

Exploring Sedentary Behaviour in Young Adult Cancer Survivors

By

© Ryan Collins

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Abstract

Purpose: To explore sedentary behaviour (SB), physical activity (PA), and quality of life (QoL) in young adult cancer survivors (YACS). **Methods:** YACS aged 18-44 completed an online survey, which assessed SB, PA, and QoL using validated measures (i.e., The SIT-Q, Leisure Score Index (LSI), Short Form-36 Health Survey (SF-36), and Functional Assessment of Cancer Therapy: General (FACT-G)). **Results:** Participants had an average of 777.1 ($SD= 274.0$) minutes/day of total sedentary time and 113.4 minutes/week of moderate-to-vigorous PA ($SD= 132.4$), which was positively correlated with the physical component score (PCS) ($r= .32, p<.01$) of the SF-36. Multiple regression analyses showed that moderate and vigorous PA significantly predicted the PCS ($R^2= .10, p<.01$), as did napping and TV viewing time ($R^2= .13, p<.01$). **Conclusion:** YACS were sedentary, inactive, and their activity levels positively correlated with indicators of QoL. Future research should focus on developing effective interventions to improve these behaviours in YACS.

Keywords: Sedentary Behaviour, Physical Activity, Quality of Life, Young Adult Cancer Survivors

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List of Abbreviations

ACS	American Cancer Society
ACSM	American College of Sports Medicine
BMI	Body Mass Index
BP	Bodily Pain
CCO	Cancer Care Ontario
CCS	Canadian Cancer Society
COPD	Chronic Obstructive Pulmonary Disease
CSEP	Canadian Society for Exercise Physiology
EWB	Emotional Well-Being
FACT-G	Functional Assessment of Cancer Therapy – General
FWB	Functional Well-Being
GH	General Health Perceptions
LSI	Leisure Score Index Questionnaire
MCS	Mental Component Score
MH	Mental Health
MVPA	Moderate-to-Vigorous Physical Activity
NCCS	National Coalition for Cancer Survivorship
NCI	National Cancer Institute
PA	Physical Activity
PCS	Physical Component Score
PF	Physical Functioning
PWB	Physical Well-Being
QoL	Quality of Life
RE	Role Limitations due to Emotional Problems
RP	Role Limitations due to Physical Problems
RT	Resistance Training

SB	Sedentary Behaviour
SF	Social Functioning
SF-36	Short Form Health Survey
SIT-Q	SIT Questionnaire
SWB	Social Well-Being
TV	Television
V	Vitality
YACS	Young Adult Cancer Survivors

List of Definitions

Cancer	a type of chronic illness that occurs when abnormal cells begin to grow uncontrollably, invading other/nearby tissue and causing normal cells to be overwhelmed/crowded out.
Cancer Survivor	a term used to describe a person diagnosed with cancer from the point they are diagnosed until the end of their life.
Exercise	a subtype of physical activity that is planned, structured, repetitive, and has the intention to improve physical fitness.
Physical Activity	any bodily movement produced by muscles that results in energy expenditure.
Physical Inactivity	a term used to describe the activity level of someone who is not regularly meeting the recommended weekly amount of moderate-to-vigorous physical activity.
Quality of Life	a multidimensional construct that includes areas related to physical, emotional, and social functioning. In research dealing with medical populations such as cancer survivors, this term typically refers exclusively to “health-related quality of life.”
Sedentary Behaviour	sitting or lying for extended periods of time without whole-body movement.
Young Adult Cancer Survivor	a person who was diagnosed with cancer as a young adult (between the ages of 18 and 44).

Chapter One: Introduction

1.1 Background

Cancer is a type of chronic illness that occurs when abnormal cells begin to grow uncontrollably, which causes normal cells to be overwhelmed and crowded out (American Cancer Society [ACS], 2015). This results in the body having to work harder to function as it should (ACS, 2015). Cancer can develop in any part of the body and, if left untreated, will eventually begin to spread to other areas (ACS, 2015). There are many different types of cancer (e.g., breast, prostate, colorectal, lung, leukemia, cervical, non-Hodgkin lymphoma, etc.), and collectively they account for over 80,000 deaths in Canada every year, making it the leading cause of death in the country (Canadian Cancer Society [CCS], Statistics Canada, Public Health Agency of Canada, & Provincial/Territorial Cancer Registries, 2017). Over the course of a lifetime, cancer will affect half of the Canadian population (CCS et al., 2017). The number of new cancer cases has been rising over the past 30 years and will continue to rise in the coming years due to the aging population and improvements in screening technology (CCS et al., 2017).

Fortunately, a positive trend that has emerged over the years is that cancer is now more survivable than it has been at any other time in the past (CCS et al., 2017). For example, age-standardized mortality rates have been on the decline since the late 1980's for males and the mid 1990's for females (CCS et al., 2017), and, due to improved treatment options and early detection, diseases that were, at one time, considered to be fatal (e.g., testicular cancer, Hodgkin's disease, childhood acute leukemia) now have a much better prognosis and are cured regularly (Ganz, 2006). As of 2009, there were over 810,000 people in Canada who received a cancer diagnosis within the previous 10 years

(CCS et al., 2017). In the cancer literature, these people are referred to as cancer survivors, which is a term used to describe people who have been diagnosed with cancer from the time of their diagnosis until the end of their lives (Mullan, 1985). While it is a positive trend that cancer is now more survivable than it has been in previous years (CCS et al., 2017), this also, unfortunately, means that a large portion of the population may be living with the adverse side effects of cancer and its treatments for years after their cancer has been cured, negatively affecting their quality of life (QoL).

1.2 The Negative Side Effects of Cancer and Cancer Treatments

Cancer survivors now have numerous treatment options available to them following their cancer diagnosis, including chemotherapy, radiation therapy, surgery, hormone therapy, and a combination of multiple types of treatments. While these treatments have become highly effective over the years, they are also associated with many side effects. These side effects are typically grouped into either short-term side effects, which are felt immediately, and late appearing long-term side effects, which may not emerge until months or even years after cancer treatments have been completed and may persist for up to a lifetime (ACS, 2014a; 2014b).

The short-term side effects of cancer treatments are felt immediately and can range in severity and type based on the treatment received. For chemotherapy, cancer patients can experience fatigue, nausea, loss of appetite, weight gain, and the development of an infection or anemia (ACS, 2014a). Similarly, radiation therapy can cause cancer patients to experience fatigue, blood count changes, eating and digestive problems, and emotional problems, such as depression, frustration, and a feeling of helplessness (ACS, 2014b).

While the immediate side effects of cancer treatments last for only a short period of time, the late appearing side effects of cancer treatments may persist indefinitely (ACS, 2014a). This is problematic because these adverse side effects can decrease the QoL of the cancer survivors who experience them (Irwin, 2013; LeMasters, Madavan, Sambamoorthi, & Kurian, 2013; Schmitz et al., 2010), and unfortunately there is a high probability that at least one side effect will be felt, preventing cancer survivors from being able to live a normal life (Fong et al., 2012; Ganz, 2009; Young & White, 2006). The late appearing negative side effects of cancer vary based on the type of treatment that was received and the type of cancer that was treated. For cancer survivors who had surgery, side effects can include pain, psychosocial effects, sexual dysfunction, difficulty breathing, vomiting, and fatigue (Ganz, 2009). Patients who received radiation therapy can experience cancer recurrence, hypertension, various hormone deficiencies, and low blood counts (ACS, 2014b). Chemotherapy and hormone therapy can also cause late appearing long-term side effects, which include cancer recurrence, mobility disorders, heart inflammation, and immune suppression (ACS, 2014a).

Because the late appearing adverse side effects of cancer and its treatments persist for such a long time, cancer is considered to be a chronic illness, and it may require ongoing care (Phillips & Currow, 2010). This may come as a surprise to many cancer survivors, as most expect to be able to jump right back into their pre-diagnosis routine after successfully completing their treatments (Fong et al., 2012). This is undoubtedly a frustrating reality for cancer survivors, which may add to the stress they feel. Based on the challenges that are associated with returning to a normal life following cancer treatment, and on the growing number of people being affected by cancer, there is an

increased need to find effective ways to improve cancer survivors QoL. One method for improving the QoL of cancer survivors that has shown promise, and is receiving increased attention, is through physical activity (PA) and exercise interventions (Fong et al., 2012; Rock et al., 2012).

1.3.1 Physical Activity, Quality of Life, and Cancer

By definition, PA refers to any bodily movement produced by muscles that results in energy expenditure, and exercise, a subtype of PA, refers to planned, structured, and repetitive activities that have the intention of improving physical fitness (Caspersen, Powell, & Christenson, 1985). Research indicates that increasing PA and exercise levels has a tremendous effect across the cancer continuum; from prevention, by decreasing the risk of developing cancer (World Cancer Research Fund & American Institute for Cancer Research, 2007), to post-diagnosis, both during and after treatment, by improving QoL, self-esteem, physical fitness, body composition, body strength, and by decreasing fatigue, depression, and anxiety (Courneya et al., 2007; Fong et al., 2012; Segal et al., 2009; Speck, Courneya, Masse, Duval, & Schmitz, 2010). It has been documented that PA can aid cancer patients in preparing for their cancer treatments by helping them cope with their disease, both physically and emotionally, by improving their fitness level, which will help in allowing difficult treatments to move forward, and by potentially delaying treatment through an increase in managing the disease and its symptoms (Courneya & Friedenreich, 2007). Additionally, PA can help alleviate some of the side effects associated with cancer treatment, and it can assist cancer survivors in returning to the health status they had before being diagnosed with cancer (Fong et al., 2012). This makes

PA an important behaviour to target in interventions focused on improving the QoL of cancer survivors.

There has been a surge in PA and cancer research over the last decade, with numerous reviews establishing its effectiveness as a legitimate QoL intervention for cancer survivors (Baumann, Zopf, & Bloch, 2012; Fong et al., 2012; Knobf, Musanti, & Dorward, 2007). In a meta-analysis, Fong et al. (2012) reviewed 34 randomised controlled trials that examined the effects of PA in cancer survivors of different cancer types who had completed their treatments and they concluded that PA improved physiology, physical functions (e.g., peak oxygen consumption, peak power output, aerobic capacity), psychological outcomes (e.g., reduced fatigue, reduced depression), body composition, and QoL. Similarly, Knobf, Musanti, and Dorward (2007) conducted a review on the effects of exercise on numerous different types of cancer survivors and they concluded that exercise significantly improved both the physical and psychological QoL of the cancer survivors. Additionally, Baumann, Zopf, and Bloch (2012) performed a systematic review of exercise interventions on prostate cancer survivors and they concluded that incontinence, fitness, fatigue, body constitution, and QoL can all be improved through exercise.

It is important to note that, in addition to the benefits felt after completing cancer treatments, PA has benefits when performed during cancer treatments, and it has also been deemed safe and feasible during this period as well (Courneya & Friedenreich, 2007). Not only does it help with alleviating pain and fatigue and improving sleep patterns, body satisfaction, and mood states during treatment, but it can make the treatment more effective by helping patients manage the negative side effects, maintain

their physical functioning, prevent muscle loss and fat gain, and increase the likelihood of completing their treatment (Courneya & Friedenreich, 2007). In breast cancer survivors, a review conducted by Knols et al. (2005) found that exercise during treatment improved functional capacity, psychological well-being, and self-reported outcomes (e.g., nausea), and a meta-analysis by Ibrahim and Homaidh (2011) found that PA reduced both breast cancer mortality and all-cause mortality by 30% and 41%, respectively. Finally, in cancer patients of a wide variety of cancer types, a review found that exercise during cancer treatment has positive outcomes on QoL, fatigue, depression, and anxiety (Schwartz, 2008).

