Improving Prostate Cancer Survivorship: Building Community Partnerships Through Physical Activity

By

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A thesis submitted to the

School of Graduate Studies

in partial fulfillment of the requirements for the degree of

Master of Science in Kinesiology– Psychology of Exercise, Sports, and Recreation

School of Human Kinetics and Recreation

Memorial University of Newfoundland

December 2018

St. John's Newfoundland

Abstract

Background: Physical activity (PA) has been shown to improve prostate cancer survivors physical functioning and quality of life (QoL). **Purpose:** To investigate the impact of a community-based PA program on the QoL, fitness, fatigue, strength, and physical functioning of prostate cancer survivors, with a secondary purpose to examine the program's feasibility and sustainability. **Methods:** PROFit, a 12-week community-based, supervised PA program was developed by reviewing the current PA and cancer literature, and through establishing partnerships with a cancer care program, community fitness facility, and university. Specifically, 15 prostate cancer survivors and their partners (*N*=4) were recruited to take part in the PA program, which consisted of strength (i.e., circuit training) and aerobic training. Survivors QoL, fatigue, prostate cancer specific symptoms, physical functioning, and PA levels were assessed at baseline, six and 12-weeks. Program attendance and cost were recorded to determine feasibility and sustainability. Satisfaction surveys were administered to participants and partners at six and 12-weeks. **Results:** One-way repeated measures analysis of variance found significant increases in lower body strength across all time points and flexibility from baseline to 12 weeks. No significant improvements were found in upper body strength, agility, aerobic fitness, weekly moderate-vigorous PA, QoL, and fatigue; however, non-significant increases in participant upper body strength, weekly moderate-vigorous PA, and agility were noted. Participants and partners reported a high level of satisfaction with the program, and program attendance and intervention costs were satisfactory. **Conclusion:** The PROFit program had a positive impact on prostate cancer survivorship. Due to the lack of evidence surrounding community-based PA programs in prostate cancer survivors, the PROFit program delivers valuable insight into the collaboration between hospitals, universities and community centers to provide prostate cancer survivors with a resource for improving survivorship (i.e., QoL, physical functioning) following treatment.

Acknowledgements

First and foremost, I would like to thank my supervisor, Dr. Erin McGowan, for her time and support throughout this process. With your guidance and level of commitment, I have grown as a student, and as a professional, and I deeply appreciate every word of encouragement you've given me along the way.

Secondly, I would like to thank my committee member, Dr. Kevin Power, as well as other faculty and peers for their help. A special thank you to Richard Buote and Ryan Collins; you were my source of motivation time and time again. As well, I would like to extend gratitude to the Certified Exercise Physiologist, Thomas Dymond, and the other volunteers for their assistance with the PROFit program.

I wish to thank Eastern Health for the funding to financially support the PROFit program, as well as the oncologists, staff at The Works facility, and other individuals that helped make the PROFit program a reality.

Finally, to the participants – I thank you. Your strength and resiliency have inspired me, and helped me to grow as a person. To my family and friends, I could not have done this without you, and I am grateful to have such a strong support system.

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List of Abbreviations

ADT – Androgen Deprivation Therapy

ANOVA – Analysis of Variance

BMI – Body Mass Index

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

CEP – Certified Exercise Physiologist

CFFL – Cancer Foundation for Life

CPM – Counts Per Minute

E&T – Exercise and Thrive

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

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

FSFL – FitSTEPS for Life

MET – Metabolic Equivalent of Task

MVPA – Moderate to Vigorous Physical Activity

PA – Physical Activity

PAR-Q+ - Physical Activity Readiness Questionnaire

PCS – Prostate Cancer Subscale

QoL – Quality of Life

SFT – Seniors Fitness Test

SF-36 – Short-Form Health Survey

6-MWT – Six Minute Walk Test

Chapter 1: Introduction

1.1 Background

Cancer is the leading cause of death in Canada, accounting for approximately 30% of all deaths annually (Canadian Cancer Society's Advisory Committee on Cancer Statistics [CCSACCS], 2017). In 2017, it was estimated that 206,200 Canadians would be diagnosed with cancer, and 80,800 will die from the disease (CCSACCS, 2017). The greatest percentages of Canadians (i.e., 90%) who develop cancer are over the age of 50 and, given the aging population, the number of new cancer cases is expected to double in those 65 years of age and over (CCSACCS, 2017). Fortunately, cancer is not a death sentence as it once was believed to be (Reb, 2007). The five-year relative survival ratio for all cancers has risen to 60% (CCSACCS, 2017). These improvements can be attributed to advances in cancer screening procedures and treatment options (Siegel et al., 2012).

Improved survival rates in Canada have created a growing population of cancer survivors (CCSACCS, 2017; Jefford et al., 2013), and it is estimated that there are approximately 1 million cancer survivors currently in Canada (CCSACCS, 2017). A cancer survivor is defined as a person at any stage of cancer care, from diagnosis to long-term survival (Siegel et al., 2012). The term survivorship includes the physical and psychosocial outcomes of a cancer diagnosis and treatment (Dow, 2003). Despite the increase in survival rates, many cancer survivors experience long-lasting physical and psychological side effects as a result of their cancer and treatments. Short-term side effects such as nausea, vomiting, fatigue, and pain can appear immediately following treatments (Courneya & Friedenreich, 2007); while other long-term side-effects including muscular atrophy, loss of bone density, increases in adipose tissue and psychosocial concerns (i.e., anxiety and depression) have been identified by cancer survivors much later (CCSACCS, 2017; DeSantis et al., 2014). Some adverse effects, such as fatigue and fear of cancer reoccurrence have been found to persist for months, and even years following cancer treatments (Resnick et al., 2013). The short- and long-term adverse effects experienced by cancer survivors' can significantly impact their quality of life (QoL) and physical functioning (Ferrer, Huedo-Medina, Johnson, Ryan and Pescatello, 2010; Irwin, 2013; Schmitz et al., 2010). As such, strategies to improve cancer survivorship are warranted. Research exploring the role that physical activity (PA) and exercise plays in improving survivorship has grown in the past few decades (Speck, Courneya, Masse, Duval and Schmitz, 2010), and has found that engaging in regular PA can help cancer survivors manage the side effects, as well as promote overall health (Mishra et al., 2012; Rock et al., 2012).

1.2 Physical Activity and Cancer

In the last several years there has been a surge in PA and cancer research. The research has clearly determined that PA is safe and feasible for cancer survivors, and participation in PA has been found to improve overall health and QoL, and lower mortality rates (Brown et al., 2011; Ferrer et al., 2010; Fong et al., 2012; Mishra et al., 2012; Speck et al., 2010). In a meta-analysis, Fong et al. (2012) reviewed 34 randomized controlled trials that explored the effects of PA in various cancer survivor groups who had completed cancer treatment, and established that PA improved body composition (i.e., BMI), QoL, psychological outcomes (e.g., fatigue, depression), as well as physical functioning (e.g., aerobic capacity, peak power output) and physiological (e.g., strength) outcomes. It was also noted by Fong and colleagues (2012), that in studies that combined both aerobic and resistance training there were significantly larger improvements in the physical and functional well-being of survivors compared to studies that used aerobic exercise alone. These findings are supported by similar studies showing improvements in fatigue (Brown et al., 2011), physiological fitness including strength and aerobic capacity (Speck et al., 2010) and QoL (Mishra et al., 2012) in cancer survivors. Furthermore, PA interventions implemented during and after treatment can produce these beneficial effects during various stages of their cancer trajectory (Mishra et al., 2012; Speck et al., 2010). Improvements in physical functioning and fatigue following PA interventions have led to a higher QoL both during and after treatment in cancer survivors (Ferrer et al., 2010).

Adopting a physically active lifestyle has shown significant promise in cancer survivors returning to an optimal QoL once treatments are finished (Fong et al., 2012). Despite the benefits of PA for cancer survivors, many are insufficiently active to achieve such health benefits. Research has found that 22.6% of cancer survivors in complete remission and 17.8% of cancer survivors currently with cancer are active (Coups & Ostroff, 2005; Neil, Gotay and Campbell, 2014), meaning that the greatest proportion of cancer survivors do not participate in the recommended levels of PA. This is distressing, especially when considering that cancer survivors have been shown to express an interest in PA programs (Wong, McAuley and Trinh, 2018). Experts in PA and cancer research at The American College of Sports Medicine (ACSM) and the American Cancer Society (ACS) have developed PA guidelines for cancer survivors (Schmitz et al., 2010). Guidelines state that cancer survivors should engage in at least 150 minutes of moderate-to-vigorous PA per week (Buffart, Galvao, Brug, Chinapaw and Newton, 2014; Schmitz et al., 2010), and incorporate strength-training exercises to improve physical fitness, reduce the likelihood of comorbidities (e.g., cardiovascular disease, type 2 diabetes), and enhance QoL (Mishra et al., 2012). As stated by Schmitz and colleagues (2010), cancer survivors should avoid inactivity and be as active as their condition allows; unfortunately, the effects of cancer treatments can make it difficult to begin and maintain a PA routine (Irwin, 2009). Given these findings, PA interventions including aerobic and resistance training exercises are an effective and feasible non-pharmaceutical approach to improve cancer survivors' physical and psychological health.

1.3 Prostate Cancer and its Side Effects

In 2017, prostate cancer was the most commonly diagnosed form of cancer in males, reflecting nearly 21% of all male cancer cases (CCSACCS, 2017). Fortunately, due to improvements in early detection (Stattin et al., 2014) and treatment options (Thorsen, Courneya, Stevinson and Fossa, 2008), prostate cancer has a five-year relative survival rate of 95% (CCSACCS, 2017), meaning that a large portion of men will survive their cancer diagnosis. Treatment options are considered based on prognostic factors, including the stage of the cancer (i.e., where the primary tumor is), and age (Keyes et al., 2013). Common treatment options include chemotherapy, radiotherapy, hormonal therapy such as Androgen Deprivation Therapy (ADT), and surgery. Surgery to remove the prostate is a commonly used treatment for otherwise healthy men under the age of 70 (Keyes et al., 2013). Radiotherapy can be used in the early stages of prostate cancer, but is usually combined with other treatments in the later stages to improve survival (Segal et al., 2009), while chemotherapy may be used to control or delay symptoms (ACS, 2016). Hormonal therapies (i.e., ADT) aim to reduce the levels of androgens in the body to prevent the size of cancerous cells in and around the prostate from growing (Alibhai et al., 2010). Advancements in treatment options can increase survival; however, the adverse side effects from treatment may have negative consequences even years after treatment is completed. Treatment-related symptoms can vary depending on the types and stages of cancer involved and how they impact health-related QoL (Mystakidou et al., 2013).

