Randomized Controlled Trial of a Behaviour Change Intervention to Increase Aerobic and Resistance Exercise and Quality of Life in Older Prostate and Breast Cancer Survivors: The OutPACE Trial

By

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Abstract

Background: Physical activity (PA) has been shown to provide numerous benefits for breast and prostate cancer survivors. **Purpose**: To test the efficacy of an implementation intention intervention on aerobic and resistance training and improving QoL in older (55+) prostate and breast cancer survivors. **Methods**: Survivors (*N*=41) were randomly assigned to one of three groups: (1) two-time implementation intention, (2) one-time implementation intention, or (3) control group following baseline assessments. PA, both self-reported and objectively measured, and QoL measures were assessed at baseline, one, and three months post-randomization. **Results**: Analyses of covariance did not find significant differences in PA behaviours between groups at follow-ups irrespective of PA measure. Breast cancer survivors in the two-time intervention group reported significant improvements on breast cancer subscale at both follow-ups. **Conclusion**: Although significant differences in PA behaviours were not found, breast cancer survivors reported QoL improvements. The small sample resulted in this study being underpowered to detect small differences in PA behaviour, justifying additional research

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List of Abbreviations

ACSM – American College of Sports Medicine

BMI – Body mass index

CCSACCS – Canadian Cancer Society's Advisory Committee on Cancer Statistics

CPM – Counts per minute

CSEP – Canadian Society for Exercise Physiology

FACIT-F – Functional Assessment of Chronic Illness Therapy – Fatigue

FACT-B – Functional Assessment of Cancer Therapy – Breast Cancer

FACT-P – Functional Assessment of Cancer Therapy – Prostate Cancer

LSI – Leisure Score Index

MET – Metabolic Equivalent of Task

MVPA – Moderate-to-vigorous physical activity

PA – Physical activity

PBC – Perceived behavioural control

QoL – Quality of life

SF-36 – Short-Form Health Survey

TPB – Theory of Planned Behaviour

Chapter 1 Introduction

1.1 Background

In 2015, an estimated 196,900 new cases of cancer were diagnosed in Canada and 78,000 Canadians died from the disease (Canadian Cancer Society's Advisory Committee on Cancer Statistics [CCSACCS], 2015). Of the new cases diagnosed, approximately 25% were breast or prostate cancers (CCSACCS, 2015). Most new cases of breast and prostate cancers occurred in individuals 50 and older, with this age group accounting for 82% and 98% of new cases, respectively (CCSACCS, 2015). Despite high diagnosis rates, survival rates for both cancers are high, with the five-year relative survival rate of female breast cancer being 88% and 96% for prostate cancer (CCSACCS, 2015). Survival rates saw marked improvements between 1992-94 and 2006-08, with five-year relative survival of breast cancer increasing about 6%, and prostate cancer improving 9% (CCSACCS, 2015). Improved survival rates result from advancements in both treatment options and detection (Siegel et al., 2012). These positive changes have led to a larger population of cancer survivors living in Canada, putting the total up to roughly one million (CCSACCS, 2015).

Although survival rates have risen, cancer and its treatments can have many side effects, both physical and psychological. Physical side effects can include weight changes, increases in adipose tissue, bone loss, and decreases in muscle mass, and physical functioning (Aftimos, Gombos, Pugliano, Awada, & Piccart, 2013; Canadian Cancer Society, 2016; Schmitz et al., 2010). The psychosocial side effects of cancer may include increased fatigue, depression, anxiety, and distress (Krupski & Litwin, 2007; Lemieux, Bordeleau, & Goodwin, 2007). Side effects may appear months after treatment

has been completed and may last for years and can lead to a decrease in cancer survivor's quality of life (QoL) and wellbeing (Irwin, 2013; LeMasters, Madavan, Sambamoorthi, & Kurian, 2013; Schmitz et al., 2010). Due to these long lasting and late appearing side effects, cancer is classified as a chronic disease, as it may require ongoing care and treatments (Phillips & Currow, 2010). Similarly, a person is considered a cancer survivor from the time of diagnosis for the remainder of their lives (Mullan, 1985). The number of cancer survivors in Canada is large and growing, creating an increasing need for novel and innovative means to help improve their QoL and wellbeing. One area receiving increased research attention is physical activity (PA) and exercise (Fong et al., 2012; Rock et al., 2012).

1.2 Physical Activity and Cancer

A recent review from Fong et al. (2012) established that PA is an effective method for reducing typical side effects of cancer and its treatments (e.g., weight gain, loss of muscle mass, fatigue), and leads to improvements in QoL. When focusing on PA for breast and prostate cancer survivors, the evidence is compelling. Reviews on PA for breast and prostate cancer survivors (McNeely et al., 2006; Thorsen, Courneya, Stevinson, & Fosså, 2008) have shown that PA can lead to improvements in QoL, fatigue, physical function, and fitness. Research has consistently shown PA is safe and feasible both during and following cancer treatment (Schmitz, et al., 2010). Specifically, Schmitz et al. (2010) found that aerobic and resistance activities offered many benefits for breast and prostate cancer survivors and had few adverse effects, including breast cancer survivors at risk for lymphedema. This panel felt that the existing age-specific

guidelines would be appropriate for cancer survivors, with some specific items for cancer and treatment-specific recommendations (e.g., modifications for those at an increased risk of bone fractures following certain treatments). Overall, cancer survivors should be as active as possible with the goal of achieving at least 150-minutes of activity per week to improve their QoL and maintain physical function.

Because many of those being diagnosed with these cancers are older than 50 years, declines in QoL that result from cancer can be worsened by accompanying QoL declines from aging (Courneya et al., 2004). Despite the fact that the majority of individuals' who are diagnosed with cancer are older and may face worsened outcomes, research on this population is limited. Reviews have shown that randomized controlled trials often exclude those over the age of 65 (Zulman et al., 2011), and 68% of cancer-related clinical trial participants were 64 years and younger (Murthy, Krumholz, & Gross, 2004). Despite the limited research involving older cancer survivors, evidence has established that PA for older breast and prostate cancer survivors can lessen declines in physical function, reduce cancer-related fatigue, and improve lean body mass and muscle strength (Brown et al., 2011; Morey et al., 2009). Although there is strong evidence to support the value of PA for cancer survivors, many are not doing enough to achieve these benefits. In a recent survey of the Canadian population, only 22.6% of those who had cancer in the past and 17.8% of those who currently had cancer were classified as "active" (>3.0 kcal/kg/daily, approximately 60 minutes of walking daily; Neil, Gotay, & Campbell, 2014). Physical activity can offer many benefits to cancer survivors, particularly older breast and prostate cancer survivors (McNeely et al., 2006; Thorsen,

Courneya, Stevinson, & Fosså, 2008). Older cancer survivors are currently underserved in the field of PA and cancer, regardless of the fact that they make up a large percentage of cancer survivors. This creates an apparent need to help these cancer survivors increase their PA levels through the development of behavioural interventions specifically targeting this age group.

When developing interventions for cancer survivors, it is important to consider the activities being suggested. Fong et al. (2012) found that 64% of PA interventions used an aerobic-based exercise program, and only 14% used a strength or resistance training program. Regardless of this small pool of studies, results suggest that studies, which incorporated both aerobic and resistance exercise plans, as compared to aerobic alone, reported larger improvements in physical and functional wellbeing. A recent meta-analysis examined outcomes from 11 randomized controlled trials focused specifically on resistance training in cancer survivors (Strasser, Steindorf, Wiskemann, & Ulrich, 2013). Results showed strong improvements in muscle function and body composition, as well as smaller improvements in fatigue. These findings are especially meaningful for breast and prostate cancer survivors, bearing in mind typical side effects of treatment include increased body fat, loss of bone mineral density, and decreased muscle strength (Baumann, Zopf, & Bloch, 2012; Loprinzi & Cardinal, 2012), all of which can be mitigated through resistance exercise. In addition to typical cancer treatments (e.g., surgery, chemotherapy, radiation), treatment for breast and prostate cancer may include hormone therapy. Hormone therapy can exacerbate side effects from primary therapies or have similar side effects, such as loss of muscle mass, weight gain, and fatigue

(American Cancer Society, 2014; American Cancer Society, 2015). Considering both breast and prostate cancer survivors may undergo hormone therapy during treatment, and resistance training can improve these side effects, it is important to encourage these survivors to take part in resistance exercise. Therefore, because of the success and need to increase these behaviours in this population, interventions should be sure to include both resistance and aerobic exercises when developing behaviour change interventions for breast and prostate cancer survivors.

Although many trials have had some success changing behaviour in cancer survivors, these changes can be short-lived. McGowan, North, and Courneya (2013) tested a PA intervention on a sample of prostate cancer survivors. This intervention used PA guidelines and implementation intention intervention, consisting of a goal-setting and planning activity, either self-administered or with telephone-assistance. Those in the self-administered group increased their PA behaviour by 168 minutes/week after a one-month follow-up but these changes were not maintained at the three-month follow-up. Implementation intentions may be able to increase PA behaviour in the short-term but participants may need a "boost" in the form of an additional follow-up intervention to maintain the behaviour over time. Studies that have tested interventions using a booster found that the desired behaviours were maintained for longer than those without (Flieg, Pomp, Schwarzer, & Lippke, 2013; Müller-Riemenschneider, Reinhold, Nocon, & Willich, 2008). By providing additional interventions in the form of boosters, changes in PA behaviours may be maintained beyond the trial period (Flieg, Pomp, Schwarzer, & Lippke, 2013).

1.3 Physical Activity Measures

When assessing PA as an outcome, studies often use self-report measures because of the ease and affordability of these assessments (Dishman, Washburn, & Schoeller, 2001). However, these measures are at risk for many confounds. Participants may misreport their activity due to issues with memory, they may feel the need to report higher levels of activity due to social desirability, and they may not understand questions about PA or may not know what intensity of activity they are doing (Esliger & Tremblay, 2007). This creates a major limitation for PA behaviour change research, since the main outcome is PA levels. When performing a PA behaviour change intervention, it is important to know the degree to which the targeted behaviour has "*actually*" changed. Using objective measures (e.g., pedometers or accelerometers) of PA can help reduce these confounds and allows for a more accurate evaluation of the PA changes occurring over the course of these trials and gives a clearer picture of the success of the intervention.

Recent population-based research has highlighted the discrepancies between objective and subjective measures of PA (Colley et al., 2011; Eastwood, 2014; Troiano et al., 2008). In a survey of the Canadian population (Colley et al., 2011), 52.5% of people self-reported meeting recommended PA levels. When objectively measuring behaviour, only 15.4% were sufficiently active, highlighting the discrepancies between these measures. Further, recent research has suggested that objective measures can more effectively predict health-related outcomes compared to subjective measures (Anokye, Trueman, Green, Pavey, & Taylor, 2012; Celis-Morales et al., 2012). In addition,

although some the aforementioned studies focus on PA in bouts of 10-minutes or more, accelerometry can capture PA that happens in sporadic, short bouts of activity. Although studies typically examine PA in the form of structured activity occurring in 10-minute bouts, some evidence exists that suggests living an active lifestyle can help improve health (Ayabe et al., 2012; Glazer et al., 2013; Loprinzi & Cardinal, 2013). This free-living activity would be difficult to capture using self-report measures. Considering past research has examined both PA accumulated in 10-minute bouts and in free-living activity, it may be important to examine both and how PA relates to health outcomes in older cancer survivors.

1.4 Psychological Theory and Behaviour Change

Although it is clear that PA can improve QoL for cancer survivors, these findings alone are not enough to encourage cancer survivors to become more active. Interventions have been developed in an attempt to change health-related behaviour, but some may discount the importance of theory as a blueprint to intervention development. In many cases, health-related behaviour change interventions have greater success when developed around existing theories (Brown et al., 2011; Noar, Benac, & Harris, 2007; Webb & Sheeran, 2006). When reviewing PA specific interventions, Gourlan et al. (2016) found that theory driven PA interventions were able to create changes in PA behaviour that represented a small to medium effect. Although often successful, the theoretical framework applied can vary from one intervention to the next. A variety of theories have been used in PA behaviour change research. Nigg, Borrelli, Maddock, & Dishman (2008), identified the most commonly applied theories: Social Cognitive

Theory (Bandura, 1986), the Transtheoretical Model (Prochaska & Di Clemente, 1982), and the Theory of Planned Behaviour (TPB; Azjen, 1991). These theories have had success creating changes in a variety of populations, but it is important to determine the appropriate framework for the population being studied. In this study, the TPB was chosen because it is the most widely used in the field of PA behaviour change for cancer survivors (Pinto & Ciccolo, 2011), and interventions using this theory have had previous success changing PA behaviour in cancer populations (e.g., Lowe, Watanabe, Baracos, & Courneya, 2012; Vallance, Plotnikoff, Karvinen, Mackey, & Courneya, 2010).

