Pilot Study on Nordic Pole Walking and Individuals with Cancer: Effects on Physical Function and Health-Related Quality of Life

By

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Abstract

Individuals diagnosed with cancer experience a high symptom burden that has a significant impact on their quality of life and an individualized, community-based Nordic pole walking (NPW) program may help to alleviate this.

The primary objective of this eight-week multi-centred randomized controlled pilot study was to assess the feasibility of a NPW program for individuals with stage I-IV non-small cell lung cancer (NSCLC), prostate cancer, colorectal cancer, and endometrial cancer. The secondary objective was to determine the effects of NPW on physical function and health-related quality of life (HRQoL). Participants were randomly assigned to either the NPW group (one supervised NPW session and up to three independent NPW sessions) or the control group (usual daily routine).

The pilot study suggests that examining the effects of NPW on individuals diagnosed with cancer is feasible with modifications. Recommendations include: 1) Recruit participants at hospital cancer centres; 2) Individualize NPW and integrate behavioural change techniques into the program; 3) Use pedometers or accelerometers to increase the accuracy of measured physical activity levels; and 4) Organize NPW programs for individuals with NSCLC alongside programs for individuals with other chronic respiratory diseases. Results indicate trends of improved overall physical activity levels and HRQoL measures. The NPW group experienced a significant decrease in thigh circumference measurements from the baseline assessment (Right Thigh: median 49.4 cm (range 8.7); Left Thigh: median 49.0 cm (range 6.0)) to the final assessment (Right Thigh: median 48.5 cm (range 6.5); Left Thigh: median 46.3 (range 4.0)) ($p<0.05$). Significant improvement was also found in the NPW group 30-s chair stand test (Baseline: median (SD) 10.5 (3.7); Final: median 14.3 (4.2)) ($p<0.05$). Further research with larger sample sizes should be completed to more conclusively determine the impact of NPW.

Keywords: Cancer, Neoplasms, Nordic Pole Walking, Exercise/physiology, Walking, Rehabilitation

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List of Abbreviations Used

ADT	Androgen Deprivation Therapy
AIAA	Aromatase Inhibitor-Associated Arthralgia
BMI	Body Mass Index
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
DNA	Deoxyribonucleic Acid
EF	Energy/Fatigue
EW	Emotional Well-Being
EWB	Emotional Well-Being
FACT-G	Functional Assessment of Cancer Therapy - General
FACT-L	Functional Assessment of Cancer Therapy - Lung
FWB	Functional Well-Being
GH	General Health
GTA	Greater Toronto Area
HRQoL	Health-Related Quality of Life
IPAQ	International Physical Activity Questionnaire
Lat	Latissimus Dorsi
LCS	Lung Cancer Symptom Specific
LOS	Length of Hospital Stay
MD	Mean Difference
MDFSI-SF	Multi-Dimensional Fatigue Symptom Inventory – Short Form
METS	Metabolic Equivalents

MCID	Minimal Clinical Important Difference
NPW	Nordic Pole Walking
NSCLC	Non-Small Cell Lung Cancer
P	Pain
PF	Physical Function
PICO	Population, Intervention, Comparison, and Outcome
PPC	Postoperative Pulmonary Complications
PWB	Physical Well-Being
RCT	Randomized Controlled Trial
RL-E	Role Limitation - Emotional
RPE	Rate of Perceived Exertion
SD	Standard Deviation
SF	Social Function
SF-36	36-Item Short Form Health Survey
SWB	Social/Family Well-Being
TNM	Tumour, Node, Metastasis Staging System
TOI	Total Outcome Index
UULEX	Unsupported Upper Limb Exercise Test
VO_2max	maximal oxygen uptake
VO_2peak	Peak Oxygen Consumption
6MWT	Six-Minute Walk Test
30-s	30-second

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1.0 Introduction

1.1 Overview

Cancer rates in Canada continue to rise. A cancer diagnosis affects all aspects of an individual's life and much consideration goes into determining the best treatment plan for each patient. The most common treatments for solid tumour cancers are surgery, radiation, chemotherapy, and palliative care (alone or in combination). Achieving a cure or remission may not always be possible; however, over time advances in medical technology and treatment have allowed physicians to help patients live longer after diagnosis. The benefit of living longer often comes with cancer and treatment related side effects that significantly impact an individual's health-related quality of life (HRQoL). Some of the side effects that patients may experience include fatigue, weakness, weight loss or gain, pain, anxiety, and depression. There is a continual search for interventions to help patients manage or minimize these side effects.

Exercise has been recognized for the key role it can play in helping patients with cancer manage symptoms. Exercise is not only considered to be safe and beneficial for cancer patients with different symptoms (Knols, Aaronson, Uebelhart, Fransen, & Aufdemkampe, 2005; Velthuis, Agasi-Idenburg, Aufdemkampe, & Wittink, 2010), but it has been acknowledged for its positive impact on HRQoL, fatigue, muscular strength, and aerobic fitness (Cramp & Byron-Daniel, 2012; Mishra et al., 2012; Repka et al., 2014). In a population with decreased physical activity levels and an increased risk of developing other chronic diseases, exercise is vital. Recently, exercise guidelines have been established for individuals with cancer by Cancer Care Ontario (Segal et al., 2015) and the American College of Sports Medicine (Schmitz et al., 2010). While there is an

understanding that incorporating exercise into the lifestyles of those living with cancer is important, there remains a lack of knowledge about the most beneficial exercise prescription and the long-term effects of exercise. Also, the impact of exercise on individuals with certain types of cancer has been studied less than other types (i.e. non-small cell lung cancer (NSCLC), endometrial cancer, and colorectal cancer) and the sustainability of exercise has not been considered.

There is growing interest in the benefits of Nordic pole walking (NPW) as an effective exercise for improving overall fitness. NPW involves walking with a pair of poles that are customized to an individual's height and stride length. Research on NPW has shown improvements in functional status, physical activity, HRQoL, and cardiorespiratory outcomes of men and women with varying clinical diagnosis (Fritschi, Brown, Laukkanen, & Uffelen, 2012a). There is limited research on the effects of NPW and the cancer population. Studies that have been conducted focus on individuals with breast cancer. Researchers have determined that NPW is a safe form of rehabilitation for individuals with breast cancer and that it may help to improve the muscular endurance of the upper body (Malicka et al., 2011; Sprod, Drum, Bentz, Carter, & Schneider, 2005). More research on the impact of NPW in individuals with other various types of cancer is needed. NPW is a low-impact, inexpensive, and practical type of exercise that is easy to incorporate into one's daily lifestyle making it a potentially effective exercise solution for this population. Individuals diagnosed with cancer are often considerably deconditioned and incorporating the upper body into walking by using the poles, could possibly help to improve this population's overall physical function during daily activities.

A pilot study on the feasibility of an eight-week individualized community-based NPW program for individuals diagnosed with stage I to IV NSCLC, prostate cancer, colorectal cancer, or endometrial cancer was conducted.

1.2 Statement of the Problem

Innovative developments in cancer detection and treatment have allowed individuals with cancer to live longer after diagnosis. In Canada, based on 2006 to 2008 estimates, more than 60% of individuals diagnosed with cancer are expected to survive for five years or more (Canadian Cancer Society, 2016). This longer life expectancy, although generally positive, may be outweighed by symptoms that individuals with cancer experience. According to the American Cancer Society, more than one in four cancer survivors have a high symptom burden one year after diagnosis (Shi et al., 2011). Symptoms that patients endure (e.g. fatigue, pain, weight loss or gain, weakness, anxiety, and depression) impact their HRQoL and therefore careful monitoring and management is needed. In considering these symptoms, it is not a surprise that at diagnosis patients with cancer are more likely to be inactive than those who never had cancer (Neil, Gotay, & Campbell, 2014). Over time a cycle of inactivity and functional decline can continue as strength and cardiovascular fitness deteriorate with worsening symptoms. While people now live longer with cancer, often their longer lives are wrought with excess fatigue, limited function, and low quality. Thus, it becomes essential that we seek ways to both prolong and to advance the HRQoL for cancer patients. Exercise is being recognized for its potential to improve overall function in addition to increased longevity in this population.

1.3 Purpose of the Study

The *purpose* of this pilot study was to determine the feasibility of an eight-week individualized community-based NPW program for individuals diagnosed with stage I to IV NSCLC, prostate cancer, colorectal cancer, or endometrial cancer. NPW has been selected as an appropriate exercise for cancer patients because it is a low-impact, economical, and a practical form of exercise that can be executed anywhere. In addition, using the upper body when walking with the poles emulates the continuous use of the entire body and the endurance that is needed during everyday tasks. This pilot study on NPW and individuals with various types of cancer is the first of its kind and provides a better understanding of how NPW can be applied in a clinical setting with cancer patients.

1.4 Research Questions

The *primary research question* is*:* 1) What is the optimal design (patient sample, instruments) and operational processes to assess the effects of NPW on individuals who have been diagnosed with stage I-IV NSCLC, prostate cancer, endometrial cancer, or colorectal cancer? *Secondary research questions* are: 2) How does participating in an eight-week NPW program affect physical function? and, 3) How does participation in the NPW program affect the health-related quality of life (HRQoL) of these individuals?

1.5 Hypotheses

The hypotheses are that the NPW program for individuals who have been diagnosed with stage I-IV NSCLC, prostate cancer, endometrial cancer, and colorectal cancer would: 1) be feasible; 2) improve physical function; and 3) improve the HRQoL.

1.6 Proposed Research Framework: Pilot Studies

Pilot studies are conducted to assess feasibility prior to conducting a large-scale investigation (Thabane et al., 2010). They are an important step in the research process. The purpose of running a pilot study is usually related to trialling a study design and/or testing a new instrument, and establishing that investigators understand the research protocol and are able to collect data in a consistent manner (Gardner, Gardner, MacLellan, & Osborne, 2003). The specific rationale for performing a pilot study can be classified into four categories:

i) *Process:* To assess operational processes that take place within the study. For example, determining recruitment and retention rates.

ii) *Resources:* To assess any difficulties that may occur related to time and budget. For example, the length of time it takes for participants to complete the questionnaires.

iii) *Management:* To observe any potential human and data optimization problems that may occur. For example, issues that may arise at participating centres.

iv) *Scientific:* To assess treatment safety, determine dose levels and response, and estimate treatment effect and its variance (Thabane et al., 2010).

While pilot studies have little to contribute statistically and theoretically, they provide extensive understanding of the research process and help to adapt the design and operational processes of a full study (Gardner et al., 2003). Clearly identifying feasibility objectives and how they will be measured enables researchers to gather more detailed information to better evaluate recruitment, randomization, retention, assessment

procedures, new methods, and/or the implementation of a new intervention (Leon, Davis, & Kraemer, 2011). Carrying out a pilot study increases the probability of conducting a successful large-scale randomized controlled trial (RCT), which is important especially when stake holders will be committing significant amounts of time and money to the project (Leon et al., 2011; Tickle-Degnen, 2013).

2.0 Literature Review

2.1 Introduction

This section provides an overview of cancer through examining epidemiology, pathophysiology, staging, treatments, and the side effects that occur from cancer and treatment of it. A brief description of lung cancer, prostate cancer, colorectal cancer, and endometrial cancer is provided because these four types of cancer are the focus of this project. Recent research on each type of cancer and exercise is then reviewed. Finally, a synopsis of the literature on the physical and psychosocial effects of walking and Nordic pole walking (NPW) is provided followed by a more specific examination of the literature on NPW and individuals with cancer. At this current time, only one study was found involving NPW and individuals with lung cancer (Jastrzebski et al., 2015). The remaining studies on NPW and cancer have been conducted with individuals diagnosed with breast cancer (Fields, Richardson, Hopkinson, & Fenlon, 2016; Fischer et al., 2015; Malicka et al., 2011; Sprod et al., 2005).

2.2 Search Strategy

The majority of the search strategy concentrated on cancer, exercise, and NPW. Articles on exercise and non-small cell lung cancer (NSCLC), prostate cancer, colorectal cancer, and endometrial cancer were obtained by entering the MESH terms for each type of cancer and exercise into the Cochrane library and PubMed databases. Filters included: systematic reviews, review, meta-analysis, humans, and English. For this literature search no date restriction was set. Articles that were relevant to the background of the literature review were identified. See Figure 1 for specific search details. The articles on NSCLC and exercise also included one article (Coats, Maltais, Tremblay, & Saey, 2014) that was

received directly from the author, a systematic review (Rodriguez-Larrad, Lascurain-Aguirrebena, Abecia-Inchaurregui, & Seco, 2014) that was found upon further inquiry into the works cited in another review, and a pilot study (Jastrzebski et al., 2015) that involved NPW as part of a cancer rehabilitation intervention. The effects of the study by Jastrzebski et al. (2015) are discussed in the literature review of cancer and NPW.

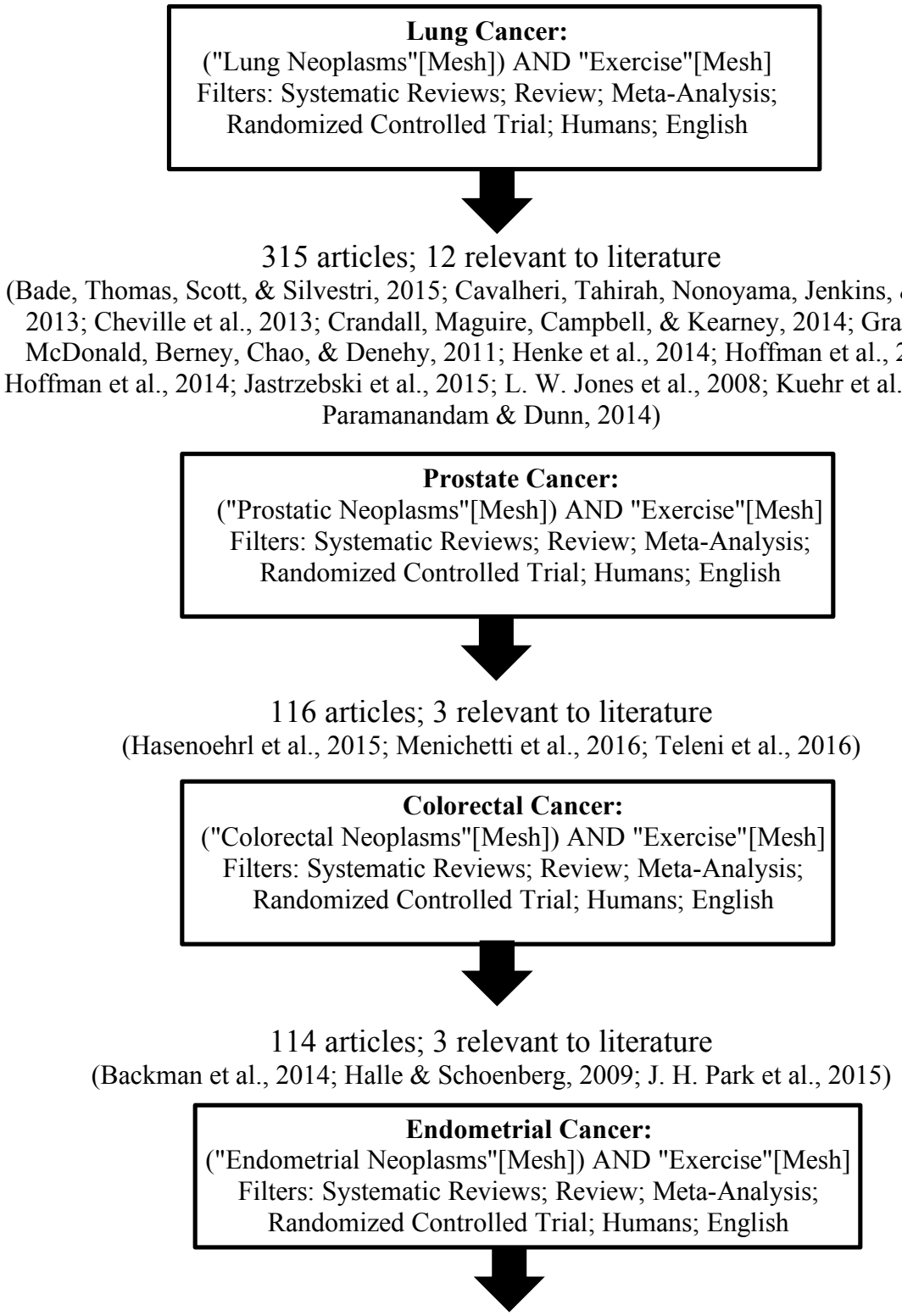

Figure 1. The search strategy for literature on cancer and exercise.
Note: No date restriction was set for this search.

A systematic review conducted by Fritschi, Brown, Laukkanen, and Uffelen (2012b) was used as a starting point for the literature review on NPW. To update the review the search strategy was directly obtained from Fritschi et al. (2012a) and a search of PubMed, Cochrane library, EMBASE, SPORTdiscuss, CINAHL, and PEDRO databases was conducted up until July 2016 (Figure 2). Two independent reviewers excluded non-relevant articles by scanning titles and abstracts. A third reviewer was used when reviewers did not agree. In total 460 potential articles were identified, 227 duplicate articles were found, and 75 articles met the inclusion criteria. Five studies that are relevant to the thesis topic of NPW and cancer patients are discussed within the literature review (Fields et al., 2016; Fischer et al., 2015; Jastrzebski et al., 2015; Malicka et al., 2011; Sprod et al., 2005). Two RCTs investigated NPW in the breast cancer population using outcomes similar to our study (upper body strength and endurance) (Malicka et al., 2011; Sprod et al., 2005). Due to the limited number of studies examining NPW in the cancer population three feasibility studies are included. One pilot study as mentioned above, investigates NPW as part of the pulmonary rehabilitation program for patients with advanced lung cancer who are undergoing chemotherapy treatment (Jastrzebski et al., 2015). Two other feasibility studies that investigated similar outcomes (HRQoL, and physical activity levels) are described (Fields et al., 2016; Fischer et al., 2015).

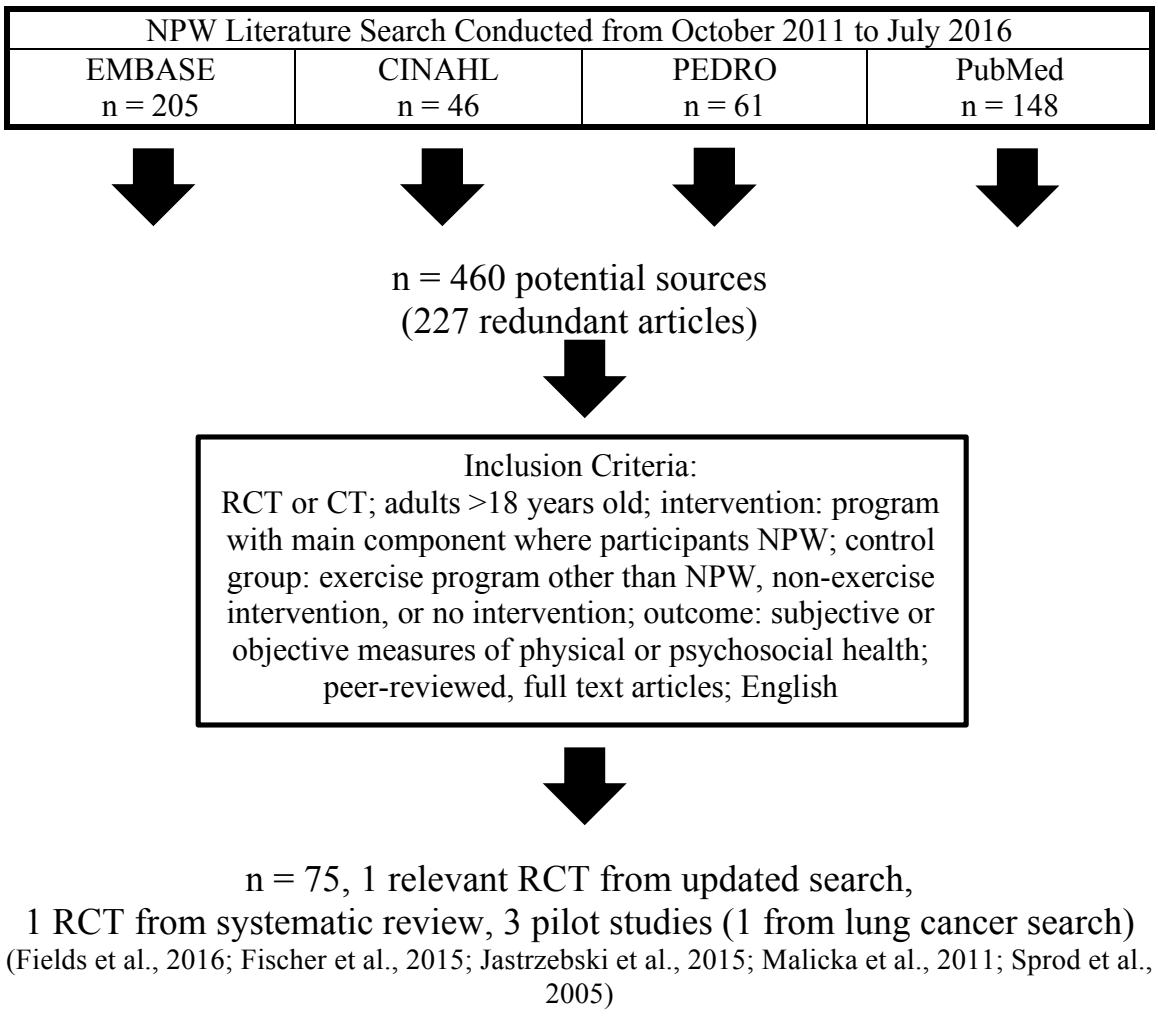

Figure 2. The search strategy for literature on NPW.

2.3 Cancer Overview

2.3.1 Epidemiology of Cancer in Canada

About two in five Canadians will develop cancer in their lifetime and in 2016 it is estimated that 202,400 people in Canada will be newly diagnosed (Canadian Cancer Society, 2016). Cancer is responsible for 30% of all deaths in Canada making it the leading cause of death ahead of cardiovascular disease (Canadian Cancer Society, 2016). Prostate, breast, lung, and colorectal cancers are the most commonly diagnosed cancers in Canada

(Canadian Cancer Society, 2016). Over the age of 50 years, these four types of cancers are expected to make up more than half of all cancers diagnosed in 2016 (Canadian Cancer Society, 2016). As the Canadian population continues to grow and age, cancer diagnosis rates are expected to rise (Canadian Cancer Society, 2016).

The cost of cancer treatment in Canada is substantial. Cancer is already considered the third most costly disease after cardiovascular and musculoskeletal diseases (de Oliveira, Bremner, Pataky, Gunraj, Chan, et al., 2013). In 1998 cancer care in Canada was estimated to cost $14.2 billion (de Oliveira, Bremner, Pataky, Gunraj, Chan, et al., 2013). A study published in 2013 reviewed the cancer costs in Ontario of 402,399 patients who were 19 years of age and older and had been diagnosed with different cancers (de Oliveira, Bremner, Pataky, Gunraj, Chan, et al., 2013). The mean post-diagnosis cost (defined by date of diagnosis to subsequent 12 months) for the cohort was $25, 914 (95% CI $25, 782 - $26, 046). The expenses that contributed the most to these costs included: inpatient hospital admission (38%), chemotherapy (9%), physician services (9%), and diagnostic testing (9%). The post-diagnosis costs related to cancer have continued to increase over time due to the development of new expensive treatments. For example, in Ontario from 1997 to 2007 for patients age 45 years and older the mean costs for lung cancer have increased by about 50% (from $15,170 to $34,471) (de Oliveira, Bremner, Pataky, Gunraj, Haq, et al., 2013). The economic burden of the disease is a concern for health care in Canada.

2.3.2 Pathophysiology & Staging of Cancer

In the normal physiological processes of the body, cells renew and regenerate every day. Cancer occurs when normal cells develop abnormal characteristics during

regeneration causing them to proliferate uncontrollably. This process is known as carcinogenesis. If cancer is not eradicated, the tumour will eventually spread or metastasize from its original location (Pienta, 2009).

Different types of cancer share common characteristics or hallmarks that allow for tumour growth and metastatic development (Hanahan & Weinberg, 2011). These hallmarks include: sustaining proliferative signaling, evading growth suppressors, resisting cell death, enabling replicative immortality, inducing angiogenesis, and activating invasion and metastasis (Hanahan & Weinberg, 2011). However, each type of cancer does have a unique phenotype based on the organ from which it originates, the microscopic appearance of the cancer cells, and the molecular defects that initiate the cancer.

Information collected from physical examination, laboratory test results, imaging studies, endoscopy, biopsy, observations during surgery, and the microscopic examination of tissue help identify the stage of cancer (Canadian Cancer Society, 2017l). Staging describes the magnitude and spread of cancer within the body, which helps establish an appropriate treatment plan for each patient (Canadian Cancer Society, 2017l). For solid tumour cancers, the most common system used for staging is the Tumour, Node, Metastasis (TNM) Staging System (Canadian Cancer Society, 2017l). 'T' specifies the size of the primary tumour and the amount that it has spread to nearby tissues (Canadian Cancer Society, 2017l). 'N' indicates if the cancer has spread to nearby lymph nodes as well as the size of the nodes and the number of lymph nodes with cancer (Canadian Cancer Society, 2017l). 'M' states if the cancer has spread or metastasized to distant organs (Canadian Cancer Society, 2017l). Each type of cancer has its own unique TNM system with

additional numbers or letters after the T, N, M supplying more specific details (Canadian Cancer Society, 2017l).

After the TNM classification is assigned for a specific cancer, an overall stage from 0 to IV is used to identify whether the cancer is in the early or advanced stages (Canadian Cancer Society, 2017l). An assignment of stage 0 indicates a carcinoma *in situ*, which means that the tumour cells have not invaded the surrounding tissue (Canadian Cancer Society, 2017l). Stage I and II is assigned when the cancer is located within the organ or area where it began or has spread to a close by structure (Canadian Cancer Society, 2017l). This is called a localized spread (Canadian Cancer Society, 2017l). Stage III specifies that the cancer has expanded more into a surrounding structure or the regional lymph nodes, referred to as a regional spread (Canadian Cancer Society, 2017l). Stage IV denotes that the cancer has spread to a distant site in the body, which is known as a metastatic spread (Canadian Cancer Society, 2017l).

2.3.3 Cancer Treatments and Side Effects

Cancer affects all aspects of an individual's life and much consideration goes into determining an appropriate treatment plan. Achieving a cure or remission for an individual diagnosed with cancer may be unlikely or impossible depending on the type of cancer, the stage of cancer, the individual's overall health, or other significant comorbidities (Rosmarin, 2009). The benefits and drawbacks of treatment options are discussed between the individual and their healthcare team. Some individuals may decide the goal of their treatment plan is palliation or relief from the symptoms caused by cancer and others may decide to focus on treatment that delays symptoms.

The five most common ways that solid tumour cancer is treated are: 1) surgery; 2) radiation; 3) chemotherapy; 4) palliative care; and 5) integrated rehabilitative therapies. The following is a brief overview of these treatments and the side effects that are associated with each.

