in the table below.

For the resistance training portion of this week's exercise prescription, you will complete **two 60 minute** sessions on non-consecutive days. Please select 8 to 10 exercises from the exercise menu (pg 21) that you would like to try. Please record what you have accomplished in the table below.

Don't forget to warm-up, cool-down, and stretch for each session

Week 12:

Aerobic Training and Group Exercise:

Session	**Intensity RPE range 14-15**	**Time (60 min)**	**Type (e.g. program exercise video, walking, cycling, etc.)**	**Notes:**
1. **Aerobic** ___/__/___ (mm/dd/yy)				
2. **Aerobic** ___/__/___ (mm/dd/yy)				
3. **Aerobic** ___/__/___ (mm/dd/yy)				
Group Exercise ___/__/___ (mm/dd/yy)		60 min	Group Exercise (aerobic and resistance training)	

Continue to next page for resistance training

Don't forget to warm-up, cool-down, and stretch for each session

Week 12: Resistance Training				
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
1. **Resistance** ____/__/____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			
Session	**Exercise & Stage**	**Sets**	**Reps**	**Notes:**
2. **Resistance** ____/__/____ (mm/dd/yyyy) **Time (60 min):** _____to_____	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			

9.8 Appendix 8 - Exercise Prescription Sheet

Study ID:_____ Eligibility ID:_____ Date:_____

Next Exercise Prescription for Week:_____

Aerobic-

Type:

_____

Days per week:

2 **3**

Duration per session:

30 min **45 min** **60 min**

Resistance Exercises

Number of Sessions per week**:** **1** **2**

Duration	Exercise		Sets	Reps	Notes
30 Min	☐	**Squat**			
	☐	**Hamstring Curl**			
	☐	**Seated/ Standing Row**			
	☐	**Upright Row**			
45 Min	☐	**Shoulder External Rotation**			
	☐	**Straight Arm Lowers**			
	☐	**Standing Bicep Curls**			
	☐	**Standing Tricep Extension**			
60 Min	☐	**Lateral Arm Raise**			
	☐	**Pallof Press (Anti-Rotation)**			

9.9 Appendix 9 – Exercise & Intensity Tracking Sheet

Study ID:_____
Date:_____

Exercise Prescription Meeting Week _____
On a scale of 1-10 how would you rate the difficulty of the previous week's exercises?

1 2 3 4 5 6 7 8 9 10
(Easy) (Moderate) (Very Difficult)

Did you experience any pain or discomfort during the exercise duration?

○ **YES** ○ **NO**

If YES, Describe the pain or discomfort:

Previous Week# _____

Previous Week -Aerobic Training and Group Exercise Performed				
Session	**Intensity RPE range**	**Time**	**Type (e.g. Program exercise video, walking, cycling, ect**	**Notes:**
1. Aerobic ___/___/___. (MM/DD/YY)				
2. Aerobic ___/___/___. (MM/DD/YY)				
3. Aerobic ___/___/___. (MM/DD/YY)				
Group Exercise ___/___/___. (MM/DD/YY)		60 min	Group Exercise (aerobic and resistance training)	

Previous Week - Resistance Exercises

Number of Sessions performed**:** **1** **2**

Duration	Exercise		Sets	Reps	Notes
_____ **Min**	☐	**Squat**			
	☐	**Hamstring Curl**			
	☐	**Seated/ Standing Row**			
	☐	**Upright Row**			
	☐	**Shoulder External Rotation**			
	☐	**Straight Arm Lowers**			
	☐	**Standing Bicep Curls**			
	☐	**Standing Tricep Extension**			
	☐	**Lateral Arm Raise**			
	☐	**Pallof Press (Anti-Rotation)**			

NOTES:

9.10 Appendix 10 – Patient Report Outcomes

9.101 Appendix 10.1 - Background Information

1. **How old are you?**

2. **Where were you born?**

   Canada?

   Other (please specify)

3. **What language(s) do you speak at home?**

   English Portuguese

   French Mandarin

   Italian Cantonese

   Spanish Other (please specify)

4. **What is the highest level of education you have completed?**

   Some /Completed Elementary School Some/Completed High School

   Some/Completed College/University Some/Completed Post-Graduate

   Other (please specify)

5. **Are you currently:**

   Married/Common Law Divorced/Separated

   Widowed Single, never married

   Other (please specify)

6. **Do you have any children?**

   Yes # of children < 18 years # of children > 18 years

No

7. **What is your current employment status?**

Working Full time | Working Part- Time

Full-time Homemaker | Unemployed

On Leave/ Disability | Retired

Other (please specify)

9.102 Appendix 10.2 - Leisure Time Activities

1. During a typical **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your free time (write on each line the appropriate number),

	Times per week
STRENUOUS EXERCISE (HEART BEATS RAPIDLY) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)	
MODERATE EXERCISE (NOT EXHAUSTING) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing	
MILD EXERCISE (MINIMAL EFFORT) (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)	

2. During a typical **7-Day period** (a week), in your leisure time, how often do you engage in any regular activity **long enough to work up a sweat** (heart beats rapidly)?