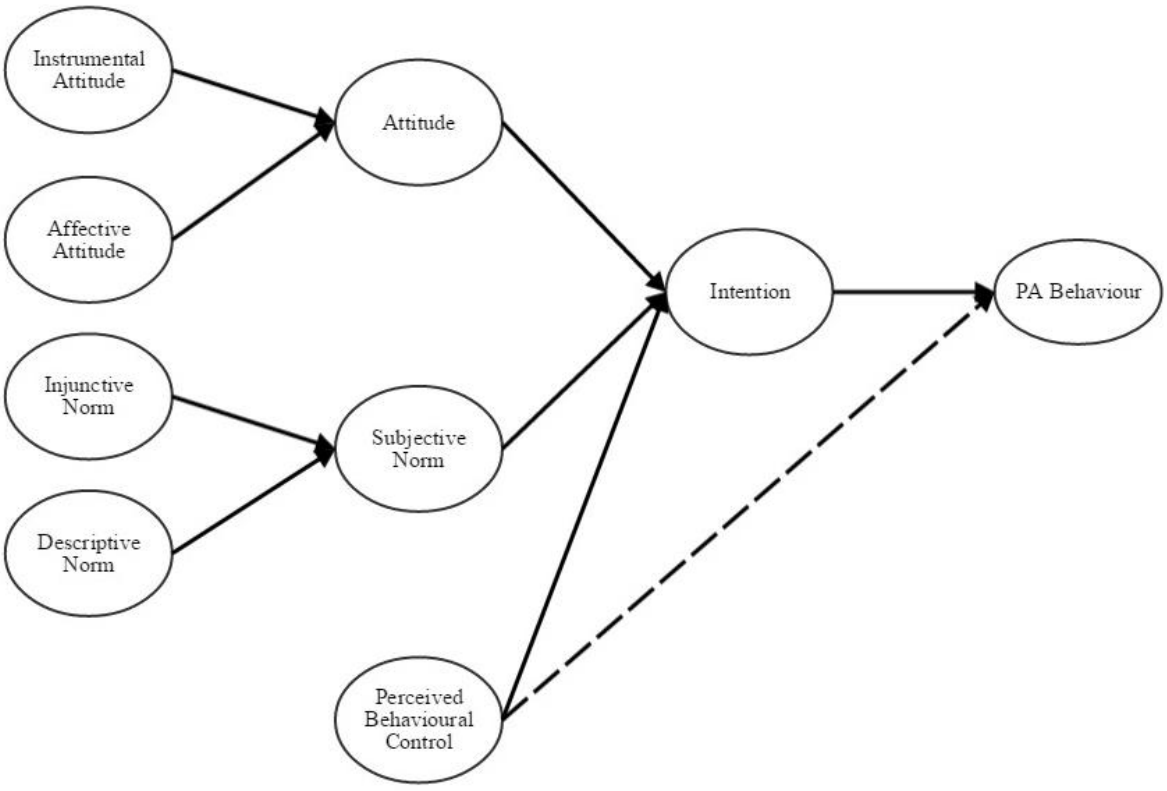

Figure 1. Ajzen's Theory of Planned Behaviour (adapted from Rhodes & Courneya, 2003).

The TPB posits that a person's behaviour is determined by their intentions (Ajzen, 1991). One's intention is determined by their attitude toward behaviour, subjective norms, and perceived behavioural control (Figure 1, Ajzen, 1991). Studies from cancer populations have shown that the TPB constructs of subjective norms, attitudes, and perceived behavioural control are associated with intentions to take part in PA and intentions are related to PA behaviours (Husebø, Dyrstad, Søreide, & Bru, 2012; Rabin, 2008). Regardless of this relationship, one's intentions do not always lead to behaviour. There can be a "gap" between ones intention and actions, where one may intend to act but this does not translate into action (Orbell & Sheeran, 1998). Implementation intentions (e.g., goal-setting and planning), may be able to help a person translate their intentions into desired behaviours (Gollwitzer, 1999). The TPB framework, along with implementation intentions, has been used as means of engendering PA behaviour changes in cancer populations (e.g., McGowan et al., 2013; Vallance, Plotnikoff, Karvinen, Mackey, & Courneya, 2010). Because cancer can be a "teachable moment" for many, a cancer survivor's intention to engage in beneficial behaviours is likely to be high (Demark-Wahnefried, Aziz, Rowland, & Pinto, 2005). The TPB framework allows for a better understanding of the driving force (i.e., constructs and intentions) behind a person's behaviour. Therefore, using interventions, which include implementation intention may increase the likelihood of intentions becoming action, thereby leading to potential increases in PA among cancer survivors.

1.5 Purpose of Study

Physical activity has been found to be safe and beneficial for cancer survivors. Despite this, cancer survivors are still inactive. The primary objective is to determine the utility of a goal-setting and planning intervention on aerobic and resistance exercise in older (55+) prostate and breast cancer survivors. A secondary objective will be to compare the effects of the intervention on QoL, fatigue levels, cancer specific symptom management, and physical functioning.

1.6 Significance of Study

This trial will provide a significant contribution to the PA and cancer literature by exploring: (1) cancer survivorship in older adults, (2) changing both aerobic and strength training practices, (3) what cancer survivors are *'actually'* doing through the use of objective measures, and (4) more frequent intervention delivery to produce longer-term behaviour change in cancer survivors. If the proposed trial proves to be effective at increasing PA levels, and improving QoL, fatigue, symptom management, and physical functioning in older prostate and breast cancer survivors it could impact the development of future PA interventions for cancer survivors. Specifically, as this intervention is print-based, as well as cost- and time-effective, it has the potential to reach large numbers of cancer survivors (i.e., variety of cancer groups, rural areas).

1.7 Objectives

- To explore the utility of an implementation intention intervention on aerobic and resistance training, and improving QoL, fatigue, and cancer symptom management in older (55+) prostate and breast cancer survivors.

- To explore the relationship between self-reported and objectively measured PA and QoL in older breast and prostate cancer survivors.
- To examine associations between self-reported and objectively measured PA levels in older breast and prostate cancer survivors.

1.8 Research Hypotheses

It is hypothesized that:

1) those who receive an implementation intention intervention will increase both aerobic and resistance training behaviours, and have improvements in QoL, fatigue, and cancer symptom management;
2) both self-reported and objectively measured PA will be related to QoL;
3) participants will self-report higher levels of PA than those measured objectively.

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Chapter 2 Literature Review

2.1 Cancer in Canada

It is predicted that two in five Canadians will develop cancer in their lifetime. Of these people, an estimated 25% will die of this disease (Canadian Cancer Society's Advisory Committee on Cancer Statistics [CCSACCS], 2015). In 2015, it was estimated that 196,900 Canadians would develop cancer and 78,000 would die from the disease. At the beginning of 2009, there were roughly 810,000 people living in Canada who had been diagnosed with cancer within the previous 10 years (CCSACCS, 2015). This number has continued to grow, and it is expected that there are now over one million cancer survivors in Canada alone. According to the Canadian Cancer Society and the National Coalition for Cancer Survivorship you are considered a 'cancer survivor', "from the time of diagnosis, through the balance of his or her life" (National Coalition for Cancer Survivorship, 2016, para. 1). Cancer survivors may deal with the side effects of cancer and its treatment years following diagnosis and some side effects may appear months or years following treatment (Stein, Syrjala, & Andrykowski, 2008). Additionally, in 2009, it was estimated that cancer cost the Canadian government $22.5 billion dollars and cost some families tens of thousands of dollars (Thomson & Young, 2011; Canadian Cancer Society, 2013). Due to the large population of cancer survivors and high cost of drugs and treatment, it is vital to develop cost effective programs to reduce mortality and morbidity in cancer patients and survivors as well as manage long-term side effects of cancer and its treatments.

Cancer is a disease of age. The Canadian Cancer Society (CCSACCS, 2015) reported the median age of cancer diagnosis is between 65 and 69 years and 89% of

cancers are diagnosed in those over the age of 50 years. Despite the fact that cancer is being diagnosed more often in older populations, the research on this group is lacking. In 2004, according to the American National Cancer Institute, 68% of cancer clinical trial participants were between the ages of 30 and 64 years (Murthy, Krumholz, & Gross, 2004). This age group accounted for 37.5% of cancer incidents in the same time frame. This is compared to the ages 65-74 and those 75 and up, who accounted for 23.7% and 8.3% of clinical trial participants respectively, while accounting for 31.4% and 31.2% of cancer incidents, respectively. In reviews focusing specifically on PA and cancer, Fong and colleagues (2012) reviewed 34 randomized, controlled trials, of which only four studies had a median age of 60 years or older. Similarly, in a review on resistance training for cancer survivors (De Backer, Schep, Backx, Vreugdenhil, & Kuipers, 2009), only three of the 24 studies had a mean age of 60 years or older. These numbers illustrate the underrepresentation of older adults in cancer research, despite this age group being most affected by the disease. Additionally, due to the combined deleterious effects of aging and cancer, older survivors often experience a greater reduction in physical function and health, as well as an increased risk of developing secondary cancers and other chronic disease (Avis & Deimling, 2008). Considering the majority of cancer cases occur in those 65 and older, and this population faces greater challenges than their younger counterparts, additional research on this population is warranted.

Among Canadians aged 60 and older, breast and prostate cancers are the most prevalent, accounting for 10.4% and 15.1% of new cases of cancer, respectively (Statistics Canada, n.d.). Despite this, breast and prostate cancers have some of the

highest survival rates. For those diagnosed with prostate cancer, the five year survival ratio is 96%, while for breast cancer it is 88% (CCSACCS, 2015). Survival rates have seen improvement over the last 25 years, as five-year survival rates for breast and prostate cancer from 1992-94 were 86% and 82%, respectively (CCSACCS, 2015). These improvements can be attributed to earlier detection and improved treatment methods. Typical treatment for breast cancer may include surgery, chemotherapy, radiation therapy, hormone therapy and targeted or bone-directed therapy (American Cancer Society, 2016a). Some patients may undergo a combination of these treatments. Similarly, the treatment for prostate cancer may include surgery, radiation therapy, cryotherapy, hormone therapy, chemotherapy, vaccine treatment, bone-directed treatment, or some may opt for watchful waiting (American Cancer Society, 2016b). These treatments can have a variety of side effects including bone loss, weight gain, fatigue, secondary cancers, and overall poorer health for cancer survivors than their cancer-free counterparts (DeSantis et al., 2014; Shapiro & Recht, 2001; Yabroff, Lawrence, Clauser, Davis, & Brown, 2004). Despite the high survival rates, many prostate and breast cancer survivors will live with the negative side effects of cancer and its treatment for years to come.

2.2 Quality of Life among Cancer Survivors

Quality of life (QoL) is a multidimensional construct consisting of physical, psychological, social, and spirituality components, that interact to create a subjective assessment of overall wellness (Carr, Higginson, & Robinson, 2003; Jansen, Koch, Brenner, & Arndt, 2010). Although cancer treatments have been improved, they are not

without negative side effects. Cancer-survivors have a worse QoL than those who have never had cancer (LeMasters, Madhavan, Sambamoorthi, & Kurian, 2013), which can negatively affect many aspects in the life of a cancer survivor. In general, cancer survivors are more likely to report poorer health, have issues with arthritis or bone injuries, hypertension, and report multiple comorbid conditions compared to a matched, cancer-free, control (Yabroff, Lawrence, Clauser, Davis, & Brown, 2004). Further, cancer survivors may also experience declines in QoL due to reductions in physical, mental, psychosocial, and functional health (LeMasters et al., 2013). In a trial by Saquib and colleagues (2011), they studied a sample of breast cancer survivors and found that those who had a poorer QoL were more likely to have breast cancer recurrence, and had higher rates of all-cause mortality. Additionally, it has been found that QoL can negatively impact financial status; cancer survivors with lower QoL are more likely to have a higher financial burden (Zafar et al., 2015). Because reduced QoL can impact a variety of areas in the life of a cancer survivor, it is important to develop means to help maintain or improve the QoL for this population.

2.3 Physical Activity and Quality of Life Among Cancer Survivors

Research has explored the role of physical activity (PA) as a means for improving QoL in cancer survivors. During treatment, cancer survivors have a significant reduction in PA levels and these levels rarely return to pre-diagnosis levels (Courneya & Friedenreich, 1997). Results from a recent community health survey in Canada found that only 17.8% of those with cancer and 22.6% of those with a past cancer diagnosis were classified as ‘active’ (>3.0 kcal/kg/daily, approximately 60 minutes of walking daily)

compared to 27.8% of those who had no history of cancer (Neil, Gotay, & Campbell, 2014). When exploring specific cancer types, the lowest rates of PA have been found in breast cancer survivors; only 16.6% were classified as active, while only 23.9% of prostate cancer survivors were active (Courneya et al., 2008). As a result, few cancer survivors are active enough to experience improvements in QoL or health (e.g., physical functioning, cancer-specific symptoms). This is unfortunate considering research has consistently demonstrated the benefits of PA for cancer survivors (Basen-Engquist et al., 2006; Fong et al., 2012; Milne, Wallman, Gordon, & Courneya, 2008).

