UNIVERSITY OF CALGARY

Determinants of meeting physical activity guidelines for cancer prevention in an Alberta cohort

by

Fabiola Aparicio-Ting

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Abstract

There is strong epidemiological evidence for the protective influence of physical activity for a number of major cancers, including colorectal, breast, and endometrial cancers. However, it is unknown what portion of Albertans participate in sufficient physical activity for cancer prevention benefits, which are higher than traditionally recommended for general health benefits. Moreover, there is a lack of understanding of determinants of physical activity at these levels. Knowledge regarding determinants is crucial for the development of future cancer prevention interventions.

The purpose of this study was to describe physical activity behaviour at levels sufficient for cancer prevention benefits among a sample of Albertans in relation to the guidelines set forth by the Population Health Agency of Canada (PHAC), the American Cancer Society (ACS) and the U.S. Department of Health and Human Services (HHS). Taking an ecological perspective and using a cross-sectional design, potential determinants of compliance with each of these guidelines at the individual, social, and neighbourhood environment levels were investigated and differences in sex and age were explored.

Logistic regression with a cross-validation design was used to identify potential individual level determinants for engaging in sufficient activity for cancer prevention. Scheduling and planning, self-efficacy and decisional balance pros and cons were associated with sufficient activity. Overweight and obesity were also identified as potential determinants, with a stronger association for men than for women. Social support was identified as a potential social environment determinant of sufficient activity. For women, companionship for physical activity was also associated. Multilevel logistic

regression identified neighbourhood educational attainment and walkability as potential determinants, with walkability identified as a potential determinant only for women.

There appears to be individual, social and neighbourhood level factors that work together to determine physical activity behaviour at levels sufficient for cancer prevention. These results suggest that an ecological framework for the development of multidimensional intervention strategies that work together to promote physical activity at sufficient levels for cancer prevention is warranted. More research is needed to provide population estimates of physical activity at levels for cancer prevention and to further elucidate the determinants for physical activity at these levels.

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Dedication

This research is dedicated to my daughters and their generation,

in hopes that they may have a healthy future.

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List of Abbreviations

Abbreviation	Definition
ACB-REB	Alberta Cancer Board Research Ethics Board
ACS	American Cancer Society
CCHS	Canadian Community Health Survey
CCS	Canadian Cancer Society
CHREB	Conjoint Health Research Ethics Board
95% CI	Ninety-five percent Confidence Interval
CSEP	Canadian Society for Exercise Physiology
DNA	Deoxyribonucleic Acid
DPAQ	Determinants of Physical Activity Questionnaire
HHS	United States Department of Health and Human Services
IPAQ	International Physical Activity Questionnaire
MET	Metabolic Equivalent
MOS	Medical Outcomes Study
NEWS	Neighbourhood Environment Walkability Scale
OR	Odds Ratio
PHAC	Public Health Agency of Canada
PIL	Physical Intensity Level
PYTPAQ	Past Year Total Physical Activity Questionnaire
RDD	Random Digit Dial
SCT	Social Cognitive Theory
TTM	Transtheoretical Theory

Chapter One: Introduction

1.1 Overview

Epidemiological studies have established strong evidence for the protective influence of physical activity and an increased risk with inactivity for a number of major cancers, including colorectal, breast, and endometrial cancers (Friedenreich, 2001; Lee, 2003; Moore et al., 1998). Given the positive influence of physical activity on reducing the risk of several cancers, low levels of physical activity among Canadian adults warrant an investigation of the factors that influence participation in physical activity as potential targets for cancer prevention. These barriers and factors are known as the determinants of physical activity. However, the understanding of physical activity determinants remains cursory. Research on the determinants of physical activity has been largely limited to individual factors traditionally used to explain health behaviour, such as age, income, education, race/ethnicity, perceived behavioural control, self-efficacy, social support, and outcome expectations (Giles-Corti and Donovan, 2002a; Nies and Kershaw, 2002). Furthermore, research into the influence of social and physical environments, including availability and access to facilities and neighbourhood designs, is in its early stages compared to the rest of physical activity research (Giles-Corti and Donovan, 2002b; Handy et al., 2002; Pikora et al., 2003; Stahl et al., 2001). An understanding of these and other unexplored determinants of physical activity is necessary to direct future cancer prevention efforts.

1.2 Cancer Burden in Alberta

There were an estimated 171,00 new cases of cancer and 75,300 cancer deaths in Canada in 2009 (Canadian Cancer Society (CCS), 2009). In Alberta, there were an estimated 15,700 new cases of cancer and an estimated 6,100 cancer deaths (CCS, 2009). The leading cancers in Alberta were lung, colorectal, breast cancer for women, and prostate cancer for men. Lung cancer accounted for an estimated 31% of all new cancer cases and colorectal cancer accounted for an estimated 11% of new cancer cases in Alberta (CCS, 2009). The incidence rates of lung cancer have been steady for men but increasing for women over the past decade. The incidence rates of colorectal cancer, however, have been steady for both men and women at about 60 per 100,000 for men and about 45 per 100,000 for women. Together, lung and colorectal cancer accounted for an estimated 35% of cancer deaths in Alberta in 2009 (CCS, 2009). Prostate cancer was the leading cancer in men, making up an estimated 34% of new cancer cases and 14% of cancer deaths in men (CCS, 2009). Moreover, the rates of prostate cancer have been slowly increasing over the past decade (CCS, 2009). Breast cancer is the most common cancer and the most common cause of cancer death in women, accounting for 37% of new cancer cases and 22% of cancer deaths in women. Clearly, cancer is an important concern for the health of Albertans and strategies to prevent cancer are warranted.

Moreover, cancer places a substantial economic burden on the population. In 1998, the total economic cost of cancer was estimated at $14.2 billion for Canada (Health Canada, 1998). This cost represented roughly 9% of the total cost of illness in Canada and ranked cancer third in terms of attributable total cost, after cardiovascular (12%) and musculoskeletal (10%) diseases (Health Canada, 1998). The direct costs of cancer,

associated with treatment, care and rehabilitation, were estimated at $2.5 billion and the indirect costs, associated with the value of life lost attributed to premature death and productivity lost attributed to disability, accounted for an estimated 16% of the total cost of illness in Canada, equivalent to $11.8 billion (Health Canada, 1998). These estimates highlight the economic impact of cancer in Canada with similar percentages of total costs likely applicable to Alberta. Consequently, a focus on cancer prevention could be an investment that results in substantial future savings for the Province.

1.3 Physical Activity

Physical activity refers to any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure over the basal level (Pettee et al., 2009). Physical activities can be structured or unstructured and are usually categorized into general categories corresponding to leisure or recreational, transport, occupational or household activities (Pettee et al., 2009). Leisure and recreational activities are activities that are done in one's free time away from work, from other responsibilities (such as household and caretaker responsibilities) and from routine self-care activities (for example, sleeping and eating) (Pettee, et al., 2009). Transport activities most often include walking or cycling and refer to active modes of transportation used to get from one place to another, such as work, school or for running errands. Occupational and household activates refer to activities that occur in the workplace and in the household, respectively (Peettee, et al., 2009) Past physical activity research has focused largely on leisure activities but a more recent approach has been to attempt to measure total physical activity by assessing as many different types of activities as possible to obtain a more

accurate estimate of the overall energy expenditure of individuals (Pettee et al., 2009; Sallis and Owen, 1999). Therefore, including leisure, occupational, transport and household activities in the estimation of physical activity may be the best approach.

Physical activity can be described by the frequency, duration and intensity of the activity (Sallis and Owen, 1999). Frequency of physical activity is usually defined as the number of sessions or days per week or month that an activity is performed (Pettee et al., 2009). Duration refers to the amount of time spent, in minutes or hours, in one session of a specific activity (Pettee et al., 2009). Intensity refers to the level of effort required to perform the activity (Pettee et al., 2009). The intensity of any activity can be vigorous, moderate or light. Vigorous intensity activity is defined as any activity that makes the heart beat rapidly and causes sweating and heavy breathing such as jogging, aerobics, heavy digging, and vigorous bicycling (Pettee et al., 2009; Sallis and Owen, 1999). Moderate intensity activity, such as walking at a brisk pace, gardening, and yoga, is not exhausting and leads to light perspiration, while light levels of physical activity, such as driving a car, requires only minimal effort without perspiration (Pettee et al., 2009; Sallis and Owen, 1999). Intensity can be expressed as the ratio of energy expenditure of an activity to the energy cost of the metabolic rate at rest (Pettee et al., 2009). This ratio is known as Metabolic Equivalents (METs) and the METs for the metabolic resting rate has a MET of 1 kilocalorie per kilogram body weight per hour (kcal/kg/hr) (Ainsworth et al., 2000; Pettee et al., 2009).

Physical activity research originally focused on exercise, which is a subset of physical activity. Exercise is a planned and structured physical activity that someone undertakes for the purposes of improving or maintaining one or more components of

physical fitness or health (Buckworth and Dishman, 2002a). Physical fitness is the capacity to meet the physical challenges of daily living (Buckworth and Dishman, 2002a). Skill-related physical fitness attributes are those who relate to agility, balance, coordination, speed, power and reaction time. Health-related components of physical fitness include body composition, cardiovascular fitness (maximal capacity of the cardiorespiratory system to take up and use oxygen), flexibility, muscular endurance, neuromuscular learning and strength (Buckworth and Dishman, 2002a). While genetics contribute to physical fitness, higher levels of health and skill-related fitness are associated with vigorous intensity levels typically achieved during exercise. However, participation in general physical activity has been associated with increased health-related fitness (Buckworth and Dishman, 2002a)

In 2008, only 48% of Canadian adults over the age of 20 were estimated to participate in at least 30 minutes of moderate to vigorous leisure activity on most days of the week (Canadian Fitness and Lifestyle Research Institute (CFLRI), 2009). These levels of physical activity are the minimum levels recommended for a healthy lifestyle (Public Health Agency of Canada, 2003). Men were more likely to be sufficiently physically active for health benefits than women, and physical activity decreased with increasing age (CFLRI, 2009). In Alberta, 52% of residents 20 years and older were estimated to be physically active at these levels (CFLRI, 2009). Although Albertans may be more physically active than the national average, these levels of activity are low and underscore the need to increase physical activity levels in Alberta.

1.4 Physical Activity and Cancer

Physical activity is thought to impact cancer both directly and indirectly. Physical activity exerts its protective effects during the process of carcinogenesis, including tumor initiation and progression. Carcinogenesis, or the change from normal cells to cancer cells, begins with mutations in the genetic material, or DNA, of the normal cell (Rogers et al., 2008). Such mutations can result in uncontrolled cell proliferation and lead to the development of a tumor. Cancerous tumors can invade other organs, spread to distant location and become life threatening (Rogers et al., 2008). Physical activity may alter carcinogenesis by altering levels of sexual and metabolic hormone levels, growth factors, and components involved in inflammation and insulin resistance (Friedenreich and Orenstein, 2002; Rogers et al., 2008).

Indirectly, physical activity acts through body weight to impact cancer risk. There is strong evidence that being overweight and obese increases the risk of a number of cancers, including colon, postmenopausal breast, endometrial, kidney and oesophageal cancers (International Agency for Research on Cancer (IARC), 2002). Similar to physical inactivity, overweight and obesity result in a shift in the sex and metabolic hormone balance in the body, and influence the availability of a number of growth factors involved in the insulin resistance and inflammations pathways to initiate and promote carcinogenesis (IARC, 2002). Physical activity can help reduce overweight and obesity by favorably shifting energy balance to a point where energy expenditure through activity is higher than energy intake, through food and dietary habits (IARC, 2002). As a result, physical activity also works through weight control to reduce the risk of cancer.

The most definitive epidemiological evidence for an association between physical activity and cancer exists for colon or colorectal cancer (IARC, 2002; World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR), 2007). An estimated risk reduction has been found to be at least 20–30%, and up to 57% reduction in risk for colorectal cancer for both men and women (WCRF/AICR, 2007). There is also some evidence of an average risk reduction of 20-30% for endometrial cancer for women and 20-40% for breast cancer among post-menopausal women who participate in recreational activity (Friedenreich, 2001; WCRF/AICR, 2007). In addition, some research suggests an estimated average risk reduction of 10–30% for prostate cancer in physically active men (Friedenreich, 2001; WCRF/AICR, 2007). Preliminary evidence that physical activity may have a role in the prevention of lung, pancreatic, testicular and ovarian cancer also exists, however, the evidence is limited and more research is needed for a convincing association between these cancers and physical activity (IARC, 2002; WCRF/AICR, 2007).

The specific dose, or the frequency and intensity, of physical activity necessary for cancer prevention is not entirely clear, although there appears to be a dose-response between physical activity and the reduction of breast and colon cancer risks such that increased amounts of energy expenditure through physical activity are associated with increased reductions in risk (DHHS, 2008). The current evidence of the association between physical activity and risk reduction for breast and colorectal cancers is based solely on observational studies. For risk reduction of breast cancer, the greatest risk reductions have been found among women who participate in exercise, primarily at vigorous intensities, for at least one to four hours per week (Adams-Campbell, et al.,

2001; Bernstein et al., 1996; Rockhill et al., 1999; Thune et al., 1997). On the other hand, sustained moderate physical activity raises metabolic rate and increases health-related fitness, including reduction in insulin resistance and circulating sex hormones (WCRF/AICR, 2007). Consequently, moderate intensity physical activity performed three to five hours per week has also been associated with a risk reduction in breast cancer and colorectal cancer (Carpenter, et al., 1999; Friedenreich & Orenstein, 2002; Lee et al., 2001; Rogers, et al., 2008; Ueji et al., 1998). However, although a dose-response pattern of increased risk reduction in breast cancer with increased frequency and intensity of physical activity has been generally observed, there is much heterogeneity in the results across studies aiming to quantify physical activity levels for breast cancer risk reduction, with a number of studies finding no dose-response relationship between physical activity and breast cancer and colorectal cancer (WCRF/AICR, 2007). Moreover, there is insufficient research to conclusively recommend a dose of physical activity specific for other cancers, although other cancers are also likely to benefit from increasing levels of physical activity (DHHS, 2008). As such, although a literature review by the U.S Department of Health and Human Services suggest at least five to seven hours of moderate to vigorous physical activity is required for significant reduction in cancer risk, there is currently insufficient evidence on the frequency, duration, and intensity of physical; activity required for significant cancer risk reduction to make definitive dose recommendations (WCRF/AICR, 2007).

1.5 Physical Activity Guidelines

The overwhelming evidence that physical activity plays an important role in the prevention of chronic diseases including cancer, cardiovascular disease and diabetes, has driven the development of guidelines regarding the level, including the intensity and amount, of physical activity needed for maintaining health (U.S. Department of Health and Human Services (DHHS), 2008). The purpose of these guidelines are to encourage inactive populations to engage in physical activity and to provide a target for physical activity that can be used to set personal physical activity goals and measure progress (Biddle and Mutrie, 2008). A number of organizations have produced physical activity guidelines aimed at promoting a healthy lifestyle and maintaining health, including the Public Health Agency of Canada (Biddle and Mutrie, 2008). Fewer organizations have produced guidelines with the specific interest of chronic disease and cancer prevention. However, the physical activity guidelines proposed by the American Cancer Society and the United States Department of Health and Human Services are two guidelines that recommend physical activity at levels sufficient for cancer prevention (Sharratt and Hearst, 2007).

1.5.1 Public Health Agency of Canada (PHAC) guidelines for healthy living

In 1998, in response to a national strategy for reducing inactivity set by Canadian Federal, Provincial, and Territorial Ministers responsible for sport, physical activity and recreation, Health Canada and the Canadian Society for Exercise Physiology (CSEP) co-chaired National Advisory Committees to develop guidelines for adults, older adults and children (Sharratt and Hearst, 2007). The Committee included representatives from

provinces and territories, key national organizations with an interest in supporting physical activity, and scientific experts (Sharratt and Hearst, 2007). The process of guideline development included: preliminary market research to establish the need for national guidelines and the approach to be used; a scientific review process to inform the technical content; prototype development; and national concept testing (Sharratt and Hearst, 2007).

The Guide is currently disseminated by Public Health Agency of Canada (PHAC) and the physical recommendations outlined in the Guide are referred to here as the PHAC guidelines. The original purpose of the PHAC guidelines was to increase levels of physical activity in the sedentary population since the evidence reviewed by the Committee indicated that the greatest improvements in health status are seen when sedentary individuals become physically active (Sharratt and Hearst, 2007).

In 2005 PHAC guidelines recommended that adults participate in a minimum of 30 minutes of moderate-vigorous activity most days of the week. Adults were encouraged to incorporate 10 minute sessions of these intensities of activity into their daily routines at home, at school, at work and at play. Notably, these recommendations did not encourage sufficient levels of physical activity for cancer prevention (DHHS, 2008). Aside from leisure activities, the Guide also provided examples of household (raking leaves) and transportation (walking or cycling for short trips), indicating that the intention of these guidelines was to increase total physical activity through all types of activities, not just leisure activities (Sharratt and Hearst, 2007).

1.5.2 American Cancer Society (ACS) guidelines for cancer prevention

The American Cancer Society is a nationwide, voluntary organization in the United States whose mission is to eliminate cancer as a major health problem through decreasing cancer morbidity and mortality and through cancer prevention (American Cancer Society, 2010). In keeping with its commitment to cancer prevention, the ACS has developed its own set of physical activity guidelines. These guidelines are reviewed and published every five years by a national panel of experts in cancer research, epidemiology, public health and policy (Byers et al., 2002).

For cancer prevention benefits, in 2005, the recommendations from ACS were for at least 45 minutes of moderate and preferably intense physical activity, at least 5 days per week (Byers et al., 2002). Much like PHAC, the ACS guideline document, *The Complete Guide – Nutrition and Physical Activity*, also provides a number of examples of leisure, transport, occupational, and household activities that can be incorporated into one's daily routine to achieve sufficient levels of physical activity (Byers et al., 2002).

1.5.3 U.S. Department of Health and Human Services (HHS) guidelines for chronic disease prevention

The United States Department of Health and Human Services (HHS) is a federal department of the United States government responsible for the administration of all federal programs dealing with health and welfare. As part of the 2005 Dietary Guidelines for Americans, the HHS released the most comprehensive recommendations for adult physical activity (U.S. Department of Health and Human Services (DHHS) and U.S. Department of Agriculture (USDA), 2005). These guidelines were developed based on

the recommendations of a Dietary Guidelines Advisory Committee composed primarily of researchers (DHHS and USDA, 2005). The Committee provided a scientific-based report reflective of the current dietary and physical activity research that was used to develop key recommendations for dietary intake and physical activity (DHHS and USDA, 2005). The focus of these recommendations was physical activity for weight loss and management, given the strong evidence for the negative influence of overweight and obesity on a number of health concerns, including cancer (USDHHS and USDA, 2005). The physical activity recommendations for adults were as follows:

- To reduce the risk of chronic disease, adults should engage in at least 30 minutes of moderate to vigorous physical activity on most, preferably all, days of the week.
- To help manage body weight and prevent gradual unhealthy body weight gain, adults should engage in approximately 60 minutes of moderate to vigorous intensity activity on most days of the week.
- To sustain weight loss in adulthood, adults should participate in 60 to 90 minutes of daily moderate to vigorous intensity physical activity.

Of the three levels of physical activity recommended, the last two are relevant to cancer prevention. The first recommendation does not recommend sufficient physical activity for cancer prevention (DHHS and USDA, 2005). Since overweight and obesity have been associated with increased risk of several cancers, the recommendations relating to weight management are very relevant to cancer prevention (DHHS and USDA, 2005). In fact, the International Agency for Research on Cancer recommends both weight

control and physical activity for effective cancer prevention (Bianchini et al., 2002; Friedenreich and Orenstein, 2002; Rogers et al., 2008).

Similar to previous guidelines discussed, the HHS physical activity guidelines seem to be concerned with total physical activity that includes all types of activity, not just leisure. Although specific examples for achieving adequate physical activity are not provided, adults are encouraged to incorporate physical activity into their daily routines through sessions of at least 10 minutes (DHHS and USDA, 2005).

1.6 The Ecological Framework for Physical Activity

In order to increase physical activity levels in adults to levels sufficient for cancer prevention, understanding the factors, known as determinants, which influence physical behaviour, is important. Moreover, since technological and automation advances have reduced the amount of physical activity necessary for accomplishing daily and occupational tasks, physical activity is no longer an incidental part of daily life and incorporating physical activity into one's daily routine requires a conscious effort (Latikka et al., 1998). As is the case for other voluntary health behaviours, participation in physical activity is a complex behaviour that is influenced by an intricate framework of determinants that exist at the level of the individual, as well as the social and physical environments outside of the individual. For example, participation in physical activities can be for a variety of reasons, involving a variety of cognitive, psychological, and social experiences and within a variety of contexts (Laitakari and Miilunpalo, 1998). Physical activity can range from simple and low risk activities, such as walking, which require few facilities, to more complex activities, which that can require special facilities and

equipment, making the practice of physical activity vulnerable to external interferences (Marttila et al., 1998). Furthermore, the immediate consequences of physical activity can be unpleasant and uncomfortable, while its greatest benefits are long term and not immediately obvious, particularly for the beginner (Laitakari and Miilunpalo, 1998). Therefore, physical activity behaviour is complex and difficult to characterize without the consideration of multiple levels of behavioural influence and facilitation.

Sallis and Owen (2001) have proposed an ecological model for physical activity behaviour that incorporates individual, social, and environmental components. The ecological perspective approaches the understanding of physical activity behaviour by focusing on the nature of the interactions between individuals and their multidimensional external environments (Sallis and Owen, 2001). Specific to physical activity, the ecological model proposes that intrapersonal, socio-cultural, and physical environment determinants work in consort to influence physical activity behaviour (Motano and Kasprzyk, 2001). The socio-cultural environment includes several aspects, such as social influences, cultural norms and the political environment that dictates related policies, while the physical environment encompasses all aspects of the built environment as well as the natural environment, which includes the weather, geography and climate (Eyler et al., 2002; Sallis and Owen, 2001; Spence and Lee, 2003). Therefore, an ecological model for physical activity behaviour provides a conceptual framework for studying the relationships and interplay between determinants that are intrapersonal and environmental determinants external to the individual (Motano and Kasprzyk, 2001; Spence and Lee, 2003).

Given the complexity of the external environment and the range of factors of which it is comprised, it becomes necessary to focus on a select number of environmental factors in any given study. It is not feasible to simultaneously collect, analyze and interpret data pertaining to all aspects of the socio-cultural and physical environment within one study. Such extensive data collection would be extremely resource intensive. In addition, there are limitations in the statistical software available to conduct multilevel analyses with more then three levels. As such, the current study focused on aspects of the social environment but excluded cultural and political dimensions, and only included neighbourhood environment as a component of the physical environment. The ecological framework for physical activity, as it was applied in this study is presented in Figure 1.1.

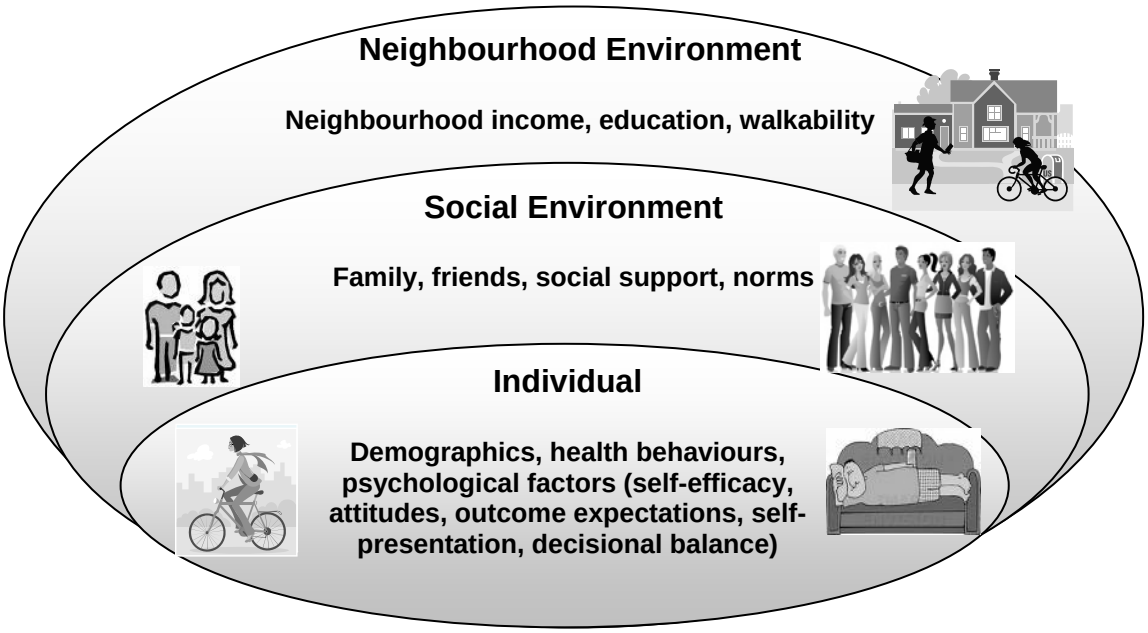

Figure 1.1. An ecological framework for physical activity

1.7 Determinants of Physical Activity

An ecological framework also supports a multilevel approach that considers determinants at different levels of influence at once, including determinants at the level of the individual and the social and physical environments. Noticeably, the majority of the determinants that have been identified are at the individual level. Research focus has been largely limited to individual factors traditionally used to explain health behaviour, such as age, income, education, race/ethnicity, perceived behavioural control, self-efficacy, and outcome expectations (Sallis and Owen, 2001; Spence and Lee, 2003). Research during the past decade has clearly established that demographic characteristics, such as age, sex, educational level and socioeconomic status influence individual choices of lifestyle. Individual factors, including personal attributes and psychological factors, have also repeatedly been found to be significant predictors of physical activity participation, adherence, and maintenance (Giles-Corti and Donovan, 2002a; Nies and Kershaw, 2002). Consistent with an ecological conceptual framework, social determinants are also important to consider. Although less is known about this level of influence at the individual level, certain social factors have been shown to be determinants of physical activity behaviour, especially social support specific to physical activity. Lastly, neighbourhood environment determinants, as part of the physical environment, of physical activity have been the least studied determinants but have recently come into focus.

1.7.1 Determinants at the level of the individual

1.7.1.1 Demographic characteristics

Age has consistently been found to be correlated with physical activity behaviour. Many studies of varying design and among several populations have established that increasing age is associated with decreasing participation levels in physical activity (Booth et al., 1993; Brownson et al., 1996; Seefeldt et al., 2002; Trost et al., 2002). A decrease in physical activity among older adults may be attributable to a change in barriers to physical activity as a result of aging. For instance, many older adults have decreased physical functioning and are more prone to injury. Low levels of physical functioning may be significant barriers to physical activity participation for older adults since there is a strong association between physical disability and low physical activity levels (Brownson et al., 1996; Conn, 1998; Nies and Kershaw, 2002; Seefeldt et al., 2002; Trost et al., 2002). Older adults are also more likely to suffer from poor health than younger adults, possibly limiting their ability to participate in physical activities. A population-based study investigating physical activity preferences and perceived barriers found that older sedentary adults were significantly more likely to cite injury or poor health as barriers to physical activity than younger adults (Seefeldt et al., 2002). Not surprisingly, older adults were also more likely to prefer activities with low risk of injury, such as walking, than younger adults (Booth et al., 1997).

However, reduced physical activity with increasing age cannot be explained by aging alone. Physical activity has been found to a be key component of healthy aging, which is defined as “ a low risk of disease and disease-related disability, high mental and physical functioning, and active engagement in life (Booth et al., 1997). In fact, cross-

sectional and prospective studies have found that participation in physical activity in early and mid adulthood can reduce the risk of dementia, reduced physical functioning, and incidence of chronic illness later in life (Hartman-Stein and Potkanowicz, 2003). Consequently, being sedentary or inactive earlier in life increases the risk of poor aging, which, in turn, can result in inactivity later in life. Therefore, it is important to consider physical activity behaviour early in life as an important determinant of physical activity behaviour in later adulthood.

Lower participation in physical activity has also been found among women compared to men. Women who belong to ethnic minorities and who have low socioeconomic status, have routinely reported lower levels of physical activity than men (Hartman-Stein and Potkanowicz, 2003; Haveman-Nies et al., 2003; Laurin et al., 2001; Plonczynski, 2003; Schroll, 2003; Visser et al., 2002). Research has shown that women are less likely to adhere to structured physical activity programs, to participate in levels of activity sufficient to achieve health benefits, and are less likely to partake in leisure activities than men (Loitz et al., 2009; Seefeldt et al., 2002; Trost et al., 2002). There are a number of cultural and social contextual variables, including gender roles, which result in differences between men and women in physical activity participation (Azevedo et al., 2007; Barrett et al., 2007; Ross, 2000; Seefeldt et al., 2002; Trost et al., 2002). However, the argument has also been made that women have been found to be less physically active than men because instruments used to measure leisure activity levels have traditionally excluded activities more commonly engaged in by among women than men, such as dancing and gymnastics, or that incorporate activities more likely to be part of a woman’s life, such as caring for children and household work (Seefeldt et al., 2002).