1.3.2 Inactivity in Cancer Survivors

While the benefits of PA in relation to cancer are clear, an unfortunate reality is that cancer survivors are not as active as they could be. According to the American College of Sports Medicine (ACSM) and the ACS, based on a round table made up of experts in PA and cancer research, cancer survivors should strive to meet the same PA recommendations as the general population (Schmitz et al., 2010), which state that adults should engage in at least 150 minutes of moderate-to-vigorous PA in at minimum 10-minute bouts per week to receive health benefits (Canadian Society for Exercise Physiology (CSEP), 2012). Furthermore, this round table also strongly recommended that cancer survivors “avoid inactivity,” and it was stressed that it is important for cancer survivors to understand that some PA is better than none and that cancer survivors should try to be as active as possible to obtain as many benefits from PA as they can (Schmitz et al., 2010). However, research has determined that only 22.6% of cancer survivors in complete remission are active and only 17.8% of cancer survivors currently with cancer

are active (Coups & Ostroff, 2005; Neil, Gotay, & Campbell, 2014). While this is quite low, it is also comparable to the general Canadian adult population, as approximately 22% of Canadian adults meet the recommended PA guidelines (Stats Canada, 2015). Considering the vast health benefits that are associated with regularly meeting the recommended PA guidelines, both cancer survivors and members of the general population need help in improving their activity levels, and while many interventions have been successful in improving PA in cancer survivors, typically the improved behaviour changes do not last long-term. For example, McGowan, North, and Courneya (2013) conducted a PA intervention with prostate cancer survivors utilizing goal setting and planning activity and results indicated that the prostate cancer survivors improve their PA levels by 168 minutes per week after a one-month follow-up. However, these changes were not maintained at the three-month follow-up. Past research on the general population has shown evidence that PA interventions have moderate success in improving PA at a minimum of six months follow-up, but few studies have shown success beyond twelve months (Greaves et al., 2011), indicating that long-term behaviour change is difficult to maintain. It is especially important to find success in PA interventions for cancer survivors because of the lowered QoL they experience as a result of adverse side effects from cancer treatments. Thus, more research is needed to find new and innovative ways to improve long-term behaviour change in cancer survivors.

Recently, cancer researchers have explored the feasibility of targeting other health behaviours that can be improved in cancer survivors as a means of enhancing QoL in this population. One such health behaviour, which is very similar to physical inactivity, is sedentary behaviour (SB). With SB becoming more prominent due to advancement's in

modern technology, research in this area on cancer survivors has increased over the last several years, making this a relevant topic to explore.

1.4 Sedentary Behaviour and Cancer

While similar, SB is distinctly different than physical inactivity, despite the two terms often being used interchangeably in the research. SB refers to extended periods of either sitting or lying without whole-body movement (Owen, Bauman, & Brown, 2009), whereas physical inactivity refers to the failure to meet recommended moderate-to-vigorous PA guidelines (Legh-Jones & Moore, 2012). By these definitions, it is therefore possible for someone to be both physically active and sedentary. This is a problem for a couple of reasons. First, PA and SB have been shown to be independently associated with markers of cardiometabolic health and there is evidence to suggest that SB has greater health risks than physical inactivity (Hensen et al., 2013). Secondly, with the exponential rise in the advancements in and the use of technology in modern society (making our daily tasks easier to achieve and overall life more convenient), it is inevitable that SB will continue to rise for the foreseeable future. This makes it a relevant topic and a behaviour of interest in behaviour change research.

On average, Canadian adults have moderately high levels of SB, spending approximately 9.8 hours per day in sedentary time (Stats Canada, 2015). While research is not yet thorough, it has been purported that cancer survivors are also a sedentary population, with previous research indicating that cancer survivors spend 66% of their waking hours being sedentary (Lynch et al., 2010). This may be a result of cancer survivors experiencing prolonged fatigue and distress as a result of their cancer and treatment. However, because the research conducted to date has not made use of

comprehensive, validated measures of SB, there is more information that needs to be collected on a wider range of cancer survivor populations. This is especially important because it is plausible that high levels of SB in cancer survivors may increase the risk of experiencing the negative side effects of cancer and its treatments for a considerably longer period of time.

Although there is not yet comprehensive, conclusive research in the area of SB in cancer survivors, it has been shown that cancer survivors typically decrease their PA levels after becoming diagnosed with cancer and it is unlikely that they will return to their pre-diagnosis levels (Courneya & Friedenreich, 1997). In a study by Irwin et al. (2003), it was determined that a sample of breast cancer survivors decreased their PA from pre- to post-diagnosis by approximately 11%, equating to 2 hours per week. This is suggestive that cancer survivors are spending high amounts of time being sedentary, and due to the negative effects of SB, sedentary cancer survivors are exposing themselves to an increased risk of developing an additional cancer, cancer progression, and overall cancer mortality (Lynch et al., 2013). Because of this, it is important to study SB in cancer survivors so as to develop effective ways to reduce it. While research in SB and its impact on cancer survivors is not yet well understood, it appears as though researchers are beginning to recognize that there is a gap in this research area, as suggested by the increase in studies conducted in recent years.

A number of reviews and meta-analyses have recently been conducted on SB in cancer survivors. Lynch (2010) conducted a systematic review of SB and cancer research that investigated 18 articles that focused on either SB and cancer risk or SB and health outcomes in cancer survivors. The results of the review suggested a positive association

with SB and colorectal, endometrial, ovarian, and prostate cancer risk, cancer mortality in women, and weight gain in colorectal cancer survivors. Later, Lynch et al. (2013) published a research agenda for SB and cancer research and, in it, proposed that SB may be a more feasible and appropriate behaviour to target in future behaviour change interventions. More recently, Cong et al. (2014) performed a meta-analysis of observational studies on the associations between SB and colon and rectal cancer. The authors concluded that SB had a significant association with colon cancer, but not with rectal cancer. However, subgroup analyses were conducted on cohort studies and the results indicated that there was a positive association between SB and rectal cancer risk. These results suggest that it is important to reduce SB for reducing the risk of developing colorectal cancer. Another recent meta-analysis conducted by Shen et al. (2014) focused on research that investigated SB and cancer incidence. The overall results of the study showed that SB increased the risk for developing cancer. After sub analyses were performed, it was determined that prolonged SB is significantly associated with endometrial, colorectal, breast, and lung cancers. The results of these reviews and meta-analyses suggest that interventions for SB are essential to reduce the risk of developing cancer and improve the health of cancer survivors.

There have been few behaviour change interventions that have targeted the reduction of sedentary time in cancer survivors; however, there has been a growth in studies that have investigated SB and QoL in cancer survivors finding mixed results. Lynch, Cerin, Owen, Hawkes, and Aitken (2011) examined the association between television viewing time and QoL in colorectal cancer survivors in a 3-year study. Over 1,000 participants were interviewed about their health behaviours at 5, 12, 24, and 36

months post-diagnosis. The results indicated that participants who watched more than 5 hours of television (TV) per day had a 16% lower total QoL score than participants who watched less than 2 hours of television per day. Opposing these results, Trinh, Plotnikoff, Rhodes, North and Courneya (2013) did not find a relationship between SB and QoL in kidney cancer survivors. The authors did, however, find that the kidney cancer survivors had a high prevalence of sitting time, as the average amount of time spent sitting was 8 hours per day on work days and 6.5 hours per day on non-work days. Additionally, the authors found a negative relationship between sitting time and the physical and functional aspects of QoL in participants younger than 60 years of age. Vallance, Boyle, Courneya, and Lynch (2014) used accelerometers to assess the associations between SB and QoL in colon cancer survivors. The results indicated that SB was not associated with health-related QoL. The mixed results indicate that further research exploring the relationship between SB and QoL in cancer survivors is necessary to draw stronger conclusions.

Despite what we know about the relationship between sedentary time and cancer survivorship so far, there is still limited evidence to make definitive conclusions (Lynch et al., 2013). While efforts are being made to add to our current understanding of the subject, there is still a lot more research that needs to be conducted and there are many areas that are left to be explored. One of the areas that has been ignored completely is research on SB in young adult cancer survivors (YACS). In fact, studies with a focus on YACS in general have been few and far between. In terms of health behaviours, there is not much known about this population.

1.5 Young Adult Cancer Survivors

Young adult cancer survivors are a demographic that are underrepresented in the

literature (Rabin, Horowitz, & Marcus, 2013). This is in part due to the challenges in working with this population, such as their transient lifestyle. However, there are multiple reasons why it is important to research YACS. First, YACS have an increased risk of long-term adverse physical outcomes in their lifetime, including cancer recurrence (Kero et al., 2013; Woodward, Jessop, Glaser, & Stark, 2011), as well as an increased risk of prematurely developing and experiencing accelerated progression of chronic diseases (Finnegan, Wilkie, Wilbur, Campbell, & Zong, 2007). Secondly, research shows that PA levels among YACS are low, despite feeling able to take part in PA (Bélanger, Plotnikoff, Clark, & Courneya, 2011, 2012). Finally, due to the devastating toll of cancer survivorship at such a young age, YACS have a higher risk of experiencing adverse psychological effects, such as depression (Deyell et al., 2013; Hewitt & Rowland, 2002).

While there are challenges in conducting research with YACS, there have been a few researchers who have been able to overcome these challenges. One recent example of this is Kero et al. (2013), who investigated cardiovascular morbidity in YACS. In this population-based study, cardiovascular risk was investigated in YACS and their healthy siblings. Using information collected from the national hospital discharge registry in Finland, the results indicated that the YACS were at a significantly higher risk for several adverse cardiovascular outcomes (e.g., myocardial infarction, cardiac arrhythmia, and cardiac insufficiency) than their cancer-free siblings, thus indicating that YACS are a medically vulnerable population.

Because YACS are at an increased risk for developing other health issues, such as cardiovascular outcomes (Kero et al., 2013) and mental health conditions (Deyell et al., 2013), it is crucial that YACS improve their lifestyle behaviours (e.g., PA, SB) as much

as they can, and results from previous research examining PA and SB in YACS indicate that improvements can be made in those areas in this population (Bélanger et al., 2011). Examining PA prevalence in YACS, Bélanger et al. (2011) found that only about half of YACS meet the PA recommended guidelines, about a quarter of YACS were sufficiently inactive, and another quarter were said to be completely sedentary. However, despite these findings, a subsequent study by Bélanger et al. (2012) found that the majority of YACS were interested in PA and felt as though they were capable of doing it. Similarly, Rabin (2011) concluded in a review that YACS express an interest in learning more about exercise, and in another study, Rabin, Simpson, Morrow, and Pinto (2011) found that there are a number of barriers that affect the PA levels of YACS, including psychosocial barriers (e.g., a lack of motivation), health-related barriers (e.g., fatigue, late treatment effects), practical barriers (e.g., limited time), and education barriers (e.g., a lack of awareness of programs, a lack of existing programs). This suggests that YACS need help in improving their PA levels through interventions. This is supported by Valle, Tate, Mayer, Allicock, and Cai (2013), who conducted a social media-based PA intervention for YACS and found that behaviour change therapies have the potential to be effective in this population, as significant increases in PA levels over a 12-week period were seen in groups of YACS.

Based on past research about the behaviours of YACS, it seems apparent that behaviour change therapies are important to develop in this population. Motivating YACS to increase their PA levels would help them in reducing their risk of developing other chronic conditions and help them in coping with psychological conditions, such as depression, and thus improve their QoL. While we do not know yet the SB levels in this

population, it is possible that motivating YACS to reduce their sedentary time would result in improvements to their QoL as well. However, to create effective interventions for this specific population, comprehensive research on their existing health behaviours needs to occur. This study will assist in providing knowledge in this area by collecting valuable information about YACS PA, SB, and QoL, which can be used to develop effective behaviour interventions with the goal of improving QoL and health outcomes in this population.

1.6.1 Purpose of Study

Sedentary behaviour has been found to be associated with negative long-term effects in many cancer survivors, and not only is PA beneficial for cancer survivors, it has been determined to be safe and feasible for them as well. However, it has been estimated that cancer survivors are a sedentary and inactive population. Therefore, the purpose of this study was to collect information about SB and PA levels in YACS, a population that faces unique challenges in their daily life, such as having to try and build a career and care for a family while experiencing the long-term late effects of cancer and its treatments. Additionally, this study aimed to explore the QoL (and its relationship to SB and PA), health behaviours, demographics, and medical characteristics in this population as well.

1.6.2 Significance of Study

This study will extend the SB, PA, and cancer literature by: (1) collecting valuable information about the SB, PA levels, and QoL of YACS between the ages of 18-44, (2) determining the relationship between SB, PA, and QoL in YACS, and (3) collecting information about the health behaviours, demographics, and medical information about

YACS. The information gathered in this study can potentially enable researchers to develop effective SB and PA interventions that specifically target YACS, improving their QoL. Furthermore, the information collected will help us understand how often health care professionals are sharing PA information to cancer patients, which will enable researchers to find ways to properly inform health care professionals about the benefits of PA so that this type of information can be more frequently shared with patients dealing with a cancer diagnosis.