Although PA levels decline during cancer treatment and do not typically return to pre-diagnosis levels, recent research suggests that behaviour change interventions can be successfully used to target and improve these behaviours in cancer survivors (e.g., Demark-Wahnefried et al., 2007; Vallance, Courneya, Plotnikoff, Yasui, & Mackey, 2007; von Gruenigen et al., 2008). Vallance and colleagues (2007) tested the effects of a behaviour change intervention aimed at improving QoL for breast cancer survivors. This program used mail-outs of tailored PA information and/or pedometers. At post-intervention, those who received print material along with pedometers increased self-reported PA, as well as QoL. Similar studies have also been done involving survivors of other cancer types. In a study involving breast, colorectal, and prostate cancer survivors, (Morey et al., 2009) a home-based intervention involving telephone counselling and mail-out workbooks was successful at improving PA behaviour, which subsequently improved QoL. A similar intervention from Demark-Wahnefried and colleagues (2007) utilized a 10-month mail-out program promoting an increase in healthy lifestyle

behaviours (e.g. diet, physical activity, smoking) in a sample of breast and prostate cancer survivors. Those in the experimental group received print materials, which included workbooks and newsletters tailored to the participant to encourage improving their lifestyle. Those who received this material had improved diet and exercise behaviours compared to an attention control group. The findings from these aforementioned studies demonstrate the importance of behaviour change interventions for increasing PA levels in cancer survivors.

Through interventions targeting PA, researchers have been successful at improving cancer survivors' QoL (Fong et al., 2012). In the most recent review on PA interventions and cancer survivors, Fong and colleagues (2012) examined 37 randomized controlled trials. Outcomes included body composition, QoL, psychological outcomes, and physical functioning. In multiple trials across different cancer types, the review found that PA was able to reduce body mass index (BMI), body weight, fatigue, and depression in cancer survivors. Results established that PA can improve the physical, social, and mental health components of QoL. Considering the physical, social, and mental health of a breast and prostate cancer survivor is negatively impacted by cancer and its treatments, these findings are especially important (Baumann, Zopf, & Bloch, 2012; Loprinzi & Cardinal, 2012). This review gives evidence that PA can help ameliorate these side effects and improve QoL for cancer survivors.

Further research is needed to determine exactly which type of intervention is most successful at creating PA behaviour change and which activities should be involved to create the greatest improvements in QoL and other health outcomes in cancer survivors.

Many trials use supervised PA within a research facility to determine the impact PA has on QoL. This type of research is beneficial, as it helps to determine the relationship between PA and QoL but these findings may not translate into increased PA post-intervention (Bourke et al., 2015), as they do not resemble a 'real-world setting'. There should be a focus on helping survivors continue their activity beyond a supervised exercise program by offering home-based programs to allow survivors to become more active in their leisure time.

In addition to benefiting survivors through creating changes in behaviours, home-based programs have been found to be the preference of cancer survivors (Jones & Courneya, 2002), but typically only focus on aerobic activity (Courneya, Rogers, Campbell, Vallance, & Friedenreich, 2015; Fong et al., 2012) despite the benefits of resistance training (e.g., Segal et al., 2009). Progressive resistance bands have been used as a means of increasing resistance training in home-based programs. An example of this was seen in a trial involving breast and prostate cancer patients who were beginning radiation therapy (Mustian et al., 2009). These participants did both aerobic (i.e., walking seven days a week for the four-week trial period) and resistance exercise (i.e., progressive resistance band training for seven days a week over the four-week trial period). This trial was successful at increasing both aerobic and resistance training behaviours, as well as improving cancer-related fatigue and QoL. These results suggest that using a combination of aerobic and resistance-training interventions can increase PA and QoL in a cancer population. The changes in resistance training behaviour that were observed in the trial from Mustian and colleagues (2009) are especially important for breast and prostate

cancer survivors bearing in mind the side effects of treatments. Hormone therapies and chemotherapy can result in loss of bone density, osteoporosis, and loss of muscle mass (Saylor & Smith, 2009; Van Poznak & Sauter, 2005), all of which can be positively impacted by resistance training (Galvão et al., 2006; Schwartz, Winters-Stone, & Gallucci, 2007; Van Poznak & Sauter, 2005). Cancer survivors should be encouraged to take part in resistance training to emiliorate common side effects of cancer treatments. Lastly, a program such as this is also similar to 'real-world' conditions and results can potentially be replicated when implemented at a population level. By creating home-based interventions, more people can be reached, creating larger scale behaviour changes (Harden, Fanning, Motl, McAuley, & Estabrooks, 2014; Pinto, Frierson, Rabin, Trunzo, & Marcus, 2005).

A cancer diagnosis has been identified as a "teachable moment", meaning it can be a time in which people are more willing to make lifestyle changes (McBride, Clipp, Peterson, Lipkus, & Demark-Wahnefried, 2000). Many who are diagnosed with breast and prostate cancers are likely to live at least 5-10 years past diagnosis (CCSACCS, 2015); therefore, it would be beneficial to encourage PA within this population to ensure the best QoL during their cancer survivorship. Because of the importance of PA for cancer survivors, and the increased willingness to make lifestyle changes during a "teachable moment," it is essential that increases to PA behaviours are encouraged within this population. Interventions have been developed which create PA changes, but, because of the large number of cancer survivors, more needs to be done to ensure these

interventions are able to impact a greater number of people, and can be easily implemented while remaining cost and time effective.

2.4 Physical Activity and Older Cancer Survivors

Older cancer survivors may experience greater deterioration in QoL, as the combination of aging and cancer treatment may worsen age-related decline (Courneya et al., 2004). In a review of studies that tested the effects of exercise on older cancer survivors, Courneya and colleagues (2004) suggest that PA may help offset the decline in health. Although research is limited, initial findings suggest exercise in older cancer survivors can improve, or reduce the decline in, physical and mental function (Courneya et al., 2004). Considering the impact of cancer on older persons, more needs to be done to determine how existing research and interventions may be applied to an older age group, and the benefits that may be gained from PA interventions.

Beyond the intensified effects caused by the combined decline of aging with a cancer diagnosis, this segment of the population also must deal with a greater negative impact of cancer treatment. Older cancer patients are more likely to have infection, longer hospital stays, and additional complications following cancer surgery (Courneya et al., 2004). Older cancer survivors are also at a high risk of developing depression, fatigue, bone loss, and muscle wasting. Although PA has been shown to help offset these side effects, population research shows that older adults are typically the least active and most sedentary segment of the population (Colley et al., 2011; Matthews, et al., 2008; Troiano et al., 2008). Because PA rates often drop during cancer treatment and may not return to prediagnosis levels (Courneya & Friedenreich, 1997; Irwin et al., 2004), older

cancer survivors are also the least active, as compared to their younger counterparts (Neil, Gotay, & Campbell, 2014). This is unfortunate, considering the potential benefits that could be achieved by increasing PA behaviours.

From the few studies that have been done among older cancer survivors, it appears there are many potential benefits that can be received by this population through PA. Supervised PA programs designed for older cancer survivors have improved muscle strength and mass, mobility, cardiopulmonary function, and overall QoL (Courneya et al., 2003; LaStayo, Marcus, Dibble, Smith, & Beck, 2011; Winters-Stone et al., 2012). These trials highlight the benefits of PA for this population, but it is also important to test behaviour change interventions to increase PA behaviours outside of a supervised environment. In one of the few randomized controlled behaviour change trials focusing on older cancer survivors, the RENEW trial tested a tailored, home-based program aimed at increasing PA, improving diet, and encouraging weight loss (Demark-Wahnefried et al., 2012; Morey et al., 2009). Those in the intervention group were compared to a waitlist control group, and it was found that both groups had a decline in physical function but the decline was significantly less in the intervention group (Morey et al., 2009). Additional outcomes from this trial showed that even those who only increased their light intensity activity (1.5-2.9 Metabolic Equivalent of Task [METs]) levels saw attenuations in functional decline (Blair et al., 2014). This program was successful at increasing PA behaviours, and thereby reducing the rate of functional decline in a sample of older, overweight, breast, prostate, and colorectal cancer survivors. Through interventions aimed at increasing PA behaviours in older cancer survivors, we can

improve QoL, and may improve or slow the decline of physical function (Demark-Wahnefried et al., 2006; Morey et al., 2009). Regardless of the early success, and the number of older cancer survivors, there is very little research available targeting this age group. This is a significant gap in the PA and cancer literature and should be a focus of future trials.

2.5 Physical Activity and Breast Cancer Survivorship

Although there are many potential side effects of breast cancer and its treatment, PA has been shown to be a safe and effective means of counteracting these side effects. Physical activity can significantly impact QoL, fatigue, physical function, aerobic fitness, and body composition of breast cancer survivors (McNeely et al., 2006; Schmitz, 2011). There has been a great deal of research conducted on breast cancer patients and survivors, as they are a highly motivated group and willing to take part in PA trials. From Fong and colleagues (2012), 65% of the studies reviewed were either done among only breast cancer survivors or had some breast cancer survivors as participants. Due to the overrepresentation of breast cancer survivors, researchers have been able to test a variety of programs with this population. This has led to a great deal of evidence for the benefits of PA for this population as well as a large amount of heterogeneity in the literature.

Research has clearly illustrated the benefits of PA for breast cancer survivors. Through a variety of programs, PA has been found to improve QoL, physical fitness and function, cardiopulmonary function and reduce fatigue, anxiety, disease-related and all-cause mortality and risk of cancer recurrence (Courneya et al., 2003; McNeely et al., 2006; Schmid & Leitzmann, 2014; Schmitz, Ahmed, Hannan, & Yee, 2005; Segar et al.,

1998). Regardless of the wealth of research, breast cancer survivors remain the least active, as compared to other cancer types (Courneya et al., 2008). Similar to the research testing the effectiveness of PA for improving health outcomes in breast cancer survivors, there is a plethora of behaviour change interventions that have been tested, but there are gaps remaining in this field.

Bluethmann, Vernon, Gabriel, Murphy, & Bartholomew (2015) reviewed high quality, randomized, controlled behaviour change trials among breast cancer survivors. They noted the heterogeneity of methods and assessments within these trials, as methods varied in the areas of supervision, mode of delivery, and length of trial. Typically, long-term follow-ups were not performed, and when they were, behaviour changes were not maintained. Further, the range of mean ages for these trials was 45-60, which is not representative of the population of breast cancer survivors. Although there is an abundance of research in the field of PA and breast cancer survivorship, there is room for improvement. More should be done to determine how to best maintain changes in PA behaviours beyond the trial period, or for a longer period of time, and the samples used within these studies should be more representative of the true breast cancer population.

The heterogeneity of PA trials among breast cancer survivors can be seen in the type of activity recommended for participants. Trials have been done using only aerobic or only resistance training as well as a combination of both. Some have used a solely aerobic exercise program and found success improving multiple outcomes, such as overall QoL, happiness, cardiopulmonary outcomes (Courneya et al., 2003). Studies using resistance exercise have also had success improving multiple aspects of breast

cancer survivorship. Improvements have been seen in both overall physical and psychological QoL, lean muscle mass, and upper and lower body strength (Ohira, Schmitz, Ahmed, & Yee, 2006; Winters-Stone et al., 2012). Aerobic and resistance training is typically aimed at improving different physical outcomes. Aerobic exercise focuses on improving cardiopulmonary outcomes (i.e., heart and lung efficiency, reduced blood pressure, and lower triglycerides) and resistance exercise for increasing muscle mass, size, and strength (Anshel, 2006); therefore, it is plausible that a combination of the two would allow for greater improvements than a single approach. There is limited evidence available but current research suggests that combining resistance and aerobic activity creates significantly larger effects than aerobic alone (Fong et al., 2012).

Although the existing results have been positive, there have been limited studies testing the effects of combined aerobic and resistance exercise on breast cancer survivors. Herrero and colleagues (2006) tested a combined aerobic and resistance training program on a sample of breast cancer survivors. Over the eight-week trial period, participants took part in both resistance training and aerobic activities. At the end of the program, participants were compared to a sedentary control group. Those in the intervention group had significantly improved QoL on the European Organization for Research and Treatment of Cancer Questionnaire QLQ-C30 (EORTC-C30), muscle function through sit-to-stand testing and leg press performance, and cardiorespiratory function through VO_{2peak} compared to a control group. Findings such as these suggest that breast cancer survivors can benefit from a PA intervention that uses both aerobic and resistance training, even over a short period of time. Although these results are promising, this study

is not without limitations. As this was considered a pilot study, the sample size was quite small (*N*= 16), therefore, larger trials should be conducted to ensure these results are consistent. Considering the large amount of research on PA among breast cancer survivors, it is clear that it is important to encourage survivors to take part in PA to improve survivorship. Studies can be improved by encouraging changes in both aerobic and resistance training activity and testing novel methods to create longer-term behaviour changes.