Nonetheless, there is evidence that women and men have differing factors that motivate them to participate in physical activity. For example, body-related concerns seem to be more salient participation motives for women than men (Stutts, 2002). Body-related concerns include body image, a person's conception of and feelings about his or her body - its form, size, shape and the way it fits society's norms (Stutts, 2002). Women have consistently reported having more body-related concerns than men. A survey of a random sample of adult Norwegians found that women were significantly more concerned with their physical appearance than their male counterparts (Loland, 1998). Research among young adult women has found that those who were more concerned about a body image that fits perceived cultural expectations were also significantly more likely to be physically active (Parsons and Betz, 2001). Similarly, qualitative research among physically active middle aged women has found that appearance and health concerns were commonly reported as equally important reasons for being physically active (McDermott, 2000; Thompson et al., 2003).

Low socioeconomic status has also been strongly associated with decreased participation in physical activity. People of low socioeconomic status are more likely to have low educational attainment and low levels of income, which often result in barriers to healthy behaviours and opportunity to seek medical care. Low socioeconomic status is often associated with caregiver responsibilities, time devoted to childcare, physical labour as an occupation, lack of transportation, unsafe neighbourhoods, inflexible work schedules and transient domiciles (Seefeldt et al., 2002). As a result, people of low socioeconomic status are less likely to adopt and maintain active lifestyles (Seefeldt et al., 2002).

A number of studies have found a positive association between physical activity levels and socioeconomic status (Booth et al., 1993; Giles-Corti and Donovan, 2002b; Ross, 2000). Educational attainment and household income have consistently been found to be positive correlates of participation in physical activity (Booth et al., 1993; Ross, 2000; Trost et al., 2002). However, while some studies have shown that educational attainment is associated with physical activity participation but not with intensity of physical activity, others have found that educational attainment and income positively influence participation in both leisure activity and strenuous organized exercise (Booth et al., 1993; Giles-Corti and Donovan, 2002b; Ross, 2000).

Interestingly, there is some evidence that individuals with higher educational attainment are more likely to be in higher stages of change (Booth et al., 1993). Stage of change is a component of the Transtheortical Model (TTM) and proposes that change of behaviour progresses through a series of stages that utilize different processes to support change at different stages (Booth et al., 1993; Prochaska et al., 2001). The earlier stages of precontemplation, contemplation, and preparation, within the context of physical activity behaviour, relate to the initiation and adoption of physical activity. Individuals with higher educational attainment have been found to be more likely in the preparation stage with respect to physical activity, than individuals of lower educational attainment (Booth et al., 1993). These results suggest individuals with lower education may have intentions to change their physical activity behaviour but have not taken behavioural steps in this direction and interventions that reduce barriers to physical activity in this population may be beneficial (Booth et al., 1993; Prochaska et al., 2001).

1.7.1.2 Personal health behaviours

Important personal health behaviours associated with physical activity behaviour include physical activity history, smoking, and obesity. History of exercise participation is a useful predictor of future exercise, possible because individuals who are regularly active may develop superior methods for overcoming common barriers that help sustain their physical activity behaviour over long periods of time and despite setbacks (Booth et al., 1993; Yordy and Lent, 1993). It is also possible that having participated previously in regular physical activity has resulted in increased physical activity self-efficacy, which in turn facilitates current physical activity behaviour (Buckworth and Dishman, 2002b; Giles-Corti and Donovan, 2002a; Seefeldt et al., 2002). Additionally, individuals who were physically active in the past are more likely to have experienced the benefits of physical activity and these benefits may promote current physical activity behaviour (Stutts, 2002).

Being a smoker has also been associated with low physical activity (Trost et al., 2002). It is possible that smokers are be less likely to participate in healthy lifestyle behaviours (Trost et al., 2002). However, smokers are more likely to have lower educational attainment and lower annual income than non-smokers, and education and income have been positively associated with physical activity (Seltzer, 2003). An association between smoking and increased health risks has been established, including obesity and increased risks of coronary heart disease, stroke, cancer (lung, cervix, pancreas, kidney, bladder, oesophagus, and pharynx), pulmonary disorders, and cerebrovascular disease (Ball et al., 2001; Lahti-Koski et al.). Since poor health and reduced physical functioning are barriers to physical activity, then these barriers may be

more prevalent among smokers than among their non-smoking counterparts. Therefore, the association between smoking and physical activity behaviour is mediated by a number of other established determinants of physical activity behaviour.

A number of studies have found that overweight and obese individuals are less likely to participate in physical activity than their normal weight counterparts (Besson et al., 2009; De Bourdeauhuij and Sallis, 2002; Westerterp and Goran, 1997). Overweight and obese individuals may face challenges related to pain, discomfort, or embarrassment when they attempt physical activities and therefore, may be less likely to try them again (Steptoe et al., 2000). Overweight and obese individuals may also have more perceived barriers related to being physically active (Catlin et al., 2003). It is important to consider the bidirectional relationship between overweight and obesity and physical activity. While they may be considered factors that decrease physical activity, physical activity also influences overweight and obesity. Increased levels of physical activity lead to weight loss (Steptoe et al., 2000). Therefore, overweight and obesity play an important role in physical activity behaviour.

1.7.1.3 Psychological determinants

A number of possible psychological determinants of physical activity have been identified. For example, there is evidence that the perceived benefits and barriers to physical activity participation may be important to physical activity behaviour (McDermott, 2000; Mitchell and Olds, 1999; Trost et al., 2002; Zunft et al., 1999). The most commonly reported perceived benefits of physical activity are to maintain good health, release of tension, stress reduction, emotional well-being, and to increase fitness

(McDermott, 2000; Mitchell and Olds, 1999; Zunft et al., 1999). Perceived benefits may serve as motivating factors for the uptake of physical activity. While some studies suggest that perceived benefits are not associated with physical activity, others have found that they are related to physical activity maintenance (Mitchell and Olds, 1999; Steptoe et al., 2000; Zunft et al., 1999). This variability in findings could be attributable to the fact that many of the long-term benefits of physical activity that are not immediately obvious, such as benefits related to reduced illness or improved health (De Bourdeauhuij and Sallis, 2002; Laitakari and Miilunpalo, 1998). However, once the benefits become apparent, they may encourage continued participation in physical activity. Therefore, while the perception of benefits of participating in physical activity may be necessary, they may not be sufficient to support changes in physical activity behaviour among sedentary adults.

A number of perceived personal and logistic barriers to physical activity are cited in the literature. These barriers relate to factors that individuals attribute to their level of inactivity. Lack of time, other priorities, work and family commitments and lack of motivation are the most often reported perceived barriers to physical activity among insufficiently active adults (Booth et al., 1997). Injury and poor health are also important reported barriers among older adults (Booth et al., 1997; Thompson et al., 2003; Zunft et al., 1999). Additionally, being too tired or too weak, fear of falling, and lack of exercise partners have also emerged as predictors of leisure activity among both men and women (King et al., 2000). Importantly, a perception that barriers to physical activity are present is associated with a reduced likelihood of participating in and maintaining sufficient

levels of physical activity for health benefits (Andersen et al., 1997; Mitchell and Olds, 1999; Trost et al., 2002; Zunft et al., 1999).

There are also psychological factors that are influenced by both cognitive process and social influences. Since physical activity behaviour is a complex behaviour subject to influence by a number of cognitive, social and environmental factors, a large portion of physical activity research has investigated these types of factors as potential determinants of behaviour. Factors such as self-efficacy, outcome expectations, intention, attitude, self-presentation, subjective norms, and decisional balance have all been investigated within the context of physical activity behaviour.

Self-efficacy is the personal confidence in one's ability to perform a behaviour and is a construct within the Social Cognitive Theory proposed by Bandura, where it is considered the primary determinant of behaviour (Nies and Kershaw, 2002). Physical activity self-efficacy refers to an individual's confidence in their ability to be physically active on a regular basis (Nies and Kershaw, 2002). Of all the psychological determinants investigated, physical activity self-efficacy has been the factor most consistently found to be predictive of physical activity. Several studies have confirmed that self-efficacy is a strong determinant of physical activity participation and maintenance, as well as a predictor of the level of physical activity achieved, regardless of age, gender or socioeconomic status (Bengocchea and Spence, 2003; Castro et al., 1999; Courneya and McAuley, 1994; Dishman et al., 1985; Nies and Kershaw, 2002; Rovniak et al., 2002; Trost et al., 2002; Yordy and Lent, 1993). Self-efficacy has also been found to be associated with physical activity intentions regarding duration, intensity and frequency among young adults (Courneya and McAuley, 1994). In addition, evidence suggests self-

efficacy is especially important in physical activity initiation and maintenance in women (De Bourdeauhuij and Sallis, 2002; Pan et al., 2009). Importantly, there is evidence to suggest that self-efficacy is lower in women, older adults, and among those of low educational attainment and household income (Bengocchea and Spence, 2003).

Aside from being a determinant of physical activity, self-efficacy has also been found to be an outcome of physical activity. Several studies have reported increases in self-efficacy as a result of physical activity interventions (Buckworth and Dishman, 2002b; McAuley and Blissmer, 2000). As individuals successfully initiate physical activity they gain confidence in their ability to be physically active (McAuley and Blissmer, 2000). Thus, being physically active increases the sense of self-efficacy leading to continued physical activity (McAuley and Blissmer, 2000).

While self-efficacy has been found to have direct effects on physical activity behaviour, the effects of self-efficacy may also be mediated by other factors. Studies have found that self-efficacy has direct effects on self-regulation, which, in turn, affects physical activity behaviour (Anderson et al., 2006; Nies and Kershaw, 2002; Rovniak et al., 2002). Self-regulation involves goal setting, planning, problem solving and self-monitoring (a comparison of the behaviour and its outcomes to self-set goals resulting in an adjustment of the behaviour**).** Goal setting is important because it provides the motivation for physical activity behaviour, as long as the goals are realistic and attainable (Nies and Kershaw, 2002). Planning is also important because it allows individuals to set goals and leads to engagement in physical activity (Baranowski et al., 2002; Plotnikoff et al., 2008; Rovniak et al., 2002). Interestingly, a study among young adults found that most of the effects of self-efficacy on physical activity were mediated through the effects

of self-regulation (Rovniak et al., 2002). Participants with higher levels of self-efficacy were more likely to use self-regulation strategies that resulted in higher levels of physical activity (Rovniak et al., 2002). Therefore, while self-efficacy is a strong predictor of physical activity, it may also be important to consider the effects of self-regulation on physical activity behaviour.

Another factor that has been found to influence physical activity behaviour is the concept of outcome expectations. According to the expectancy-value models, individuals are more motivated to perform behaviours they believe will result in highly valued outcomes and less motivated when they do not believe that valued outcomes will follow the behaviour or when the expected outcomes are not valued (Giles-Corti and Donovan, 2002a). Outcome expectations have been found to be associated with physical activity behaviour (Poulton et al., 2002; Rovniak et al., 2002). For example, predictions of activity-related discomfort have been found to correlate with participation in that activity (Poulton et al., 2002).

In a study that asked participants to rate expected levels of discomfort prior to and after exercising on a stationary bike, participants who anticipated high levels of discomfort were more likely to decline participation in the bike exercise than those who anticipated low levels of discomfort (Poulton et al., 2002). Moreover, individuals who predicted levels of discomfort higher than actually experienced had worse physical health and reported fewer days of at least 30 minutes of physical activity (Poulton et al., 2002). Interestingly, female participants were more likely to over-predict the amount of exercise-associated discomfort (Poulton et al., 2002).

Outcome expectations vary according to the degree of how explicit they are for that person and can change over time according to experience and life situation (Giles-Corti and Donovan, 2002a). Some outcome expectations are personal, while others are culturally shared. Kenyon (1968) identified six instrumental expected outcomes of physical activity: social experience, health and fitness, pursuit of vertigo (sensation seeking), aesthetic experience (possessing beauty or artistic qualities, such as dance), catharsis (stress relief) and ascetic experience (self-discipline associated with competitiveness). These can be understood as expected outcomes of participation in structured physical activities; however, they have not been fully investigated.

There are also a number of other psychological factors for which a role as determinants of physical activity behaviour is not clear. Intention to participate in physical activity is one such factor. Intention is a construct in the Theory of Reasoned Action, Theory of Planned Action, and the Social Cognitive Theory and serves as an important immediate determinant of action within these theories often applied to health behaviours (Yordy and Lent, 1993). While individual and environmental factors influence intention differently in the three theories, all three describe intentions as a mediator between other factors and behaviour. The investigation of the association between intention to increase activity levels and actual physical activity achieved has had mixed success. While some studies have found intentions to be predictive of physical activity participation, others have not (Courneya and McAuley, 1994; Trost et al., 2002).

Similarly, the role of attitudes towards physical activity in predicting physical behaviour is not well established. Attitudes toward physical activity have been described as determinants of intention that are shaped by outcome expectations (Yordy and Lent,

1993). Intuitively, positive attitudes toward physical activity may facilitate activity levels, while negative attitudes can discourage the uptake of physical activity. However, physical activity research has had conflicting results regarding attitudes as a predictor of behaviour. Some studies have reported attitudes to be a moderate predictor of physical activity behaviour (Godin, 1993). On the other hand, attitudes have not been found to be significant predictors of physical activity or inactivity in a number of other studies (Courneya and McAuley, 1994; Giles-Corti and Donovan, 2002a; Trost et al., 2002; Yordy and Lent, 1993).

These contrary results may be attributable to the fact that attitudes are distal determinants of physical activity behaviour. Since they help shape intentions to be active, positive attitudes may be necessary to encourage physical activity but not sufficient to facilitate physical activity behavioural change, and negative attitudes alone may not be detrimental to physical activity uptake without the presence of other factors that also negatively influence physical activity intentions (Giles-Corti and Donovan, 2002a). Another consideration is that different definitions of attitudes important to physical activity have been used across studies, making comparisons across studies difficult. For example, Courneya and McAuley (1994) measured physical activity attitudes by asking participants to rate how important physical activity is to them, compared to other activities (watching television, working, spending time with family, etc), Yordi and Lent (1993) measured attitudes by asking participants to judge the extent to which they viewed exercise as good or bad, beneficial or harmful, and desirable or undesirable, and Giles-Corti and Donovan (2002) asked participants how they would feel if they tried to participate in regular activities (foolish/wise, dissatisfied/satisfied, and good/bad), and

how they felt about the process of trying to do a regular exercise routine as measures of physical activity attitude. Although all of these measures relate to attitudes, they each related to different aspects of physical activity attitudes that may shape intentions.

Self-presentation is another factor for which a relationship with physical activity participation has not been clearly established (Seefeldt et al., 2002). Self-presentation is the monitoring and control of how one is perceived by others. Projecting an undesired self-image, an image that is contrary to images held in favour by ones-self or other influential others, results in adverse feelings like embarrassment and consequently leads to behavioural efforts to restore one's image (Leary et al., 1994). If a particular health behaviour is perceived to threaten self-presentation, individuals will likely avoid that behaviour to avoid self-presentation failure (Leary et al., 1994).

How self-presentation may affect physical activity behaviour may be dependent on the perception of image-related consequences of physical activity behaviour. If participating in physical activity is perceived to be threatening to self-presentation because it may result in projecting an undesirable self image, physical activity may be avoided (Leary et al., 1994). For example, older adults are sensitive to age-related and health-related changes that make them look dependent or inept, and more likely to yield to social perceptions that physical activity is a youthful activity that lacks proper decorum for them (Seefeldt et al., 2002). Thus, self-presentation may have a contributing role in low levels of physical activity related to aging. Consistent with this interpretation, studies have found overweight women prefer exercise classes that include only overweight women; such an environment may help overcome concerns about visibility, embarrassment and judgement by others (Leary et al., 1994).

Alternatively, self-presentation may persuade some adults to change their physical activity behaviour to help restore or preserve self-presentation; for example, by enhancing their personal appearance (Martin et al., 2000). The social perceptions of the ideal female body type, coupled with body-related concerns of many women, may encourage physical activity for the sake of positive self-presentation (Epstein and Roemmich, 2001). Additionally, negative social perceptions of people who engage in unhealthy practices or of sedentary people may motivate some adults to become physically active (Martin et al., 2000; Seefeldt et al., 2002).

Related to self-presentation, subjective norms reflect a person's perceptions of whether or not a particular behaviour is endorsed by influential individuals and the motivation to comply (Motano and Kasprzyk, 2001). With regards to physical activity behaviour, subjective norms relate to individuals' beliefs that important people in their lives think that they should or should not participate in physical activity. However, the influence of subjective norms on physical activity behaviour is unclear.

Studies have found inconsistent evidence between subjective norms and physical activity behaviour, while others have found no association (Giles-Corti and Donovan, 2002a; Godin, 1994; Trost et al., 2002). Interestingly, subjective norms have been positively associated with intentions for physical activity. However, the gap between intentions and actual behaviour may influence the ability of subjective norms to act as a strong determinant of physical activity behaviour (Giles-Corti and Donovan, 2002a). Alternatively, subjective norms may act in concordance with other factors to influence physical activity behaviour.

Decisional balance is a component of the Transtheoretical Model. The Transtheoretical Model (TTM) posits that behavioural change occurs as an individual progresses through a series of stages of change (Prochaska et al., 2001). In physical activity behaviour, decisional balance reflects the balance between the perceived benefits and the perceived costs or disadvantages of being physically active (Plotnikoff et al., 2001a; Prochaska et al., 2001). According to the TTM, as an individual moves through the stages of change, this balance shifts from the cons outweighing the pros in the early stages to the pros outweighing the cons in the action and maintenance stages (Plotnikoff et al., 2001a; Prochaska et al., 2001). Indeed, the balance between the perceived benefits and perceived costs of physical activity have been found to be associated with physical activity behaviour (Marcus et al., 1994).

1.7.2 Determinants at the level of the social environment

Participating in activities may also fill the need to form close emotional bonds with, to be attached to, and be involved in warm relationships with others (Reeve and Sickenius, 1994). This need for social contact and relationships is referred to as the need for affiliation (Reeve and Sickenius, 1994). Activities that provide opportunities for affiliation are more motivating than those who do not (Carron et al., 1988; Wankel and Berger, 1990). In fact, social interaction is one of the most common reasons cited for involvement in leisure-time sports and physical activities (Wankel and Berger, 1990). Research has also found affiliation to be a positive predictor of adherence to exercise programs (Wankel, 1985). However, it appears that the social aspects of physical activity involvement are more motivating for women than for men (Frederick and Ryan, 1993;

Wankel, 1993). Studies have also shown that older adults are more likely to participate in physical activity to satisfy their need for companionship and affiliation than younger adults (Duda and Tappe, 1988; Wankel, 1993). The social environment plays an important role in shaping personal characteristics and providing a context for health behaviour. Social factors can both encourage and facilitate physical activity, or they can also provide an environment of barriers to such behaviour.

Social support is defined as a behavioural or functional dimension of social relationships, such as the frequency with which one is encouraged to participate in physical activities, having company to participate in activities with, or the approval of those most important to the individual of a physically active lifestyle (Chogahara et al., 1998; Mitchell and Olds, 1999; Sallis et al., 1989). Quantitative and qualitative studies have found social support to be a consistent predictor of physical activity participation and maintenance, regardless of age, gender, or socioeconomic status (Chogahara et al., 1998; Dishman et al., 1985; Eyler et al., 1999; Mitchell and Olds, 1999; Trost et al., 2002). Social support has also been associated with participating in levels of physical activity sufficient for health benefits and a lack of social support has been associated with being sedentary (Eyler et al., 1999; Trost et al., 2002).

Social support specific to physical activity can come from a number of sources, of which friends and family have been the most commonly investigated. Having friends or family who participate regularly in physical activity has been significantly associated with physical activity (Eyler et al., 1999; Trost et al., 2002). Furthermore, social support has its strongest impact when it provides company for the individual in physical activities. Several studies have found that having a friend or family member to exercise

with significantly increases the likelihood of participating in physical activity at levels sufficient for health benefits (Eyler et al., 1999; Giles-Corti and Donovan, 2002a). Spousal support, for example can greatly impact physical activity levels. Wallace, Raglin, and Jastremski (1995) found that monthly attendance in a fitness program was significantly higher for married couples who participated together than for married individuals whose partners did not attend with them. Furthermore, only 6% of married couples dropped out of the 12 month program, compared to 43% of married individuals who joined the program without their spouse (Wallace et al., 1995) Importantly, 50% of singles that dropped out reported reasons for leaving the program as family responsibilities and lack of spousal support (Wallace et al., 1995).

While some research suggests that social support from family members or from friends has differential impact on overall physically active lifestyles, other studies have reported findings to the contrary (Eyler et al., 1999). Environments that provide general physical activity social support, either from non-friends or family have been found to be successful in encouraging participation in physical activity (Estabrooks and Carron, 1999; Eyler et al., 1999). For example, perceptions of class cohesion among older adults enrolled in an exercise class have been related to exercise adherence (Estabrooks and Carron, 1999). The provision of a socially supportive environment may be sufficient. Additionally, the cohesion-adherence relationship in this study sample seemed to be long term, extending at least 12 months after the initial assessment of perceptions (Estabrooks and Carron, 1999). Focus groups with women have found the social aspect of group physical activity is a motivating factor for commencing or maintaining a physical activity habit (Eyler et al., 1999). It is possible that the presence of some social support,

regardless of source, may be sufficient to influence physical activity behaviour (Eyler et al., 1999).

Physicians have also been found to provide important social support related to physical activity (Andersen et al., 1997; Booth et al., 1997; Seefeldt et al., 2002). The physician's role is especially critical in counselling adults and prescribing physical activity because most adults (80%, according to a recent survey) visit the doctor at least 1-3 times each year and the vast majority of adults cite their doctor as their primary source of health information (Andersen et al., 1997; Seefeldt et al., 2002). The role of the physician in promoting physical activity may be especially relevant to those who accord high esteem to physicians, such as older adults (Andersen et al., 1997; Seefeldt et al., 2002). Specifically regarding physical activity, among a random population sample of inactive adults, 38% wanted to receive advice on appropriate activities from a doctor or other health professional (Booth et al., 1997).

To be effective in promoting physical activity, physicians must be able to recognize readiness to change behaviour, communicating to the patient the need for increased physical activity, providing the necessary conditions for activity to occur, and furnishing support and evaluation for physical activity maintenance (Seefeldt et al., 2002). Physicians can provide valuable information to patients about the medical importance of physical activity and help alleviate fears regarding the risks of participating in physical activities (Andersen et al., 1997). Physicians can also play an important role in helping their patients with goal setting by providing advice tailored to their individual health status and lifestyle.

Not surprisingly, the impact of social support on physical activity behaviour may vary according to the target population. For example, there is evidence that social support may be more important for older adults over the age of 50, than younger adults (Chogahara et al., 1998; Sallis et al., 1989). In addition, social support may be more important in encouraging physical activity among women than for men. Women who enrolled in an exercise program by themselves were twice as likely to drop out of an exercise program than men who enrolled by themselves (Wallace et al., 1995).

Moreover, the source of social support may be important in promoting physical activity among specific groups. A recent survey of inactive Australian adults asked respondents what type of help they would prefer if they were to exercise more or take up exercise and offered the following response choices: advice from a doctor or other medical professional, a group of other people to exercise with, advice over the telephone, a video tape on exercise, a book on how to exercise, an exercise kit with pamphlets and practical tips, a mail correspondence course, and no form of assistance (Booth et al., 1997). Over 50% of older adults reported a desire to receive medical advice to help motivate them to participate in physical activity, while the preferred source of support for younger adults was a group to exercise with (Booth et al., 1997).

The mechanisms through which social support influences physical activity behaviour have not been clearly delineated. Social support may provide an environment that fosters personal characteristics that have a positive influence on physical activity behaviour and has been associated with higher levels of intention to be physically active, perceived behavioural control and physical activity self-efficacy (Chogahara et al., 1998;

Rovniak et al., 2002). Social support specific to physical activity may also provide the initial motivation necessary to increase physical activity levels (Eyler et al., 1999).

1.7.3 Determinants at the level of the neighbourhood environment

The neighbourhood environment provides cues and opportunities for physical activity. Passively, community design can encourage or discourage incidental physical activity. The neighbourhood environment may foster certain cultural or normative beliefs that can encourage residents to be physically active (Ross, 2000). Actively, neighbourhood infrastructure can provide physical activity opportunities that are accessible, convenient, safe, and appealing (Giles-Corti and Donovan, 2002b). Neighbourhood socioeconomic characteristics and built environment characteristics have been identified as potential determinants of physical activity behaviour of neighbourhood residents.

1.7.3.1 Neighbourhood socioeconomic characteristics

Neighbourhoods may affect physical behaviour because people are influenced by others, copying their physical activity behaviour so that it spreads (modeling), and because neighbourhoods can provide residents with opportunities and resources that promote physical activity, such as bike paths, pleasant walkways, community tennis courts and pools, good schools and formal services like police protection (Ross, 2000). Similar to the effects at the individual level of influence, the socioeconomic characteristics of a neighbourhood has been associated with the physical activity behaviour of its residents (Giles-Corti and Donovan, 2002b; Ross, 2000; Sallis et al.,

1997). Neighbourhoods characterized by residents with high income and educational attainment are more likely than disadvantaged neighbourhoods to have residents who participate in moderate physical activity, such as walking. (Giles-Corti and Donovan, 2002a; Ross, 2000). Disadvantaged neighbourhoods, where a high proportion of residents are low income and have low educational attainment, likely extend fewer opportunities and resources that encourage physical activity and present more constraints, such as crime, poor access to paths, and lack of facilities (Ross, 2000). Furthermore, the prevailing normative climate for residents to model may encourage behaviours with negative consequences rather than healthy behaviours, such as walking or cycling (Ross, 2000).

1.7.3.2 Neighbourhood built environment

Walking and cycling have been reported as the preferred physical activities of adults of all ages (Booth et al., 1997). Walking and other moderate intensity may be perceived to be inexpensive compared with more structured vigorous activities that may include sports fees, equipment, and facility fees (Sallis et al., 1997; Salmon et al., 2003). Additionally, walking and cycling are relatively easy for the vast majority of the population and offer little risk of injury (Handy et al., 2002). Consequently, individuals within environments that facilitate walking and cycling and present minimal constraints against such activities have increased opportunity to participate in moderate physical activity. For walking and cycling, the quality of the experience, including perceptions of safety, comfort, and aesthetics, may be important components (Handy et al., 2002).

The evidence regarding the built environment as a determinant of physical activity behaviour has been mixed. Many studies found environmental correlates of physical activity to include access to facilities (sidewalks, footpaths), neighbourhood safety (traffic, adequate lighting, crime), frequent observation of others engaging in physical activity (modeling) and enjoyable scenery (Saelens et al., 2003). For example, qualitative research has reported that people were more likely to walk if there were footpaths available, traffic measures to control the flow of traffic, and shops nearby (Pikora et al., 2003). Quantitative studies have also found that being close to facilities (parks, shops, recreation areas, and schools), having shaded footpaths, safe walking environments, and attractive areas to walk in that included pleasant streets, trees, and parks, encouraged walking and were associated with physical activity (Pikora et al., 2003; Sallis et al., 1992). A national cross-sectional survey of Australian adults found that the most frequently used facilities were public open spaces, the beach, and streets, and that the use of facilities was negatively associated with low access (Giles-Corti and Donovan, 2002b). Access to places that allow physical activity was also found to be a significant predictor of leisure physical activity behaviour among Australians (Bengocchea and Spence, 2003).

Distance has also been identified as a potential determinant of physical activity because it may determine access, with those living closer to facilities, including pathways, having increased opportunities for use and paying less for transportation (Giles-Corti and Donovan, 2002b). In some instances, the effect of distance may be moderated by the attractiveness of a facility and its proximity to other facilities or activities (Giles-Corti and Donovan, 2002b). Geographic location also becomes a barrier,

for example, if climatic conditions lead to inaccessibility to facilities (Seefeldt et al., 2002). Additionally, location in urban versus rural communities can affect perception of access to places that offer physical activity opportunities and the availability of low cost or free recreational facilities in one's community or neighbourhood (Bengocchea and Spence, 2003).

On the other hand, other studies have not found that individual level factors are better determinants of physical activity than environmental factors (Giles-Corti and Donovan, 2002a; King et al., 2000; Nies and Kershaw, 2002; Sallis et al., 1997; Salmon et al., 2003). A national cross-sectional survey of Australian adults found that, after adjusting for other determinants, physical activity as recommended was more strongly associated with individual factors, such as higher perceived control, use of behavioural skills, and intentions to be physically active, than environmental factors (Giles-Corti and Donovan, 2002a). However, access to facilities determined their use and supported physical activity by providing opportunity, suggesting that access to facilities may be a necessary but not sufficient condition for physical activity (Giles-Corti and Donovan, 2002a).

Similarly, a study among women found that access to facilities near home or work did not increase physical activity levels (Nies and Kershaw, 2002). Moreover, individual perception of neighbourhood, including enjoyable scenery, footpaths, and safety were found to have no influence on walking behaviour, after adjusting for neighbourhood socioeconomic status (Sallis et al., 1997). Reasons cited for these contradictory results have proposed that perhaps people in neighbourhoods not conducive to convenient or enjoyable physical activity are active in other more suitable environments (Sallis et al.,

1997). However, given the strong confounding effect of socioeconomic status on the relationship between environmental factors and physical activity behaviour, it is possible that access and other environmental determinants may be proxy measures of a neighbourhood's socioeconomic status. Access to programs, facilities, pleasant surrounding and safety are expected to vary with neighbourhood socioeconomic status and poor access in disadvantaged areas may contribute to low physical activity levels among residents (Giles-Corti and Donovan, 2002a; Sallis et al., 1997).