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Chapter Two: Literature Review

2.1 Cancer in Canada

Cancer is the leading cause of death in Canada, causing more deaths annually than heart disease, cerebrovascular diseases, and chronic lower respiratory diseases combined (Canadian Cancer Society [CCS], Statistics Canada, Public Health Agency of Canada, & Provincial/Territorial Cancer Registries, 2017). In 2012, cancer caused slightly more than 30% of deaths in Canada, and it is estimated that cancer will reflect the loss of 80,800 Canadians in 2017 alone (CCS et al., 2017). It was also estimated that 202,400 Canadians were diagnosed with some form of cancer in 2016, and roughly one in two Canadians will be diagnosed with cancer at some point during their lifetime (CCS et al., 2017). The prevalence level of cancer in Canada has been rising over the last several decades due to population growth and an aging population (CCS et al., 2017). Despite this, treatment options have become more advanced over time, improving survivability as a result (CCS et al., 2017). At the beginning of 2009, there were over 800,000 people living in Canada who had a cancer diagnosis within the past 10 years, representing approximately 2.4% of the Canadian population, and there are now more cancer survivors in Canada than there ever have been in the past (CCS et al., 2017). A cancer survivor is most commonly defined as a person who has experienced living with, through, and beyond a cancer diagnosis – meaning that someone is considered a cancer survivor the moment they are diagnosed with the disease (National Coalition for Cancer Survivorship [NCCS], 1996). Though it varies significantly by type of cancer, the overall five-year relative survival ratio for cancer survivors in Canada is now about 60% (CCS et al., 2017). This means that when a Canadian is diagnosed with cancer, the odds of that person surviving for five

years beyond the diagnosis, in comparison to members of the general population, is 63%, illustrating the improvements in treatments and advancements in early diagnosis over the years. Because of this, a cancer diagnosis is no longer considered to be an ‘automatic death sentence’, as it once was. This is important to note because, though cancer survivorship is better than it has been in previous years, it means that a high number of people will have to live with the long-term adverse effects of cancer and cancer treatments for a very long time, placing a particularly large burden on both the Canadian population and health care decision-making.

2.2 Side Effects of Cancer Treatment

Cancer survivorship has vastly improved over the years, and we are now beginning to learn more about the long-term negative side effects associated with cancer and its treatments (e.g., chemotherapy, radiation therapy, surgery, hormone therapy). While it is important to highlight the effectiveness of cancer treatments, it is also crucial to note that an unfortunate consequence of these treatments is that they cause acute and chronic side effects that decrease quality of life (QoL; Courneya, Rogers, Campbell, Vallance, & Friedenreich, 2015). The adverse side effects are wide ranging in severity and may persist indefinitely. The negative side effects of cancer treatments are normally categorized into one of two groups, which include short-term side effects, felt during and shortly after treatment, and late-appearing, long-term effects, which may not emerge for months or, perhaps, years after treatment has been completed (American Cancer Society [ACS], 2014a; 2014b).

In regards to the short-term side effects of cancer treatment, the negative effects may vary based on the type of treatment received. For example, chemotherapy has a

number of short-term side effects that can be felt during and shortly after treatment completion, which can include: fatigue; hair loss; nausea and vomiting; a loss of appetite; constipation; diarrhea; mouth, gum, tongue, and throat problems (e.g., dryness, irritation, sores, and infections); nerve and muscle problems (e.g., loss of balance, problems walking, jaw pain, vision problems, and hearing problems); skin and nail changes (e.g., acne, dryness, and itchiness); urine changes and kidney and bladder problems (e.g., pain while urinating, increased frequency of urination, bloody urine, and fevers); weight gain; and an increased chance of bruising, bleeding, and developing an infection or anemia (ACS, 2014a). Additionally, radiation therapy also has a wide range of short-term side effects, which can include: fatigue; skin problems (e.g., red, irritated, swollen, irritated, blistered, sunburned, dry, and itchy skin); hair loss; blood count changes; eating and digestive problems; and emotional problems (e.g., depression, anger, fear, frustration, loneliness, and a feeling of helplessness; ACS, 2014b).

While short-term side effects of cancer treatment are typically a result of individual therapies, cancer care is often made up of a combination of different cancer therapies, and this commonly results in late-appearing, long-term side effects (Aziz, 2007). Similar to the short-term side effects, late-appearing effects are wide ranging and may vary depending on what treatments were received and what type of cancer was being treated. For example, cancer survivors who experienced surgery as part of their cancer care may experience pain, cosmetic effects, psychosocial effects (e.g., anxiety, depression, sleep patterns, body image), sexual dysfunction, impaired immune function, difficulty breathing, nausea, vomiting, and fatigue, among other late-appearing effects (Ganz, 2009). Treatments including radiation therapy may cause cancer reoccurrence,

hypertension, various hormone deficiencies, and low blood counts (ACS, 2014b). Additionally, therapies including chemotherapy and hormone therapy also have late-appearing effects, such as cancer reoccurrence, heart inflammation, immune suppression, numbness and tingling, and mobility disorders (ACS, 2014b; Ganz, 2009). Not only are there a significant number of effects that may occur, but the majority of cancer treatments currently available are associated with a very high risk that at least one late effect will be experienced (Ganz, 2009). Unfortunately, this means that the QoL of cancer survivors may be adversely affected indefinitely.

The wide range of negative effects of cancer treatment that exist combined with the high probability that at least one will be felt is a big burden that cancer survivors have to face. Aside from causing immense pain and discomfort, these side effects can also prevent cancer survivors from living a normal life (Young & White, 2006; Fong et al., 2012). Many cancer survivors expect to be able to jump back into their pre-cancer diagnosis routine after successfully completing cancer treatment (Fong et al., 2012), only to find the side effects persisting for a considerable amount of time afterwards, making it impossible to live the life they had before. Lingering health issues are a frustrating reality for cancer survivors, which may increase their stress. It is important to create a realistic set of expectations in cancer survivors regarding how to manage their life after their cancer and treatment. This can be done through a wellness plan, which is an action plan for healthy living developed by a cancer survivor and their healthcare team following cancer treatment (CCS, n.d.). Educating cancer survivors about implementing a wellness plan for living with and recovering from cancer can help them feel more in control of their life. A good wellness plan would include a reduction in risk behaviours, such as

smoking and sun exposure, and an increase in health behaviours, such as a balanced, nutritious diet and regular physical activity (PA; CCS, n.d.). Engaging in the recommended levels of PA is known to improve the QoL of cancer survivors by reducing fatigue and improving muscle strength, flexibility, aerobic fitness, body constitution, and overall well-being (Baumann, Zopf, & Bloch, 2012). Therefore, PA in cancer survivors is a research topic that has been garnering increased attention for quite some time, and is a research topic that requires further investigation.

2.3 Quality of Life & Physical Activity in Cancer Survivors

Although there is not a standard definition, QoL is commonly referred to as a multidimensional construct that includes areas related to physical, emotional, and social functioning (Jansen, Koch, Brenner, & Arndt, 2010). In research dealing with medical populations such as cancer survivors, QoL typically refers exclusively to ‘health-related quality of life’ because researchers in this area are primarily focused on how medical disorders impair everyday functioning within this population and how their health status is evaluated (Kaplan & Bush, 1982; Kaplan & Ries, 2007). Researchers are particularly concerned with the QoL of cancer survivors because it has been found that cancer survivors have a poorer overall QoL than similar individuals who have never had cancer (LeMasters, Madhavan, Sambamoorthi, & Kurian, 2013). For example, cancer survivors report more activity limitations than non-cancer survivors as well as a poorer perceived general health (LeMasters et al., 2013). Additionally, cancer survivors are more likely to report poorer outcomes on a number of burden measures, including arthritis or rheumatism, back or neck problems, bones or joint injuries, hypertension, and lung problems, as well as more likely to report multiple comorbid conditions (Yabroff,

Lawrence, Clauser, Davis, & Brown, 2004). On top of this, it has also been determined that cancer survivors face more burdens than their non-cancer counterparts that may last for as long as 11 years beyond their diagnosis (Yabroff et al., 2004).

While it is unfortunate that cancer survivors typically have a lower QoL than those who have never had cancer, a positive finding that has emerged from research is that cancer survivors can improve their QoL through increased PA, both during treatment and after it has been completed (Courneya et al., 2007; Fong et al., 2012; Segal et al., 2009; Speck, Courneya, Masse, Duval, & Schmitz, 2010). To illustrate, reviews on the topic have shown that increased PA levels improve the QoL of cancer survivors by reducing stress, fatigue, pain, shortness of breath, insomnia, constipation, depression, and anxiety, and by improving sleep disturbance (Albrecth & Taylor, 2012; Courneya et al., 2015; Mishra et al., 2012a, 2012b). Furthermore, it has been determined that PA is safe and feasible for cancer survivors, making it an ideal behaviour to target in QoL interventions (Courneya & Friedenreich, 2007).

There has been a surge in research on the topic of PA in cancer survivors in recent years, and a number of reviews have been conducted to highlight the vast benefits that PA interventions have had on cancer survivors (Albrecth & Taylor, 2012; Fong et al., 2012; Friedenreich, Neilson, Ferris, & Courneya, 2016; Furmaniak, Menig, & Markes, 2016; Knols et al., 2005; Mishra et al., 2012a, 2012b). Knols et al. (2005) determined in a review that exercise during breast cancer treatment improved functional capacity, psychological well-being, and self-reported outcomes, such as nausea. In a systematic review, Furmaniak et al. (2016) investigated 32 studies on the effects of physical exercise on breast cancer survivors undergoing adjuvant therapy. Through their review, Furmaniak

et al. (2016) concluded that exercise during adjuvant therapy likely improves physical fitness, fatigue levels, and cognitive functioning, and additionally may lead to small improvements in health-related QoL, cancer site-specific QoL, and depression. In another review, Friedenreich et al. (2016) looked at 26 studies of post-diagnosis PA in breast, prostate, and colorectal cancer patients. Based on the review, the authors determined that when comparing the most active patients to the least active patients, a 37% reduction was seen in cancer-specific mortality, and risks of cancer recurrence were lowered as well. Moreover, Fong et al. (2012) conducted a meta-analysis of studies involving randomised controlled trials of PA in cancer survivors after their treatment ended. Through their review, Fong et al. (2012) concluded that PA improved the physical functioning, social functioning, and mental health of cancer survivors of various types of cancers. Other reviews on this subject have made similar conclusions, finding that exercise and PA improves fatigue, well-being, physical QoL, and psychological QoL (Knobf, Musanti, & Dorward, 2007; Bauman, Zopf, & Bloch, 2012).

Despite the findings that PA has positive benefits for cancer survivors, and similar to adults in the general population, cancer survivors often do not report high levels of PA. For example, Smits et al. (2015) found that only 21% of ovarian cancer survivors met PA recommendations, which is very comparable to the 22% of adult Canadians in the general population that meet the recommended PA guidelines (Stats Canada, 2015). However, Lynch et al. (2010) found through objective measures of PA that a sample of breast cancer survivors only averaged 4 minutes of moderate-to-vigorous PA per day, which is lower than adults in the general population, where it has been reported that, on average, adult Canadians spend approximately 25 minutes per day in moderate-to-vigorous PA

(Stats Canada, 2015). According to Foucaut et al. (2015), breast cancer survivors have a significant deterioration of PA and an increase in sedentary behaviour (SB) during the time between their diagnosis and chemotherapy treatment, and Lynch et al. (2016) found that just 9% of participants in their study expressed that they received PA advice by their doctor. This is problematic, as it has been suggested that there is no reason why activity advice should not be provided to patients by healthcare professionals when advice about smoking cessation is, as both are equally important, and inactivity may be a greater risk for all-cause mortality than smoking (Coombes, Law, Lancashire, & Fassett, 2015). It has also been determined that there have been very few exercise trials that have specifically targeted cancer survivors based on their need for improvement of a given symptom, such as fatigue or depression, suggesting that the majority of exercise trials have a ceiling or floor effect for a given symptom and, thus, indicating an underestimation of the positive effects exercise can have (Courneya et al., 2015; Speck, Courneya, Masse, Duval, and Schmitz, 2010). Moreover, the number of cancer survivors who meet PA recommendations beyond interventions has been 65% at best (Courneya et al., 2015), suggesting that improvements can be made, making it justifiable to conduct more research in this area. It is also important to investigate other modifiable health behaviours in cancer survivors so that the QoL of cancer survivors can be improved as much as possible. Helping cancer survivors make positive changes to improve their QoL is especially feasible because it has been suggested that a cancer diagnosis is a ‘teachable moment’ in which cancer survivors are more willing to make changes in their lifestyle behaviours, indicating that interventions targeted towards this population have the potential to be very effective (McBride, Clipp, Peterson, Lipjus, & Denmark-Wahnefried,

2000). One modifiable health behaviour that is related to PA and is becoming increasingly relevant in the modern world due its increased prevalence as technology advances is SB.