2.6 Physical Activity and Prostate Cancer Survivorship

Although there is a wealth of PA research on breast cancer survivorship, other cancer types are lacking the quality and quantity of evidence. Prostate cancer is the most common cancer among Canadian men and survivors of this disease often face unique challenges. Of the 2 million prostate cancer survivors in the US, more than a third are receiving androgen deprivation therapy (ADT) through the use of gonadotropin-releasing hormone agonists (Saylor & Smith, 2009), which is the most commonly used therapy (Keating, O'Malley, & Smith, 2006). The use of this treatment can often result in weight gain, loss of muscle mass, and loss of bone mineral density for men receiving this therapy (Higano, 2003). Physical activity can improve these side effects but resistance exercise is especially vital for prostate cancer survivors, as resistance exercise can have an impact on most, if not all, of these side effects (Segal et al., 2003).

In a review on studies involving prostate cancer survivors, Thorsen, Courneya, Stevinson, & Fosså (2008) examined the effects of PA on several health outcomes. Through the review of 16 studies, PA was found to offer improvements in a variety of

areas for participants including QoL, physical function, fatigue and muscular fitness. The studies reviewed included a variety of different interventions of varying quality. Some were randomized controlled trials while others were observational. The outcomes were clear regardless; increased PA improves multiple health outcomes in prostate cancer survivors. Further, in many of the studies reviewed, the interventions made use of resistance exercise either alone or in combination with other activities.

In a trial of men receiving ADT for prostate cancer, Segal and colleagues (2003) found that the use of resistance training was able to improve QoL and fatigue. Participants took part in a 12-week program that consisted of three weekly progressive strength-training exercises led by a fitness consultant. Compared to a waitlist control group, it was found that the exercise group had improved health-related QoL and fatigue, while the control had slight declines in both. These results suggest that the use of resistance exercise is beneficial for the QoL in men with prostate cancer receiving ADT. Similar outcomes have been found in other studies which offer a structured resistance training program for prostate cancer survivors (Galvão et al., 2006; Galvão, Taaffe, Spry, Joseph, & Newton, 2010; Winters-Stone et al., 2015); including improvements in strength for multiple muscle groups, lessened disability, improved physical function, and body composition. These studies provide strong evidence of the importance of resistance activity for prostate cancer survivors undergoing ADT, but are limited by the use of a supervised facility as opposed to a home-based approach. These supervised, structured activity programs are often more expensive to implement, as compared to behavioural or lifestyle interventions and may create additional barriers due to cost, transportation, and

scheduling (Müller-Riemenschneider, Reinhold, & Willich, 2009; Pinto, Frierson, Rabin, Trunzo, & Marcus, 2005). Finally, home-based approaches have been found to be the preference for cancer survivors (Jones & Courneya, 2002), so they should be used when possible.

Although less common, home-based resistance training programs have been implemented through the use of inexpensive equipment. A trial using both aerobic and resistance training in a home-based setting was implemented by Culos-Reed and colleagues (2010) with a sample of prostate cancer survivors. This intervention consisted of an individually tailored PA program, which consisted of walking, stretching and resistance exercises using Thera-Bands. Participants also attended weekly group booster sessions in which they took part in an hour of activity and a half hour of discussion and education. Those in the intervention group significantly increased their PA levels, and improved blood pressure and neck and waist girth. These findings again indicate how activity programs can impact the health of prostate cancer survivors. Considering the benefits, it is apparent that the focus needs to be how to encourage cancer survivors to become active or to increase their activity.

To address the needed behaviour change in prostate cancer survivors, McGowan, North, & Courneya (2013) tested the efficacy of an implementation intention intervention on PA and QoL in a sample of prostate cancer survivors. This was the first trial to test an implementation intention intervention for increasing PA for any cancer type. The design of this study was a three-armed randomized controlled trial, using a telephone-assisted implementation intention intervention and comparing the outcomes to a self-administered

implementation intention intervention and an attention control group that received only standard PA guidelines. The implementation intention intervention consisted of a goal-setting and planning activity designed to help participants increase their PA levels. The results of this trial found that the self-administered group significantly increased their PA levels by 168-minutes per week, while the telephone-assisted and standard recommendation group had smaller, not significant changes in PA behaviours. Unfortunately, these changes were not maintained at the three-month follow-up, which suggests this type of implementation intention intervention can lead to short-term increases in PA in cancer survivors. It is plausible that subsequent interventions are needed to help participants maintain these changes over time. More research is needed to determine how best to create and maintain longer-term PA behaviour changes.

2.7 Theory of Planned Behaviour

Although it is clear that PA can improve QoL for cancer survivors, these findings alone are not enough to encourage cancer survivors to become more active. Interventions have been developed in an attempt to change health-related behaviour but some may discount the importance of theory as a blueprint for intervention development. Theory allows researchers to better understand and predict PA behaviours of participants, as well as create outlines on which to build future interventions (Lox, Martin Ginis, & Petruzzello, 2010). Additionally, health-related behaviour change interventions have greater success when developed around existing theories (Brown et al., 2011; Noar, Benac, & Harris, 2007; Webb & Sheeran, 2006). When reviewing PA specific interventions, Gourlan and colleagues (2016) found that theory-driven PA interventions

were able to create changes in PA behaviour that represented a small to medium effect. Although often successful, the theoretical framework applied can vary from one intervention to the next. A variety of theories have been used in PA behaviour change research, Nigg, Borrelli, Maddock, & Dishman, (2008) identified the most commonly applied theories: Social Cognitive Theory (Bandura, 1986), the Transtheoretical Model (Prochaska & DiClemente, 1983), and the Theory of Planned Behaviour (TPB; Azjen, 1991). These theories have had success creating changes in a variety of populations, but it is important to determine the appropriate framework for the population being studied. In this study, the TPB was chosen because it is the most widely used in the field of PA behaviour change for cancer survivors (Pinto & Ciccolo, 2011), and it has previous success changing PA behaviour in cancer populations (Vallance, Plotnikoff, Karvinen, Mackey, & Courneya, 2010; Lowe, Watanabe, Baracos, & Courneya, 2012).

The TPB posits that an individual's intention is the main determinant of whether they will perform a certain behaviour, such as PA (Ajzen, 1991). Intention is shaped by three constructs: attitude, subjective norms, and perceived behavioural control (PBC; Ajzen, 1991). Attitude is generally how positive or negative one feels about performing the behaviour and is influenced by both affective (is the behaviour enjoyable/unenjoyable) and instrumental attitudes (is the behaviour beneficial/harmful; Ajzen, 2000; Courneya, Karvinen, & Vallance, 2007). Subjective norm describes one's feelings of societal pressure to perform the behaviour and consists of injunctive norms (whether important others would want them performing this behaviour) and descriptive norms (whether important others are performing this behaviour; Ajzen, 2000; Courneya,

Karvinen, & Vallance, 2007). Lastly, PBC is one's belief about how much control they personally have over performing the behaviour, which includes self-efficacy (confidence in ability to perform the behaviour) and controllability (how much personal control to perform the behaviour; Ajzen, 2000; Courneya, Karvinen, & Vallance, 2007). This model has been found to predict PA behaviour in cancer populations (e.g., Vallance, Courneya, Plotnikoff & Mackey, 2008). In a sample of breast and prostate cancer survivors (Blanchard, Courneya, Rodgers, & Murnaghan, 2002), 45% of the variance in exercise intention of breast cancer survivors and 36% of the variance in prostate cancer survivors was explained by the constructs of attitude, subjective norm, and perceived behavioural control. Given its previous success among cancer populations, this model gives a framework aid in the development of successful behaviour change interventions by providing constructs to target.

However, intentions do not always lead to behaviour. There can be a "gap" between ones intention and their actions, where one may intend to act but this does not translate into action (Orbell & Sheeran, 1998). By using implementation intentions (e.g., goal-setting and planning), one may be able to translate their intentions into the desired behaviour (Gollwitzer, 1999). Through the use of the TPB, alongside implementation intentions, PA behaviour changes in cancer populations may be generated (McGowan, North, and Courneya, 2013; Vallance, Plotnikoff, Karvinen, Mackey, & Courneya, 2010). Cancer can be a "teachable moment" for many, therefore, a cancer survivor's may have high intentions to engage in positive health behaviours (Demark-Wahnefried, Aziz, Rowland, & Pinto, 2005). Through the TPB framework, we can understand the driving

force behind a person's behaviour. By targeting constructs of this theory, we can increase the likelihood of intentions becoming action, thereby increasing PA among cancer survivors and impacting QoL.

2.8 Assessment of Physical Activity

Physical activity is defined as "any bodily movement produced by skeletal muscles that result in energy expenditure" (Caspersen, Powell, & Christenson, 1985, para. 2). This differs from the term exercise as exercise is defined as "a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness" (Caspersen, Powell, & Christenson, 1985, para. 2). Physical activity, even at light intensities, has been found to reduce the rates of chronic disease, and therefore is more often the target of public health interventions than exercise (Smith, Ekelund, & Hamer, 2015). When designing interventions to enhance PA in cancer survivors, researchers have numerous methods that they can use to quantify PA. Care must be taken when choosing the approach, as results may be impacted by how the PA of participants is assessed. Broadly, PA is assessed either subjectively or objectively. Subjective measures are gathered through self-report methods; such are recall or diaries. Objective measures of PA include direct observation or through the use of a device such as a pedometer or accelerometer. There is no "gold standard" for PA measurement, which has resulted in over a dozen different ways to capture a participant's PA behaviours (Dishman, Washburn, & Schoeller, 2012). When comparing self-report and objective measures of PA, objective measures are at less risk of biases (e.g., social desirability, recall issues, misinterpretation of questions; Esliger &

Tremblay, 2007), but can be more expensive and harder to implement in larger samples or at a population level. Conversely, self-report measures are usually inexpensive and simple to implement, regardless of population size. Much of the behaviour change research has used self-report as the sole measure of PA behaviour regardless of the risk of biases.

A recent review from Prince and colleagues (2008), examined the agreement between subjective and objective assessments of PA. This review included 173 studies that used both subjective and objective measures within the same study. Of these studies, 148 reported correlations between self-reported and objectively measured PA, which ranged from -0.71 to 0.98, with a low-to-moderate mean correlation of 0.34. Population-based research has further highlighted the discrepancy between subject and objective measures of PA, while also providing strong rationale for using objective measures in PA research. In the US, the National Health and Nutrition Examination Survey (NHANES) found that from a sample of 4773 adults, 59.6% reported meeting the PA guidelines of 150-moderate-to-vigorous PA minutes per week, in bouts of at least 10-minutes (Tucker, Welk, & Beyler, 2011). When assessed using an accelerometer, only 8.2% were found to be meeting these guidelines. Similar population-based results have been found in Canada (Colley et al., 2011) and the United Kingdom (Eastwood, 2014), highlighting the discrepancies between these measures.

In addition, although some studies focus on PA in bouts of 10-minutes or more, accelerometers can capture PA that happens in sporadic, short bouts of activity. Some evidence exists that suggests living an active lifestyle can help improve health outcomes,

as opposed to just PA in 10-minute bouts (Ayabe et al., 2012; Glazer et al., 2013; Loprinzi & Cardinal, 2013). This free-living activity would be difficult or impossible to capture using self-report measures. Further, recent research has suggested that objective measures can better predict health-related outcomes than subjective, making them especially useful for research with cancer-related outcomes (Anokye, Trueman, Green, Pavey, & Taylor, 2012; Celis-Morales et al., 2012).

Objective measures of PA are currently not commonly used but are gaining popularity. When comparing objective measures of PA, accelerometers have benefits over other measures, such as pedometers, as they can not only assesses duration of activity but also intensity (Westerterp, 1999). In addition, accelerometers can be used to assess a larger breadth of activities than a pedometer, as they can record amount of time spent in different positions as opposed to a single measurement of daily activity. Accelerometers are a beneficial tool for PA research to get an accurate assessment of participants' activity levels without relying solely on self-report measures. Regardless, studies focusing on PA among cancer survivors typically use self-report as the means of assessing PA behaviour.

When reviewing randomized PA trials among cancer survivors, Rogers (2010) identified only 10 trials that had used either pedometers or accelerometers to assess the PA behaviours of participants. Considering the importance of PA in this population, it is crucial to determine what they are '*actually'* doing to determine the impact of differing levels of activity and, for a behaviour change intervention, to determine if the behaviour has in fact changed (i.e., success of the intervention). Most research to date has not

included objective measures of PA, even though it is central to determining the relationship between PA and QoL (Rogers, 2010). Because many of these interventions are assessing PA as a primary outcome, it is especially important to get the most accurate assessment of these behaviours to get a clear picture of the efficacy of the intervention being tested.