2.3.3.1 Surgery

When cancer is detected in the early stages of progression, surgery is often the most successful option (Rosmarin, 2009). Historically, surgery was the first type of treatment used to control and cure cancer (Stewart & Stewart, 2009). Initially, doctors believed that radical surgery was necessary for the best possible outcome and this meant that large areas surrounding the tumour were removed along with the tumour (Stewart & Stewart, 2009). Over time clinical investigators discovered that a more modest approach involving the removal of the mass in addition to other treatments, such as radiation or chemotherapy provided the same survival and clinical outcomes (Stewart & Stewart, 2009). Surgery may also be performed to diagnose cancer, to stage cancer, to remove a discomfort or disability caused by cancer, and to insert a device needed for the treatment of cancer (American Cancer Society, 2017a).

The side effects associated with surgery vary depending on the type of surgery performed, the location of the surgery, and the overall health of the patient (Canadian Cancer Society, 2017h). Improvement in sterile technique and wound control, as well as technological advances such as laparoscopy, robotics, and laser surgery have resulted in reduced morbidity associated with surgery (Stewart & Stewart, 2009). Some of the long-term side effects caused by surgery are: pain due to tissue trauma, neurological pain or damage that causes numbness or changes in feeling, swelling of a limb due to lymph node

removal (lymphedema), and scarring (Canadian Cancer Society, 2017h). These side effects can alter a patient's movement by limiting their range of motion and potentially decreasing their strength and balance.

2.3.3.2 Radiation Therapy

Radiation is a localized treatment that impairs cell division by breaking the strands of deoxyribonucleic acid (DNA) in the cells of the body (Stewart & Stewart, 2009). It is possible for radiation to be administered in various ways including: 1) by an external beam, 2) by seeds or rods that are implanted (brachytherapy), and 3) by radioisotopes that are ingested or injected into the body (Stewart & Stewart, 2009). To ensure the damage to DNA is permanent, oxygen needs to be present (Stewart & Stewart, 2009). Therefore, radiation has been found to be less effective in some malignant tumours that have outgrown their blood supply since these tumours have areas with little oxygen (Stewart & Stewart, 2009).

The doses of radiation that a patient receives are measured in grays (Stewart & Stewart, 2009). The higher the dose of radiation the better the tumour can be controlled, but the risk of complications increases (Stewart & Stewart, 2009). Therefore, radiation treatment is often given in smaller doses called fractions because these smaller doses are not only more effective against tumour cells, but they are less likely to permanently damage the healthy cells (Stewart & Stewart, 2009).

Although care is taken to minimize the damage of healthy tissue, side effects still occur and certain tissues are more sensitive to being exposed to radiation than others (Canadian Cancer Society, 2017g). The tissues with rapidly dividing cells are most affected, such as skin cells, and cells lining the gastrointestinal tract (Canadian Cancer

Society, 2017g). The side effects that a patient experiences depends on numerous factors including (but not limited to) the area or organs being treated, the size of the area being treated, the type of radiation treatment, the amount of radiation delivered, the treatment schedule, the patient's overall health, and concomitant medications the patient may be taking (Canadian Cancer Society, 2017g). Some side effects of radiation may occur during treatment while others may occur weeks after the treatment is complete (Canadian Cancer Society, 2017g). Common side effects experienced by patients include: fatigue, skin reactions, weight loss or gain, nausea, vomiting, loss of appetite, bone marrow suppression, reduced bone growth, hair loss in the treatment area, anxiety or depression, and insomnia (Canadian Cancer Society, 2017g). There is also a small risk that patients who are treated with radiation could develop a second cancer (Canadian Cancer Society, 2017g).

2.3.3.3 Drug Therapy

Drug therapy works to destroy cancer cells, prevent metastases, or to slow down cancer cell growth (Canadian Cancer Society, 2017b). Patients may also be given drugs to help reduce or relieve the side effects caused by cancer or its treatments (Canadian Cancer Society, 2017b). Each type of drug therapy uses a different mechanism to act against cancer cells. The various types of drug therapies include: chemotherapy, hormonal drug therapy, immunotherapy, targeted therapy, and supportive drug prevention (Canadian Cancer Society, 2017b). Chemotherapy is discussed in detail, as it is the most common therapy and has the greatest relevance to this study.

2.3.3.3.1 Chemotherapy

Chemotherapy uses a combination of drugs to treat cancer (Stewart & Stewart, 2009). Due to the heterogeneous nature of tumour cells, cancer can easily overcome the

biological mechanism of one drug (Stewart & Stewart, 2009). In order to prevent or minimize the development of this drug resistance, a combination of drugs affecting several biological mechanisms at once are used to kill the cancer cells (Stewart & Stewart, 2009). Chemotherapy is given to the patient orally, intravenously, or by injection (Stewart & Stewart, 2009).

The side effects a patient experiences from chemotherapy drugs varies greatly depending on the type of drug, the dose prescribed, how it was administered, and the patient's general health (Canadian Cancer Society, 2017a). Similar to radiation therapy, chemotherapy drugs affect the rapidly dividing cells within the body the most, and side effects may occur immediately, or in a few days, weeks, or years (Canadian Cancer Society, 2017a). Side effects that often occur early include nausea and vomiting (Stewart & Stewart, 2009). Delayed side effects may include lowered blood counts, diarrhea, alopecia, fatigue, and weakness (Stewart & Stewart, 2009). Some examples of more rare side effects that can occur are kidney failure, lung scarring, and heart failure (Stewart & Stewart, 2009).

2.3.3.4 Palliative Care

Palliative care helps patients manage the psychological and physical symptoms associated with cancer to improve their quality of life (Stewart & Stewart, 2009). In Ontario, primary care physicians work with patients to establish their needs and goals associated with care (Cancer Care Ontario, 2015). Once this is established various services are accessed to ensure the patient is as comfortable as possible. Pain and symptom management, psychosocial support, spiritual support, hospice care, and end of life support are several services that are frequently provided by a multi-disciplinary team (Stewart & Stewart, 2009).

2.3.3.5 Integrated Rehabilitative Therapies

Other interventions are used along with traditional medical treatment to address the physical, emotional, and spiritual needs of patients (Stewart & Stewart, 2009). Some examples include naturopathy, acupuncture, meditation, massage therapy, and dietary treatment (Stewart & Stewart, 2009). Exercise has also shown to help with symptom-related management (Knols et al., 2005; Velthuis et al., 2010) and will be discussed in detail in section 2.8. While these treatments are not substitutes for standard oncology treatment, they can benefit patients immensely by alleviating the side effects and improving HRQoL (Stewart & Stewart, 2009). For example, yoga may help a patient's mood, and acupuncture may help to reduce pain (Stewart & Stewart, 2009).

2.4 Lung Cancer

Lung cancer accounts for 14% of all cancer cases diagnosed in Canada, making it the most commonly diagnosed type of cancer (Canadian Cancer Society, 2016). It is also the leading cause of cancer related deaths in Canada (Canadian Cancer Society, 2016). About 20,800 people were expected to die of lung cancer in 2016: more than breast, prostate, and colorectal cancers combined (Canadian Cancer Society, 2016).

Lung cancer is a malignant tumour that originates in the cells of the lungs (Canadian Cancer Society, 2017d). Individuals who have been exposed to tobacco smoke, asbestos, and radiation are at increased risk of developing lung cancer (Canadian Cancer Society, 2017f). Most people diagnosed with lung cancer are asymptomatic, however common early signs of lung cancer include a persistent cough, hemoptysis (the coughing up of blood), chest pain (that is worse with deep breathing, laughing, or coughing), hoarseness, weight-loss, shortness of breath, wheezing, general weakness or fatigue, and infections such as

bronchitis or pneumonia that do not get better (American Cancer Society, 2017b).

Lung cancer is classified as either small cell lung cancer or NSCLC. Small cell lung cancer originates in the bronchi in the centre of the lung and is the most aggressive of all types of lung cancer because it usually results in metastases to other parts of the body (Canadian Cancer Society, 2017j). It comprises approximately 10% to 15% of all lung cancer cases (Canadian Cancer Society, 2017j).

Non-small cell lung cancer is the most common type of lung cancer accounting for 85% to 90% of all cases (Canadian Cancer Society, 2017e). There are three main types of NSCLC: 1) adenocarcinoma (usually begins in the periphery of the lung), 2) squamous cell carcinoma (almost always found in people with a history of smoking and is usually located in the large bronchi near the centre of the lung) and, 3) large cell carcinoma (least common type of NSCLC) (Canadian Cancer Society, 2017e). An individual with NSCLC has a better prognosis the earlier they are diagnosed and treated (Canadian Cancer Society, 2017e).

Upon diagnosis, NSCLC is classified based on the extent of cancer in the body using the TNM system. The following descriptions of each stage can be applied to most NSCLC diagnosis: i) *Stage I:* Tumours are less than 3 centimeters in diameter and are completely within the lung. ii) *Stage II:* Tumours have metastasized to the bronchial or hilar lymph nodes. iii) *Stage III:* Tumours have metastasized to the mediastinal lymph nodes. iv) *Stage IV:* Tumours have metastasized to the pleura, the other lung, or to other organs outside of the chest (Canadian Cancer Society, 2017k).

Treatment for lung cancer includes lung resection, chemotherapy, radiation therapy, or a combination thereof (Canadian Cancer Society, 2014). The treatment

provided will depend on an individual's stage of cancer, health history, and functional ability. On average, 17% of patients diagnosed with NSCLC will survive for at least five years (Canadian Cancer Society, 2017m). For those diagnosed with small cell lung cancer, lung resection is rarely an option and median survival rates range from 16 to 24 months for limited stage cancer and six to 12 months for extensive stage cancer (Canadian Cancer Society, 2017j). This research project included patients who have been diagnosed with NSCLC because of its higher prevalence and survival rate.

2.5 Prostate Cancer

Prostate cancer occurs when a malignant tumour begins to grow in the cells of the prostate, usually in the glandular cells, which make part of the seminal fluid (Canadian Cancer Society, 2017t). Most often this type of cancer is slow growing, and can be treated successfully (Canadian Cancer Society, 2017t). In Canada, males are more likely to be diagnosed with prostate cancer than any other type of cancer with one in eight expected to be diagnosed in their lifetime (Canadian Cancer Society, 2016). In 2016 in Canada, 21,600 individuals were expected to be diagnosed with prostate cancer, accounting for 21% of all newly diagnosed cancer cases in males (Canadian Cancer Society, 2016).

The common signs and symptoms of prostate cancer include changes in bladder habits such as the need to frequently or urgently urinate, blood in the urine or semen, and painful ejaculation (Canadian Cancer Society, 2017i). The prostate-specific antigen (PSA) test is used to diagnose prostate cancer and monitor a patient's response to treatment (Canadian Cancer Society, 2017c). PSA is a protein that is made by the prostate and it is also a tumour marker (Canadian Cancer Society, 2017c). High amounts of PSA in the blood can indicate the presence of prostate cancer (Canadian Cancer Society, 2017c). Active

surveillance, surgery, radiation therapy, hormonal therapy, and chemotherapy are treatment options available for patients with prostate cancer (Canadian Cancer Society, 2017q).

2.6 Colorectal Cancer

A malignant tumour that begins to grow in the cells of the colon or rectum is known as colorectal cancer (Canadian Cancer Society, 2017s). The gland cells that produce mucus to help the stool move through the colon are where the cancer cells usually start to develop and in the early stages individuals may not experience any symptoms because the tumour is very small (Canadian Cancer Society, 2017s). Diarrhea, constipation, blood in the stool, changes in the look of stool, gas, bloating, and weight loss are some of the signs and symptoms of colorectal cancer (Canadian Cancer Society, 2017n). Bowel resection, radiation therapy, chemotherapy, targeted drug therapy, or a combination thereof may be used to treat colorectal cancer (Canadian Cancer Society, 2017r).

Colorectal cancer accounts for 13% of all cancers making it the second most common type of cancer in Canada (Canadian Cancer Society, 2016). Obesity, physical inactivity, consumption of red and processed meats, and smoking are a few of the modifiable risk factors that have been associated with colorectal cancer (Canadian Cancer Society, 2016).

2.7 Endometrial Cancer

Endometrial cancer starts when malignant cells grow in the uterus (Canadian Cancer Society, 2017u). The two main types of endometrial cancer are endometrial carcinoma (abnormal cell growth that begins in the endometrium) and uterine sarcoma

(cancerous growth that begins in the supportive tissues of the uterus) (Canadian Cancer Society, 2017u). It is estimated that endometrial cancer accounted for 6.6% of all newly diagnosed cancer cases in females in 2016 (Canadian Cancer Society, 2016). Between the years 2005 to 2010 the incidence of endometrial cancer increased by 2.5% in Canada and the United States of America (Canadian Cancer Society, 2016). Risk factors include, but are not limited to exposure to increased estrogen, obesity, genetic predisposition, diabetes, and endometrial hyperplasia (Canadian Cancer Society, 2016). Abnormal vaginal bleeding including changes in menstruation, bleeding between periods, bleeding after menopause, and spotting, is the most frequent symptom of endometrial cancer (Canadian Cancer Society, 2017o). Endometrial cancer is treated by surgery, radiation therapy, hormone therapy, or chemotherapy (Canadian Cancer Society, 2017p).

2.8 Exercise and Cancer

As previously mentioned exercise can play a crucial role in helping individuals diagnosed with cancer. Before progressing further on this topic, the difference between "physical activity" and "exercise" will be explained. Physical activity is defined by Caspersen, Powell, and Christenson (1985, p. 126) as "any bodily movement produced by skeletal muscles that results in energy expenditure." Exercise is a subcategory of physical activity. Exercise is known as "physical activity that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective" (Caspersen et al., 1985, p. 128). This review summarizes the effects of exercise on individuals diagnosed with cancer focusing specifically on NSCLC, prostate cancer, colorectal cancer, and endometrial cancer.

Exercise is safe and beneficial for individuals with various symptoms caused by cancer and cancer-related treatments (Knols et al., 2005; Velthuis et al., 2010). Encouraging exercise in this population is important because many individuals with cancer are at an increased risk of developing other chronic diseases such as diabetes and heart disease. Additionally, epidemiological studies have shown that sedentary lifestyle and obesity impact tumour development (Inoue et al., 2008; Mai et al., 2007; Martinez et al., 1997). The cardiovascular and fatigue improvements following rehabilitative exercise have been shown irrespective of cancer type (Repka et al., 2014). A Cochrane review by Cramp and Byron-Daniel (2012) of 56 studies, with 4068 participants, established that aerobic exercise is beneficial for individuals with solid cancer tumours who experience cancer-related fatigue during and post-cancer treatment. This is important since 70% to 100% of the cancer population has reported experiencing this debilitating type of fatigue that affects an individual physically, emotionally, and mentally, interfering with their activities of daily living (Mock, 2001). Furthermore, another Cochrane Review that included 40 trials, with 3694 participants, reported that exercise had a positive impact on HRQoL, including cancer-specific concerns, body image and self-esteem, emotional well-being, sexuality, sleep disturbance, social functioning, anxiety, fatigue, and pain (Mishra et al., 2012). Research is still needed to determine the most effective type of exercise (according to mode, intensity, frequency, duration, and timing) for optimal HRQoL and to determine how the positive effects of exercise can be sustained over time (Cramp & Byron-Daniel, 2012; Mishra et al., 2012).

Exercise guidelines have been created by Cancer Care Ontario (Segal et al., 2015) and the American College of Sports Medicine (Schmitz et al., 2010) for adults living with

cancer who are undergoing treatment or who have completed treatment. The recommendations of both organizations are similar with minor variations. The suggested duration, frequency, and intensity include 150 minutes of moderate-intensity aerobic exercise over three to five days, along with resistance training (involving major muscle groups) at least twice during the week (Schmitz et al., 2010; Segal et al., 2015). Exercise is recognized as being safe for this population and essential for the long-term physical and psychological health (Schmitz et al., 2010; Segal et al., 2015). It is recommended that individuals living with cancer incorporate moderate intensity exercise into their lifestyle to see improvements in quality of life, muscular strength, and aerobic fitness (Schmitz et al., 2010; Segal et al., 2015).

2.8.1 Exercise and Lung Cancer

Exercise interventions for patients with NSCLC pre- and post-surgery have been determined to be safe, feasible, and well tolerated, even in those with advanced and metastatic disease (Crandall et al., 2014; Hoffman et al., 2013; L. W. Jones et al., 2008). Additionally, low to moderate intensity aerobic, resistance, and balance exercises were found to be well tolerated in patients with NSCLC who underwent chemotherapy and/or radiation treatment (Hoffman et al., 2014; Kuehr et al., 2014). Recent reviews of exercise in lung cancer report that exercise has been shown to reduce symptoms, increase exercise tolerance, improve HRQoL, and potentially reduce length of stay and post-operative complications (Bade et al., 2015; Coats et al., 2014). Much of the evidence in NSCLC to date has focussed on exercise in the perioperative and advanced stages.

2.8.1.1 Perioperative Exercise

In 2013, a Cochrane review identified three randomized controlled trials (RCTs)

involving 178 participants who took part in an exercise intervention within 12 months of lung resection for NSCLC (Cavalheri et al., 2013). The review found exercise capacity, as measured by the six-minute walk test (6MWT), was significantly greater in the intervention group compared to the control group (mean difference (MD) 50.4m; 95% confidence interval (CI) 15.4 to 85.2m) (Cavalheri et al., 2013). There was no reported difference in HRQoL between groups (Cavalheri et al., 2013). Authors noted that the results of this review should be interpreted with caution due to the limited number of RCTs and significant risks of bias associated with small sample sizes, lack of blinding, and performance bias (Cavalheri et al., 2013). The quality of evidence in this research area is negatively affected by the limited number of RCTs that have been done (Cavalheri et al., 2013).

Three other systematic reviews investigated the effect of exercise in the NSCLC population (Crandall et al., 2014; Granger et al., 2011; Rodriguez-Larrad et al., 2014). In the systematic review by Granger et al. (2011) (n=675, 2 RCTs, 8 observational studies) interventions included aerobic training, resistance training, stretching exercises, or a combination thereof and outcomes included exercise capacity, HRQoL, and safety. Overall, NSCLC patients benefited from exercise interventions pre-operatively or post-cancer treatment (surgery, chemotherapy, and/or radiation) evidenced by significant improvements in exercise capacity (6MWT distance or peak oxygen consumption (VO_2peak)) (Granger et al., 2011). Some domains of HRQoL were positively affected (Granger et al., 2011). Exercise was also found to be safe for NSCLC patients before and after cancer treatment (Granger et al., 2011).

Crandall et al. (2014) completed a systematic review (n=575, 8 RCTs, 10 single group trials) on exercise interventions for lung cancer patients who were surgically treated. Studies included in this review involved exercise interventions that were supervised or unsupervised inpatient, or community or home-based outpatient (Crandall et al., 2014). Researchers concluded that exercise led to improved cardiopulmonary exercise capacity, increased muscle strength, reduced fatigue, decreased post-operative complications, and shorter hospital length of stay in patients with resectable NSCLC (Crandall et al., 2014). Three RCT's measured the effects of post-operative exercise programs on HRQoL and found no significant difference between groups. However, differences in HRQoL measurement tools (generic/specific), intervention designs, and the extent of surgery made comparison between studies difficult (Crandall et al., 2014). Future studies should use similar measurement tools that have demonstrated reliability and validity within the specific patient population (Crandall et al., 2014).

Rodriguez-Larrad et al. (2014) conducted a systematic review (n=599, 8 RCTs) examining the use of perioperative respiratory physiotherapy in patients who underwent pulmonary resection for lung cancer. Interventions included chest physiotherapy or intermittent positive pressure breathing only, with or without aerobic and resistance training (Rodriguez-Larrad et al., 2014). Each study included in the review examined at least two or more of the following outcome variables: functional capacity, postoperative pulmonary complications (PPC), or length of hospital stay (LOS) (Rodriguez-Larrad et al., 2014). Pre-operative aerobic exercise in patients undergoing lung cancer resection was found to improve functional capacity and reduce postoperative morbidity (e.g. pneumonia, or respiratory complications requiring addition ventilatory support) (Rodriguez-Larrad et

al., 2014). The addition of aerobic and resistance training to the usual care or standard physiotherapy in the post-operative period did not reduce PPC or LOS in patients undergoing lung resection (Rodriguez-Larrad et al., 2014). These results should be taken with caution because of the high variability in the types of interventions used; it was not possible to establish the effectiveness of each individual intervention (Rodriguez-Larrad et al., 2014).

To summarize, evidence indicates that perioperative exercise is safe and may benefit the exercise capacity and HRQoL of lung cancer patients. Due to significant between-study heterogeneity within the systematic reviews, it was not feasible to conduct meta-analyses and pool results (Crandall et al., 2014; Granger et al., 2011; Rodriguez-Larrad et al., 2014). Future research should continue to analyze various types of exercise in order to inform health care professionals of the optimal exercise prescription and setting for NSCLC patients. In addition, larger sample sizes, clear reporting structure, and adequate allocation concealment should also be considered.

2.8.1.2 Advanced Disease and Exercise

Lung cancer patients with advanced stages (III or IV) of NSCLC have notably decreased exercise capacity due to decreased pulmonary function and peripheral muscle strength (Yilmaz et al., 2013). This reduced exercise capacity negatively impacts the functional categories of HRQoL in these patients (Yilmaz et al., 2013). The combination of symptoms, including diminished muscle strength, decreased HRQoL, increased dyspnea, and greater levels of fatigue provide a strong rationale for referring this patient population to a formal exercise program such as pulmonary rehabilitation (Holland, Wadell, & Spruit, 2013).

In 2013, a RCT (n=66) examined the effects of a home-based walking and strength training exercise program (versus usual care) on physical function, fatigue, and sleep quality in patients with stage IV lung and colorectal cancer (Cheville et al., 2013). Twenty out of 26 of the participants in the intervention group adhered to the program (Cheville et al., 2013). They showed significant improvements in mobility, fatigue, and sleep quality over time (Cheville et al., 2013). Henke et al. (2014) also conducted a RCT (n=46) to test the effects of strength and endurance training on functional capacity (6MWT distance and staircase walking), muscle strength (maximum number of repetitions doing a bicep curl, tricep extension, bridging, and abdominal exercise), the independence in carrying out activities of daily living, and HRQoL of lung cancer patients with advanced disease during three cycles of palliative chemotherapy treatment (Henke et al., 2014). The intervention group (n=18) participated in cardiovascular exercise daily and strength training every other day; the control group (n=11) received conventional physiotherapy consisting of manual therapy and breathing techniques (Henke et al., 2014). Out of 46 patients only 29 completed the trial (patients died (n=6), were non-compliant (n=10) or they continued treatment at a different hospital (n=1)) (Henke et al., 2014). Of those who completed the trial, there was a significant difference between groups in patient's independence in activities of daily living, self-reported symptoms (pain, neuropathy, cognitive functioning, dyspnea), and exercise capacity (both functional capacity and muscle strength) (Henke et al., 2014).

As mentioned earlier, cancer-related fatigue is a disabling symptom that often interferes with an individual's activities of daily living particularly in those who are diagnosed with advanced stage cancer. Paramanandam and Dunn (2014) conducted a detailed literature review (n=192, 9 prospective single group intervention studies, 1 case

study) examining the influence of exercise on cancer-related fatigue experienced by lung cancer patients. Exercise interventions were all supervised and included aerobic exercise (including interval training), resistance training, a combination of both aerobic and resistance training, and breathing and mobility exercises (Paramanandam & Dunn, 2014). The intensity, frequency, and duration of exercise programs varied greatly (Paramanandam & Dunn, 2014). All studies showed some improvement in fatigue with three out of ten of the studies reporting a significant reduction in fatigue (Paramanandam & Dunn, 2014). The findings of these studies are limited by the lack of control groups and small sample sizes (Paramanandam & Dunn, 2014). The clinical application of results is reduced due to the substantial variation in exercise interventions, and participants included in the study (Paramanandam & Dunn, 2014). Evidence from the review may support the use of exercise in the management of cancer-related fatigue experienced by lung cancer patients, however studies of higher methodological quality are needed to substantiate this finding (Paramanandam & Dunn, 2014).

Overall, evidence suggests that exercise capacity and symptom burden in patients with advanced lung cancer can be improved with exercise; however, optimal mode, frequency, duration, and intensity of prescription have not been established. Most studies on exercise in this population have consisted of in-hospital supervised exercise programs, which may be restrictive to some patients and has been associated with poor compliance. Home or community-based exercise programs including new modalities of exercise may be more accessible and feasible for this patient population (Coats et al., 2013).

2.8.2 Exercise and Prostate Cancer

The prognosis of individuals with prostate cancer can vary greatly depending on the severity of disease and the general health of the individual at diagnosis, but most often patients with prostate cancer are long-term survivors (Menichetti et al., 2016). The HRQoL of prostate cancer survivors is effected by their medical and psychological needs as they age. It is important to understand how exercise may benefit these individuals and help to improve their HRQoL. Three systematic reviews have explored the effect of exercise on individuals with prostate cancer (Hasenoehrl et al., 2015; Menichetti et al., 2016; Teleni et al., 2016).

Menichetti et al. (2016) reviewed 17 RCTs (n = 1989) that explored the effect of lifestyle interventions (including exercise, dietary, or behavioural components) on the HRQoL of individuals with prostate cancer. The duration of the interventions ranged from four to 96 weeks (median 12 weeks) and most studies included participants that received a specific type of treatment, including androgen deprivation therapy (ADT) (8 studies), radiation (3 studies), active surveillance (1 study), radical prostatectomy (1 study), or radiation in addition to ADT (1 study) (Menichetti et al., 2016). Two studies involved patients who had multiple active treatment options and one study included patients with a wide range of treatment conditions (Menichetti et al., 2016). Most interventions reported significant improvements in quality of life outcomes (59%) (Menichetti et al., 2016). Exercise interventions were found to have the greatest number of positive results on quality of life outcomes (67%), compared to dietary interventions (50%), and mixed lifestyle interventions (33%) (Menichetti et al., 2016). In particular, resistance training over 12 or 24 weeks resulted in significant improvement in patients' quality of life (Courneya et al., 2004; Segal et al., 2003) and other outcomes, such as sexual functioning (Cormie, Newton,

Taaffe, et al., 2013), fatigue (Segal et al., 2003), and physical functioning (Courneya et al., 2004; Galvao et al., 2014; Galvao, Taaffe, Spry, Joseph, & Newton, 2010; S. W. Park et al., 2012). The results of this systematic review are supported by two other RCTs. Monga et al. (2007) found that an eight-week cardiovascular intervention with individuals who were receiving radiation for prostate cancer (n=21) improved cardiovascular fitness, flexibility, muscle strength, overall HRQoL, and prevented fatigue. Segal et al. (2009) compared cardiovascular training and resistance training in 121 patients starting radiation with or without ADT. Both cardiovascular training and resistance training groups improved, yet the improvements in the resistance training group lasted longer (Segal et al., 2009).