Pikora and colleagues (2003) have proposed a framework where functional elements (walking surface, streets, traffic, permeability), safety elements (personal safety and traffic control), aesthetic elements (streetscape and views), and destination facilities are factors that promote or discourage walking and cycling in a community. However, more research is needed to elucidate the role of neighbourhood environmental factors as determinants of physical activity behaviour.

1.8 Current Study

Past research has focused on lower levels of physical activity, such as those recommended by PHAC, for maintaining a healthy lifestyle in general. However, very little is known about the prevalence of physical activity at higher levels relevant to cancer prevention. In addition, there is a gap in research in identifying determinants of physical activity specifically at levels adequate for cancer prevention benefits. In order for cancer prevention strategies to utilize physical activity as an effective intervention target, information regarding how well adults currently meet physical activity guidelines for cancer prevention would be helpful for program planning. Moreover, identifying the

determinants for physical activity at cancer prevention levels would be crucial for the development of physical activity intervention specific for cancer prevention.

In an effort to contribute to this developing field of physical activity and cancer prevention research, this study aimed to describe physical activity and identify potential determinants of physical activity in adults that could serve as intervention targets for cancer prevention. Specifically, this study examined physical activity behaviour at levels sufficient for cancer prevention benefits among a sample of Albertans. The physical activity levels of Albertans in relation to the guidelines set forth by three different organizations: the Population Health Agency of Canada (PHAC), the American Cancer Society (ACS) and the U.S. Department of Health and Human Services (HHS) were described and, taking an ecological perspective and using a cross-sectional design, potential determinants of compliance with each of these guidelines at the individual, social, and neighbourhood environment levels were investigated. In addition, the investigation of potential determinants for meeting each of the guidelines considered differences in sex and age, reflecting previous research that has suggested differences between men and women, and with increasing age on a number of potential physical activity determinants.

This study represents a novel approach to physical activity research and has the potential to make a valuable contribution to cancer prevention research. Currently, no other study exists that examines the determinants of physical activity within the context of physical activity guidelines specific for cancer prevention. These guidelines are important because they can serve as standards that physical activity promotion efforts strive to promote. Moreover, research has not explored the determinants of levels of

physical activity that correspond to cancer prevention, as those set by ACS or HHS. The physical activity requirements for cancer prevention appear to be higher than those generally promoted for a healthy lifestyle. Since there has been a recent focus on physical activity as a cancer prevention strategy, understanding the factors that may determine physical activity at levels adequate for cancer prevention has become important. Lastly, this project includes a consideration of the potential determinants of physical activity at three levels of influence: the individual, the social environment, and the neighbourhood environment. As physical activity research moves away from focusing on individual factors and moves toward interactions between individuals and their social and physical environments, this study has the potential to contribute to that emerging research. Ultimately, the results of this research could be used to guide further research and the development of effective cancer prevention interventions that target physical activity behaviour to reduce the burden of cancer in Alberta.

1.8.1 Study Overview

This study was undertaken in two phases. Phase 1 estimated the prevalence of physical activity of Albertans in relation to physical activity guidelines set by PHAC, ACS and HHS using secondary data analysis of baseline data collected from participants in the Alberta cohort project, the Tomorrow Project. Phase 2 investigated the potential determinants of physical activity using a cross-sectional survey of a sub-sample of Albertans enrolled in the Tomorrow Project. The investigation of physical activity determinants used a multilevel approach, consistent with the ecological framework, and

involved potential determinants at the individual and social and neighbourhood environment levels.

1.8.2 Phase 1 objectives

The primary objective of Phase 1 was to estimate the prevalence of physical activity among adult Albertans, 35 to 64 years of age, based on three guidelines for physical activity recommended by PHAC, ACS and HHS. A secondary objective was to investigate the potential association of sociodemographic factors and a small number of individual characteristics, including weight status, smoking, self-rated health status, the presence of a chronic condition and social support, as a preliminary assessment of the potential determinants for meeting physical activity guidelines for cancer prevention.

1.8.3 Phase 2 objectives

The primary objective of Phase 2 was to investigate the possible association between a number of potential determinants at the individual, social and neighbourhood environment levels and meeting physical activity guidelines for cancer prevention benefits among a random sub-sample of Albertans, 35 to 64 years of age, participating in the Alberta Cohort, known as the Tomorrow Project.

Chapter Two: Methods for Phase 1

2.1 Overview of Phase 1

Phase 1 was a secondary data analysis of cross-sectional baseline data collected from participants enrolled in the Tomorrow Project between 2000 and 2004. Phase 1 was undertaken with the primary aim of describing the proportion of Albertans that meet physical activity guidelines as prescribed by the Public Health Agency of Canada (PHAC), the American Cancer Society (ACS), and the U.S. Department of Health and Human Services (HHS). A secondary aim was to conduct a preliminary analysis of the possible associations of a limited number of potential determinants of meeting physical activity guidelines, primarily sociodemographic characteristics.

Phase 1 of this study began with a description of the study sample and an estimate of the proportion that met each of the three physical activity guidelines. The study sample was then used to provide an estimate of the proportion of Albertans, aged 35 to 64, who meet PHAC, ACS and HHS physical activity guidelines. Lastly, a multivariate analysis was conducted using logistic regression to explore potential determinants of meeting each of the three physical activity guidelines in this study sample. All data management, data cleaning and analyses were completed using the statistical software package STATA10® (StataCorp, 2001).

2.2 The Tomorrow Project

The Alberta Cohort Study, know as The Tomorrow Project, is a longitudinal research initiative with the primary aim of collecting prospective data regarding lifestyle, biologic and other risk factor data for cancer aetiology research. The ultimate objective of

The Tomorrow Project is to elucidate some of the mechanisms that contribute to cancer incidence (Bryant, 2006). The goal of The Tomorrow Project is to assemble a sample of 50,000 adult Albertans, who have never been diagnosed with cancer and are between 35 and 69 years of age at the time of enrolment. Participants are invited regularly to contribute information about their health, lifestyle and occurrence of illnesses over a long period of follow-up; to either age 85 or death (The Tomorrow Project, 2009). Most recently, the Tomorrow Project joined with other provinces to form the Canadian Partnership for Tomorrow Project. This pan-Canadian study will follow the health of 300,000 people in British Columbia, Alberta, Ontario, Quebec, and Atlantic Canada for next 20 to 50 years (The Tomorrow Project, 2009). The Tomorrow Project in Alberta is funded by the Canadian Partnership Against Cancer, the Alberta Cancer Prevention Legacy Fund, and the Alberta Cancer Foundation.

From 2000 to 2008, participants for the Tomorrow Project were recruited at random using the Random Digit Dial (RDD) method (Lavrakas, 1993) applied in waves of recruitment (RDD waves). Given that 97% of Albertan households had at least one telephone line in 2000, this sampling strategy helped ensure participants reflected the population of Alberta from all geographic regions of the province (Statistics Canada, 2001). Recruitment was limited to Albertans with no known history of cancer, other than non-melanoma skin cancer; those planning to reside in Alberta for at least one year; and English speaking, to allow for collection of self-reported data (Bryant et al., 2006). The overall enrolment rate from February 2001 to June 2003 was 32%; comparable to other cohort studies worldwide (Bryant et al., 2006). To date, participants come from a variety of socioeconomic backgrounds from over 400 cities, towns, and villages, and from all

rural areas throughout the province and are considered a reasonable representative sample of Albertans, aged 35 to 69 (Bryant et al., 2006).

2.3 Phase 1 Data Sources

Phase 1 of this study utilized baseline data collected from The Tomorrow Project participants enrolled between 2001 and 2005 during recruitment waves RDD1 to RDD6. Participants who provided informed consent to participate in The Tomorrow Project were asked to complete three self-administered, mailed questionnaires that were used to collect baseline information about lifestyle risk factors and exposures: The Health and Lifestyle Questionnaire (HLQ), the Diet History Questionnaire, and the Past Year Total Physical Activity Questionnaire (PYTPAQ). For this study, only data provided from the Health and Lifestyle Questionnaire and the Past Year Total Physical Activity Questionnaire were used.

The Tomorrow Project study protocol has been approved by the Conjoint Health Research Ethics Board (CHREB) and the Alberta Cancer Board Research Ethics Board (ACB-REB). The Tomorrow Project abides by strict privacy and confidentiality rules that protect participants and restrict access to personal identifiable information to select Tomorrow Project personnel. Access to HLQ, PYTPAQ data, and participant postal codes was obtained for this study only after a data sharing and privacy agreement was signed by the researcher and after the protocol for this study was also approved by CHREB and ACB-REB (Appendix A and Appendix B). The data were provided without personal identifiers.

2.3.1 Potential Determinants of Physical Activity from the Health and Lifestyle Questionnaire

The Health and Lifestyle Questionnaire (HLQ) is a self-administered questionnaire used to collect information about health status and lifestyle risk factors. It was developed as a compilation of valid and reliable items used in other large studies to assess health history, family history, cancer screening practices, smoking, stress, social support and demographic characteristics (Bryant et al., 2006). For example, items concerning personal and family health history, including cancer history, were adapted from the Prostate, Lung, Colorectal and Ovarian Screening Trial, the Women's Health Initiative (WHI) study, and the 2001 Canadian Community Health Survey (Beland, 2002; Prorok et al., 2000; The Women's Health Initiative Study Group, 1998). To obtain anthropometric measures, participants were provided detailed instructions and illustrations. This method has been tested for validity and reliability by other researchers (Kushi et al., 1988). The HLQ is 32 pages and takes an estimated 40 minutes to complete.

2.3.2 Measuring physical activity using the Past Year Physical Activity Questionnaire

The Past Year Total Physical Activity Questionnaire (PYTPAQ) is a self-administered questionnaire that collects information about the frequency, duration, and intensity of occupational, household and recreational physical activities done in the past twelve months (Appendix C). The PYTPAQ is the past year component of the *Lifetime Total Physical Activity Questionnaire*, a validated questionnaire that measures frequency, duration and intensity of occupational, household and recreational activity conducted from childhood to the time of the interview (Friedenreich et al., 1998).

The PYTPAQ has been independently tested for validity and reliability among a sample of 75 men and 79 women aged 35-65 years using a one year cohort study design (Friedenreich et al., 2006). To assess validity, PYTPAQ summary values were compared to one-year averages from seven-day physical activity logs (7-day PALs) and accelerometer data, which were collected four times during a one-year period. The intraclass correlation (ICC) between the PYTPAQ and 7-day PALs was 0.42 (0.28-0.54) and for accelerometer data were 0.18 (0.03-0.32) for total activity (Friedenreich et al., 2006). PYTPAQ summary values were also correlated with physical fitness and anthropometric data. Spearman correlations between PYTPAQ vigorous hours/week and VO_{2max} were 0.37 and 0.32 at baseline and follow-up one year later, respectively (Friedenreich et al., 2006). To assess reliability, the PYTPAQ was completed twice, nine weeks apart (Friedenreich et al., 2006). Spearman correlations for reliability, in MET-hours/week, were 0.64 for total activity, 0.70 for occupational, 0.73 for recreational and 0.65 for household activity (Friedenreich et al., 2006). Overall, the PYTPAQ is a valid and reliable self-report measure of past year total physical activity.

2.4 Phase 1 Sampling Frame

Tomorrow Project participants who completed both the PYTPAQ and the HLQ served as the sampling frame for this study. The sampling frame was further restricted to participants 35 to 64 years of age. Seniors (those 65 years and older) were excluded because research has shown that seniors have different physical activity needs and different determinants of physical activity behaviour than younger adults, especially because of increasing physical disability and restriction and deteriorating health status

(Booth et al., 1997; Burton et al., 1999; Conn, 1998; Eyler et al., 1999). Other exclusion criteria used to establish the study sample were: transgender, pregnancy, history of cancer and underweight status.

2.5 Phase 1 Variables

2.5.1 Outcome variables

The outcome variables for Phase 1 were either meeting or not meeting each of the three guidelines: PHAC, ACS or HHS. These three outcome variables were derived from data collected using the PYTPAQ.

The PYTPAQ is comprised of four sections assessing four different types of activities: occupational (including paid employment and volunteer activities); transportation (to and from work); household; and recreation (including all exercise and sports activities).Within each broad type of activity, respondents were required to identify specific activities they engaged in during the past year. For each specific activity, respondents reported frequency, duration and physical intensity level (PIL). Physical intensity level was reported on a scale from 1 to 4, with the various levels of the scale defined at the start of each section. A PIL of 1 signified activities mainly engaged in while sitting down; a PIL of 2 described activities done mainly standing that do not increase heart rate or cause sweating; a PIL of 3 described activities that cause slight increases in heart rate and some light sweating; and a PIL of 4 described activities that cause heart rate to increase substantially and lead to heavy sweating (Friedenreich et al., 2006).

To estimate physical activity, each reported activity was assigned a unique activity code. Corresponding MET values were then assigned to each reported activity using the Compendium of Physical Activities (Ainsworth et al., 2000). Reported values for frequency and duration for each separate activity with intensity of 3 or more METs (considered a moderate intensity levels) were multiplied together to calculate a single estimate of the hours per week at moderate to vigorous intensity. It was necessary to exclude light intensity activities from the final estimate of time spent doing physical activity per week because all three physical activity guidelines being included only moderate to vigorous intensity activities in their recommendations. In addition, there is only evidence for cancer prevention benefits for moderate and vigorous intensities and not for light intensities (WCRF/AICR, 2007). The total hours/week for each of the four broad types of activity was estimated by summing all of the individual activity hours/week. To yield an overall estimate of moderate and vigorous activity per week that reflected an individual's total activity, the four separate totals for each type of activity were summed.

Since all three guidelines under consideration were expressed achieving adequate physical activity through leisure, transportation, occupation and household activities, all four types of activity at moderate and vigorous intensities were used in the calculation of total time spent in moderate and vigorous physical activity where possible. The PHAC guidelines recommend a minimum of 30 minutes of moderate intensity to vigorous activity most days of the week; equivalent to 2.5 hours/week (0.5 hours x 5 days/week) of moderate to vigorous intensity activity (Public Health Agency of Canada, 2003). Participants who reported 2.5 hours/week or more of moderate to vigorous intensity

activity were coded as “met PHAC guidelines”; those who reported less than 2.5 hours/week of moderate to vigorous intensity activity were coded as “did not meet PHAC guidelines.”

The ACS guidelines specify a minimum of 45 minutes of moderate intensity to vigorous activity five days per week; equivalent to 3.75 hours/week (0.75 hours x 5 days/week) of moderate to vigorous intensity activity (Byers et al., 2002). Participants who reported 3.75 hours/week or more of moderate to vigorous intensity activity were coded as “met ACS guidelines.”

The HHS guidelines for physical activity are dependent on weight status as measured by Body Mass Index (BMI). BMI is the ratio of a participant’s weight to his or her height squared. Adults with a BMI less than 25 kg/m^2, considered normal weight, are recommended at least 60 minutes of moderate to vigorous intensity activity most days of the week; and adults with a BMI equal to or greaten than 25 kg/m^2, considered overweight and obese, are recommended 60 minutes of daily moderate to vigorous intensity activity (DHHS, 2008). These are equivalent to 5 hours/week (1 hour x 5 days/week) and 7 hours/week (1 hour x 7 days/week) of moderate to vigorous intensity activity, respectively. To calculate outcome measures for HHS, participants were first categorized as having either BMI <25 kg/m^2 or BMI ≥ 25 kg/m^2. Participants with a BMI <25 kg/m^2 who reported 5 hours/week or more of moderate to vigorous intensity activity and participants with a BMI ≥ 25 kg/m^2 who reported 7 hours/week or more of moderate to vigorous intensity activity were coded as “met HHS guidelines.”

2.5.2 Explanatory variables

The explanatory variables for this phase of the study were derived from data collected using the HLQ and included age at the time of HLQ, sex, annual household income, educational attainment, marital status, employment status, weight status, having any of a list of pre-existing chronic conditions, self-rated health status, current smoking behaviour, social support and urban or rural residence.

Annual household income, educational attainment, marital status, employment status and self-rated health status were assessed using items proposed for the Canadian Community Health Survey (CCHS) 1.1 (Statistics Canada). The CCHS 1.1 was a national cross-sectional survey conducted by Statistics Canada in 2000/2001 to provide estimates of health determinants, health status and health system utilization. It was administered in a 45 to 60 minute interview using computer-assisted interviewing (CAI), meaning that, as the questions were developed, the associated logical flow into and out of the questions was programmed (Statistics Canada). This questionnaire was field tested and found to be acceptable for data collection among Canadians (Statistics Canada), thus items that originated from this questionnaire were considered valid.

Weight status and BMI were derived from height and weight measurements collected as part of the HLQ. Participants were provided detailed instructions, illustrations, and a tape measure to accurately measure their height, wait, and hip measures based on approaches taken by the Iowa Women's Study (1985) and The Canadian Study of Diet, Lifestyle and Health (1997) shown to be valid and reliable (Bryant et al., 2006; Kushi et al., 1988). Participants were also given instructions for obtaining and recording a measurement of body weight using any scale available to them.

BMI was then categorized as follows: BMI <18.5 kg/m^2 as underweight, BMI between 18.5 and 24.9 kg/m^2 as normal weight; BMI between 25 and 29.9 kg/m^2 as overweight; and BMI higher than 30 kg/m^2 as obese.

The HLQ also contained a number of items related to chronic conditions. An amalgamation of chronic conditions were used that had previously been proposed in questionnaires used by the CCHS1.1 (Statistics Canada), the Prostate, Lung, Colorectal and Ovarian Cancer Screening Trial (National Cancer Institute) and the European Prospective Investigation into Cancer and Nutrition (International Agency for Research on Cancer, 2010). Participants were asked: “Has a doctor ever told you that you had any of the following conditions?” to which they indicated yes or no. The list of chronic conditions included high blood pressure, angina, high cholesterol, heart attack, stroke, emphysema, chronic bronchitis, diabetes, polyps in the colon or rectum, ulcerative colitis, Crohn’s disease, hepatitis, and cirrhosis of the liver.

Data regarding current smoking status were collected using items used in the CCHS 1.1 and based on definitions and recommendations from the Workshop on Data for Monitoring Tobacco Use (Mills et al., 1994). These items solicited information regarding current and past use of cigarettes, cigarillos, cigars and pipes; frequency of use currently and in the past; and for cigarettes, how many per day and in a lifetime. For this study, only data regarding current use of cigarettes, cigarillos, cigars and pipes and frequency of use were relevant. Participants were categorized as currently not smoking (no smoking in the past 30 days), smoking occasionally (at least one cigarette in the past 30 days, but not every day), and smoking daily (at least one cigarette every day for the past 30 days).

Social support was measured in the HLQ using the Medical Outcomes Study (MOS) Social Support Survey (Sherbourne and Stewart, 1991). The MOS was a two year study of patients with chronic conditions. The MOS Social Support Scale is a brief, multidimensional, self-administered, social support survey that was developed to provide a comprehensive assessment of social support and does not measure social support specific to physical activity (Sherbourne and Stewart, 1991). In this scale, participants were asked to respond on a five-point Likert scale (none of the time to all of the time) to 19 items regarding how often different kinds of support were available to the participant. Examples of support included someone to provide advice during a crisis, someone to help with daily chores when sick and someone to do something enjoyable with. The complete scale can be found in Appendix D. This scale has been tested for validity and reliability (Sherbourne and Stewart, 1991). The average score per item is used to obtain an overall support index; a higher support index indicates higher social support.

Urban or rural residence was derived from participant postal codes. Canadian postal codes are six-character uniformly structured, alphanumeric codes in the form “ANA NAN” where “A” represents an alphabetic character and “N” represents a numeric character (Canada Post, 2010). The second character in the postal code indentifies either an urban address (numerals 1 to 9) or a rural address (numeral 0) (Canada Post, 2010). This method for deriving rural and urban residence has been used by the Tomorrow Project in data analyses.

2.6 Phase 1 Data Analysis

2.6.1 Descriptive Analysis

The descriptive analysis of the data served multiple purposes. Firstly, univariate analysis served to provide an overview of each variable to provide an assessment of the amount of missing data, to provide an overall description of the study sample, and to ensure adequate cell sizes for categorical variables for subsequent multivariate analysis. Descriptive analysis of reported physical activity (hours per week in moderate and/or vigorous activity) was also used to explore the amount of self-reported physical activity.

The amount of missing data was assessed using univariate analysis, and these results were used to inform the necessity of using imputation for missing values. Typically, 5% missing data is used as the cut-off above which missing data becomes a concern and the imputation of the missing data may be necessary. Complete case analysis, analysis using cases with complete data only, is warranted only when missingness is below 5% (Harrell, 2001b). The percentage of missing data was estimated for each variable to identify any variables for which the amount of missing data may be of concern. The decision was then made whether to use complete case analysis or to employ imputation techniques for missing data.

To provide a more detailed description of participants who did and did not meet each of the three sets of guidelines, two-way tables were created for each explanatory variable versus meeting each of the three guidelines. These tables were also used to ensure adequate cells sizes for categorical variables for subsequent logistic regression analysis. Categories for which cell sizes were deemed too small were collapsed.

2.6.2 Estimating physical activity levels for all Albertans

The representativeness of the study sample of the general population of Alberta was assessed first. The distributions of participants by five-year age groups, sex, educational attainment, annual household income and health region were compared with distributions of Albertans, using 2001 Canadian Census data. Prevalence rates relating to smoking status and weight status were obtained from the CCHS 2.2.A postal code conversion file from Statistics Canada was used to code participants into health regions according to 2001 census data.

The primary objective of Phase 1 was to obtain an estimate of the proportion of Albertans that meet each of the three physical activity guidelines. Data for the calculation of sample weights were obtained from a special tabulation of the Census 2001 data. Weights were estimated using the distribution weights of age group, sex, educational attainment, and annual household income by health region from the Alberta population to the study sample to obtain estimates of the proportion of Albertans that met each of the three physical activity guidelines.

2.6.3 Logistic Regression Analysis

Given the three dichotomous outcome variables for each guideline (met or did not meet each guideline), multivariate exploration of potential determinants of physical activity behaviour in this study warranted a logistic regression modeling approach. Logistic regression is a mathematical modeling approach that is used to analyze the association between explanatory variables and a dichotomous (categorical with only two categories) outcome variable (Kleinbaum and Klein, 2002a). It fits a log-odds function to

the data to estimate the log odds of the outcome given a specified set of values for the explanatory variables. Maximum likelihood is used to estimate the coefficients for the log odds model, with the aim of producing a fitted model which produces the highest overall probability for the observed outcomes (Kleinbaum and Klein, 2002a). The exponentiated forms of the estimated coefficients are used to estimate the Odds Ratio (OR) for each explanatory variable, controlling for all other variables in the model. The OR compares the odds of the outcome between two particular values of the explanatory variable (Kleinbaum and Klein, 2002a).

Prior to modelling, the data were assessed for multicollinearity. Multicollinearity occurs when strong correlations between explanatory variables exist (Norman and Streiner, 2000). The presence of multicollinearity inflates the variance of the parameter estimates in logistic regression, which may lead to lack of statistical significance of individual explanatory variables while the overall model may be strongly significant. Multicollinearity may also result in erroneous directionality and magnitudes of regression coefficient estimates, and consequently in incorrect conclusions about relationships between the explanatory and outcome variables (Harrell, 2001; Norman and Streiner, 1999). To avoid multicollinearity in this study, correlations between all possible pair combinations of explanatory variables were assessed using either Spearman or Pearson correlation. Pairs of continuous variables with a Pearson coefficient greater than 0.8 were considered collinear (Norman and Streiner, 2000). Correlation pairs involving categorical variables was assessed using Spearman Rank Correlation; pairs of variables with a Spearman coefficient greater than 0.8 were also considered to be collinear.

In preparation for logistic regression modeling, the variable for age was centered (mean age was subtracted from each participant's age) so that the effects of age could be more interpretable. When age is centered, the coefficient of age reflects the association between age and meeting a physical activity guideline for a participant of average age rather than the association between the outcome and every one year change in age (Norman and Streiner, 2000).

Logistic regression models were built using the hierarchical backward elimination approach (Kleinbaum and Klein, 2002b). This model building strategy begins with the largest possible meaningful model that incorporates the largest number of explanatory variables and eliminates unnecessary ones starting with the least statistically significant. The goal is to define the most parsimonious model that best represents the data (Kleinbaum and Klein, 2002b). The largest model included all potential explanatory variables including: age (centered), sex, weight status, self-reported health status, smoking status, marital status, educational attainment, employment status, annual household income, social support index and all of the pre-existing chronic conditions. Age, sex and weight status were included in all models regardless of statistical significance because these have been shown to be predictors of physical activity in the literature and to also be associated with a number of potential determinants, thereby acting as potential confounders, (Booth et al., 1997; Brownson et al., 2000; Sallis et al., 1992; Trost et al., 2002). Subsequent reduced models were created and variables were dropped when their contribution to the model was deemed insignificant, as assessed using the Likelihood Ratio (LR) test (Kleinbaum and Klein, 2002b). The LR test assesses a change in the log likelihood, known as the deviance, between a reduced model and a full

model, when the former is nested within the latter. The null hypothesis for the LR test is that a specified set of parameters in the full model are equal to zero. An insignificant change in the log likelihood indicates that the variables being considered do not contribute significantly to the model and can be removed without impacting the predictive value of the model (Kleinbaum and Klein, 2002b).

Variable selection can be a great source of variability in modeling multiple explanatory variables for a given outcome because of multiple comparison problems. In addition, stepwise variable selection can result in overfitting (Harrell, 2001c). Overfitting occurs when the model is too tightly tailored to study data, which often occurs when maximum likelihood estimation is used (Harrell, 2001c). Such a model does not generalize well to new data, does not replicate well and does a poor job of predicting future responses (Harrell, 2001b). One way to prevent overfitting is by using a *k*-fold cross-validation procedure to build a model. In *k*-fold cross-validation, the dataset is partitioned into *k* equal subsets at random and the first *k*-1 subsets are then used to develop the model (the training set). The model is then fitted to the remaining subset (the test subset). This process is repeated until each subset has been used as a test subset. The resulting coefficient estimates from each test subset are then averaged to get an estimate for each coefficient (Harrell, 2001c).

To avoid overfitting, a 10-fold cross-validation strategy was used to build models for each of the three guidelines. For each guideline, hierarchical backward elimination was used to build a model with each of 9 training sets and then fitted to each of 10 test subsets, following a 10-fold cross validation procedure. Variables that were selected by the model building strategy in at least three of the 10 folds were included in the final

model. Being selected at least three times was a criterion for being included in the final model in order to minimize Type 2 error, which could result from not including all predictive variables. Type 1 error was also minimized because explanatory variables that were significant less than 30% of the time would be considered weak predictors and should not be included in the final model.

Estimates for the coefficients and their standard error were averaged across all 10 folds and these estimates were used to yield estimates of Odds Ratios (ORs) and corresponding 95% confidence intervals (95% CI). Following the above procedure, three final logistic regression models were created for meeting each of the three physical activity guidelines: PHAC, ACS, and HHS guidelines. All explanatory variables selected through the model building strategy were considered to be possible determinants of meeting the physical activity guidelines. However, only those explanatory variables for which a statistically significant association with meeting the guidelines was observed, at the level of $p \leq 0.05$, were considered to be potential determinants for meeting those guidelines.

2.6.4 Assessing model fit and assumptions

To assess model fit, the final models were fitted to the whole sample (n=14,047). These models were then tested for goodness-of-fit and predictive value, and also assessed for appropriateness of the logit link, meaning that a logistic regression approach was appropriate. The Hosmer-Lemeshow (H-L) Test for goodness of fit was used to assess each model. The H-L test uses the estimated predictions from a model, orders them, and divides them into a number of groups (g) based on this ordering (Harrell, 2001a). The

observed and expected frequencies for the estimated predictions are compared by Pearson $\chi 2$ test, with $g - 2$ degrees of freedom. A statistically insignificant test statistic suggests model being tested is a reasonably good fit to the data (Harrell, 2001c).

To test the predictive value of each model, Receiver-Operator Characteristic (ROC) curves were plotted. An ROC curve is a plot of the sensitivity and 1-specificity at several cut-off points of the predicted probability (Bewick et al., 2004). The sensitivity of the model represents the proportion of observed positive outcomes that were correctly predicted as positive outcomes by the model (true positives). Since the specificity refers to observed negative outcomes that were correctly predicted as negative outcomes by the model (true negatives), then 1-specificity indicates the proportion of false positives (Bewick et al., 2004). The area under the curve then provides a measure of the probability of concordance between the predicted probability and the response (Harrell, 2001a). This measure, called the *c*-index, measures the predictive ability of a model; a value of 0.5 indicates random prediction and a value of 1 indicates perfect prediction (Bewick et al., 2004; Harrell, 2001a). Taken together, a moderate to high *c*-index and insignificant H-L test indicate that the final, most parsimonious models provide a reasonable representation of the data and that logistic regression model assumptions are unlikely to be violated.