2.9 Rationale and Significance

Based on the aforementioned limitations in the PA and cancer literature, it is important to rectify these shortcomings to better explore how PA behaviours (i.e., both aerobic and resistance) impact QoL in older cancer survivors. In addition, this study will explore a novel method of creating longer-term changes in PA behaviours in this population through the use of booster interventions. To do this, we will use the TPB as a framework to target and predict behaviour change, as well as make use of objective measures of PA to get a more accurate assessment of 'actual' PA levels. The proposed study will address the gaps in the literature, and test the use of a novel theory-driven intervention to improve PA behaviours and QoL in older breast and prostate cancer survivors.

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Chapter 3
Randomized Controlled Trial of a Behaviour Change Intervention to Increase Aerobic and Resistance Exercise and Quality of Life in Older Prostate and Breast Cancer Survivors: The OutPACE Trial

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3.1 Introduction

Breast and prostate cancer are the most prevalent cancer types in Canadian women and men, respectively. These cancers account for around 25% of new diagnoses yearly, most of which occurring in those 50 years of age and older (Canadian Cancer Society's Advisory Committee on Cancer Statistics [CCSACCS], 2015). Despite high diagnosis rates, survival rates for both cancers are high. Unfortunately, treatments that improve survival can have physical and psychological side effects, which can be acute and/or late appearing (e.g., weight changes, bone loss, fatigue), and can significantly impact cancer survivor's quality of life (QoL; Irwin, 2013; LeMasters, Madavan, Sambamoorthi, & Kurian, 2013). Research has found that, in older cancer survivors, declines in QoL can be worsened by the accompanying declines from aging (Courneya et al., 2004). Since cancer is a disease of age, the number of older cancer survivors in Canada is large and growing, creating an increasing need for the creation of novel and innovative means to improve their health, wellbeing, and QoL.

One research area that has received increased attention is physical activity (PA). Research has shown that, by increasing or maintaining PA levels, cancer survivors may improve their QoL, lessen declines in physical functioning, reduce cancer-related fatigue, improve lean body mass and muscle strength, as well as reduce cancer-related and all-cause mortality, and decrease the likelihood of cancer recurrence (Brown et al., 2011; Holmes, Chen, Feskanich, Kroenke, & Colditz, 2005; Kenfield, Stampfer, Giovannucci, & Chan, 2011; Morey et al., 2009). Regardless of the evidence to support the value of PA for cancer survivors, many are not doing enough to achieve these benefits (Neil, Gotay,

& Campbell, 2014). According to the American College of Sports Medicine and the American Cancer Society, it is recommended that cancer survivors meet the same guidelines as the general population (Rock et al., 2012; Schmitz et al., 2010); 150 minutes of moderate-to-vigorous PA (MVPA) per week. These guidelines detail the benefits of activity, recommended amounts of PA, suggestions on how to be more active, and examples of moderate and vigorous activities. Survivors should also take part in two days of muscle strengthening activity weekly. This is particularly important for this population, since treatments for breast and prostate cancers (i.e., hormone therapies, radiation therapy) can result in unique side effects that can be offset by resistance training (e.g., decreased muscle strength and mass, loss of bone mass; DeSantis et al., 2014; Shapiro & Recht, 2001; Yabroff, Lawrence, Clauser, Davis, & Brown, 2004).

Although it is clear that PA can improve QoL for cancer survivors, many are not active enough to receive these benefits; therefore, novel, inexpensive, and far-reaching behaviour change interventions are needed. Further, behaviour change interventions aimed at increasing PA behaviour should incorporate theory to improve their effectiveness. The Theory of Planned Behaviour (TPB) is the most widely used theory in the field of PA behaviour change for cancer survivors, and has been found to be successful at changing PA behaviour in cancer populations (i.e., Lowe, Watanabe, Baracos, & Courneya, 2012; Pinto & Ciccolo, 2011; Vallance, Plotnikoff, Karvinen, Mackey, & Courneya, 2010). The TPB posits that a person's behaviour is determined by their intentions, which are influenced by one's attitude toward the behaviour, subjective norms, and perceived behavioural control (Ajzen, 1991). Regardless of this relationship,

one's intention does not always lead to action resulting in a "gap" between ones' intention and actions (Orbell & Sheeran, 1998). Implementation intentions focus on creating detailed action plans (i.e., what, how, where, and who) to perform the desired behaviour (Gollwitzer, 1999) to bridge this gap.

Although trials have had some success in changing behaviour in cancer survivors, these changes are often short-lived. McGowan, North, and Courneya (2013) tested an implementation intention intervention among prostate cancer survivors, which increased PA levels at one-month follow-up, but this change was not maintained at a three-month follow-up. To maintain these changes and further improve QoL, it is suggested that participants may need additional strategies, such as boosters (i.e., behaviour change interventions subsequent to the primary intervention). Studies testing interventions using a booster have found that the desired behaviours were maintained for longer than those without (Flieg, Pomp, Schwarzer, & Lippke, 2013; Müller-Riemenschneider, Reinhold, Nocon, & Willich, 2008). This is the first study to our knowledge to test a booster implementation intention intervention in any cancer population.

When assessing PA as an outcome, studies often use self-report measures because of the ease and affordability of these assessments (Dishman, Washburn, & Schoeller, 2001); however, these measures are at a high risk of biases, leading to a discrepancy between self-report and objective measures (Colley et al., 2011; Eastwood, 2014; Esliger & Tremblay, 2007; Troiano et al., 2008). To better understand how the targeted behaviour has '*actually*' changed, objective measures of PA should be considered to help reduce confounds and give a more accurate evaluation of PA changes, illustrating the

success of the intervention. This is especially important when assessing QoL, as it has been found that objective measures can better predict health-related outcomes than self-report (Anokye, Trueman, Green, Pavey, & Taylor, 2012; Celis-Morales et al., 2012).

In this paper, we report the primary results of the OutPACE trial, which was designed to explore the effectiveness of a one-time and a two-time implementation intervention on aerobic and resistance behaviours and QoL in older (55+) breast and prostate cancer survivors. It is hypothesized that the two-time and one-time implementation intention intervention groups will report greater increases in self-reported and objectively measured PA, resistance training, and QoL compared to the control group. It is also anticipated that the two-time implementation intention group will be more beneficial than the one-time implementation intention group.

3.2 Methods

3.2.1 Participants and Procedures

Ethical approval was obtained from the host institutions ethics committee and the study was registered with ClinicalTrials.gov (NCT02321358). The study is a prospective, three-armed, randomized, controlled trial. Participants were recruited through posters and brochures at local hospitals and cancer clinics, presentations at local support groups, and through the Newfoundland and Labrador Cancer Registry. Eligible survivors who expressed an interest in participating were mailed the initial study package, which contained: (a) an information letter explaining the study, (b) the baseline questionnaire booklet, and (c) a postage-paid return envelope. To participate, participants returned the completed questionnaire and were contacted by the research team for further instruction.

To improve response rates, postage-paid business reply envelopes, coloured paper, assurances of confidentiality, and university/institution sponsorship were provided (Ransdell, 1996). This study followed the Total Design Method survey protocol (Dillman, 2000), including a postcard reminder and second questionnaire package for those who had not returned their baseline questionnaire.

Assessments were conducted at baseline (prior to randomization) and at one- and three-months post-randomization. The baseline measurements consisted of assessments of PA behaviours through objective and subjective measures, and a questionnaire measuring demographic and medical variables, cancer-specific symptoms, QoL, fatigue, and the TPB constructs (data not presented). The one- and three-month follow-up questionnaires assessed the same measures as the initial questionnaire package with the exception of the medical and demographic questionnaires.

3.2.2 Randomization

After completing the baseline assessment, participants were randomized at a 1:1:1 ratio into one of the three groups using a computer-generated random numbers list (GraphPad Software, San Diego, CA): (1) two-time implementation intention, (2) one-time implementation intention, and (3) control groups.

3.2.3 Intervention Groups

The one and two-time implementation intention groups received the CSEP Canadian PA Guidelines for Adults (18-64 years of age; CSEP, 2012a) and for Older Adults (65+ years; CSEP, 2011b). The two implementation intention groups also received a resistance training DVD and three progressive resistance training Thera-

Bands. The DVD was developed by a Certified Exercise Physiologist with experience working in clinical populations, and was modelled after existing cancer resistance training programs (Culos-Reed et al., 2010; Mustian et al., 2009; Segal et al., 2009; Segal et al., 2003; Winters-Stone et al., 2012). This DVD followed the ACSM recommendations for progressive resistance training for novice weightlifters and older adults, which suggest one to three sets of eight to ten exercises at a resistance where participants can complete eight to 12 repetitions (i.e., 60–80% of one-repetition maximum; Chodzko-Zajko et al., 2009; Ratamess et al. 2009). Lastly, the DVD included information about proper techniques to avoid injury, explained progression, and exercise modifications.

In addition, participants who were not in the control group received an implementation intention intervention to complete on their own. The intervention began by explaining the S.M.A.R.T. (i.e., specific, measurable, attainable, realistic and timely; Doran, 1981) goal-setting principles to help participants set quality goals for themselves. Participants were instructed to write down their current PA levels (e.g., duration, intensity, and frequency) before creating a new PA goal based on the PA guidelines. If they were currently meeting the guidelines, they were asked to further increase their aerobic and resistance activity; if they were not currently meeting the guidelines, they were encouraged to increase their activity to meet these guidelines. After completing the goal-setting portion of the activity, participants were asked to make a detailed plan on how they intended to achieve their goal. They were encouraged to be as detailed as possible and describe where and when they would be active and how and with whom

they intend to be active. Participants were also encouraged to identify three PA barriers that may prevent them from being active and develop strategies to overcome these barriers. Finally, once the goal-setting and planning activity was completed, participants created a summary sheet where their activity goal, plan, barriers, and strategies for overcoming these barriers were highlighted. This summary was to be placed in a visible location, such as on the fridge or on a nightstand for encouragement. Participants also received an activity tracker sheet, which allowed them to track their progress toward their goals.

The two-time implementation intention group received a follow-up implementation intention intervention activity six weeks after the first intervention. This second implementation intention activity was mailed out as a booster to allow participants to refine their goals after some experience with goal-setting and being active. It also served to help keep participants motivated and maintain behaviour changes received from the initial intervention until the post-intervention follow-up (Janssen, De Gucht, van Exel & Maes, 2014).

The control group was given the Canadian Food Guide to Healthy Eating (Health Canada, 2011), which is a publicly available educational brochure on healthy eating. They did not receive any information related to PA, as previous research has shown that simply providing PA public health guidelines may increase PA levels in cancer survivors (McGowan et al., 2013). Since it has been clearly established in the literature that PA and exercise can help alleviate the negative effects experienced by cancer survivors from their treatments (i.e., loss of muscle mass and bone density, increased fat mass, fatigue;

LeMasters, Madavan, Sambamoorthi, & Kurian, 2013; Irwin, 2013), those in the control group were provided all intervention materials following the final follow-up.

3.2.4 Measures

Participants' demographic and medical information was assessed using self-report. Demographic variables included age, marital status, education level, family income, current employment status, and weight and height to calculate body mass index (BMI). Medical variables assessed included date of diagnosis, disease stage, treatments (e.g., watchful waiting, surgery, radiation, chemotherapy, and hormone therapy), current status of treatments, cancer recurrence, and current disease status.

The primary outcome of this study was PA, both aerobic and resistance. Aerobic activity was assessed using both self-report and objective measures, while resistance activity was assessed using self-report alone. The leisure score index (LSI) of the Godin Leisure Time Exercise Questionnaire (Godin & Sheppard, 1985) was used to assess self-reported PA, as it has been extensively validated (Jacobs, Hartman, & Leon, 1993). The LSI uses three questions to assess the frequency of light, moderate, and vigorous PA over a typical week in the past month, performed for at least 10-minutes during one's leisure time. For the purpose of this trial, the LSI was modified to contain a measure for duration, which is a common modification in the field of PA and cancer (e.g., Courneya et al., 2002; McGowan et al., 2013). Resistance training was assessed with a similar modification - participants were asked the frequency, duration, and type of resistance activities they had taken part in over the previous week or month (Speed-Andrews et al., 2013). These modifications allowed for the calculation of self-reported PA minutes,

which were used as our primary endpoint, and to determine whether participants were meeting the recommended PA guidelines (i.e., 150-minutes of MVPA per week).