2.4 Sedentary Behaviour and Cancer Survivorship

A relatively new research area that is similar to, but independent of, PA is SB. The word sedentary is rooted from the Latin term sedere, which means, “to sit” (Gibbs, Hergenroeder, Katzmarzyk, Lee, & Jakicic, 2015). Today, SB takes on a little more of a deeper meaning; however, there is not yet a consensus on how to define it. One way to define SB is by referring to it as any waking behaviours that are performed while in a seated position and expend energy less than or equal to 1.5 times the resting metabolic rate (The Sedentary Behaviour Research Network, 2012). Another, more simplified, common definition describes SB as sitting or lying down for extended periods of time without whole-body movement (Owen, Bauman, & Brown, 2009). In either case, SB is distinctly different than physical inactivity, which refers to the failure to meet the recommended levels of moderate-to-vigorous PA of 150 minutes per week in bouts of at least 10 minutes (Legh-Jones & Moore, 2012). Through this understanding, SB and PA are mutually exclusive behaviours, as both cannot be performed at the same time; however, they are not collectively exhaustive, either, in that a person may regularly engage in the recommended levels of PA, but spend high amounts of time being sedentary during the rest of their day, or a person may be physical inactive, but spend very little time being sedentary. Because SB is a unique behaviour that is independent of physical inactivity, and because modern lifestyles require less energy demands due to the advancements in and accessibility of technology that make daily tasks much easier to

perform than ever before, research on the health outcomes of SB is warranted, which has resulted in a growth on the topic in recent years.

It has been demonstrated that SB is associated with adverse health outcomes that are independent from those associated with physical inactivity (Owen, 2012), and regardless of PA levels, SB will still yield deleterious effects (Biswas et al., 2015; Hensen et al., 2013). Furthermore, there is evidence to suggest that SB has greater health risks than physical inactivity (Hensen et al., 2013). A recent meta-analysis (Biswas et al., 2015) concluded that high levels of sedentary time were positively associated with a higher risk for numerous causes of mortality, including cardiovascular disease mortality, cancer mortality, and all-cause mortality, as well as being positively associated with a higher risk for incidence of chronic diseases, such as cardiovascular disease, cancer, and type 2 diabetes. Moreover, sedentary time was also found to be significantly associated with breast, colon, colorectal, endometrial, and epithelial ovarian cancer (Biswas et al., 2015), and recent research indicates that high amounts of sedentary time is associated with negative metabolic consequences (Dallal et al., 2016; Healy, Matthews, Dunstan, Winkler, & Owen, 2011), such as increased central adiposity and higher endogenous estrogen levels (Lynch, 2010). In addition to this, not only is total sedentary time detrimental to health, but so are prolonged uninterrupted bouts of SB (Cavalheri et al., 2016; Healy et al., 2011), and public health campaigns have recommended that sedentary time should both be reduced and interrupted with light activity every 30 minutes (Cavalheri et al., 2016; Lynch et al., 2011).

Sedentary behaviours can encompass many different activities. In today's world, these activities are wide ranging, and can include screen time behaviours (e.g., phone

usage, computer usage, television (TV) viewing, video games), reading, transportation, and time spent eating meals, to name a few. In western countries, television (TV) viewing is the most common SB in adults (Cao et al., 2015; Grontved & Hu, 2011; Wijndaele et al., 2011) and it effectively ranks individuals by sedentary lifestyle (Fung et al., 2000; Owen, Healy, Matthews, & Dunstan, 2010), thus indicating its importance in SB research. The effects of TV viewing have generated interest in research in recent years, as it has been found that a high level of TV viewing is associated with a host of negative effects, including metabolic disorders, diabetes, mental health disorders, self-rated health, clotting disorders, cancer, bladder disease, and bowel disease (Shiue, 2016). Longitudinal studies have been conducted on the long-term effects of TV viewing, which have further legitimized the detrimental effects of this behaviour. For example, a longitudinal study over a 14-year period following older adults found that a 2 hour per day increase in TV viewing was significantly associated with higher mortality rates for cancer, heart disease, chronic obstructive pulmonary disease, diabetes, influenza/pneumonia, Parkinson disease, liver disease, and suicide (Keadle et al., 2015). Additionally, a longitudinal study conducted by Keevil et al. (2015) found that adults who watched less than 2 hours of TV per day had a walking speed of 4.29 cm/second faster than those who watched greater than 4 hours of TV per day, suggesting that more sedentary time is associated with increased lethargy. Further research has demonstrated that every hour increase in TV viewing is associated with higher body mass index (BMI), waist circumference, fasting insulin, and HOMA-IR (Wiseman, Lynch, Cameron, & Dunstan, 2014), and additionally, it has been found that watching TV for greater than 4 hours per day is linked with a

higher risk of dying from chronic obstructive pulmonary disease (COPD) than watching TV for less than 2 hours per day (Ukawa et al., 2015).

There is evidence that suggests there are adverse health effects for high levels of TV viewing in cancer survivors (Arem et al., 2015; Lynch, Cerin, Owen, Hawkes, & Aitken, 2011). For example, Cao et al. (2015) assessed pre- and post-diagnostic time spent sitting while watching TV and other sedentary behaviours in male colorectal cancer survivors. Results indicated that high amounts of pre-diagnostic TV viewing was linked with a higher risk of colorectal cancer-specific mortality, regardless of PA levels. Furthermore, it was found that participants who had higher TV viewing habits before diagnosis spent more time being sedentary while doing other activities at home than others, had lower levels of PA, and reported lower dietary scores.

Sedentary behaviour prevalence is quite high in today's world, which is problematic for cancer survivors and their health. To date, there has been limited research conducted on SB rates for cancer survivors. However, based on the limited research that has been conducted thus far, estimates using objective measures have suggested that cancer survivors spend approximately 60-70% of their waking hours in SB (Courneya, Rogers, Campbell, Vallance, & Friedenreich, 2015), and Lowe et al. (2015) found that, when including sleep, cancer patients were sedentary for approximately 20.2 hours a day and only stood for 2 hours per day. Additionally, it has been suggested that Canadian adults in general spend most their time being sedentary, with estimates of waking time SB for men and women being 68% and 69%, respectively (Colley et al., 2011). Moreover, in an experimental study, Cavalheri et al. (2016) compared SB levels of non-small cell lung cancer survivors to healthy controls and found that, while there was not a significant

difference, the non-small cell lung cancer survivors had a higher percentage of waking hours in sedentary time than the control group, suggesting that cancer survivors may be at least as sedentary as the general population. This is problematic for cancer survivors because, due to the adverse effects associated with high levels of SB, sedentary cancer survivors are putting themselves at an increased risk of developing an additional cancer, cancer progression, and overall cancer mortality (Lynch et al., 2013). Nelson et al. (2016) studied a large cohort of breast cancer survivors and found that low levels of PA, indicating a sedentary lifestyle, is significantly linked with breast cancer mortality. Additionally, it has also been found that for every additional fifteen minutes spent being sedentary, there is a 0.13 cm increase in waist circumference (Saunders et al., 2013), indicating that greater sedentary time is linked with increased weight, and that sedentary time is adversely associated with multiple markers of cardiometabolic health, including glucose, HDL-cholesterol, and triacylglycerol (Hensen et al., 2013). These adverse effects suggest that sedentary cancer survivors are at an increased risk of developing other chronic illnesses, such as type 2 diabetes and cardiovascular disease (e.g., heart disease, stroke).

While the research on SB in cancer survivors is still limited, a number of studies utilizing objective measures to study SB in cancer survivors have been conducted in recent years, particularly in breast cancer survivors, finding varying results. For example, Boyle, Vallance, Ransom, and Lynch (2016) objectively measured PA and SB levels in breast cancer survivors and found that participants averaged about eight hours per day of sedentary time, which was roughly 57% of their waking hours. This is in contrast to other studies that have used objective measures to assess SB in breast cancer survivors, which

found that participants were sedentary for over ten hours per day (Sabiston, Brunet, Vallance, & Meterissian, 2014) and a little over nine hours per day (Lynch et al., 2010; Phillips et al., 2015a), respectively. Phillips et al. (2015b) also used objective measures for assessing PA and SB in breast cancer survivors and the results showed that breast cancer survivors displayed more SB than controls, and on average, spent approximately 66.4% of their waking time engaged in SB. Furthermore, another study showed that in the first year following treatment, breast cancer survivors had roughly eleven hours of sedentary time per day, or 78% of waking hours, and about fourteen-to-sixteen minutes per day of moderate-to-vigorous PA (Sabiston, Brunet, Vallance, & Meterissian, 2014). All in all, the limited research thus far suggests that breast cancer survivors spend between 57 to 78% of their waking hours in sedentary time. The effects of SB have been shown to be detrimental to the health of breast cancer survivors, as indicated by Trinh, Amireault, Lacombe, and Sabiston (2015a), who found that SB was linked with higher fatigue, pain, and symptoms of depression in breast cancer survivors, and Phillips et al. (2015a), who found that sedentary time was positively associated with fatigue duration in breast cancer survivors.

In addition to objectively measured SB research conducted on breast cancer survivors, there have also been studies in this area conducted on colon cancer survivors. Among these studies, SB was linked with poor survival (Campbell, Patel, Newton, Jacobs, & Gapstur, 2013), a higher risk of heart disease (Hawkes, Lynch, Owen, & Aitken, 2011), increased BMI (Wijndaele et al., 2009), and lower QoL scores (Lynch, Cerin, Owen, Hawkes, & Aitken, 2014). Lynch et al. (2016) conducted a study that investigated patterns of PA and sedentary time in colon cancer survivors who wore

accelerometers for a week. The results indicated that gender, comorbidities, and BMI were correlated with sedentary time. That is, women spent forty-two minutes per day less in sedentary activities compared to men, participants with two or more comorbidities were more sedentary by thirty-four minutes per day in comparison to participants with no comorbidities, and obese participants were more sedentary than participants with a normal BMI by about forty-four minutes per day. Additionally, light PA was moderately correlated with moderate-to-vigorous PA and strongly inversely correlated with SB. There was also a moderate inverse correlation between SB and moderate-to-vigorous PA. Overall, participants had an average of five hours per day of light-intensity activities and almost nine hours of sedentary time per day, with sedentary time typically being higher on Saturdays and in the evenings.

Studies utilizing accelerometers to study SB in other groups of cancer survivors have also taken place in recent years. For example, Lowe et al. (2015) examined objectively measured sedentary time in patients with brain metastases who were receiving palliative whole brain radiotherapy, as well as the variables associated with the theory of planned behaviour. Results indicated that higher SB was strongly associated with lower levels of affective attitude (i.e., perceived enjoyment) and instrumental attitude (i.e., perceived benefits) of PA. Also, older age was linked with higher levels of SB. Additionally, in another study, Lynch et al. (2011) conducted a study on prostate cancer survivors using objective measures and found that the participants only averaged about six minutes per day of moderate-to-vigorous PA, indicating an inactive lifestyle.

While the above studies demonstrate the high prevalence of SB in cancer survivors, as well as its deleterious effects, it is important to note that, overall, studies

examining the relationship between sedentary time and health outcomes in cancer survivors is misunderstood, as results for these studies have yielded mixed conclusions. To illustrate, Vallance, Boyle, Courneya, and Lynch (2014) found no relationship between QoL, fatigue, depression, anxiety, or life satisfaction with SB in colorectal cancer survivors. However, in contrast to this, findings from a similar study have also indicated that substituting SB with standing or PA may be linked with improvements in certain health-related QoL outcomes in colorectal cancer survivors (Van Roekel, 2016). Additionally, brain metastases patients who reported at least 20.7 hours per day or sedentary time reported higher depression, anxiety, drowsiness, and lower well-being compared to patients who were sedentary for less than 20.7 hours per day (Lowe et al., 2015). Surprisingly, such patients also had better physical functioning, indicating a protective effect for sitting in people with advanced cancer. Furthermore, participants who stood for greater than 1.6 hours per day had a higher QoL than those who stood for less than 1.6 hours per day (Lowe et al., 2015). These contradictory findings suggest that it is still unknown what the relationship is between SB and physical health outcomes (e.g., BMI, functional well-being), health-related fitness outcomes (e.g., cardiorespiratory fitness, muscular strength), and cancer-related outcomes (e.g., cancer recurrence, mortality), and it is important for future research to understand these health outcomes as they relate to sedentary time (Courneya et al., 2015).