A link test was also performed on each model to ensure the logit link was appropriate. In logistic regression modelling, the assumption is made that the logit of the outcome variable is a linear combination of the independent variables and that the logit function is the correct function to use (UCLA Academic Technology Services). The link test in STATA10® can be used to verify that the logit function is appropriate. In STATA10®, if the model is properly specified, there should not be any additional

predictors that are statistically significant except by chance. The link test uses the linear predicted value (_hat) and linear predicted value squared (_hatsq) as the predictors to rebuild the model. The variable _hat should be a statistically significant predictor, since it is the predicted value from the model, unless the model is incorrectly specified (UCLA Academic Technology Services). On the other hand, if the model is correctly specified, variable _hatsq should not have predictive power except by chance. Therefore, if _hatsq is statistically significant, then the link test is significant (UCLA Academic Technology Services). Thus, a non-statistically significant link test indicates that the model was correctly specified and that the logit function is appropriate.

Chapter Three: Methods for Phase 2

3.1 Overview of Phase 2

Phase 2 of this study focused on an analytic investigation of the individual, social, and neighbourhood environment determinants of physical activity among a sample of Tomorrow Project participants. It involved cross-sectional data collection followed by multivariate analyses. First, logistic regression analysis was conducted to identify the most influential self-reported individual and social determinants of adult physical activity for meeting each of PHAC, ACS and HHS guidelines. This analysis provided an in-depth exploration of all of the self-reported determinants at the individual level, as well as providing a basis for the subsequent analysis. Next, a multilevel approach was taken that considered two levels of influence; the individual and the neighbourhood level. Using multilevel modeling, this approach is consistent with the ecological framework for physical activity. All data management, data cleaning and analyses were completed using the statistical software package STATA10® (StataCorp, 2001).

3.2 Phase 2 Data Collection

Data collection took place in consort with the Tomorrow Project's 2008 follow-up. Starting in May 2008, The Tomorrow Project mailed a follow-up questionnaire, *Survey 2008*, to approximately than 26,000 participants. Participants were randomly allocated to one of six mailing groups of approximately 4,500 participants each. Mail-outs of *Survey 2008* were then conducted once a month staring in May 2008, with the last one in October 2008. In order to take advantage of this unique opportunity to reach Tomorrow Project participants, the data collection tool for this study, the *Determinants of*

Physical Activity Questionnaire (DPAQ) was included the in the *Survey 2008* mail-out packets in August and September 2008. Combining the DPAQ into the mail-out was only possible after obtaining ethics approval from CHREB and the ACB-REB for the change in protocol, since the original protocol was an independent wave of data collection among a random sample of Tomorrow Project participants. Such a change in protocol was justifiable because it would allow recruitment to reach 9,000 potential participants, instead of just the 950 originally proposed. In addition, having the DPAQ included in the *Survey 2008* packet was likely to increase response rates for the DPAQ because the DPAQ would be perceived as being sent from a trusted source, the Tomorrow Project.

3.2.1 Recruitment

Recruitment to this study was greatly facilitated by combining data collection for this study with the *Survey 2008* mail-outs to 9,000 Tomorrow Project participants. Along with *Survey 2008* and other Tomorrow Project related material, participants received an invitation letter to participate in this study, an informed consent form and the DPAQ. The informed consent form did not require a signature; completing and sending back the questionnaire was considered giving consent to participate in this study (Appendix E). Participants who consented were invited to return the completed DPAQ in the same envelope used to return by mail the completed *Survey 2008*. Participants who had not mailed-back their completed *Survey 2008* within 6 weeks were mailed a reminder postcard that encouraged them to review the contents of their mail-out packet. In addition, a brief description of this study and the inclusion of the DPAQ in the *Survey*

2008 packets were included in the Tomorrow Project's August 2008 newsletter, *Tomorrow's News*. This newsletter was sent to all Tomorrow Project participants every six months.

Since the DPAQ was combined with the *Survey 2008* questionnaire, the DPAQ had to be revised to reduce redundancy between the two questionnaires. Therefore, items related to demographic characteristics, postal code, self-rated health status, current smoking status, weight, height, pre-exiting chronic conditions, measures of physical activity, and the Neighbourhood Environment Walkability Scale were removed from the DPAQ. These data were obtained from the *Survey 2008* questionnaire.

3.2.2 Determinants of Physical Activity Questionnaire

The Determinants of Physical Activity Questionnaire (DPAQ) is a cross-sectional questionnaire aimed at collecting information about a number of psychosocial and social determinants of adult physical activity indentified in the literature that may apply to physical activity levels recommended for cancer prevention by ACS (Appendix F). It was designed as part of a separate study by Dr. Heather Bryant (Principal Investigator) and Fabiola Aparicio-Ting (Research Assistant), with input from Drs. Christine Friedenreich and Ron Plotnikoff (Co-Investigators). The development and validation of the DPAQ was funded by a project grant from the Canadian Cancer Etiology Research Network (CCERN).

The DPAQ was designed as a self-administered questionnaire for use among the general population. It has readability at a grade 8 level. Items and scales for the instrument came primarily from adaptations of existing tools. The questionnaire consists

of mainly selection-style items (multiple choice, true/false) and Likert-scaled items. The number of items in the preliminary draft of the instrument exceeded the number desired for the final draft to ensure a sufficient number of items after testing. Scoring schema for scales and subscales were also determined. The instrument underwent several revisions before the draft was deemed ready for pre-testing.

The draft questionnaire was pre-tested among a convenience sample of adults who were self-rated physically active (N=10) and physically inactive or sedentary (N=10) and ranged in age from 20 to 65 years old. Feedback regarding the understandability and readability of the questionnaire and to identify problem areas in the questionnaire was collected. Participants were queried about the questionnaire in general, as well as about each specific section of the questionnaire. Feedback was also solicited regarding any determinants that were not included in the questionnaire but that participants felt relevant. The results of the pre-test were used to inform further revisions of the questionnaire until a draft was deemed ready for testing by focus groups.

The draft questionnaire was then tested by focus groups conducted by Qualitative Coordination, a marketing research company specializing in focus groups and qualitative research. Overall, 13 males and 11 females participated, with 9 physically active and 15 physically inactive adults. Participants ranged in age from 20 to 65 years old and came from a variety of socioeconomic backgrounds. Focus group participants completed the questionnaire and discussions focused on the overall questionnaire and to each section specifically. The information collected by the focus groups was useful to identify problem areas, solicit suggestions for improvement, and deletion of repetitive items. The

focus group findings were summarized in a comprehensive report that was used to inform further revisions of the questionnaire.

The revised was then reformatted into TELE*form*® for ease of data entry (TELE*form* V8.1; Sunnyvale CA USA) and field tested among a random sample of Calgarians. A mailing list of 700 random Calgarians was purchased from a marketing firm in Calgary, Bungay International. The mailing list was composed of 363 females and 337 males, aged 20 to 65, residing in all quadrants of the city. A mail-out packet that included an invitation letter, an informed consent form, and the DPAQ was sent to each individual. Ninety-one packets were returned by the post office because the person no longer resided at that address.

A signed consent form and completed DPAQ was returned by 124 individuals (20.4%), 65 females (52%) and 59 males (48%). To assess reliability, participants were asked to complete the DPAQ again two weeks later. There were 48 participants (38.7%) who completed the DPAQ a second time. A validity analysis was conducted, using Cronbach's alpha to measure internal consistency of each scale within the questionnaire. These were then compared to the published Cronbach's alpha for each scale and the scales in the DPAQ were found to have similar validity as that of the original source Pearson's correlation was used to assess reliability. The overall reliability of the DPAQ was found to be 0.63.

The DPAQ consisted of five sections containing 150 items and took 35 to 40 minutes to complete. Potential determinants measured in the DPAQ included physical limitations, participation and intent to be physically active, outcome expectations, self-

efficacy, decisional balance, attitudes, self-presentation, scheduling and planning, normative behaviours, subjective norms, and social support.

3.2.3 Tomorrow Project Survey 2008 Questionnaire

The *Survey 2008* questionnaire was designed as a self-administered questionnaire to measure a number of lifestyle factors and exposures. It consisted of a compilation of items previously used in the HLQ and by other cohort studies. The purpose of *Survey 2008* was to collect follow up information from participants regarding lifestyle, measure current physical activity and to collect new information regarding employment and residential history to capture potential exposures. *Survey 2008* questionnaire contained 220 items and took 45 to 70 minutes to complete.

3.3 Data Entry and Management

Completed DPAQs and corresponding *Survey 2008* questionnaires completed by the same participant were passed onto the researcher to expedite the process of obtaining data from *Survey 2008* needed to fulfill the objectives of this study. Tomorrow Project staff estimated that it would take about one year to complete data entry for *Survey 2008* because the Tomorrow Project was recruiting participants for the Canadian Partnership for Tomorrow Project and collecting biosamples at the same time. Both the DPAQ and the *Survey 2008* questionnaires were scanned and verified using TELE*form*® software. Due to the large number of questionnaires that needed to be entered, two research clerks were enlisted to scan and verify all questionnaires received. To ensure data quality, both clerks received training about the questionnaires and were given explicit verification

procedures. All data entered were exported to a SQL database, a separate database for DPAQ data and for *Survey 2008* data. These databases were later merged and converted to STATA10® datasets for data cleaning and analysis.

3.4 Phase 2 Study Sample

The study sample consisted of Tomorrow Project participants who returned a completed DPAQ and *Survey 2008* questionnaire. Exclusion criteria for this study were age 65 and older, transgender, pregnancy, history of cancer, underweight status, and limited mobility.

3.5 Phase 2 Variables

3.5.1 Outcome measures

The outcome variables for Phase 2 were dichotomous; either meeting or not meeting each of the three guidelines: PHAC, ACS or HHS. These three outcome variables were derived from data collected in *Survey 2008* using the self-administered version of the *International Physical Activity Questionnaire* (IPAQ).

The IPAQ collects information about physical activity over the past 7 days (Craig et al., 2003). Respondents were asked to report how many days and how much time per day they spent doing moderate and vigorous intensity physical activity for four types of activity: occupational, for transportation (walking and bicycling), household and leisure. The IPAQ has been shown to be valid and reliable across a number of countries and populations and has been used by researchers worldwide (Craig et al., 2003).

To derive the outcome variables, the time spent in moderate and vigorous physical activity was firstly estimated for each of the four types of activity reported on the IPAQ: occupational, household, active transport and leisure activities. All four types of activities were included in response to recommendations made in each of the guidelines regarding including all types of physical activity, not just leisure activity, into daily routine in order to get adequate physical activity. Once these estimates were obtained, the need arose to investigate the time spent in each type of physical activity more closely. As such, it became necessary to classify participants who reported moderate and vigorous occupational physical activity as having a physically active job or not using U.S Department of Labour's O*NET Online, which is an interactive website that provides detailed descriptions of occupations (United States Department of Labor/Employment and Training Administration (USDL), 2009). Among many other characteristics, it lists over 830 job titles/occupations and provides a rating out of 100 of general physical activities for each. General physical activities are considered activities that require considerable use of arms and legs whole body movement, such as climbing, lifting, stooping and handling of materials (USDL, 2009). Job titles with a rating of 40 or higher require at least moderate activity as an integral part of the job (USDL, 2009). Information regarding participants' current occupations was obtained from an item in the *Survey 2008* questionnaire that asked participants to report their current job title. Examples of physically active jobs included dancers, fitness instructors, iron and steel workers, clinical nurses, and maintenance workers. Examples of inactive jobs included classroom teachers, executives, academics and managers.

Classification of participants into categories of either meeting or not meeting each of the three guidelines was conducted using procedures previously outlined in Section 2.5.1. Classification included the use of leisure, transportation, occupation and household activities at moderate and vigorous intensities to calculate total time spent in moderate and vigorous physical activity, where possible. The results were three dichotomous variables: met or did not meet PHAC, met or did not meet ACS guidelines and met or did not meet HHS guidelines. These dichotomous variables were used as the dependent variables in logistic regression modeling.

3.5.2 Determinants of physical activity

A number of determinates of physical activity were used in this study as explanatory variables. These were largely measured using the DPAQ, including self-rated health status, intent to do physical activity, physical activity self-efficacy, outcome expectations for physical activity, decisional balance, attitudes toward physical activity, self presentations, scheduling and planning for physical activity, subjective norm, social support for physical activity, and having a companion for physical activity.

In the DPAQ, participants were instructed to think about being physically active as participating in activities “at a moderate intensity of a brisk walking pace or faster that makes your heart beat faster and causes light perspiration. Your activity must add up to a total of 30 to 45 minutes or more per day and be done at least 5 days per week.” This time referent applies to physical activity as recommended by PHAC and ACS, since the original purpose of the DPAQ was to measure potential determinants of physical activity at levels for cancer prevention.

To assess self-rated health status, respondents were asked “In general, would you say your health is excellent, very good, good, fair or poor?” Respondents were given a rating based on their answer (from 5 to 1).

Intent to do physical activity was assessed by asking respondents “Do you plan to be physically active for at least the next 6 months?” The response choices were a 5 point Likert scale ranging from “definitely not” to “definitely yes”.

Self-efficacy was assessed using a modified version of the Exercise Self-efficacy Scale (Division of Education Studies at Emory University, 2004). Respondents were asked to rate, on a five-point Likert scale how confident they were that they could be physically active given a number of situations (not at all confident – extremely confident). Self-efficacy scores were obtained by calculating the average response for the 17 items in the scale.

Outcome expectations were assessed using the Outcome Expectations for Exercise Scale (Resnick et al., 2000). This 17 item scale listed a number of potential outcomes for physical activity (e.g. being physically active will make me feel tired, will make my muscles stronger). Respondents were asked to report their level of agreement with the statement on a five-point Likert scale, from strongly disagree to strongly agree. Items corresponding to negative outcomes were reverse coded. Calculating the average response for the 17 items in the scale yielded an outcome expectations score.

Attitudes towards physical activity were assessed by a modified five-item scale used and validated by other researchers (Blanchard et al., 2003). Respondents were asked to indicate how useless/useful, harmful/beneficial, unenjoyable/enjoyable, stressful/relaxing, or boring/interesting the process of trying to get adequate exercise

would be regardless of success or failure. Respondents answered using a 5 point Likert scale and the average response per item reflected attitudes toward physical activity.

Decisional balance was assessed using a modified version of the Exercise Decisional Balance Scale (Plotnikoff et al., 2001a). This scale contains two subscales: decisional balance pros (5 items) and decisional balance cons (5 items). Respondents were asked to indicate how much each of a number of statements has influenced their decision about whether or not to be physically active on a five-point Likert scale ranging from not at all to very much. Average responses for each of the subscales were estimated.

Self presentation was assessed using five items that asked respondents their level of agreement with statements about how others might perceive someone who is physically active (e.g. being physically active, others will think I have good stamina, others will think that I am in good shape) (Gammage et al., 2004). Self-presentation was obtained by calculating the average score among the five items.

Scheduling and planning of physical activities was assessed using a nine-item scale validated and used in other psychosocial studies of physical activity (Rovniak et al., 2002). Respondents were asked to indicate how well a number of statements regarding the ability to schedule time for physical activity described them on a five point Likert scale ("does not describe me" to "describes me completely"). The average item score was a measure of scheduling and planning physical activity.

Subjective norm was measured for this study by one item (Courneya and McAuley, 1995). This item asked respondents to rate the statement "Most people who are important to me think I should be physically active", on a five-point Likert scale, ranging from "very unlikely" to "very likely."

Three different sources of physical activity social support were assessed in this study: social support from family (a spouse/partner and any immediate or extended relative that the respondent may have frequent contact with), friends and physician (if visited in the last year) (Sallis et al., 1987). Each type of support was measured by a collection of items that asked respondents to report how often the source of social support had said or done something to either support or discourage physical activity, described by a number of statements. An average score for each source of support was estimated.

To collect information regarding having a companion for physical activity, respondents were asked how often, over the past month, any of the listed people did physical activity with them: spouse or partner, family member, friend, co-worker, and someone from their neighbourhood (Giles-Corti and Donovan, 2002a). Answers were given by indicating never, once or twice, three times or four or more times. Respondents who indicated that no one had accompanied them during a physical activity session in the past month were categorized as having no companion for physical activity. Respondents who indicated having someone do physical activity with them at least once or twice over the past month were categorized as having a companion of physical activity.

Demographic characteristics were obtained from information collected in the *Survey 2008* questionnaire, including age, sex, annual household income, educational attainment, employment status and marital status. The *Survey 2008* questionnaire was also the source for height and weight, current smoking status and pre-existing chronic conditions.

Participants were provided detailed instructions, illustrations and a tape measure to measure their height, wait, and hip measures, as previously measured in the HLQ at

baseline (Bryant et al., 2006; Kushi et al., 1988). Participants were also given instructions for obtaining and recording a measurement of body weight using any scale available to them. BMI was then estimated and used to indicate each participant's weight status.

Items regarding current and past use of cigarettes, cigarillos, cigars and pipes, and frequency of use of each of these currently and in the past were used in the *Survey 2008* questionnaire (Mills et al., 1994). For this study, only data regarding current use of cigarettes, cigarillos, cigars and pipes and frequency of their current use were relevant. Respondents were categorized as currently not smoking (no smoking in the past 30 days), smoking occasionally (at least one cigarette in the past 30 days, but not every day), and smoking daily (at least one cigarette every day for the past 30 days).

Respondents to the *Survey 2008* questionnaire were also asked to report any pre-existing chronic conditions. Respondents were asked: "Has a doctor ever told you that you had any of the following conditions?" to which they indicated "yes" or "no". The list of chronic conditions included high blood pressure, angina, high cholesterol, heart attack, stroke, heart problems, emphysema, chronic bronchitis, asthma, diabetes, polyps in the colon or rectum, ulcerative colitis, Crohn's disease, hypo- and hyper-thyroid, arthritis, osteoporosis, hepatitis, and cirrhosis of the liver. Given the low prevalence of many of these conditions in this sample, several chronic conditions were collapsed into broader categories to ensure adequate numbers in each category for the multivariate analysis. Polyps in the colon or rectum, ulcerative colitis, Crohn's disease were collapsed into one category for colorectal problems. High blood pressure and high cholesterol were collapsed into cardiovascular problems. Hepatitis and cirrhosis of the liver were collapsed into liver problems. Hypo- and hyper-thyroid were collapsed into thyroid problem.

Lastly, arthritis and osteoporosis were collapsed into one category for bone and joint problems.

3.5.3 Neighbourhood and neighbourhood characteristics

Participants from Calgary and Edmonton were classified into neighbourhoods using postal code conversion files obtained from the Maps, Academic Data and Geographic Information Centre (MADGIC) department at the University of Calgary. MADGIC also provided the corresponding neighbourhood profiles from 2006 census data. These postal code conversion files and neighbourhood profiles are special products from Statistics Canada commissioned and purchased by the City of Calgary and the City of Edmonton and are restricted to University students, staff and faculty. Such specialized census data were not available for Lethbridge or Medicine Hat; therefore, only participants residing in Calgary or Edmonton were included in this part of the analysis. Neighbourhood profiles yielded median neighbourhood income and educational attainment. Median neighbourhood educational attainment was estimated by categorizing neighbourhoods according to the highest educational level achieved by 50% or more of its residents: high school diploma or less, technical certificate or diploma, some college/college degree, some university/university degree or higher.

Neighbourhood environment was measured by individual self-report using the Neighbourhood Environment & Walkability Scale (NEWS) since objective data for neighbourhood characteristics were not available (Appendix G). The NEWS was included as part of *Survey 2008*. In the NEWS, respondents are asked to report on a number of characteristics (subscales) relating to their neighbourhood including: access to

amenities and services within walking distance; street connectivity; places for walking and cycling; neighbourhood aesthetics; safety from traffic; and safety from crime (Saelens et al., 2003). The score on the NEWS, including all subscales, indicates the walkability of the neighbourhood. Residents of high-walkability neighbourhoods score significantly higher on the NEWS than residents of the low-walkability neighbourhoods (Saelens et al., 2003). In addition, correlations between perceived environment, as measured by the NEWS, and actual environment have been shown to be 0.58 or greater for both high-walkability and low walkability neighbourhood participants. Test-retest reliability of the NEWS has also been reported to be high, with an intraclass correlation greater than 0.75 for all subscales (Saelens et al., 2003). Overall, this evaluation study found the NEWS, although based on self-report by individuals, provided a valid measure of neighbourhood environment and walkability. Since objective assessment of neighbourhood environment was not available for Calgary or Edmonton and the collection of such data would require the use of Geographical Information Systems (GIS) methods and mapping (which is beyond the scope of this thesis) the NEWS was used as a valid proxy measure of neighbourhood physical environment and walkability.

3.6 Phase 2 Logistic Regression Analysis

3.6.1 Descriptive Analysis

Univariate analysis was carried out first, to provide an overview of each variable, an overall description of the study sample, and to ensure adequate cell sizes for categorical variables for subsequent multivariate analysis. Descriptive analysis of reported physical activity (minutes per week in moderate to vigorous activity) was also

done. The mean proportion of total minutes per week in moderate to vigorous activity spent in each type of physical activity (active transport, leisure, and occupational) for those meeting each physical activity guideline was estimated for males, females, and for each age group. This provided a breakdown of the type(s) of physical activity that helped participants to meet each of the three guideless. In addition, univariate analysis was used to assess the amount of data and to make a decision regarding the need for imputation of missing values as previously described in Section 2.6.1.

The amount of missing data for items that were part of scales was also assessed. For each scale, patterns of missing responses were examined for all items that comprised a scale. Patterns that showed certain items within a given scale were consistently missing indicated a problem with the scale; therefore, a scale score should not be estimated. If no pattern of missing responses was found within the scale, data were considered missing at random and calculating a scale score using complete data were deemed appropriate (Harrell, 2001b).

The sociodemographic characteristics of the study sample were compared to that of the Alberta population at large using Census 2006 data. The percent distribution of males and females by age group, educational attainment and annual household income for the study sample and for the Alberta population were estimated. This comparison helped to assess the representativeness of the study sample to the Alberta population.

An objective of Phase 2 of this study was to determine if physical activity determinants differed for women and men, or by age group. Therefore, a stratified descriptive analysis by sex and by three age groups was also conducted. Age groups were created by dividing the data into tertiles to create age groups of approximately equal size.

To provide a detailed description of the study sample, each explanatory variable was described by sex and age group. Categories of explanatory variables for which cell sizes were deemed too small (n <5) were collapsed. Stratified descriptive analysis provided a comparison between men and women and between age groups, with respect to all the explanatory variables.

3.6.2 Logistic regression modeling and cross-validations

Logistic regression analysis was used to explore the association between explanatory variables and the three dichotomous outcome variables for each guideline (met or did not meet each guideline). As in Phase 1 of this study, the data were first assessed for multicollinearity before any modeling was done (Section 2.6.3).

Figure 3.1 provides an overview of the logistic regression modeling strategy used. First, single level logistic regression models were created to provide the basis for subsequent two-level logistic regression models that incorporated neighbourhood factors. Logistic regression modeling was stratified by sex and three age strata, resulting in two final sex-specific models and three final age-specific models for meeting each of the three physical activity guidelines. In total, 15 logistic regression models were built.

Logistic regression models were built using the hierarchical backward elimination approach with the goal of defining the most parsimonious model that best represented the data (Kleinbaum and Klein, 2002b). Prior to creating age and sex-specific models, hierarchical backward elimination was used on the whole sample as a data reduction strategy for each guideline. The level of significance was set at $p \leq 0.25$ to minimize Type 2 error so that no potentially predictive variables were excluded prematurely. The

resulting models were then used as the starting (largest) models for subsequent strata-specific model building.

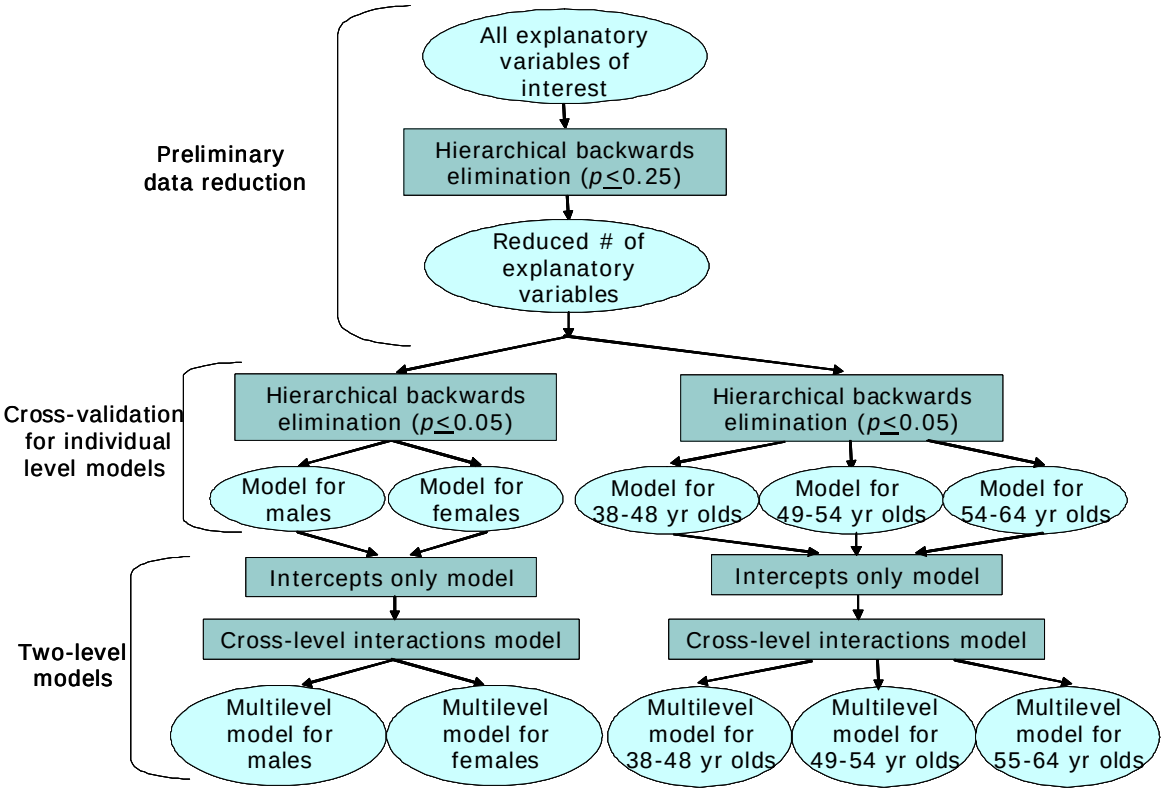

Figure 3.1. Logistic regression modelling strategy for identifying potential determinants of meeting each of three physical activity guidelines

The largest model included all potential explanatory variables including: age (centered) (for sex stratified models), sex (for age stratified models), weight status, self-reported health status, smoking status, marital status, educational attainment, employment status, annual household income, all pre-existing chronic conditions, intent to do physical activity, physical activity self-efficacy, outcome expectations for physical activity, decisional balance, attitudes toward physical activity, self presentations, scheduling and planning for physical activity, subjective norm, socials support for physical activity, and

having a companion for physical activity. Subsequent reduced models were created and variables were dropped when their contribution to the model was deemed insignificant as assess using the Likelihood Ratio (LR) test (Kleinbaum and Klein, 2002b). Age (for sex-specific models), sex (for age-specific models), weight status, educational attainment, employment status and annual household income have all been shown to be confounders in previous research and, therefore, were included in all of the models and prohibited from being dropped by the variable selections strategy. As a result, all final models for the association between the explanatory variables and meeting each of the guidelines were adjusted for these variables.

Similar to the analysis in Phase 1, a *k*-fold cross-validation strategy was used for model building for each of the three guidelines to avoid overfitting (Figure 3.1) (Harrell, 2001c). For each guideline, hierarchical backward elimination was used to build a model with each of *k*-1 training sets and then fitted to each of *k* test subsets. Given that stratification reduced sample size for analysis, two 5-fold cross validations were conducted for sex-specific models and three 3-fold cross validations were conducted to the age group specific models. This was achieved by creating new random subsets for each round of cross validation. In this way, sample sizes for each test subset of the cross validation could have sufficient power for logistic regression with a large number of explanatory variables. There is evidence that although a 5 fold cross-validation improves the reliability of coefficient estimates, replicating cross-validations can produce even more robust estimates (Kohavi, 1995).

Using this approach, 10 folds of coefficient estimates were created for each sex-specific model, and nine folds were created for each age-specific model. Variables that

were selected by the model building strategy in at least three of the 10 folds for the sex-specific models and at least three of the 9 folds for the age group specific models were included in the final models. Being selected at least three times was a criteria for inclusion in the final model in order to minimize Type 2 error, by not including all potentially predictive variables, while minimizing Type 1 error by including variables that are not good predictors of the outcome (Harrell, 2001c). Estimates for the coefficients and their standard error were averaged across all folds and these estimates were used to yield estimates of Odds Ratios (ORs) and corresponding 95% confidence intervals (95% CI). All explanatory variables selected through the cross validation strategy to be included in the final models were considered to be possible determinants of meeting the physical activity guidelines. However, only those explanatory variables for which a statistically significant association with meeting the guidelines was observed, at the level of $p \leq 0.05$, were considered to be identified as potential determinants for meeting those guidelines.