Physical activity was objectively measured using the ActiGraph wGT3X-BT tri-axial accelerometer (ActiGraph, LLC, Pensacola, FL, USA), which has been found to be a valid and reliable PA measure (Santos-Lozano et al., 2013; Skotte, Korshoj, Kristiansen, Hanisch, & Holtermann, 2014). This device provides information on a participant's activity counts, energy expenditure, and activity levels. Participants were given the device, programmed with their weight and height, along with an elastic belt to wear the device around their waist. They were told the device could be worn under or on top of their clothes, but the device was to be worn on the right hip in a vertical position. Participants were instructed to wear the device for seven consecutive days, during their waking hours. However, since the device is not waterproof, it was not worn for showering or water activities (e.g., swimming). Participants were provided with a log to track the times and reasons for removing the device. For complete data, participants were required to wear the device a minimum of ten hours per day for at least four days (Trost, McIver, & Pate, 2005). Data was analyzed using the ActiLife software (version 6.11.9). Cut points for MVPA used for this study were Troiano Adult cut points (Troiano et al., 2008). These cut points categorize sedentary behaviour as 0-99 counts per minute (CPM), light activity as 100-2019 CPM, moderate as 2020-5998 CPM, and vigorous as >5999 CPM.

Our secondary endpoints were prostate/breast cancer symptoms, QoL, and fatigue. Prostate/breast cancer symptoms were assessed using the Prostate Cancer

Subscale (FACT-P; Esper et al., 1997) and the Breast Cancer Subscale of the Functional Assessment of Cancer Therapy-Breast (FACT-B; Brady et al., 1997). Quality of life was assessed using the short-form-36 health survey (SF-36; Jenkinson, Wright, & Coulter, 1994). Fatigue was assessed using the Fatigue Subscale of the Functional Assessment of Chronic Illness Therapy (FACIT-F; Webster, Odom, Peterman, Lent, & Cella, 1999). Higher scores on the FACT-B, FACT-P, SF-36 and FACIT-F represent better cancer-related symptom management, QoL, and fatigue levels respectively.

Adherence to the intervention was also collected from the two intervention groups. Specifically, participants were asked if they completed the goal-setting and planning activity, and how long it took them. These measures were used to determine intervention adherence. Additionally, survivors were asked a variety of questions about their perceived efficacy of the intervention material. Questions included whether the DVD, Thera-Bands, PA guidelines, and goal-setting and planning activity were successful at helping them increase their PA levels and if they found the DVD and PA guidelines informative. Survivors indicated their responses on a 7-point Likert scale ranging from 1 (“not at all”) to 7 (“extremely”).

3.2.5 Statistical Analysis

Analyses of covariance (ANCOVA) was used to examine group differences on our primary outcomes (e.g., MVPA minutes/week, resistance training minutes/week) at month one and month three, and secondary outcomes (e.g., QoL) at months one and three. Adjusted variables in the ANCOVA included baseline values of the outcome, age, disease stage, surgery, radiation, hormone therapy, chemotherapy, and disease status.

Adjusted variables were chosen based on previous literature (e.g., Courneya et al., 2009; Courneya et al., 2012). Bonferroni corrections were applied to the ANCOVA to adjust for multiple comparisons.

To overcome the problem of missing data, intention to treat analysis was used (Fisher et al., 1990). Participants' last recorded value was carried forward following dropout. The relationships between self-reported PA and QoL, and objectively measured PA and QoL in older breast and prostate cancer survivors were explored by placing participants into two PA categories (i.e., meeting PA guidelines vs. not meeting PA guidelines) and tested using analysis of variance (ANOVA). The relationship between objectively measured PA and self-reported PA was explored using a two-way mixed intraclass correlation coefficient (ICC) to calculate the level of absolute agreement between the two types of measurements.

3.3 Results

3.3.1 Flow of Participants Through Trial

Figure 1 shows the flow of the participants through the trial. One hundred twenty-two surveys were mailed to consenting breast and prostate cancer survivors. Sixty-nine completed surveys (56.6%), and 53 surveys were excluded for various reasons (e.g., returned blank or not returned at all, not interested). Forty-three of the 69 participants who returned completed surveys agreed to take part and were asked to wear an accelerometer to finalize baseline assessments prior to randomization. At month one, 42 participants (97.7%) completed follow-up; 38 completed the month three follow-up (88.4%). Participants were lost because they could not be reached in time for follow-up

(n = 2) or requested dropout (n = 3). Two participants from the control group were removed during data analysis, having self-reported PA amounts more than three standard deviations from the mean.

3.3.2 Baseline Characteristics

Baseline characteristics for all randomly assigned survivors are presented in Table 1. Groups were found to be balanced on all measures except a higher proportion of survivors in the two-time intervention group were married (p = .016), and more participants in the one-time intervention group indicated they were still receiving some form of cancer treatment (p = .038).

3.3.3 Intervention Adherence and Evaluation

At month one, most participants in both the one- and two-time intervention groups reported reading the PA guidelines (96.6%) and 20 (69.0%) completed at least "some" of the goal-setting and planning activity, taking an average of 29 minutes. Six participants (20.7%) reported using the DVD at least once weekly and 10 (34.5%) reported using the Thera-Bands. This was similar at the three-month follow-up, in which five participants (19.2%) reported using the exercise DVD at least once a week or more, and nine (34.6%) used the Thera-Bands. Of the fourteen participants in the two-time intervention group, nine (64.3%) completed at least some of the booster goal-setting and planning activity, taking 30 minutes on average. Only one (7.1%) participant said they found the booster at least "quite" helpful in increasing their PA levels, with most finding it "somewhat" (30.8%) useful, while others (23.1%) found the booster was not helpful. The only significant difference between groups was at post-intervention; the one-time

group reported finding the Thera-Bands more helpful at enabling them to increase their activity (p = 0.034).

3.3.4 Changes in Physical Activity Behaviours

Tables 2 and 3 present the effects of the implementation intention intervention of PA levels at one- and three-months. There were no significant changes at either time point for objectively measured or self-reported MVPA or self-reported resistance training behaviours. All three groups had self-reported increases in weekly MVPA at month one follow-up (control: +37.2 min/week, 24.8% increase; one-time group: +90.67 min/week, 66.5% increase; two-time group: +42.4 min/week, 23.1% increase). The two-time intervention group had increases in resistance training at both time points, but failed to reach significance (month one follow-up, +15.1 min/week, 72.9% increase, p = .207; month three follow-up, +20.1 min/week, 97.0% increase, p = .413).

The agreement between the self-reported and objectively measured MVPA was explored. There was poor to fair agreement between the self-reported and objectively measured PA. Using two-way mixed ICC, the average measure ICC were .487 (F(39, 39) = 2.290, p = .006), .490 (F(40, 40) = 2.470, p = .003), and .386 (F(40, 40) = 1.762, p = .039) at baseline, month 1, and post-intervention follow-ups, respectively. Additionally, paired samples t-test indicated there were significant differences between measures at all time points (baseline p < .001; month one p < .001; post-intervention p = .003)

3.3.5 Changes in Quality of Life Measures

Tables 4 and 5 show the changes in QoL measures at the month one and three-month follow-up. Only the Breast Cancer Subscale (FACT-B) had significant group

changes over time (month one p = .029; month three p = .016). The two-time group had improvements on this scale at both one and three month follow-ups (month one: +3.3; post-intervention: +5.0), while the one-time group remained stable (month one: +0.1; post-intervention: -0.7) and the control group saw a slight decline (month one: -3.3; post-intervention: -1.5).

3.3.6 Physical Activity and Quality of Life Measures

Table 6 shows the relationships between QoL measures with PA guidelines. When analyzing the relationship between those who were meeting PA guidelines and QoL measures, it was found that those who self-reported meeting PA guidelines scored significantly better on QoL measures FACT-P (p = .015), FACT-B (p = .037), and the physical health component of SF-36 (p = .003) but not the FACIT-F (p = .067) or the mental health component of the SF-36 (p = .617). Those who were found to be meeting PA guidelines through objective measure also scored higher on all QoL components of the SF-36 except mental health (p = .597), but the only significant difference was found for the FACT-B (p = .022).

3.4 Discussion

The primary goal of the OutPACE study was to explore the effectiveness of an implementation intention intervention on both aerobic and resistance PA and QoL in older (55+) breast and prostate cancer survivors. The study was unable to support the hypotheses and demonstrate significant improvements in PA levels in the intervention groups. This is unfortunate, as previous implementation intention research in cancer survivors successfully increased PA levels in the short-term (McGowan et al., 2013). All

groups in the present study had increases in self-reported PA levels, suggesting these cancer survivors may be a motivated population. Although not significant, the two-time intervention group was able to maintain the small increases in self-reported MVPA, and had increases in resistance training at both follow-ups. Furthermore, the amplitude of these changes were similar to previous studies testing PA interventions within a cancer population, which have found increases between 20-60 minutes of MVPA weekly (Demark-Wahnefried et al., 2007; Morey et al., 2009; Vallance, Courneya, Plotnikoff, Yasui, & Mackey, 2007). The inability to demonstrate significant improvements in PA levels in the intervention groups was likely due to the small sample size, which lead to the study being underpowered to detect small differences in PA. Therefore, further research is warranted and additional participants will continue to be recruited.

The secondary purpose of this study was to examine the impact of an implementation intention intervention on QoL in older breast and prostate cancer survivors. There were significant changes for breast cancer survivors in the two-time intervention group. These participants showed improvements in breast cancer-specific symptoms on the FACT-B subscale at both time points. It is unclear why participants had improvements in breast cancer specific symptoms, but this may suggest some lifestyle changes that were not captured by this study (e.g., reduced sedentary time, increased light activity time). These findings demonstrate the importance of further testing this intervention in a larger sample to determine why this intervention impacted participants' breast cancer specific symptoms. It is possible that changes were not seen on the other measures of QoL due to participants scoring quite high at baseline on the SF-36 and

FACIT-F questionnaires, creating a ceiling effect. Ceiling effects are common in PA research (Dennett, Peiris, Shields, Prendergast, & Taylor, 2016; Saarto, et al., 2012; Short, James, Girgis, D'Souza, & Plotnikoff, 2015), as those with lower QoL are less likely to volunteer to take part in a PA trial (Attwood, Morton, Mitchell, Van Emmenis, & Sutton, 2016). In comparison to Canadian normative data (Hopman et al., 2000), this sample scored above the mean of 48.1 on the physical component scale for those aged 65-74. Additionally, the sample in this study had comparable scores on the FACIT-F scale as the general population (Cella, Lai, Chang, Peterman, & Slavin, 2002). Considering the overall health of this sample, it may be that greater improvements may be seen if a less 'healthy' population was to be targeted; potentially done by recruiting those closer to diagnosis dates. Those who took part in this study were, on average, six years post-diagnosis; although irrespective of this, breast cancer survivors in the two-time intervention group reported improvements in breast cancer-related symptoms. This, in combination with scores on QoL measures, may indicate that participants may be experiencing long-lasting side effects, which could be improved but are not having a strong, negative impact on their QoL.

The population targeted by this study may have also influenced the success of the intervention. Previous research has found that older persons, especially males, are less likely to adopt lifestyle changes than other populations (Demark-Wahnefried, Aziz, Rowland, & Pinto, 2005). Because the sample was older cancer survivors, who are not typically a target of cancer interventions, and more than half of who were males, it may have lessened the efficacy of the intervention, as participants were less willing to make

lifestyle changes. Regardless of the challenges faced when working with this population, there is still a great need to create effective behaviour change interventions within this group. Future research should explore how to best help older cancer survivors, especially prostate cancer survivors, create meaningful PA changes.

There were significant differences between the self-reported and objectively measured PA. This was anticipated and has been highlighted by past studies (Colley, et al., 2011; Prince et al., 2008). This current study adds to the existing literature that highlights the discrepancies between the two measures. In the case of this study, it is possible that participants were over-reporting their PA levels, considering how many more weekly MVPA minutes were self-reported than measured objectively. Additionally, those who self-reported meeting PA guidelines also reported higher QoL on multiple measures. Although many of those found to be meeting PA guidelines through objective measures scored higher on QoL scales, the relationship was stronger with self-reported measures. This is contrary to previous research (Anokye, Trueman, Green, Pavey, & Taylor, 2012), which has shown a stronger relationship between objectively measured PA and QoL measures. This may suggest that a portion of the participants in this study may have been taking part in activity that was not captured by the accelerometers (e.g., water sports, cycling).

The main challenge of this study was recruitment, which resulted in a low sample size and power. The research team exhausted recruitment through local support groups, the cancer clinic, and cancer registry. Recruitment challenges resulted in lower group sizes than anticipated. In addition to the low recruitment numbers, few participants

reported using the DVD. It is unclear whether the DVD was an inappropriate format, or if participants did not want to or require a video to exercise. Only one study was found that used PA DVDs for older adults (McAuley et al., 2013). The aforementioned study used a DVD along with intervention materials (e.g., telephone exercise tips, provided participants with yoga mats) and participants reported increases in PA behaviours and physical function and strength (Gothe et al., 2015; McAuley et al., 2013). Additional research needs to be done to determine the efficacy of a PA DVD-based intervention among older cancer survivors. Although few reported using the DVD, participants reported finding the Thera-Bands useful to increase their PA levels. Since programs using resistance bands have created changes in behaviours among cancer populations (Culos-Reed et al., 2010; Mustian et al., 2009; Winters-Stone et al., 2012), additional research should be done to determine if a DVD is an effective means of providing informational support to participants.