Sedentary behaviour research on cancer survivors is still relatively new and there are many areas that need to be further explored. One area that has yet to be fully studied is the development of SB interventions in cancer survivors. Thus far, there have not been many intervention studies designed to reduce SB, and even less in cancer survivor

populations. Matthews et al. (2015) followed a large sample of older adults over a six-year period and found that higher sitting time had an increased association with all-cause and cardiovascular mortality. Furthermore, it was found that replacing one hour per day of sitting time with either exercise or non-exercise activities (e.g., household chores, gardening, walking) resulted in lower all-cause mortality, indicating the promise of SB interventions. In a mixed methods study on African American breast cancer survivors, Paxton, Anderson, Sarkar, and Taylor (2016) found that the biggest challenge in terms of breaking up sitting time for this population was their health, such as pain and fatigue, suggesting that SB intervention studies on cancer survivors will be challenging and have barriers to overcome. Because of the many adverse effects associated with SB, it is important for research to focus on developing interventions to reduce this behaviour. However, it is also important for more information to be collected on SB in various populations of cancer survivors using both objective and subjective measures. Results from previous studies have shown that the self-reporting of PA is inflated when compared to objective measures (Lynch et al., 2010; Lynch et al., 2011). Thus far, there have been few studies comparing objective and subjective measures of SB in cancer survivors. A recent study (Boyle, Lynch, Courneya, & Vallance, 2015) compared accelerometer and self-reporting data for both PA and SB in colon cancer survivors, and results showed that self-reporting and accelerometer data did not have strong agreement. While objective measures provide more accurate data on PA and SB, self-reporting offers immense value as a tool to collect data, as self-reporting measures are cost effective, time efficient, and are able to reach a large number of people. Thus, since SB research in cancer survivors is still limited, it is essential for more data to be collected in this area using both objective

and subjective measures, particularly in more vulnerable cancer survivor populations. One group of cancer survivors that is especially at risk is young adult cancer survivors (YACS), who display higher risk-taking behaviours than other cancer survivors and, therefore, are at an increased risk for developing chronic illness (Bellizzi, Rowland, Jeffery, & McNeel, 2005), making YACS an important population to study for the purpose of finding ways to improve their QoL.

2.5 Young Adult Cancer Survivors and Health Behaviours

Cancer is the leading cause of death in adolescents and young adults behind suicide, poisoning, and accidental death by injury (Australian Institute of Health & Welfare, 2011; Bleyer & Barr, 2009; Patterson, McDonald, Zebrack, & Medlow, 2015), and is the leading cause of disease-related death in this age group (Chou & Moskowitz, 2016). In fact, in young adults between the ages of twenty and thirty-nine, cancer accounts for more deaths than heart disease, human immunodeficiency virus, diabetes mellitus, chronic liver disease, cerebrovascular disease, and congenital anomalies combined (Jemal et al., 2005). Adolescent and YACS are uniquely challenged socially and psychologically, with their cancer diagnosis impacting their identity development, coping, distress, and social relationships (D'Agostino, Penney, & Zebrack, 2011; Zebrack, 2011; Zebrack, Hamilton, & Smith, 2009). There are many milestones that are achieved during young adulthood, such as separation from parents, starting a family, completing education and professional training, starting a career, and establishing financial security (Barnett et al., 2016; Chou & Moskowitz, 2016; Feldman, 2002). Being diagnosed with cancer can be a major interruption for these milestones, and compared to older cancer survivors, YACS have more concerns about being physically unable to have

children, more challenges in pursuing their most desirable career choice, difficulty changing jobs because of a fear of losing health insurance, feelings of anger, less able to provide for their family, more job discrimination, and more problems with family or children (Baker, Denniston, Smith, & West, 2005; Chou & Moskowitz, 2016).

Approximately 10,000 young adults between the ages of twenty and forty-four are diagnosed with cancer every year in Canada and it is estimated that, since 1980, there have been over 150,000 Canadian cancer survivors that were diagnosed at a young age (Cancer Care Ontario (CCO), Public Health Agency of Canada, & Canadian Cancer Society, 2006). Moreover, rates of adolescent and YACS are rising (Bleyer, O'Leary, Barr, & Ries, 2006). Fortunately, the five-year relative survival rate for adolescent and YACS is over 80% (Breitenbach, Epstein-Reeves, Hacker, Corte, & Piano, 2014; National Cancer Institute [NCI], 2013). Regrettably, this also means that YACS have to live with the long-term negative consequences of cancer treatments for a very long time, and despite this, YACS are a demographic that are underrepresented in the literature (Rabin, Horowitz, & Marcus, 2013). This is in part due to the challenges in working with this population, such as their transient lifestyle. However, there are numerous reasons why it is important to research YACS. Firstly, YACS have an increased risk of long-term adverse physical outcomes in their lifetime, including cancer recurrence (Kero et al., 2013; Woodward, Jessop, Glaser, & Stark, 2011), as well as an increased risk of prematurely developing and experiencing accelerated progression of chronic diseases (Finnegan, Wilkie, Wilbur, Campbell, & Zong, 2007). Chao et al. (2016) presented such evidence when they found that adolescent and YACS were twice as likely to be at risk for cardiovascular disease in comparison to people of the same age without a cancer

diagnosis, and Rugbjerg et al. (2014), who performed a Danish cohort study with data from 1943-2009, found that adolescent and YACS are at an increased risk for cardiovascular disease over the course of their life. Additionally, research shows that PA levels among YACS are low, despite them feeling able to take part in PA (Bélanger, Plotnikoff, Clark, & Courneya, 2011, 2012). Furthermore, YACS can live forty to sixty years longer than older cancer survivors, meaning the years affected by cancer are four to six times greater (Bleyer, 2007), and thus indicating that YACS have to live with a lowered QoL for a longer period of time compared to other cancer survivor populations. It can be said that young adults are or will become the most productive members of society; therefore, there are an immense number of benefits to improving the duration and QoL of this population (Bleyer, 2007). Finally, due to the devastating toll of cancer survivorship at such a young age, YACS have a higher risk of experiencing adverse psychological effects, such as depression (Deyell et al., 2013; Hewitt & Rowland, 2002), and roughly 60% of YACS experience physical and/or psychological late-appearing effects (Greenen et al., 2017; Hudson et al., 2013; Michel & Vetsch, 2015; Oeffinger et al., 2006).

The reasons stated above suggest that further research on YACS is warranted. While research on this population is currently limited, there have been a few studies conducted on YACS in relation to their needs, QoL, and PA levels. In terms of needs, DeRouen et al. (2015) interviewed adolescent and YACS and found that two thirds (67%) of this population felt that their cancer-related information needs were not being met and about half (47%) felt that their cancer diagnosis negatively impacted the control they have over their life. In a systematic review, Barnett et al. (2016) investigated psychosocial

outcomes and interventions in adolescence and YACS, and they concluded that adolescent and YACS have different experiences than other cancer survivors and require age-appropriate information and treatment to foster improved psychological outcomes and long-term survivorship. Raque-Bogdan et al. (2016) interviewed young adult breast cancer survivors in a qualitative study and a common theme was that cancer was related to feelings of a loss of control over career success and work choices. Additionally, young women who had more treatment and experienced more side effects indicated that they had greater work struggles (Raque-Bogdan et al., 2016). In another systematic review, Warner et al. (2016b) concluded that adolescent and YACS commonly report difficulties related to employment, educational attainment, and financial stability, as well as trouble with peer, family, and intimate relationships. It was also found that adolescent and YACS have a desire for supportive services (Warner et al., 2016b). It is clear, based on this research, that YACS have unique needs that are not being met, supporting the notion that more research on this population is necessary.

Studies that have assessed the QoL of YACS suggest that this population experience detrimental affects in many areas of their life (Daniel et al., 2016; Salsman et al., 2014). In a study that compared YACS to healthy controls on numerous measures, including health-related QoL and psychological adaptation, Salsman et al. (2014) found that YACS reported a poorer physical and emotional well-being. Daniel et al. (2016) performed a study on adolescent and YACS that measured sleep quality, sleep patterns, and psychological function. Results indicated that YACS had more fatigue than controls, and within cancer survivors who had sleep and fatigue problems, depression, anxiety, and post-traumatic stress symptoms were higher. Health behaviours in adolescent and YACS

were investigated by Warner et al. (2016) and it was determined that this population commonly engage in unhealthy behaviours. Kaul, Veeranki, Rodriguez, and Kuo (2016b) surveyed adolescent and YACS and found that they were significantly more likely to smoke than non-cancer controls of similar demographics. Furthermore, the presence of comorbidities and poorer health overall were seen among the cancer survivor group, and cancer survivors who were smokers reported more comorbidities and poorer health in comparison to non-smoking cancer survivors. In another study by Kaul, Fluchel, Spraker-Perlman, Parmeter, and Kirchhoff (2016a), adolescent and YACS reported lower satisfaction for their health care in comparison to non-cancer controls. Nagler, Puleo, Sprunck-Harrild, Viswanath, and Emmons (2014) found that active seeking of health information among childhood and YACS who smoke to be very low. Moreover, Goldfarb and Casillas (2016) found that in young adult thyroid cancer survivors, neuromuscular, anxiety, and concentration complaints all predicted lower health-related QoL. Finally, Berg, Stratton, Giblin, Esiashvili, and Mertens (2014) conducted an online health behaviours intervention on young adult survivors of childhood cancers and found health-related mental and physical QoL were significantly lower (DeRouen et al., 2015).

Studies on the PA levels of YACS have been limited, but have increased in recent years. However, the results that have been collected so far suggest that PA levels in this population are typically low (Bélanger et al., 2011). Examining PA prevalence in YACS, Bélanger et al. (2011) found that only about half of YACS meet the PA recommended guidelines, about a quarter of YACS were sufficiently inactive, and another quarter were completely inactive. However, despite these findings, a subsequent study by Bélanger et al. (2012) found that the majority of YACS were interested in PA and felt as though they

were capable of doing it. Similarly, Rabin (2011) concluded in a review that YACS express an interest in learning more about exercise, which is a finding that was subsequently mirrored in a study by Murnane, Gough, Thompson, Holland, & Conyers (2014). Murnane et al. (2014) interviewed adolescent and YACS and found that PA levels significantly decreased both during treatment and post-diagnosis, and among survivors who met PA recommended guidelines, QoL was found to be significantly higher. Additionally, less than half of the participants reported that they had not received any information about exercise at all after their diagnosis, and the authors concluded that interventions to improve PA and QoL in this population would be well received and may be critical to improve QoL and long-term health in this population.

Furthermore, in addition to the information collected about PA in YACS, there have been a small number of intervention studies that have taken place over the last few years. In an adventure therapy intervention study, Gill, Goldenberg, Starnes, and Phelan (2016) found that a weeklong camp intervention for YACS significantly increased PA both during camp and three months post-camp, albeit the effects were attenuated over time. Additionally, Hauken, Holsen, Fismen, and Larsen (2014) led a rehabilitation program for YACS over a six-month period that led to significant improvements in performance and satisfaction in the program, with key factors of the program being reported as PA, psychoeducation, peer-to-peer support, and follow-up over time. In a follow-up study, Hauken, Holsen, Fismen, and Larsen (2015) found that a rehabilitation program significantly improved health-related QoL and results were shown to be stable one year later, and there were improvements seen in physical fitness, lung capacity, all functional dimensions, and a decrease in fatigue. Finally, Rabin, Pinto, and Fava (2016)

performed a twelve-week PA and meditation theory-based intervention for YACS. After twelve weeks, the intervention group had significantly higher PA levels and significantly better cardiovascular fitness than the control group. The authors concluded that the intervention was deemed feasible and acceptable by the participants based on interviews that were conducted, and there was evidence to suggest that the intervention enhanced mood as well.

While there have been a limited number of studies on the QoL and PA of YACS, there have been virtually no studies conducted yet on the SB in this population. Due to the increase in SB research over recent years, and due to its increasing relevance, this is a big gap in the literature that needs to be addressed. Additionally, because YACS are at an increased risk for developing other health issues, such as cardiovascular outcomes (Kero et al., 2013) and mental health conditions (Deyell et al., 2013), it is crucial that they improve their lifestyle behaviours (e.g., PA, SB) as much as they can. Rabin, Simpson, Morrow, and Pinto (2011) found that there are a number of barriers that affect the PA levels of YACS, including psychosocial barriers (e.g., a lack of motivation), health-related barriers (e.g., fatigue, late treatment effects), practical barriers (e.g., limited time), and education barriers (e.g., a lack of awareness of programs, a lack of existing programs). This suggests that YACS need help in improving their PA levels through interventions, and based on what we know about the behaviours of YACS so far, it seems apparent that behaviour change therapies are important to develop in this population. Motivating YACS to increase their PA levels would help them in reducing their risk of developing other chronic conditions and help them in coping with psychological conditions, such as depression, and thus improve their QoL. While the SB levels in this

population are currently unknown, it is possible that motivating YACS to reduce their sedentary time would result in improvements to their QoL as well. However, in order to create a framework for effective interventions for this specific population, comprehensive research on YACS existing health behaviours needs to be performed. This study will help build a foundation of knowledge in this area by collecting valuable information about YACS' PA levels, SB levels, and QoL, which can be used to develop effective behaviour interventions with the goal of improving QoL and health outcomes in this population.