If the final models did not differ substantially by sex or age strata, one all-inclusive model for each guideline would be presented. If the strata-specific models did indeed yield differing results, the strata-specific models would be presented and unstratified models would not be pursued. In this case, strata-specific models were more informative, especially when considering implications for promoting physical activity as a cancer prevention strategy.

3.6.3 Assessing model fit and assumptions

To assess model fit, each of the 15 final logistic regression models was fitted to the whole samples (for example, all females). These models were then tested for goodness-of-fit, predictive value, and the logit function assessed for appropriateness as previously outlined in Section 2.6.4.

3.7 Phase 2 Multilevel modeling

The final objective of this study was to investigate the association of the neighbourhood environment with meeting each of the three physical activity guidelines, in keeping with the Ecological Model for Physical Activity. Neighbourhood was the level-2 grouping variable and neighbourhood group annual household income and neighbourhood group educational attainment were level two explanatory variables. Level-1 explanatory variables were those identified through the previous logistic regression modeling. Once again, multilevel modeling was stratified by sex and age group. The modeling strategy began the simplest model, the random intercepts model, followed by assessment of the appropriateness of a two-level approach and then the building of a more complex random slopes and intercepts model, where appropriate. Building two-level models allowed the examination of how meeting each of the three physical activity guidelines was influenced by neighbourhood environment for each sex and age group (Figure 3.1).

3.7.1 Neighbourhood level group sizes

The distribution of participants across neighbourhoods was closely examined to confirm there were a sufficient number of participants in each neighbourhood for a multilevel model. Neighbourhoods with fewer than 10 participants were grouped with other neighbourhoods that had similar median household incomes and educational attainment profiles and were either adjacent to or in close geographical proximity. Although there is no exact cut-off for group size, research suggests that a cluster size of 10 is acceptable, especially when there are a large number of groups (Luke, 2004).

Neighbourhood group household income for each new neighbourhood group was estimated using an average of the median household incomes of the neighbourhoods that were grouped together. Neighbourhood educational attainment for each new neighbourhood group was estimated using educational attainment data from the 2006 census data for each of the neighbourhoods in the group. To ensure that neighbourhood group profiles reflected individual neighbourhood profiles, median household incomes and educational attainment were compared between neighbourhoods and neighbourhood groups. Pearson correlation was used to assess the correlation between neighbourhood household income and neighbourhood group household income for each participant. The frequency distributions of participants by median neighbourhood educational attainment and median neighbourhood group educational attainment were also compared, using Spearman Rank correlation. This process helped ensure participants' neighbourhood level characteristics remained unchanged despite having to create neighbourhood groups to attain adequate group sizes for multilevel modeling.

3.7.2 Descriptive analysis of sub-sample neighbourhood characteristics

Descriptive analysis was conducted by providing a univariate description of the proportion of sub-sample participants who met each of the three physical activity guidelines and each neighbourhood level explanatory variable. The univariate analysis provided a basis for comparison between the sub-sample and whole sample to assess the representativeness of the sub-sample. The descriptive analysis was also stratified by sex and age group.

3.7.3 Multilevel logistic regression modeling using STATA10®.

Multilevel model building for each guideline began with the addition of the level 2 explanatory group variables to the level 1 explanatory variables to form a two-level model. Models were estimated using two-level logistic regression. This approach accommodates the conditional dependence of binary outcomes for individuals who live in the same neighbourhood group (Luke, 2004; Snijders and Bosker, 1999b). The conditional dependence stems from the fact that, if neighbourhood environment is considered to be a determinant of physical activity behaviour, then participants who live in the same neighbourhood may have similar likelihood of meeting physical activity guidelines, regardless of individual level characteristics. In this case, the outcomes for individuals within the same neighbourhood group are not independent and thus, a single-level logistic regression model is not appropriate (Luke, 2004). A two-level logistic regression model can be used in this case to allow for within-neighbourhood dependence, especially for estimates of neighbourhood level characteristics, and to estimate the

variability that can be accounted for by neighbourhood environment (known as between neighbourhood group differences) (Luke, 2004; Snijders and Bosker, 1999b).

Sex and age-specific two-level models were built for each of the three physical activity guidelines. Level one explanatory variables were those selected through previous logistic regression models using hierarchical backwards elimination with cross-validation, with the addition of the NEWS score. These variables had already been identified as a good fit for the individual-level data. In addition, using the finalized individual-level logistic regression models as the basis for the level-1 variables served as a data reduction strategy, which accommodated for the decrease in sample size that resulted from using a sub-sample of only Calgary and Edmonton residents. These variables are referred to as the fixed effects of a multilevel model (Luke, 2004). The random effects refer to the group effect or the neighbourhood effects (Luke, 2004). Two-level logistic regression estimates the fixed effects coefficients and provides an estimate of the variance component of the random effects.

The first step in building each sex and age-specific two-level logistic regression model was to consider a random intercepts model, which examined the intercepts of the fixed effects as a function of the level two variable (Luke, 2004). A random intercepts model assumes the association between the fixed effects and meeting physical activity guidelines is consistent across neighbourhoods and that the differences in meeting physical activity guidelines may be, in part, attributable to between-neighbourhood differences. A Likelihood Ratio (LR) was used to assess the appropriateness of the two-level model by comparing the deviance between the two-level model and ordinary one-level logistic regression model that did not incorporate neighbourhood effects (Snijders

and Bosker, 1999a). A statistically significant LR test indicated that variation between the random effects, hence the two-level model is deemed appropriate (Snijders and Bosker, 1999a). A statistically insignificant LR test indicates the opposite; that there is no evidence of variation between neighbourhood regarding meeting the physical activity guideline and that a two-level model is not necessary.

If a random intercepts model was deemed appropriate, the residual intraclass correlation coefficient (ICC) was estimated. The ICC quantifies the proportion of variance in the outcome variable that is accounted for by the level-2 groups (Luke, 2004; Snijders and Bosker, 1999a). For this study, the ICC measured the proportion of variance in meeting the physical activity guideline being considered that was accounted for by neighbourhood group. The ICC is obtained by dividing the estimated neighbourhood variance by the total variance, which is the sum of the between-neighbourhood and between-individual variance. In the case of multilevel logistic regression, the between-individual variance is estimated by $\pi^2/3$ (Snijders and Bosker, 1999a).

For the random intercepts models that were found to be appropriate for each guideline, random intercepts and slopes models were also considered. A random slopes model examined if neighbourhood group characteristics (educational attainment and household income) had an impact on the association between fixed effects and meeting each of the three physical activity guidelines (Snijders and Bosker, 1999a). A variation in slopes indicated a difference in association between the fixed effects and meeting the physical activity guideline mediated by the neighbourhood characteristics, also known as a cross-level interaction (Luke, 2004). To estimate cross-level interaction, models for meeting each guideline were specified with interaction terms between the fixed effects

and each neighbourhood group characteristic. The LR test was used to assess change in deviance between random intercepts and slopes models and random intercepts only models. If the LR test was statistically significant, then the random intercepts and slopes models were deemed appropriate and the cross-level interactions were described (Luke, 2004; Snijders and Bosker, 1999a). The most complex two-level model that explained the most variability in the data were chosen as the final model for each physical activity guideline.

3.7.4 Assessing model fit

Plots of deviance residuals versus predicted probabilities were used to identify the presence, if any, of potential outliers that may unduly influence the results. Deviance residuals are based on the LR chi-squared statistic and measure each observation's contribution to the model lack of fit (Snijders and Bosker, 1999a). When deviance residuals are plotted against the predicted probabilities, outlier observations can be easily identified visually: outliers are separate from the rest of the data points and have a deviance larger then 2. These outliers may be influential and need to be assessed carefully to ensure that the model is indeed a good representation of the data and is not biased based on one or few extreme observations (UCLA Academic Technology Services).

Secondly, the goodness-of-fit was also assessed by estimating the ability of each model to predict the outcome correctly (Rodriguez, 2009). The fitted models were used to predict the outcome of meeting the physical activity guidelines being assessed based on the fitted probabilities of the model. Fitted probabilities that exceeded 0.5 (or 50%) were

indicative of meeting the guidelines, while lower fitted probabilities indicated not meeting the guidelines. The observed and predicted outcomes were then cross-tabulated and the proportion of cases predicted correctly was estimated. The higher the proportion of correctly predicted outcomes, the better the predictive ability of the model and the better the fit of the model to the data.

Chapter Four: Phase 1 Analysis Results

4.1 Overview

The purpose of this analysis was primarily to describe the proportion of Tomorrow Project participants, enrolled between from 2000 and 2004, that met physical activity guidelines set forth by the Public Health Agency of Canada (PHAC), the American Cancer Society (ACS), and the U.S. Department of Health and Human Services (HHS). Secondarily, this analysis was also used to provide a preliminary exploration of a limited number of potential determinants of meeting these guidelines, based on data collected for Tomorrow Project participants at the time of enrolment, known as baseline assessment.

4.2 Study Sample

There were 16,040 Tomorrow Project participants who completed both the HLQ and the PYTPAQ at the baseline assessment from 2001 to 2005. A total of 1,746 participants were excluded from the study sample based on the established exclusion criteria: transgendered (n=2), age over 65 (n=1,328), pregnant (n=55), prior cancer diagnosis (n=188), non-Alberta residence (n=75), and being underweight (n=98). The remaining 14,294 Tomorrow Project participants comprised the sample for Phase 1 of this study.

4.3 Missing Data

Descriptive univariate analysis revealed that the amount of missing data were negligible. There were complete data for physical activity, age, sex, urban or rural

residence. The variables for annual household income, educational attainment and weight status had the highest amount of missing data at 1.9%. The remaining variables had a range of missing data between 0.5% and 1.7%. Overall, only 2% (288) of participants had any missing data. Given the completeness of the data and the very low proportion of participants with missing data, imputation was not considered for this study and complete case analysis was used.

4.4 Study Sample Characteristics

The sample's characteristics are outlined in Table 4.1. The study sample was composed largely of women (60%) and the average age of participants was 48. Participants had high educational attainment, with more than 30% of participants having some University education or higher. Annual household income was also high among this sample, with about 37% of participants reporting an annual household income of $80,000 or higher. The vast majority of participants were married or living with a common-law partner (77%), employed either full-time or part time (77.5%), and resided in an urban area (80%). A little over 60% rated their health as very good or better and participants were largely free from chronic conditions. The most commonly reported chronic condition was cardiovascular problems (having high cholesterol or high blood pressure) at 36%, compared to less than 5% for all other chronic conditions. There were few daily smokers in this sample, with 81% of participants reporting not having had a cigarette within the past month. Lastly, 65% of participants were overweight or obese, based on their self-reported body mass index.

Table 4.1 Study sample characteristics

Variable (n)	Frequency	Mean (SD) or Percent
Age (Range: 34.8-65) (n=14,294)		
Mean(SD)		48.7(7.9)
%missing		0.0%
Sex (n= 14,294)		
Male	5,729	40.1%
Female	8,565	59.9%
Total	14,294	
%missing		0.0%
Weight Status (n=14,022)		
Normal	4,964	35.4%
Overweight	5,525	39.4%
Obese	3,533	25.2%
Total	14,022	
%missing		1.9%
Marital Status (n=14,216)		
Married/Common Law	11,316	76.9%
Divorced, separated or widowed	2,160	15.2%
Single	740	6.5%
Total	14,216	
%missing		0.5%
Educational Attainment (n=14,005)		
Less than High School	1,206	8.6%
High School Diploma	2,607	18.6%
Technical School/College training	5,582	39.9%
Some University/University Degree	3,202	22.9%
Post-Graduate University Education	1,408	10.1%
Total	14,005	
%missing		1.9%
Employment Status (n=14051)		
Employed full-time	8,529	60.7%
Employed part-time	2,361	16.8%
Unemployed	1,897	13.5%
Retired	1,124	8.0%
Self-Employed	140	1.0%
Total	14,051	
%missing		1.7%

Table 4.1 Study sample characteristics (continued)

Variable (n)	Frequency	Mean (SD) or Percent
Annual Household Income (n=14,022)		
< $20,000	841	6.0%
$20,000 - $39,999	2,327	16.6%
$40,000 - $59, 999	2,804	20.0%
$60,000 - $79, 999	2,806	20.1%
$80,000 - $99, 999	2,033	14.5%
≥ $100,000	3,211	22.9%
Total	14,022	
%missing		1.9%
Rural or Urban Residence (n=14,294)		
Rural	2,800	19.6%
Urban	11,494	80.4%
Total		
%missing		0.0%
Self-rated Health Status (n=14,036)		
Excellent	2,428	17.3%
Very Good	6,092	43.4%
Good	4,688	33.4%
Fair	744	5.3%
Poor	84	0.6%
Total	14,036	
%missing		1.8%
Current Smoking Status (n=14,151)		
Non-smoker	11,392	80.5%
Occasional	495	3.5%
Daily	2,264	16.0%
Total	14,151	
%missing		1.0%
Cardiovascular Problems (n=14180)		
No	9,132	64.4%
Yes	5,048	35.6%
Total	14,180	
%missing		0.8%
Heart Problems (n=14,194)		
No	13,811	97.3%
Yes	383	2.7%
Total	14,194	
%missing		0.7%

Table 4.1 Study sample characteristics (continued)

Variable (n)	Frequency	Mean (SD) or Percent
Stroke (n=14,222)		
No	14,137	99.4%
Yes	85	0.6%
Total	14,222	
%missing		0.5%
Respiratory Problems (n=14,222)		
No	13,696	96.3%
Yes	526	3.7%
Total	14,222	
%missing		0.5%
Colorectal Problems (n=14,180)		
No	13,471	95.0%
Yes	709	5.0%
Total	14,180	
%missing		0.8%
Diabetes (n=14,237)		
No	13,696	96.2%
Yes	541	3.8%
Total	14,237	
%missing		0.4%
Social Support Score (n=14,217) (Range: 18-65)		
Mean(SD)		3*(0.8)
%missing		0.5%

*The value 3 corresponds to having general social support for most of the time based on the Medical Outcomes Study (MOS) Support scale.

4.5 Comparison between the Study Sample and the Alberta Population

Table 4.2 provides a comparison of the sociodemographic characteristics between the study sample and the Alberta population. There was a larger proportion of females (60%) in the study sample than in the Alberta population (50%) and the study sample was generally older, with 42% of the study sample over the age of 50, compared to 37% of the Alberta population. The study sample also had a larger proportion of overweight and

obese adults than the Alberta population (Table 4.2). In the Alberta population, 37% of individuals were overweight, compared to 39% of the study sample. Only 15% of the Alberta population was obese, compared to 25% of the study sample.

There were also differences between the study sample and the Alberta population in educational attainment and annual household income (Table 4.2). The study sample had a much lower proportion of individuals with an education below high school and a higher proportion of individuals with technical school or college training and beyond a university degree than that of the Alberta population. The annual household incomes of study participants were also higher than that of the Alberta general population. The study sample had a higher proportion of individuals with an income over $60,000 and lower proportion of individuals with an income less than $20,000 than the Alberta population. Overall, participants in this study were more likely to be female, older, more highly educated and had higher annual household incomes compared to the Alberta population.

Overall, study participants represented all nine Health Regions. The majority of participants were from the major metropolitan areas, 34% from the Calgary health Region and 30% from the Capital Health Regions (Table 4.2). In comparison to the Alberta population, the study sample had a lower percentage of urban residents and a higher percentage of non-urban residents, reflecting intentional over-sampling of non-urban residents by The Tomorrow Project (Bryant et al., 2006).

4.6 Hours per Week of Physical Activity

The total hours per week each participant spent in moderate and vigorous intensity physical activity, including leisure, household, occupation, and transportation

Table 4.2 Comparison of sociodemographics between the study sample and the Alberta population

Sociodemographics	Study Sample	Alberta*
Age		
35-39 years old	16.6%	21.4%
40-44 years old	20.6%	22.5%
45-49 years old	20.3%	19.7%
50-54 years old	17.7%	16.0%
55-59 years old	14.3%	11.5%
60-64 years old	10.4%	9.0%
Male	40.1%	50.3%
Female	59.9%	49.7%
Weight Status^		
Normal	35.4%	43.5%
Overweight	39.4%	38.1%
Obese	25.2%	18.4%
Current Smoking Status^		
Daily smoker	16.0%	24.5%
Educational Attainment		
Less than High School	8.6%	22.3%
High School Diploma	18.6%	16.0%
Technical School/College training	39.9%	29.1%
Some University/University Degree	22.9%	27.4%
Post-Graduate University Education	10.1%	5.1%
Annual Household Income		
< $20,000	5.8%	32.6%
$20,000 - $39,999	16.2%	29.3%
$40,000 - $59, 999	19.5%	19.3%
$60,000 - $74, 999	19.7%	8.2%
> $75,000	36.6%	10.5%
Health Region		
Chinook	5.2%	4.6%
Palliser	5.0%	3.0%
Calgary	33.7%	36.8%
David Thompson	10.0%	8.9%
East Central	3.9%	3.6%
Capital	29.6%	31.8%
Aspen	6.4%	5.5%
Peace	4.4%	3.9%
Northern Lights	1.9%	1.9%

*data from 2001 Census
^data from CCHS 2.2 (2003)

physical activities were estimated. When all types of physical activity were considered, the median amount of time participants spent in moderate to vigorous activity was 14.7 hours per week with an interquantile range between 7 and 37 hours per week. Given that this estimate was equivalent to 50% of the study sample doing an average of about 2 hours per day or more of moderate and vigorous physical activity, an inspection of the amount of physical activity reported by type of physical activity was undertaken. Closer examination of the hours per week of moderate and vigorous of physical activity reported by type of activity revealed that more than 5% of the sample reported doing more than 22 hours of moderate to vigorous household activity per week. However, when household activity was excluded from the calculation of total hours per week of activity, the estimated median hours per week spent in moderate and vigorous physical activity was 8.1 hours per week, with an interquantile range between 3.3 and 27.9 hours per week. The mean total hours per week spent in moderate and vigorous occupational activity was 14.5, with an interquantile range of 0 to 30.6 hours per week. Only occupational activity for those who reported being employed (full-time, part-time and self-employed) was considered. Therefore, only occupation, transportation, and leisure time activities contributed to the final estimate of the number of hours spent in moderate to vigorous physical activity for this sample. This estimate of physical activity based on leisure, occupation, and active transport activities was then used to determine which participants did and did not meet each of the three guidelines. In addition, estimates of the proportion of the sample that met each of the three guidelines were also done for each type of activity individually.

4.7 Meeting Physical Activity Guidelines

Regardless of the type of activity considered, more participants met PHAC guidelines than the other guidelines and HHS guidelines were met by the lowest percentage of participants. A comparison of the proportion of the participants who met each guideline by type of physical activity found that the highest proportion of participants who met PHAC and ACS guidelines occurred when leisure activity alone was considered, compared with household, occupational or active transport activity (Table 4.3). On the other hand, the highest percentage of participants who met HHS guidelines occurred for the estimates based on occupational activity. The lowest proportion of meeting each of the three guidelines was found when only active transport activities were considered.

When leisure, household, occupational and active transport activities were combined, a vast majority of the study sample met all three guidelines (Table 4.3). Similar results were found when leisure household and occupational activities were combined, with approximately 92% meeting PHAC guidelines, 77% meeting ACS guidelines, and 77% meeting HHS guidelines. However, when leisure, occupational and active transport activities were combined 81% met PHAC guidelines, 72% met ACS guidelines, and 59% met HHS guidelines. Given concerns about of the estimate of household activity previously described (Section 4.6), it was the combination of leisure, occupational, and active transport activities that was used for the estimates of physical activity for subsequent analyses.

Table 4.3 Meeting physical activity guidelines by type and combinations of types of physical activity

Physical Activity*	Met PHAC guidelines		Met ACS guidelines		Met HHS guidelines	
	No.	%	No.	%	No.	%
Type of activity						
Leisure activity	8,773	62.6	6,734	48.1	4,115	29.5
Household activity	7,711	55.1	6,034	43.1	4,156	29.8
Occupation activity	5,680	40.6	5,387	38.5	4,930	35.3
Active transport activity	470	3.4	162	1.2	50	0.4
Combinations of types of activity						
Leisure, household, occupational and active transport	12,965	92.6	12,322	88.0	10,912	78.1
Leisure, household and occupation	12,920	92.3	12,254	87.5	10,793	77.3
Leisure, occupation and active transport	11,320	80.8	10,067	71.9	8,191	58.6

*Moderate and vigorous intensity activity

4.7.1 Meeting Public Health Agency of Canada (PHAC) guidelines

When leisure, occupational and active transport activities were taken into account, 81% of participants reported sufficient physical activity to meet PHAC guidelines (Table 4.3). These were the least demanding of the guidelines under study, requiring 30 minutes of moderate to vigorous activity most days of the week.

Bivariate analysis revealed that the group that met these guidelines through leisure, occupational and active transport activities had a higher proportion of males, employed individuals, and individuals with educational attainment than high school that the group who did not meet these guidelines (Table 4.4). Individuals who met PHAC

Table 4.4 Study sample characteristics by meeting physical activity guidelines through total physical activity (N=14,006)

Variables	Met PHAC Guidelines				Met ACS Guidelines				Met HHS Guidelines			
	No		Yes		No		Yes		No		Yes	
Age (in years) (Range: 35-64)												
Mean(SD)	49.5(8.2)		45.5(7.9)		49.2(8.1)		48.5(7.9)		49.1(8.0)		48.4(7.8)	
Sex												
Male	807	14.4%	4,807	85.6%	1,182	21.1%	4,432	78.9%	1,873	33.4%	3,727	66.6%
Female	1,879	22.4%	6,513	77.6%	2,757	32.9%	5,635	67.1%	3,907	46.7%	4,464	53.3%
Total	2,686	19.2%	11,320	80.8%	3,939	28.1%	10,067	71.9%	5,780	41.4%	8,191	58.6%
Weight Status												
Normal (BMI <25)	892	18.0%	4,060	82.0%	1,336	27.0%	3,616	73.0%	1,725	34.8%	3,227	65.2%
Overweight (25<BMI <30)	946	17.2%	4,553	82.8%	1,444	26.3%	4,055	73.7%	2,372	43.1%	3,127	56.9%
Obese (BMI >30)	836	23.8%	2,684	76.3%	1,143	32.5%	2,377	67.5%	1,683	47.8%	1,837	52.2%
Total	2,674	19.1%	11,297	80.9%	3,923	28.1%	10,048	71.9%	5,780	41.4%	8,191	58.6%
Marital Status												
Married/Common Law	2,091	19.1%	8,834	80.9%	3,101	28.4%	7,824	71.6%	4,579	42.0%	6,324	58.0%
Divorced, separated or widowed	420	19.5%	1,734	80.5%	593	27.5%	1,561	72.5%	862	40.1%	1,286	59.9%
Single	175	18.9%	752	81.1%	245	26.4%	682	73.6%	339	36.8%	581	63.2%
Total	2,686	19.2%	11,320	80.8%	3,939	28.1%	10,067	71.9%	5,780	41.4%	8,191	58.6%
Educational Attainment												
Less than High School	280	23.2%	926	76.8%	359	29.8%	847	70.2%	461	38.4%	741	61.6%
High School Diploma	516	19.8%	2,091	80.2%	743	28.5%	1,864	71.5%	1,067	41.0%	1,535	59.0%
Technical School/College training	1,002	18.0%	4,580	82.0%	1,495	26.8%	4,087	73.2%	2,151	38.6%	3,415	61.4%
Some University/University Degree	624	19.5%	2,578	80.5%	914	28.5%	2,288	71.5%	1,426	44.7%	1,767	55.3%
Post-Graduate University Education	264	18.8%	1,144	81.3%	428	30.4%	980	69.6%	675	48.0%	732	52.0%
Total	2,686	19.2%	11,319	80.8%	3,939	28.1%	10,066	71.9%	5,780	41.4%	8,190	58.6%

Table 4.4 Study sample characteristics by meeting physical activity guidelines through total physical activity (continued)

Variables	Met PHAC Guidelines				Met ACS Guidelines				Met HHS Guidelines			
	No		Yes		No		Yes		No		Yes	
Employment Status												
Employed full-time	1,464	17.2%	7,035	82.8%	2,220	26.1%	6,279	73.9%	3,326	39.2%	5,155	60.8%
Employed part-time	408	17.4%	1,937	82.6%	585	24.9%	1,760	75.1%	895	38.2%	1,448	61.8%
Unemployed	547	29.0%	1,342	71.0%	749	39.7%	1,140	60.3%	992	52.9%	884	47.1%
Retired	240	21.4%	879	78.6%	348	31.1%	771	68.9%	520	46.5%	598	53.5%
Self-Employed	23	15.9%	122	84.1%	31	21.4%	114	78.6%	42	29.0%	103	71.0%
Total	2,682	19.2%	11,315	80.8%	3,933	28.1%	10,064	71.9%	5,775	41.4%	8,188	58.6%
Annual Household Income												
< $20,000	186	22.8%	630	77.2%	240	29.4%	576	70.6%	312	38.6%	497	61.4%
$20,000 - $39,999	487	21.4%	1,787	78.6%	669	29.4%	1,605	70.6%	894	39.5%	1,372	60.5%
$40,000 - $59, 999	560	20.5%	2,178	79.5%	781	28.5%	1,957	71.5%	1,109	40.6%	1,621	59.4%
$60,000 - $79, 999	512	18.6%	2,246	81.4%	777	28.2%	1,981	71.8%	1,153	41.9%	1,600	58.1%
$80,000 - $99, 999	367	18.5%	1,621	81.5%	573	28.8%	1,415	71.2%	855	43.1%	1,128	56.9%
≥ $100,000	504	16.1%	2,635	83.9%	813	25.9%	2,326	74.1%	1,330	42.4%	1,807	57.6%
Total	2,616	19.1%	11,097	80.9%	3,853	28.1%	9,860	71.9%	5,653	41.3%	8,025	58.7%
Rural or Urban Residence												
Rural	505	18.0%	2,295	82.0%	722	25.8%	2,078	74.2%	1,007	36.1%	1,781	63.9%
Urban	2,181	19.5%	9,025	80.5%	3,217	28.7%	7,989	71.3%	4,773	42.7%	6,410	57.3%
Total	2,686	19.2%	11,320	80.8%	3,939	28.1%	10,067	71.9%	5,780	41.4%	8,191	58.6%
Self-rated Health Status												
Excellent	310	13.0%	2,080	87.0%	495	20.7%	1,895	79.3%	789	33.0%	1,601	67.0%
Very Good	998	16.6%	5,007	83.4%	1,566	26.1%	4,439	73.9%	2,407	40.2%	3,584	59.8%
Good	1,050	22.7%	3,568	77.3%	1,467	31.8%	3,151	68.2%	2,057	44.7%	2,544	55.3%
Fair	254	34.7%	477	65.3%	319	43.6%	412	56.4%	406	55.8%	321	44.2%
Poor	39	47.0%	44	53.0%	49	59.0%	34	41.0%	54	65.1%	29	34.9%
Total	2,651	19.2%	11,176	80.8%	3,896	28.2%	9,931	71.8%	5,713	41.4%	8,079	58.6%

Table 4.4 Study sample characteristics by meeting physical activity guidelines through total physical activity (continued)

Variables		Met PHAC Guidelines				Met ACS Guidelines				Met HHS Guidelines			
		No		Yes		No		Yes		No		Yes	
Current Smoking Status													
	Non-smoker	2,059	18.3%	9,213	81.7%	3,087	27.4%	8,185	72.6%	4,686	41.7%	6,563	58.3%
	Occasional	80	16.5%	406	83.5%	126	25.9%	360	74.1%	179	37.0%	305	63.0%
	Daily	547	24.3%	1,700	75.7%	725	32.3%	1,522	67.7%	914	40.9%	1,323	59.1%
	Total	2,686	19.2%	11,319	80.8%	3,938	28.1%	10,067	71.9%	5,779	41.4%	8,191	58.6%
Cardiovascular Problems													
	No	1,584	17.6%	7,433	82.4%	2,400	26.6%	6,617	73.4%	3,531	39.2%	5,466	60.8%
	Yes	1,102	22.1%	3,887	77.9%	1,539	30.8%	3,450	69.2%	2,249	45.2%	2,725	54.8%
	Total	2,686	19.2%	11,320	80.8%	3,939	28.1%	10,067	71.9%	5,780	41.4%	8,191	58.6%
Heart Problems													
	No	2,590	19.0%	11,022	81.0%	3,809	28.0%	9,803	72.0%	5,605	41.3%	7,974	58.7%
	Yes	94	24.9%	283	75.1%	125	33.2%	252	66.8%	168	44.8%	207	55.2%
	Total	2,684	19.2%	11,305	80.8%	3,934	28.1%	10,055	71.9%	5,773	41.4%	8,181	58.6%
Stroke													
	No	2,658	19.1%	11,250	80.9%	3,902	28.1%	10,006	71.9%	5,726	41.3%	8,148	58.7%
	Yes	25	29.1%	61	70.9%	34	39.5%	52	60.5%	48	56.5%	37	43.5%
	Total	2,683	19.2%	11,311	80.8%	3,936	28.1%	10,058	71.9%	5,774	41.4%	8,185	58.6%
Respiratory Problems													
	No	2,541	18.9%	10,919	81.1%	3,746	27.8%	9,714	72.2%	5,520	41.1%	7,910	58.9%
	Yes	139	26.7%	381	73.3%	185	35.6%	335	64.4%	247	48.0%	268	52.0%
	Total	2,680	19.2%	11,300	80.8%	3,931	28.1%	10,049	71.9%	5,767	41.4%	8,178	58.6%

Table 4.4 Study sample characteristics by meeting physical activity guidelines through total physical activity (continued)

Variables	Met PHAC Guidelines				Met ACS Guidelines				Met HHS Guidelines			
	No		Yes		No		Yes		No		Yes	
Colorectal Problems												
No	2,518	19.0%	10,749	81.0%	3,698	27.9%	9,569	72.1%	5,437	41.1%	7,797	58.9%
Yes	162	23.1%	540	76.9%	233	33.2%	469	66.8%	331	47.3%	369	52.7%
Total	2,680	19.2%	11,289	80.8%	3,931	28.1%	10,038	71.9%	5,768	41.4%	8,166	58.6%
Diabetes												
No	2,553	19.0%	10,916	81.0%	3,749	27.8%	9,720	72.2%	5,510	41.0%	7,926	59.0%
Yes	131	24.9%	396	75.1%	187	35.5%	340	64.5%	265	50.5%	260	49.5%
Total	2,684	19.2%	11,312	80.8%	3,936	28.1%	10,060	71.9%	5,775	41.4%	8,186	58.6%
Social Support Score (Range: 18-65)												
Mean(SD)	3**(0.9)		3(0.8)		3(0.8)		3(0.8)		3(0.8)		3(0.8)	

guidelines were also more likely to report an annual household income greater than $60,000 and live in a rural setting. The group that did not meet these guidelines had a higher proportion of females, a higher proportion of obesity and a higher mean age (50 years old versus 46 years old) than the group that met these guidelines. Individuals who did not meet these guidelines were also more likely to report their health as poor or fair, smoke daily and report a chronic condition. There were no differences in marital status or social support scores between participants who did and did not meet these guidelines.