A systematic review by Teleni et al. (2016) examined seven RCTs (n=585) that investigated the effect of exercise on HRQoL, ADT symptoms, and/or metabolic risk factors in individuals with prostate cancer treated with ADT. Individuals receiving ADT may experience side effects such as vasomotor distress, depression, anxiety, mood swings, poor sleep quality, and compromised sexual function (Teleni et al., 2016). This treatment also causes individuals to be more likely to develop metabolic conditions (e.g. diabetes, cardiovascular disease, abdominal obesity, and osteoporosis) (Teleni et al., 2016). RCTs included in the review examined a combination of resistance training and aerobic training (4 studies) (Bourke et al., 2011; Bourke et al., 2014; Galvao et al., 2014; Galvao et al., 2010), resistance training only (2 studies) (Culos-Reed et al., 2010; Segal et al., 2009), aerobic training only (1 study) (Alberga et al., 2012; Segal et al., 2009), and football training sessions (1 study) (Uth et al., 2014). In the studies that involved aerobic training, intensity ranged from 55% to 85% of maximal heart rate or 11 to 15 points on the Borg

Rate of Perceived Exertion (RPE) Scale (Teleni et al., 2016). Intensity was not reported in most of the resistance training studies, for those that did, participants trained at 60% to 70% of one repetition maximum (Teleni et al., 2016). Exercise was found to significantly improve HRQoL (n= 427, 5 studies) (Alberga et al., 2012; Bourke et al., 2011; Culos-Reed et al., 2010; Galvao et al., 2014; Galvao et al., 2010) and disease-specific quality of life (3 studies, n= 271(Alberga et al., 2012; Bourke et al., 2011; Bourke et al., 2014) in men undergoing ADT. However, the effect size of exercise on these outcomes was small to moderate, and because most of the studies involve a combination of resistance and aerobic training, it was not possible to determine whether one type of training or a combination of the two was more beneficial (Teleni et al., 2016). No studies included in the review on exercise examined the effect on ADT symptoms and/or metabolic risk factors (Teleni et al., 2016). Total body weight, waist to hip ratio, waist circumference measures, and body composition measures did not significantly improve with exercise (Teleni et al., 2016). Similarly, exercise did not significantly improve systolic blood pressure, blood glucose levels, total cholesterol, triglycerides, LDL cholesterol, or HDL cholesterol (Teleni et al., 2016). Teleni et al. (2016) acknowledge that more research on the optimal exercise type, intensity, and duration is needed. Also, future trials are needed to determine an intervention that is effective in reducing the symptoms of ADT and managing metabolic risk factors (Teleni et al., 2016).

Hasenoehrl et al. (2015) conducted a systematic review to understand the effects of resistance exercise on the management of side effects experienced by individuals with prostate cancer who were receiving or had received ADT. Thirteen trials (n=876), many of which were included in the systematic review by Teleni et al. (2016), were included in the

review (Bourke et al., 2011; Bourke et al., 2014; Cormie et al., 2015; Cormie, Newton, Spry, et al., 2013; Galvao et al., 2006; Galvao et al., 2014; Galvao et al., 2010; Hanson et al., 2013; S. W. Park et al., 2012; D. Santa Mina et al., 2013; Segal et al., 2003; Segal et al., 2009; Winters-Stone et al., 2014). Exercise interventions ran for 12 to 52 weeks and exercise prescription varied greatly (Hasenoehrl et al., 2015). Some studies included a combination of resistance training and aerobic training, while others focused only on resistance training (Hasenoehrl et al., 2015). Hasenoehrl et al. (2015) concluded that resistance exercise was safe and successful in improving muscular strength and performance as well as fatigue and HRQoL. Similar to the Teleni et al. (2016) systematic review, there was inadequate evidence to determine if resistance training improved cardiovascular performance, body composition, blood lipids, bone mineral density, and immune response (Hasenoehrl et al., 2015).

Research indicates that exercise interventions are feasible and safe for individuals with prostate cancer during and after various types of treatment. Both aerobic and resistance exercise have been shown to improve physical performance capacity and HRQoL. Future studies are needed to determine optimal exercise type, duration, frequency, and intensity to reduce symptoms and manage metabolic risk factors in this population.

2.8.3 Exercise and Colorectal Cancer

A review article by Halle and Schoenberg (2009) provides some insight into the research that has been conducted on the effects of exercise on individuals with colorectal cancer. Epidemiological investigations and prospective cohort studies have shown that men and women who participate regularly in exercise have a decreased risk of developing colon cancer (Halle & Schoenberg, 2009). A study of 150,000 people (70,403 men and

80,771 women; median age of 63 years) determined that an individual's risk of developing colon cancer decreased significantly as the number of hours of exercise participation increased per week (Chao et al., 2004). In fact, individuals who exercised for over 7 hours each week had a 40% decreased risk of colon cancer (Chao et al., 2004). Three prospective studies on lifestyle changes and disease outcomes have shown that exercise can also improve the prognosis of individuals with colon cancer, even in those with advanced stage disease (Haydon, Macinnis, English, & Giles, 2006; Haydon, Macinnis, English, Morris, & Giles, 2006; Meyerhardt, Giovannucci, et al., 2006; Meyerhardt, Heseltine, et al., 2006). The effect of exercise on rectal cancer is inconsistent (Halle & Schoenberg, 2009), with some studies indicating risk reduction with increased levels of exercise, while other studies do not (Halle & Schoenberg, 2009).

Backman et al. (2014) conducted a randomized pilot study examining the feasibility and adherence of regular walking among 71 breast (n=54) and colorectal (n=17) cancer patients undergoing chemotherapy. Over 10 weeks the intervention group (breast n=27, colorectal n=8) aimed to walk 10,000 steps a day and participate in a weekly supervised group walk while the control group did not (Backman et al., 2014). Adherence averaged 91% during the intervention period and was measured by how many participants reported the steps they took each day (Backman et al., 2014). The majority of the intervention group completed the 10-week intervention and these participants averaged 8300 steps per day, with 34% of participants reaching the step goal of 10,000 steps per day every week (Backman et al., 2014). It was feasible for individuals with breast and colorectal cancer who were receiving chemotherapy treatment to take part in the walking intervention (Backman et al., 2014). However, this was considered to be a low-intensity activity and no

significant differences were seen between groups in HRQoL in individuals with colorectal cancer (Backman et al., 2014). To improve outcomes, researchers recommended higher intensity exercise, more objective assessment measures, and a larger sample size (Backman et al., 2014).

While a definite link between exercise levels and the risk of colorectal cancer has been established, no scientifically based exercise guidelines have been created specifically for individuals with colorectal cancer. More research is required to determine the most optimal exercise prescription for individuals during treatment or after treatment for colorectal cancer. Developing the most beneficial exercise is a difficult task since this also depends on one's exercise capacity, perception, motivation, and needs (Halle & Schoenberg, 2009). Halle and Schoenberg (2009) suggest that individuals with colorectal cancer begin with low intensity exercise and gradually increase training over time. Exercising three to five times per week for 30-minutes at a time is recommended, ensuring that strength training is spaced out by two days to prevent exhaustion (Halle & Schoenberg, 2009).

More recently an RCT by J. H. Park et al. (2015) examined whether oncologists' exercise recommendations of at least 150 minutes of moderate aerobic exercise and twice a week strengthening exercises for individuals with breast and colorectal cancer survivors (n=162) were more effective with or without the use of motivational tools including an exercise DVD, pedometer, exercise diary, and exercise education session. It was determined that participants who received the oncologists' exercise recommendations with the motivation tools had significantly increased the amount they participated in exercise compared to the control group who did not receive any exercise recommendations or

motivation tools (J. H. Park et al., 2015). Also, the oncologists' exercise recommendations alone were not enough to significantly increase the amount of exercise individuals participated in and therefore oncologists' exercise recommendations should be provided with tools to help encourage and facilitate exercise participation (J. H. Park et al., 2015).

In conclusion, exercise has been shown to reduce the risk of developing colon cancer, yet evidence remains inconclusive as to whether exercise has a similar effect on rectal cancer. Research has demonstrated that exercise interventions are feasible for individuals with colon cancer who are undergoing chemotherapy treatment. More research is needed to determine the most beneficial exercise prescription (i.e. type, intensity, frequency, and duration) for this population. Also, it has been determined that motivational tools (e.g. pedometers, exercise diaries, and educational sessions) are necessary along with oncologists' recommendations to assist individuals with colorectal cancer in increasing their levels of exercise participation.

2.8.4 Exercise and Endometrial Cancer

Currently, there is limited research examining the effects of exercise on individuals with endometrial cancer. The majority of endometrial cancer survivors do not meet current exercise recommendations, and many are overweight or obese and have been diagnosed with other comorbidities (Smits, Lopes, Das, Bekkers, & Galaal, 2014; von Gruenigen et al., 2011). Consequently, this population should be provided with further education about the risk of continuing to lead an unhealthy lifestyle and opportunities should be created for this group to take part in healthy lifestyle programs including exercise and nutritional counselling (von Gruenigen et al., 2011).

A systematic review by Smits et al. (2015) (n= 413 participants, 3 RCTs, 1 randomised parallel intervention trial, 1 controlled trial, 3 single-arm intervention trials) concluded that the HRQoL of endometrial and ovarian cancer survivors could be improved by lifestyle interventions, such as exercise or nutritional counselling interventions. There was only one RCT in the review that examined the feasibility and effect of a physical activity intervention on gynaecological cancer survivors (total: n=33; ovarian: n=12; endometrial: n=11; uterine n=4; cervical: n=4; mixed gynaecological tumour: n=2) during and post treatment (Donnelly et al., 2011). The intervention group (n=16) in the trial participated in a 12-week, home-based, moderate intensity exercise behaviour change intervention that aimed to follow exercise guidelines of 30 minutes of exercise on at least five days of the week (Donnelly et al., 2011). Exercise involved walking and a strength training program (Donnelly et al., 2011). At the beginning and at the end of the 12-weeks participants met with a physiotherapist and in-between this time weekly phone calls were made to track participants' progress (Donnelly et al., 2011). Standard care was delivered to the control group (n=17) with no advice on exercise being provided (Donnelly et al., 2011). Researchers reported that fatigue as measured by the Multi-Dimensional Fatigue Symptom Inventory – Short Form (MDFSI-SF) was significantly decreased in the intervention group compared to the control group at the 12-week and six month assessments (12-week: mean difference: -11.06, 95% confidence interval (CI): -21.89 to -0.23, p=0.046; 6 month: mean difference: -19.48, 95% CI: -19.67 to -19.15, p = 0.01) (Donnelly et al., 2011). Additionally, a significant difference between groups in the sleep dysfunction (measured by the Pittsburgh Sleep Quality Index) was reported at 12-weeks, and was maintained at follow up, six weeks later (Donnelly et al., 2011). Other secondary

outcome measures (including HRQoL, depression, body composition, physical functioning, and self-reported physical activity) did not show any significant differences (Donnelly et al., 2011). Overall, researchers found that facilitating an exercise behaviour change intervention for gynaecological cancer survivors was feasible since initial appointments and phone calls resulted in excellent adherence (Donnelly et al., 2011).

In summary, while exercise and nutritional counselling is thought to improve the HRQoL and reduce symptoms experienced by individuals with endometrial cancer, evidence at this time remains limited. More rigorous trials including women with a wide range of body mass index (BMI) and physical activity levels are needed (Smits et al., 2015). Researchers should aim to investigate the optimal mode, intensity, frequency, and duration of exercise protocols for individuals with endometrial cancer and the long-term effects and sustainability of exercise needs to be considered (Smits et al., 2015).

2.9 Nordic Pole Walking

2.9.1 Walking and Cancer

Studies examining the exercise preferences of individuals diagnosed with various types of cancer indicate that walking is overwhelmingly the most preferred type of exercise (Blaney, Lowe-Strong, Rankin-Watt, Campbell, & Gracey, 2013; L. W. Jones & Courneya, 2002). In Taiwanese patients with lung cancer, walking was identified as the most preferred type of exercise because it is flexible and can be performed alone (Lin, Lai, Lu, Lai, & Lin, 2013). Exercise preferences are important to consider in research and clinical practice for the cancer population since they may result in greater recruitment and adherence rates in addition to improved outcomes that impact physical function and HRQoL (L. W. Jones & Courneya, 2002).

Moderate-intensity walking programs have been studied in various cancer populations. An RCT by Nyrop et al. (2017) examined the effects of a home-based walking program (n=31) on women diagnosed with breast cancer who were experiencing moderate to severe aromatase inhibitor-associated arthralgia (AIAA) (including symptoms of joint pain, stiffness, and achiness) compared to a control group (n=31) who received the usual care (Nyrop et al., 2017). The walking intervention was six-weeks in length and participants were asked to walk at a safe, comfortable, and sustainable pace for 150 minutes per week (Nyrop et al., 2017). Immediately following the six-weeks, participants in the intervention group experienced a significant increase in their walking minutes per week (walking group: +76.22 minutes/week ($p<0.01$); control: +10.52 minutes/week), decrease in stiffness, less difficulty with activities of daily living, and less perceived helplessness in handling joint symptoms (Nyrop et al., 2017). At the six-month follow up, the improvement seen in joint stiffness and daily activities in the walking group was maintained; however, the walking minutes per week had decreased significantly (Nyrop et al., 2017). This demonstrates that a home-based walking program assisted women with breast cancer in managing AIAA.

Another RCT examined the effects of a 12-week moderate-intensity, home-based, walking program on individuals with lung cancer (n=116) (Chen, Tsai, Wu, Lin, & Lin, 2015). Participants that were randomly assigned to the walking group (n=58) walked for 40 minutes per day, three days per week, and received weekly exercise counselling (Chen et al., 2015). Participants in the control group (n=58) received the usual care (Chen et al., 2015). It was determined that individuals in the walking group had a significant improvement in their anxiety levels and depression compared to the control group (Chen

et al., 2015). Researchers concluded that walking is an effective method for lung cancer patients to deal with anxiety and depression and should be encouraged as part of a rehabilitation program (Chen et al., 2015). Other studies on individuals diagnosed with colorectal and breast cancer support these results (Courneya et al., 2003; Mock et al., 1997).

Overall walking as a form of exercise is preferred by cancer patients and moderate-intensity, home-based walking programs have been found to reduce anxiety, depression, and the severity of cancer-related symptoms. With this in mind, NPW is considered as a potentially more effective exercise intervention for individuals diagnosed with cancer.

2.9.2 Overall Effects of NPW

Nordic pole walking is a low-impact form of exercise that involves walking with a pair of poles customized to the participant's height and stride length. As a registered kinesiologist working with individuals who have various health considerations, it has been my experience that people are not only enthusiastic about learning to NPW, but that their adherence to a prescribed NPW program is greater than to a general walking program. While walking will improve an individual's aerobic capacity, walking with the poles increases the use of the upper body creating an opportunity to potentially improve upper body muscular endurance as well.

While NPW has become an increasingly popular type of exercise, research on the effects of NPW is still evolving. Fritschi et al. (2012a) conducted a systematic review to determine the effects of NPW on physical and psychosocial health. Included in the review were 10 RCTs and 3 control trials, 10 published since 2010 (Fritschi et al., 2012a). Participants in these studies were primarily mid to older aged men and women with varying clinical diagnosis, including type 2 diabetes, cardiovascular disease, musculo-skeletal

conditions, chronic obstructive pulmonary disease (COPD), Parkinson's disease, fibromyalgia, Sjogren's syndrome, and breast cancer. On average the studies included about 60 participants and the NPW programs were 14.2 weeks long (Fritschi et al., 2012a). There were only two studies of nonclinical populations in this review, leaving healthy people without diagnosed conditions inadequately represented (Fritschi et al., 2012a). The NPW programs consisted of one to five exercise sessions per week, 20 to 70 minutes in length (Fritschi et al., 2012a). Most programs required participants to exercise at moderate intensity determined by both subjective and objective measures, including RPE, heart rate, and accelerometer data (Fritschi et al., 2012a).

All studies included in the systematic review had at least one positive effect from NPW (Fritschi et al., 2012a). Yet comparison between studies was difficult due to the variety of study populations, control groups, and outcome measures. Fritschi et al. (2012a) concluded that NPW improved functional status, physical activity, HRQoL, and cardiorespiratory outcomes. The effects of NPW on pain, anthropometric measures, muscle strength and flexibility, gait parameters, and blood glucose levels were inconclusive (Fritschi et al., 2012a). Two other reviews that were published earlier also support these results (Laukkanen, 2007; Morgulec-Adamowicz, Marszałek, & Jagustyn, 2011).

2.9.3 NPW and Cancer

The research focusing on the effects of NPW in the cancer population is limited. Jastrzebski et al. (2015) conducted a RCT (n=20) where NPW was incorporated into the pulmonary rehabilitation program for individuals with advanced stage lung cancer (stage III or IV) who were undergoing chemotherapy treatment. The aim of the RCT was to determine the effects of pulmonary rehabilitation on exercise efficiency, dyspnea, and the

HRQoL of these individuals (Jastrzebski et al., 2015). Twelve patients (NSCLC: n=10, small-cell lung cancer: n=2) were randomly allocated to an eight-week hospital-based rehabilitation program that involved four two-week rehabilitation cycles, each beginning with a round of chemotherapy (Jastrzebski et al., 2015). Depending on their results from the 6MWT patients were divided into two groups (Jastrzebski et al., 2015). Group A (6MWT > 200 meters (m): n=8) participated in 45 minutes of NPW (70% of predicted maximal heart rate), 30 minutes of aerobic and respiratory exercises, and 30 minutes of resistance training each day, on five days of the week (Jastrzebski et al., 2015). Group B (6MWT < 200m: n=4) participated in an individualized program involving exercises for the respiratory muscles and peripheral muscles of the upper and lower extremities (cycle ergometer) (Jastrzebski et al., 2015). The eight patients (all diagnosed with NSCLC) randomized to the control group did not participate in any rehabilitation program during the eight-week period (Jastrzebski et al., 2015). Assessments of all participants were to be conducted before and after the eight-week period and some participants stayed in the program longer, while others finished earlier than expected due to anemia and general weakness (Jastrzebski et al., 2015). No statistically significant improvement was found in the 6MWT for those who completed the pulmonary rehabilitation program compared to the control group (Jastrzebski et al., 2015). Despite this, there was a definite trend towards increased distance that these patients were able to walk after the eight-week training period (Jastrzebski et al., 2015). The rehabilitation group went from an average (SD) 6MWT distance of 527.3m (107.0) to an average 6MWT distance of 563.9m (64.6) at the final assessment (Jastrzebski et al., 2015). In comparison, the control group walked on average 502.8m (105.0) at the initial 6MWT and 509.4m (134.3) at the final 6MWT (Jastrzebski et

al., 2015). In the rehabilitation group, there was a significant increase in forced expired volume in one second (66.9 (13.2) versus 78.4 (17.7) of percent predicted; $p = 0.016$), less dyspnea, and a tendency towards improvement in HRQoL (as measured by the 36-item short form health survey (SF-36)) compared to the control group (Jastrzebski et al., 2015). Pulmonary rehabilitation using NPW was found to be feasible in patients with advanced lung cancer during chemotherapy (Jastrzebski et al., 2015). While the small sample size of this study made it difficult to determine if significant changes occurred, researchers acknowledge the practical implications of the study and suggested that NPW is an economical form of exercise that participants can continue independently at home (Jastrzebski et al., 2015).

Most of the research on NPW and individuals with cancer has focused on the breast cancer population. Sprod et al. (2005) conducted an eight-week RCT (n=12) to determine if NPW would improve shoulder ROM and upper body muscular endurance in female breast cancer survivors. Both the NPW group (n=6) and the control group (n=6) met with an exercise specialist twice a week to do 20 minutes of walking and a resistance training program for eight weeks (Sprod et al., 2005). During the 20 minutes of aerobic activity, the NPW group walked with poles while the control group walked without (Sprod et al., 2005). At the beginning and at the end of the eight-week training period the range of motion (including right and left shoulder flexion, extension, and abduction) and muscular endurance (including repetitions possible before volitional muscular fatigue doing bench press, shoulder press, and latissimus dorsi (lat) pull down) were measured in both groups (Sprod et al., 2005). More than 18 months had elapsed since participants had undergone treatment and therefore little impairment was found in the shoulder range of motion of

either group (Sprod et al., 2005). However, results did show significant improvements in the bench press and lat pull down muscular endurance tests in the NPW group compared to the control group (Table 1) suggesting that walking with poles helped to improve muscular endurance of the upper body (Sprod et al., 2005).

Table 1. *Comparison of Differences in Muscular Endurance between the NPW Group and Control Group*

Muscular Endurance Measure	NPW Group	Control Group
Bench Press (repetitions)	6.83*	-0.8
Shoulder Press (repetitions)	1.17	-0.4
Lat Pull Down (repetitions)	13.00*	5.2

*differs significantly from pretest values ($p<0.05$)

Note: Data from The effects of Walking Poles on Shoulder Function in Breast Cancer Survivors by Sprod et al. (2005).

Malicka et al. (2011) also conducted an eight-week RCT examining the effects of NPW on the upper body strength and lymphedema in 38 women (average age of 62.8 years) who had been treated for breast cancer. The control group (n=15) did no exercise while the NPW group (n=23) participated in two 60-minute NPW classes per week (Malicka et al., 2011). The average upper body pushing muscle strength for the NPW group was only significantly higher for the left upper extremity (Malicka et al., 2011). There was no change in muscle strength for the pulling motion of the upper extremities (Malicka et al., 2011). No occurrence of lymphedema was reported and so NPW was considered a safe form of rehabilitation for patients with breast cancer (Malicka et al., 2011).

More recently, two feasibility studies exploring the effects of NPW on individuals with breast cancer were completed (Fields et al., 2016; Fischer et al., 2015). Fischer et al. (2015) aimed to determine the feasibility of a NPW program to help individuals who had finished treatment for breast cancer to improve their well-being and shoulder function. Of the 28 women who started the NPW intervention, 23 women completed the 10-week

program (Fischer et al., 2015). Two women dropped out because of the progress of their breast cancer during the program and three other women dropped out due to medical reasons unrelated to breast cancer (Fischer et al., 2015). The program involved 10-weekly hour long training sessions with the initial six sessions focusing on walking technique and the last four sessions focusing on improving endurance and muscle strength (Fischer et al., 2015). Subjective well-being (measured using the SF-36) and individual's perceptions of shoulder mobility were assessed at the start of the program, at the end of the program, and then again six months later (Fischer et al., 2015). Shoulder range of motion was also measured at the beginning and at the end of the program (Fischer et al., 2015). Focus groups were held six months after the program so that researchers could gain insight into the participants' experiences and the perceived benefits and drawbacks of the intervention (Fischer et al., 2015). At three and six months, subjective wellbeing showed significant improvement in vitality compared to baseline (Fischer et al., 2015). During the focus groups, researchers learned that participants greatly valued the social support that they received from others taking part in the study (Fischer et al., 2015). This social support continued after the end of the program as participants could relate to similar physical and psychosocial consequences from cancer and treatment (Fischer et al., 2015). Fischer et al. (2015) concluded that NPW is a feasible and enjoyable activity for breast cancer survivors. The exploratory nature of this study meant there were several limitations, including no control group for comparison and a small sample size (Fischer et al., 2015).

Fields et al. (2016) conducted a feasibility study (n=40) using a randomized control design to examine the effects of a NPW program for women with breast cancer who had AIAA. Women who were randomized to the NPW group (n=20) participated in one

supervised NPW session per week for six weeks, followed by another six weeks of NPW independently four times a week for 30-minutes (Fields et al., 2016). The control group (n=20) received enhanced usual care where they were contacted twice a week to check if they were experiencing any new pain, injury, or lymphedema (Fields et al., 2016). Researchers collected data on feasibility outcomes, including recruitment, attrition and adherence rates, safety, suitability of methods, and physical activity levels of participants (Fields et al., 2016). On average participants were 63 years old, 36-months post diagnosis, had been on endocrine therapy for 27 months and had been experiencing arthralgia for 22 months (Fields et al., 2016). All of the study participants had been treated for breast cancer surgically, 75% were also treated with radiation, and 50% had chemotherapy (Fields et al., 2016). There was a 10% attrition in the NPW group with two participants dropping out of the study before the intervention started due to other commitments and one due to sudden bereavement (Fields et al., 2016). Two other participants dropped out after the first six-weeks of NPW because of longstanding musculoskeletal problems unrelated to AIAA (Fields et al., 2016). No one in the control group dropped out of the study (Fields et al., 2016). There was a high level of adherence (90%) for the supervised weekly NPW sessions and during the unsupervised NPW sessions (one to two walks per week was achieved by 68%-85%) (Fields et al., 2016). Over the twelve-week period, 39% of NPW participants reported an increase in vigorous physical activity (including NPW), but no participants reported a change in walking activity. Comparatively, 15% of control group participants reported an increase in their vigorous activity and 45% of the control group reported an increase in their walking activity (Fields et al., 2016). In the survey completed at the end of the study, all participants indicated that they enjoyed NPW and 81% confirmed that they

intended to continue to exercise three to four times per week (Fields et al., 2016). This study determined that it is possible to recruit and retain women with AIAA to participate in NPW and that NPW is found to carry a low risk of injury and did not make the lymphedema experienced by participants worse (Fields et al., 2016).

Overall, there has been little research done on NPW in individuals with cancer. Research has found that for individuals with breast cancer, NPW is a safe form of rehabilitation and that it may help to improve the muscular endurance of the upper body (Malicka et al., 2011; Sprod et al., 2005). When NPW was incorporated into pulmonary rehabilitation for lung cancer patients, a significant increase in forced expired volume in one second and a trend towards improved exercise capacity, HRQoL, and less dyspnea were shown (Jastrzebski et al., 2015). Feasibility studies on NPW and individuals with breast cancer have established that program adherence is generally high, physical activity levels of participants are improved, and overall enjoyment is apparent (Fields et al., 2016; Fischer et al., 2015). Future research should investigate how NPW impacts the physical function and HRQoL of individuals with various types of cancer. Outcome measures that are common within the cancer population should be applied when possible to allow researchers to compare NPW to other exercise modalities.

2.9.4 NPW and Quality of Life

In the literature, quality of life and HRQoL are often used interchangeably, however they do have different meanings and therefore it is important to define these two terms. Quality of life is a broad term that refers to all aspects of an individual's life including (but not limited to) psychological, economical, biological, and social aspects (hnoble, 2014; Karimi & Brazier, 2016). While HRQoL overlaps with quality of life, it is centred on the

specifics of how illness and treatment impact one's quality of life (hnoble, 2014; Karimi & Brazier, 2016).

One study out of four (Breyer et al., 2010) on NPW (Collins et al., 2005; Gram, Christensen, Christiansen, & Gram, 2010; Strombeck, Theander, & Jacobsson, 2007) showed significant improvement in some HRQoL domains of the Medical Outcomes Study 36 Item Short-Form Health Survey (SF-36). The SF-36 includes eight domains that can be categorized as part of the physical component summary (PCS) score or the mental component summary (MCS) score. Both scores range from 0 to 100 and a score greater than 50 points represents a better generic HRQoL.