Prostate cancer treatment can lead to short- and long-term side effects. Side effects range from psychological trauma, including depression, stress, anxiety, and a loss of self-control, to physical symptoms, such as decreased muscular strength, diminished cardiovascular function, and increased fatigue, nausea, and pain (Courneya & Friedenreich, 1999; Krupski & Litwin, 2007; Thorsen et al., 2008). There are varying side effects associated with each treatment for prostate cancer. For example, ADT can result in increased fatigue, sexual dysfunction, anemia, loss of bone density, and muscular atrophy (Gardner, Livingston and Frazer, 2014; Higano et al., 2003; Alibhai et al., 2010). The side effects of cancer treatment are generally short-term, such as an increased level of fatigue immediately following radiation therapy (Segal et al., 2009). However, late-appearing side effects may persist for months or even years after completing prostate cancer treatments (Resnick et al., 2013). Increases in fat mass, decreases in lean body mass, and increased fatigue levels have been found within 3-12 months' post-treatment (Alibhai, Gogov & Allibhai, 2006; Basaria et al., 2002; Gardner et al., 2014), and declines in sexual, urinary, and bowel function can last up to 15-years following treatment (Keyes et al., 2013; Resnick et al., 2013; Thorsen et al., 2008). In turn, these physical side effects have been found to significantly influence psychological health, leading to a diminished

QoL, and an increased risk of anxiety and depression (Thorsen et al., 2008). In fact, men have reported sexual incontinence and long-term bowel and urinary dysfunction as a significantly diminishing factor in their overall QoL (Davis et al., 2014; Ferrer et al., 2013).

A cancer diagnosis and course of treatment can be out of an individual's control; however, there are behavioral strategies that can help cancer survivors regain control of their perceptions and ability to cope (Karvinen, Courneya, North and Venner, 2007). Studies have shown significant improvements in prostate cancer survivors' QoL and physical fitness through participation in PA programs (Thorsen et al., 2008), and this area of research is gaining considerable attention.

1.4 Physical Activity and Prostate Cancer

Physical activity has been shown to improve many of the negative side effects of prostate cancer treatments (Bourke et al., 2016). In a review by Thorsen et al. (2008), the authors investigated the effects, prevalence, and determinants of PA on health outcomes in prostate cancer survivors. The results indicated improvements in body composition, flexibility, muscular strength, QoL, and fatigue with increased levels of PA. A review by Gardner et al. (2014) examined exercise and treatment-related side effects in prostate cancer patients and provided support for these findings. As mentioned in the review, using some form of aerobic and/or resistance training exercises can lead to improvements in the adverse effects of prostate cancer treatments, such as increases in muscular strength and endurance, and mitigating levels of fatigue. Given these findings, incorporating aerobic and resistance exercises into PA and exercise interventions can provide a great benefit to prostate cancer survivors' physical and psychological health. Unfortunately, less than half of the total population of prostate cancer survivors are sufficiently active and have difficulty maintaining a regular PA routine (Thorsen et al., 2008). Research continues to encourage prostate cancer survivors to adopt or continue a physically active lifestyle (Baumann, Zopf & Bloch, 2012), and a study by Segal et al. (2009) provides a list of specific precautions to be considered (i.e., risk of bone fractures due to hormone therapy) when creating PA and exercise programs for prostate cancer survivors. Any PA programs should be modified to accommodate these precautions, but overall survivors should aim to be as active as possible to receive the greatest benefit.

While individual training programs have been shown to be an effective method of exercise prescription in prostate cancer survivors (Galvao et al., 2006), group-based (i.e., participants exercising together at the same time) programs have also been found to improve physical fitness, functional performance, QoL, and fatigue levels (Keogh & MacLeod, 2012; Segal et al., 2009). In addition, exercising in groups can provide greater social supports and camaraderie between participants (Haas & Kimmel, 2011). PA interventions have typically been conducted in a research setting with limited transferability to a ‘real-world’ environment. In recent years, the use of community-based PA programs and their effect on the physical fitness and QoL of cancer survivors has been studied by researchers with promising results (Cheifetz et al., 2014). Through collaboration between fitness and research facilities, community-based PA programs have the potential to be a sustainable and effective resource for increasing PA levels in cancer survivors.

1.5 Community-Based Physical Activity for Cancer Survivors

Few studies have examined the effects of community-based PA and exercise programs in cancer survivors, but some differences between community-based and other forms of unsupervised PA (e.g., home-based) have been discussed. Santa Mina et al. (2018) identified the benefits of supervised, group-based PA for cancer survivors in fitness facilities, including stronger social supports, and improved program adherence and physical functioning, when compared to unsupervised PA programs. The study also suggests that providing the option of community-based PA program for cancer survivors is an important addition to the continuum of cancer-related care, allowing survivors to continue with their PA-related needs. Potential benefits of incorporating PA in a community-based setting have been explored in recent studies. Improvements in fatigue, physical functioning (i.e., flexibility and muscular strength), mental health (i.e., anxiety), and social supports were found in cancer survivors participating in a 12-week community-based exercise program at the YMCA (Rajotte et al., 2012). Similar results were found in another community-based exercise program of the same duration and location by Foley, Barnes and Hasson (2015), with significant improvements in physical functioning and emotional, functional, and total well-being. The exercises in both studies were completed in small groups - an important aspect of the community-based approach. Group-based activity has been shown to benefit QoL and physical functioning in cancer patients (Kolden et al., 2002; Mutrie et al., 2007; Segal et al., 2009), while mitigating any intimidation towards exercise in a social setting (Haas & Kimmel, 2011). Also, creating a PA program for cancer survivors allows participants to connect with each other for social support. For example, Foley et al. (2015) incorporated 30 minutes of ‘community building' time at the end of their exercise session for participants to share personal experiences, adding to the beneficial effect of a group-based setting. The high adherence rates associated with these community-based PA programs suggest that if more of these PA programs were made available, a greater number of cancer survivors would take advantage of them (Foley et al., 2015; Haas & Kimmel, 2011; Rajotte et al., 2012).

A recent example of a community-based exercise and education program targeting all people with cancer is CanWell (Cheifetz et al., 2014). The CanWell program was a 12-week program consisting of weekly exercise sessions including aerobic, resistance, and flexibility exercises. Significant improvements were found in overall health-related QoL and walking distance, as well as a reduction in the experienced symptoms commonly associated with cancer (e.g., pain, fatigue and nausea). CanWell demonstrates how collaboration between a cancer center, university, and community institution can create successful community-based exercise programs that are not in a research center, which is commonly where they take place.

However, the limitations associated with the CanWell program (e.g., low adherence rates) could be attributed to the participant sample including all persons living with cancer at different stages of cancer care. The inclusion of participants undergoing active treatment can have a negative effect on adherence when compared to other studies showing a much greater adherence rate (Foley et al., 2015; Rajotte et al., 2012). This suggests examining specific cancer populations (e.g., prostate) at certain stages of cancer treatment (e.g., post-treatment) for future studies, while using the CanWell design as a useful reference point for creating new community-based PA interventions. Group-based, yet individually tailored exercise intervention has been shown to improve participant self-efficacy and physical health, and promote sustainability (Campbell, Mutrie, White, McGuire and Kearney, 2005), but some types of cancer (e.g., breast) have been more heavily researched than others. With the increased number of prostate cancer survivors currently living with the adverse effects of cancer treatments, sustainable and effective PA programs are needed to improve overall health and well-being.

1.6 Purpose of Study

The physical/psychological health and QoL of prostate cancer survivors has been shown to improve with participation in regular PA. Unfortunately, many prostate cancer survivors are insufficiently active, with participation rates as low as 29-30% (Thorsen et al., 2008). To generate health benefits, prostate cancer survivors need support to improve and maintain PA levels. Community-based PA programs have been shown to improve physical functioning and QoL in a social setting that promotes inclusion and adherence (Foley et al., 2015; Haas & Kimmel, 2011; Murray et al., 2012). However, there is little research investigating the benefits of implementing PA interventions in prostate cancer survivors in a community-based setting. By determining if a prostate cancer survivors QoL and physical functioning are benefited through participation in a community-based PA program, survivors may be more enticed to join a PA program and maintain long-term adherence to a physically active lifestyle. Furthermore, the community-based PA program should be accessible and sustainable to promote survivor participation. The purpose of this study was to examine the impact of PROFit, a community-based PA program on QoL, fitness, fatigue, strength, and physical functioning of prostate cancer survivors. The secondary purpose was to evaluate the feasibility, sustainability, and satisfaction of the PROFit program.

1.7 Significance of Study

This study will be a valuable contribution to the current research surrounding PA and prostate cancer survivors. If the proposed PA program proves to be effective in: (1) improving QoL, (2) reducing levels of fatigue and (3) improving physical functioning, it will provide a solid framework for developing community-based PA programming for prostate cancer survivors. Additionally, this program may aid in providing social support to participants, in the hope of enhancing connections between prostate cancer survivors. Understanding the challenges associated with running this program, which includes participant adherence and operational costs, will give further insight into the sustainably and accessibility of a survivorship program. Healthcare professionals (i.e., oncologists) can potentially use this program as a resource to enhance PA in prostate cancer survivors who need guidance and in turn, may reduce the use of hospital resources by improving survivors' health.

1.8 Objectives

- To assess the effect of a community-based PA program on physical functioning, strength, fitness, fatigue and QoL in the prostate cancer survivor population.
- To explore the feasibility and sustainability, and satisfaction, of a community-based PA program for prostate cancer survivors through program attendance, cost of implementing the program, and participant/partner satisfaction surveys.

1.9 Research Hypotheses

Based on the results of previous studies examining PA and prostate cancer survivors, it is anticipated that participants in the community-based PA program will experience improvements in their QoL, improve aerobic and strength training fitness, and have reduced fatigue levels. Also, we anticipate high satisfaction with the PROFit program, and evidence of program feasibility and sustainability.

As a final note, the present dissertation was completed using Memorial University's manuscript format. Included in this dissertation is an introduction (Chapter 1), review of the relevant literature (Chapter 2), and research manuscript (Chapter 3). Based on this formatting some of the information presented in the dissertation may be repetitive.

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Chapter 2 Literature Review

2.1 Cancer in Canada

Approximately one in two Canadians will be diagnosed with cancer in their lifetime and one of four will die of the disease (Canadian Cancer Society's Advisory Committee on Cancer Statistics [CCSACCS], 2017). Cancer is the leading cause of death in Canada, accounting for 30% of all deaths (CCSACCS, 2017). In 2017, it was estimated that 206,200 Canadians were diagnosed with cancer, and 80,800 Canadians were expected to pass away from the disease (CCSACCS, 2017). However, with improvements in screening procedures and treatment options, the likelihood of surviving a cancer diagnosis has improved in the past few decades (DeSantis et al., 2014). The five-year age-standardized net survival rate has grown from 53.0% in 1992-1994 to 60% in 2006-2008 (CCSACCS, 2017). In other words, the odds of an individual surviving 5 years after their cancer diagnosis is 60%, when compared to the general population. At the beginning of 2009, there were 810,045 Canadians alive who were given a cancer diagnosis in the previous 10 years, and it is estimated that there are over one million cancer survivors living in Canada today (CCSACCS, 2017). A cancer survivor is defined as a person at any stage of cancer care, from diagnosis to long-term survival (Siegel et al., 2012). With the general population continuing to increase in Canada, we can estimate that the number of cancer diagnoses will increase as well, leading to an expanding population of cancer survivors (CCSACCS, 2017). Hence, it is expected that there will a large number of people living with the long-term adverse effects of cancer and its treatment, impacting cancer survivorship and quality of life (QoL).