4.7.2 Meeting American Cancer Society (ACS) guidelines

Approximately 72% of participants were physically active enough to meet guidelines set by ACS, which required at least 45 minutes of moderate to vigorous activity most days of the week, when leisure, occupation and transportation physical activities were considered (Table 4.3). Those who met these guidelines were more likely to be male, single and self-employed than those who did not (Table 4.4). The group that met these guidelines also had a higher proportion of individuals with technical school or college training, an annual household income over $100,000 and a rural residence. However, those who did not meet ACS guidelines were more likely to be obese, rate their health as poor or fair, smoke daily, and report a chronic condition. There was no difference in mean age or social support score between those who met and did not meet ACS guidelines.

4.7.3 Meeting U.S. Department of Health and Human Services (HHS) guidelines

Only 59% of the study sample was sufficiently active to meet the most demanding physical activity recommendations from HHS through leisure, occupation and active transport physical activity (Table 4.3). These guidelines recommend at least 1 hour of moderate to vigorous activity most days of the week for normal weight individuals, and at least 1 hour daily for individuals who are overweight or obese.

Similar to PHAC and ACS guidelines, the group that met HHS guidelines had a higher proportion of men, employed individuals, and individuals who resided in a rural setting (Table 4.4). On the other hand, the group that did not meet these guidelines had a higher proportion of overweight and obese individuals, individuals who rated their health as poor or fair, had an annual household income of $60,000 or higher and a university or higher. Individuals who reported a chronic condition were also less likely to meet HHS guidelines. Lastly, there was no difference in mean age or social support scores between individuals who met and did not meet these guidelines.

4.8 Estimating the Proportion of Albertans Who Met Physical Activity Guidelines

Given the sociodemographic differences between the study sample and the general Alberta population, study sample data were weighted by age, sex, and health region of residence to obtain an estimate of the proportion of Albertans who meet the PHAC, ACS and HHS guidelines (Table 4.5). In general, the Alberta estimates for the proportion meeting physical activity guidelines were higher than those found in the study sample. The estimates were approximately 4% higher for the Alberta population than for the study population for meeting PHAC guidelines, 4.2% higher for meeting ACS

guidelines and 4.4% higher for meeting HHS guidelines when leisure, occupation and transportation physical activities were considered. However, the differences were much smaller when the estimate of meeting guidelines was based on leisure activity alone. Overall, the majority of Albertans may participate in enough physical activity to meet PHAC physical activity guidelines for general good health. However, the proportion of Albertans who may meet guidelines relevant for cancer prevention from ACS and HHS is comparatively low, especially when only leisure activity is considered.

Table 4.5 Estimate of percentage that met physical activity guidelines for the Alberta population and study sample

Guidelines	**Alberta Estimate** (Weighted*) Percent that Met Guidelines	**Study Sample** (Unweighted) Percent that Met Guidelines
Leisure, occupation and transportation physical activity^		
PHAC Guidelines	84.8%	80.8%
ACS Guidelines	76.1%	71.9%
HHS Guidelines	63.0%	58.6%
Leisure activity only		
PHAC Guidelines	64.4%	62.6%
ACS Guidelines	50.1%	48.1%
HHS Guidelines	31.3%	29.5%

*Weighted using 2001 Census data
^Total physical activity includes all leisure, occupational and active transport activities

4.9 Identifying the Potential Determinants of Meeting Physical Activity Guidelines by Logistic Regression Modeling

Given the cross-sectional design of this study, it was not possible to establish a cause and effect relationship between the explanatory variables being explored and

meeting each of the three guideline under consideration. In response, explanatory variables found to have a statistically significant association, or correlation, with meeting any of the guidelines were referred to as potential determinants because being identified as correlates identifies then as candidates for exploration in prospective studies seeking to identify determinants of physical activity at levels for cancer prevention. Leisure, occupation and transportation activities were used to estimate physical activity participation for meeting each of three guidelines.

4.9.1 Multicollinearity

No collinearity was found among any of the explanatory variables. Some collinearity may have been expected between educational attainment, annual household income, current smoking status and/or employment status. However, none of the pair wise correlations between any of these variables yielded a Spearman rank coefficient high enough to be considered collinear for the purposes of this study; coefficients ranged between 0.10 and 0.26, reflecting weak correlations in this sample. Therefore, multicollinearity was not considered to be present in these data and logistic regression analysis was able to proceed as planned. The resulting Odds Ratios (OR) for the association between the sample characteristics and meeting each of the three physical activity guidelines estimated by 10-fold cross-validation of logistic regression are presented in Table 4.6.

4.9.2 Potential determinants of meeting PHAC guidelines

Hierarchical backwards elimination revealed age, sex, weight status, marital status, educational attainment, employment status, rural or urban residence, smoking status, social support and cardiovascular problems were all possible determinants of meeting PHAC guidelines (Table 4.6). However, the only explanatory variables that were estimated to have statistically significant associations with meeting these guidelines were sex and self-rated health status. Therefore only sex and self-rated health status were identified as potential determinants of meeting PHAC guidelines. Women were estimated to be 45% (95% CI 23%-60%) less likely than men to meet PHAC guidelines. Participants who rated their health as good or fair were estimated to be 45% (95% CI 12%-66%) and 67% (95% CI 34%-83%), respectively, less likely to meet these guidelines compared to those who rated their health as excellent.

4.9.3 Potential determinants of meeting ACS guidelines

Similar to modeling for potential determinants of PHAC guidelines, hierarchical backwards elimination identified age, weight status, marital status, educational attainment, employment status, rural or urban residence, smoking status, and social support as possible determinants of meeting ACS guidelines, but any potential associations between these variables and meeting these guidelines were too weak to be identified as statistically significant by the cross-validation process (Table 4.6). Much like for meeting PHAC guidelines, women were less likely than men to meet ACS guidelines. However, women were estimated to be 51% (95% CI 35%-63%) less likely

Table 4.6 Estimated Odds Ratios* for meeting physical activity guidelines

	PHAC Guidelines			ACS Guidelines			HHS Guidelines		
Variable	**Odds Ratio**	**95% CI**		**Odds Ratio**	**95% CI**		**Odds Ratio**	**95% CI**	
Age-(Centred)	0.99	0.97 ,	1.01	0.99	0.97 ,	1.01	0.99	0.98 ,	1.01
Sex									
Male	1.00			1.00			1.00		
Female	0.55	0.40 ,	0.77	0.49	0.37 ,	0.65	0.47	0.36 ,	0.61
Weight Status									
Normal (BMI <25)	1.00			1.00			1.00		
Overweight (25<BMI <30)	1.02	0.72 ,	1.44	0.96	0.71 ,	1.29	0.61	0.46 ,	0.80
Obese (BMI >30)	0.80	0.54 ,	1.16	0.81	0.58 ,	1.14	0.57	0.41 ,	0.78
Marital Status									
Married/Common Law	1.00			1.00			1.00		
Divorced, separated or widowed	1.25	0.82 ,	1.91	1.29	0.89 ,	1.87	1.06	0.74 ,	1.53
Single	1.24	0.66 ,	2.31	1.32	0.77 ,	2.28	1.18	0.70 ,	2.00
Educational Attainment									
Less than High School	1.00			1.00			1.00		
High School Diploma	1.05	0.59 ,	1.86	0.94	0.56 ,	1.59	0.85	0.52 ,	1.40
Technical School/College training	1.04	0.61 ,	1.77	0.93	0.58 ,	1.51	0.87	0.55 ,	1.38
Some University/University Degree	0.91	0.51 ,	1.62	0.79	0.47 ,	1.33	0.64	0.39 ,	1.05
Post-Graduate University Education	0.88	0.45 ,	1.73	0.66	0.36 ,	1.20	0.51	0.29 ,	0.91
Employment Status									
Employed full-time	1.00			1.00			1.00		
Employed part-time	1.20	0.79 ,	1.82	1.37	0.95 ,	1.99	1.29	0.92 ,	1.81
Unemployed	0.71	0.47 ,	1.07	0.75	0.52 ,	1.09	0.72	0.50 ,	1.04
Retired	1.08	0.60 ,	1.92	1.04	0.62 ,	1.73	0.91	0.56 ,	1.48
Self-Employed	1.31	0.24 ,	2.15	1.56	0.34 ,	2.24	1.63	0.42 ,	2.38

Table 4.6 Odds Ratios* for meeting physical activity guidelines (continued)

Variable	PHAC Guidelines			ACS Guidelines			HHS Guidelines		
	Odds Ratio	95% CI		Odds Ratio	95% CI		Odds Ratio	95% CI	
Annual Household Income									
< $20,000							1.00		
$20,000 - $39,999							0.90	0.51 ,	1.59
$40,000 - $59, 999							0.76	0.43 ,	1.36
$60,000 - $79, 999							0.70	0.39 ,	1.26
$80,000 - $99, 999							0.64	0.35 ,	1.19
≥ $100,000							0.68	0.37 ,	1.24
Urban Residence	0.83	0.57 ,	1.20	0.83	0.60 ,	1.14	0.80	0.59 ,	1.08
Self-rated Health Status									
Excellent	1.00			1.00			1.00		
Very Good	0.74	0.47 ,	1.18	0.71	0.49 ,	1.05	0.73	0.52 ,	1.03
Good	0.55	0.34 ,	0.88	0.56	0.37 ,	0.84	0.61	0.42 ,	0.88
Fair	0.33	0.17 ,	0.66	0.35	0.19 ,	0.66	0.39	0.21 ,	0.72
Poor	0.25	0.05 ,	1.29	0.23	0.04 ,	1.21	0.32	0.06 ,	1.67
Current Smoking Status									
Non-smoker	1.00			1.00					
Occasional	1.17	0.46 ,	2.98	1.07	0.51 ,	2.21			
Daily	0.73	0.50 ,	1.08	0.81	0.58 ,	1.15			
Social Support	1.09	0.91 ,	1.31	1.06	0.90 ,	1.25	1.03	0.88 ,	1.20
Cardiovascular Problems	0.97	0.71 ,	1.33				0.90	0.69 ,	1.16

*Estimated from 10-fold cross-validation

than men to meet ACS guidelines, compared to 45% less likely than men to meet PHAC guidelines. Self-rated health status was also a significant potential determinant of meeting ACS guidelines and had similar estimated association strength as for meeting PHAC guidelines. Individuals who rated their health status as good or fair were estimated to be 44% (95% CI 16%-63%) and 65% (95% CI 34%-81%), respectively, less likely to meet these guidelines compared to those who rated their health as excellent.

4.9.4 Potential determinants of meeting HHS guidelines

Sex, weight status, educational attainment and self-rated health status were estimated to have statistically significant associations with meeting HHS guidelines and were considered potential determinants of meeting HHS guidelines (Table 4.6). Similar to meeting PHAC and ACS guidelines, women were less likely than men to meet HHS guidelines. This association was strongest for meeting HHS guidelines; women were estimated to be 53% (95% CI 39%-64%) less likely than men to meet these guidelines, compared to 45% and 51% less likely to meet PHAC and ACS guidelines, respectively. Overall, women appear to be less physically active than men and less likely to participate in sufficient activity for cancer prevention.

Self-rated health status was also found to be a potential determinant for meeting HHS guidelines, as it was for meeting PHAC and ACS guidelines. However, this association was less pronounced for meeting HHS guidelines, for which participants with a self-rated health status of good or fair were estimated to be 39% (95% CI 12%-58%) and 61% (95% CI 28%-79%) respectively, less likely to meet HHS guidelines than those who rated their health as excellent.

Uniquely, weight status was found to be a statistically significantly associated with meeting HHS guidelines. Overweight and obese participants were an estimated 39% (95% CI 20%-54%) and 43% (95% CI 22%-59%) less likely to meet HHS guidelines than their normal weight counterparts. Educational attainment was negatively associated with meeting HHS guidelines but not found to be associated with meeting other guidelines. Participants who reported having an education beyond a university degree were 49% (95% CI 9%-71%) less likely than those with an education below a high school diploma to meet these guidelines.

4.9.5 Assessment of model fit

The process of cross-validation was closely monitored to help ensure a good model fit as outlined in Chapter 2. The results for test sets across the 10 folds were very similar, indicating that the resulting model was a good representation of the data. In addition, there was no indication of influential outliers during the cross-validation, which would have resulted in 1 or 2 folds being very different from the others. Overall, the cross-validation process yielded consistent results across the folds.

A more formal assessment of the three resulting models was also done. The model for meeting each of the guidelines was applied to the entire sample to assess appropriateness and fit. The model for meeting PHAC guidelines was found to be a good fit by the Hosmer-Lemeshow (H-L) Test for goodness of fit, which yielded an insignificant chi-squared statistic (X^2=8.2 (df=8), p=0.41) (Figure 4.1)

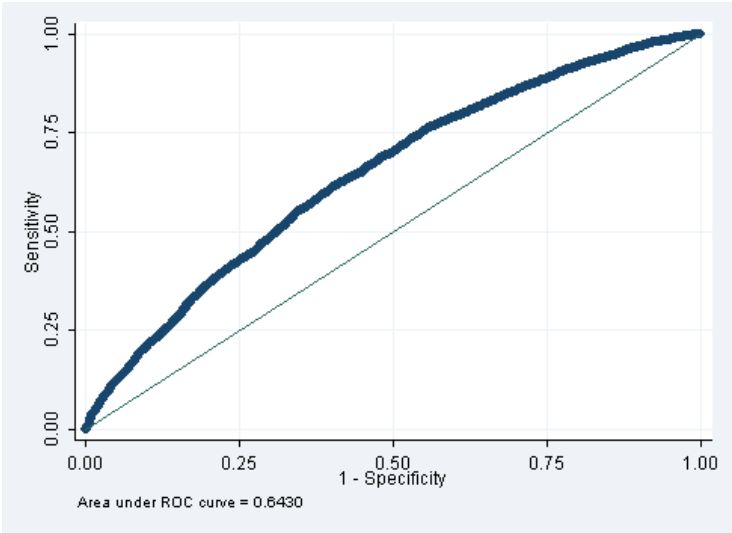

Figure 4.1 Receiver Operator Curve (ROC) for modeling potential determinants of meeting PHAC guidelines

Similar results were obtained using the H-L goodness of fit test for the models for meeting ACS (X^2=8.6 (df=8), p=0.36) and HHS(X^2=8.7 (df=8), p=0.37) guidelines. Figure 4-1 displays an ROC with a c-index of 0.643, indicating the model for meeting PHAC guidelines has good predictive value. Similarly, the ACS and HHS models were also shown to have good predictive values using an ROC, as shown in Figure 4.2 and Figure 4.3 (c-index = 0.638 and 0.637, respectively).

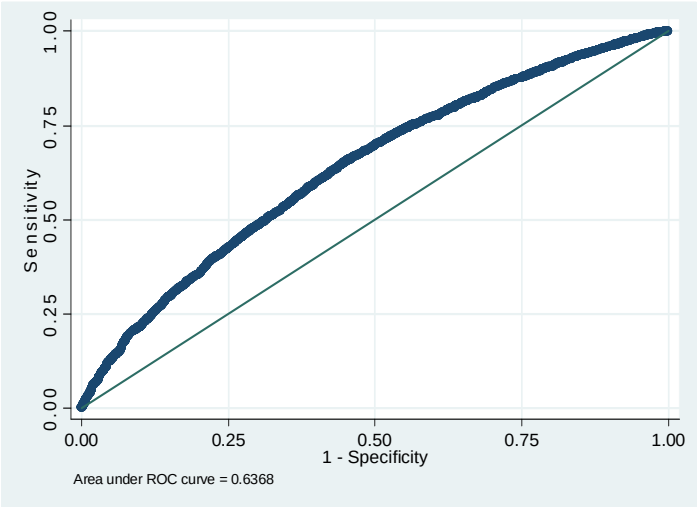

Figure 4.2 Receiver Operator Curve (ROC) for modeling potential determinants of meeting ACS guidelines

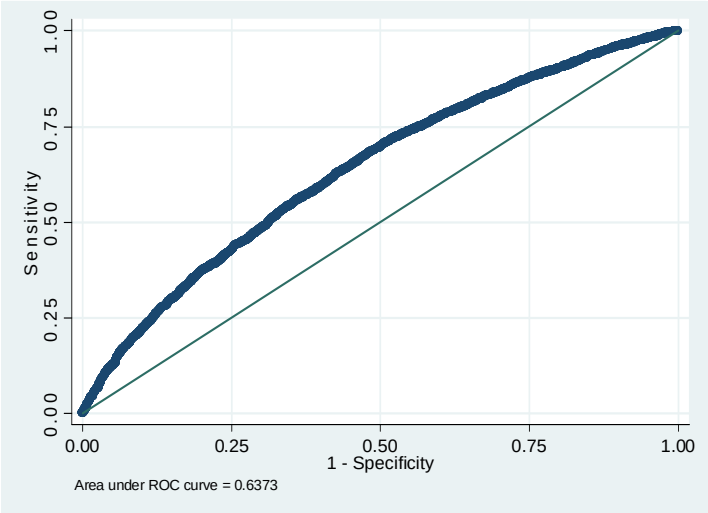

Figure 4.3 Receiver Operator Curve (ROC) for modeling potential determinants of meeting HHS guidelines

A link test was also performed for all three models to assess the appropriateness of the logit link of the logistic regression for the data. The link test was statistically

insignificant for all three models, indicating the logit link was appropriate for these data and that logistic regression was an appropriate approach for modeling these data. Overall, all three models were considered to be a good fit to the data and to have good predictive value, indicating the models were a reasonable representation of the determinants for meeting each guideline for this study sample.

Chapter Five: Phase 2 Analysis Results

5.1 Overview

The purpose of this phase of the analyses was to conduct an in-depth investigation of the potential association between a number of individual, social and neighbourhood environment determinants and meeting PHAC, ACS and HHS physical activity guidelines among a subsample of The Tomorrow Project participants. Data were collected for this analysis using the DPAQ and *Survey 2008.* A hierarchical backward elimination modelling strategy and cross-validation were used to identify determinants of meeting each of the three guidelines and to build sex- and age-specific logistic regression models to describe these associations. This was followed by a multilevel logistic model approach to investigate potential neighbourhood environment determinants as a second level of influence, consistent with the ecological framework.

5.2 Study Sample

In total, 4,040 Tomorrow Project participants returned a completed DPAQ, corresponding to a 45% response rate, which was lower than the 56% response rate for *Survey 2008* questionnaires received by the Tomorrow Project from the same mail-out period to the same participants. A total of 1,253 participants were excluded from the study sample based on the exclusion criteria: age 64 and older (595), pregnant (4), prior cancer diagnosis (245), being underweight (17), and having limited mobility that restricted self-care or ability to perform usual activities (392). In addition, 16 participants were excluded because they reported unrealistic levels of physical activity (more details

in Section 5.3). The remaining 2,771 participants composed the sample for Phase 2 of this study.

5.3 Missing Data

In the univariate descriptive analysis there were complete data for the variables related to physical activity, age, sex, and urban or rural residence. For all other variables, the amount of missing data was negligible. The variables for annual household income and weight status had the largest amounts of missing data; 3.8%.and 5.3% respectively (Table 5.1). The remaining variables had between 0.1% and 2.5% missing data. Given the low amount of missing data, imputation of missing values was not considered for this study and complete case analysis was used (Harrell, 2001).

Even though the amount of missing data was small, it was important to determine that missing data occurred at random and was not a result of some systematic process, especially for items that informed scale scores. The patterns of missing items within each scale used were examined as described in Section 3.6.1. Examination of each scale and its corresponding items revealed that all missing responses were missing at random and calculations of scale scores proceeded as planned.

5.4 Study Sample Characteristics

The sample's characteristics are outlined in Table 5.1 for categorical variables and Table 5.2 for continuous variables. More women than men participated in this study, 60.7% versus 39.2% respectively, and the average age of participants was 52.7 years.

Table 5.1 Categorical study sample characteristics by sex (N=2,771)

	Overall		Sex			
			Male		Female	
Variable	**No.**	**%**	**No.**	**%**	**No.**	**%**
Physical Activity Guidelines*						
Met PHAC Guidelines						
No	731	26.4%	285	26.2%	446	26.5%
Yes	2,040	73.6%	802	73.8%	1,238	73.5%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
Met ACS Guidelines						
No	1,034	37.3%	380	35.0%	654	38.8%
Yes	1,737	62.7%	707	65.1%	1,030	61.2%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
Met HHS Guidelines						
No	1,430	51.6%	542	51.3%	888	55.2%
Yes	1,235	48.4%	515	48.7%	720	44.8%
Total	2,665	100.0%	1,057	100.0%	1,608	100.0%
Study Sample Characteristics						
Age Group						
38 to 48 years old	903	32.6%	362	33.3%	541	32.1%
49 to 55 years old	927	33.5%	347	31.9%	580	34.4%
56 to 65 years old	941	34.0%	378	34.8%	563	33.4%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				
Weight Status						
Normal Weight	1,013	38.0%	263	24.9%	750	46.6%
Overweight	1,010	37.9%	502	47.5%	508	31.6%
Obese	642	24.1%	292	27.6%	350	21.8%
Total	2,665	100.0%	1,057	100.0%	1,608	100.0%
% missing		3.8%				
Marital Status						
Married	2,223	80.5%	906	83.7%	1,317	78.4%
Divorced, separated or widowed	369	13.4%	101	9.3%	268	16.0%
Single	169	6.1%	75	6.9%	94	5.6%
Total	2,761	100.0%	1,082	100.0%	1,679	100.0%
% missing		0.4%				
Employment Status						
Employed full-time	1,765	65.3%	874	81.9%	891	54.5%
Employed part-time	384	14.2%	66	6.2%	318	19.4%
Unemployed	272	10.1%	27	2.5%	245	15.0%
Retired	281	10.4%	100	9.4%	181	11.1%
Total	2,702	100.0%	1,067	100.0%	1,635	100.0%
% missing		2.5%				

Table 5.1 Categorical study sample characteristics by sex (continued)

	Overall		Sex			
			Male		Female	
Variable	**No.**	**%**	**No.**	**%**	**No.**	**%**
Annual Household Income						
<$30,000	136	5.2%	36	3.4%	100	6.3%
$30,000 - $59,999	467	17.8%	141	13.5%	326	20.7%
$60,000 - $99,999	726	27.7%	285	27.2%	441	28.0%
$100,000 - $149,999	711	27.1%	314	30.0%	397	25.2%
$150,000 or more	584	22.3%	271	25.9%	313	19.8%
Total	2,624	100.0%	1,047	100.0%	1,577	100.0%
% missing		5.3%				
Educational Attainment						
Less than high school	149	5.4%	56	5.2%	93	5.5%
High School Diploma	467	16.9%	147	13.6%	320	19.0%
Technical School/College training	1,103	39.9%	435	40.1%	668	39.7%
Some University	219	7.9%	73	6.7%	146	8.7%
University Degree	482	17.4%	217	20.0%	265	15.8%
Post-Graduate University Education	346	12.5%	156	14.4%	190	11.3%
Total	2,766	100.0%	1,084	100.0%	1,682	100.0%
% missing		0.2%				
Birth Place						
Foreign born	350	12.8%	158	14.8%	192	11.6%
Born in Canada	2,376	87.2%	912	85.2%	1,464	88.4%
Total	2,726	100.0%	1,070	100.0%	1,656	100.0%
% missing		1.6%				
Urban or Rural Setting						
Rural	528	19.1%	196	18.0%	332	19.7%
Urban	2,243	80.9%	891	82.0%	1,352	80.3%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				
Current Smoking Status						
Daily	283	10.2%	120	11.0%	163	9.7%
Occasionally	128	4.6%	80	7.4%	48	2.9%
Not at all	2,357	85.2%	886	81.6%	1,471	87.5%
Total	2,768	100.0%	1,086	100.0%	1,682	100.0%
% missing		0.1%				
Self-rated Health Status						
Excellent	514	18.6%	181	16.7%	333	19.8%
Very Good	1,227	44.4%	442	40.7%	785	46.7%
Good	873	31.6%	389	35.9%	484	28.8%
Fair/Poor	152	5.5%	73	6.7%	79	4.7%
Total	2,766	100.0%	1,085	100.0%	1,681	100.0%
% missing		0.2%				

Table 5.1 Categorical study sample characteristics by sex (continued)

	Overall		Sex			
			Male		Female	
Variable	**No.**	**%**	**No.**	**%**	**No.**	**%**
Intent to be Physically Active						
Definitely/Probably Not	326	11.8%	182	16.8%	144	8.6%
Unsure	262	9.5%	101	9.3%	161	9.6%
Probably Yes	713	25.8%	273	25.2%	440	26.2%
Definitely Yes	1,461	52.9%	529	48.8%	932	55.6%
Total	2,762	100.0%	1,085	100.0%	1,677	100.0%
% missing		0.3%				
Subjective Norms						
Very Unlikely	248	9.1%	103	9.6%	145	8.8%
Unlikely	146	5.4%	65	6.1%	81	4.9%
Neither unlikely nor Likely	594	21.8%	233	21.7%	361	21.9%
Likely	826	30.3%	336	31.3%	490	29.7%
Very Likely	909	33.4%	335	31.3%	574	34.8%
Total	2,723	100.0%	1,072	100.0%	1,651	100.0%
% missing		1.7%				
Normative Behaviour (spouse/partner, family and close friends)						
No Examples	840	30.7%	356	33.1%	484	29.1%
At least one example	1,896	69.3%	718	66.9%	1,178	70.9%
Total	2,736	100.0%	1,074	100.0%	1,662	100.0%
% missing		1.3%				
Stage of Change						
Precontemplation	233	8.5%	130	12.1%	103	6.2%
Contemplation	458	16.8%	186	17.4%	272	16.4%
Preparation	444	16.3%	142	13.3%	302	18.2%
Action	286	10.5%	88	8.2%	198	12.0%
Maintenance	1,305	47.9%	525	49.0%	780	47.1%
Total	2,726	100.0%	1,071	100.0%	1,655	100.0%
% missing		1.6%				
Have a Companion for Physical Activity						
No	418	15.1%	165	15.2%	253	15.0%
Yes	2,353	84.9%	922	84.8%	1,431	85.0%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				
Health Problems						
Angina						
No	2,725	98.3%	1,063	97.8%	1,662	98.7%
Yes	46	1.7%	24	2.2%	22	1.3%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				

Table 5.1 Categorical study sample characteristics by sex (continued)

	Overall		Sex			
			Male		Female	
Variable	**No.**	**%**	**No.**	**%**	**No.**	**%**
Heart Problems						
No	2,591	93.5%				
Yes	180	6.5%	999	91.9%	1,592	94.5%
Total	2,771	100.0%	88	8.1%	92	5.5%
% missing		0.0%	1,087	100.0%	1,684	100.0%
Cardiovascular Problems						
No	1,688	60.9%				
Yes	1,083	39.1%	580	53.4%	1,108	65.8%
Total	2,771	100.0%	507	46.6%	576	34.2%
% missing		0.0%	1,087	100.0%	1,684	100.0%
Pulmonary Problems (Chronic Bronchitis or Emphysema)						
No	2,691	97.1%	1,059	97.4%	1,632	96.9%
Yes	80	2.9%	28	2.6%	52	3.1%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				
Asthma						
No	2,499	90.2%	980	90.2%	1,519	90.2%
Yes	272	9.8%	107	9.8%	165	9.8%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				
Bone Related Problems (Osteoporosis and/or Arthritis)						
No	2,098	75.7%	913	84.0%	1,185	70.4%
Yes	673	24.3%	174	16.0%	499	29.6%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				
Thyroid Related Problems						
No	2,487	89.8%	1,046	96.2%	1,441	85.6%
Yes	284	10.2%	41	3.8%	243	14.4%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				
Liver Related Problems						
No	2,667	96.2%	1,052	96.8%	1,615	95.9%
Yes	104	3.8%	35	3.2%	69	4.1%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				
Colorectal Problems						
No	2,372	85.6%	975	89.7%	1,397	83.0%
Yes	399	14.4%	112	10.3%	287	17.0%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				

Table 5.1 Categorical study sample characteristics by sex (continued)

	Overall		Sex			
			Male		Female	
Variable	**No.**	**%**	**No.**	**%**	**No.**	**%**
Diabetes						
No	2,655	95.8%	1,029	94.7%	1,626	96.6%
Yes	116	4.2%	58	5.3%	58	3.4%
Total	2,771	100.0%	1,087	100.0%	1,684	100.0%
% missing		0.0%				

*Based on moderate and vigorous leisure, occupation and transportation activities

Reported annual household income for participants was high, with 49% of participants reporting an annual household income of $100,000 or higher (Table 5.1 and Table 5.2). Correspondingly, 65% of the study sample was employed full-time. Participants were also generally well-educated, with about 30% of participants having a university degree or higher (Table 5.1). The vast majority of participants were married or living with a common-law partner (81%), Canadian-born (87%), and resided in an urban area (81%).