Breyer et. al (2010) in a RCT, compared a three month NPW program (n=30) to no intervention (n=30) in 60 COPD patients. At baseline, 53 patients with COPD had an impaired PCS score (<50 points) and 30 patients had an impaired MCS score (<50 points) (Breyer et al., 2010). The NPW group significantly increased their PCS scores compared to baseline and controls, and these scores continued to be improved after six and nine months (Table 2) (Breyer et al., 2010). Controls showed no change in PCS scores after three, six, and nine months compared to baseline (Table 2) (Breyer et al., 2010). Both the NPW group and the control group did not show any change in MCS scores at any time over the nine-month period (Table 2) (Breyer et al., 2010).

Table 2 – *SF-36 Scores for Individuals with COPD Over Time*

SF-36 Component	Baseline		Three Months		Six Months		Nine Months	
	NPW Group	Control Group	NPW Group	Control Group	NPW Group	Control Group	NPW Group	Control Group
PCS Score (mean, SD)	32.2 ±6.5	31.7 ±5.79	42.5*‡ ±9.62	32.7 ±6.39	44.1*‡ ±8.12	30.8 ±7.4	43.6*§ ±9.52	29.9 ±6.89
MCS Score (mean, SD)	42.8 ±7.41	39.2 ±9.4	47.2 ±10.7	41.53 ±12.8	47.4 ±8.91	40.7 ±9.36	46.3 ±9.27	38.7 ±8.71

Statistical comparisons within groups: * $p<0.01$ compared to baseline
Statistical comparisons between groups (Nordic Walking vs. Control): ‡ $p<0.01$, § $p<0.05$
Note: Reprinted from Nordic Walking Improves Daily Physical Activities in COPD: a randomised control trial by Breyer, et al. (2010).

In summary, more research on the effects of NPW on HRQoL is needed. Researchers should consider using the SF-36 questionnaire so that comparisons between trials can be made.

2.10 Gaps in Literature and Future Research

There is increasing evidence that exercise is beneficial for individuals who are diagnosed with cancer, but more research is needed. Low to moderate intensity exercise is safe, and can be effective at improving the HRQoL of individuals with cancer who are undergoing treatment or who have completed treatment (Mishra et al., 2012). General exercise guidelines for this population have been created (Schmitz et al., 2010; Segal et al., 2015), although further research should be done to determine the most effective type of exercise according to mode, intensity, frequency, duration, and timing. Providing health care professionals with this information would assist them in making sure that the exercise prescription they provide is appropriate, safe, and effective.

In some cancer populations research on exercise is more limited than others. For example, as mentioned earlier, lung cancer is the most commonly diagnosed type of cancer in Canada (14% of all cancer cases) (Canadian Cancer Society, 2016), yet there remain few

RCT's with high quality research on exercise in this population. Studies investigating the effects of exercise on individuals with endometrial cancer is also limited. It is important to understand how exercise effects individuals with various cancer diagnoses. What may be most beneficial for individuals with one type of cancer may not be for individuals diagnosed with another type of cancer. A better understanding of the role exercise can play in various cancer diagnosis will allow for more individualized exercise programing. Additionally, studying exercise in individuals with certain types of cancer is difficult and therefore, effort needs to be made to better understand and overcome the barriers to research in these populations. More rigorous methodological studies (i.e. RCTs) examining the effects of exercise are needed. Future trials should consider the long-term effects and sustainability of exercise.

Nordic pole walking has been shown to improve functional status, physical activity (including exercise), HRQoL, and cardiorespiratory outcomes of adults with various clinical diagnosis (Fritschi et al., 2012a). Current research on NPW in the cancer population focuses on the upper body strength and range of motion of breast cancer survivors. One study exploring the effects of an eight-week pulmonary rehabilitation program involving NPW combined with aerobic and resistance exercises in individuals with lung cancer found that patients in the NPW group tended to be able to walk a greater distance and have improved HRQoL compared to the control group (Jastrzebski et al., 2015). This trend towards improved functional exercise capacity and HRQoL warrants further investigation in individuals with various types of cancer. Walking with the poles is a low-impact, inexpensive, and practical type of exercise that anyone can participate in. The uncomplicated nature of NPW makes it a practical alternative for individuals with

cancer to incorporate into their lifestyle. In the future, RCTs with larger sample sizes should be conducted. The most appropriate outcome measures for the cancer population need to be considered so that comparisons can be made to other exercise protocols that have been studied in individuals with cancer.

3.0 Methods

3.1 Study Design

This was an eight-week multi-centre randomized controlled pilot study to assess the feasibility of examining the effects of Nordic pole walking (NPW) on the physical function and health-related quality of life (HRQoL) of individuals with non-small cell lung cancer (NSCLC), prostate cancer, colorectal cancer, and endometrial cancer. Examining feasibility allows researchers to establish optimal study design and operational processes (Gardner et al., 2003; Thabane et al., 2010). The intervention group participated in a community-based individualized NPW program, while the control group continued their usual daily routine.

3.2 Participants

3.2.1 Eligibility Criteria

Inclusion criteria were: 1) a primary diagnosis (including a cancer reoccurrence) of histologically confirmed stage I-IV NSCLC, prostate cancer*, colorectal cancer*, or endometrial cancer* (with any concurrent cancer treatment) (*Note: These types of cancer were included later as a result of difficulty recruiting individuals with NSCLC.); 2) over the age of 55 years; 3) able to communicate in English; 4) diagnosed or treated for cancer within the last three years; 5) approval by the primary treating physician to participate in an exercise program; and 6) the capacity to consent as judged by the researchers (e.g., cognitive impairment). Participants were excluded if they had been using Nordic walking poles on a regular basis within the last six-months.

Ethical approval was obtained from the University of Ontario Institute of Technology and both community-based hospitals involved in the study. All participants provided written consent to take part in the study prior to their initial assessments.

3.2.2 Recruitment

Researchers used several strategies to recruit participants over eight-months including: 1) recruiting participants from community-based hospitals; 2) displaying posters in various locations; 3) posting information on social media websites; 4) attending cancer support group meetings; and 5) promoting snowball referrals from clinician experts and participants.

1) Hospital Recruitment: Recruitment took place at two community-based hospital sites in the Greater Toronto Area (GTA) where potential study participants with NSCLC were screened and introduced to the study by the primary treating physician and/or the oncology nurses during their clinic visits. Potential participants were provided with a study information page to read on their own time (Appendix A). At Community Hospital 1, interested potential participants were asked to directly contact researchers. At Community Hospital 2, interested potential participants provided consent to the nurses to release their contact information to the research team. The name and contact information of potential participants were then forwarded to the research team who contacted them to obtain informed consent.

2) Posters: Posters informing potential participants about the study were displayed at various community-based cancer centres and clinics including Wellspring Cancer Support Centres and the Hearth Place Cancer Support Centre as well as at the recreational facilities

where the NPW intervention took place (Appendix B). Interested participants were provided contact information to inquire further about the study.

3) Social Media: Social media was used as a recruitment tool to reach out to the lung cancer community. Messages and information were intended for clinician experts, professional societies, and patient advocacy groups to make them aware of the study. The Twitter account for the study was @NPWlungcancer and the Facebook account was https://www.facebook.com/NPWlungcancer/?ref=aymt_homepage_panel.

4) Cancer Support Groups: Researchers spoke directly to individuals with colorectal cancer about the study at support group meetings and worked with both the colorectal cancer and prostate cancer support group leaders to send out emails with information about the study to individuals who attended these support groups.

5) Snowball Referrals from Clinician Experts and Participants: Clinician experts across the country who regularly provided care for individuals with cancer or instructed NPW were informed about the study by email. This included: oncology surgeons, physiotherapists, kinesiologists, and massage therapists. An article (Cunningham, 2016) describing the importance of exercise in the lung cancer population and providing information about the study was published in the Ontario Respiratory Care Society professional development publication. The purpose of this article was to provide knowledge translation and to assist with snowball sampling. To recruit individuals diagnosed with NSCLC an information session about NPW and the study was held by researchers at a Senior Centre near the Community Hospital 2 during a seniors' lunch.

A sample size calculation was not performed prior to conducting the study because the primary outcome measure of the study was feasibility. Pilot studies are not designed to

determine effect size, but rather to help test and refine the study design (Tappin, 2014). We anticipated enrolling 10 participants per group prior to conducting the study. Suggested sample sizes for pilot studies are 10% of the sample expected for the larger study or 10 to 30 participants (Tappin, 2014). The sample sizes of pilot studies are not easy to determine because these studies are influenced by many unpredictable factors. It is important to have a large enough sample to thoroughly examine the study methodology (Tappin, 2014).

3.2.3 Randomization

Block randomization (block size of 4) of intervention and control groups was computer generated (Sealed Envelope Ltd., 2015) and administered by a person who was at arm's length from the study. The person who coordinated the randomization process was not involved in the screening process or outcome assessments. Allocation was concealed by placing the assignment within aluminum foil, and then in opaque envelopes. Study participants opened the allocation envelope after consenting to the study and upon completion of the initial assessment. Since this was an exercise intervention, it was not possible to blind the intervention from participants and the assessors.

3.3 Study Procedures

The flow of study procedures is detailed in Figure 3. During the study, participants had a baseline assessment, an eight-week NPW or control period, and then a follow-up assessment within two weeks of completing the intervention or control period. Participants who were in the intervention group were given the option to have weekly follow-up phone calls or emails for added support and encouragement during the NPW program. When

participants completed the NPW program, they were asked to complete the program evaluation survey (Appendix C).

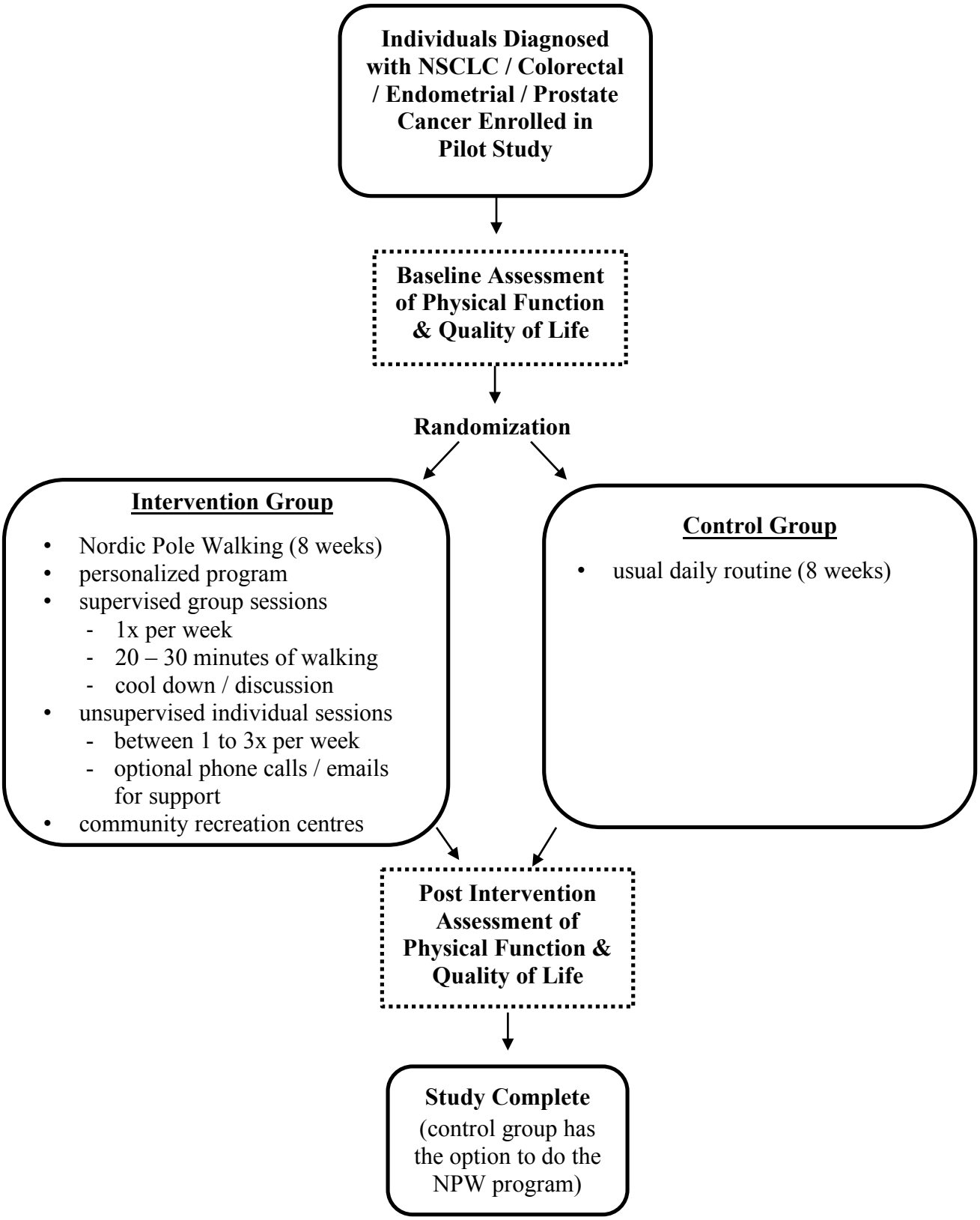

Figure 3. A detailed layout of the randomized controlled pilot study procedures.

3.3.1 Feasibility Analysis

The framework proposed by Thabane et al. (2010) was used to assess the study's design, operation, and feasibility. The framework employs four criteria: "Process" (assesses the feasibility of the processes that are critical to the success of the study); "Resources" (assesses time and resource problems that can occur during the study); "Management" (assesses potential human and data management problems); and "Scientific" (assesses treatment safety, dose response, effect, and variance of the effect). Within each category the following was examined, considered, and monitored:

1) recruitment, consent, and randomization procedures;
2) sample size required for a full study;
3) inclusion/exclusion process;
4) appropriateness of assessment tools used in the study;
5) appropriate timing of data collection;
6) suitability of data collection materials;
7) operational processes; and
8) protocols for NPW exercise prescription.

Table 3 describes in detail each feasibility objective, measure, and respective outcomes. Notes regarding the study process were routinely recorded throughout the pilot study.

Table 3. *Feasibility Objectives, Measures and Outcomes*

Objective	Measures	Outcomes
Process Assesses the feasibility of the processes that are critical to the success of the study.	1. Recruitment rate 2. Are the inclusion and exclusion criteria appropriate (too limited or too broad)? 3. Were there any complications with recruitment? 4. Which stage (I-IV) of cancer patients was best to include in this study? 5. Which cancer treatments (surgery, chemotherapy, radiation, and other drug therapy treatments) are most appropriate for study patients to be receiving? 6. How appropriate were recruitment procedures?	1. Recruitment rate tracked on call tracking sheet (Appendix D) 2. Review of call tracking sheet (Appendix D) to see who was considered for study (limited – there were a significant # of people considered, but not enrolled; broad - everyone considered was enrolled, some of these people may have had difficulty completing the NPW program) 3. Field notes – documented challenges during recruitment 4. Adherence rate, reasons for not enrolling in or withdrawing from the study 5. Adherence rate, reasons for not enrolling in or withdrawing from the study 6. Recruitment rate & field notes - Reflection of overall recruitment process, could any changes be made to improve process?
Resources Assesses time and resource problems that can occur during the study.	7. How did the recruitment procedure impact the hospital staff? 8. Enrolment, adherence, and completion rates 9. What are the reasons for enrolling or not enrolling in the study? 10. What are the reasons for non-adherence to the NPW program? 11. What are the reasons for loss to follow up? 12. Did weekly follow up contact (phone or email) have an effect on adherence? 13. How long did it take to complete the assessments? 14. Were there too few or too many outcome measures? 15. Was the testing equipment readily available when needed?	7. Field notes – any documented comments made by hospital staff or complications with procedures at hospital 8. Attendance records, exercise logs (Appendix E) 9. Call tracking sheet (Appendix D) documents reasons for participation or nonparticipation 10. Exercise log (Appendix E) – patient documents reasons for not adhering to required NPW sessions 11. Attendance records – effort made to find out reasons for loss to follow up 12. Patient follow-up survey (Appendix C) – ask patients if they felt follow up contact was helpful 13. Recorded time of assessment & field notes

Resources (continued)	16. How long did it take to make regular follow up contact via phone or email? 17. How long were the NPW classes? 18. How many participants could participate in one NPW class? 19. Costs for the following: facility rental, Nordic Poles, assessment equipment, administrative tasks (printing), phone bills, miscellaneous	14. Field notes - did patients comment on timing of assessment? - reflection of recorded time 15. Field notes – comments on availability of assessment equipment 16. Follow up contact tracking sheet (Appendix F) - recorded time of follow up 17. Field notes – recorded time of each class – includes set up and take down 18. Attendance sheet & field notes – documentation of number of patients per class, comments regarding class procedures that indicate impact of number of patients per class 19. Expense tracking sheet (Appendix G)
Management Assesses potential human and data management problems.	20. Did the patients understand how to complete the tasks and questionnaires? 21. Were the patients able to complete the assessment tasks and questionnaires? 22. Did the recreational centres do what they committed to doing? 23. Was the partnership with the Nordic pole company effective? 24. Was there appropriate space to perform the assessment and NPW program? 25. Were the research assistants able to assist with the patient assessments and facilitate the NPW program? 26. What other challenges did the research team have? 27. Did participants find the exercise journal helpful? 28. What were the challenges that patients experienced when NPW independently? 29. Were the exercise tracking sheets appropriate? 30. Was there enough room on the data collection sheets?	20. Field notes – reflection on communication of assessment tasks 21. Assessment tracking sheets (Appendix H & I) & field notes – any challenges with completing assessment tasks 22. Field notes – review of relationship with recreation centres – successes or challenges 23. Field notes – review of relationship with Nordic pole company – successes or challenges 24. Field notes – any difficulties that were noted with space allotted for assessment (area, accessibility, noise level etc.) 25. Field notes – discussion with research assistants about their experience & observations made regarding ability to assist with study process 26. Field notes – discussion with research assistants about challenges they faced 27. Patient follow up survey (Appendix C) & field notes – any discussion that was documented on helping participants adhere to and understand the program

Management (continued)		28. Patient follow up survey (Appendix C) & field notes – any discussion that was documented on challenges participants experienced when NPW independently 29. Exercise logs (Appendix E) & patient follow up survey (Appendix C) – were exercise logs filled out correctly 30. Were data collection sheets filled out correctly with sufficient room?
Scientific Assesses treatment safety, dose response, effect, and variance of the effect.	31. Were there any outcome measures that should have been assessed that were not? 32. Did patients find the NPW program too easy or difficult? 33. Was there a training effect? If so, how long did it take for patients to understand how to walk with the poles? 34. How many participants purchased Nordic poles upon completing the study? 35. Was NPW safe?	31. Field notes – were any changes noticed that were not considered? 32. Patient follow up survey (Appendix C), exercise logs (Appendix E), field notes – look at adherence to program, observations made on ability to NPW during class 33. Field notes – observations made of ability to learn NPW during first few weeks of study 34. Patient tracking sheet (Appendix F) – ask participants if they would like to purchase Nordic poles 35. Field notes noting any adverse effects

Following the Thabane et al. (2010) framework for conducting a pilot study, there are four possible outcomes: 1) *stop* – the study is not feasible; 2) *continue, but modify the protocol* – the study is feasible with modifications; 3) *continue without modifications, but monitor closely* – the study is feasible with close monitoring; and 4) *continue without modifications* – the study is feasible as is. Ideally, the specific acceptable outcomes for each of the four criteria should have been identified a priori to determine if the study was feasible or not. Instead, the outcome of the pilot study was determined by analyzing the overall process, resources, management, and scientific outcomes described in Table 3.

Upon study completion, researchers received additional feedback on the main operational processes from research assistants and nurses. In addition to using this framework, participants who completed the NPW program were asked to reflect on their experience and provide feedback by completing a program evaluation survey (Appendix C). The survey included close-ended questions where participants were asked to rate whether they agreed or disagreed with statements about the NPW program and their experience participating on a scale of one (agreed with the statement) to five (disagreed with the statement).

The statements asked participants who completed the NPW program (including those in the control group who completed the program after) to consider the following:

- how easy or difficult it was to participate,
- whether motivation, fatigue, or anxiety made participating in the program challenging,
- how beneficial the program was to them,
- whether they would recommend the program to others with cancer,
- how well they were able to master the technique of NPW and follow the prescribed program,
- how well organized the program was,
- how helpful the instructors were, and
- whether they would be continuing to NPW on their own after the study.

The survey concluded with open-ended questions where participants were asked to provide feedback on what they liked about participating in the NPW program, what challenges they experienced while participating in the NPW program, and how they would improve the

NPW program in the future. Additional space was provided for any other comments or feedback from participants.

3.3.2 NPW Outcome Measures

The NPW assessment measures include: 1) demographic information, health history, and physical attributes; 2) lower body physical function; 3) upper body physical function; and 4) HRQoL.

3.3.2.1 Demographic Information, Health History, and Physical Attributes:

During the baseline assessment, each participant provided demographic information as well as details about their cancer diagnosis and treatment, side effects, general health history, and smoking status. Participation in regular physical activity and exercise is closely related to population mental and physical health (Hills, Street, & Byrne, 2015). As previously mentioned physical activity refers to "any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen et al., 1985, p. 126). Exercise is a type of physical activity that is "planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective" (Caspersen et al., 1985, p. 128). Improving physical activity levels is important in the prevention and management of chronic diseases (Hills et al., 2015). To measure physical activity level (within the last week), participants completed the short form self-administered International Physical Activity Questionnaire (IPAQ) (IPAQ Group, 2004) at baseline and post intervention. The short form IPAQ is used to collect comparable data on health-related physical activity. Questions are asked about walking, moderate-intensity activities, vigorous-intensity activities, and sitting during the following four domains: a) leisure time physical activity; b) domestic and gardening activities; c)

work-related physical activity; and d) transport-related physical activity. Researchers were available to answer any questions from participants about the IPAQ as they completed it. Researchers also documented and described any planned exercise that participants were taking part in at the time of the baseline and final assessments. Resting heart rate and oxygen saturation (Nellcore N-20, probe Durasensor DS-100A) levels were also recorded as part of the baseline and final assessments.

Participants' height, weight, and circumference measurements (bicep, chest, waist, hips, and thigh) were taken at both the baseline and final assessment. Anthropometric measures provide information about the dimensions of bone, muscle, and adipose tissue of participants in the study. Individuals with increased amounts of adipose tissue are at risk for many chronic diseases including hypertension, diabetes, cardiovascular disease, arthritis, and cancer (Canadian Society of Exercise Physiology, 2013; Health Canada, 2003). In Canada, body mass index (BMI) (BMI = weight (kilograms) / height (meters)^2) and waist circumference are used to determine the risk of developing health complications due to being overweight or underweight (Canadian Society of Exercise Physiology, 2013). A BMI of 18.5 to 24.9 is considered normal with the least risk for health complications (Canadian Society of Exercise Physiology, 2013). In comparison, an individual with a BMI of 25.0 to 29.9 is considered overweight and an individual with a BMI of 30 plus is considered obese (Canadian Society of Exercise Physiology, 2013). A higher BMI is associated with increased risk for health complications (Canadian Society of Exercise Physiology, 2013). The Canadian Guidelines indicate that for a person 65 years of age and older the normal range of BMI may be slightly higher (Health Canada, 2003). A waist circumference of 90 centimeters or more in men and 80 centimeters or more in women is

associated with increased risk for diabetes, coronary heart disease, and hypertension (Canadian Society of Exercise Physiology, 2013).

For all anthropometric measurements participants were asked to remove footwear and wear a minimal amount of clothing. Height measurements were taken against the wall, with feet close together. Participants were weighed on an electric scale (Weight Watchers Glass Body Analysis Scale, Conair Consumer Products Inc., Woodbridge, Ontario, Canada). Waist circumference was measured at the highest point of the iliac crest (Canadian Society of Exercise Physiology, 2013). For all other circumference measurements, there are no international standards, but researchers used the same method consistently throughout the study. Bicep circumference was measured with the participants' arms at their side and the measurement was taken at the midway point between the acromion process and the olecranon process (Wood, 2001a). Chest circumference was measured at the fullest part of the participant's bust, under the axilla with arms relaxed at their sides (Wood, 2001b). Hip circumference was measured around the maximum posterior extension of the buttocks (Wood, 2001c). Thigh circumference was measured with the participant's weight evenly distributed between both feet and the measurement was taken midway between the inguinal crease and the patella (Wood, 2001d).

3.3.2.2 Lower Body Physical Function:

Lower body physical function was measured during the baseline and final assessment using the six-minute walk test (6MWT) (American Thoracic Society, 2002) and the 30-second (30-s) chair stand test (C. J. Jones, Rikli, & Beam, 1999). The 6MWT has been recognized as a valid measure of submaximal functional capacity in those with

pulmonary disease and cancer (American Thoracic Society, 2002; Schmidt, Vogt, Thiel, Jager, & Banzer, 2013). This self-paced test assesses aerobic fitness by measuring the distance that an individual can walk over a 25 or 30 metre track in six minutes (American Thoracic Society, 2002). Granger, Holland, Gordon, and Denehy (2015) estimated the minimal clinical important difference (MCID) for deterioration of the 6MWT in lung cancer patients to be between 22 meters and 42 meters or a change of 9.5%. Having a greater 6MWT distance was correlated with better function, increased physical activity, and decreased dyspnea (Granger et al., 2015).

The 30-s chair stand test is a valid indication of lower body strength in the older adult population (C. J. Jones et al., 1999). The test requires participants to complete as many sit to stands as possible in 30 seconds (C. J. Jones et al., 1999). The MCID for the 30-s chair stand test in the cancer population has not been determined; however, there are MCID values for individuals with hip osteoarthritis (MCID within patient: 2.6 repetitions; MCID between patient: 2.1, p=0.06) (Wright, Cook, Baxter, Dockerty, & Abbott, 2011).

3.3.2.3 Upper Body Physical Function:

Upper body physical function was measured during the baseline and final assessments with the Unsupported Upper Limb Exercise Test (UULEX) (Janaudis-Ferreira, Hill, Goldstein, Wadell, & Brooks, 2013; Takahashi, Jenkins, Strauss, Watson, & Lake, 2003) and the hand grip strength test (Kilgour et al., 2013; Navigante et al., 2013). The UULEX is a valid incremental test that has been used to measure peak unsupported arm exercise capacity in the chronic lung disease population (Janaudis-Ferreira et al., 2013; Takahashi et al., 2003). It has not currently been used in the cancer population. The test requires the seated participant to lift a bar (0.2 kg) through eight levels at a constant cadence

of 30 beats per minute as directed by a metronome. The test begins with a two-minute warm up where the participant moves the bar extending their arms from neutral to the first level. After the warm up the participant lifts the bar to the next higher level for one minute. This progression continues every minute until the maximum height is reached. At this time, the weight of the bar is increased by 0.5 kg every minute to a maximum weight of 2.0 kg. The test continues until the participant experiences fatigue and decides to stop. Normative values for the UULEX in the healthy Canadian population were established by Lima et al. (2017) and compared to the study population.