2.2 Side Effects of Cancer Treatment

Improvements in cancer patient survival rates are due in large part to earlier detection and advancements in types modalities (DeSantis et al., 2014). DeSantis and colleagues discuss various cancer treatments available, including: chemotherapy, surgery, radiation therapy and hormone therapy, and treatment plans are based on the type of cancer, stage of cancer progression, the cancers' characteristics, and other individual considerations. Treatments can be used alone, or in combination with each other depending on the treatment plan. However, the authors also mention that while improved survival rates are attributable to successful cancer treatments, survivors may experience acute and chronic side effects as a result. The severity and longevity of these side effects can vary between treatments. For example, chemotherapy drugs strive to kill the fast-growing cancer cells, but it damages healthy cells in the process resulting in side effects that include: hair loss; fatigue; nausea and vomiting; mouth, gum, tongue and throat problems (e.g., sores and infections); constipation; diarrhea; poor appetite; nerve and muscle issues (e.g., loss of balance and fine motor coordination), and weight gain (American Cancer Society [ACS], 2016). Another commonly used cancer treatment is radiation therapy; high-energy particles that destroy or damage cancer cells. The radiation can create skin problems (e.g., swollen, blisters, dryness), increase levels of fatigue and cause hair loss (ACS, 2016). Like radiation, surgery to remove the cancerous cells creates several short-term side effects such as lymphedema, pain, weight changes and fatigue (ACS, 2016). Even after treatments are complete and the initial side effects subside, cancer survivors may experience a wide range of late-appearing side effects. For example, radiation therapy can cause a hardening of the arteries around your heart (i.e., increasing your risk of a heart attack), heart valve damage, and cognitive impairments (ACS, 2016), and patients who have undergone surgery can experience sexual dysfunction, neuromuscular conditions, impaired lung function, psychosocial concerns, and cancer reoccurrence (DeSantis et al., 2014). Other therapies such as chemotherapy and hormone therapy have been associated with late-appearing effects like immune suppression, loss of bone density and muscular atrophy (ACS, 2016; DeSantis et al., 2014). The appearance of these side effects is not always immediately recognizable, but they play a large role in the standard of living for survivors. The physical and psychological consequences of cancer treatments have been shown to significantly diminish a cancer survivor's QoL (Ferrer, Huedo-Medina, Johnson, Ryan and Pescatello, 2010), and have been known to persist for months and even years after treatment (Resnick et al., 2013), making the return to a normal lifestyle difficult.

2.3 Quality of Life and Physical Activity in Cancer Survivors

Examined in numerous research studies, QoL is a general term used to assess life satisfaction; including the physical, social and emotional aspects of an individual's life (Cella & Tulsky, 1993). When associated with some form of disease or health condition, the term 'health-related quality of life' has been used in research areas surrounding clinical populations such as cancer survivors. The importance of an individual's QoL has not gone unnoticed by cancer researchers, and the relationship between treatment side effects and QoL has gained considerable attention. Cancer survivors have reported a significantly diminished QoL when compared to those who have never been diagnosed with cancer (LeMasters, Madhavan, Sambamoorthi and Kurian, 2013). As discussed in a review by Mishra et al. (2012), adverse effects from cancer treatments are wide reaching and have a negative impact on the major domains (i.e., physical, psychological) of a cancer survivors' overall well-being. Specifically, survivors have reported musculoskeletal issues (i.e., arthritis), hypertension, and impaired lung capacity when compared to individuals without cancer (Mishra et al., 2012; Yabroff, Lawrence, Clauser, Davis and Brown, 2004). LeMasters et al. (2013) found that survivors of all types of cancer reported more activity limitations and poorer health than their cancer-free counterparts, and specific cancer types were found to experience greater distress than others. Colorectal cancer survivors experienced the greatest limitations in activity, and prostate cancer survivors expressed greater fatigue when compared to their non-cancer controls. Unfortunately, studies have shown these limitations can last for years after their diagnosis (Yabroff et al., 2004). In recent years, research exploring the importance of physical activity (PA) for cancer survivors has grown. Research has established that PA has been found to be safe and feasible for cancer survivors, and leads to beneficial improvements in QoL, cancer symptom management, strength, fatigue, depression, and physical functioning (Courneya & Friedenreich, 2007). More specifically, compared to cancer survivors who are not physically active, those who participate in PA have reported greater physical functioning and generally lower levels of symptoms (e.g., fatigue, pain, nausea and vomiting; Tang et al., 2016). In addition, PA is associated with reduced all-cause and cancer-specific mortality (Ballard-Barbash et al., 2012). The benefits of PA have been well documented across the cancer continuum, ranging from prevention to palliative care (Courneya & Friedenreich, 2007; Ferrer et al., 2010; Friedenreich & Orenstein, 2002; Mishra et al., 2012; Newton & Galvao, 2008).

For survivors undergoing active treatment, PA and exercise has been shown to improve physical functioning, reduce pain, improve sleep patterns and emotional states, such as fatigue, depression, and anxiety (Courneya & Friedenreich, 2007; Mishra et al., 2012). In an extensive review, consisting of 82 studies (40% of which were conducted during active treatment), positive effects were seen in aerobic fitness, muscular strength, functional QoL, anxiety and self-esteem (Speck, Courneya, Masse, Duval and Schmitz, 2010). Of the studies examining PA during active treatment, the majority included aerobic interventions (i.e., 88%) at various intensities and frequencies. However, a study by Courneya et al. (2007) examining breast cancer patients receiving chemotherapy found resistance training provided similar benefits, including improved body composition, physical functioning, and muscular strength. This would suggest using some variation of PA and exercise (i.e., aerobic or resistance) may produce comparable benefits in cancer survivors. In support of this finding, a study by Adamsen et al. (2003) evaluated the physical capacity and health benefits of an exercise program that included aerobic and resistance exercise in cancer patients undergoing chemotherapy. At the end of the program, significant increases were found in aerobic and muscular capacity, as well as improvements in QoL and general well-being, when compared to baseline measurements. Similar results were found in a home-based aerobic and resistance exercise intervention in breast and prostate cancer patients undergoing radiation therapy (Mustian et al., 2009). Cancer patients in the exercise group had significantly higher QoL and lower cancer-related fatigue than the cancer patients in the control group. Furthermore, these improvements were found post-intervention and at the 3-month follow-up.

Not only have the beneficial effects of PA and exercise been examined in cancer patients undergoing treatment, PA has been found to improve QoL in cancer survivors once their treatment has ended. In a review by Speck et al. (2010), 60% of the studies included examined PA and cancer survivors' post-treatment, and significant improvements in aerobic fitness, upper- and lower-body strength, body fat percentage, overall QoL, mood and fatigue were identified. Similar benefits, including improvements in physical functioning, psychological outcomes (i.e., reduced levels of fatigue and depression) and QoL, were found in an extensive meta-analysis involving PA and cancer survivors' post-treatment (Fong et al., 2012). These findings show the importance of adopting and maintaining a physically active lifestyle. In addition, it highlights the relationship between the structure of a PA program (i.e., types of exercises included, intervention environment) and the PA levels of cancer survivors. For example, interventions that are a minimum of 12-weeks in duration, include behavior changing techniques (e.g., self-monitoring), and are offered in different settings (e.g., one-on-one or group-based) have been found to be effective at promoting PA maintenance (Short, James, Stacey and Plotnikoff, 2013). Some PA interventions have additional benefits to their design, such as improved social support between participants in group-based PA (Haas & Kimmel, 2011), when compared to one-on-one training.

Due to the positive benefits of PA for cancer survivors, Schmitz et al. (2010) recommends cancer patients undergoing non-invasive treatments, such as chemotherapy and radiation therapy, to participate in PA. The authors specify that cancer survivors are recommended to participate in 150-minutes of moderate-to-vigorous PA (MVPA) per week, as well as two days of muscular strength training. Unfortunately, levels of PA in cancer survivors have been shown to decrease following a cancer diagnosis and treatment (Neil, Gotay and Campbell, 2014). In Canada, less than 22% of cancer survivors have been found to be physically active, with rates as low as 13.8% and 16.6% reported by female colorectal and breast cancer survivors, respectively (Courneya, Katzmarzyk and Bacon, 2008). Physical inactivity is a major contributor to disease burden and mortality, regardless of disease state (Lee et al., 2012), and has been compared to smoking and obesity for its harmful effects (Bouchard, Blair and Katzmarzyk, 2015). Finally, Courneya, Rogers, Campbell, Vallance, and Friedenreich (2015) found that just over half (65%) of cancer survivors meet recommended PA levels post-intervention, suggesting the need for a sustainable PA program. Future research studies may wish to consider exploring different PA program settings to find beneficial ways of increasing levels of PA in cancer survivors.