With respect to health-related characteristics, 63% rated their heath as very good or excellent, likely corresponding to the fact that participants were largely free from chronic conditions (Table 5.1). Current smoking was not common in the sample, with only 10% of daily smokers and 85% of participants not having had a cigarette within the past month. Only 38% of participants were considered to be of normal weight according to their BMI, estimated from self-reported height and weight measurements. Correspondingly, 38% of the study sample was overweight and 24% were obese.

Table 5.2 Continuous study sample characteristics by sex (N=2771)

							Sex									
		Overall					Male					Female				
Characteristic	**Missing**	**No.**	**Mean**	**(sd*)**	**Min**	**,Max**	**No.**	**Mean**	**(sd*)**	**Min**	**,Max**	**No.**	**Mean**	**(sd*)**	**Min**	**,Max**
Age (years)	0.0%	2771	52.7	(6.6)	38.8	,65.0	1087	52.8	(6.6)	39.3	,65.0	1684	52.7	(6.6)	38.8	,65.0
BMI (kg/m^2)	3.8%	2665	27.2	(5.0)	18.5	,57.1	1057	28.0	(4.4)	19.2	,49.9	1608	26.6	(5.3)	18.5	,57.1
Scale Scores																
Self-efficacy	0.3%	2762	3.0	(0.8)	1.0	,5.0	1082	3.0	(0.8)	1.0	,5.0	1680	3.0	(0.8)	1.0	,5.0
Outcome Expectations	0.5%	2757	4.0	(0.5)	1.6	,5.0	1080	3.9	(0.5)	1.9	,5.0	1677	4.0	(0.5)	1.6	,5.0
Attitudes	0.7%	2752	4.3	(0.7)	1.2	,5.0	1081	4.3	(0.7)	1.4	,5.0	1671	4.4	(0.6)	1.2	,5.0
Decisional Balance Pros	0.7%	2751	3.8	(0.9)	1.0	,5.0	1082	3.6	(0.9)	1.0	,5.0	1669	3.9	(0.8)	1.0	,5.0
Decisional Balance Cons	0.7%	2750	1.8	(0.7)	1.0	,5.0	1082	1.8	(0.6)	1.0	,5.0	1668	1.8	(0.7)	1.0	,5.0
Self-Presentation	0.8%	2748	2.5	(1.1)	1.0	,5.0	1081	2.5	(1.1)	1.0	,5.0	1667	2.4	(1.1)	1.0	,5.0
Scheduling & Planning	0.7%	2753	2.5	(0.8)	1.0	,4.6	1082	2.4	(0.8)	1.0	,4.6	1671	2.6	(0.8)	1.0	,4.6
Normative Behaviour	1.3%	2736	2.7	(1.4)	0.0	,5.0	1074	2.6	(1.4)	0.0	,5.0	1662	2.8	(1.4)	0.0	,5.0
Social Support-Family	1.0%	2742	1.9	(0.8)	0.0	,4.7	1079	1.9	(0.9)	0.0	,4.7	1663	1.9	(0.8)	0.0	,4.4
Social Support-Friends	1.3%	2735	1.5	(1.0)	0.0	,5.0	1074	1.4	(0.9)	0.0	,5.0	1661	1.6	(1.0)	0.0	,5.0
Social Support-Physician	0.7%	2752	2.0	(1.3)	0.0	,5.0	1078	1.9	(1.3)	0.0	,5.0	1674	2.0	(1.3)	0.0	,5.0

*Standard deviation of the mean

5.4.1 Comparison between the study sample and the Alberta population

A comparison between some sociodemographic characteristics of the study sample and of the Alberta population was completed in order to ascertain the representativeness of the study sample. There was a larger proportion of women (61%) in the study sample than in the general Alberta population (50%) (Table 5.3). The study sample was generally older than the general Alberta population and this held true for both men and women. The largest proportion of female participants was in the 49 to 55 year old age group, while the largest proportion of women in the Alberta population was in the 38 to 48 year old age group.

Differences between the study sample and the Alberta population in educational attainment and annual household income were also identified (Table 5.3). In general, the study sample had a higher educational attainment then the Alberta population, but technical school or college training was the most common education level achieved for both the study sample and the Alberta population. However, the difference in educational attainment was most pronounced for men. Forty percent of men in the study sample had an education of some university training or higher compared to 24% of men in the Alberta population. This difference was greater than that seen comparing women: 36% women in the study sample had an education of some university or higher compared to 25% of women in the Alberta population.

In general, study participants also reported higher annual household incomes than Albertans in the general population (Table 5.3). However, the differences in income between men and women were more dramatic for the study sample than for the Alberta population. In the study sample, 56% of men reported an annual household income of

Table 5.3 Comparison of characteristics between the study sample and the Alberta population

Characteristics	Study Sample		Alberta*	
	Male	Female	Male	Female
Total	39.2%	60.8%	50.3%	49.8%
Age Group				
38 to 48 years old	33.3%	32.1%	48.5%	49.0%
49 to 55 years old	31.9%	34.4%	24.5%	24.1%
56 to 65 years old	34.8%	33.4%	27.0%	27.0%
Weight Status^				
Normal	24.9%	46.6%	33.8%	52.1%
Overweight	47.5%	31.6%	43.2%	29.1%
Obese	27.6%	21.8%	23.0%	18.8%
Current Smoking Status^				
Daily smoker	11.0%	9.7%	22.4%	17.4%
Educational Attainment				
Less than High School	5.2%	5.5%	17.1%	15.2%
High School Diploma	13.6%	19.0%	21.1%	27.1%
Technical School/College training	40.1%	39.7%	37.3%	32.4%
Some University/University Degree	26.7%	24.5%	18.3%	21.3%
Post-Graduate University Education	14.4%	11.3%	6.1%	4.1%
Annual Household Income				
<$30,000	3.4%	6.3%	10.2%	11.5%
$30,000 - $59,999	13.5%	20.7%	20.2%	21.7%
$60,000 - $99,999	27.2%	28.0%	30.3%	29.4%
$100,000 - $149,999	30.0%	25.2%	23.5%	21.9%
$150,000 or more	25.9%	19.8%	15.9%	15.4%

*data from 2006 Census
^data from 2007 CCHS

$100,000 or higher compared to 45% of women. In the Alberta population the difference was much smaller, with 39.4% of men and 37.3% of women reporting an annual household income of $100,000 or higher.

The study sample was generally more overweight and obese than the Alberta population (Table 5.3). Although both groups showed similar trends, with men being

more overweight and obese than women, the study sample had a larger proportion of both men and women than the Alberta population. However, there were substantially fewer smokers in the study sample. In the study sample, 11% of men and 10% of women were smokers, while 24% and 17% of the Alberta men and women, respectively, were smokers.

In summary, the study sample was older, more highly educated, had a higher annual household income and a higher proportion of women than the Alberta population. The differences in educational attainment and annual household income between the study sample and the Alberta population were more pronounced for men than they were for women.

5.4.2 Study sample characteristics by sex

Since the analysis was stratified by sex, it was important to describe the study characteristics for each sex and to highlight important differences. There were some basic differences in characteristics between men and women who participated in this study (Table 5.1). For example, women who participated were more likely to be married (84% versus 78%), to be employed part-time (19% versus 6%) to be Canadian-born (88% versus 85%), and to live in a rural setting (20% versus 18%) than men. Men, however, were more likely to be employed full-time (82% versus 55%), report an annual household income of $100,000 or higher (56% versus 45%), and have a university degree or higher (34% versus 27%) than women.

In addition, men in this study had worse health indicators than women (Table 5.2). Men were less likely than women in this sample to rate their health as very good or

excellent (57% versus 67%) and to be non-smokers (82% versus 88%). Men were also significantly less likely to be normal weight than the women in this sample (25% versus 47%). With respect to chronic conditions, men were more likely to report angina, heart problems, cardiovascular problems and diabetes than the women. However, women in this sample were more likely to report pulmonary, bone related, thyroid and colorectal problems than men.

5.4.3 Study sample characteristics by age group

Sample characteristics were also described by age group since the analysis was also stratified by age groups. All age-specific analyses were done using three age groups, each with approximately 33% of the study sample: 38 to 48 years, 49 to 55 years, and 56-64 years. Differences in characteristics and potential determinants across age groups can be seen in Table 5.4 and Table 5.5. There was a larger proportion of women in the 49 to 55 age group than in the other two age groups (63% versus 60% and 60%) (Table 5.4).

Participants in the youngest age group were more likely to be married (82% versus 80% and 80%) and those in the 49 to 55 and 56 to 64 age groups were more likely to be divorced and separated (15% compared to 10% in the youngest age group). The youngest age group also had the largest proportion of single participants. Participants in the oldest age group were least likely to be employed full-time, most likely to be employed part-time and, not surprisingly, more likely to be retired than participants in the younger two age groups. Correspondingly, the oldest age group was also the least likely to report an annual household income of $100,000 or more (37% compared to 57% in the youngest and 54% in the middle age groups). Educational attainment was also highest

Table 5.4 Categorical study sample characteristics by age group (N=2,771)

	Age Group					
	38 to 48 yrs old		49 to 55 yrs old		56 to 65 yrs old	
Characteristic	**No.**	**%**	**No.**	**%**	**No.**	**%**
Physical Activity Guidelines						
Met PHAC Guidelines						
No	238	26.4%	246	26.5%	247	26.2%
Yes	665	73.6%	681	73.5%	694	73.8%
Total	903	100.0%	927	100.0%	941	100.0%
Met ACS Guidelines						
No	344	38.1%	335	36.1%	355	37.7%
Yes	559	61.9%	592	63.9%	586	62.3%
Total	903	100.0%	927	100.0%	941	100.0%
Met HHS Guidelines						
No	474	54.7%	478	53.5%	478	52.8%
Yes	392	45.3%	416	46.5%	427	47.2%
Total	866	100.0%	894	100.0%	905	100.0%
Study Sample Characteristics						
Sex						
Male	362	40.1%	347	37.4%	378	40.2%
Female	541	59.9%	580	62.6%	563	59.8%
Total	903	100.0%	927	100.0%	941	100.0%
Weight Status						
Normal Weight	355	41.0%	335	37.5%	323	35.7%
Overweight	297	34.3%	350	39.1%	363	40.1%
Obese	214	24.7%	209	23.4%	219	24.2%
Total	866	100.0%	894	100.0%	905	100.0%
Marital Status						
Married	736	81.8%	735	79.6%	752	80.2%
Divorced, separated or widowed	89	9.9%	137	14.8%	143	15.2%
Single	75	8.3%	51	5.5%	43	4.6%
Total	900	100.0%	923	100.0%	938	100.0%
Employment Status						
Employed full-time	659	74.6%	684	75.3%	422	46.3%
Employed part-time	125	14.2%	99	10.9%	160	17.6%
Unemployed	96	10.9%	95	10.5%	81	8.9%
Retired	3	0.3%	30	3.3%	248	27.2%
Total	883	100.0%	908	100.0%	911	100.0%

Table 5.4 Categorical study sample characteristics by age group (continued)

	Age Group					
	38 to 48 yrs old		49 to 55 yrs old		56 to 65 yrs old	
Characteristic	**No.**	**%**	**No.**	**%**	**No.**	**%**
Annual Household Income						
<$30,000	26	3.0%	38	4.4%	72	8.2%
$30,000 - $59,999	110	12.6%	145	16.6%	212	24.1%
$60,000 - $99,999	241	27.6%	217	24.9%	268	30.5%
$100,000 - $149,999	275	31.5%	260	29.8%	176	20.0%
$150,000 or more	220	25.3%	212	24.3%	152	17.2%
Total	872	100.0%	872	100.0%	880	100.0%
Educational Attainment						
Less than high school	30	3.3%	41	4.4%	78	8.3%
High School Diploma	126	14.0%	184	19.9%	157	16.7%
Technical School/College training	408	45.3%	377	40.7%	318	33.9%
Some University	73	8.1%	73	7.9%	73	7.8%
University Degree	158	17.5%	147	15.9%	177	18.8%
Post-Graduate University Education	106	11.8%	104	11.2%	136	14.5%
Total	901	100.0%	926	100.0%	939	100.0%
Birth Place						
Foreign born	103	11.6%	96	10.5%	151	16.4%
Born in Canada	785	88.4%	821	89.5%	770	83.6%
Total	888	100.0%	917	100.0%	921	100.0%
Urban or Rural Setting						
Rural	135	15.0%	179	19.3%	214	22.7%
Urban	768	85.0%	748	80.7%	727	77.3%
Total	903	100.0%	927	100.0%	941	100.0%
Current Smoking Status						
Not at all	750	83.1%	798	86.2%	809	86.1%
Occasionally	52	5.8%	36	3.9%	40	4.3%
Daily	100	11.1%	92	9.9%	91	9.7%
Total	902	100.0%	926	100.0%	940	100.0%
Self-rated Health Status						
Excellent	176	19.5%	170	18.4%	168	17.9%
Very Good	407	45.1%	408	44.1%	412	43.9%
Good	263	29.2%	303	32.8%	307	32.7%
Fair/Poor	56	6.2%	44	4.8%	52	5.5%
Total	902	100.0%	925	100.0%	939	100.0%

Table 5.4 Categorical study sample characteristics by age group (continued)

	Age Group					
	38 to 48 yrs old		49 to 55 yrs old		56 to 65 yrs old	
Characteristic	**No.**	**%**	**No.**	**%**	**No.**	**%**
Intent to be Physically Active						
Definitely/Probably Not	95	10.5%	110	11.9%	121	12.9%
Unsure	88	9.8%	76	8.2%	98	10.5%
Probably Yes	244	27.1%	242	26.2%	227	24.3%
Definitely Yes	475	52.7%	496	53.7%	490	52.4%
Total	902	100.0%	924	100.0%	936	100.0%
Subjective Norms						
Very Unlikely	71	7.9%	72	7.9%	105	11.4%
Unlikely	54	6.0%	47	5.2%	45	4.9%
Neither unlikely nor Likely	187	20.9%	208	22.9%	199	21.6%
Likely	276	30.9%	271	29.9%	279	30.3%
Very Likely	306	34.2%	309	34.1%	294	31.9%
Total	894	100.0%	907	100.0%	922	100.0%
Normative Behaviour (spouse/partner, family friends)						
No Examples	247	27.6%	266	29.2%	327	35.2%
At least one example	648	72.4%	646	70.8%	602	64.8%
Total	895	100.0%	912	100.0%	929	100.0%
Stage of Change						
Precontemplation	64	7.2%	75	8.3%	94	10.2%
Contemplation	154	17.2%	153	16.8%	151	16.4%
Preparation	182	20.3%	144	15.8%	118	12.8%
Action	115	12.8%	93	10.2%	78	8.5%
Maintenance	380	42.5%	444	48.8%	481	52.2%
Total	895	100.0%	909	100.0%	922	100.0%
Have a Companion for Physical Activity						
No	116	12.8%	136	14.7%	166	17.6%
Yes	787	87.2%	791	85.3%	775	82.4%
Total	903	100.0%	927	100.0%	941	100.0%
Health Problems						
Angina						
No	894	99.0%	912	98.4%	919	97.7%
Yes	9	1.0%	15	1.6%	22	2.3%
Total	903	100.0%	927	100.0%	941	100.0%

Table 5.4 Categorical study sample characteristics by age group (continued)

	Age Group					
	38 to 48 yrs old		49 to 55 yrs old		56 to 65 yrs old	
Characteristic	**No.**	**%**	**No.**	**%**	**No.**	**%**
Heart Problems						
No	864	95.7%	875	94.4%	852	90.5%
Yes	39	4.3%	52	5.6%	89	9.5%
Total	903	100.0%	927	100.0%	941	100.0%
Cardiovascular Problems						
No	661	73.2%	584	63.0%	443	47.1%
Yes	242	26.8%	343	37.0%	498	52.9%
Total	903	100.0%	927	100.0%	941	100.0%
Pulmonary Problems (Chronic Bronchitis or Emphysema)						
No	883	97.8%	895	96.5%	913	97.0%
Yes	20	2.2%	32	3.5%	28	3.0%
Total	903	100.0%	927	100.0%	941	100.0%
Asthma						
No	801	88.7%	833	89.9%	865	91.9%
Yes	102	11.3%	94	10.1%	76	8.1%
Total	903	100.0%	927	100.0%	941	100.0%
Bone Related Problems (Osteoporosis and/or Arthritis)						
No	794	87.9%	707	76.3%	597	63.4%
Yes	109	12.1%	220	23.7%	344	36.6%
Total	903	100.0%	927	100.0%	941	100.0%
Thyroid Related Problems						
No	841	93.1%	822	88.7%	824	87.6%
Yes	62	6.9%	105	11.3%	117	12.4%
Total	903	100.0%	927	100.0%	941	100.0%
Liver Related Problems						
No	886	98.1%	887	95.7%	894	95.0%
Yes	17	1.9%	40	4.3%	47	5.0%
Total	903	100.0%	927	100.0%	941	100.0%
Colorectal Problems						
No	784	86.8%	809	87.3%	779	82.8%
Yes	119	13.2%	118	12.7%	162	17.2%
Total	903	100.0%	927	100.0%	941	100.0%

Table 5.4 Categorical study sample characteristics by age group (continued)

	Age Group					
	38 to 48 yrs old		49 to 55 yrs old		56 to 65 yrs old	
Characteristic	**No.**	**%**	**No.**	**%**	**No.**	**%**
Diabetes						
No	881	97.6%	890	96.0%	884	93.9%
Yes	22	2.4%	37	4.0%	57	6.1%
Total	903	100.0%	927	100.0%	941	100.0%

among participants in the oldest age group; 33% of 56 to 64 year olds had a university degree or higher, compared to 30% in the 38 to 48 year old group and 27% in the 49 to 55 year old group. Participants in the 56 to 64 year old group were more likely to be born in Canada and to live in a rural setting. Interestingly, the proportion of participants living in an urban setting decreased with increasing age.

Although the majority of the study sample rated their health as excellent or very good, participants in the youngest and the oldest age groups were more likely to rate their health as fair or poor, compared to those in the middle age group (Table 5.4) . In addition, the youngest age group had the lowest proportion of non-smokers and the highest proportion of daily smokers, compared to the middle age and older age groups.

The proportion of participants reporting a chronic condition increased with each age group for all chronic conditions, with the exception of asthma and pulmonary conditions, which were highest among the youngest age groups. However, the vast majority of participants were free of any chronic conditions, regardless of age group. The most common chronic condition reported was related to cardiovascular problems, with 52% of those in the oldest age group having either high blood pressure or high cholesterol.

Participants scored similarly across age groups on most psychosocial scales (Table 5.5). The only scale from with there was a slightly decreasing score with age was the social support from friends scale.

5.5 Hours per Week of Physical Activity

Total hours per week of moderate and vigorous intensity physical activity were estimated to obtain a measure of the amount of activity each participant reported. The initial calculation included occupation, transportation, household and leisure time physical activities and yielded a median amount of time participants spent in moderated to vigorous activity of 15 hours per week with and interquantile range between 7.75 and 29 hours per week. Since this level of activity was equivalent to 25% of the study sample participating in an average of about 4 hours per day or more of moderate and vigorous physical activity, time spent in each type of activity was further investigated.

A closer examination of the hours per week of moderate and vigorous of physical activity reported revealed a problem with the number of hours of household activity and the number of hours of occupational activity at moderate and high intensities. More than 25% of the study sample reported participating in over 12 hours of moderate to vigorous household activity per week. Given that this was equivalent to about 2 hours of daily moderate and vigorous household activity alone, it was decided to exclude household activity from the estimated total time spent in moderate to vigorous activity per week.

Table 5.5 Continuous study sample characteristics by age group (N=2771)

	Age Group														
	38 to 48 years old					49 to 55 years old					56 to 64 years old				
Characteristic	**No.**	**Mean**	**(sd*)**	**Min**	**,Max**	**No.**	**Mean**	**(sd*)**	**Min**	**,Max**	**No.**	**Mean**	**(sd*)**	**Min**	**,Max**
BMI (kg/m^2)	866	27.0	(5.4)	18.5	,57.1	894	27.1	(4.9)	18.6	,46.5	905	27.3	(4.8)	18.5	,55.1
Scale Scores															
Self-efficacy	900	3.0	(0.8)	1.0	,5.0	925	3.0	(0.8)	1.0	,5.0	937	3.0	(0.8)	1.0	,5.0
Outcome Expectations	899	4.0	(0.5)	2.0	,5.0	926	4.0	(0.5)	1.9	,5.0	932	3.9	(0.5)	1.6	,5.0
Attitudes	895	4.3	(0.6)	1.8	,5.0	925	4.3	(0.7)	1.6	,5.0	932	4.3	(0.7)	1.2	,5.0
Decisional Balance Pros	893	3.8	(0.9)	1.0	,5.0	925	3.8	(0.9)	1.0	,5.0	933	3.7	(0.9)	1.0	,5.0
Decisional Balance Cons	892	1.9	(0.7)	1.0	,5.0	925	1.8	(0.6)	1.0	,5.0	933	1.7	(0.6)	1.0	,5.0
Self-Presentation	892	2.6	(1.1)	1.0	,5.0	924	2.4	(1.1)	1.0	,5.0	932	2.4	(1.1)	1.0	,5.0
Scheduling & Planning	896	2.5	(0.8)	1.0	,4.6	924	2.5	(0.8)	1.1	,4.6	933	2.5	(0.8)	1.0	,4.6
Normative Behaviour	895	2.8	(1.4)	0.0	,5.0	912	2.8	(1.4)	0.0	,5.0	929	2.6	(1.4)	0.0	,5.0
Social Support-Family	897	1.9	(0.8)	0.0	,4.4	918	1.9	(0.9)	0.0	,4.6	927	1.9	(0.8)	0.0	,4.2
Social Support-Friends	897	1.7	(1.0)	0.0	,5.0	916	1.5	(1.0)	0.0	,5.0	922	1.4	(1.0)	0.0	,5.0
Social Support-Physician	899	1.8	(1.3)	0.0	,5.0	922	2.0	(1.3)	0.0	,5.0	931	2.0	(1.2)	0.0	,5.0

*Standard deviation of the mean

Similarly, of those who reported being employed, 25% reported more than 2.5 hours of daily moderate and vigorous activity at work for a 5 day work week. However, only 14.1% of participants were considered to have an active job. Ten percent of those with what were considered inactive jobs reported 12 hours of weekly moderate and vigorous activity related to their job. Inactive jobs, by their nature, are considered to involve only occasional moderate to vigorous intensity physical activity (USDL, 2009). Therefore, occupational activity only for those who reported an active job was included in the calculation of total moderate and vigorous activity per week in order to avoid misclassification.

When leisure, transport, and occupational activities for those with active jobs were included, the median hours per week spent in moderate and vigorous physical activity was 5.3 hours per week, with an interquantile range between 2.2 and 11.5 hours per week. The mean number of hours per week spent in moderate and vigorous activity was 9.1. Sixteen participants who reported total physical activity per week over 112 hours per week were dropped, as recommended by the guide for the International Physical Activity Questionnaire (IPAQ).

5.6 Meeting Physical Activity Guidelines

5.6.1 Meeting Public Health Agency of Canada (PHAC) guidelines

Overall, 74% of the sample met the physical activity guidelines set by the Public Health Agency of Canada (PHAC) based on leisure, occupation and transportation activities (Table 5.1). These are the least demanding guidelines to be considered, requiring 30 minutes of moderate to vigorous intensity physical activity, most days of the

week. There were no differences in the proportion of men or women who met PHAC physical activity guidelines: about 74% of men and women met these guidelines. There were also no differences in the proportion of participants who met PHAC physical activity guidelines by age groups (Table 5.4).

There were differences in the amount of hours spent in weekly activity by type of physical activity (Figure 5.1). For men who met PHAC guidelines, occupational activity accounted for 43% of their time spent in weekly moderate and vigorous physical activity, compared to 24% for women. On the other hand, women who met these guidelines spent a higher proportion of their time in physical activity per week participating in active transport and leisure physical activities than the men in this sample. Participants in the 38 to 48 year old and the 49 to 55 year old age groups who met these guidelines also reported a higher proportion of occupational physical activity than those in the 56 to 64 year old age group. Similar to women, those who met PHAC guidelines in the oldest age group had a higher proportion of time spent in active transport and leisure moderate and vigorous physical activity than those in the other age groups.

5.6.2 Meeting American Cancer Society (ACS) guidelines

Similar to Phase 1 results from this study, the proportion of the sample that was active enough to meet guidelines decreased as the guidelines became more demanding. Sixty-three percent of participants were physically active enough to meet guidelines recommended by the American Cancer Society (ACS) based on participation in leisure, occupation and transportation activities. These guidelines recommended at least 45

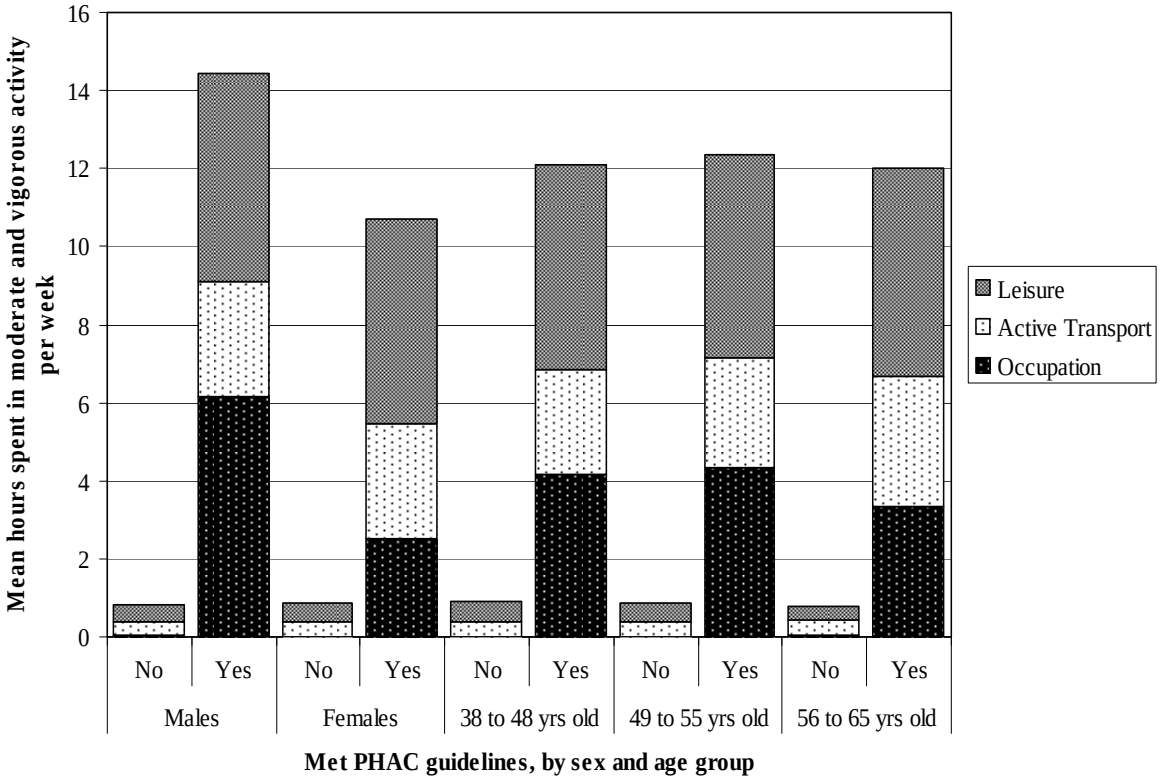

Figure 5.1 Weekly hours spent in moderate and vigorous occupation, active transport and leisure activities for meeting PHAC guidelines, by sex and age group

minutes of moderate to vigorous activity most days of the week for cancer prevention. Unlike for PHAC guidelines, there were differences in the proportion that met these guidelines between sex and age groups. Sixty-five percent of men were physically activity enough to meet ACS guidelines, compared to 61% of women (Table 5.1). Furthermore, participants who met ACS guidelines were slightly more likely to be in the middle age group (64% versus 62% in the other age groups) (Table 5.4).