2.6 Measures of SB, PA, and QoL

The primary measure for the current study will be SB and it will be assessed using the SIT-Q, which has been validated as a measure of SB (Lynch et al., 2014). There are currently very few questionnaires that measure multiple types of sedentary behaviours in adults (Healy et al., 2011). Many studies that have examined adult SB have had limitations in their methodology in terms of measurement. For example, most studies that have investigated SB have only measured a specific domain of SB, such as occupational sitting or screen time behaviours (Chau, Van Der Ploeg, Dunn, Kurko, & Bauman, 2012; Clark et al., 2011; Marshall, Miller, Burton, & Brown, 2010; Rosenberg et al., 2010; Salmon, Owen, Crawford, Bauman, & Sallis, 2003). Additionally, much of the data in the literature on SB comes from studies that have administered PA based questionnaires whereby SB is measured in a small section as simply a function of total sitting time (Rosenberg et al., 2008). The SIT-Q was chosen to assess adult SB for this study because it aligns well with the goals of project, which is to provide an exhaustive look at SB across multiple domains in YACS.

The SIT-Q asks participants to report their usual amount of time sitting or lying

across a number of different behaviours over the past twelve months. It asks about sedentary behaviours in six separate sections, which include: (1) sleeping and napping; (2) meals; (3) transportation; (4) work, study, and volunteering; (5) childcare and elder care; and (6) light leisure and relaxing (e.g., TV viewing time, leisure computer time, reading time, and other leisure sitting time such as listening to music, doing crosswords, and writing, among other things). The questions ask participants to estimate the amount of time they usually engage in a behaviour in hours and minutes on both weekdays and weekend days. Participants are also told not to ‘double count’ multiple behaviours if they typically occur at the same time. In addition to this, there is a final section at the end of the survey that asks participants to indicate if there are other specific sedentary behaviours that they normally engage in that were not asked about in the questionnaire. If there are, participants will list the items and report how often they take part in the behaviour in hours and minutes for both weekdays and weekend days. Finally, participants are asked to estimate how long it took them to complete the questionnaire.

Secondary measures will be assessed in this study, including PA levels and QoL. The Leisure Score Index (LSI) of the Godin Leisure Time Exercise Questionnaire (Godin & Sheppard, 1985) will assess PA levels. The LSI is a validated measure of PA (Jacobs, Hartman, & Leon, 1993) that assesses the frequency of PA in three areas: light, moderate, and vigorous. Specifically, it asks participants to report the frequency of their PA in these areas over the past month when it occurred for longer than ten minutes and was done during leisure time. The LSI is a common questionnaire in PA and cancer research because it is easily modifiable to include an additional measure that assesses average duration of PA (Courneya, Friedenreich, Sela, Quinney, & Rhodes, 2002; Karvinen et al.,

2006; McGowan, North, & Courneya, 2013; Trinh, Plotnikoff, Rhodes, North, & Courneya, 2012). With this modification, we can calculate PA minutes per week and compare them to the public health PA guidelines (Canadian Society for Exercise Physiology [CSEP], 2012) to determine which participants are meeting the PA guidelines.

In addition to PA, this study will also measure QoL. The Short-Form 36 (SF-36) health survey (Jenkinson, Wright, & Coulter, 1994) is an overall measure of health and functioning that will assess health-related QoL. The SF-36 contains numerous dimensions, including physical functioning, social functioning, role limitations due to physical problems, role limitations due to emotional problems, mental health, energy and vitality, pain, and general health perception. Each dimension generates a score that is scaled from 0 to 100, with higher scores indicating better health status. In addition to this, the Functional Assessment of Cancer Therapy (FACT-G) scale (Cella et al., 1993) is a questionnaire that will assess the QoL specific to patients who have received cancer treatment. The FACT-G uses a 5-point Likert scale (0 to 4) to measure well-being in four domains: (1) physical; (2) social/family; (3) emotional; and (4) functional.

2.7.1 Rationale and Significance

The current study will contribute to the existing literature in a number of ways. First, by obtaining a population-based sample on YACS, this study will collect valuable information about health behaviours, such as SB, PA, and QoL, in a population of people that are underrepresented in the research. Second, the relationship between SB and QoL has not yet been fully studied. It is well known that there is a direct correlation between PA and QoL levels, namely in cancer survivors. Because PA and SB have similarities, it is possible that SB and QoL have a relationship that is not unlike the relationship between

PA and QoL. This study will add to the current knowledge on SB as it pertains to QoL in cancer survivors. Finally, the effects that SB has on cancer survivors has not yet drawn definitive conclusions. As it currently stands, research on the relationship between SB and cancer survivors has yielded mixed results, and the prevalence levels of SB in cancer survivors are not well known. The data collected from the current study will shed more light on the relationship between SB and cancer survivors, which will help future researchers to develop future interventions targeting SB and PA in YACS. For the current study, YACS will be defined as cancer survivors who were diagnosed between the ages of 18 and 44, which is an upper cut point that has been used in previous research (e.g., Bélanger et al., 2011).

2.7.2 Objectives

There are four main objectives for this study, which are as follows:

1. Explore and categorize SB in YACS;
2. Determine PA levels in YACS;
3. Determine the QoL and well-being of YACS;
4. Examine the relationship between SB and QoL in YACS.

2.7.3 Research Hypotheses

Based on the research presented, it is hypothesized that YACS will show high levels of SB. Similarly, it is expected that YACS will have low levels of PA.

Additionally, it is hypothesized that participants who show high levels of SB and low PA levels will have a lower QoL than participants with low levels of SB and high levels of PA.

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Chapter Three: Manuscript

Exploring Quality of Life and its Associations with Sedentary Behaviour and Physical Activity in Young Adult Cancer Survivors

Ryan H. Collins¹, MSc (candidate) & Erin L. McGowan², PhD

Ryan H. Collins, BA, MSc (candidate)

¹ School of Human Kinetics & Recreation

Memorial University of Newfoundland, St. John's, Newfoundland, Canada

Email: ryanc@mun.ca

Erin L. McGowan, PhD

² School of Human Kinetics & Recreation

Physical Education Building (PE 2022B)

Memorial University of Newfoundland, St. John's, Newfoundland, Canada

Email: emcgowan@mun.ca

Telephone: +1 (709) 864-7269

Fax: +1 (709) 864-3979

Abstract

Purpose: To explore sedentary behaviour, physical activity, and quality of life in young adult cancer survivors (YACS), a population that is underrepresented in the literature.

Methods: Participants included YACS aged 18-44, recruited through social media and cancer support group websites (e.g., Young Adult Cancer Canada), completed an online survey, which assessed sedentary behaviour, physical activity, and quality of life using validated measures (i.e., The SIT-Q, Leisure Score Index (LSI), Short Form-36 Health Survey (SF-36), and Functional Assessment of Cancer Therapy: General (FACT-G)).

Results: Results indicated that YACS accumulated an average of 777.1 ($SD= 274.0$) minutes/day of total sedentary time and reported watching TV for an average of 140.1 ($SD= 111.1$) minutes/day. For physical activity, participants reported a mean of 113.4 minutes/week of moderate-to-vigorous physical activity ($SD= 132.4$) and low levels of resistance exercise ($M= 25.8$ minutes/week, $SD= 58.0$). Almost a third of the participants met the public health recommended physical activity guidelines, and moderate-to-vigorous physical activity was positively correlated with the physical component score (PCS) ($r= .32, p<.01$) of the SF-36. Regression analyses showed that moderate-to-vigorous physical activity significantly predicted the PCS ($F(1, 93)= 10.57, p < .01, R^2= .10$), as did napping and TV viewing time ($F(2, 93)= 6.59, p < .01, R^2= .15$).

Conclusion: YACS are a sedentary and inactive population, and their activity levels are positively correlated with indicators of quality of life. It would be beneficial for future research to focus on developing effective interventions to reduce sedentary behaviour and improve physical activity levels in YACS.

Introduction

Cancer is the leading cause of disease-related death in young adults.^{1, 2} To illustrate, in the year 2012 alone, cancer reflected the loss of 8,337 American adults aged 20-39.³ In Canada, prevalence rates for cancer in young adults have risen over the last 30 years, and the five-year relative survival rate for young adult cancer survivors (YACS) and adolescent cancer survivors in the US is over 80%.⁴⁻⁶ While decreases in cancer mortality have occurred due to improvements in early detection and treatment, this also means that YACS must endure the consequences of cancer and its treatments for a long time.⁴ After completing cancer treatments, cancer survivors can experience late-appearing side effects, which occur even after the cancer is cured, may take months to develop, and may persist permanently.^{7, 8} There are a plethora of late-appearing side effects that may occur, and roughly 60% of YACS will experience physical and/or psychological late-appearing effects.⁹⁻¹² This, unfortunately, results in adverse effects for YACS that can negatively impact their quality of life (QoL).

Unfortunately, YACS are a demographic that are unrepresented in the literature.¹³ This is in part due to challenges in recruiting members of this population for research studies (e.g., transient lifestyle). However, there are reasons why it is important to study YACS. For instance, many milestones are achieved during young adulthood, such as separation from parents, starting a family, completing education, starting a career, and establishing financial security.^{1, 14, 15} Being diagnosed with cancer can cause major interruptions in these milestones, and in comparison to other groups of cancer survivors, YACS are uniquely challenged both socially and psychologically as a result of their cancer diagnosis.¹⁶⁻¹⁸ Additionally, studies that have assessed the QoL of YACS suggest

that this population experiences detrimental affects in many areas of their life,^{19, 20} making YACS a priority for QoL research.

One proven method of improving QoL in cancer survivors is through physical activity (PA).²¹ In a study on a sample of YACS and adolescent cancer survivors, results showed that participants who met PA guidelines had a significantly higher QoL than those who were inactive,²² which is similar to findings from randomized controlled trials in a variety of cancer survivor groups.²¹ Research on the PA levels of YACS have been limited, but the results that have been collected so far suggest that PA participation in this population is low.²³ However, results indicate that YACS are interested in PA and feel as though they are capable of doing it.²⁴ Similarly, YACS express an interest in learning more about PA and exercise,^{25, 26} suggesting that YACS need help in getting motivated to become more active. Nevertheless, before PA interventions can be developed for YACS, more information on their PA levels and health behaviours must be collected.

While information on PA levels in YACS is limited, no previous studies were found that have measured sedentary behaviour (SB) as the primary outcome. Studies conducted on other groups of cancer survivors have found that cancer survivors typically display a high level of sedentary time during their waking hours,^{27, 28} and in a survey measuring PA in YACS, about a quarter of YACS were categorized as completely sedentary for not having any moderate or vigorous PA weekly minutes.²³ However, this study did not measure SB directly. While SB and physical inactivity are terms that are often used interchangeably, it is important to note that they are distinctly different concepts. That is, SB refers to the act of sitting or lying for extended periods of time without whole-body movement,²⁹ whereas physical inactivity refers to the failure to meet

recommended levels of moderate-to-vigorous PA (MVPA).³⁰ Therefore, a person can be both physically active and sedentary. Because of this, it is important to investigate SB in YACS more comprehensively to address this gap in the literature. This study examined the prevalence of SB and PA in YACS, as well as the relationships between SB and PA with QoL in YACS, which is an area that has not yet been investigated.

Methods

Participants & Procedures

Ethical approval was granted by the host institutions Health Research Ethics Board. The study consisted of a cross-sectional online study for YACS. Participants were included if they were between the ages of 18 and 44, were diagnosed with cancer as an adult (18+), and were from English-speaking countries (i.e., Canada, USA, UK, Ireland, Australia, and New Zealand). Data collection occurred between September 2015 and February 2017. Cancer support groups (e.g., Young Adult Cancer Canada) were contacted and asked to assist in the recruitment of participants. For those that agreed to assist, information about the survey was posted on websites and social media pages, which directed participants to the survey. The survey asked questions about SB, PA, and QoL, and took approximately 20-45 minutes to complete, after which participants were given the opportunity to enter a lottery draw for a prize package as compensation.

Measures

The SIT-Q, a validated measure, was used to assess SB.³¹ The SIT-Q asks participants to estimate their sedentary time in six domains: sleeping and napping; meals; transportation; work; childcare and elder care; and leisure (e.g., watching TV). Total sedentary time was computed by combining total leisure (i.e., screen time, reading, and

other leisure), total care (i.e., child and elderly care), meal, and transportation time.