2.4 Community-Based Physical Activity Programs for Cancer Survivors

Although the beneficial effects of PA have been well documented, there is limited research examining PA programming offered in a real-life settings and its impact on cancer survivors QoL. This gap in the literature creates a disconnect between the positive effects (e.g., enhanced QoL and improved physical health) associated with increased PA levels (Fong et al., 2012) and the practical application of PA programs for cancer survivors. The limited research surrounding community-based programs and cancer survivors has found improvements in fatigue, physical functioning (e.g., muscular strength and flexibility), and psychosocial outcomes, such as anxiety and social support systems (Cheifetz et al., 2014; Haas & Kimmel, 2011; Rajotte et al., 2012). In one of the first studies examining a community-based exercise program, Haas & Kimmel (2011) discuss the development of the Cancer Foundation for Life (CFFL). In their study, they outlined the various barriers to PA participation that cancer survivors face, such as treatment-related adverse effects, intimidation in an exercise environment, and the cost of gym membership fees and/or personal trainers. The CFFL was designed by a retired oncologist in collaboration with local hospitals, cancer centres and community organizations. The exercise program FitSTEPS For Life (FSFL) was created by the CFFL as a program that accepts all persons with cancer (regardless of age, cancer type, and stage of disease) and consists of supervised aerobic and resistance exercises. Upon evaluation of the program, doctor referrals increased from 168 in 2001 to 2,456 in 2010 and patient encounters increased from 15 in 2001 to 66,017 in 2010, suggesting an increased need for the program and positive adherence. A drop-out rate of 50% was noted, however, 46% of dropouts were a result of complications from cancer and other diseases, new illness or exercising on their own. The development of the FSFL program was one of the first programs to address the need for an effective community-based PA and exercise program for cancer survivors. Years later, researchers have continued to assess the use of community-based PA programs in cancer survivors. In 2008, the LIVESTRONG® foundation at the YMCA (a community fitness facility) partnered with a research center survivorship project to create Exercise and Thrive (E&T), an exercise program for cancer survivors who had finished treatments. Rajotte et al. (2012) used a pre- and post-testing study design to examine the effectiveness and safety of the 12-week bi-weekly E&T program with their 221 cancer survivors. The participants completed individualized aerobic and resistance training exercises in a group setting while supervised by YMCA personal training staff. Their findings indicated improvements in fatigue, physical function (i.e., flexibility, walking endurance and upper and lower body strength), musculoskeletal symptoms, mental health, social support and PA levels. In addition, adherence rates to the program were high with 88% of participants attending more than half of the activity sessions, and program satisfaction was high (>95%). The personal trainers monitoring participant exercise received 16 hours of training in cancer terminology, staging, treatment options and adverse effects, as well as psychosocial issues facing cancer survivors prior to beginning the program. The preparation of the trainers, and that the program was offered in 13 different YMCA locations in the region likely contributed to its overall success. The LIVESTRONG® program continued to grow at YMCA facilities, serving over 29,000 participants by 2015 (Heston, Schwartz, Justice-Gardiner and Hohman, 2015). Participants reported their satisfaction with the program and the environment of the YMCA. A recent evaluation of the LIVESTRONG® program on cancer survivors PA, fitness, cancer-related fatigue and QoL by Irwin et al. (2017) found improvements in all outcomes following participation in the 12-week program. Furthermore, this study highlighted the safety of the program through lack of injuries reported in the 186 participants, and the requirement of physician consent before participants can begin the exercise program. The high adherence rates noted by Rajotte et al. (2012) are similar to the adherence rate (81.5%) of adolescents with cancer to a community-based PA program designed by Keats & Culod-Reed (2008). Both studies demonstrate the feasibility of a community-based PA program for individuals on the cancer care continuum.

An important aspect of these community-based programs is the social setting. Improvements in well-being, emotional adjustment, and QoL have been found in cancer survivors after psychosocial interventions or group therapy sessions (Goodwin, 2005; Spiegel et al., 2007). Group-based PA and exercise interventions have also been found to benefit QoL and physical functioning (Kolden et al., 2002; Mutrie et al., 2007). A recent review of home- and community-based PA interventions in cancer survivors by Swartz et al. (2017) determined that using group-based PA produces the largest effect sizes in respect to physical functioning. Organizing PA interventions for cancer survivors in a group-based design can mitigate any intimidation towards exercise and allow survivors to connect with one another for support and encouragement (Haas & Kimmel, 2011). Furthermore, positive support from family and friends is associated with better physical and mental health-related QoL in cancer survivors, suggesting the importance of including a partner in community-based PA program to promote confidence in PA (Mehnert, Lehmann, Graefen, Huland and Koch, 2010). Murray et al. (2012) examined the effect of exercise and psychosocial support using a community-based program on QoL and fatigue in 42 cancer survivors. The exercise sessions were conducted two days per week by personal trainers, while the psychosocial support group was once per week and lead by a licensed clinical social worker. At the end of the 12-week program, there were statistically significant improvements found in QoL, as well as a reduction in fatigue. The benefits of a psychosocial support group, as the study by Murray and colleagues suggests, demonstrates the effectiveness of including a group-based approach in future community-based PA programs for cancer survivors.

In a recent study by Cheifetz et al. (2014), the authors created the community-based exercise and education program 'CanWell' for cancer survivors. The 12-week program took place at the YMCA fitness facility and consisted of weekly exercise sessions including aerobic, resistance training, and flexibility exercises, similar to the structure of previous community-based PA programs (Haas & Kimmel, 2011; Murray et al., 2012; Rajotte et al., 2012). The exercise program was conducted in a social setting using individualized exercise prescriptions for each participant, as determined by unique cancer type, stage of disease and any contraindications. A total of 139 cancer survivors participated in 'CanWell' and upon completion of the program, the researchers found significant improvement walking ability from baseline to 6 weeks, improved health-related QoL and a reduction in symptoms experienced from baseline to week 12. These findings support the need for programs that are at least 12-weeks in duration, as participants' physical performance improved significantly within the first six weeks, but significant improvements in QoL and symptoms were not found until 12 weeks. In addition, the 'CanWell' program was designed through collaboration between an acute care hospital, academic center and a YMCA facility. Previous activity programs created for cancer survivors had a similar design (Haas & Kimmel, 2011; Rajotte et al., 2012), and demonstrates the success of providing a PA and exercise program for cancer survivors through collaboration. The improvements in physical functioning and QoL found in the 'CanWell' program (Cheifetz et al., 2014) are similar to the results found in a more recent study by Foley, Barnes and Hasson (2015). The researchers examined physical function and QoL outcomes in 59 cancer survivors who had participated in a 12-week community-based exercise program. After the completion of the program, participants were found to have increased walking capacity, increased functional mobility and improved physical, emotional, functional and total well-being. Improvements in physical functioning (i.e., mobility, upper and lower body strength, balance, and upper extremity flexibility) and QoL (i.e., emotional, physical, functional, social and total well-being) were also determined by Foley, Hasson and Kendall (2018) when examining a 12-week community-based multi-modal exercise program in 52 breast cancer survivors. Furthermore, the breast cancer survivors in this study were assigned to an early start group (<1 year since completing cancer treatment) and a late start group (>1 year since completing cancer treatment) to determine if there was any difference in outcome effects. Irwin and colleagues found no significant difference between the early start and late start groups in relation to physical functioning and QoL, except for significant improvements in the emotional well-being subscale for the early start group compared to the late start group. These findings encourage cancer survivors to adopt a physically active lifestyle, but some may feel unmotivated to do so, even if they begin immediately after completing treatment or more than year later.

The implementation and impact of community-based PA programs in cancer survivors is a growing area of research, and the results of these studies are encouraging. However, research surrounding community-based PA programs has typically involved cancer survivors in general, creating limitations in the applicability of these results to specific cancer populations. As an example, a recent study by Kalter et al. (2015) investigated various moderators of the effects of group-based exercise on cancer survivors' QoL and one of the moderators was the type of treatment (i.e., radiation therapy and/or chemotherapy). Findings indicated that the effect of the exercise intervention on global QoL was larger in cancer survivors who received radiotherapy, or a combination of chemoradiotherapy, compared to those who did not. These results suggest that cancer treatment modality can moderate the effect of an exercise program on cancer survivors' QoL. For this reason, it is important to determine what other factors should be accounted for when designing an effective community-based PA program (Basen-Engquist et al., 2017; Courneya et al., 2015). To fill this gap in the research, future studies should focus on developing community-based PA programming for specific cancer populations (i.e., breast, prostate), and its effect on physical functioning and QoL.

2.5 Prostate Cancer, Treatment Side Effects and Physical Activity

Prostate cancer is the fourth most common type of cancer, accounting for 10% of all cancers diagnosed (CCSACCS, 2017). In males, prostate cancer is the most commonly diagnosed type of cancer in Canada, reflecting 21% of all male cancer cases and accounting for 21,300 estimated new cancer cases diagnosed in 2017 (CCSACCS, 2017). While prostate cancer can occur at any age, the majority of new cancer cases (i.e., 38%) occur between the ages of 60-69 (CCSACCS, 2017). When taking into consideration the increase in the aging population, this suggests a future increase in the number of prostate cancer cases diagnosed each year. Despite being the most commonly diagnosed form of cancer in males, the mortality rate in men with prostate cancer is 10%, with a five-year relative survival ratio of 95% (CCSACCS, 2017). With an increase in the diagnosis rate of prostate cancer accompanied by a lower mortality rate, the result is a large population of prostate cancer survivors living in Canada. High survival rates are attributed to improvements in screening procedures (Stattin et al., 2014), as well as advanced treatment procedures such as surgery, radiotherapy (i.e., external-beam radiation and brachytherapy), hormonal therapy (i.e., androgen deprivation therapy [ADT]), and chemotherapy (Thorsen, Courneya, Stevinson and Fossa, 2008). In the early 1990's, the advent of prostate-specific antigen (PSA) screening resulted in an increase of men with early-stage prostate cancer, allowing for greater treatment options (Krupski & Litwin, 2007). Treatment options are considered based on prognostic factors, such as initial PSA levels, stage of the cancer (i.e., where the primary tumor is, are regional lymph nodes affected, etc.), age, co-morbidities and baseline urinary function (Keyes et al., 2013). Surgery to remove the prostate is a commonly used treatment when the cancer is localized to the prostate gland (Eton & Lepore, 2002) and for otherwise healthy men under the age of 70 (Keyes et al., 2013). Similarly, radiotherapy can be curative in the early stages of prostate cancer, but works with other treatments in the later stages to improve overall survival (Segal et al., 2009). In advanced stages of the disease, when it has spread from the prostate to other areas of the body, hormonal and chemotherapeutic treatments can be used to control or delay symptoms (ACS, 2016; Eton & Lepore, 2002). Androgen Deprivation Therapy (ADT) is a hormonal treatment that reduces the levels of androgen hormones (i.e., testosterone) in the body to prevent cancer cells from growing; patients will usually receive ADT for 2-3 years (Alibhai et al., 2010). In some instances, patients will receive no immediate treatment at all, and this is typically referred to as 'active surveillance'. Men who are diagnosed with low-risk prostate cancer may opt out of immediate treatment, instead they choose to monitor their PSA levels coupled with repeated biopsies to determine the rate of progression and when it is necessary to follow through with further treatments (Cooperberg, Carroll and Klotz, 2011). Advancements in treatment options can increase survival; however, the adverse side effects typically associated with treatments can have negative consequences. Treatment-related symptoms can vary depending on the types and stages of cancer involved and how they impact health-related QoL (Mystakidou et al., 2013).

Prostate cancer treatments can lead to short- and long-term side effects. Side effects range from psychological trauma, including depression, stress, anxiety, and a loss of self-control, to physical symptoms, such as decreased muscular strength, diminished cardiovascular function, and increased fatigue, nausea, and pain (Courneya & Friedenreich, 1999; Eton & Lepore, 2002; Krupski & Litwin, 2007; Thorsen et al., 2008). Different types of treatments can result in variable effects. For example, ADT impacts the levels of androgens in the body and in turn, affects the individuals skin, bones, muscles and sexual function. ADT can cause increased fatigue, sexual dysfunction, hot flashes and anemia (Gardner, Livingston and Frazer, 2014; Higano et al., 2003). Radiation therapy, commonly used in combination with other treatments, is associated with increased levels of fatigue and skin problems, such as blisters and soreness (ACS, 2016; Segal et al., 2009). Unfortunately, all treatments for prostate cancer can result in similar effects, such as sexual dysfunction and urinary incontinence (Ferrer et al., 2013). Prostate cancer patients typically receive at least one form of treatment, or a combination of treatments to target the cancerous cells. Short-term side effects occur during or shortly after treatments are given. Sadly, short-term side effects may persist for months, or even years, after treatments have been completed (Resnick et al., 2013). For example, increased levels of fatigue remain 3-12 months after finishing ADT (Alibhai et al., 2006; Stone, Hardy, Huddart, A'Hern and Richards, 2000), while declines in sexual, urinary and bowel function are common (Keyes et al., 2013; Thorsen et al., 2008) and can last up to 15-years following treatment (Litwin, Sadetsky, Pasta and Lubeck, 2004; Potosky et al., 2000; Resnick et al., 2013). Declines in uro-genital functioning are common in age-matched men without a history of prostate cancer, however they are more prevalent in prostate cancer survivors (Thorsen et al., 2008).