Handgrip strength is correlated with survival, weight loss, sarcopenia, and HRQoL characteristics in advanced cancer patients (Kilgour et al., 2013; Navigante et al., 2013). Individuals were seated holding the dynamometer (Jamar® Hydraulic Hand Dynanometer, Patterson Medical Supply Inc, Mississauga, Ontario, Canada) in one hand with their shoulder adducted, elbow flexed 90 degrees, and their forearm in neutral (Rehabilitation Measures Database, 2014). Three successive trials for both hands were recorded and the maximum grip strength was determined by averaging these three trials for each hand (Rehabilitation Measures Database, 2014). The MCID for grip strength in the cancer population has not been established, however the MCID for grip strength has been identified for individuals who have had a stroke (MCID: 5.0 kg and 6.2 kg for affected dominant and non-dominant sides) (Lang, Edwards, Birkenmeier, & Dromerick, 2008).

3.3.2.4 Health-Related Quality of Life:

The HRQoL of participants was assessed using the 36-Item Short Form Health (SF-36) questionnaire (Ware & Sherbourne, 1992) during the baseline and final assessments. The SF-36 has been validated and used extensively as a measure of HRQoL (Ware &

Sherbourne, 1992). It assesses eight health concepts: 1) limitations in physical activities because of health problems; 2) limitations in social activities because of physical or emotional problems; 3) limitations in usual role activities because of physical health problems; 4) bodily pain; 5) general mental health (psychological distress and well-being); 6) limitations in usual role activities because of emotional problems; 7) vitality (energy and fatigue); and 8) general health perceptions. The SF-36 has been used in other studies to examine HRQoL in the cancer population (Brocki et al., 2014; Cormie, Newton, Spry, et al., 2013; Edvardsen et al., 2014; Galvao et al., 2014; Lemonnier et al., 2014; S. W. Park et al., 2012; Stigt et al., 2013; von Gruenigen et al., 2012). Canadian normative data for the SF-36 was established by Hopman et al. (2000) and compared with the study population.

Participants diagnosed with NSCLC also completed the Functional Assessment of Cancer Therapy – Lung (FACT-L) questionnaire (Cella et al., 1995) during the baseline and final assessment. The FACT-L is a valid and reliable measure of HRQoL (Cella et al., 1995). The questionnaire includes four general and one lung cancer symptom-specific domain. The general domains (27 questions) include: physical well-being (PWB), social/family well-being (SWB), emotional well-being (EWB), and functional well-being (FWB). The lung cancer symptom specific (LCS) domain (7 questions) evaluates symptoms that are commonly experienced by lung cancer patients (i.e. shortness of breath, weight loss, and chest tightness). Domain scores are then combined to calculate the Total Outcome Index (TOI) (TOI = PWB + FWB + LCS), Functional Assessment of Cancer Therapy – General (FACT-G) score (FACT G = PWB + SWB + EWB + FWB), and FACT-L score (FACT-L = FACT- G + LCS).

3.3.3 Intervention

The intervention group participated in an eight-week community-based individualized NPW program. An eight-week NPW training period was selected because this was the average training time used in other NPW studies, demonstrating that individuals could experience changes in this amount of time (Fritschi et al., 2012a). Participants were instructed on walking with the poles immediately after their initial assessment and were asked to practice using the poles for one-week prior to starting the program to allow them time to improve their NPW technique. To assist with program adherence, the NPW prescription was individualized to meet needs of each participant as recommended by Bourke et al. (2013). The IPAQ was used as an indicator of each participant's cardiorespiratory fitness since it has been correlated with maximal oxygen uptake (VO_2max) (Schembre & Riebe, 2011). Based on each participant's IPAQ score and their observed ability level during the instruction, participants were categorized to a NPW prescription group. These categories were used as a starting point with adjustments made to the NPW prescription when needed. The NPW prescription groups were categorized as follows:

1) Highly Active Group: Participants assigned to this NPW exercise prescription were categorized as having a 'high' total physical activity IPAQ score. As defined by the IPAQ these participants performed vigorous-intensity physical activity on at least three days achieving a minimum of at least 1500 metabolic equivalents (METS)-minutes/week, or on seven or more days they completed any combination of walking, moderate-intensity, or vigorous-intensity activities achieving a minimum of at least 3000 METS-minute/week (IPAQ Group, 2004).

This exercise prescription began with 30 minutes of walking and progressed at a relatively fast pace to 60 minutes of NPW on the eighth week of the program (Appendix J).

2) Minimally Active Group: Participants assigned to this NPW exercise prescription were categorized being 'minimally active' according to their total physical activity IPAQ score. These participants had: i) three or more days of vigorous physical activity of at least 20 minutes per day, ii) five or more days of moderate-intensity physical activity or walking of at least 30 minutes per day, or iii) five or more days of any combination of walking, moderate-intensity, or vigorous intensity physical activities achieving a minimum of at least 600 METS-minutes/week (IPAQ Group, 2004). This exercise prescription began with 30 minutes of walking and gradually progressed to 35 minutes, 40 minutes and finally 45 minutes of walking (Appendix K).

3) Inactive Group: Participants assigned to this NPW exercise prescription were categorized as being "inactive" according to their total physical activity IPAQ score. This means that these participants either reported no physical activity at all or some physical activity, but not enough to meet the minimally or highly physically active criteria (IPAQ Group, 2004). It was not uncommon for this group of participants to require breaks when walking, especially as the amount of time that they were walking increased. This exercise prescription began with 20 minutes of walking and gradually progressed to 25 minutes and finally 30 minutes

of walking (Appendix L).

Participants were instructed to closely monitor themselves using the Borg Rate of Perceived Exertion (RPE) scale (six to 20, higher number indicating greater exertion) and to maintain exertion to levels that suited their physical capacity (moderate intensity RPE between 12 and 15) (Reed & Pipe, 2016). Throughout the study participants were instructed to follow their specific individualized NPW prescription. To meet the specific needs of each participant, instructors modified the prescribed NPW program as necessary. For example, if a participant began radiation treatment part way through the NPW program and was not capable of completing the same amount of walking time, instructors modified the program to ensure participants were able to continue NPW.

The NPW program consisted of one supervised group NPW session per week held at one of two community recreational centres in the GTA. The group session was supervised by a trained instructor who was certified to teach NPW. NPW instructor training was provided for a research assistant who then assisted with facilitating the NPW program. The training was led by a physiotherapist who provided background information about the benefits of NPW followed by a practical, hands on workshop on instructing the proper NPW technique. During the group sessions at the recreational centres, the instructor corrected technique, monitored participants' progression according to the pre-determined exercise prescription, and addressed any questions or concerns raised by participants. Participants were told to immediately report any abnormal responses that they experienced when exercising to the research team. Additional supports were utilized by participants (such as oxygen, tables, walls, and chairs) when necessary. Throughout the remainder of each week, participants completed up to three independent NPW sessions at home or at the

community recreational centre. Participants were provided with written instructions on how to NPW (Appendix M) and NPW instructors shared their contact information so that participants could ask questions or address concerns when completing the NPW sessions independently.

To promote program adherence, several recommended behavioural change techniques (Bourke et al., 2013) were incorporated into the NPW program. This included goal setting, self-monitoring, practicing, and generalizing behaviour to other non-supervised contexts. Participants were asked to write out their motivation behind taking part in the NPW program and to set exercise related goals prior to beginning the NPW program (Appendix N). Documentation of program adherence is critical to understanding treatment dose (Bourke et al., 2013). Therefore, each time participants completed a NPW session (supervised or at home) they were asked to make an entry in a journal (Appendix E) reporting distance walked, duration, and RPE. On days when participants did not complete a NPW session they were asked to record the reason that they were not able to walk. The research team offered to contact participants weekly by phone or email (according to their preference) to encourage and support participation. At the end of the program participants reflected on the goals they had set to see how close they were to achieving them.

The control group was instructed to continue their usual daily routine (i.e. activities of daily living) for eight-weeks and was provided the opportunity to participate in the same NPW program after this time period. The research team did not contact individuals in the control group during the eight-week period and no data was collected on their daily routine other than the documentation of planned exercise participation that was mentioned earlier.

3.4 Data Analysis

3.4.1 Feasibility

All feasibility outcomes were documented as the study progressed. There was no formal interpretive qualitative analysis done as this was beyond the scope of the study. The research team met periodically to assess the ongoing feasibility of the study and adjustments to the protocol were made as needed. Between meetings if the lead researcher noticed issues with completing the protocol, they would consult with the research team. For example, if there were issues with recruitment, it was brought up with the research team and actions were taken to improve the recruitment rate. At the end of the study, all the documents were summarized and categorized according to the four feasibility criteria (Thabane et al., 2010). Ultimately, the outcome of the pilot study (stop; continue, but modify the protocol; continue without modifications, but monitor closely; or continue without modifications) was based on the judgement of the research team.

3.4.2 NPW Outcomes

Descriptive statistics (mean, median, and standard deviation) were calculated for numeric data. Non-parametric tests were used to compare the intervention and control: a Wilcoxon signed-rank test to see if changes occurred over time, and a Mann-Whitney U test to see if there was a difference between groups (pre, post, and effect sizes). A p-value of less than 0.05 was considered significant. Non-parametric tests were selected for two reasons. First, two assumptions for parametric tests (such as ANOVA) require the data be normally distributed with no significant outliers. It was uncertain if these assumptions were met due to the small sample size. Secondly, non-parametric tests are more conservative

analyses and may detect true differences i.e. result in less Type I error IBM SPSS Version 24 was used for the analysis (IBM Corporation, 2016).

4.0 Results

4.1 Feasibility Analysis

The following is a description of the study design, operation, and feasibility with reference to the four criteria of the Thabane Framework (Process, Resources, Management and Scientific) as described in Section 3.3.1.

4.1.2 Inclusion/Exclusion Criteria

(Objective: Process)

Initially, researchers were only considering individuals diagnosed with non-small cell lung cancer (NSCLC). After four-months the initial recruitment yielded only two participants, and therefore, the research team decided to broaden the inclusion criteria to accept individuals with prostate cancer, colorectal cancer, or endometrial cancer. This change in recruitment criteria did, in fact, facilitate recruitment. After two months, six new participants were enrolled in the study. Alternatively, the study design could have been changed to a pre-post design with the NSCLC population only. However, researchers were not certain an adequate number of patients with NSCLC would be recruited even for this design. Figure 4 provides a more specific timeline of participants' enrollment. The altered inclusion criteria were still discriminative because some individuals were excluded from the study. For example, some individuals were excluded because they had an ineligible type of cancer or their cancer treatment had occurred more than three years ago.

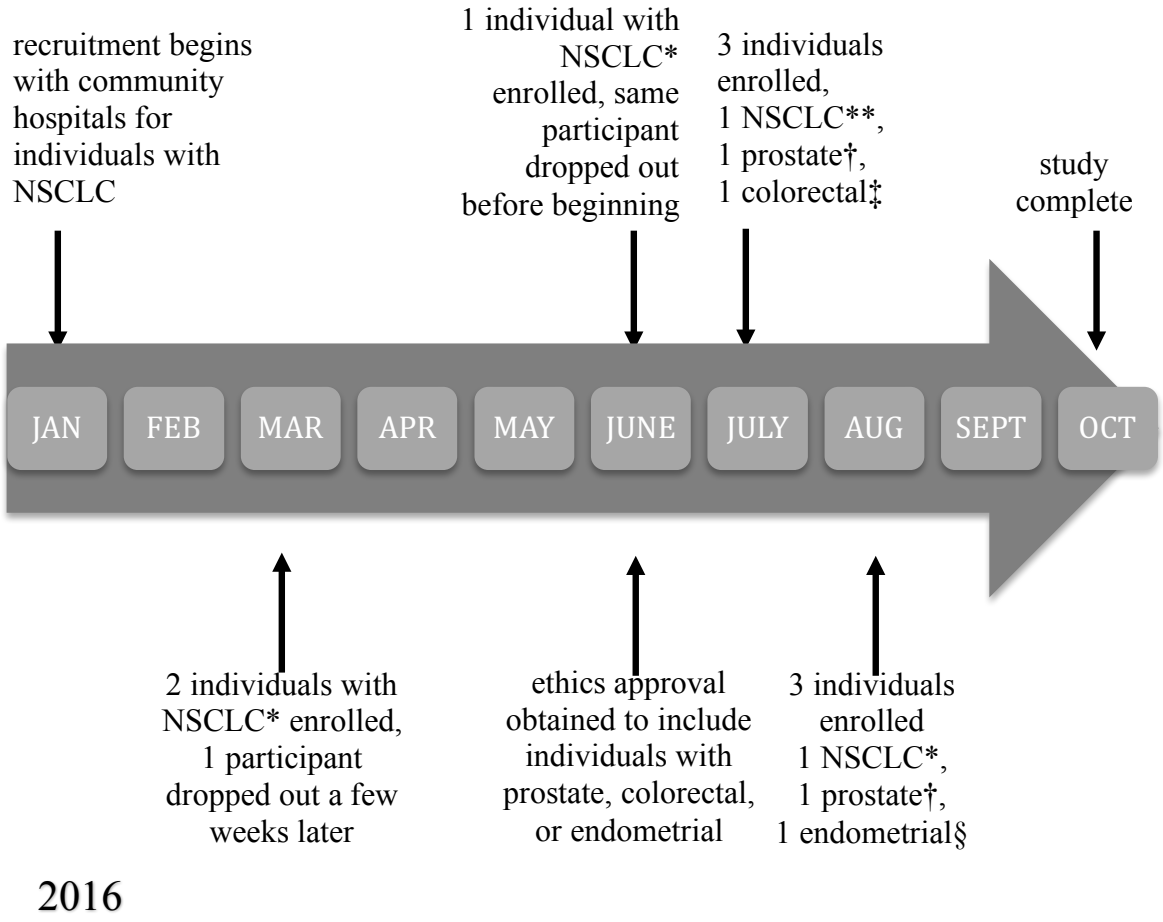

Figure 4. A detailed timeline indicating when recruitment began, when changes were made in inclusion/exclusion criteria and when participants enrolled in the study. *Note:* *recruited through hospital cancer centre, **recruited through word of mouth, † recruited through support group email, ‡ recruited through support group meeting, § recruited through poster displayed at cancer support centre

4.1.3 Recruitment Rate

(Objectives: Process and Resources)

Due to time constraints, we were not able to reach the projected sample size of 20 participants. A total of 18 potential participants were contacted about the study and of those, two individuals did not meet the eligibility criteria. One individual had been diagnosed with prostate cancer more than three years ago and the other was diagnosed with breast cancer. Seven others declined participation. This resulted in a 50% recruitment rate

(n=9). Reasons for declining participation included having a busy schedule, already participating in other physical activities, travelling for an extended period of time, and living too far away from the location where the study was taking place. See Figure 5 for a detailed flow diagram of participants through the study.

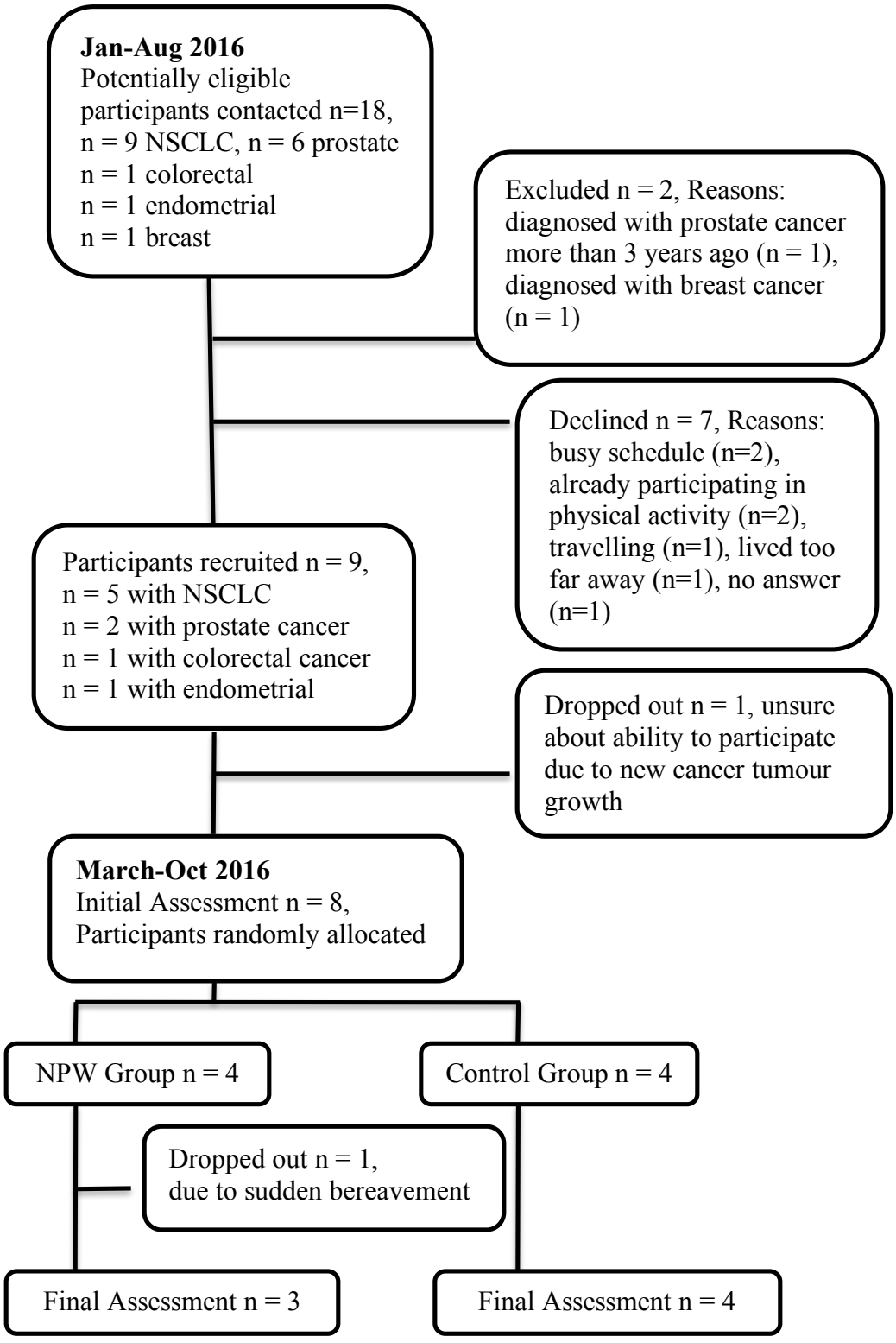

Figure 5. A flow diagram of participants through the pilot study from first contact to final assessment.
Note: The recruitment rate is 50% and the completion rate is 77.78%.

4.1.4 Recruitment Procedures

(Objective: Process)

Recruitment of individuals with NSCLC was considerably more challenging than expected. In the GTA, there are very few (if any) support groups and rehabilitation programs for individuals coping with lung cancer. This may be due to a poor prognosis since most individuals are not diagnosed until the later stages of the disease when they may not be well enough to participate. Thus, researchers had to rely heavily on recruitment at both hospital sites and could not be actively involved in the day-to-day recruitment procedures.

Once researchers obtained approval from the Research and Ethics Board to begin recruiting individuals with prostate cancer, colorectal cancer, or endometrial cancer (in June), recruitment was more successful. Researchers were able to contact patients who had been diagnosed with prostate cancer or colorectal cancer through support groups. Also, patients with these types of cancer were more likely to attend programming at the cancer support centres.

Table 4 provides information about recruitment method success rates. The process for each recruitment method is then discussed in detail.

Table 4. *Recruitment Numbers and Success Rates According to Recruitment Method*

Recruitment Method	Number of Individuals Contacted	Number of Individuals Recruited	Recruitment Success Rate (%)
Hospital	7	4	57
Posters	3	1	33
Social Media	0	0	0
Support Groups	7	3	43
Snowball Referrals	1	1	100

4.1.4.1 Hospital Recruitment

At the Community Hospital 1, no participants were recruited for the pilot study and in fact, no inquiries were received from Community Hospital 1 patients. Initially, physicians at the Community Hospital 1 Cancer Centre were informed about the pilot study during a presentation at the monthly lung rounds. During this first meeting the physicians asked questions, provided feedback, and agreed to assist with recruitment, indicating that recruiting participants with NSCLC for the study should be easy. Unfortunately, from the time of the preliminary discussion with the physicians, to the submission and approval of the Research and Ethics Board application, research personnel in the hospital changed and this negatively affected the recruitment process. During preliminary talks, hospital staff agreed that researchers were welcome to be on site at the hospital to recruit patients. However, with staff changes, the final recruitment process that was agreed upon relied on a team of approximately 15 nurses to inform and recruit potential study participants with NSCLC. After receiving the information, it then became the responsibility of the individuals who were interested to contact researchers. This did not allow researchers to develop any rapport with the patients or staff. Moreover, a hospital research staff member mentioned that Community Hospital 1 undertakes multiple randomized controlled drug trials and that this "competition" may have contributed to poor recruitment. Finally, no one at the Community Hospital 1 site served to champion the recruitment process, and therefore, the study was not the focus of nurses and physicians during their daily activities.

At the Community Hospital 2 participant recruitment was more successful. Four of the five individuals with NSCLC were recruited from the Community Hospital 2. One individual with NSCLC heard about the study by word of mouth. Although researchers

were not on site to recruit participants, a medical oncologist, and two nurses championed the study. They were enthusiastic about the research, and communicated consistently with researchers. Once the study was complete, researchers discussed the recruitment process with the nurses to obtain feedback. Overall the nurses felt that recruitment minimally impacted their daily work routine. They mentioned the importance of having the study information sheet visible so that they were reminded regularly of the study. The biggest recruitment challenge mentioned was the timing of providing the NPW study information to the patients. Many patients are overwhelmed as they are coping with a new cancer diagnosis, multiple medical appointments, new treatment, and not knowing what side effects they may experience due to the cancer or treatment. For this reason, the nurses discussed the study during the initial appointment and then approached the patients again about the study a few weeks later.

4.1.4.2 Posters

The posters displayed at community recreation centres and cancer support centres were somewhat successful in recruiting individuals for the study. Only one potential participant with NSCLC heard about the study from a poster displayed at a cancer support facility in Ottawa. Unfortunately, because of the travel distance to the GTA this individual declined participation. Another individual who was diagnosed with endometrial cancer was successfully recruited after seeing a poster that was displayed at the Wellspring Cancer Centre in Toronto. Program organizers at the various centres disclosed that individuals with NSCLC do not often participate in their programs and therefore, it is unlikely that they would have seen the posters.

4.1.4.3 Social Media Recruitment

Social media was used to reach out to individuals within the NSCLC community, including clinician experts, professional societies, and patient advocacy groups. The inability of researchers to create an online presence resulted in poor recruitment through social media. Information that was tweeted out at regular intervals did not get retweeted by key organizations or people. Even though individuals who have NSCLC are not likely to be on social media, it was hoped that the health professionals, care givers, friends, and family of these individuals would see the posts.

4.1.4.4 Cancer Support Groups Recruitment

Individuals with prostate cancer were recruited through two support groups (one in York Region, one in Durham Region). These groups usually meet face-to-face once a month, except during the summer (when the intervention took place). Instead, researchers emailed information about the study to members of the support groups. Six potential participants with prostate cancer contacted researchers and two of these individuals enrolled in the study.

The NPW study was presented in person to the colorectal cancer support group in the Durham region. Four members of the support group attended the meeting and one individual was recruited. Attendance at the meeting was low because it was held during the summer months.

No support groups or rehabilitation programs could be located for individuals with NSCLC or endometrial cancer.

4.1.4.5 Snowball Referrals Recruitment

An article (Cunningham, 2016) about the study that was published in the professional development publication for Ontario Respiratory Care Society yielded no referrals. Neither did the emails that were sent to oncology surgeons, physiotherapists, kinesiologists, and massage therapists within the cancer care community.

We provided information about the study to seniors within the community, but were unsuccessful in recruiting individuals with NSCLC. Most seniors within the community did not know of anyone with lung cancer, and those who did know someone with lung cancer were uncomfortable with sharing the information about the study with that person because they believed them to be incapable of participating in a walking program.

One person who found out about the study through word of mouth referred a friend who had lung cancer to the study. The referrer had more knowledge about the importance of exercise to individuals with cancer compared to the general public and also had hands on experience using the Nordic walking poles.

One study participant with NSCLC mentioned having a friend with lung cancer who might be eligible to participate in the study. However, this participant felt uncomfortable mentioning the study to her friend because she felt that her friend was experiencing worse symptoms than herself, making her friend unable to participate.

4.1.5 Attrition

(Objectives: Process and Resources)

Two participants withdrew from of the study. One did so before the initial assessment because she was unsure of her ability to participate after having been informed of new cancer tumour growth. Another person who was randomly allocated to the NPW

group withdrew after the second week of participating in the intervention due to sudden bereavement.

4.1.6 Participant Characteristics

(Objectives: Process)

The average age of participants (n=8) who enrolled in the study was 67 years of age (standard deviation (SD) 5.8). The youngest was 59 years old and the oldest was 75 years old. Four participants were diagnosed with NSCLC, two were diagnosed with prostate cancer, one was diagnosed with colorectal cancer and one was diagnosed with endometrial cancer. Participants had been diagnosed with cancer on average 27.4 months prior to our initial assessment (range 3.8 to 43.1 months).

Seventy-five percent (6 of 8) of the participants in the study were female, half of the sample lived alone, and 37.5% of the sample were widowed. None of the participants smoked at the time of the study, but 75% of them had previously smoked. The average (SD) duration of smoking for former smokers was 31.3 (19.9) years and they had quit 16.2 (15.1) years ago. There were no statistical differences in baseline characteristics between the two groups. See Table 5 and 6 for additional information.