The strengths of this study include the use of both objective and self-report measures of PA, as well as the three-armed, randomized controlled design. Additionally, it is the first study, to our knowledge, to examine the effects of a booster implementation intention intervention on PA for cancer survivors, as well as the first to use a home-based DVD program targeting older cancer survivors. The limitations that impacted the ability to draw conclusions on the efficacy of this intervention include, small sample size and relatively low adherence to the DVD program. It may be worthwhile to explore a similar intervention with a larger population, as it has potential to be a novel and inexpensive means of increasing PA for cancer survivors. Similar interventions have had success at

creating some changes in behaviours (McGowan et al., 2013), but long-term behaviour change interventions need to be developed to benefit the growing population of cancer survivors.

In summary, our results suggest that an implementation intention intervention was not beneficial to increasing PA in older breast and prostate cancer survivors compared to a control group. These results are related to recruitment challenges that plagued the study, as similar interventions have been found to be successful in previous cancer work (McGowan et al., 2013). Regardless, breast cancer survivors in the two-time intervention arm reported improvements in breast cancer specific symptoms (FACT-B), which may suggest some changes in lifestyle behaviours that were not detected. Results add to the literature by measuring objective and self-reported PA in a unique and under-served cancer population. Lastly, because similar interventions have had success changing PA behaviours, additional recruitment and testing is warranted to determine if this intervention is effective for this population. Future research should focus on developing ways to improve QoL for this growing and underserved population of cancer survivors, as inexpensive and far-reaching interventions are needed. Recruitment will continue for this study; as clear conclusions cannot be drawn from the current sample.

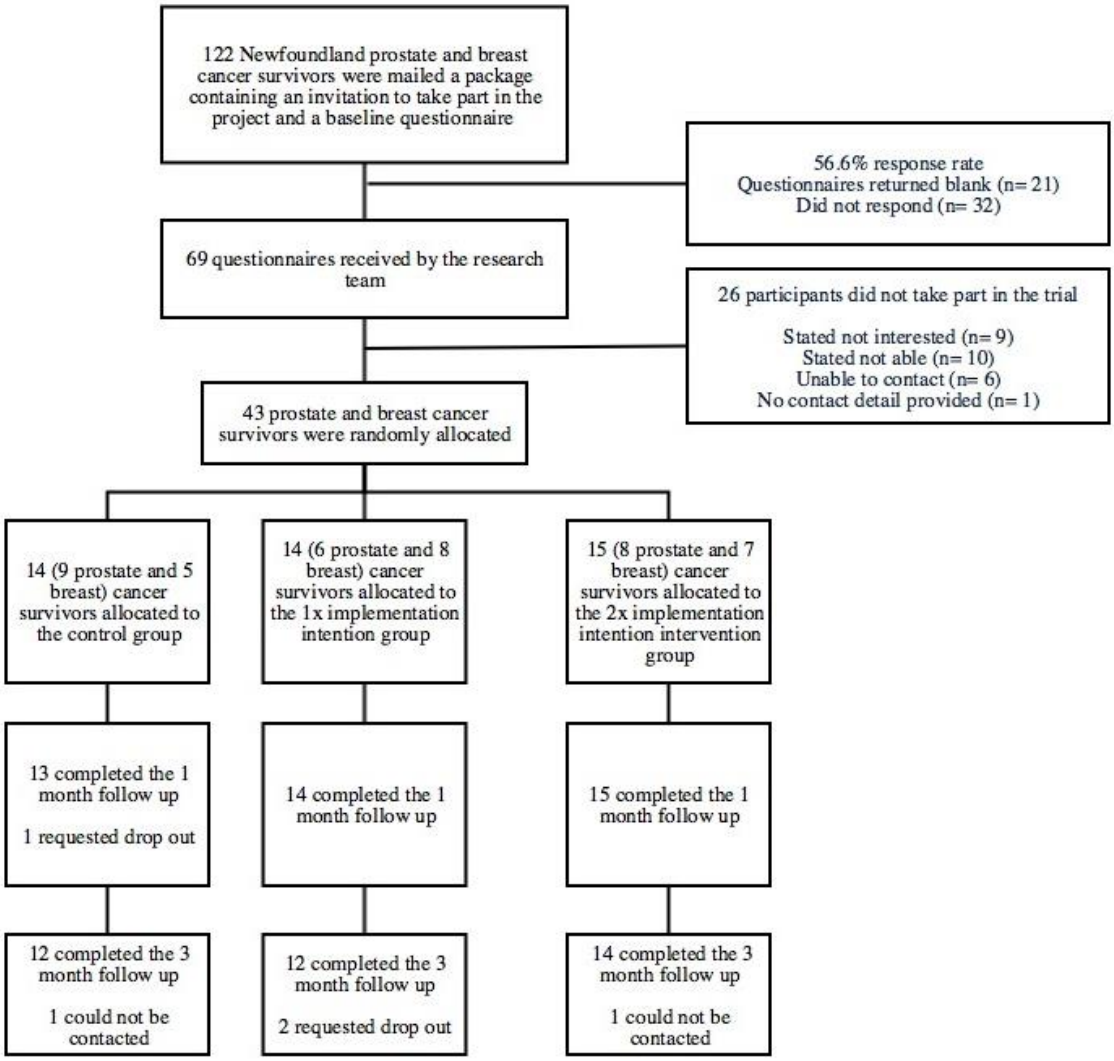

Figure 1. Flow of participants through trial

Table 1. Baseline characteristics of participants.

Variable	Overall (N = 41)	Two Time (N = 15)	One Time (N = 14)	Control (N= 12)	
Demographics					
Age					
Mean	68.95	67.47	69.79	69.83	$F(2,38) = .957$, $p = .393$
SD	5.22	4.73	5.69	5.24	
Range	56-79	56-74	62-79	58-78	
Sex					
Male (No. (%))	23 (56.1%)	9 (60.0%)	6 (50.0%)	8 (66.7%)	$X^2(2) = 1.634$, $p = .442$
Married (No. (%))	28 (68.3%)	12 (80.0%)	8 (57.1%)	8 (66.7%)	$X^2(8) = 18.799$, $p = .016$
Completed University/College	13 (31.7%)	6 (40.0%)	4 (28.6%)	3 (25.0%)	X^2 (10) = 7.976, $p = .631$
Income (> $60,000/year)	20 (48.8%)	8 (53.3%)	6 (46.2%)	5 (41.7%)	X^2 (10) = 11.869, $p = .294$
Retired	32 (78.0%)	12 (80.0%)	11 (78.6%)	9 (75.0%)	X^2 (6) = 5.671, $p = .461$
Caucasian	41 (100.0%)	15 (100.0%)	14 (100.0%)	12 (100.0%)	N/A
Medical					
Weight, pounds					
Mean	178.32	176.80	176.57	182.25	$F(2,38) = .148$, $p = .863$
SD	29.193	24.762	35.705	28.072	
BMI (kg/m^2)					
Mean	28.10	28.10	28.30	27.87	$F(2,38) = .038$, $p = .962$
SD	3.820	2.827	4.531	4.303	
Overweight	17 (41.5%)	7 (46.7%)	5 (35.7%)	5 (41.7%)	X^2 (2) = .358, $p = .836$
Obese	15 (36.6%)	5 (33.3%)	6 (42.9%)	4 (33.3%)	X^2 (2) = .360, $p = .835$
Months post-diagnosis					
Mean	76.7	63.6	90.1	78.0	$F(2,32) = .654$, $p = .527$
SD	59.68	43.04	68.47	71.72	
Disease Stage					
Local	21 (51.2%)	7 (46.7%)	7 (50.0%)	7 (58.3%)	X^2 (6) = 5.673, $p = .461$
Locally Advanced	10 (24.4%)	6 (40.0%)	3 (28.6%)	1 (8.3%)	
Metastatic	3 (7.3%)	0 (0.0%)	2 (14.3%)	1 (8.3%)	
Unsure	7 (17.1%)	2 (13.3%)	2 (7.1%)	4 (25.0%)	
Treatment					
Watchful Waiting[a]	9 (39.1%)	2 (22.2%)	4 (57.1%)	3 (37.5%)	X^2 (2) = 2.049, $p = .359$
Surgery	30 (73.2%)	11 (73.3%)	11 (78.6%)	8 (66.7%)	X^2 (2) = 0.467, $p = .792$
Radiation	28 (68.3%)	11 (73.3%)	8 (57.1%)	9 (75.0%)	X^2 (2) = 1.229, $p = .541$
Chemotherapy	9 (22.0%)	2 (13.3%)	4 (30.8%)	3 (25.0%)	X^2 (2) = 1.073, $p = .585$
Hormone Therapy	23 (57.5%)	6 (42.9%)	10 (71.4%)	7 (58.3%)	X^2 (2) = 2.939, $p = .230$
Cancer Recurrence[b]	7 (18.4%)	2 (14.3%)	2 (16.7%)	3 (25.0%)	X^2 (2) = 0.530, $p = .767$
Cancer Treatment Status					
Completed Treatment	33 (80.5%)	13 (86.7%)	8 (57.1%)	12 (100.0%)	X^2 (4) = 8.321, $p = .081$
Undergoing Treatment	5 (12.2%)	1 (6.7%)	4 (28.6%)	0 (0.0%)	
Unsure	3 (7.3%)	1 (6.7%)	2 (14.3%)	0 (0.0%)	
Current Cancer Status					
Disease-free	23 (56.1%)	9 (60.0%)	7 (50.0%)	7 (58.3%)	X^2 (4) = 7.362, $p = .118$
Existing Disease	7 (17.1%)	0 (0.0%)	5 (35.7%)	2 (16.7%)	
Unsure	11 (26.8%)	6 (40.0%)	2 (14.3%)	3 (25.0%)	
Activity Restriction					
No	38 (92.7%)	14 (93.3%)	13 (92.9%)	11 (91.7%)	X^2 (2) = 0.028, $p = .986$
Comorbidities					
Hypertension[c]	15 (36.6%)	7 (50.0%)	4 (28.6%)	4 (33.3%)	X^2 (2) = 1.498, $p = .473$
High Cholesterol	21 (51.2%)	9 (60.0%)	5 (35.7%)	7 (58.3%)	X^2 (2) = 2.053, $p = .358$
Arthritis	26 (63.4%)	9 (60.0%)	12 (85.7%)	5 (41.7%)	X^2 (2) = 5.522, $p = .063$
Diabetes	7 (17.1%)	2 (13.3%)	2 (14.3%)	3 (25.0%)	X^2 (2) = 0.758, $p = .685$

[a] n = 23
[b] n = 38
[c] n = 40

Table 2. Effects of implementation intention intervention on objectively measured and self-reported MVPA at one-month follow-up

Variable	Baseline Mean (SD)	Month 1 Mean (SD)	Bonferroni-adjusted between-group comparisons[a] Mean (95% CI)	Partial η^2	*p* value
Objectively Measured MVPA (mins/week)					
Control (n = 12)	38.0 (46.16)	44.81 (66.93)	Control vs Two-time 4.45 (-26.62 to 35.52)	0.016	0.796
One-time (n = 13)	63.4 (81.01)	74.35 (111.82)	One-time vs Control 3.94 (-27.22 to 35.11)		
Two-time (n = 15)	119.4 (99.47)	107.44 (100.52)	Two-time vs One-time -8.39 (-39.84 to 23.06)		
Self-reported MVPA (mins/week)					
Control (n = 12)	150.0 (177.57)	187.2 (194.65)	Control vs Two-time 14.17 (-86.01 to 114.36)	0.055	0.426
One-time (n = 14)	136.43 (144.91)	227.1 (256.88)	One-time vs Control 37.56 (-62.08 to 137.20)		
Two-time (n = 15)	183.3 (145.93)	225.7 (193.62)	Two-time vs One-time -51.73 (-154.40 to 50.93)		
Resistance Training (mins/week)					
Control (n = 12)	45.00 (155.88)	0.00 (0.00)	Control vs Two-time -15.93 (-40.52 to 8.66)	0.100	0.207
One-time (n = 14)	64.29 (122.77)	25.00 (47.96)	One-time vs Control 13.72 (-10.42 to 37.86)		
Two-time (n = 15)	20.67 (33.75)	35.73 (52.96)	Two-time vs One-time 2.21 (-23.43 to 27.84)		

Table 3. Effects of implementation intention intervention on objectively measured and self-reported MVPA at three-month follow-up