Different from long-term side effects, some adverse effects are late-appearing, and do not begin until after treatments have been completed. For example, within 3-12 months after initiation of treatment, increases in fat mass (9-11% increase) and decreases in lean body mass (2-4% decrease) have been found (Basaria et al., 2002; Gardner et al., 2014). In prostate cancer survivors especially, a loss of bone density over time due to hormonal therapies is common and increases the likelihood of future bone fractures (Shahinian, Kuo, Freeman and Goodwin, 2005). Physical side effects have been found to significantly influence psychological health, leading to a diminished QoL and an increased risk of anxiety and depression (Thorsen et al., 2008). Prostate cancer survivors have noted a decline in their QoL during and shortly after treatments, caused in part by increased levels of fatigue, urinary incontinence, and sexual and bowel dysfunction (Potosky et al., 2004; Sanda et al., 2008). Treatment-related side effects can linger for years, continuing to have a negative impact on prostate cancer survivors' daily activities and QoL. As an example, men have reported sexual and bowel dysfunction and urinary incontinence as a significantly diminishing factor in their overall QoL for up to 10 years after treatments (Davis et al., 2014; Ferrer et al., 2013). Furthermore, prostate cancer treatments can lead to feelings of hopelessness, pessimism, and a lack of concentration, all of which can reduce participation in activities of daily living (Baumann, Zopf and Bloch, 2012). Examination of these short- and long-term side effects and how they affect QoL (Davis et al., 2014) provides the basis for developing and implementing behavioral interventions in prostate cancer survivors. While many interventions have been explored to alleviate the negative side effects of cancer diagnosis and treatment, especially on QoL, one that has gained considerable attention is PA and exercise.

Research studies examining the effects of PA interventions in prostate cancer survivors has grown in the past decade. PA has been found to reduce the risk of prostate cancer specific mortality by 35% and all-cause mortality by 33% in men who exercise ≥9-MET hours per week (i.e., moderate-vigorous PA). In addition, prostate cancer survivors who are more physically active post-diagnosis or who have performed recreational PA before and after their diagnosis lived longer (Kenfield, Stampfer, Giovannucci, and Chan, 2011; Friedenreich et al., 2016). Apart from cancer-related mortality, PA has been found to improve multiple health outcomes in prostate cancer survivors. A review by Thorsen et al. (2008) examined the prevalence of PA and the effects of PA on health outcomes in prostate cancer survivors. Of the 16 studies included, the results indicated beneficial effects in physical functioning, muscular fitness, fatigue and health-related QoL. Similar results were found in a recent review by Bourke et al. (2016), examining the effects of exercise for men with prostate cancer across different stages and types of cancer treatments. Of the 16 randomized controlled trials included, improvements in submaximal fitness, lower body strength, and cancer-specific QoL and fatigue were found. The exercise interventions in the review consisted of home-based, supervised, or a mixture of the two, suggesting the benefit associated with various forms of exercise interventions. Also, as highlighted in the review by Thorsen et al. (2008), many of the studies using PA and exercise interventions consisted mainly of resistance training exercises. The effects of resistance training in prostate cancer survivors receiving ADT was examined previously by Segal et al. (2003). Following a 12-week resistance training program including 155 participants, results showed significant improvement in fatigue, health-related QoL and upper- and lower-body muscular strength (42% and 32%, respectively) when compared to the control group. Standard resistance exercises were used in the study (i.e., leg extension, calf raises, leg curl, chest press, bicep curls, overhead press), and the program was completed three times per week. Other studies using similar resistance exercise programs have produced comparable results, showing significant improvements or some beneficial effect on various health outcomes in prostate cancer survivors receiving ADT (Galvao et al., 2006; Gardner et al., 2014).

In addition to resistance exercise, the effects of aerobic exercise in PA programs have been investigated using only aerobic interventions or in combination with resistance exercises. Aerobic exercise with moderate-to-vigorous intensity has been shown to significantly improve walking distance, functional capacity, fatigue levels, and resting heart rate (Culos-Reed, Robinson, Lau, O'Connor and Keats, 2007), and prevent increases in fatigue commonly experienced during radiation treatments (Windsor et al., 2004). Segal et al. (2009) conducted a randomized control trial, where 121 men receiving radiation therapy for prostate cancer were randomly assigned to resistance exercise, aerobic exercise or a control group for 24 weeks. While resistance training improved upper- and lower-body strength and QoL, both aerobic and resistance exercise mitigated levels of fatigue in participants.

In prostate cancer survivors, sexual dysfunction is a common long-term side effect of radiotherapy and has a detrimental impact on QoL (Sanda et al., 2008). However, significant improvements in sexual functioning are found with increases in PA (Dahn et al., 2005). Furthermore, increased PA and exercise behaviors result in similar improvements in sexual functioning in men receiving ADT (Cormie et al., 2013; Galvao et al., 2010). Since sexual dysfunction has been established as a major contributor to poor QoL in prostate cancer survivors, this provides added support for the benefit of PA programs in reducing symptoms experienced by survivors and enhancing QoL.

Improvements in the health-related QoL of prostate cancer survivors has been found at various intensities and frequencies of PA. As an example, Phillips, Stampfer, Chan, Giovannucci and Kenfield (2015) examined the relationships between different intensities and types of activity (e.g., walking, jogging, swimming, weight training, heavy outdoor work), and health-related QoL in prostate cancer survivors. Participants reporting ≥5 hours per week of non-vigorous activity and ≥3 hours per week of walking had greater hormone/vitality scores compared to those reporting <1 hour of each activity, respectively. In addition, men who walked at a normal/average or brisk pace had improved urinary irritation/obstruction, hormone functioning/vitality, urinary incontinence and sexual functioning compared to men who walked at an easy pace. Finally, ≥90 minutes of normal/brisk walking pace lead to greater hormone/vitality scores. The results suggest that engaging in ≥240 minutes of walking per week can improve hormone functioning and vitality, but 90 minutes of walking at a normal/brisk pace per week can be beneficial as well. This is important for prostate cancer survivors that want to become more physically active, but may feel they need to engage in large amounts of activity to feel any improvement. Varying levels of exercise can help improve fatigue, incontinence, muscular strength, aerobic fitness, flexibility and QoL, as established in a recent systematic review by Baumann et al. (2012). Furthermore, Baumann and colleagues created general exercise guidelines to be considered when implementing PA and exercise in prostate cancer patients. As an example, resistance training can begin prior to, during, or shortly after radiation and ADT treatments, and should be completed indefinitely two-three times per week, consisting of seven-eight full-body exercises and six-twelve reps per exercise for two-four sets. These guidelines are valuable for future research studies investigating PA and its effects on prostate cancer survivors. They provide guidelines about what type, frequency, duration, and intensity of exercise should be utilized for optimal benefits.

Despite these benefits, prostate cancer survivors are insufficiently active with 29-30% of survivors participating in PA (Thorsen et al., 2008). Keogh et al. (2010) found that only 14% of prostate cancer patients on ADT perform one session of strength training in a week, less than the recommended two sessions of strength training per week by Schmitz et al. (2010). Barriers such as treatment-related side effects, lack of motivation, additional comorbidities and an increased age in prostate cancer survivors reduce the likelihood that men will participate in PA (Keogh et al., 2014; Ottenbacher et al., 2011). Despite these barriers, a recent review by Wong et al. (2018) found that cancer survivors are interested in participating in PA programs. The authors even highlight PA preferences identified by participants, such as moderate-intensity activity, and supervised versus home-based. Elements such as cancer type and level of cancer care could also affect PA preferences. Encouragement to adopt a more physically active lifestyle can be provided through physicians and other social supports, such as friends and family (Keogh et al., 2014). It is important that healthcare professionals are given the appropriate tools to educate prostate cancer survivors on the benefits of beginning or maintaining PA to mitigate treatment side effects and enhance overall QoL, as well as improve long-term prognosis. The likelihood of continuing a physically active lifestyle can be further sustained by close supports, such as family, friends and other prostate cancer survivors (Thorsen et al., 2008). Future research could investigate the relationship between prostate cancer survivors and the effects of a community-based PA program on QoL, fitness and function.

2.6 Rationale and Significance

This study aims to develop a sustainable community-based PA program, with the purpose of improving the QoL, physical functioning, and overall survivorship of prostate cancer survivors. PA has been shown to consistently improve treatment-related adverse effects in prostate cancer survivors, including fatigue, strength, QoL, and physical functioning; however, participation in PA among prostate cancer survivors is low (29-30%; Thorsen et al., 2008).

In Newfoundland specifically, survivorship has been identified as an important gap in the current cancer care model (Easley & Miedema, 2012; Fitch et al., 2009). The goals of this study were developed based on the needs identified within the Cancer Care Program of Eastern Health. Many prostate cancer survivors request guidance on lifestyle issues, such as PA (Ottenbacher et al., 2011), and currently there is no resource to refer them to. Community-based PA programs allow prostate cancer survivors to re-connect with their community, and represent a 'real-word' approach to PA programming through collaboration between a cancer centre, an academic center and a fitness facility (Cheifetz et al., 2014; Foley et al., 2015). The community-based approach allows for a more supportive and cohesive group, which has been shown to improve participant adherence to PA (Rajotte et al., 2012). An important factor for a successful community-based PA program is its feasibility and sustainability. This study will provide valuable information on the relationship between a community-based PA program designed specifically for prostate cancer survivors, and its effect on participants' survivorship.

2.7 Objectives

The study sought to further expand the PA and cancer literature by investigating the following research objectives:

1. To examine the effect of a community-based PA program on QoL, fitness, fatigue, strength and physical functioning in prostate cancer survivors.
2. To evaluate the feasibility and sustainability (i.e., dropout rate, reasons for low commitment, cost), and participant satisfaction of a community-based PA program for prostate cancer survivors.

2.8 Research Hypothesis

Based on previous research, it was expected that following participation in our 12-week community-based PA program called 'PROFit'; we would see improvements in the QoL, fitness, fatigue, strength, and physical functioning in prostate cancer survivors, and provide support for the feasibility (i.e., adherence rate, retention), sustainability (i.e., cost-effectiveness) and program satisfaction .