Table 5. *Participant's Baseline Demographics, Cancer Diagnosis, Treatment, and Smoking Status*

Variable		NPW N = 4 (%)	Control N = 4 (%)	Total N = 8 (%)
Females		2 (25)	4 (50)	6 (75)
Males		2 (25)	0 (0)	2 (25)
Living Arrangement	Lives Alone	3 (37.5)	1 (12.5)	4 (50)
	Lives with Spouse / Partner	1 (12.5)	2 (25)	3 (37.5)
	Lives with Sister	0 (0)	1 (12.5)	1 (12.5)
Marital Status	Married / Common Law	0 (0)	1 (12.5)	1 (12.5)
	Never Married	0 (0)	2 (25)	2 (25)
	Divorced / Separated	2 (25)	0 (0)	2 (25)
	Widowed	2 (25)	1 (12.5)	27.5
Education	High School or Less	2 (25)	0 (0)	2 (25)
	Any Vocation / College	1 (12.5)	2 (25)	3 (37.5)
	Any University	1 (12.5)	2 (25)	3 (37.5)
Employment	Retired	3 (37.5)	2 (25)	62.5
	Full-time	0 (0)	2 (25)	2 (25)
	Part-time / Casual	1 (12.5)	0 (0)	1 (12.5)
Household Income	$25,000 to $45,000	1 (12.5)	1 (12.5)	2 (25)
	$45,001 to $65,000	1 (12.5)	1 (12.5)	2 (25)
	More than, or equal to $65,001	2 (25)	1 (12.5)	3 (37.5)
	Did Not Answer	0 (0)	1 (12.5)	1 (12.5)
Type of Cancer	Lung	2 (25)	2 (25)	4 (50)
	Prostate	2 (25)	0 (0)	2 (25)
	Colorectal	0 (0)	1 (12.5)	1 (12.5)
	Uterine	0 (0)	1 (12.5)	1 (12.5)
Stage of Cancer	1b	0 (0)	1 (12.5)	1 (12.5)
	2a	0 (0)	1 (12.5)	1 (12.5)
	2b	2 (25)	0 (0)	2 (25)
	3a	0 (0)	2 (25)	2 (25)
	Prostate*	2 (25)	0 (0)	2 (25)
Type of Treatment	Surgery	1 (12.5)	3 (37.5)	4 (50)
	Radiation	3 (37.5)	3 (37.5)	6 (75)
	Chemotherapy	2 (25)	3 (37.5)	5 (62.5)
	Brachytherapy	1 (12.5)	0 (0)	1 (12.5)
	No Treatment	1 (12.5)	0 (0)	1 (12.5)

Currently Smoke	Yes	0 (0)	0 (0)	0 (0)
Previously Smoked	Yes	4 (50)	2 (25)	6 (75)

*Note: Prostate cancer is graded differently than the other types of cancer. Doctors grade prostate cancer using the General Grading System or the Gleason Grading System. Participants in this study with prostate cancer were unsure of the grade of their cancer.

Table 6. *Participant Smoking Statistics*

Variable	NPW N = 4 Mean ± SD	Control N = 4 Mean ± SD	Total N = 8 Mean ± SD
Number of Years of Smoking	31.3 ± 15.0	31.3 ± 26.5	31.3 ± 19.9
Number of Years Since Quitting Smoking	18.7 ± 19.5	12.5 ± 10.6	16.2 ± 15.1

All participants who received cancer related treatment experienced some side effects including: metastasis (1 of 8), lack of energy (1 of 8), fatigue (1 of 8), weakness (2 of 8), pain (2 of 8), bruising easily (1 of 8), decreased bone density (1 of 8), difficulty coughing (1 of 8), increased coughing (1 of 8), dyspnea (3 of 8), constipation (1 of 8), urinary retention (1 of 8), headaches (1 of 8), neuropathy (1 of 8), and ear blockage (1 of 8). Participants were also diagnosed with the following chronic health conditions: another type of cancer (2 of 8), food allergies (2 of 8), other allergies (4 of 8), asthma (2 of 8), arthritis or rheumatism (4 of 8), back problems (not arthritis or rheumatism) (4 of 8), high blood pressure (3 of 8), chronic bronchitis (1 of 8), chronic obstructive pulmonary disease (COPD) (2 of 8), diabetes (1 of 8), cataracts (3 of 8), glaucoma (1 of 8), multiple chemical sensitivities (1 of 8), dyslexia (1 of 8), heart murmur (1 of 8), and osteopenia (1 of 8).

4.1.7 Location of Study

(Objective: Management)

Both the Community Recreation Centres were easily accessible for study participants and the staff at both centres were very friendly, accommodating, and easy to

communicate with on multiple occasions. At Community Recreation Centre 1, the atrium was used to conduct assessments. The atrium had plenty of space, was fairly quiet, and there was a reasonable amount of privacy for the participants. At Community Recreation Centre 2 the space that was originally agreed upon for the assessment was no longer available due to renovations being done. Facility staff were very accommodating and arrangements were made to use the hall space near the information desk. For the 6MWT this space was not ideal because participants had to walk in the hallway that was also being used by people who were coming and going from the facility. Also, the area was fairly noisy and it lacked privacy.

The NPW program at Community Recreation Centre 1 was conducted on a large, spacious track. Participants had enough space to walk beside someone else who was NPW and there was plenty of space off to the side of the track to do other necessary tasks such as sit and rest, do stretches, fill out paper work, and have discussions with participants. At Community Recreation Centre 2 the NPW program took place on a small track. The space worked, but participants were not able to walk beside someone else who was NPW and there was limited space off to the side of the track. Seating was limited so that during busy times participants had to wait for a seat to take a rest and at the end of the NPW session participants left the track area to go to a downstairs hallway to fill out their paper work and have any necessary discussions. Both facilities possessed sufficient outdoor space for walking (e.g. sidewalks in neighborhoods and trails in parks). For individuals with lung cancer the indoor facilities were ideal as walking outside makes breathing difficult especially during the very hot or cold weather.

To facilitate study participation, researchers went to the homes of some participants (n=2) who were located further from the recreational facilities. Assessments at home were easily conducted and as long as the weather was fair and conditions were safe, participants agreed to do the 6MWT outdoors. These participants were comfortable with NPW outdoors. Home visits were essential, since weekly supervision was not feasible and participants lived quite a distance from the track at the recreational facilities.

4.1.8 Study Expenditures

(Objectives: Resources)

The total cost of conducting the study from January to October 2016 was $3023.73. Researchers benefited from the donation of 15 poles by Nordixx Pole Walking Incorporated and from the discounted fees for passes at the community recreation centres. The initial cost for beginning to NPW is approximately $124.04 (Nordixx Walking Poles: $79.04, Private Instruction: $40.00, Walking Pass: $5.00). Continued costs range from approximately $5.00 daily for a walking pass to $15.00 per class to attend group programing. For a detailed breakdown of the cost of conducting the study refer to Table 7.

Table 7. *Study Expense Report*

ITEM	COUNT	COST
Community Recreation Centre 1 Passes (booklet)	100	$66.67
Community Recreation Centre 2 Passes (booklet)	100	$500.00
Printing (posters, information sheets, assessment documents)	120	$90.00
NPW Instructor Training	2	$250.00
Poster and Information Sheet Stands	6	$40.00
Duotangs	6	$12.00
Dynamometer	1	$350.00
Measuring Tape	1	$16.00
Flexible Measuring Tape	2	$10.00
Oxygen Saturation & Heart Rate Monitor	1	$25.00
Digital Body Weight Scale	1	$20.00
Plastic Stool	1	$25.00
Pylons	12	$13.50
Painters Tape	1	$19.50
Masking Tape	1	$3.00
Wooden Dowels (materials for UULEX weighted bar)	5	$25.00
Foam Core Board (materials for UULEX wall-mounted board)	2	$13.56
Lentils (materials for UULEX weighted bar)	1	$2.00
Duct Tape (materials for UULEX wall-mounted board)	1	$7.00
Stop Watch	1	$30.00
Clipboard	1	$7.00
Mileage (50 cents per kilometre)	599 km	$299.50
	TOTAL	**$1,824.73**
TASK	**HOURS**	**COST**
Data Collection	22.5	$495.00
NPW Classes	32	$704.00
	TOTAL	**$1,199.00**
	GRAND TOTAL	**$3,023.73**

4.1.9 Exercise Adherence

(Objectives: Process, Resources and Scientific)

Due to small sample size, it is not possible to determine if NPW was more suitable for patients at a particular cancer stage or treatment. One participant with prostate cancer had brachytherapy treatment just prior to enrolling in the study, and then had radiation

treatment while participating in the NPW program. This participant mentioned the radiation treatment caused him to have problems with his bowels preventing him from NPW on some days when he had planned to walk. Despite this, he was able to adhere to the program by altering which days he completed the independent NPW sessions. Another participant in the control group was undergoing chemotherapy treatment for NSCLC while enrolled in the study. This participant was still able to complete the baseline and final assessments without difficulty.

There was 100% adherence to the weekly supervised NPW sessions (for the intervention participants who completed the study; n=2 with prostate cancer, n=1 with NSCLC). Sessions were scheduled in advance and at a time that was convenient for the participant. The two individuals with prostate cancer walked an average of 4 times a week (once with NPW instructor, 3 times independently). The participant with NSCLC walked an average of twice a week (once with NPW instructor, once independently). Participants with prostate cancer were able to walk outside on their own whereas those with NSCLC walked at the community centre since breathing outside was often difficult. Walking on a level surface and having a place to sit when necessary also made walking more feasible for the individual with NSCLC. Two participants in the study experienced low back pain that was likely not related to the NPW. The instructors helped them to manage the pain with stretches and if the pain was great enough to prevent them from walking one day then these participants rescheduled their independent walk for another day.

Individuals who had weekly supervised NPW sessions preferred not to have follow-up phone calls or email contact. Having weekly contact with the NPW instructor was enough to keep participants motivated to walk regularly, though with a larger group,

weekly follow-up may be more important, since instructors would have less time with each individual participant during sessions. Instructors reminded participants of their motivation for taking part in the program and the goals that they had set before starting. Participants decided to take part in the NPW program to improve breathing (n=1), to improve endurance (n = 1), to lose weight (n = 1), to feel better (n = 1), to improve overall fitness level (n = 1), to help with prevention of cancer growth (n = 1), and to return fitness levels to what they once were (n = 1). In the post-program survey one participant stated, "It (the program) was long enough to teach me a new habit of NPW daily." This demonstrates that participating in the NPW program helped individuals incorporate regular exercise into their daily routine. After being in the control group, all participants took advantage of the opportunity to participate in the NPW program. Those who could not attend weekly supervised NPW sessions did rely on weekly contact with instructors by phone or email. Of the eight program participants (individuals in the NPW group and individuals in the control group who decided to do the NPW afterwards) six purchased a set of Nordic poles with the intention of continuing to walk independently.

4.1.10 Safety

(Objectives: Management and Scientific)

No adverse events occurred during the study. However, one individual in the control group and two in the NPW program did report pain during the study. They indicated that the pain experienced was not a result of their participation. The individual in the control group had chronic low back and hip pain, nevertheless she was still able to complete the assessment tasks without difficulty. One individual in the NPW group injured his low back when shoveling and lifting dirt and another in the NPW group had chronic low back pain

that he had been managing over a number of years. Regardless, both NPW participants were able to continue walking and if their back pain worsened, the NPW instructors guided them on technique and appropriate stretches.

4.1.11 Intervention Evaluation

(Objectives: Resources, Management and Scientific)

Nordic pole walking classes ranged from 20 to 70 minutes long with five to ten minutes of stretching upon completion. There was no set up or take down involved. Researchers took five to ten minutes at the end of each class to review participants' progress and ensure they had a plan to complete their independent NPW sessions for the week.

The NPW program was individualized to meet the needs of each participant so all participants were able to adhere to their program regardless of any cancer or treatment related side effects that they might have experienced. NPW instructors adjusted the prescribed NPW plan as needed. Both participants with prostate cancer were prescribed the 'Highly Active' NPW program and both participants with NSCLC were prescribed the 'Inactive' NPW program. Researchers successfully determined participants' NPW prescription based on their IPAQ score and observed ability level. The 6MWT could have been used to determine overall fitness instead of the IPAQ; however, the IPAQ is practical and easy to conduct without the need for equipment or a 30-metre space. The IPAQ was also selected as an indicator of functional ability and fitness because of its capacity to measure overall daily activities based on real world conditions (effectiveness) compared to the 6MWT which is a clinical measure.

The individuals with prostate cancer did have an easier time with NPW compared to participants with NSCLC because their general fitness level was higher. The main challenge for the participants with NSCLC was managing their breathing. Over the course of eight-week NPW program individuals were not walking faster, but their overall endurance throughout the session was improved. For example, one participant with NSCLC began week one with 20 minutes of NPW taking a break every 5 minutes and by the end of the eight-week program this participant was able to walk for 30 minutes without resting.

Researchers observed that there is a training effect when learning to NPW for the first time, making it essential to provide participants with a week to practice walking with the poles prior to starting the study. Most participants were surprised by the concentration required to maintain proper technique in the beginning. A participant commented that they found it "challenging to learn the NPW technique because they had walked with the poles a few years ago using the incorrect technique." Also, throughout the eight-week program NPW instructors continued to focus on ensuring the participants maintained proper walking technique. This was critical since the fatigue that results from longer periods of walking often compromises proper technique.

The research assistant understood the NPW technique after training, but he did not feel that he had completely mastered it. After shadowing researchers during the first NPW sessions the research assistant became more comfortable with instruction and was able to hold classes on his own. The research assistant commented that more training on how to correct an individual's gait patterns would have been helpful.

4.1.12 Assessment Procedures & Equipment

(Objectives: Resources and Management)

Assessments took on average one and a half to two hours to complete. This was longer than researchers expected, but the extended time doing assessments enabled us to develop rapport and give support to participants as they shared their experience of being diagnosed with and treated for cancer. Participants with more aggressive forms of cancer took more time during the assessment to elaborate on their story. Some participants considered the baseline assessment to be too long, although all participants were able to complete the physical tests and questionnaires and they understood the importance of each test. The final assessment was completed in less time because the demographics questionnaire did not have to be completed and participants were already familiar with the assessment procedure.

Researchers readily obtained the necessary testing equipment prior to conducting the study. For the UULEX a wall-mounted chart and weighted bars (0.2 kilograms (kg), 0.5 kg, 1.0 kg, 1.5 kg, and 2.0 kg) had to be constructed according to the guidelines provided by Takahashi et al. (2003). Building these assessment tools took researchers about three hours. The assessment equipment was easily transported to the location where it was being used and the set up for each assessment took approximately half an hour.

4.1.13 Suitability of Outcome Measures

(Objectives: Scientific)

The upper and lower body physical function assessment tasks were easily explained and completed. One participant with NSCLC did have to stop the UULEX because of underarm pain caused by a scar from lung resection surgery.

Questionnaires were completed by participants with the help of the researcher to ensure that they were completed in a timely manner. When completing the IPAQ some participants had difficulty recalling how much of the time they spent each day doing vigorous or moderate physical activities, walking, and sitting during that week. In addition, the wording of some of the questions in the SF-36 questionnaire required some clarification.

The first participant with NSCLC who completed the FACT-L questionnaire refused to answer the last question about smoking regrets. This participant wrote on the questionnaire, "How insulting! How do you think I feel? If I had the information 40 plus years ago that is available now do you think I would have smoked?" As a result, researchers removed this question from subsequent questionnaires so that other participants would not become upset by it. It is likely this did not affect the results from the questionnaire since this question is not included in the scoring. In addition, the cancer specific aspects of the questionnaire did not pertain to the participants enrolled in the study since the questions related to individuals undergoing chemotherapy or radiation therapy. This is also the reason why other FACT questionnaires were not completed for the other cancer populations in the study.

The changes in the 6MWT was not reflective of improvements that occurred in participants' aerobic fitness. Over the eight-week NPW program, researchers observed that each participant's pace did not change, while their overall endurance during the session improved. By the end of the program one participant with NSCLC who could only walk for five minutes at a time was able to walk for 30 minutes continuously. The scores for the 6MWT did not reflect this improvement in overall endurance.

4.1.14 Data Collection

(Objectives: Management)

Some alterations need to be made to the data collection sheets before a large-scale trial is conducted. These adjustments are required to correct errors that were made during the design of the data collection sheets and to allow for some additional data to be obtained during the assessment. Changes required for the initial and final assessment forms include:

1) Adding a second measurement for biceps (left and right) and thighs (left and right).
2) Adding fatigue and dyspnea measures for before and after both the 6MWT and the UULEX.
3) Providing a space to record the heart rate and oxygen saturation levels after the 6MWT.
4) Removing the second trial time for the UULEX.
5) Providing a space to indicate the highest level that participants can reach for the UULEX.

Participants completed the weekly exercise tracking sheets correctly suggesting that they do not need to be modified. In the post program survey, all participants indicated that the journal was informative and useful. A space could be provided for participants to document challenges that they may have experienced while NPW each day (e.g. shortness of breath, back pain, etc.). This would assist NPW instructors with helping participants overcome these challenges during the program and promoting their success.

4.1.15 Participant Feedback

(Objectives: Management and Scientific)

The participant feedback collected from the post-program survey was generally positive. Participants indicated that they enjoyed the program, that the instructors were

encouraging and supportive throughout, and that they benefited from taking part in the study. One participant stated, “It (NPW) made me want to exercise and gave me more energy.” Another participant remarked, “I believe that in a way it (NPW) changed my life. Now I have an activity which I can continue on a daily basis as long as I am able to. It improved not only the physical side, but most importantly the mental, emotional - my internal side!” Some of the challenges mentioned by participants included overcoming fatigue, managing unrelated pain, learning the NPW technique, and time management. For all a detailed list of responses to the open-ended survey questions see Appendix O.

4.2 NPW Outcome Analysis

4.2.1 Anthropometric Measures

At the baseline assessment half of the participants (n = 4) had a BMI of 25 or higher, classifying them as overweight or obese and at increased risk of developing health complications (Canadian Society of Exercise Physiology, 2013). All of the female participants (n=6) had a waist circumference of 80 centimeters or higher. Having a waist circumference greater than 80 centimeters means these women are at an increased risk for diabetes, coronary heart disease, and hypertension (Canadian Society of Exercise Physiology, 2013). For men, the cut off value for waist circumference is 90 centimeters. One male participant had a waist circumference above this value and the other male participant had a waist circumference below this value (Canadian Society of Exercise Physiology, 2013). The participants that were in the NPW group experienced a significant decrease in thigh circumference measurements from the baseline assessment (Right Thigh: median 49.4 cm (range 8.7); Left Thigh: median 49.0 cm (range 6.0)) to the final

assessment (Right Thigh: median 48.5 cm (range 6.5); Left Thigh: median 46.3 (range 4.0)) ($p<0.05$). No other significant change in body weight, or circumference measurements occurred between the two groups, over the eight-week period. Refer to Table 8 for detailed information about the anthropometric measurements.

Table 8. – *Anthropometric Measures, Heart Rate, and Oxygen Saturation Levels by Group*

	NPW				Control			
	Baseline Assessment		Final Assessment		Baseline Assessment		Final Assessment	
	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)
Height (cm)	170.8 (12.0)	174.5 (26)	-------	-------	160.8 (6.2)	161.8 (14.5)	-------	-------
Weight (kg)	69.1 (8.8)	69.6 (21.6)	74.1 (5.1)	72.8 (10.0)	77.3 (20.2)	70.8 (45.4)	78.0 (20.1)	70.5 (43.6)
BMI	23.9 (4.0)	23.2 (9.1)	25.7 (4.7)	24.9 (9.2)	29.7 (6.1)	28.35 (14.3)	29.0 (5.9)	28.2 (13.6)
Bicep – Right (cm)	29.1 (2.0)	28.8 (4.0)	29.0 (1.3)	29.5 (2.5)	30.6 (2.1)	30.8 (5.0)	31.1 (2.2)	31.8 (5.0)
Bicep – Left (cm)	30.8 (2.5)	30.5 (5.0)	30.0 (2.6)	28.5 (4.5)	31.2 (2.8)	32.5 (5.0)	31.3 (2.6)	31.0 (5.3)
Chest (cm)	98.0 (8.1)	99.3 (17.5)	103.3 (4.7)	105.0 (9.0)	108.1 (15.2)	108.0 (35.5)	108.3 (13.7)	107.3 (31.5)
Waist (cm)	93.0 (9.0)	94.0 (20.0)	99.2 (9.3)	103.5 (17.0)	101.1 (14.6)	98.3 (32.3)	99.5 (13.6)	95.3 (30.5)
Hips (cm)	100.9 (5.2)	99.8 (11.0)	104.0 (8.8)	104.5 (17.5)	111.4 (13.3)	108.5 (31.5)	110.1 (15.3)	105.8 (35.0)
Thigh - Right (cm)	48.1 (3.9)	49.4 (8.7)	48.0* (3.3)	48.5* (6.5)	52.0 (6.8)	49.8 (15.5)	50.6 (7.6)	47.3 (16.0)
Thigh – Left (cm)	49.0 (3.0)	49.0 (6.0)	46.4* (2.0)	46.3* (4.0)	49.8 (0.3)	50.0 (0.5)	47.3 (1.0)	47.0 (2.0)
Resting Heart Rate (bpm)	71.8 (21.3)	69.0 (51.0)	68.00 (11.5)	69.0 (23.0)	67.5 (13.0)	70.0 (30.0)	71.3 (9.7)	70.0 (19.0)
Resting Oxygen Sat (%)	97.0 (0.8)	97.0 (2.0)	95.3 (2.9)	97.0 (5.0)	97.8 (1.0)	97.5 (2.0)	98.0 (1.8)	98.0 (4.0)

*$p<0.05$ significant within group difference between baseline assessment and final assessment

Note: Height was not measured again during the final assessment.

4.2.2 Physical Activity Levels, & Lower Body & Upper Body Physical Function

The total amount of energy expended during walking, moderate-intensity activities and vigorous-intensity activities during the week was calculated based on the self-reported IPAQ questionnaire. The mean (SD) physical activity levels of participants in the NPW group improved, but was not statistically significant (baseline: 2346.0 Met-min/week (2532.6); final: 5051.0 Met-min/week (3455.7)), while the physical activity level of participants in the control group declined (baseline: 4419.0 Met-min/week (4021.9); final: 1743.3 Met-min/week (1987.0)). A significant improvement was found in the 30-s chair stand test ($p<0.05$), but no change occurred in the 6MWT. There was no improvement in upper body physical function (grip strength and UULEX). The mean duration (SD) of the UULEX test in healthy Canadian females age 60 to 69 is 12.54 minutes (2.0) (Lima et al., 2017). In males age 60 to 69 the mean duration (SD) was 13.15 minutes (1.67) (Lima et al., 2017). The mean duration for the UULEX test for participants in this study was close to these norms. No statistical difference between groups was found, but there was a significant trend in the effect sizes (pre-post differences) between the IPAQ for moderate activities (-8.3 (22.5) NPW versus -102.5 (91.8) control, minutes), IPAQ for walking activities (118.3 (106.8) NPW versus -47.5 (37.7) control) and total METS-min/week (1956 (1635) NPW versus -2675.8 (2124.4) control), $p=0.057$. See Table 9 for more detailed information comparing the NPW group to the control group. Refer to Table 10 & 11 for individual physical activity level scores from the IPAQ questionnaire.

Table 9. – *Physical Activity Levels, and Lower Body and Upper Body Physical Function Results*

	NPW (n=3)				Control (n=4)			
	Baseline Assessment		Final Assessment		Baseline Assessment		Final Assessment	
	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)
Metabolic Equivalent (METS) Total Score (Met-min/week)	2346.0 (2532.6)	2193.0 (4800.0)	5051.0 (3455.7)	5919.0 (6746.0)	4419.0 (4021.9)	2692.5 (8505.0)	1743.3 (1987.0)	1064.0 (4251.0)
6MWT Distance (m)	435.9 (169.0)	448.5 (353.3)	512.3 (153.0)	591.0 (273.8)	489.4 (77.1)	464.5 (174.0)	523.6 (46.0)	513.0 (104.3)
6MWT Pre-Fatigue	0.5 (0.5)	0.5 (1.0)	0.2 (0.3)	0 (0.5)	1.3 (1.3)	1.0 (3.0)	2.0 (1.4)	2.5 (3.0)
6MWT Post-Fatigue	0.5 (0)	0.5 (0)	2.2 (2.5)	1.0 (4.5)	2.0 (1.0)	2.0 (2.0)	2.3 (1.5)	3.0 (3.0)
6MWT Pre-Dyspnea	0.7 (1.2)	0 (2.0)	0.7 (1.2)	0 (2.0)	1.5 (1.7)	1.5 (3.0)	1.8 (1.7)	1.5 (4.0)
6MWT Post-Dyspnea	0.8 (0.4)	0.8 (0.5)	3.5 (3.3)	3.0 (6.5)	2.7 (1.5)	3.0 (3.0)	2.9 (2.0)	3.0 (4.5)
6MWT Post-Heart Rate (bpm)	77.3 (28.3)	71.5 (66.0)	84.7 (25.2)	88.0 (50.0)	81.3 (16.2)	82.0 (33.0)	96.8 (9.0)	93.0 (19.0)
6MWT Post-Oxygen Saturation (%)	97.8 (1.7)	97.5 (4.0)	95.3 (4.0)	96.0 (8.0)	97.5 (3.1)	98.5 (7.0)	96.5 (3.0)	96.0 (6.0)
30-s Chair Stand	10.5 (3.7)	10.5 (9.0)	14.3* (4.2)	13.0* (8.0)	9.5 (2.4)	10.5 (5.0)	11.8 (3.2)	13.0 (7.0)
Grip Strength – Right (kg)	25.1 (15.6)	28.0 (32.8)	30.2 (16.0)	37.0 (29.7)	23.4 (3.2)	23.7 (6.3)	23.3 (2.7)	22.5 (6.3)
Grip Strength - Left (kg)	28.1 (16.1)	28.2 (32.0)	33.0 (13.3)	39.3 (24.3)	20.2 (4.6)	19.5 (10.3)	22.2 (5.7)	22.7 (11.3)

UULEX Time (min)	10.9 (5.7)	12.7 (12.0)	11.7 (5.8)	15.0 (10.0)	13.0 (2.5)	13.6 (5.2)	13.8 (2.4)	15.0 (4.8)
UULEX Weight (kg)	1.6 (0.9)	2.0 (1.8)	1.4 (1.0)	2.0 (1.8)	1.9 (0.3)	2.0 (0.5)	2.0 (0)	2.0 (0)
UULEX Pre-Fatigue	8.7 (3.8)	7.0 (7.0)	7.7 (2.9)	6.0 (5.0)	9.0 (2.0)	9.0 (4.0)	7.8 (5.7)	9.0 (13.0)
UULEX Post-Fatigue	10.3 (2.3)	9.0 (4.0)	11.7 (3.2)	13.0 (6.0)	11.7 (2.3)	13.0 (4.0)	10.8 (5.8)	11.5 (14.0)
UULEX Pre-Dyspnea	1.0 (1.7)	0 (3.0)	1.2 (1.6)	0.5 (3.0)	1.8 (1.3)	2.0 (2.5)	1.5 (0.6)	1.5 (1.0)
UULEX Post-Dyspnea	2.3 (1.5)	2.0 (3.0)	1.8 (1.9)	1.0 (3.5)	2.7 (0.6)	3.0 (1.0)	2.0 (0.8)	2.0 (2.0)

*p<0.05 significant within group difference between baseline assessment and final assessment

Table 10. – *Physical Activity Levels by Participant*

ID	METS Total Score (Met-min/week)	
	Baseline Assessment	Final Assessment
1NPW	99	---
4NPW	240	1244
6NPW	4899	5919
9NPW	4146	7990
2C	3159	1758
5C	2226	370
7C	10398	4548
8C	1893	297

Table 11 - *Differences in Individual Vigorous, Moderate, Walking, and Sitting Activity between Baseline and Final Assessments*

ID	Difference in Met-min/week Vigorous Activity	Difference in Met-min/week Moderate Activity	Difference in Met-min/week Walking	Sitting Difference (minutes/week)
4NPW	0	80	924	-240
6NPW	-480	-480	1980	-180
9NPW	-1760	60	5544	60
2C	720	-240	-1881	-60
5C	-120	-680	-1056	255
7C	-720	-2160	-2970	120
8C	-720	-480	-396	60

4.2.3 Health-Related Quality of Life

Results from the SF-36 questionnaire indicated a trend towards improved HRQoL in the participants in the NPW group compared to the control group (Table 9). More specifically, the mean values of each domain in the SF-36 stayed the same or improved in the NPW group whereas in the control group most of these values decreased and any improvement that occurred was less than the NPW group with the exception of the domain assessing pain (Figure 6). There was no statistical difference between groups. The NPW group experienced an improvement in mean scores (SD) for the Role Limitations Due to Emotional Health domain (baseline: 55.6 (50.9); final: 100.0 (0)), the Emotional Well-being domain (baseline: 74.7 (8.3); final: 88.0 (8.0)), and the Energy and Fatigue domain (baseline: 61.7 (23.6); final: 73.3(20.8)), while the control group declined in these categories (Role Limitations Due to Emotional Health – baseline: 66.7 (38.5); final: 50.0 (43.0); Emotional Wellbeing – baseline: 75.0 (17.7); final: 74.0 (16.8); Energy and Fatigue – baseline: 57.5 (19.4); final: 53.8 (22.1)). The SF-36 values of study participants at baseline were below Canadian normative values for this age group (65 to 75 years old) (Hopman et al., 2000). After participating in the eight-week NPW program the SF-36 values of participants at final assessment were above the Canadian normative data except in the domains measuring Physical Function and General Health. Refer to Table 12 and Figure 6 for more detailed information.