   Often

   Sometimes

   Rarely

9.103 Appendix 10.3 - Functional Assessment of Cancer Therapy-Breast (FACT-B)

Below is a list of statements that other people with your illness have said are important**. Please circle or mark one number per line to indicate your response as it applies to the past 7 days.**

Physical Well-Being	Not at all	A little bit	Somewhat	Quite a bit	Very much
I have a lack of energy	0	1	2	3	4
I have nausea	0	1	2	3	4
Because of my physical condition, I have trouble meeting the needs of my family	0	1	2	3	4
I have pain	0	1	2	3	4
I am bothered by side effects of treatment	0	1	2	3	4
I feel ill	0	1	2	3	4
I am forced to spend time in bed	0	1	2	3	4
Social/ Family Well-Being	**Not at all**	**A little bit**	**Somewhat**	**Quite a bit**	**Very much**
I feel close to my friends	0	1	2	3	4
I get emotional support from my family	0	1	2	3	4
I get support from my friends	0	1	2	3	4
My family has accepted my illness	0	1	2	3	4
I am satisfied with family communication about my illness	0	1	2	3	4
I feel close to my partner (or the person who is my main support)	0	1	2	3	4
Regardless of your current level of sexual activity, please answer the following question. If you prefer not to answer it, please mark this box and go to the next section ☐ I am satisfied with my sex life		1	2	3	4

Functional Assessment of Cancer Therapy-Breast (FACT-B) Continued

Please circle or mark one number per line to indicate your response as it applies to the past 7 days.

Emotional Well-Being	Not at all	A little bit	Somewhat	Quite a bit	Very much
I feel sad	0	1	2	3	4
I am satisfied with how I am coping with my illness	0	1	2	3	4
I am losing hope in the fight against my illness	0	1	2	3	4
I feel nervous	0	1	2	3	4
I worry about dying	0	1	2	3	4
I worry that my condition will get worse	0	1	2	3	4
Functional Well-Being	**Not at all**	**A little bit**	**Somewhat**	**Quite a bit**	**Very much**
I am able to work (include working at home)	0	1	2	3	4
My work (include work at home) is fulfilling	0	1	2	3	4
I am able to enjoy life	0	1	2	3	4
I have accepted my illness	0	1	2	3	4
I am sleeping well	0	1	2	3	4
I am enjoying the things I usually do for fun	0	1	2	3	4
I am content with the quality of my life right now	0	1	2	3	4

Functional Assessment of Cancer Therapy-Breast (FACT-B) Continued

Please circle or mark one number per line to indicate your response as it applies to the past 7 days.

Additional Concerns	Not at all	A little bit	Somewhat	Quite a bit	Very much
I have been short of breath	0	1	2	3	4
I am self-conscious about the way I dress	0	1	2	3	4
One or both of my arms are swollen or tender	0	1	2	3	4
I feel sexually attractive	0	1	2	3	4
I am bothered by hair loss	0	1	2	3	4
Additional Concerns (continued)	**Not at all**	**A little bit**	**Somewhat**	**Quite a bit**	**Very much**
I worry that other members of my family might someday get the same illness I have	0	1	2	3	4
I worry about the effects of stress on my illness	0	1	2	3	4
I am bothered by a change in weight	0	1	2	3	4
I am able to feel like a woman	0	1	2	3	4
I have certain parts of my body where I experience pain	0	1	2	3	4

9.104 Appendix 10.4 - Functional Assessment of Cancer Therapy-Fatigue (FACT-F)

Below is a list of statements that other people with your illness have said are important.

Please circle or mark one number per line to indicate your response as it applies to the past 7 days.

	Not at all	A little bit	Somewhat	Quite a bit	Very much
I feel fatigued	0	1	2	3	4
I feel weak all over	0	1	2	3	4
I feel listless ("washed out")	0	1	2	3	4
I feel tired	0	1	2	3	4
I have trouble starting things because I am tired	0	1	2	3	4
I have trouble finishing things because I am tired	0	1	2	3	4
I have energy	0	1	2	3	4
I am able to do my usual activities	0	1	2	3	4
I need to sleep during the day	0	1	2	3	4
I am too tired to eat	0	1	2	3	4
I need help doing my usual activities	0	1	2	3	4
I am frustrated by being too tired to do the things I want to do	0	1	2	3	4
I have to limit my social activity because I am tired	0	1	2	3	4

9.105 Appendix 10.5 - State-Trait Anxiety Inventory (STAI-S)

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to **indicate how you feel *right* now, that is, *at this moment*.**