Secondary measures included PA and QoL. PA (i.e., light, moderate, vigorous, and resistance) was assessed by the Leisure Score Index (LSI) of the Godin Leisure Time Exercise Questionnaire.^{32, 33} The LSI is a common PA questionnaire used in PA and cancer research because it is easily modifiable to include an additional measure that assesses average duration of PA.³⁴⁻³⁷ With this modification, MVPA can be calculated in minutes/week and compared to the PA recommendations of 150-minutes/week of MVPA in at least 10-minute bouts.³⁸ QoL was assessed by the Short Form-36 (SF-36) and the Functional Assessment of Cancer Therapy (FACT-G), which is specific to cancer survivors.³⁹⁻⁴¹ Higher scores on the SF-36 and FACT-G indicate better health-related QoL levels. Additionally, self-reported demographic information, medical characteristics, and health behaviours were assessed.

Statistical Analysis

Descriptive and frequency statistics were used to assess demographics, medical characteristics, SB, PA, and QoL measures. Average daily sedentary time in minutes/day was determined across all the domains in the SIT-Q. For PA, minutes/week was determined for each intensity level by multiplying the number of times the participant engaged in the behaviour/week by the number of minutes the participant engaged in that session. MVPA was then calculated by adding the number of moderate PA minutes/week with the number of vigorous PA minutes/week. Because this was an exploratory study in a new area, we wanted to examine all relationships that might exist between variables; therefore, correlations were examined between the SF-36 and FACT-G dimensions and SB domains and PA. For any significant correlations that were found, regression analyses

were then performed using the QoL measures as dependent variables and the SB domains and PA levels as independent variables.

Results

In total, 192 participants took part in the survey with a completion rate of 64.1%. Overall, 96 participants were excluded from the analysis, as they either did not fully complete to survey or provide outcome measures ($n= 69$), they were diagnosed with cancer before the age of 18 ($n= 21$), or they were older than 44 years of age ($n= 6$). Therefore, 96 participants were included in the analysis.

Demographic and Medical Characteristics

Demographics, medical characteristics, and health behaviours are presented in Tables 1, 2, and 3. To summarize, participants mean age was 31.9 ± 5.7 , 89.1% were white, 81.6% were female, 71.4% completed university/college or higher, and 66% were employed. Most participants had completed their treatments (75%) and were currently disease-free (67.7%), and the most commonly diagnosed cancers were breast (25%) and Hodgkin's lymphoma (15.6%).

Sedentary Behaviour & Physical Activity

Participants self-reported levels of SB and PA are displayed in Table 4. Participants indicated a mean of 777.1 ± 274.0 minutes of total sedentary time/day, a mean of 337.8 ± 288.1 minutes/day of sedentary screen time, and participants spent an average of 68.8% of their waking hours being sedentary. For PA, participants had a mean of 113.4 ± 132.4 minutes/week of MVPA, and only 31.3% of participants met the recommended PA level guidelines of 150-minutes/week of MVPA.

Quality of Life

QoL dimensions for the SF-36 and FACT-G are highlighted in Table 6, and correlations between the SB domains, PA levels, and QoL measures are presented in Tables 5-7. For total sedentary time, no significant relationships were found with any of the QoL measures. However, TV viewing had significant negative correlations with many QoL measures. Similarly, there were multiple significant positive correlations shown with MVPA and QoL measures. Regression analyses showed that MVPA ($B = .026$) significantly predicted the Physical Component Score (PCS) of the SF-36 ($F(1, 93) = 10.57, p < .01$), explaining 10% of the variance ($R^2 = .10$). Additionally, napping ($B = -.045$) and TV viewing time ($B = -.019$) also significantly predicted the PCS ($F(2, 93) = 6.89, p < .01$), with an R^2 of .13. All other regression analyses performed were non-significant.

Discussion

The purpose of this study was to examine the prevalence of SB and PA in YACS, and to explore the associations between SB and PA with QoL in this population. Research in these areas is limited, and SB in particular has not yet been investigated in YACS. To summarize the results, participants averaged almost 13 hours/day of sedentary time, over 2 hours/day of TV viewing, 113 minutes/week of moderate-to-vigorous PA, and TV viewing and PA were both independently associated with multiple measures of QoL.

Participants reported high levels of SB. A similar study that conducted a survey on YACS in Canada found that 23% were completely sedentary.²³ However, being sedentary was operationally defined as having no MVPA, and the survey did not directly measure SB. The amount of SB reported by YACS in this study are similar to SB rates reported by adults without a history of cancer but are higher than has been indicated in numerous

studies that investigated SB in cancer survivors, particularly in those that have used objective measures⁴²⁻⁴⁷, perhaps indicating that the participants in this study overreported their SB. Comparative to this study, the amount of sedentary time found in studies that have examined SB in breast cancer survivors using objective measures has ranged from approximately 8 to 11 hours.⁴³⁻⁴⁶ A study examining SB in colon cancer survivors using accelerometers found that the participants averaged almost 9 hours of sedentary time/day.⁴⁷ Because of the high levels of SB reported in this study, it may suggest that YACS are increasing their risk for the adverse effects that have been shown to be associated with SB in cancer survivors, such as poorer survival, an increased risk of developing heart disease, and increased BMI.⁴⁸⁻⁵⁰

While overall SB was high, it did not appear to negatively impact QoL in this population, as strong correlations between total SB and QoL measures were not identified. This is similar to a recent study on colorectal cancer survivors that found no relationship between QoL, depression, anxiety, or life satisfaction with SB.⁵¹ However, there are other studies that have investigated the relationship between SB and QoL in various groups of cancer survivors and found indications of a negative relationship between the two variables. For example, findings from previous research suggest that substituting SB with standing or PA may be linked with improvements in certain health-related QoL outcomes in colorectal cancer survivors.⁵² It is noteworthy to point out that most of the participants in the current study were highly sedentary, as 75% of the participants reported being sedentary for at least 9 hours/day and 90% of participants indicated they were sedentary for at least 6.6 hours/day. Therefore, it is possible that, because the majority of participants reported at least moderately high levels of SB, the

QoL scores were negatively affected amongst almost all participants, leading to little differences between all groups. However, alternatively, these results could simply indicate that there is no meaningful relationship between SB and QoL. Regardless, the current study demonstrates the mixed results that are present in the literature in this area, and further research is warranted.

Despite total SB levels not being strongly correlated with any of the QoL measures, TV viewing was negatively correlated with multiple QoL measures, notably with the PCS of the SF-36 and with the FWB measure of the FACT-G. Furthermore, TV viewing and napping significantly predicted the PCS, explaining 13% of the variance. This may be an indication that TV viewing is a type of sedentary activity that has particularly detrimental physical effects in comparison to other forms of SB. Previous studies have found adverse effects associated with high amounts of TV viewing in cancer survivors.^{53, 54} In a sample of colorectal cancer survivors, prolonged prediagnostic TV viewing was associated with a higher risk for cancer-specific mortality independent of PA levels, while other prediagnostic sitting behaviours did not show the same associations.⁵³ Additionally, it was found that a sample of colorectal cancer survivors who watched 5 or more hours of TV/day had a 16% lower total QoL score than participants who watched 2 hours or less of TV/day.⁵⁴ While it is important to acknowledge that correlation does not infer causation, it can be noted that, because of the detriments to QoL that have been shown to be associated with high levels of TV viewing, the results in the current study may suggest that TV viewing is a critical behaviour to target for improvement in QoL interventions directed toward cancer survivors.

Similar to previous research that has been conducted on PA levels in cancer survivors, the participants in the current study reported having low levels of PA, averaging approximately 113 minutes of MVPA/week. Furthermore, it was found that only about a third of the participants met the recommended guidelines for PA. Previous research on other groups of cancer survivors have suggested that as little as 29.6% to 47.3% of cancer survivors are meeting PA guidelines.⁵⁵ However, in YACS specifically, the PA levels found in this study are lower than has been found in recent years where approximately half of YACS were meeting the recommended levels of MVPA.²³ Additionally, PA levels were directly correlated with various indicators of QoL in this study, which is also similar to previous research.^{27, 46, 56} Previous research has found that higher PA levels are associated with higher levels of physical well-being, physical functioning, and health-related QoL, as well as lower levels of fatigue and improved mental health.^{46, 51, 57} In the current study, PA was positively correlated with PF, RP, BP, GH, V, and PWB, as well as the overall PCS. Additionally, moderate PA and vigorous PA significantly predicted the PCS, accounting for approximately 10% of the variance. This provides further evidence in support of the robust relationship PA has on the QoL of cancer survivors.

This study had a number of strengths. This is the first study to investigate SB in YACS through the use of a validated measure of SB. SB is becoming a more relevant topic in today's technologically advanced world, and in health-related research. Furthermore, because research in general on YACS is very limited, this study helps fill a gap in this area of research. This study was also the first to investigate the relationship

between SB and QoL in YACS. However, due to the equivocal nature of the studies exploring the relationship between SB and QoL, further research is needed.

While the information obtained from this study helps to fill a large gap in the literature, it must be noted that there were limitations. First, the data collected was self-reported and not objectively measured. Previous research has indicated that participants may misreport their activity levels for various reasons.⁵⁸ In this study's case, despite the instructions stating not to "double count," it is possible that participants overestimated their sedentary time for multiple sedentary activities in their reporting in the SIT-Q. For example, if a person eats meals while watching TV, they may have counted both as instances where they were sedentary, even though they occurred at the same time. Second, our sample consisted of mostly white, working, highly educated females, and this may not be representative of the population of YACS. Finally, the sample for this study was not as large as we hoped it would be. Unfortunately, due to the challenges faced in recruitment, our sample goal was not reached, despite providing an incentive to participate and have advertisements on social media pages that had the potential to reach many YACS. However, this was not surprising, as YACS are a challenging population to recruit for research, as discussed in previous research.¹³

This study adds to the limited research that is available on SB, PA levels, and QoL in YACS. However, it is important to note that more research is needed in this area, such as larger studies and studies that utilize objective measures of SB. While previous research has indicated that high levels of SB are associated with deleterious effects,⁵⁹⁻⁶¹ the results in our study did not show any negative QoL effects related to total SB, but TV viewing was related to lower QoL scores in multiple areas, which may indicate that future

QoL interventions should target the reduction of TV viewing rather than total SB. As expected, PA had a direct relationship with QoL in our sample, which is a finding that has been shown in multiple groups of cancer survivors.^{27, 46, 56} As it stands now, there have been limited PA intervention studies developed for YACS. However, the results from this study demonstrate the low levels of PA in this population, suggesting it is imperative that more PA interventions are developed for this population so that the QoL is substantially improved, allowing YACS to live with reduced side effects from cancer treatment and improve survivorship. In addition to this, it is important for innovative methods of recruitment to be developed specific to YACS so that research studies on this population are wider reaching, enabling more generalizable conclusions.

Conclusions

SB levels were high in our sample of YACS, and compared to previous studies on other groups of cancer survivors, YACS showed a higher number of sedentary hours/day. While sedentary levels were high, the amount of total sedentary time shown by YACS did not appear to have an impact on QoL. However, this was not the case for sedentary TV watching, as this behaviour was negatively associated with numerous QoL measures. Additionally, PA levels were low, and most YACS indicated that they were not meeting the recommended levels of PA. This was the first study to investigate the relationship between PA and QoL in YACS, but like previous studies on other groups of cancer survivors, PA had a positive impact on indicators of QoL. That is, QoL was higher among those who reported higher PA levels. This provides further evidence in support of the profound relationship that exists between PA and QoL. Finally, since there have been few

studies in this area, it is important for further research to be conducted, particularly through the use of objective measures for SB and PA.

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The authors disclose that there were no conflicts of interest in conducting this research.