Table 12. – *SF-36 Questionnaire Results*

	NPW			Control			Canadian Normative Values Age 65-74
	B*	F*	Difference between Baseline & Final (SD)	B*	F*	Difference between Baseline & Final (SD)	
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)		Mean** (SD)
Physical Function (PF)	71.7 (36.2)	71.7 (40.4)	0 (5.0)	66.3 (25.0)	66.3 (34.7)	0 (12.9)	75.7 (22.2)
Role Limitation Physical (RL-P)	33.3 (57.7)	83.3 (28.9)	+50.0 (50.0)	25.0 (50.0)	43.8 (31.5)	+18.8 (55.4)	76.2 (36.5)
Role Limitation Emotional (RL-E)	55.6 (50.9)	100.0 (0)	+44.4 (50.9)	66.7 (38.5)	50.0 (43.0)	-16.7 (19.2)	83.4 (32.8)
Energy/ Fatigue (EF)	61.7 (23.6)	73.3 (20.8)	+11.7 (10.4)	57.5 (19.4)	53.8 (22.1)	-3.7 (9.5)	67.7 (18.1)
Emotional Wellbeing (EW)	74.7 (8.3)	88.0 (8.0)	+13.3 (16.2)	75.0 (17.7)	74.0 (16.8)	-1.0 (2.0)	79.3 (15.0)
Social Function (SF)	62.5 (33.1)	95.8 (7.2)	+33.3 (40.2)	65.6 (31.3)	78.1 (6.3)	+12.5 (30.6)	87.0 (19.8)
Pain (P)	77.5 (22.5)	78.3 (18.8)	+0.8 (11.3)	69.4 (33.0)	72.5 (34.6)	+3.1 (13.8)	74.0 (23.9)
General Health (GH)	70.0 (26.6)	70.0 (33.5)	0 (5.0)	75.0 (14.1)	71.3 (25.0)	-3.7 (11.1)	73.5 (18.4)

**Note: B:Baseline; F:Final*

***Note: Data from Canadian Normative Data for the SF-36 Health Survey, Canadian Multicentre Osteoporosis Study Research Group by Hopman et al. (2000).*

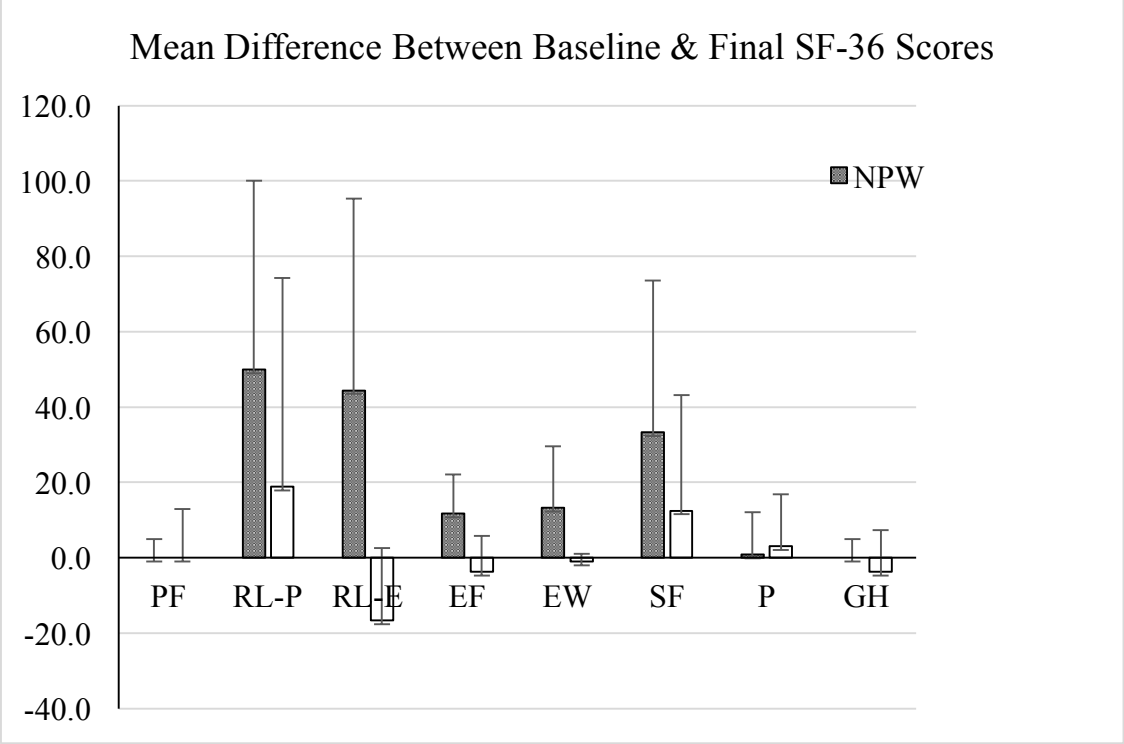

Figure 6. A graph of the mean difference between the baseline and final SF-36 scores.

Only three participants with NSCLC completed the study limiting the data that was obtained from the FACT-L questionnaire. Individual FACT-L scores that are displayed in Table 13 and 14 show that the one participant with NSCLC who completed the NPW program had improved HRQoL when subscales were combined to calculate the Total Outcome Index (TOI) score, the FACT- G score and FACT-L score. In comparison, the two participants with NSCLC in the control group experienced a decline in HRQoL over the eight-week period as demonstrated by a decrease in each of these scores.

Table 13. – *FACT-L Questionnaire Domain Results by Participant at the Baseline (B) and Final (F) Assessments*

ID	PWB *Score Range: 0 to 28*		SWB *Score Range: 0 to 28*		EWB *Score Range: 0 to 24*		FWB *Score Range: 0 to 28*		LCS *Score Range: 0 to 28*	
	B	F	B	F	B	F	B	F	B	F
2C	19	18	24.5	25.7	19	13	14	16	17	14
5C	26	23	26.8	28	24	24	26	24	13	23
4NPW	25	24	28	28	18	17	13	16	16	22

Note: PWB – Physical Well-Being; SWB – Social/Family Well-Being; EWB – Emotional Well-Being; FWB – Functional Well-Being; LCS – Lung Cancer Subscale

Table 14 - *FACT-L Questionnaire Total Scores by Participant at the Baseline (B) and Final (F) Assessments*

ID	TOI *Score Range: 0 to 84*		FACT-G *Score Range: 0 to 108*		FACT-L *Score Range: 0 to 136*	
	B	F	B	F	B	F
2C	50	48	76.5	72.7	76.5	72.7
5C	75	70	102.8	99	102.8	99
4NPW	54	62	84	85	84	85

Note: TOI – Total Outcome Index

5.0 Discussion

The discussion is separated into two sections. The first section focuses on the feasibility of the study and describes the modifications and recommendations aimed at improving study and program design for future studies and clinical practice. These relate to the process, resources, management, and scientific objectives previously identified. Researchers considered these objectives when determining the outcome of the study out of four possibilities (1) *stop* – the study is not feasible; 2) *continue, but modify the protocol* – the study is feasible with modifications; 3) *continue without modifications, but monitor closely* – the study is feasible with close monitoring; and 4) *continue without modifications* – the study is feasible as is.) The next section considers the outcome measures with the understanding that the focus of a pilot study is on feasibility and not on testing intervention effectiveness (Tickle-Degnen, 2013).

5.1 Feasibility

Based on the Thabane et al. (2010) framework, the pilot study suggests that examining the effects of NPW on individuals diagnosed with NSCLC, prostate cancer, colorectal cancer, and endometrial cancer is feasible with modifications. Analysis of the study methodology resulted in the identification of various study facilitators and a number of potentially modifiable barriers (Table 15) that support this conclusion. Furthermore, adherence to the eight-week individualized NPW program was high with no adverse events reported.

Table 15. – *Study Facilitators and Barriers*

Facilitators	Barriers
• relationships with community recreation centres • appropriate space at community recreation centres (accessible, quiet, private, and spacious) • behavioural change techniques assisted with program adherence (goal setting, self-monitoring, practice, and generalizing behaviours to non-supervised contexts) • individualized NPW prescription • rapport established with participants • NPW instructor training • assessment equipment easily obtained, transported, and set up • supervised NPW classes • type of exercise – enjoyed, inexpensive, easily learned, can be performed anywhere, and safe	• type of cancer (higher symptom burden more difficult to participate in exercise) • recruitment process • unable to organize group NPW sessions • accuracy of daily physical activity measures • outcome measures (HRQoL and physical activity became the most relevant)

In the future, researchers could decide to perform a large-scale randomized controlled trial (RCT) or an effectiveness trial. If researchers decide to perform an RCT, then consideration should be given to the sample size and homogeneity of the population being studied to minimize bias and ensure the sample population is representative of general population. Larger sample sizes have been recommended in similar NPW studies where recruitment has also been a challenge (Fritschi et al., 2012a; Jastrzebski et al., 2015; Malicka et al., 2011; Sprod et al., 2005). Furthermore, in this pilot study individuals with different types of cancer experienced different side effects that affected their physical

fitness level to a varying degree. To more accurately determine how NPW affects individuals with cancer, it is essential to ensure the population being studied is as homogeneous as possible and therefore, individuals with one specific type of cancer should be studied. Conducting an RCT would provide researchers with the knowledge of how NPW specifically effects individuals with certain types cancer.

When an RCT may be difficult to organize, researchers may choose to run a patient preference trial. During a patient preference trial participants are able to select their desired treatment or those who do not have an opinion on which treatment they receive are randomly allocated into one treatment group or another (Torgerson & Sibbald, 1998). At least two analyses should be completed: one comparing randomised participants between the treatment groups and the other (comparing non-randomized treatment groups) treated like an observational trial, including adjusting for confounders. (Torgerson & Sibbald, 1998). While patient preference trials do not replace RCTs, they do allow researchers to measure the acceptability of the treatment options that are available (Torgerson & Sibbald, 1998).

Another perhaps more practical option for studying NPW and the cancer population, may be to continue with an effectiveness trial. This type of a quality improvement study would be performed in a specific clinical or community setting as a program evaluation tool. Examining NPW for individuals with cancer in a specific location would allow researchers to take into consideration the staff, setting, resources, safety and priorities that are unique to the program location (Ogrinc et al., 2017). This option would provide researchers with the opportunity to compare NPW to other interventions that are the current standard of care within the clinical or community setting with the goal of

improving healthcare (Ogrinc et al., 2017). The disadvantage of this approach is that it does not let us determine the specific effect of NPW on the cancer population.

To inform future research and clinical practice, it is valuable to reflect on the design and operational processes of this study. The following discussion considers the facilitators and barriers of the study that were presented earlier in Table 15.

Participant recruitment was one of the greatest challenges in ensuring the success of this pilot study. This is not uncommon in health research, especially research that involves participants diagnosed with cancer or other chronic diseases (Miller, Bakas, Buelow, & Habermann, 2013; Payne & Hendrix, 2010; Sygna, Johansen, & Ruland, 2015). Sully, Julious, and Nicholl (2013) reported that only 55% of studies involving health-related research reached their target sample size. Due to the difficulty in recruiting participants with NSCLC, modifications to the inclusion and exclusion criteria were necessary to achieve a large enough sample. The recruitment of individuals diagnosed with NSCLC was especially challenging because patients experience a high symptom burden and their prognosis is frequently poor. Despite the increasing evidence supporting the benefits of exercise in this population, exercise is not yet included in standard care. Also, it often is difficult to connect with patients who have NSCLC since there are limited support groups and rehabilitation programs for this population. In studies on individuals with chronic diseases such as cancer and heart disease, this problem of establishing initial contact with potential participants is frequently reported (Miller et al., 2013). Determining and instituting optimal recruitment methods in studies examining the effects of exercise on individuals with NSCLC is crucial since systematic reviews have acknowledged the need

for larger study sample sizes (Cavalheri et al., 2013; Crandall et al., 2014; Granger et al., 2011).

In this pilot study, several recruitment methods were used, some of which were more successful than others. Social media and cancer support groups have the potential to be effective strategies for participant recruitment, but there are some important elements to consider. While social media may be a cost-effective method for recruitment, significant time and effort is needed to have a substantial and effective online presence (Khatri et al., 2015; Miller et al., 2013; Sygna et al., 2015). If social media is to be used for participant recruitment, then the groups of interest must be clearly identified and a structured framework such as the one developed by Khatri et al. (2015) needs to be followed. This framework uses Twitter, Facebook, and YouTube and involves creating content ahead of time, maintaining an updated presence, and responding in a personal and timely manner to continually engage social media users (Khatri et al., 2015).

With respect to cancer support groups, it may be worthwhile for researchers to establish a relationship with these groups. Having the opportunity to meet potential participants in person is valuable, since face-to-face interaction allows the researcher to address any questions and concerns about the study immediately and trust between the patient and researcher can begin to be established (Sygna et al., 2015). Consideration should be given to avoid recruitment through support groups during the holiday months, since meetings may not be held, and for those meetings that continue to run attendance is often low.

Hospital-based recruitment has the potential to be a highly successful recruitment method and it remains the preferred method for recruiting individuals with NSCLC.

Fundamental to hospital-based recruitment is establishing a strong relationship with the oncology health team. Researchers must educate the team on the importance of exercise-related research and how exercise is associated with increased fitness levels, strength, HRQoL, and improved symptoms in patients with cancer (Granger et al., 2017). This would empower the oncology health team and assist them in educating their patients about the benefits of exercise. Patient education has been identified as a barrier to exercise participation within the cancer population (Fernandez et al., 2015; Granger et al., 2017). Personal communications with experienced researchers in this field, located in Quebec (Coats et al., 2014) and Australia (Cavalheri et al., 2013) support these findings, as they emphasize how imperative it is that researchers develop a strong relationship with the staff who have direct contact with the patients. To ensure the success of future similar research trials, it is recommended that researchers identify organizations that align with their research goals of encouraging exercise participation to improve the HRQoL of patients. Researchers must then work to establish relationships with oncology leads within these organizations as early as possible in the research process. If the research goals of both parties do not align then researchers should look for ways to establish better collaborations or find other organizations to align with.

The recruitment procedures at the hospital must be well organized and researchers need to ensure that the workload and time of hospital staff is minimally affected. Physicians report that heavy patient loads mean there is limited time to discuss study participation with patients (Miller et al., 2013; Payne & Hendrix, 2010). During the pilot study oncology nurses introduced the study to potential participants during their first appointment and then followed up at a later date. During follow up discussions with the nurses it was suggested

that physicians should initially inform the patient about the study. The thought behind this proposal, is that the physician's endorsement of the exercise program may result in patients having more confidence in their ability to participate and that they may take this recommendation more seriously. Future studies should explore this option.

Being diagnosed with cancer is overwhelming for most and has been identified as a potential barrier to exercise participation in the NSCLC population (Granger et al., 2017). As individuals begin to come to terms with their diagnosis and what it means, they must also find time in their schedule for a number of health-related appointments. This coupled with the uncertainty of what the future holds in terms of their health and how they will manage is a constant concern, especially for those newly diagnosed with cancer. Providing clarity about the ability level needed to participate in the intervention and the time commitment involved in the study is important.

Physicians may be hesitant to suggest that patients enroll in the studies because of concerns that study participation may cause undue harm to those who are already experiencing a decline in functional status (Payne & Hendrix, 2010). To overcome this barrier and increase recruitment in future trials, frequent face-to-face interaction between clinical staff and researchers (or cross-appointed scientists) is necessary. Addressing questions regarding study participation on a regular basis may alleviate any concerns that physicians have.

Having the appropriate space to administer a NPW program is essential to its success. Strategic relationships with community facilities should be established early on in the organizational process of the study. Consideration should be given to the amount of space available, noise levels, privacy, and the accessibility of the facility. Researchers must

also ensure that there is good communication with facility staff and that they are willing to work with researchers to make certain that the study is a success. Conducting assessments and NPW at home was determined to be feasible and future studies may want to incorporate this into study procedures to facilitate greater study participation. Given that NPW can be performed in various settings, it is an adaptable exercise solution that has the potential to meet the need for long-term exercise interventions that continue to encourage the maintenance of physical activity levels in individuals with cancer after program participation (Jankowski et al., 2014; Spark, Reeves, Fjeldsoe, & Eakin, 2013). This is supported by the fact that 75% of the participants in the NPW program purchased Nordic poles upon completion. Future studies should assess NPW for its ability to facilitate continued exercise participation.

Adherence to the NPW program was high, likely because researchers followed the recommendations to individualize the exercise prescription and integrate several behavioural change techniques into the program design (Bourke et al., 2013). The behavioural change techniques included goal setting, self-monitoring, practicing, and generalizing behaviour to other non-supervised contexts. Given the success of these behavioural change techniques, perhaps, a more formal behaviour change framework could be considered. Individualizing the program allowed the NPW prescription to be designed around the participant's capabilities, making it more manageable while also improving adherence. Instructors regularly reviewed the exercise journals with the participants to review goals, discuss progress, address any difficulties, and adjust the exercise prescription appropriately. The exercise journals were regularly used by participants serving as a key learning tool throughout the NPW program. Providing individual participants with weekly

follow-up with instructors is necessary whether in person, by phone, or by email. Future studies should consider this, as it allows individuals an opportunity to ask questions and helps encourage them to stay on task. Most individuals with cancer do not meet current exercise recommendations (Fernandez et al., 2015). Thus, incorporating these techniques (i.e. journals and goal setting) into programming in future studies is essential to motivating individuals to partake in regular exercise (Bourke et al., 2013).

The pilot study did not raise any safety concerns for individuals with NSCLC, prostate cancer, colorectal cancer, or endometrial cancer. The NPW intervention was well-tolerated by all participants with no serious adverse events occurring. This is consistent with the findings of studies on NPW with individuals diagnosed with cancer (Fields et al., 2016; Fischer et al., 2015; Jastrzebski et al., 2015; Malicka et al., 2011; Sprod et al., 2005).

Group NPW sessions were not feasible during the pilot study because of the small sample size. Individuals with NSCLC were especially eager to have participants with a similar diagnosis take part in the NPW program alongside them. This may be due to a general lack of social opportunities for this population, since there are limited support groups and programing available to them. It is well known that social support is linked to increased physical activity participation in individuals with cancer (Barber, 2012; McNeill, Kreuter, & Subramanian, 2006) and for this reason future studies should consider the benefit that participants would have from socializing as a group during the NPW sessions.

The structure of the supervised NPW sessions was successful and participants were able to commit to between 20 to 70 minutes of NPW on a regular basis. Participants were able to master the NPW technique with guidance from instructors and regular practice. Providing time for participants to learn the correct technique the week before starting the

NPW program is essential because this gives participants the chance to become more co-ordinated and comfortable before starting the program (Figard-Fabre, Fabre, Leonardi, & Schena, 2010).

Instructors identified a disparity between the endurance levels of participants with NSCLC and participants diagnosed with other types of cancer. Participants with NSCLC experienced a significant amount of dyspnea, which caused them to walk at a slower pace. For this reason, it is recommended that future NPW programs for individuals with NSCLC be organized alongside programs for individuals with other chronic respiratory diseases who experience similar symptoms and may be able to relate. This has been done before. Glattki et al. (2012) successfully integrated NSCLC patients into a pulmonary rehabilitation program for patients with other chronic respiratory diseases determining that the rehabilitation programs did help to improve the exercise capacity and pulmonary function of NSCLC patients. In addition, NPW may be an ideal type of exercise for individuals with NSCLC since studies on individuals with chronic obstructive pulmonary disease (COPD) have found that participants who used NPW experienced a significantly higher VO2 compared to standard walking without increased breathlessness (Barberan-Garcia et al., 2015). This demonstrates that NPW may be able to generate higher intensities of training with similar perceived effort (Barberan-Garcia et al., 2015).

Nordic pole walking instructor training is recommended for anyone who will be leading the NPW program. Without proper training, instructors will not have the skills necessary to properly prescribe a NPW program, progress that program, and teach the NPW technique. Less qualified instructors pose a potential safety risk to participants and also has the potential to lower the effectiveness of the intervention. Training should include a

combination of theory and practice, allowing new instructors the opportunity to teach and correct technique. It may help to have additional follow up sessions with instructors to review technique and address any difficulties with instruction.

The equipment was easily acquired and transported to the study location. Having the flexibility to conduct the assessments at various locations was helpful and allowed researchers to enroll participants who were located a long way from the recreational centres. Considerations should be given to the portability of equipment when selecting assessment measures for future studies. On average, the initial assessments took longer than expected. Scheduling more time for initial assessments would be ideal so researchers are able to listen to and develop a rapport with participants. Establishing rapport creates a mutual understanding, promotes communication, and develops trust. One way to accomplish this is through motivational interviewing, where health care professionals work with an individual to help them explore and understand the need for and importance to change (Tahan & Sminkey, 2012). Having a good relationship with participants helped to encourage their continued participation in the NPW program and while some principles of motivational interviewing were incorporated (i.e. expression of empathy), it would be worthwhile to formally include these in the study.

While all assessment tasks were able to be successfully and safely completed the use of the 6MWT, the UULEX, and the FACT-L need to be re-evaluated before conducting a large-scale trial. During the 6MWT participants seemed to reach a point where they could not walk any faster. Participants with NSCLC were limited due to dyspnea, while for participants with greater functional exercise capacity, it did not seem possible that they could walk any faster. Studies examining the individuals with NSCLC should consider

focusing on assessing daily physical activity levels, since this may be more effective in capturing the overall improvement in endurance as a result of NPW participation. For participants with other types of cancer who have a tendency to have greater functional exercise capacity (i.e. individuals with prostate cancer) other more rigorous submaximal exercise tests should be examined.

With regards to the UULEX, one participant with NSCLC experienced pain when the bar was raised past a certain height causing a pull where there was a scar from lung resection surgery. Since this pain may be common in individuals who have had lung resection surgery the UULEX may not be a good outcome measure for this group.

Finally, in this particular study using the FACT-L as a cancer-specific HRQoL questionnaire was not ideal since the cancer specific questions did not pertain to the participants enrolled in the study. While this questionnaire was included to help examine the impact of NPW on cancer specific complications, this type of questionnaire appears to be better suited for individuals who are currently undergoing chemotherapy or radiation therapy treatments. For studies investigating rehabilitation interventions in the cancer population the SF-36 should be used along with questionnaires looking at specific cancer-related symptoms such as fatigue or anxiety and depression. If the FACT-L questionnaire is used as a measure of HRQoL, it is recommended that the question asking whether participants regret smoking in the past be removed, since participants found it to be highly offensive.

Incorporating a NPW program for individuals with cancer into a clinical or community setting may be beneficial. As a health care practitioner or exercise professional obtaining a NPW instructor certification is easily done and the certification is not restricted

to a specific health care practitioner. NPW is a cost-effective exercise option that can be adapted to meet the needs of various clinical or community settings. The different aspects of programming discussed within this paper were in the context of research. However, a NPW program for individuals with cancer can easily be applied in the clinical or community setting with consideration given to earlier recommendations regarding recruitment, space, assessment, program design, and instruction.

5.2 Outcome Measures

The NPW group tended to have improved overall physical activity levels and HRQoL measures after eight-weeks of NPW. A significant decrease in thigh circumference and increase in lower body physical function (30-s sit to stand test) were found ($p<0.05$). The following is an interpretation of these results including advice for future research studies.

We found that physical activity levels among participants in the NPW group improved over the duration of the study. We observed an increase in the endurance levels of participants who completed the eight-week NPW program. In the systematic review by Fritschi et al. (2012a) NPW was recognized for its ability to improve the physical activity levels of individuals with COPD and diabetes. Increased physical activity levels in cancer patients are linked to improved patient outcomes, decreased mortality, and reduced cancer recurrence rates (Arem et al., 2015; Rock et al., 2012).

Researchers in oncology have recognized the value of physical activity monitors (e.g., pedometers and accelerometers) and advocate for their use in this population (Beg, Gupta, Stewart, & Rethorst, 2017; D.; Santa Mina, 2017). Physical activity monitors enable researchers to capture data beyond measuring step count, including variability, minutes and

intensity of activity, energy expenditure, and hours spent sitting, standing, or lying down (Beg et al., 2017). Wearable fitness tracking devices (e.g., Fitbit) also have a social component that allows users to compare their progress and compete to obtain common goals making them a motivational tool (Beg et al., 2017; D.; Santa Mina, 2017). Prior to regular use of these devices in studies and clinical programs more research is needed to determine the most suitable measures for the cancer population (Beg et al., 2017). We did not use wearable monitors, but we recommend their deployment in future studies, since questionnaires are prone to errors, self-reporting bias, as well as recall bias.