	Not at all	Somewhat	Moderately so	Very much so
I feel calm	1	2	3	4
I feel secure	1	2	3	4
I feel tense	1	2	3	4
I feel strained	1	2	3	4
I feel at ease	1	2	3	4
I feel upset	1	2	3	4
I am presently worrying over possible misfortunes	1	2	3	4
I feel satisfied	1	2	3	4
I feel frightened	1	2	3	4
I feel comfortable	1	2	3	4
I feel self-confident	1	2	3	4
I feel nervous	1	2	3	4
I am jittery	1	2	3	4
I feel indecisive	1	2	3	4
I am relaxed	1	2	3	4
I feel content	1	2	3	4
I am worried	1	2	3	4
I feel confused	1	2	3	4
I feel steady	1	2	3	4
I feel pleasant	1	2	3	4

9.106 Appendix 10.6 - Centre for Epidemiological Studies-Depression Scale Short Form (CESD-SF)

During the past week...	**Rarely or none of the time** (less than 1 day)	**Some or a little of the time** (1-2 days)	**Occasionally or a moderate amount of time** (3-4 days)	**All of the time** (5-7 days)
I was bothered by things that usually don't bother me	0	1	2	3
I had trouble keeping my mind on what I was doing	0	1	2	3
I felt depressed	0	1	2	3
I felt that everything I did was an effort	0	1	2	3
I felt hopeful about the future	0	1	2	3
I felt fearful	0	1	2	3
My sleep was restless	0	1	2	3
I was happy	0	1	2	3
I felt lonely	0	1	2	3
I could not "get going"	0	1	2	3

9.107 Appendix 10.7 - BCPT Symptom Scale

We interested in knowing how much you have been bothered by any of the following problems during the **PAST 4 WEEKS.**

During the **past 4 weeks,** how much were you bothered by:	**Not at all**	**Slightly**	**Moderately**	**Quite a bit**	**Extremely**
Hot flashes	1	2	3	4	5
Nausea	1	2	3	4	5
Vomiting	1	2	3	4	5
Difficulty with bladder control when laughing or crying	1	2	3	4	5
Vaginal dryness	1	2	3	4	5
Pain with intercourse	1	2	3	4	5
General aches and pains	1	2	3	4	5
Joint pains	1	2	3	4	5
Muscle stiffness	1	2	3	4	5
Weight gain	1	2	3	4	5
Unhappy with the appearance of your body	1	2	3	4	5

BCPT Symptom Scale Continued

We interested in knowing how much you have been bothered by any of the following problems during the **PAST 4 WEEKS.**

During the **past 4 weeks,** how much were you bothered by:	**Not at all**	**Slightly**	**Moderately**	**Quite a bit**	**Extremely**
Forgetfulness	1	2	3	4	5
Night sweats	1	2	3	4	5
Difficulty concentrating	1	2	3	4	5
Being easily distracted	1	2	3	4	5
Arm swelling (lymphedema)	1	2	3	4	5
Decreased range of motion in arm on surgery side	1	2	3	4	5

9.11 Appendix 11 – PAR-Q +

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PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

Regular physical activity is fun and healthy, and more people should become more physically active every day of the week. Being more physically active is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

SECTION 1 - GENERAL HEALTH

	Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	YES	NO
1.	Has your doctor ever said that you have a heart condition OR high blood pressure?	☐	☐
2.	Do you feel pain in your chest at rest, during your daily activities of living, OR when you do physical activity?	☐	☐
3.	Do you lose balance because of dizziness OR have you lost consciousness in the last 12 months? Please answer NO if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4.	Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)?	☐	☐
5.	Are you currently taking prescribed medications for a chronic medical condition?	☐	☐
6.	Do you have a bone or joint problem that could be made worse by becoming more physically active? Please answer NO if you had a joint problem in the past, but it does not limit your current ability to be physically active. For example, knee, ankle, shoulder or other.	☐	☐
7.	Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity. Go to Section 3 to sign the form. You do not need to complete section 2.

If you answered YES to one or more of the questions above, please GO TO SECTION 2.

Delay becoming more active if:

- You are not feeling well because of a temporary illness such as a cold or fever – wait until you feel better
- You are pregnant – talk to your health care practitioner, your physician, a qualified exercise professional, and/ or complete the PARmed-X for pregnancy before becoming more physically active OR
- Your health changes – please answer the questions on Section 2 of this document and/or talk to your doctor or qualified exercise professional (CSEP

CEP- or CSEP –CPT) before continuing with any physical activity program.