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Table 1. Demographic & medical characteristics of participants (*n*= 147)

Demographic variables	<i>N</i> (%)
Age (Mean ± SD = 31.9 ± 5.7)	
18-19 years	2 (1.4%)
20-29 years	41 (27.8%)
30-39 years	98 (66.6%)
40-44 years	6 (4.2%)
Gender	
Female	120 (81.6%)
Male	26 (17.7%)
Other	1 (0.7%)
Marital status	
Married/Common law	78 (53.1%)
Never married	63 (42.9%)
Divorced/Separated	6 (4.1%)
Education	
Completed university/college	59 (40.1%)
Some/Completed graduate school	46 (31.3%)
Some university/college or lower	42 (28.5%)
Annual family income*	
< \$60,000	53 (36.0%)
\$60,000-\$99,999	47 (32.0%)
> \$100,000	43 (29.3%)
Current employment status	
Full-time/Part-time	97 (66.0%)
Disability	30 (20.4%)
Temporarily unemployed/Retired	20 (13.6%)
Ethnicity	
White	131 (89.1%)
Other	16 (10.9%)
Body mass index (Mean ± SD = 27.7 ± 8.1)*	
Underweight (< 18.5)	6 (4.2%)
Normal weight (18.5 – 24.9)	57 (39.9%)
Overweight (25 – 29.9)	35 (24.5%)
Obese (≥ 30)	48 (33.6%)
Comorbidities	
0	108 (73.5%)
1-2	32 (21.7%)
3 or more	7 (4.7%)
Comorbidities – Type	
Other cancer	10 (10.4%)
Other (e.g., arthritis, high blood pressure)	44 (45.8%)
Type of cancer	
Breast	24 (25%)
Hodgkin's lymphoma	15 (15.6%)
Non-Hodgkin's lymphoma	8 (8.3%)
Other (e.g., brain, thyroid, leukemia, colorectal)	49 (51.0%)
Cancer lymph nodes	
Yes	43 (44.8%)
No	48 (50.0%)
Unsure	5 (5.2%)
Cancer description	
Local	26 (27.1%)
Locally advanced	23 (24.0%)
Metastatic	21 (21.9%)
Unsure	26 (27.1%)
Surgery	
Yes	69 (71.9%)
No	26 (27.1%)
Unsure	1 (1.0%)
Radiation	
Yes	46 (47.9%)
No	49 (51.0%)

Unsure	1 (1.0%)
Hormone therapy	
Yes	21 (21.9%)
No	75 (78.1%)
Chemotherapy	
Yes	68 (70.8%)
No	27 (28.1%)
Unsure	1 (1.0%)
Current treatment status	
Completed	72 (75.0%)
Receiving treatment	24 (25.0%)
Cancer recurrence	
Yes	22 (22.9%)
No	68 (71.9%)
Unsure	6 (6.3%)
Cancer status	
Disease-free	65 (67.7%)
Current disease	16 (16.7%)
Unsure	15 (15.6%)
Told to limit activities	
Yes	26 (27.1%)
No	68 (71.9%)
Unsure	2 (2.1%)

* $n= 143$, ** $n= 146$

Table 2. Health behaviours of participants ($n= 96$)

Health behaviour variables	<i>N</i> (%)
Smoking status	
Never smoker	63 (65.6%)
Ex-smoker	24 (25.0%)
Occasional /regular smoker	9 (9.4%)
Drinking status	
Social drinker	69 (71.9%)
Never drinker	22 (22.9%)
Everyday drinker	5 (5.2%)
PA limited in last month	
Not at all	32 (33.3%)
A little	20 (20.8%)
Somewhat	22 (22.9%)
Quite a lot	11 (11.5%)
Completely	11 (11.5%)
Health care team discuss PA	
Yes	59 (61.5%)
No	37 (38.5%)
Health care person that discussed PA	
Oncologist	43 (44.8%)
Nurse	30 (31.3%)
Family doctor	15 (15.6%)
Physiotherapist	14 (14.6%)
Psychologist	12 (12.5%)
Nutritionist	4 (4.2%)
Other	9 (9.4%)

Table 3. Sedentary behaviour and physical activity levels of participants (*n*= 96)

SB and PA variables	Mean Mins/Day (SD)	Mean Mins/Week (SD)
Sleep time	491.5 (100.6)	-
Nap time	27.5 (58.5)	-
Meal sitting time	83.5 (78.8)	-
Transportation sitting time	84.8 (138.1)	-
Job sitting time	130.2 (122.4)	-
Child care sitting time	27.6 (70.4)	-
Elderly sitting time	2.9 (19.5)	-
TV sitting time	140.1 (111.1)	-
Computer sitting time	197.7 (289.4)	-
Reading sitting time	55.7 (79.4)	-
Other leisure sitting time	54.7 (103.8)	-
Total care sitting time	30.5 (73.4)	-
Total screen time	337.8 (288.1)	-
Total leisure sitting time	448 (299.7)	-
Total sedentary time	777.1 (274.0)	-
Light physical activity	-	121.1 (218.4)
Moderate physical activity	-	67.7 (95.0)
Vigorous physical activity	-	45.7 (79.8)
Resistance training	-	25.8 (58.0)
Moderate-to-vigorous physical activity	-	113.4 (132.4)

Table 4. Quality of life measures of Participants ($n= 96$)

Quality of life variables	Mean Score (SD)
SF-36	
Physical component score (PCS)	47.6 (10.7)
Physical functioning (PF)	47.1 (9.4)
Physical role functioning (RP)	42.9 (12.5)
Bodily pain (BP)	48.3 (10.6)
General health perceptions (GH)	39.0 (10.7)
Mental component score (MCS)	
Vitality (V)	42.5 (11.0)
Social role functioning (RS)	35.9 (9.9)
Emotional role functioning (RE)	34.2 (9.5)
Mental Health (MH)	42.3 (10.4)
FACT-G	
Quality of life score	71.5 (16.6)
Physical well-being	19.9 (6.3)
Social well-being	18.1 (5.1)
Emotional well-being	15.4 (4.5)
Functional well-being	18.0 (5.7)

Table 5. Correlations of sedentary behaviour domains and SF-36 quality of life measures (n= 96)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	-																					
2	.69 **	-																				
3	.67 **	.61 **	-																			
4	.61 **	.56 **	.59 **	-																		
5	.64 **	.70 **	.57 **	.62 **	-																	
6	.57 **	.77 **	.50 **	.51 **	.71 **	-																
7	.41 **	.63 **	.33 **	.45 **	.62 **	.74 **	-															
8	.39 **	.53 **	.40 **	.48 **	.70 **	.72 **	.77 **	-														
9	.89 **	.79 **	.83 **	.73 **	.63 **	.55 **	.30 **	.28 **	-													
10	.26 **	.51 **	.26 *	.41 **	.70 **	.77 **	.89 **	.93 **	.16 **	-												
11	-.24 *	-.26 *	-.17	.01	-.09	-.15	-.04	-.05	-.23 *	.01	-											
12	-.22 *	-.22 *	-.34 **	-.24 *	-.16	-.30 **	-.12	-.08	-.31 **	-.09	.12	-										
13	-.00	-.08	.06	.12	.04	-.10	-.06	.00	.03	-.04	.18	.00	-									
14	.05	.03	.03	.03	.08	-.01	-.09	-.05	.07	-.06	-.15	-.04	.29 **	-								
15	.11	.29 **	.13	.00	.01	.16	.15	.08	.15	.07	-.22 *	.10	-.05	-.07	-							
16	-.19	-.00	-.07	-.09	-.20	-.01	-.03	-.24 *	-.06	-.13	.00	-.12	-.11	-.05	-.14	-						
17	.07	.17	-.08	.06	.07	.01	.19	.08	.04	.10	-.08	.54 **	-.06	.03	.13	.02	-					
18	-.25 *	-.30 **	-.14	-.17	-.09	-.21 *	-.22 *	.00	-.27 **	-.05	.32	.29 **	.07	-.08	-.26 *	-.05	-.07	-				
19	.15	.09	.01	.08	.02	.11	.06	.01	.11	.02	-.17	-.13 **	-.28 **	-.17	-.20 *	.01	.01	-.20 *	-			
20	-.15	-.05	-.09	.04	.04	.08	.00	.04	-.10	.10	.11	-.14	-.02	-.07	-.08	.09	-.09	.05	-.13	-		
21	-.11	-.18	-.18	-.06	-.03	.06	-.01	.06	-.20	.10	.23 *	-.06	.05	-.11	-.14	-.06	-.07	.00	-.13	.14	-	

22	.00	.03	-.08	.04	.00	.11	-.02	.01	.00	.03	-.06	-.05	.13	.27**	-.03	.13	.07	.05	.64**	.17	.16	-
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Note: 1= Physical functioning, 2= Role limitations due to physical problems, 3= Bodily pain, 4= General health perceptions, 5= Vitality, 6= Social functioning, 7= Role limitations due to emotional problems, 8= Mental health, 9= Physical component score, 10= Mental component score, 11= Sleep, 12= Napping, 13= Meals, 14= Transportation, 15= Work, 16= Childcare, 17= Elderly care, 18= TV viewing, 19= Computer time, 20= Reading, 21= Other Leisure, 22= Total sedentary time.

* p < .05, ** p < .01.

Table 6. Correlations of physical activity levels and SF-36 quality of life measures ($n = 96$)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-														
2	.69**	-													
3	.67**	.61**	-												
4	.61**	.56**	.59**	-											
5	.64**	.70**	.57**	.62**	-										
6	.57**	.77**	.50**	.51**	.71**	-									
7	.41**	.63**	.33**	.45**	.62**	.74**	-								
8	.39**	.53**	.40**	.48**	.70**	.72**	.77**	-							
9	.88**	.79**	.83**	.73**	.63**	.55**	.30**	.28**	-						
10	.26**	.51**	.26*	.41**	.70**	.77**	.89**	.93**	.16	-					
11	.22*	.18	.22*	.27**	.28**	.14	.11	.11	.26*	.10	-				
12	.24*	.15	.17	.12	.18	.10	-.01	.05	.23*	.00	.14	-			
13	.05	-.02	-.01	-.04	.02	-.03	.02	.00	.00	.00	.16	.08	-		
14	.08	.04	.10	.25*	.05	.13	.09	.07	.11	.08	.09	.07	-.03	-	
15	.30**	.22*	.26*	.25*	.30**	.15	.06	.10	.32**	.06	.70**	.80**	.15	.10	-

Note: 1= Physical functioning, 2= Role limitations due to physical problems, 3= Bodily pain, 4= General health perceptions, 5= Vitality, 6= Social functioning, 7= Role limitations due to emotional problems, 8= Mental health, 9= Physical component score, 10= Mental component score, 11= Vigorous physical activity, 12= Moderate physical activity, 13= Light physical activity, 14= Resistance training, 15= Moderate-to-vigorous physical activity.

* $p < .05$, ** $p < .01$.

Table 7. Correlations of sedentary behaviour domains, physical activity levels, and FACT-G quality of life measures ($n = 96$)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	-																					
2	.16																					
3	.58 **	.25 *	-																			
4	.65 **	.43 **	.57 **	-																		
5	.81 **	.59 **	.77 **	.89 **	-																	
6	-.13	.08	.00	-.13	-.07	-																
7	-.24 *	.04	-.18	-.26 **	-.22	.12	-															
8	.06	.03	.00	.01	.04	.18	.00	-														
9	-.01	.04	.00	-.03	.00	-.15	-.04	.29 **	-													
10	.11	-.01	-.03	.20	.10	-.22 *	.10	-.05	-.07	-												
11	-.07	-.20 *	-.14	-.09	-.16	.00	-.12	-.11	-.05	-.14	-											
12	.12	.21 *	.02	.17	.17	-.08	.54 **	-.06	.03	.13	.02	-										
13	-.15	.11	-.03	-.26 *	-.12	.32 **	.29 **	.07	-.08	-.26 *	-.05	-.07	-									
14	-.03	-.15	.12	.04	-.01	-.17	-.13	-.28 **	-.17	-.20 *	.01	.01	-.20 *	-								
15	.00	.14	-.08	.06	.04	.11	-.14	-.02	-.07	-.08	.09	-.09	.05	-.13	-							
16	-.06	.04	.07	-.06	-.01	.23 *	-.06	.05	-.11	-.14	-.06	-.07	.00	-.13	.14	-						
17	-.06	-.07	.07	.00	-.02	-.06	-.51	.13	.27 **	-.03	.13	.07	.05	.64 **	.17	.16	-					
18	.23 *	.09	.10	.17	.20	-.11	-.10	.09	.06	.02	.00	-.07	.09	.01	.20	-.05	.14	-				
19	.15	-.01	-.01	.09	.08	-.03	-.03	-.03	.01	.14	-.13	-.07	-.02	-.10	.10	-.06	-.08	.14	-			
20	.03	.07	.00	.01	.04	.01	-.01	-.07	-.03	-.16	.02	-.05	-.23 *	-.09	.07	-.05	-.11	.16	.08	-		
21	.04	-.02	.20	.26 *	.15	.01	-.11	-.02	-.05	.01	-.01	-.05	-.12	.32 **	-.20	-.04	.24*	.09	.07	-.03	-	
22	.24 *	.05	.05	.17	.18	-.09	-.08	.03	.04	.12	-.10	-.10	.04	-.07	.19	-.07	.03	.70 **	.80 **	.15	.10	-

Note: 1= Physical well-being, 2= Social well-being, 3= Emotional well-being, 4= Functional well-being, 5= Quality of life score, 6= Sleep, 7= Napping, 8= Meals, 9= Transportation, 10= Work, 11= Childcare, 12=Elderly care, 13= TV viewing, 14= Computer time, 15= Reading, 16= Other lesiure, 17= Total sedentary time, 18= Vigorous physical activity, 19= Moderate physical activity, 20= Light physical activity, 21= Resistance training, 22= Moderate-to-vigorous physical activity.

* $p < .05$, ** $p < .01$.