Another prominent trend identified within the study was the improvement of HRQoL in the participants in the NPW group compared to the control group. Advancements in technology related to cancer diagnosis and treatment mean that individuals are living longer after diagnosis. A longer life-expectancy is generally positive; however, individuals often experience cancer and treatment related symptoms that greatly impact their HRQoL. In the pilot study, the NPW group showed improvement in domains measuring emotional health, emotional well-being, and energy and fatigue compared to the control group who declined in these domains. This is important considering that depression and cancer-related fatigue are two of the side effects have been found to impact the HRQoL of cancer patients the most (Shi et al., 2011). Systematic reviews on fatigue and HRQoL outcomes support these results (Cramp & Byron-Daniel, 2012; Mishra et al., 2012). Cramp and Byron-Daniel (2012) conducted a systematic review (56 studies, n=4068) and concluded that aerobic exercise is beneficial for individuals with breast and prostate cancer who experience cancer-related fatigue during or post cancer treatment. Mishra et al. (2012) (40 studies, n=3694) discovered that for individuals who have been diagnosed with cancer,

exercise may improve the HRQoL and specific HRQoL domains including emotional well-being (Mishra et al., 2012). A significant improvement of the change in emotional well-being scores at 12-weeks (n=617) was found when researchers conducted a meta-analysis comparing individuals who exercised with those in the control interventions (SMD 0.33; 95% CI 0.05to 0.61) (Mishra et al., 2012). In addition, Cheville et al. (2013) conducted an RCT and also found an improvement in fatigue levels in adults with stage IV lung or colorectal cancer (n=66) after participating in an eight-week incremental walking and home-based strengthening program compared to controls. Considering the importance and challenge of maintaining HRQoL in the cancer population after diagnosis, as well as the trend towards improvement in HRQoL in this pilot study, a large-scale RCT should continue to include HRQoL as an outcome measure and the focus should be placed on cancer-specific patient important outcomes (i.e. fatigue).

We observed a significant decrease in thigh circumference from the baseline to the final assessment in the NPW group. Since no other notable changes in body weight or circumference measurements occurred over the eight-week period and the change in thigh circumference was very small, the observed changes likely resulted from measurement error. Furthermore, we are not aware of any other RCTs on NPW that have noticed this change (Fritschi et al., 2012a) and there was no change in the 6MWT. It is recommended that only waist circumference be measured in future studies. The other circumference measurements are likely not routinely meaningful to this population, also other studies do not typically take circumference measurements, and there are no set international standards in place taking for these measures.

The NPW group also experienced a significant improvement in the 30-s chair stand test indicating improvement in the lower body strength of these participants. A feasibility study examining the impact of an individualized exercise program (with the goal of improving recreational aerobic physical activity) on individuals with high-risk colon cancer (n=273) showed similar results (Courneya et al., 2016). Individuals were randomly allocated to the structured exercise program (n=136) or the health education materials group (n=137) (Courneya et al., 2016). After one year of being enrolled in the study, individuals taking part in the exercise program experienced a significant increase in the 30-s chair stand test compared to the health education group (mean between group difference: +1.6 repetitions; 95% CI: +0.6 - +2.7; $p<0.001$) (Courneya et al., 2016). In addition, participants in the structured exercise group reported an increase in recreational physical activity (mean between group difference: +10.5; 95% CI: +3.1 to +17.9; p=0.002), predicted VO2max (mean between group difference: +2.2, 95% CI: -4.6 to +9.1; p=0.068), 6MWT (mean between group difference: +29; 95% CI: +0.4 to +57; $p<0.001$), 8-foot-up-and-go, (mean between group difference: -0.4 seconds; 95% CI: -0.7 to -0.2, p=0.004) and sit and reach (mean between group difference: +2.1 centimeters; 95% CI: -0.6 to +4.7; p=0.08) (Courneya et al., 2016). No differences were reported in body weight, hip and waist circumference, or upper body functioning measures (Courneya et al., 2016). Additional trials using similar outcome measurement would help explain the finding of improved lower body strength.

Future studies should focus on cancer specific patient important outcomes. NPW is unique, especially for the cancer population that commonly experiences substantial deconditioning. By walking with the poles an individual is engaging the upper body and

this may result in a difference in muscular endurance. Particularly for individuals diagnosed with NSCLC, using Nordic walking poles may help them to overcome functional limitations caused by significant deconditioning and shortness of breath. Also, many individuals with NSCLC have also been diagnosed with COPD. A study was completed to examine how NPW affects the physiological response and RPE of individuals with COPD (n=15) (Barberan-Garcia et al., 2015). Results showed that when participants used the Nordic poles on solid ground they experienced a significantly higher VO_2 ($6MNPW_{ground}$: 21ml/kg/min ± 3, $p<0.05$) compared to standard walking, without an increase in breathlessness ($6MNPW_{ground}$ RPE: 4.2 ±2.0; 6MWT RPE: 4.1 ±1.8) (Barberan-Garcia et al., 2015). This demonstrates NPW may be able to generate higher intensities of training with similar perceived effort (Barberan-Garcia et al., 2015). Findings obtained from outcome measures that are most relevant and specific to the cancer population have the potential to provide us with the greatest understanding, increasing our impact on improving the lives of individuals with cancer.

Any of the improvements in outcome measures may not only be related to exercise, but may be linked to the social benefits and supports that occur during exercise participation as well. While it was not possible to administer group sessions, participants in the NPW group did feel they received support from the NPW instructor on a weekly basis. A systematic review by Barber (2012) examining the research (15 correlational, descriptive and observational studies; 7 interventional studies) on social support and physical activity in the adult cancer population found that 50% of the studies showed a significant relationship between social support and physical activity participation. Future

research should consider measuring the social benefits of exercise to tease it out from the physical benefits.

5.3 Strengths and Limitations

This pilot study focused on feasibility, and was assessed using an established framework (Thabane et al., 2010). The process, resource, management, and scientific criteria were clearly defined along with the measures that were being used to evaluate them. A pilot study provides a first step in investigating a unique application of an intervention. By stating the objectives of a pilot study, in an upfront manner, researchers are able to provide more detailed evidence and make stronger recommendations to inform large-scale trials. The comprehensive design of this pilot study enhances the probability of success of a larger RCT and other future studies. The inclusion of a control group in the pilot study, although not necessary, provides a more accurate examination of the procedures.

This pilot study has several strengths. The adherence rate of participants to the NPW program was high. This can be attributed to the individualized NPW prescription in conjunction with several behavioural change techniques (e.g. goal setting and self-monitoring). Second, because individuals were categorized into NPW prescription groups we were able to establish a dose-response relationship. Also, weekly NPW sessions were supervised by trained NPW instructors. Weekly contact with instructors ensured participants maintained proper NPW technique, held participants accountable to completing the NPW on their own, and helped participants overcome any challenges they were experiencing during the program (e.g. back pain). NPW was not only well-tolerated by participants diagnosed with different types of cancer, individuals stated that they enjoyed walking with the poles and all participants purchased a pair of poles to continue to

use at home. We managed to establish and maintain positive relationships with community recreation centres. Furthermore, the space provided for assessments and NPW was generally adequate because if any issues with the space arose, the centres were flexible enough to accommodate our needs.

One limitation of this pilot study is that the acceptable feasibility outcomes were not identified prior to starting the study. Clearly defining primary and secondary feasibility outcome expectations would have allowed researchers to more definitively decide whether the study was feasible. Instead, upon study completion, researchers reviewed the study barriers and facilitators as a whole, resulting in less specific conclusions.

Another limitation to this pilot study is the small sample size that was insufficient to test hypotheses or thoroughly assess the efficacy and the safety of the NPW intervention in those with NSCLC, prostate cancer, colorectal cancer, and endometrial cancer. Our interactions with other researchers in this field support the recruitment challenges of this population and indicate that research needs to be conducted over a longer period of time to achieve a larger sample size. Also, the heterogeneity of the Population, Intervention, Comparison and Outcome (PICO) elements within this pilot study make it difficult to determine the specific effect that NPW had on the cancer population. The greatest variation occurred within the study population, since individuals were diagnosed with different types of cancer that caused them to experience drastically different symptoms affecting their physical capacity to varying degrees.

The short follow-up period is an additional limitation that does not allow us to determine if the effects of NPW could be sustained long-term. Studies have shown improvement in eight-week exercise interventions; however, more time may be needed to

establish a permanent behaviour change of regular exercise participation. The self-reported items used to assess physical activity levels and HRQoL may be subject to bias. As discussed, the provision of certain devices designed to track physical activities (e.g., pedometers, accelerometers) would enable collection of more standardized measures and avoid the issues associated with biases resulting from self-reporting. Researchers conducted all of the assessments and acted as NPW instructors through the duration of the study and this may have led to unintended bias. Also, anthropometric measures may be subject to measurement error since results are not supported by other studies. Before conducting a large-scale RCT, the technique of taking anthropometric measures should be systematically described and implemented.

6.0 Conclusion

In conclusion, the pilot study indicates that examining the effects of NPW on individuals with NSCLC, prostate cancer, colorectal cancer, and endometrial cancer is feasible with modifications. Recruitment through cancer centres within hospitals or through cancer support groups (rather than posters, social media, and snowball referrals) were shown to be the best methods. NPW was well-tolerated by participants despite the various cancer and treatment-related side effects they experienced. Prescribing an individualized NPW program and integrating behaviour change techniques into the program design contributed to strong adherence to the regime. Future research should focus on the effects of NPW on HRQoL and physical activity levels of patients with cancer. In addition, more accurate methods for measuring physical activity such as pedometers or accelerometers should be used. It is recommended that NPW programs for individuals with NSCLC be organized alongside programs for individuals with other chronic respiratory diseases.

Author Contributions

EC, MN, RW conceived of the study; EC, MN, RW, ML, SD were involved in the study design, contributed to the analysis and interpretation of the data and writing the thesis before submission; the research assistant assisted with data collection and facilitating the intervention.

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Appendices
Appendix A – Study Information Page

UOIT
CHALLENGE INNOVATE CONNECT

Nordic Pole Walking And Cancer

Study Title: Pilot Study on Nordic Pole Walking and Individuals with Cancer: Effects on Physical Function & Quality of Life

Purpose: To learn about how a Nordic Pole Walking (NPW) program impacts the lives of individuals with cancer. The information gained from this study may lead to health professionals better understanding how exercise can impact individuals living with cancer.

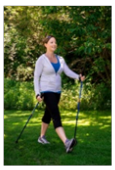
Eligibility: To be eligible to participate in the study, you must be at least 55 years of age and have a primary diagnosis of histologically confirmed stage I-IV non-small cell lung cancer, colorectal cancer, prostate cancer or endometrial cancer (with any ongoing cancer treatment). In addition, you must have been diagnosed or received cancer-related treatment within the last 3 years. It is mandatory that you have approval from your primary treating physician. You must be able to communicate (read and write) in English and have not used Nordic walking poles on a regular basis within the last six months.

Procedures: In this study you will be randomly assigned to one of two groups: 1) the NPW group or 2) the non-exercise group. Both groups will complete an initial and final assessment that will include physical assessments, fitness assessments and a series of questionnaires to examine quality of life. The NPW group will be asked to participate in an 8-week NPW program. Participation in this program involves completing one NPW class per week and three independent NPW sessions per week. The non-exercise group will be asked to continue their usual activities for the 8-week period between assessments and will have the option of participating in the NPW program after the final assessment.

Benefits: Engaging in the NPW program may or may not lead to gains in the participant's health and fitness. The information gained from this study may help healthcare professionals understand the effect of exercise for individuals with cancer. The information may be used to help other individuals with cancer that wish to take part in exercise programs. Participants in this study will benefit from having access to community centres.

Potential Risks: Risks that may occur as a result of taking part in the NPW program include: elevated heart rate and blood pressure, light-headedness, dehydration and feelings of faintness due to the body's reaction to physical activity. Other potential risks such as falls and loss of balance are unlikely since you will be using the Nordic walking poles throughout the program; additional supports may also be utilized for exercises (such as oxygen, tables, walls and chairs). All group sessions will be led by trained and certified NPW instructors.





For more information please contact the Principle Investigator:
Elise Cunningham, MHSc Student, BSc Kin, R. Kin,
phone **905.721.8668 ext. 5329** or email: **elise.cunningham@uoit.ca**

This research study has been approved by the University of Ontario Institute of Technology Research Ethics Board # 15-018 on September 29, 2015.

Appendix B – Poster

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY

Participants Needed for Research on
NORDIC POLE WALKING IN PATIENTS WITH CANCER

We are looking for volunteers to take part in a pilot study titled:
Nordic Pole Walking and Individuals with Cancer: Effects on Physical Function & Quality of Life

We want to learn more about how a Nordic Pole Walking program may impact the lives of those who are 55 years of age or older living with non-small cell lung cancer, colorectal cancer, prostate cancer or endometrial cancer.

In this 8-week study you will be asked to participate in a group Nordic pole walking class once per week and to walk with the poles 3 additional times per week independently. Assessments will be conducted before and after the 8-week period to measure changes in physical function and quality of life.

The information gained from this study may lead to a better understanding of how exercise can impact the lives of patients diagnosed with cancer.

For more information or to volunteer for this study, please contact:
Elise Cunningham at 905.721.8668 ext. 5329
or by email: elise.cunningham@uoit.ca

This research study has been approved by the University of Ontario Institute of Technology Research Ethics Board # 15-018 on September 29, 2015.

Appendix C – Program Evaluation Survey

PART I -- INSTRUCTIONS: Please circle the response that best captures your agreement with the following statements regarding the Nordic pole walking (NPW) program. . .

	Agree				**Disagree**
1. Fatigue strongly affected my ability to complete the NPW program.	1	2	3	4	5
2. I did not have enough time to complete the NPW program.	1	2	3	4	5
3. I was very anxious about my ability to complete the NPW program.	1	2	3	4	5
4. I am very motivated to continue the NPW program.	1	2	3	4	5
5. **I found it very difficult to manage (e.g., schedule time for, travel to, etc.) the group NPW session.**	1	2	3	4	5
6. **I found it very difficult to manage (e.g., schedule time for, motivate myself etc.) the NPW session independently.**	1	2	3	4	5
7. **The NPW program was very demanding.**	1	2	3	4	5
8. **Participating in the NPW program was very beneficial to me.**	1	2	3	4	5
9. **The NPW program is very relevant to individuals with cancer who are undergoing treatment**	1	2	3	4	5
10. **I am in good physical condition.**	1	2	3	4	5
11. **My quality of life has improved significantly since I started the NPW program.**	1	2	3	4	5
12. **My fitness level has improved significantly since I started the NPW program.**	1	2	3	4	5
13. **My anxiety has improved significantly since I started the NPW program.**	1	2	3	4	5
14. **I would strongly recommend this NPW program to a friend/colleague with lung cancer.**	1	2	3	4	5
15. **I was very satisfied with the NPW program.**	1	2	3	4	5
16. **I followed the prescribed NPW program closely.**	1	2	3	4	5

17. **I successfully mastered the NPW technique.**	1	2	3	4	5
18. **The NPW instructors were well informed and able to help me with my NPW technique.**	1	2	3	4	5
19. **The NPW group classes were well organized.**	1	2	3	4	5
20. **The NPW journal was very informative and useful.**	1	2	3	4	5
21. **The follow up phone calls/emails helped me to adhere to the NPW program.**	1	2	3	4	5
22. **I intend to continue NPW now that I have completed the study.**	1	2	3	4	5

PART II -- INSTRUCTIONS: What follows are some open-ended questions that will allow you to elaborate on certain ideas from the first section. Please use as little or as much space as you think you need.

23. What did you like about participating in the NPW program?

24. What challenges did you experience while participating in the NPW program?

24. How could we improve the NPW program for people with cancer in the future?

25. Do you have any additional comments or feedback?

Appendix D – Call Tracking Document

TO BE FOLLOWED UP		
No	**Call Date**	**Recruitment Method**

ENROLLED									
No	**Call Date**	**Initials**	**Recruit Method**	**Study ID**	**Enrollment Date**	**Complete?**	**# of Group Sessions**	**Reason Withdrew**	**Purchased Poles?**

NOT ENROLLED			
No	**Date**	**Recruit Method**	**Reason Not Enrolled**

Appendix E – Exercise Logs

ID #: _____ WEEK:_____

GOAL: Time: _____ Rate of Perceived Exertion (RPE): _____
Aim to walk 4 times/week (including group session)

	DAY 1	DAY 1	DAY 1	DAY 1	DAY 1	DAY 1	DAY 1
TIME eg. 10 min							
DISTANCE eg. 1 km							
RATE OF PERCEIVED EXERTION (RPE) 6-20 e.g. 15 "hard"							
DID YOU WALK WITH THE NORDIC POLES MORE THAN ONCE TODAY? (circle your answer)	YES / NO IF YES HOW MANY TIMES ?	YES / NO IF YES HOW MANY TIMES ?	YES / NO IF YES HOW MANY TIMES ?	YES / NO IF YES HOW MANY TIMES ?	YES / NO IF YES HOW MANY TIMES ?	YES / NO IF YES HOW MANY TIMES ?	YES / NO IF YES HOW MANY TIMES ?
IF YOU ARE UNABLE TO WALK ON THIS DAY PLEASE STATE THE REASON. eg. Dizziness, fatigue, lack of time							

Appendix F – Patient Information Tracking Document

Patient Information		
Study ID	First Name	Last Name

Patient Information				
Sex	Age	Primary Phone Number	Second Phone Number	Address

Patient Information			
Email	Preferred Contact Method for Weekly Follow Up	Verbal Consent Recruitment Date	Written Consent

Patient Information				
Date of Initial Assessment	Date of Final Assessment	Emergency Contact Name	Emergency Contact Relationship	Emergency Contact Number

Status			
Active/Inactive	Week	Follow Up (Y/N/W)	Time it took for Follow Up

Status	
Follow Up Notes	Reason for Inactive (Withdrawn from study, Loss to follow up, or date of death)

Appendix G – Expense Tracking Document

OFFICE				
No	DATE	ITEM	COST	Comments

FACILITY				
No	DATE	ITEM	COST	Comments

OTHER				
No	DATE	ITEM	COST	Comments

Appendix H – Initial Assessment Data Collection Document

Date:_____ ID #: _____
Assessment Conducted by: _____ Time Assessment Started:_____

- ☐ Consent Form Completed
- ☐ Demographics Intake Form
- ☐ International Physical Activity Questionnaire (short version)
- ☐ Physical Measures:
  (participant removes shoes and wears as little clothing as possible)

Height *(stand with back to wall)*	cm	Weight	kg
Waist *(top of iliac crest)*	cm	Hips *(max posterior extension of buttocks)*	cm
Bicep *(midway b/w acromion & olecranon)*	cm	Thigh *(90^o knee flex, midway b/w inguinal crease & patella)*	cm
Chest *(4^{th} costosternal joint)*	cm	Resting Heart Rate Oxygen Saturation	bpm %

- ☐ 6-minute walk test
  Distance walked in 6 minutes: _____
- ☐ 30 second sit to stand test
  # of sit to stands in 30 seconds: _____
- ☐ Unsupported Upper Limb Exercise Test
  Trial 1: Time: _____ Weight: _____
  Trial 2: Time: _____ Weight: _____
- ☐ Grip Strength

	Left Hand	Right Hand
Trial 1		
Trial 2		
Trial 3		

- ☐ SF-36 Questionnaire
- ☐ Do you take part in any planned exercise activity or program? Circle: **YES / NO**
  If **YES**, then please indicate type, duration, frequency and intensity *(low, medium or high)*. Use other side of assessment form if necessary.

  _____

Time Assessment Finished:

Appendix I – Final Assessment Data Collection Document

Date:_____ ID #: _____

Assessment Conducted by: _____ Time Assessment Started: _____

- ☐ International Physical Activity Questionnaire (short version)
- ☐ Physical Measures:
  (participant removes shoes and wears as little clothing as possible)

Height *(stand with back to wall)*	cm	Weight	kg
Waist *(top of iliac crest)*	cm	Hips *(max posterior extension of buttocks)*	cm
Bicep *(midway b/w acromion & olecranon)*	cm	Thigh *(90^o knee flex, midway b/w inguinal crease & patella)*	cm
Chest *(4^{th} costosternal joint)*	cm	Resting Heart Rate Oxygen Saturation	bpm %

- ☐ 6 minute walk test
  Distance walked in 6 minutes: _____
- ☐ 30 second sit to stand test
  # of sit to stands in 30 seconds: _____
- ☐ Unsupported Upper Limb Exercise Test
  Trial 1: Time: _____ Weight: _____
  Trial 2: Time: _____ Weight: _____
- ☐ Grip Strength

	Left Hand	Right Hand
Trial 1		
Trial 2		
Trial 3		

- ☐ SF-36 Questionnaire
- ☐ Post-program Questionnaire
- ☐ Did you take part in any planned exercise activity or program in the last 8 weeks? Circle: **YES / NO** If **YES**, then please indicate type, duration, frequency and intensity *(low, medium or high)*. Use other side of assessment form if necessary.

  _____
  _____

Time Assessment Finished: _____

Appendix J – NPW Exercise Prescription – Highly Active Group

This is how you will progress on a weekly basis as you participate in the Nordic walking program:

WEEK 1
TIME: 30 minutes

WEEK 2
TIME: 35 minutes

WEEK 3
TIME: 40 minutes

WEEK 4
TIME: 40 minutes

WEEK 5
TIME: 45 minutes

WEEK 6
TIME: 45 minutes

WEEK 7
TIME: 50 minutes

WEEK 8
TIME: 60 minutes

Appendix K – NPW Exercise Prescription – Minimally Active Group

This is how you will progress on a weekly basis as you participate in the Nordic walking program:

WEEK 1
TIME: 30 minutes

WEEK 2
TIME: 30 minutes

WEEK 3
TIME: 35 minutes

WEEK 4
TIME: 35 minutes

WEEK 5
TIME: 40 minutes

WEEK 6
TIME: 40 minutes

WEEK 7
TIME: 45 minutes

WEEK 8
TIME: 45 minutes

Appendix L – NPW Exercise Prescription – Inactive Group

This is how you will progress on a weekly basis as you participate in the Nordic walking program:

WEEK 1
TIME: 20 minutes

WEEK 2
TIME: 20 minutes

WEEK 3
TIME: 25 minutes

WEEK 4
TIME: 25 minutes

WEEK 5
TIME: 25 minutes

WEEK 6
TIME: 30 minutes

WEEK 7
TIME: 30 minutes

WEEK 8
TIME: 30 minutes

Appendix M – Nordic Pole Walking Instructions

BASIC EQUIPMENT

1. Nordic walking poles (loaned to you for the duration of the program)
2. indoor walking shoes
3. comfortable clothing
4. water bottle

THE POLES

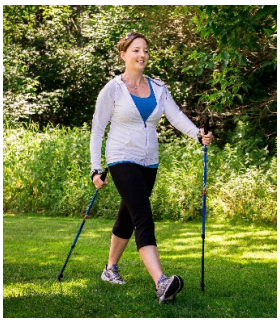
The poles are adjustable to fit the height, stride and arm swing of the individual using them.

The hand-straps are designed to allow for optimal transfer of the power from the upper body (shoulders and arms) to the poles with a loose hand grip.

The rubber boot tip can be used on hard surfaces such as the indoor track or outdoor asphalt. The carbide steel tips can be used for better traction on soft surfaces such as trails, grass and the beach.

FOUR STEPS TO LEARN THE NORDIC POLE WALKING TECHNIQUE

STEP 1 & 2



STEP 3 & 4

STEP 1: Start walking upright and naturally.

- Have your hands open and do not grip the poles.
- Start walking keeping your body upright and swinging your arms naturally at your sides.
- The poles should be dragging with the tips facing backwards on the ground behind you, following your arm swing.

STEP 2: Increase your walking speed and arm swing slightly.

- While increasing your walking speed and arm swing try not to think too much.
- Keep your hands open, walk upright and relax.
- If you are having difficulty with co-ordination, pause and start your walk from standing still with the LEFT arm and RIGHT foot forward.

STEP 3: Learn to push through your poles.

- Hold onto the handle of each pole.
- Because of the Nordic pole hand straps you don't need to hold on very tightly. Keep your grip relaxed.
- Your arm swings forward from the shoulder joint (still dragging the poles) and pushes backwards with a slightly bent elbow.
- Do not pick the poles up and place them in-front of you.

STEP 4: Improve your pole walking technique.

- Pick up the poles slightly so that you are not dragging them as you walk (be sure to keep your arms straight with a slightly bent elbow).
- Maintain a relaxed arm swing from the shoulder continuing to push through the poles as you take your arm back.

COMMON MISTAKES IN NORDIC POLE WALKING TECHNIQUE

1. Swinging the poles from the elbows only.
    - Keep arms "long" – handshake position.
2. Gripping poles too tightly.
    - Loosen grip and focus on pushing into the hand straps.
3. Difficulty coordinating arm swing with leg swing.
    - Pause and start your walk from standing still with the LEFT arm and RIGHT foot forward.
    - Slow your walk down and try not to think too much. Let your natural walking rhythm happen.

THREE KEY THINGS TO FOCUS ON DURING YOUR WALK

1. PACE – Keep in mind your rate of perceived exertion.
2. POSTURE – Remember to look ahead and stand tall as you are walking with the poles.
3. POSITION – Swing your arms from the shoulder (handshake position).

Appendix N – Goal Setting Document

ID #: _____ Date: _____

Welcome to the Nordic pole walking program! Thank you for participating. If at any time you have any questions please contact:

Elise Cunningham at 905.721.8668 ext. 5329 or by email: elise.cunningham@uoit.ca

Taking part in an exercise program is a step towards a healthy lifestyle. Please take the time to answer the following questions.

Why did you decide to participate in the Nordic pole walking program?

_____
_____
_____
_____

What would you like to achieve by participating in the Nordic pole walking program?

_____
_____
_____
_____

The answers that you have provided are a reminder about your motivation behind joining this Nordic pole walking program. Please reflect back on your answers for continued encouragement throughout the program.

Appendix O – Responses to Open-ended Questions in the Program Evaluation Survey

What did you like about participating in the NPW program?

- Excellent! I enjoyed it and it benefited me greatly.
- It made me want to exercise and it gave me more energy.
- I enjoyed the exercise and incremental weekly challenges that were provided.
- Being more active and coordinated. Help and encouragement from instructors.
- That it taught me the NPW and that I as corrected to master it. Also, it was long enough to teach me a new habit of NPW daily. It is a very natural way of exercising to strengthen the whole body.

What challenges did you experience while participating in the NPW program?

- I needed to change my technique as I walked with another type of pole years prior.
- The NPW program helped me overcome some physical back and calf pain, which initially made the program more challenging.
- Very tired at times so was not as consistent with NWP. Remembering to be aware of my posture.
- To begin to find time to do the NPW. I needed to change some priorities and it was difficult. Also, at the beginning I felt very fatigued and tired. The instructor was very helpful to keep me on track and supported me.

How could we improve the NPW program for people with cancer in the future?

- Very well set up. I can't think of any improvements.
- Having a good instructor sure helps.
- No suggestions. I thought it was very well organized and well run. Good job!
- Depending on the level of sickness perhaps to start slower (10 min, 15 min, 20 min /day to start). Also, if possible to encourage a family member to walk together (it was very helpful in my case). Dress according to the weather. Rest after.

Do you have any additional comments or feedback?

- Very happy I joined and have profited greatly from it.
- Good program. Made me walk by myself where/when I would normally not have. Something to continue with others who do Nordic pole walking? Instructors were very helpful, supportive and very encouraging.
- I feel very lucky that I noticed the study and was accepted to participate. I believe that in a way it changed my life. Now I have an activity which I can continue on a daily basis as long as I am able to. It improved not only the physical side, but most importantly the mental, emotion - my internal side! I would like to sincerely thank the instructors for being such understanding teachers/mentors.
- Thank you for organizing the program. I hope that it will continue to keep helping people for many years ahead.