Variable	Baseline Mean (SD)	Post-intervention Mean (SD)	Bonferroni-adjusted between-group comparisons[a] Mean (95% CI)	Partial η^2	*p* value
Objectively Measured MVPA (mins/week)					
Control (n = 12)	38.0 (46.16)	62.96 (97.90)	Control vs Two-time 4.73 (-50.26 to 59.72)	0.026	0.679
One-time (n = 13)	63.4 (81.01)	49.20 (92.49)	One-time vs Control -18.59 (-73.76 to 36.57)		
Two-time (n = 15)	119.4 (99.47)	113.30 (144.69)	Two-time vs One-time 13.86 (-41.80 to 69.52)		
Self-reported MVPA (mins/week)					
Control (n = 12)	150.0 (177.57)	166.2 (168.18)	Control vs Two-time -21.54 (-113.96 to 70.89)	0.025	0.615
One-time (n = 14)	136.4 (144.91)	105.0 (113.75)	One-time vs Control -33.44 (-125.36 to 58.48)		
Two-time (n = 15)	183.3 (145.93)	218.7 (229.19)	Two-time vs One-time 54.97 (-39.74 to 149.69)		
Resistance Training (mins/week)					
Control (n = 12)	45.00 (155.88)	15.00 (32.05)	Control vs Two-time -9.26 (-28.22 to 9.70)	0.057	0.413
One-time (n = 14)	64.29 (122.77)	10.00 (17.43)	One-time vs Control 0.534 (-18.08 to 19.15)		
Two-time (n = 15)	20.67 (33.75)	40.73 (52.46)	Two-time vs One-time 8.73 (-11.03 to 28.49)		

[a] Adjusted for: baseline value of PA, age, disease stage, surgery, radiation, hormone therapy, chemotherapy, and disease status

Table 4. Effects of implementation intention intervention on QoL assessments at month one follow-up

Variable	Baseline Mean (SD)	Month 1 Mean (SD)	Bonferroni-adjusted between-group comparisons[a] Mean (95% CI)	Partial η^2	*p* value
Prostate Cancer Subscale (0-48)					
Control (n = 8)	31.8 (7.27)	31.8 (8.08)	Control vs Two-time 0.26 (-3.34 to 3.86)	0.021	0.870
One-time (n = 6)	32.7 (8.82)	32.9 (11.90)	One-time vs Control 0.48 (-2.93 to 3.89)		
Two-time (n = 9)	36.6 (7.65)	38.1 (6.88)	Two-time vs One-time -0.74 (-4.72 to 3.24)		
Breast Cancer Subscale (0-40)					
Control (n = 4)	31.9 (4.33)	28.6 (6.05)	Control vs Two-time -2.90 (-5.71 to -0.10)	0.587	0.029
One-time (n = 8)	25.8 (7.76)	25.9 (8.01)	One-time vs Control 0.76 (-2.52 to 4.05)		
Two-time (n = 6)	27.0 (4.00)	30.3 (1.97)	Two-time vs One-time 2.14 (-0.74 to 5.01)		
Fatigue Scale (0-52)					
Control (n = 12)	40.4 (10.79)	42.3 (6.30)	Control vs Two-time 0.32 (-1.94 to 2.58)	0.017	0.776
One-time (n = 14)	39.3 (12.50)	41.7 (9.67)	One-time vs Control 0.34 (-1.86 to 2.53)		
Two-time (n = 15)	45.4 (6.08)	45.5 (6.66)	Two-time vs One-time -0.66 (-2.98 to 1.67)		
Mental Component Summary (0-100)					
Control (n = 12)	47.5 (7.52)	48.3 (4.41)	Control vs Two-time 0.05 (-4.14 to 4.24)	0.051	0.459
One-time (n = 14)	47.0 (12.43)	43.6 (11.75)	One-time vs Control -1.85 (-6.00 to 2.31)		
Two-time (n = 15)	48.7 (7.38)	49.2 (7.07)	Two-time vs One-time 1.80 (-2.49 to 6.09)		
Physical Component Summary (0-100)					
Control (n = 12)	49.6 (10.19)	48.2 (11.83)	Control vs Two-time -0.942 (-4.00 to 2.11)	0.045	0.505
One-time (n = 14)	47.58 (10.13)	50.6 (7.95)	One-time vs Control 1.37 (-1.66 to 4.39)		
Two-time (n = 15)	53.02 (7.83)	52.9 (6.18)	Two-time vs One-time -0.42 (-3.59 to 2.75)		

[a] Adjusted for: baseline value of measure, age, disease stage, surgery, radiation, hormone therapy, chemotherapy, and disease status

Table 5. Effects of implementation intention intervention on QoL assessments at month three follow-up

Variable	Baseline Mean (SD)	Post-intervention Mean (SD)	Bonferroni-adjusted between-group comparisons[a] Mean (95% CI)	Partial η^2	*p* value
Prostate Cancer Subscale (0-48)					
Control (n = 8)	31.8 (7.27)	35.4 (6.19)	Control vs Two-time 2.84 (-1.21 to 6.89)	0.222	0.196
One-time (n = 6)	32.7 (8.82)	33.2 (12.06)	One-time vs Control -0.93 (-4.77 to 2.92)		
Two-time (n = 9)	36.6 (7.65)	36.3 (5.78)	Two-time vs One-time -1.92 (-6.40 to 2.57)		
Breast Cancer Subscale (0-40)					
Control (n = 4)	31.9 (4.33)	30.4 (6.13)	Control vs Two-time -3.01 (-6.12 to 0.10)	0.644	0.016
One-time (n = 8)	25.8 (7.76)	25.1 (7.23)	One-time vs Control -0.44 (-4.08 to 3.21)		
Two-time (n = 6)	27.0 (4.00)	32.0 (2.45)	Two-time vs One-time 3.45 (0.27 to 6.63)		
Fatigue Scale (0-52)					
Control (n = 12)	40.4 (10.79)	43.1 (8.99)	Control vs Two-time 0.94 (-1.66 to 3.54)	0.030	0.631
One-time (n = 14)	39.3 (12.50)	41.7 (9.67)	One-time vs Control -0.14 (-2.66 to 2.37)		
Two-time (n = 15)	45.4 (6.08)	45.8 (6.14)	Two-time vs One-time -0.80 (-3.47 to 1.88)		
Mental Component Summary (0-100)					
Control (n = 12)	47.5 (7.52)	51.2 (3.41)	Control vs Two-time 0.90 (-2.71 to 4.51)	0.187	0.045
One-time (n = 14)	47.0 (12.43)	44.10 (10.54)	One-time vs Control -3.59 (-7.17 to -0.01)		
Two-time (n = 15)	48.7 (7.38)	50.35 (6.71)	Two-time vs One-time 2.70 (-1.00 to 6.39)		
Physical Component Summary (0-100)					
Control (n = 12)	49.6 (10.19)	49.0 (9.28)	Control vs Two-time -0.80 (-3.54 to 1.93)	.083	0.270
One-time (n = 14)	47.58 (10.13)	51.40 (7.76)	One-time vs Control 1.76 (-0.94 to 4.47)		
Two-time (n = 15)	53.02 (7.83)	53.50 (5.91)	Two-time vs One-time -0.96 (-3.80 to 1.88)		

[a] Adjusted for: baseline value of measure, age, disease stage, surgery, radiation, hormone therapy, chemotherapy, and disease status

Table 6. Relationships between meeting PA guidelines and QoL measures

Variable	Self-reported Meeting PA Guidelines		*p* Value	Objectively Measured Meeting PA Guidelines		*p* Value
	Yes (N = 56)	No (N = 61)		Yes (N = 26)	No (N = 90)	
Physical Component Summary (0-100)	53.57 (8.39)	49.04 (7.59)	.003	52.85 (6.07)	50.66 (8.79	.236
Mental Component Summary (0-100)	47.60 (7.21)	48.37 (9.23)	.617	47.18 (7.41)	48.16 (8.58)	.597
Breast Cancer Subscale (0-40)	30.48 (5.14)	26.80 (6.49)	.037	33.17 (4.70)	27.46 (6.10)	.022
Prostate Cancer Subscale (0-48)	37.16 (6.26)	32.68 (8.23)	.015	35.89 (3.82)	34.57 (7.73)	.522
Fatigue Scale (0-52)	44.56 (7.93)	41.64 (8.98)	.067	44.31 (6.64)	42.59 (9.08)	.373

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Chapter 4 Conclusion

Breast and prostate cancers are the most prevalent cancers for Canadian women and men, respectively (Canadian Cancer Society's Advisory Committee on Cancer Statistics [CCSACCS], 2015). Detection and treatment for these cancers has improved, and has resulted in a large population of breast and prostate cancer survivors living in Canada (CCSACCS, 2015). Unfortunately, side effects from cancer and its treatment can lead to long lasting or late appearing side effects that negatively impact cancer survivors' quality of life (QoL) and survivorship (LeMasters, Madavan, Sambamoorthi, & Kurian, 2013; Irwin, 2013). Physical activity (PA) has been found to be a successful means of improving health and QoL for breast and prostate cancer survivors (e.g., physical functioning, fatigue, depression; Bluethmann, Vernon, Gabriel, Murphy, & Bartholomew, 2015; Fong et al., 2012; McNeely et al., 2006; Thorsen, Courneya, Stevinson, & Fosså, 2008), although cancer survivors are typically not active enough to receive these benefits (Neil, Gotay, & Campbell, 2014). Because PA can be a low cost and effective means of improving QoL within this population and survivors are not active enough, it is important to develop interventions to help survivors become more physically active. This study tested the impact of an implementation intention intervention on the PA and QoL among a sample of older (55+) breast and prostate cancer survivors. Although there were limitations within this current study, there is still some evidence to suggest this intervention or one similar may be able to stimulate increases in PA levels in older breast and prostate cancer survivors.

All three groups showed improvements in self-reported PA at the one-month follow-up, and the two-time implementation intention group appeared to maintain these changes at the post-intervention follow-up. Additionally, the two-time intervention group had increases in resistance training activity at both time points. This is important because resistance training can positively impact the unique side effects breast and prostate cancer survivors may face following hormone therapies (e.g., loss of boss density, decreased muscle mass, increased fat mass; Fong et al., 2012; Galvão et al., 2006; Schwartz, Winters-Stone, & Gallucci, 2007; Van Poznak & Sauter, 2005). Breast cancer survivors within the two-time intervention group had significant improvements in breast cancer-specific symptoms (i.e., hair loss, arm tenderness) at both time points. It was not apparent in the analysis why these survivors had improvements in breast cancer symptoms, but it may suggest lifestyle changes that were not observed by our measures. This may have been related to the small sample size; therefore, further research and data collection is warranted to determine whether this intervention can successfully change PA behaviours and improve QoL within this population. If so, it would be a novel, inexpensive, and easy to administer intervention for a population in need.

This study also added to the literature on self-reported versus objectively measured PA by offering results on the agreement between the two measures in a unique population (i.e., older breast and prostate cancer survivors). There was poor to fair agreement between the measures, although the means differed at times by over 100 minutes of MVPA weekly. This further highlights the lack of agreement between these methods when assessing PA (Colley et al., 2011; Eastwood, 2014; Prince et al., 2008).

Additionally, it was found that self-reported PA was more closely related to better QoL compared to objectively measured PA, which is in contrast to other studies (Anokye, Trueman, Green, Pavey, & Taylor, 2012; Celis-Morales et al., 2012). Further research is warranted to determine the cause of the discrepancy between these measures within this population so future interventions may get a better assessment of older cancer survivors '*actual'* PA behaviours.

Finally, older adults, especially males, have been identified as a difficult population in which to create lifestyle changes (Demark-Wahnefried, Aziz, Rowland, & Pinto, 2005; McGowan, North, & Courneya, 2013). This may have affected the efficacy of this intervention, as it was done among older adults, with more than half being male. Regardless of the potential challenge, it is still very necessary to research this population. Older people are most affected by cancer, in both numbers and face greater side effects (CCSACCS, 2015; Courneya et al., 2004). Additionally, older people are currently underserved in cancer research (De Backer, Schep, Backx, Vreugdenhil, & Kuipers, 2009; Fong et al., 2012). Because older cancer survivors face the combined negative effects of aging and a cancer diagnosis, and they make up the largest proportion of cancer survivors, more research is needed on this population. Future studies should work to determine the best means of increasing PA behaviours within this population to help improve their QoL, health, and survivorship.

In conclusion, older breast and prostate cancer survivors face long-lasting and, at times, late appearing side effects from cancer and its treatments. PA can help reduce these side effects, but cancer survivors are not active enough to receive these benefits.

This intervention aimed to increase PA behaviours in a sample of older breast and prostate cancer survivors, but was unable to detect significant changes due to limitations, most notably a small sample size due to recruitment challenges. Additional research is warranted, as there remains a need to address the declines in QoL following cancer diagnoses and treatments for this currently underserved population. We will continue to recruit participants for this study, as implementation intention interventions have had success changing PA behaviours among cancer survivors (McGowan et al., 2013), and this method has potential to be a far-reaching, low cost means of creating changes in behaviour.

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