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Chapter 3

Improving Prostate Cancer Survivorship: Building Community Partnerships through Physical Activity

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Abstract

Background: Physical activity (PA) has been shown to improve prostate cancer survivors physical functioning and quality of life (QoL). **Purpose:** To investigate the impact of a community-based PA program on the QoL, fitness, fatigue, strength, and physical functioning of prostate cancer survivors, with a secondary purpose to examine the program's feasibility and sustainability. **Methods:** PROFit, a 12-week community-based, supervised PA program was developed by reviewing the current PA and cancer literature, and through establishing partnerships with a cancer care program, community fitness facility, and university. Specifically, 15 prostate cancer survivors and their partners (*N*=4) were recruited to take part in the PA program, which consisted of strength (i.e., circuit training) and aerobic training. Survivors QoL, fatigue, prostate cancer specific symptoms, physical functioning, and PA levels were assessed at baseline, six and 12-weeks. Program attendance and cost were recorded to determine feasibility and sustainability. Satisfaction surveys were administered to participants and partners at six and 12-weeks. **Results:** One-way repeated measures analysis of variance found significant increases in lower body strength across all time points and flexibility from baseline to 12 weeks. No significant improvements were found in upper body strength, agility, aerobic fitness, weekly moderate-vigorous PA, QoL, and fatigue; however, non-significant increases in participant upper body strength, weekly moderate-vigorous PA, and agility were noted. Participants and partners reported a high level of satisfaction with the program, and program attendance and intervention costs were satisfactory. **Conclusion:** The PROFit program had a positive impact on prostate cancer survivorship. Due to the lack of evidence surrounding community-based PA programs in prostate cancer survivors, the PROFit program delivers valuable insight into the collaboration between hospitals, universities and community centers to provide prostate cancer survivors with a resource for improving survivorship (i.e., QoL, physical functioning) following treatment.

3.1 Introduction

Prostate cancer is the most commonly diagnosed cancer in males in Canada, with 21,300 new cases, and 4,100 deaths in 2017 (Canadian Cancer Society's Advisory Committee on Cancer Statistics [CCSACCS], 2017). Treatments for prostate cancer improve survival, and have led to a 95% five-year relative survival ratio (CCSACCS, 2017). Unfortunately, cancer treatments are associated with varying acute, chronic, and late-appearing side effects that are detrimental to prostate cancer survivors physical functioning and quality of life (QoL; Krupski & Litwin, 2007; Resnick et al., 2013; Thorsen et al., 2008). Research has consistently shown that physical activity (PA) is beneficial for cancer survivors, and can alleviate many of the experienced side-effects (Ferrer, Huedo-Medina, Johnson, Ryan and Pescatello, 2010; Fong et al., 2012). Specifically, for prostate cancer survivors, PA has been found to improve health-related outcomes, such as cancer-related fatigue, decreasing fat mass, physical fitness (e.g., aerobic capacity and muscular strength), sexual dysfunction, urinary incontinence, and health-related QoL (Baumann, Zopf, and Bloch, 2012; Dahn et al., 2005; Gardner, Livingston and Fraser, 2013; Keogh & MacLeod, 2012; Phillips et al., 2015; Thorsen et al., 2008; Wolin, Luly, Sutcliffe, Andriole, and Kibel, 2010). Research has also established that PA following a prostate cancer diagnosis is associated with lower all-cause mortality and prostate cancer specific mortality (Bonn et al., 2014; Kenfield, Stampfer, Giovannucci, and Chan, 2011).

Despite these findings, many prostate cancer survivors (i.e., 29-30%) are insufficiently active (Thorsen et al., 2008), due in part to treatment-related side effects (Keogh et al., 2010). Barriers such as a lack of willpower and difficulty maintaining exercise routines following a prostate cancer diagnosis have also been found to contribute to low activity levels (Keogh et al., 2014; Ottenbacher et al., 2011). These findings highlight the need for PA programming to enable prostate cancer survivors to increase their PA levels, and improve their overall health.

Community-based PA and exercise programs have gained considerable attention in recent years (De Smedt, De Cocker, Annemans, De Bourdeaudhuij and Cardon, 2012; Haas & Kimmel, 2011; Murray et al., 2012; Rajotte et al., 2012). They model 'real-world' PA, have been found effective at increasing PA in cancer survivors (Cheifetz et al., 2014; Murray et al., 2012; Rajotte et al., 2012), and are a successful alternative to traditional PA programs that are offered in research or hospital settings (Cheifetz et al., 2014, Haas & Kimmel, 2011). From the limited studies exploring community-based PA interventions, the results have been promising; including demonstrating benefits such as decreased fatigue, improved physical functioning (i.e., flexibility and muscular strength), and overall health-related QoL (Foley, Barnes and Hasson, 2015; Irwin et al., 2017; Keats & Culos-Reed, 2008; Murray et al., 2012; Rajotte et al., 2012). Community-based PA programs are an example of how collaboration between a research facility, a cancer clinic, and a community institution can create opportunities for cancer survivors to increase their PA levels. Additionally, community-based PA programs implemented in a group-based setting have been found to provide social support among cancer survivors, and promote PA adherence (Haas & Kimmel, 2011; Keogh & MacLeod, 2012; Swartz et al., 2017).

A successful example of a community-based PA program is CanWell; a 12-week exercise and education program based out of the YMCA for cancer survivors (Cheifetz et al., 2014). The CanWell program demonstrated the benefits of implementing existing knowledge in cancer care and research into a 'real-world' approach to increase PA levels among cancer survivors. Significant improvements in participants' health-related QoL and physical functioning were found upon completion of the program. Given these findings, it is important to understand what enables a community-based PA program to be successful and sustainable, and in turn, use this information to develop programming specific to prostate cancer survivors looking to increase their levels of activity and health.

The purpose of this study was to examine the impact of PROFit, a community-based PA program on the QoL, fitness, fatigue, strength, and physical functioning of prostate cancer survivors. The secondary purpose was to evaluate the feasibility, sustainability, and satisfaction of the PROFit program.

3.2 Methods

3.2.1 Participants and Procedures

Ethical approval was obtained from the institutions Health Research Ethics Authority prior to participant recruitment. The study was a prospective, pre-post, cohort design. Participants were prostate cancer survivors' between the ages of 19-80, who had successfully completed cancer treatment (i.e., radiotherapy, chemotherapy, surgery, hormonal therapy), and were eligible for exercise. Participants were cleared for PA using a pre-exercise screening tool called the Physical Activity Readiness Questionnaire (PAR-Q+), or by their physician, if necessary. Participants were recruited through posters and brochures at local cancer clinics and hospitals, presentations to local support groups, referrals from oncologists, and by word of mouth. Interested participants met with the principal investigator and written informed consent was obtained prior to data collection.

In addition, partners (i.e., spouse, family or friend) were encouraged to accompany the participants if they wished to do so, and partake in the PA program to improve program adherence and social cohesion (Culos-Reed et al., 2010; Keogh & MacLeod, 2012; Mutrie et al., 2007). Partners also completed written informed consent, as well as the PAR-Q+ before beginning the PROFit program.

Assessments were completed at baseline (prior to the initiation of the PROFit program), at week six and week 12. The baseline assessments included objective PA behaviour, anthropometric data, and functional fitness. Demographic and medical variables, QoL, fatigue, and cancer specific symptoms were measured through self-report questionnaires. All measures were reassessed at week six and week 12; excluding demographic and medical information. Participant's partners did not complete the assessments or questionnaires; however, they did complete the PROFit program satisfaction survey, along with the participants at week six and week 12.

3.2.2 Intervention

The PROFit program was a 12-week group-based resistance and aerobic PA program performed at a community fitness facility. A 12-week program was chosen to improve the likelihood of detecting a change in QoL and physical functioning (e.g., Cheifetz et al., 2014; Rajotte et al., 2012). All PA sessions were supervised by the principal investigator (Certified Kinesiologist), kinesiology student volunteers, as well as a Certified Exercise Physiologist (CEP). The CEP was responsible for providing adaptations to exercises. Participants were asked to take part in two group-supervised PA sessions per week for weeks one to nine, followed by a tapering period of one supervised group PA session per week for weeks 10-12. The tapering was incorporated to encourage participants to become more independent with their PA sessions.

Each supervised PA session was one hour in duration. The session began with a 15-minute aerobic warm up, followed by 35-minutes of structured resistance training using bodyweight, resistance bands, and free-weight exercises (Campbell, Stevinson and Crank, 2012; Keogh & MacLeod, 2012). The resistance exercises were modified to account for any adverse effects of prostate cancer treatments, such as loss of bone density from hormone therapy (Buffart, Galvao, Brug, Chinapaw and Newton, 2014), and were organized into six stations, with two exercises per station (e.g., station one– bodyweight squats and lunges, station two– push-ups and chest fly). Participants were instructed to progress through stations one to six, in that order, and performed three sets of 12 repetitions for each exercise. Resistance exercises targeted the major muscle groups, and specific exercises included bodyweight squats, lunges, chest press, chest fly, lateral shoulder raise, shoulder press, step-ups, lateral band walks, band scapular retractions, seated row, plank and crunches. When using the free weights and resistance bands, the resistance was increased only when the participant could successfully complete 12 repetitions without difficulty. Participants recorded their progress in a personal logbook. At weeks one, five, and nine, the order and variations of exercises were altered to prevent familiarity and boredom. In addition, visual aids of each exercise were provided on folded boards at each station for clarification. The last five minutes of the PROFit program consisted of light static stretching to prevent muscle tightness and improve flexibility. Finally, each exercise session was followed by a half hour social gathering in a separate space on site. Participants and their partners were encouraged to attend and light refreshments were provided.

3.2.3 Measures

Demographic and medical information was assessed using self-report. Medical variables included date of diagnosis, cancer recurrence, and types of treatments completed (e.g., surgery, radiation therapy, chemotherapy, and/or hormone therapy). Demographic variables included age, marital status, current employment status, level of education, as well as weight, height and waist circumference to measure body composition and calculate body mass index (BMI).

The primary outcomes of this study included assessments of PA levels, QoL, fatigue, prostate cancer symptoms, fitness, and physical functioning. These outcomes were assessed using self-report and objective measures. QoL was assessed using the Short-Form-36 health survey (SF-36), a general health survey measuring eight multi-item dimensions (Jenkinson, Wright and Coulter, 1994). The SF-36 questionnaire is a validated tool for measuring general QoL, and has been used extensively in the general and clinical populations (Brazier et al., 1992; Mols, Vingerhoets, Coebergh and van de Poll-Franse, 2005).

Prostate cancer symptoms were assessed using the Prostate Cancer Subscale of the Functional Assessment of Cancer Therapy (FACT-P; Esper et al., 1997; Segal et al., 2003; Segal et al., 2009). Specifically, the final 12 questions of the FACT-P form include the Prostate Cancer Subscale (PCS), and addresses concerns specific to prostate cancer and its treatment. Fatigue was assessed using the Functional Assessment of Chronic Illness Therapy – Fatigue (FACIT-F), a 12-item questionnaire that measures self-reported fatigue and its impact on daily activities and function (Webster, Odom, Peterman, Lent and Cella, 1999). Low scores on each of the QoL measures reflect a lower health-related QoL and concerns relating to prostate cancer and its treatments.