PAR Q + Continued

SECTION 2 - CHRONIC MEDICAL CONDITIONS

Please read the questions below carefully and answer each one honestly: check YES or NO.			YES	NO
1.	Do you have Arthritis, Osteoporosis, or Back Problems?		☐ If yes, answer questions 1a-1c	☐ If no, go to question 2
	1a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	1b.	Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/ or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)?	☐	☐
	1c.	Have you had steroid injections or taken steroid tablets regularly for more than 3 months?	☐	☐
2.	Do you have Cancer of any kind?		☐ If yes, answer questions 2a-2b	☐ If no, go to question 3
	2a.	Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and neck?	☐	☐
	2b.	Are you currently receiving cancer therapy (such as chemotherapy or radiotherapy)?	☐	☐
3.	Do you have Heart Disease or Cardiovascular Disease? This includes Coronary Artery Disease, High Blood Pressure, Heart Failure, Diagnosed Abnormality of Heart Rhythm		☐ If yes, answer questions 3a-3e	☐ If no, go to question 4
	3a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	3b.	Do you have an irregular heart beat that requires medical management? (e.g. atrial fibrillation, premature ventricular contraction)	☐	☐
	3c.	Do you have chronic heart failure?	☐	☐
	3d.	Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer YES if you do not know your resting blood pressure)	☐	☐
	3e.	Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?	☐	☐

PAR Q + Continued

4.	Do you have any Metabolic Conditions? This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes		☐ If yes, answer questions 4a-4c	☐ If no, go to question 5
	4a.	Is your blood sugar often above 13.0 mmol/L? (Answer YES if you are not sure)	☐	☐
	4b.	Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, and the sensation in your toes and feet?	☐	☐
	4c.	Do you have other metabolic conditions (such as thyroid disorders, pregnancy-related diabetes, chronic kidney disease, liver problems)?	☐	☐
5.	Do you have any Mental Health Problems or Learning Difficulties? This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome)		☐ If yes, answer questions 5a-5b	☐ If no, go to question 6
	5a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	5b.	Do you also have back problems affecting nerves or muscles?	☐	☐

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			YES	NO
	Please read the questions below carefully and answer each one honestly: check YES or NO.			
6.	Do you have a Respiratory Disease? This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure		☐ If yes, answer questions 6a-6d	☐ If no, go to question 7
	6a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	6b.	Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy?	☐	☐
	6c.	If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week?	☐	☐
	6d.	Has your doctor ever said you have high blood pressure in the blood vessels of your lungs?	☐	☐

PAR Q + Continued

7.	Do you have a Spinal Cord Injury? This includes Tetraplegia and Paraplegia		☐ If yes, answer questions 7a-7c	☐ If no, go to question 8
	7a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	7b.	Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?	☐	☐
	7c.	Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?	☐	☐
8.	Have you had a Stroke? This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event		☐ If yes, answer questions 8a-c	☐ If no, go to question 9
	8a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	8b.	Do you have any impairment in walking or mobility?	☐	☐
	8c.	Have you experienced a stroke or impairment in nerves or muscles in the past 6 months?	☐	☐
9.	Do you have any other medical condition not listed above or do you live with two chronic conditions?		☐ If yes, answer questions 9a-c	☐ If no, read the advice on page 4
	9a.	Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months OR have you had a diagnosed concussion within the last 12 months?	☐	☐
	9b.	Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)?	☐	☐
	9c.	Do you currently live with two chronic conditions?	☐	☐

If you answered no to all of the follow up questions about your medical condition, you are ready to become more physically active.

If you answered YES to one or more of the follow up questions about your medical condition: You should seek further information from a licensed health care professional before becoming more physically active or engaging in a fitness appraisal and/or visit a qualified exercise professional (CSEP-CEP) for further information.

Par Q + Continued

SECTION 3 - DECLARATION

- You are encouraged to photocopy the PAR-Q+. You must use the entire questionnaire and NO changes are permitted.
- The Canadian Society for Exercise Physiology, the PAR-Q+ Collaboration, and their agents assume no liability for persons who undertake physical activity. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.
- If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.
- Please read and sign the declaration below:

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that a Trustee (such as my employer, community/fitness centre, health care provider, or other designate) may retain a copy of this form for their records. In these instances, the Trustee will be required to adhere to local, national, and international guidelines regarding the storage of personal health information ensuring that they maintain the privacy of the information and do not misuse or wrongfully disclose such information.

NAME _____ DATE _____

SIGNATURE _____ WITNESS _____

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER _____

For more information, please contact:
Canadian Society for Exercise Physiology
www.csep.ca

KEY REFERENCES
1. Jamnik VJ, Warburton DER, Makarski J, McKenzie DC, Shephard RJ, Stone J, and Gledhill N. Enhancing the eectiveness of clearance for physical activity participation; background and overall process. APNM 36(S1):S3-S13, 2011.
2. Warburton DER, Gledhill N, Jamnik VK, Bredin SSD, McKenzie DC, Stone J, Charlesworth S, and Shephard RJ. Evidence-based risk assessment and recommendations for physical activity clearance; Consensus Document. APNM 36(S1):S266-s298, 2011.

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