Finally, fitness and function were assessed using the Seniors Fitness Test (SFT) and Six-Minute Walk Test (6-MWT). The SFT consists of 6 simple movement tests that measure functional fitness in older adults (Rikli & Jones, 2001). The chair sit-stand and arm curl quantify the number of full stands and bicep curls completed in 30 seconds, respectively. The chair sit and reach gauges the distance to/past (-/+) the toes of the extended leg with an outstretched hand, and the back-scratch test measures the distance between the hands as you try and touch them behind the back; a more negative number indicates decreased flexibility. The eight foot up-and-go clocks the duration it takes to walk 8-feet, circle an object, and return to a seated position. The 6-MWT measures functional aerobic capacity in older adults by using a submaximal test (Solway, Brooks, Lacasse and Thomas, 2001), and has been used in research to assess walking capacity in cancer survivors (Cheifetz et al., 2014).

PA levels were objectively measured using the ActiGraph wGT3X-BT tri-axial accelerometer (ActiGraph, LLC, Pensacola, FL, USA), which has been found to be a valid and reputable tool for measuring PA behaviour (Santos-Lozano et al., 2013; Skotte, Korshoj, Kristiansen, Hanisch and Holtermann, 2014). Accelerometers provide quantitative information regarding activity counts, energy expenditure, and activity levels. The device is sensitive to low frequency movements in the range of 0.25-2.5 Hz– the common range in individuals. The device was programmed with the participants' height, weight, and age, and given to them to wear on an elastic belt around their waist for seven consecutive days, during waking hours, for a minimum of 10 hours per day (Trost, McIver and Pate, 2005). Participants' were instructed to remove the device only when showering or for water activities, as the device is not waterproof. Data was collected at baseline, week six and week 12, and was analyzed using the ActiLife software (version 6.11.9). The Troiano Adult cut points for moderate-vigorous physical activity (MVPA) were used in this study (Troiano et al., 2008), and classify 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.

Secondary endpoints included exploring the feasibility and sustainability of the PROFit program, as well as the satisfaction of participants and partners with their PROFit experience. To assess the adherence to the program, attendance was taken at each session. Reasons for absenteeism were collected from participants (e.g., illness, other commitments). The total cost of implementing the program (i.e., cost of facility space, volunteers, refreshments) was recorded to assess sustainability. Safety was assessed by incidents or near misses (e.g., falls, injuries), and were recorded using a daily log. Satisfaction with the program was assessed using a satisfaction survey, and was given at week six and week 12 of the PROFit program.

3.2.4 Statistical Analysis

Descriptive statistics were used for description of participants' baseline demographics and medical characteristics. One-way repeated measures analysis of variance (ANOVA) was used to evaluate change in physical function, prostate cancer symptoms and health-related QoL over time (i.e., baseline, six weeks, and 12 weeks), with Bonferroni corrections applied to adjust for multiple comparisons. Intention to treat analysis was used to account for missing data (Fisher, 1990).

3.3 Results

A total of 16 prostate cancer survivors were deemed eligible and consented to participate and completed the baseline assessments for the PROFit program between March and October 2015. Of these participants, two (12.5%) dropped out of the study due to issues with chronic medical conditions unrelated to cancer (i.e., rheumatoid arthritis and lower back pain), and 14 (87.5%) completed the six-week and final assessments during the program. Data from a total of 15 participants was analyzed, and intent-to-treat analysis accounted for data from one participant who completed baseline assessments, but had to drop out of the study due to health-related reasons. There were 14 participants and four partners that completed the six and 12-week satisfaction surveys. There were no exercise-related injuries that affected program completion. Participants ranged from 57-77 years of age, and over half are married, retired, and have completed some level of post-secondary education. Baseline characteristics for all participants are presented in Table 1.

3.3.1 Changes in Physical Functioning and Performance Measures

Of the 15 participants examined, significant improvements in lower body strength were found using the chair sit-stand test, Wilks' Lambda = .37, F (2, 13) = 10.9, $p <$ .05, η^2= .6. Post-hoc analysis revealed the number of completed chair sit-stands increased significantly between baseline and 6-week measurements (mean difference= 2.6; 95% CI = .6 to 4.6; $p < 0.05$), and baseline and 12-week measurements (mean difference= 2.5; 95% CI = .8 to 4.2; $p < 0.05$). Significant improvements were also found for lower body flexibility using the sit-and-reach test, Wilks' Lambda = .62, F (2, 13) = 3.9, $p < .05$, η^2=.4; however, post-hoc analysis did not find significant differences between each time measurement (see Table 3). As seen in Table 2, improvements in upper body strength (i.e., the arm curl test) and agility (i.e., the eight foot up-and-go test) were found from baseline to 12-weeks, but failed to reach significance. No significant improvements were noted for aerobic fitness (i.e., the 6-MWT) or upper body flexibility (i.e., the back-scratch test).

3.3.2 Changes in Physical Activity Behaviour

Data from 15 participants was analyzed and PA behaviour was represented as the average minutes of MVPA per week. There were no significant changes in MVPA levels at either time point, Wilks' Lambda = .95, F (2, 13) = 0.4, p = .7, η^2= .1. However, there was an increase in the weekly average of MVPA from baseline (M = 197.5 min/week) to week six (M = 221.3 min/week, +23.9 min/week, 12.1% increase), with similar levels of MVPA reported at week 12 (M = 219.2 mins/week, -2.1 min/week, 1.0% decrease).

3.3.3 Self-report health-related QoL measures

There were no significant improvements in the SF-36 physical component summary, Wilks' Lambda = .84, F (2, 13) = 1.2, p = .3, η^2=.2, SF-36 mental component summary, Wilks' Lambda = .93, F (2, 13) = 0.5, p = .6, η^2=.1, FACT-P, Wilks' Lambda = .92, F (2, 13) = .6, p = .6, η^2=.1, and FACIT-F, Wilks' Lambda = .71, F (2, 13) = 2.6, p = .1, η^2= .3 reported by participants throughout the PROFit program. In addition, post-hoc analysis showed no significant improvement in both components of the SF-36, the FACT-P, or the FACIT-F (as seen in Table 3) at each time measurement.

3.3.4 Sustainability & Feasibility: Intervention Adherence, Cost, and Satisfaction

Participants ($N = 15$) attended on average 68% of sessions during the PROFit program; ranging from 14.3% to 100% of sessions. When we eliminate the single participant included using intent-to-treat analysis, average group attendance ($N = 14$) rises to 71%. Missed sessions ($N = 15$) were accounted for and most often due to other commitments, such as family/volunteer events and out of town vacations (17%), illness (10%), and employment-related obligations (5%).

The total cost to run the PROFit program was $3,556.60. The 12-week program was completed twice for this study, meaning each run-through cost $1,778.30, or alternatively $254.04 per person. Fees included facility space and equipment rental, snacks and light refreshment, and monetary compensation to the CEP and student volunteers who assisted with the PROFit program.

At six and 12 weeks, 14 participants and four partners completed the PROFit program satisfaction survey. At week six, 93% of participants reported being 'very satisfied' with the organization and location of the program, the exercises, guidance from instructors, and encouragement from others, while 86% and 79% of participants felt 'very satisfied' with the duration of the program sessions and the group setting, respectively. From week six to week 12, 79% of participants stated they were 'very satisfied' with experiencing reduced levels of fatigue, which increased from 50% at week 6, and 93% of participants identified that they were 'very satisfied' with the group setting, which was up from 79% at week 6. In addition, 79% of participants stated they were 'very satisfied' with the social gatherings following the exercise session at both time points. Finally, the percentage of participants that reported being 'very satisfied' with the location of the program, the variation of exercises completed, and feeling encouraged to participate in the program increased to 100% from week six to week 12.

3.4 Discussion

The primary goal of PROFit was investigating the effectiveness of a 12-week community-based PA program on the QoL, fitness, fatigue, strength, and physical functioning of prostate cancer survivors. Significant benefits in lower body strength and flexibility were found, and improvements in agility, upper body strength, aerobic fitness, and weekly MVPA were also found, however were not significant. Despite the lack of significance, these findings are comparable to benefits in physical functioning (i.e., muscular strength and flexibility) and PA levels found in other studies involving group-based PA and prostate cancer survivors (Keogh & MacLeod, 2012), and supports the use of PA following prostate cancer treatments. Furthermore, the results of each physical performance measured at baseline, six weeks, and 12 weeks, fell within the normal range of scores for men between the ages of 65-80 (Jones & Rikli, 2002), and objectively measured PA levels at each time point satisfied the recommended minimum of 150 mins/week of MVPA for older adults (Canadian Society of Exercise Physiology, 2011). This supports the possibility that sufficient levels of PA may have already been present in participants prior to beginning the PROFit program, limiting the potential of the program to improve their PA behavior.

Unlike previous research that found significant enhancements in prostate cancer survivors QoL following increases in their PA (Phillips et al., 2015; Segal et al., 2003; Thorsen et al., 2008), there were no significant improvements in any QoL measures in this study. However, not all PA studies demonstrate major improvements in cancer survivors QoL (Ferrer et al., 2010). Possible explanations include the considerable length of time (average of six years) between participants' cancer diagnosis and the beginning of the PROFit program, as well as a higher physical component score (56.57) and a similar mental component score (51.31) in the SF-36 at baseline compared to Canadian men aged 65-74 averaging 48.1 and 54.6, respectively (Hopman et al., 2000). Like the SF-36, results found for prostate cancer specific QoL outcomes were greater than anticipated. PROFit participants reported an average FACT-P score of 39.1 at baseline; a greater value than post-test participant scores (37.7 and 37.8) in a study by Segal et al. (2009) using the same questionnaire. These findings are similar to the PA level outcome measure, where baseline values were higher than anticipated, affecting the impact of the intervention on participant outcomes. Finally, no statistically significant improvements in participant fatigue levels were found (see table 2), however a greater percentage of participants expressed feeling "very satisfied" with experiencing reductions in their level of fatigue from week six (50%) to week 12 (79%) as noted in the satisfaction survey. Despite the limited improvement in QoL, PA levels, and some physical functioning components, the high satisfaction rate with the organization and location of the program, and overall program design, suggests participants enjoyed attending the PROFit program each week; an important component of any successful PA program.

Other aspects of PROFit examined included program feasibility and sustainability, and participant satisfaction. Given the success of previous PA programs using a community-based approach (Cheifetz et al., 2014; Haas & Kimmel, 2011; Leach, Danyluk and Culos-Reed, 2014; Rajotte et al., 2012), the design of PROFit followed a similar layout. High satisfaction was reported for the organization and location of

PROFit, as well as the types of exercises completed by participants. More importantly, 93% of participants reported enjoying the group exercise setting, and 79% enjoyed the social gatherings after each PROFit session, suggesting participants felt greater social supports and comradery throughout the program. Program feasibility was promoted through satisfaction with the design of PROFit, program adherence, recruitment, cost to run the program, and the cooperation of cancer clinics, physicians, and the fitness facility. Participant attendance was satisfactory, with 80% of participants attending over half of the exercise sessions, despite the limited session times offered during each week. Similar scheduling challenges and adherence rates were reported by Rajotte et al. (2012), acknowledging the benefit of such community-based programs, and the need for additional classes for program development. Furthermore, PROFit was funded by the Eastern Health Lighthouse Grant, which covered the per person cost of $254.04. The lack of financial commitment for participants positively affected study recruitment; unfortunately, specific details to analyze recruitment rates are not available due to the variety of methods employed. To promote long-term sustainability of the program, a small fee could be administered to participants that wish to continue the program past the initial 12-weeks. This could offset some of the financial burden of overhead costs to run the program without deterring prostate cancer survivors' involvement. Participants may be more inclined to contribute to the financial necessities of a PA program if given the opportunity to benefit from improvements in physical functioning and QoL shown to occur in the first 12 weeks (Cheifetz et al., 2014). The cost-effectiveness to run the program, and the successful collaboration with the community fitness facility in delivering the program, fostered sustainability.

Much like the CanWell program (Cheifetz et al., 2014), PROFit has valuable components necessary for a sustainable method of enhancing prostate cancer survivors physical functioning and QoL, and its design was modeled after the CanWell program. In a follow-up study of CanWell (Cheifetz et al., 2015), researchers discovered that 85% of CanWell participants continued to exercise (on average) 29 months after program completion, and 68% of participants renewed their membership at the YMCA where CanWell was held. The researchers determined that familiarity with the fitness facility and exercise routines had a positive impact on PA adherence, unlike PA interventions held in research facilities with limited opportunity for PA continuation. These findings highlight the importance of a sustainable and feasible community-based PA program designed to encourage prostate cancer survivors to participate in PA.

The strengths of this study include the community-based design (i.e., collaboration between a research facility, cancer care center, and community fitness facility); the group-based, 'real world' setting appeared to promote participant comradely and adherence, as well as the focus on prostate cancer survivorship and treatment side effects, specifically. To our knowledge, this is the first study to examine the relationship between community-based PA and prostate cancer survivorship. However, one of the main challenges of this study was recruitment of prostate cancer survivors. Despite frequent contact with cancer clinics, oncologists, support group meetings, and word of mouth, recruitment was challenging, and resulted in a lower sample size than desired. The small sample size had a direct effect on the inability of the study to detect differences in physical functioning, QoL and PA levels. Future research could benefit from targeted strategies to increase participant recruitment to improve statistical power, such as using a computerized alert system to identify potential participants to the referring physician, or delegating a specific research assistant staff member with the sole responsibility of participant recruitment (Preston et al., 2016). In addition, changes in program design could be modified to improve outcomes, such as offering alternative or additional exercise classes to accommodate participant attendance; an issue identified by participants as reasons for missed sessions. An additional study limitation is the lack of a control group. The inclusion of a control could provide a comparison between groups about the effect of the PA intervention on all outcomes. Finally, the social support systems in other community-based programs could be measured, and its relationship to participant adherence examined.

In summary, the PROFit program has been shown to be a feasible and sustainable community-based PA program, and has been successful in encouraging prostate cancer survivors to engage in PA in a safe and supportive environment to improve and/or maintain the beneficial effects (i.e., physical functioning, QoL) associated. Participants within the study did not exhibit significant improvements in QoL and fatigue reduction as anticipated by our research hypotheses; however, there was some benefit in aerobic fitness and muscular strength noted. Also, participant satisfaction with the PROFit program was high, supporting the necessity of such community-based programs by prostate cancer survivors. Our findings highlight the need for alternative methods of improving PA levels in prostate cancer survivors, given the benefits to treatment-related side effects following increases in PA (Thorsen et al., 2008). Community-based PA programs, such as PROFit, will allow prostate cancer survivors to re-connect with their community, and use PA programming to improve survivorship and disease outcomes.

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Table 1. Participant characteristics at baseline

Variable	Overall (N = 16)
Demographics	
Age (years)	
Mean	68.1
SD	5.7
Range	57-77
Married (No. (%))	14 (85.7%)
Education	
Completed University/College	14 (85.7%)
Work Status	
Retired	12 (75.0%)
Ethnicity	
Caucasian	16 (100.0%)
Medical	
Weight, kilograms	
Mean	88.6
SD	12.2
Height, meters	
Mean	1.7
SD	0.0
BMI (kg/m^2)	
Mean	29.2
SD	3.6
Waist circumference, inches	
Mean	40.6
SD	3.9
Time since diagnosis, months	
Mean	72.3
SD	39.2
Treatment	
Surgery	10 (62.5%)
Radiation	9 (56.3%)
Hormone Therapy	1 (6.3%)

Table 2. Physical function and health-related quality of life outcomes

Variable	Pre-PROFit Mean (SD)	6 weeks Mean (SD)	12 weeks Mean (SD)	Partial eta squared
Physical Measures (*n* = 15)				
Arm curl	21.9 (6.7)	25.0 (5.9)	25.3 (5.9)	0.3
Chair sit-stand	13.1 (2.7)	15.7 (4.3)**+	15.6 (3.2)**++	0.6
Chair sit and reach (inches)	2.2 (3.8)	2.3 (3.2)	3.1 (3.3)*++	0.4
Back scratch (inches)	-6.4 (5.1)	-7.2 (5.1)	-7.5 (4.9)	0.2
Eight foot up-and-go (seconds)	00:06.32 (00:01.22)	00:05.96 (00:00.81)	00:05.94 (00:00.88)	0.2
6MWT (yards)	584.4 (70.4)	587.6 (77.5)	577.1 (68.6)	0.1
QoL Measures (*n* = 15)				
SF-36 (PCS)	56.5 (3.7)	53.8 (6.6)	54.6 (4.8)	0.2
SF-36 (MCS)	51.3 (4.3)	52.3 (4.7)	51.7 (6.0)	0.1
FACT-P	39.1 (4.7)	40.3 (6.1)	39.5 (5.8)	0.1
FACIT-F	48.0 (4.7)	46.4 (5.0)	48.5 (3.1)	0.3
PA Measures (*n* = 15)				
Objectively measured MVPA (mins/week)	197.5 (159.8)	221.3 (158.6)	219.2 (187.3)	0.1

SD, standard deviation; 6-MWT, 6-min walk test; SF-36 (PCS), 36-item short form survey (physical component summary); SF-36 (MCS), 36-item short form survey (mental component summary); FACT-P, Functional Assessment of Cancer Therapy Scale-Prostate; FACIT-F, Functional Assessment of Chronic Illness Therapy-Fatigue; MVPA, moderate-to-vigorous physical activity.
Significant improvements compared with baseline.
Wilk's Lambda values are reported in this table.
*$p < 0.05$
**$p < 0.01$
+ indicates pre-test to 6 weeks
++ indicates pre-test to 12 weeks

Table 3. Data comparisons between baseline, 6-week, and 12-week time measurements

Variable	MD	95% CI	*p*-value*
Physical Measures			
Armcurl (*n* = 15)			
Armcurl1 vs Armcurl2	-3.1	-6.5 to 0.4	0.1
Armcurl1 vs Armcurl3	-3.4	-6.9 to 0.2	0.1
Armcurl2 vs Armcurl3	-0.3	-2.4 to 1.7	1.0
Chair sit-to-stand (*n* = 15)			
Chair1 vs Chair2	-2.6	-4.6 to -0.6	0.0
Chair1 vs Chair3	-2.5	-4.2 to -0.8	0.0
Chair2 vs Chair3	0.1	-2.2 to 2.5	1.0
Sit and reach (*n* = 15)			
Sitandreach1 vs Sitandreach2	-0.0	-1.3 to 1.2	1.0
Sitandreach1 vs Sitandreach3	-0.9	-1.9 to 0.2	0.1
Sitandreach2 vs Sitandreach3	-0.9	-1.9 to 0.2	0.1
Back scratch (*n* = 15)			
Backscratch1 vs Backscratch2	0.7	-1.0 to 2.5	0.8
Backscratch1 vs Backscratch3	1.1	-0.7 to 3.0	0.4
Backscratch2 vs Backscratch3	0.4	-0.6 to 1.3	1.0
Eight-foot-up-and-go (*n* = 15)			
Eight1 vs Eight2	0.4	-0.2 to 0.9	0.2
Eight1 vs Eight3	0.4	-0.2 to 1.0	0.4
Eight2 vs Eight3	0.0	-0.3 to 0.4	1.0
6-MWT (*n* = 15)			
6-MWT1 vs 6-MWT2	-3.2	-39.1 to 32.7	1.0
6-MWT1 vs 6-MWT3	7.3	-25.9 to 40.5	1.0
6-MWT2 vs 6-MWT3	10.5	-18.7 to 39.8	1.0
Objectively measured MVPA (mins/week; *n* = 15)			
Baseline vs 6-weeks	-25.6	-104.9 to 53.8	1.0
Baseline vs 12-weeks	-23.3	-128.7 to 82.1	1.0
6-weeks vs 12-weeks	2.3	-72.2 to 76.8	1.0
QoL Measures			
SF36-PCS (*n* = 15)			
SF36-PCS1 vs SF36-PCS2	2.8	-2.2 to 7.8	0.5
SF36-PCS1 vs SF36-PCS3	1.9	-2.1 to 5.8	0.7
SF36-PCS2 vs SF36-PCS3	-0.9	-5.4 to 3.7	1.0
SF36-MCS (*n* = 15)			
SF36-MCS1 vs SF36-MCS2	-1.0	-4.3 to 2.3	1.0
SF36-MCS1 vs SF36-MCS3	-0.4	-5.7 to 4.9	1.0
SF36-MCS2 vs SF36-MCS3	.62	-2.9 to 4.1	1.0
FACT-P (*n* = 15)			
FACT-P1 vs FACT-P2	-1.1	-4.4 to 2.2	1.0
FACT-P1 vs FACT-P3	-0.3	-4.3 to 3.6	1.0
FACT-P2 vs FACT-P3	0.8	-2.2 to 3.8	1.0
FACIT-F (*n* = 15)			
FACIT-F1 vs FACIT-F2	1.6	-0.6 to 3.8	0.2

FACIT-F1 vs FACIT-F3	-0.5	-3.3 to 2.4	1.0
FACIT-F2 vs FACIT-F3	-2.1	-4.9 to 0.8	0.2

MD, Mean difference; CI, Confidence interval; 6-MWT, 6-min walk test; SF36-PCS, 36-item short form survey - physical component summary; SF36-MCS, 36-item short form survey-mental component summary; FACT-P, Functional Assessment of Cancer Therapy Scale-Prostate; FACIT-F, Functional Assessment of Chronic Illness Therapy-Fatigue.
*p-values were adjusted with Bonferroni correction for multiple comparisons.