Similar to what was found for PHAC guidelines, men in this sample who met ACS guidelines participated in more hours of weekly moderate and vigorous occupation activity than women who met these same guidelines n(Figure 5.2). Occupational activity

accounted for 44% of the total time spent in physical activity for men that met ACS guidelines, compare to 25% for women. For women who met these guidelines, the highest proportion of time spent in physical activity involved participation in leisure physical activities. In addition, participants in the oldest age group who met these guidelines spent more time in active transport than those in the other two age groups. Those in the 56 to 64 year old age group spent 28% of hours per week of physical activity in active transport, compared to 22% in both the 38 to 48 year old and 49 to 55 year old age groups.

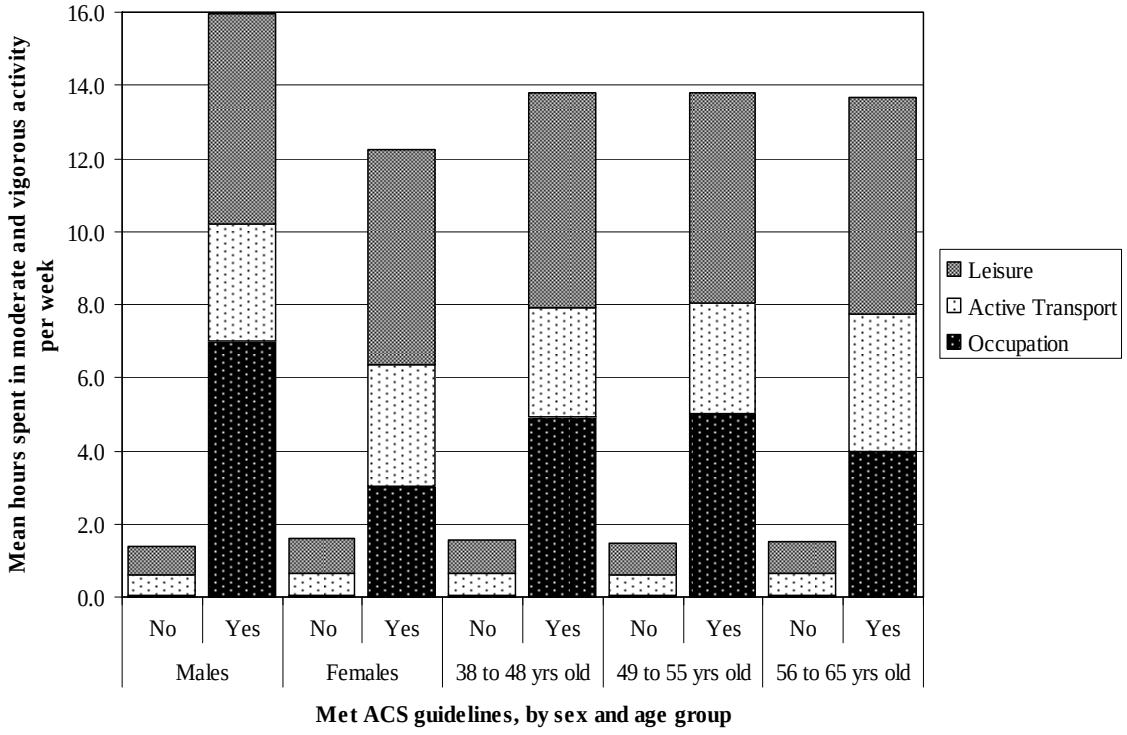

Figure 5.2 Weekly hours spent in moderate and vigorous occupation, active transport and leisure activities for meeting ACS guidelines, by sex and age group

5.6.3 Meeting U.S. Department of Health and Human Services (HHS) guidelines

Only 48% of participants were physically active enough to meet the most demanding recommendations set forth by the U.S. Department of Health and Human Services (HHS) based on participation in leisure, occupation and transportation activities (Table 5.1). These guidelines recommend at least 1 hour of moderate and vigorous activity most days of the week for normal weight individuals, and at least 1 hour daily for individuals were are overweight or obese. Once again, differences in the proportion sufficiently active to meet these guidelines occurred between sex and age groups. More men (49%) met HHS physical activity guidelines than the women in this study (49% versus 45%, respectively) (Table 5.1). The proportion of participants meeting HHS guidelines also increased slightly with increasing age group: 45% of 38 to 48 year olds met HHS guidelines and 47% of participants in the 49 to 55 and 56 to 64 year age groups met these same guidelines (Table 5.4).

Occupational activity accounted for an even higher proportion of the time spent in moderate and vigorous physical activity for men who met HHS guidelines than for meeting PHAC and ACS guidelines. About 47% of weekly hours spent in physical activity was spent in occupational activity for men that met HHS guidelines, compared to 27% for women. For women who met these guidelines, 47% and 27% of their time spent in moderate and vigorous activity involved participating in leisure and active transport activities, respectively. Similarly, occupational activity accounted for a higher proportion of time spent in moderate and vigorous activity for participants who met HHS guidelines in all three age groups, with both the 38 to 48 year old and the 49 to 55 year old age groups who met these guidelines spending approximately 40% of their time in

occupational activity compared to 32% for the 56 to 64 year old age group. Time spent in active transport accounted for a higher proportion of total time spent in moderate and vigorous physical activity for those who met HHS guidelines in the oldest age group, similar to findings for those who met PHAC and ACS guidelines.

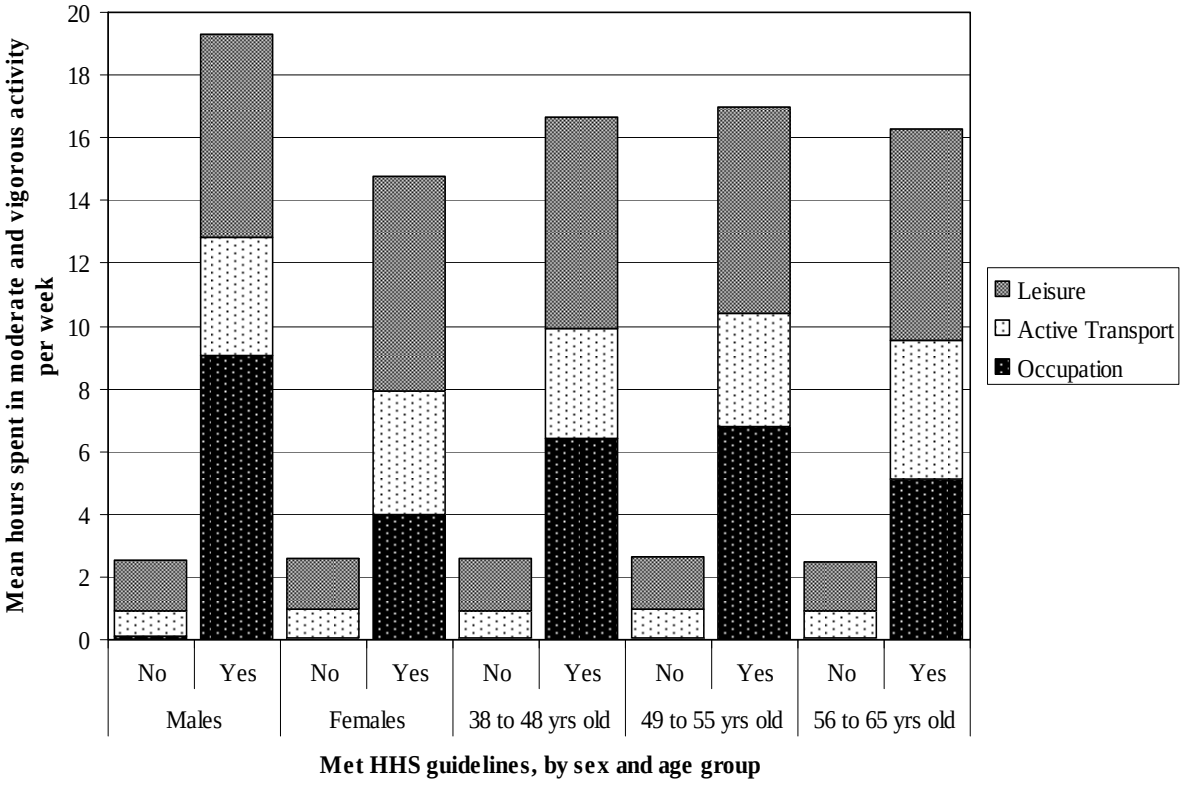

Figure 5.3 Weekly hours spent in moderate and vigorous occupation, active transport and leisure activities for meeting HHS guidelines, by sex and age group

5.7 Multicollinearity

Multicollinearity was not found among any of the explanatory variables. As previously indicated, some collinearity may have been expected. None of the pairwise correlations between any of the explanatory variables yielded a Spearman rank

coefficient high enough to be considered collinear for the purposes of this analysis, even among variables that may have been expected to be collinear, such as educational attainment, annual household income, current smoking status and/or employment status. Spearman coefficients for all pair-wise comparisons ranged between 0.08 and 0.31, reflecting weak correlations among these variables.

5.8 Identifying Potential Individual Level Determinants of Meeting Physical Activity Guidelines

A stratified analysis was used to explore potential relationships between proposed determinants and meeting each of PHAC, ACS or HHS guidelines. Sex and age differences were first explored through a descriptive analysis. Sex-specific and age-specific models were then created using a hierarchical backwards elimination modeling strategy with cross validation as outlined in Chapter 3. All Odds Ratios (OR) presented were adjusted for age, educational attainment, annual household income, and employment status. These variables were included in all of the models because they have been identified as confounders in previous research; however, none of these variables had statistically significant OR estimates. The end result of this analysis was two age-specific models and three age group specific models for each guideline, which indentified the potential determinants for meeting each of the three physical activity guidelines by sex and age group.

5.8.1 Sex differences for all possible potential determinants

A preliminary examination of the all possible determinants of being active enough to meet each of the three guidelines by sex revealed that men in this sample were more likely than women to report low intentions to become physically active in the next six months (Table 5.1). In addition, men were more likely to be in the precontemplation and maintenance stages of change and women were more likely to be in the preparation and action stages. Women in this sample also scored higher on decisional balance pros and scheduling and planning than men (Table 5.2). The mean score for decision balance pros scale for women was 3.9 compared to 3.6 for men, where a 3 indicates that potential pros, or benefits, of physical activity "somewhat" influence their decision to do physical activity and a 4 indicated that pros influence this decision "quite a lot", suggesting that women place more value on the potential benefits of physical activity than men do. The mean scheduling and planning score for women was 2.6 and 2.4 for men.

Regarding all possible social determinants, women had higher subjective norms and normative behaviour to model than men in this sample (Table 5.1). More women than men reported that people important to them were very likely to think that they should be physically active and women were more likely to have at least one close person in their lives who was physically active. In addition, women were more likely to score higher on the social support from friends scale. Despite these differences, men and women in this sample scored similarly on the self-efficacy, outcome expectations, attitudes, self-presentation and social support from family and social support from physician scales.

5.8.2 Age group differences for all possible determinants

A preliminary bivariate examination of all possible determinants of being active enough to meet each of the three guidelines by age group revealed participants in the oldest age group were more likely than others to report low intentions to become physically active in the next six months (Table 5.4). Despite these age differences, the vast majority of participants across all three age groups reported they would either probably or definitely plan to be physically active in the next six months, indicating generally high intentions to be physically active across age groups. In addition, the proportion of participants in the precontemplation and maintenance stages of change was highest among the oldest age group participants. Participants in the youngest age group, however, were more likely to be in the preparation and action stages. Participants in the youngest age group also had slightly higher scores on the self presentation scale, indicating that the positive impressions that others have about people who are physically active may be a slightly higher motivator in younger participants (Table 5.5).

Subjective norms were fairly similar between the youngest and the middle age groups but participants in the oldest age groups were the least likely to think that people important to them were very likely to think that they should be physically active (Table 5.4). In addition, there was a decreasing trend in normative behaviour with increasing age, with the oldest age group having the largest proportion of participants who had no close people in their lives who were physically active. There were also age differences in social support as well. The score for social support from friends had a slight decreasing trend with increasing age and social support to be physically active from a physician was lowest in the youngest age group. Despite the differences, participants in this sample

scored similarly on the self-efficacy, outcome expectations, attitudes, decisional balance and social support from family scales.

5.8.3 Potential determinants for meeting PHAC guidelines

The results for the sex-specific models for meeting the PHAC guidelines are presented in Table 5.6 (females) and Table 5.7 (males). Current smoking status, scheduling and planning and stage of change were found to be potential determinants for both men and women. Being a current daily smoker was associated with being an estimated 62% and 69% less likely to meet PHAC guidelines than non-smokers for women and men, respectively. Both men and women who scored higher on the scheduling and planning scale were also more likely to meet these guidelines, although this association was somewhat stronger for men than for women. For each increase on the scheduling and planning score, men were estimated to be twice as likely to meet PHAC guidelines, compared to 1.8 times as likely for women. Stage of change was also found to be a potential determinant for both men and women, but had slightly different associations with meeting PHAC guidelines for each. For women, the only stage that was significantly associated with meeting these guidelines was the maintenance stage (Table5.6). Women in the maintenance stage were estimated to be almost three times more likely to meet PHAC guidelines than women in the precontemplation stage. For men, both the action and the maintenance stages had a statistically significant association with meeting these guidelines, and the estimated association for the maintenance stage was stronger than for women (Table 5.7). Men were an estimated 4.5 times and 6.3 times more likely to meet PHAC guidelines than men in the precontemplation stage.

Table 5.6 Estimated Odds Ratios (OR)* for meeting physical activity guidelines for females

	PHAC		ACS		HHS	
Variable	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Marital Status						
Married					1.00	
Divorced, separated or widowed					1.50	(0.57,5.95)
Single					1.39	(0.25,3.79)
Weight Status						
Normal Weight	1.00		1.00		1.00	
Overweight	1.40	(0.95 ,2.06)	0.86	(0.62,1.19)	0.44	(0.32,0.60)
Obese	0.99	(0.66 ,1.48)	0.78	(0.53,1.14)	0.45	(0.31,0.66)
Current Smoking Status						
Not at all	1.00					
Occasionally	1.12	(0.63 ,1.97)				
Daily	0.38	(0.20 ,0.73)				
Self-efficacy	1.36	(1.02 ,1.81)	1.34	(1.04,1.73)	1.83	(1.29,2.63)
Scheduling and Planning	1.82	(1.32 ,2.50)	1.52	(1.17,1.99)	1.21	(1.01,1.67)
Stage of Change						
Precontemplation	1.00		1.00		1.00	
Contemplation	0.66	(0.36 ,1.22)	0.96	(0.49,1.91)	0.83	(0.40,1.72)
Preparation	0.57	(0.31 ,1.07)	1.07	(0.54,2.11)	0.96	(0.47,1.96)
Action	1.60	(0.76 ,3.38)	2.82	(1.35,5.87)	1.71	(0.81,3.61)
Maintenance	2.92	(1.40 ,6.06)	4.58	(2.22,9.44)	3.25	(1.58,6.68)
Decisional Balance						
Pros					1.01	(0.82,1.22)
Cons					0.73	(0.58,0.92)
Social Support - Family	1.28	(1.01 ,1.63)				
Social Support - Friends			1.13	(0.97,1.32)	1.17	(1.01,1.35)
Have a Companion for Physical Activity	2.10	(1.37 ,3.24)	1.57	(1.01,2.42)	1.52	(1.02,2.33)

Table 5.6 Estimated Odds Ratios (OR)* for meeting physical activity guidelines for females (continued)

	PHAC		ACS		HHS	
Variable	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Health Problem						
Cardiovascular Problems						
Heart Problems			0.46	(0.24,0.89)		

*Adjusted for age, educational attainment, annual household income, and employment status

Table 5.7 Estimated Odds Ratios (OR)* for meeting physical activity guidelines for males

	PHAC		ACS		HHS	
Variable	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Weight Status						
Normal Weight			1.00		1.00	
Overweight	1.02	(0.62,1.68)	0.75	(0.47,1.18)	0.49	(0.32,0.76)
Obese	0.57	(0.33,0.98)	0.56	(0.34,0.93)	0.42	(0.26,0.68)
Current Smoking Status						
Not at all	1.00					
Occasionally	1.34	(0.66,2.73)				
Daily	0.31	(0.16,0.61)				
Self-efficacy					1.36	(1.02,1.81)
Scheduling and Planning	2.04	(1.41,2.97)	1.99	(1.43,2.77)	1.16	(0.84,1.60)
Stage of Change						
Precontemplation	1.00		1.00		1.00	
Contemplation	1.40	(0.75,2.61)	1.23	(0.66,2.29)	0.88	(0.45,1.73)
Preparation	1.33	(0.67,2.65)	1.00	(0.51,1.98)	0.66	(0.31,1.39)
Action	4.50	(1.90,10.61)	1.79	(0.83,3.84)	1.28	(0.57,2.87)
Maintenance	6.31	(3.10,12.82)	5.14	(2.65,9.99)	2.67	(1.33,5.36)
Decisional Balance						
Pros					1.27	(1.01,1.60)
Cons					0.71	(0.51,0.98)
Social Support - Friends			1.17	(0.84,1.34)	1.22	(1.01,1.49)

Table 5.7 Estimated Odds Ratios (OR)* for meeting physical activity guidelines for males (continued)

	PHAC		ACS		HHS	
Variable	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Health Problem						
Cardiovascular Problems			1.64	(1.12,2.40)		
Heart Problems						
Rural or Urban Setting						
Rural	1.00					
Urban	1.47	(0.50,4.32)				

*Adjusted for age, educational attainment, annual household income, and employment status

Self-efficacy, social support from family and having a companion for physical activity were identified as potential determinants for only women (Table 5.6). Women were more likely to meet PHAC guidelines as their self-efficacy scores and social support from family scores increased. Women were an estimated 1.3 times more likely with each increase in self-efficacy score and social support from family score to meet these guidelines. Women were also estimated to be twice as likely to meet PHAC guidelines if they reported having a companion to do physical activity with (Table 5.6).

Weight status and living in an urban setting were identified as potential determinants unique to men (Table 5.7). While weight status was identified as a potential determinant for women, this association was not statistically significant. For men, however, being obese was significantly associated with being an estimated 45% less likely than normal weight men to meet PHAC guidelines. Similarly to weight status for women, living in a rural or urban setting was identified as a potential determinant of meeting these guidelines for men, but this association was not statistically significant (Table 5.7).

Table 5.8 presents the results for the models for meeting PHAC guidelines by age group. Scheduling and planning, and stage of change were identified as potential determinants for all three age groups. The association between scheduling and planning and meeting PHAC guidelines was consistent across all three age groups. Participants in the 38 to 48 year old, 49 to 55 year old, and 56 to 64 year old age group were estimated to be twice as likely to meet these guidelines with each increase in score. Therefore, as scheduling and planning for physical activities increased, participants were more likely to meet PHAC guidelines. Participants who were in the maintenance stage were significantly more likely to meet PHAC guidelines, regardless of age, although the strength of association did differ by age group. Participants in the 49 to 55 year old age group had the strongest association between maintenance stage and meeting PHAC guidelines (OR=7.79, 95% CI 3.77-16.09), and those in the 56 to 64 year old age group had the weakest association (OR=2.06, 95% CI 1.01-4.28).

Weight status was identified as a potential determinant for all three age groups but did not have a statistically significant association for any group except for the oldest age group. Participants in the 56 to 64 year old age group were estimated to be 42% less likely to meet PHAC guidelines if they were obese than if they were normal weight. Similarly, social support from family and having a companion for physical activity were identified as potential determinants but had statistically significant associations to meeting these guidelines for certain age groups. Social support from family was a statistically significant potential determinant for the 38 to 48 year old and 56 to 64 year old age groups. Participants in these age groups were estimated to be 1.4 times more

Table 5.8 Estimated Odds Ratios* (OR) for meeting PHAC guidelines by age group

	38 to 48 years old		49 to 55 years old		56 to 64 years old	
Variable	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Weight Status						
Normal Weight	1.00		1.00		1.00	
Overweight	1.22	(0.72,2.06)	1.68	(0.99,2.85)	1.41	(0.83,2.37)
Obese	0.77	(0.45,1.33)	1.34	(0.75,2.37)	0.58	(0.35,0.98)
Current Smoking Status						
Not at all						
Occasionally	1.99	(0.94,4.13)				
Daily	0.57	(0.37,0.89)				
Scheduling and Planning	1.94	(1.30,2.93)	1.93	(1.26,2.94)	1.99	(1.33,2.98)
Stage of Change						
Precontemplation	1.00		1.00		1.00	
Contemplation	0.86	(0.40,1.84)	1.36	(0.65,2.87)	0.69	(0.35,1.36)
Preparation	0.90	(0.41,1.95)	1.03	(0.48,2.20)	0.66	(0.31,1.42)
Action	2.09	(0.82,5.36)	2.54	(1.01,6.41)	1.55	(0.58,4.18)
Maintenance	4.58	(1.86,11.31)	7.79	(3.77,16.09)	2.06	(1.01,4.28)
Social Support - Family	1.43	(1.04,1.97)	1.07	(0.80,1.44)	1.39	(1.03,1.88)
Have a Companion for Physical Activity	1.71	(0.93,3.13)	1.96	(1.09,3.53)	1.86	(1.10,3.15)

*Adjusted for sex, educational attainment, annual household income, and employment status

likely to meet PHAC guidelines with each increase in score on the social support from family scale. Having a companion for physical activity had a statistically significant association to meeting PHAC guidelines for the middle and oldest age groups only. Participants in these age groups were estimated to be approximately twice as likely to meet these guidelines if they had someone to do physical activity with.

Daily smoking was found to be potential determinant for meeting PHAC guidelines only for the youngest age group. Participants who were 38 to 48 years old were 43% less likely to meet these guidelines if they reported smoking daily, compared to those who were non-smokers.

5.8.4 Potential determinants for meeting ACS guidelines

Weight status, scheduling and planning and stage of change were identified as potential determinants of meeting ACS guidelines for both women and men. Obese women were estimated to be 22% less likely than normal weight women to meet these guidelines (Table 5.6). For men, this association was stronger; obese men were an estimated 44% less likely to meet ACS guidelines (Table 5.7). An increase in scheduling and planning score was associated with increased likelihood of meeting these guidelines for both men and women, although the association was estimated to be stronger for men. Men were an estimated 2 times more likely to meet ACS guidelines with each increase in score, compared to women who were estimated to be 1.5 times more likely to meet these guidelines with an increasing score (Table 5.6 and Table 5.7).

Similarly to the findings for meeting PHAC guidelines, being in the maintenance stage was strongly associated with meeting these guidelines. Women and men were an estimated 4.6 times and 5.1 times more likely to meet ACS guidelines than those who reported being in the precontemplation stage (Table 5.6 and Table 5.7). However, being in the action stage also had a statistically significant association with meeting these guidelines, as women in this stage were estimated to be 2.8 times more likely than women in the precontemplation stage to meet these guidelines (Table 5.6).

Social support from friends was also identified as a possible determinant for meeting ACS guidelines among both men and women. However, the estimated associations for social support from friends were not statistically significant for either sex and was therefore, not considered potential determinants in this sample.

Potential determinants of meeting ACS guidelines specific for women were self-efficacy, having a companion for physical activity and having heart problems (Table 5.6). As was found for PHAC guidelines, women were an estimated 1.3 times more likely with each increase in self-efficacy score to meet ACS guidelines. Women in this sample were also estimated to be 1.5 times more likely to meet these guidelines if they reported having a companion to do physical activities with. Conversely, women who reported having been diagnosed with heart problems were estimated to be 54% less likely to meet ACS guidelines.

The potential determinants identified for men for meeting ACS guidelines were similar to those identified for women. The only potential determinant unique for men was having a cardiovascular problem (Table 5.7). Men with cardiovascular problems, such as high blood pressure and high cholesterol, were estimated to be 64% more likely to meet ACS guidelines than men who did not.

The results for the age-specific models can be found in Table 5.9. As was found for meeting PHAC guidelines, scheduling and planning and stage of change were identified as potential determinants regardless of age group. The association between scheduling and planning and meeting ACS guidelines was consistent across all three age groups as it was for meeting PHAC guidelines, but the association was weaker. Participants in the 38 to 48 year old, 49 to 55 year old, and 56 to 64 year old age group

were estimated to be 1.7, 1.8 and 1.7 times as likely to meet these guidelines, respectively, with each increase in score on the scheduling and planning scale.

Table 5.9 Estimated Odds Ratios* (OR) for meeting ACS guidelines by age group

	38 to 48 years old		49 to 55 years old		56 to 64 years old	
Variable	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Weight Status						
Normal Weight	1.00		1.00		1.00	
Overweight	1.03	(0.67,1.60)	1.17	(0.74,1.87)	0.97	(0.61,1.53)
Obese	1.20	(0.73,1.96)	1.20	(0.70,2.05)	0.46	(0.28,0.78)
Scheduling and Planning	1.72	(1.24,2.37)	1.75	(1.22,2.50)	1.69	(1.21,2.35)
Stage of Change						
Precontemplation	1.00		1.00		1.00	
Contemplation	0.89	(0.42,1.86)	1.10	(0.50,2.43)	1.10	(0.54,2.24)
Preparation	0.74	(0.36,1.53)	1.28	(0.57,2.87)	0.79	(0.36,1.73)
Action	1.18	(0.53,2.61)	3.82	(1.51,9.64)	3.33	(1.32,8.43)
Maintenance	4.05	(1.84,8.91)	6.86	(2.86,16.47)	3.46	(1.72,6.98)
Have a Companion for Physical Activity	1.08	(0.64,1.84)	1.88	(1.06,3.31)	2.32	(1.40,3.85)

*Adjusted for sex, educational attainment, annual household income, and employment status

Participants in the maintenance stage were also significantly more likely to meet ACS guidelines but the strength of association differed by age group. The strongest association between maintenance stage and meeting these guidelines was found among participants in the 49 to 55 year old age group (OR=6.9, 95% CI 2.9-16.5), and the weakest association was found among those in the 56 to 64 year old age group (OR=3.5, 95% CI 1.7-7.0).

Weight status was once again identified as a potential determinant for all three age groups but did not have a statistically significant association for any age group except

for 56 to 64 year old age group. While this trend was similar to that found for meeting PHAC guidelines, the association between obesity and meeting ACS guidelines was stronger. Obese participants in this age group were estimated to be 54% less likely to meet ACS guidelines than their normal weight counterparts, compared to being an estimated 42% less likely to meet PHAC guidelines if they were obese.

Much like for meeting PHAC guidelines, having a companion for physical activity was identified as a potential determinant with a statistically significant association to meeting ACS guidelines for the middle and oldest age group, but not the youngest age group. Participants who were 49 to 55 years old were estimated to be 1.9 times as likely to meet ACS guidelines and participants who were 56 to 64 years old were estimated to be 2.3 times more likely to meet these guidelines if they had someone to do physical activity with.

5.8.5 Potential determinants for meeting HHS guidelines

The results for the sex-specific models for meeting HHS guidelines are presented in Table 5.6 and Table 5.7. Weight status, self-efficacy, scheduling and planning, stage of change and social support from friends were identified as potential determinants for both women and men. In contrast to meeting any of the other guidelines, both men and women who were either overweight or obese were significantly less likely than their normal weight counterparts to meet HHS physical activity guidelines. Women and men who were overweight were an estimated 56% and 51% less likely to meet these guidelines, and women and men who were obese were an estimated 55% and 58% less likely to meet these guidelines, compared to their normal weight counterparts. Self-efficacy was also

identified as a potential determinant for both men and women for meeting HHS guidelines, although the association was stronger for women. This is in contrast to the finding for meeting PHAC and ACS guidelines, where self-efficacy was identified as a potential determinant for women only (Table 5.6). Women were estimated to be 1.8 times more likely to meet HHS guidelines with each increase in self-efficacy score, compared to men who were estimated to be 1.4 times more likely to meet these guidelines with each increase in score.

As was found for both PHAC and ACS guidelines, scheduling and planning was a potential determinant for both men and women for meeting HHS guidelines, but with a weaker association. The associations between stage of change and meeting HHS guidelines was essentially the same for both women and men, with both sexes estimated as 1.2 times more likely to meet these guidelines with each increase in scale score (Table 5.6 and Table 5.7). Also similar to the findings for ACS guidelines, social support from friends was identified as a potential determinant but the association between this type of social support and meeting HHS was statistically significant, unlike for meeting ACS guidelines. Both men and women were an estimated 1.2 times more likely to meet HHS guidelines with each increase in score for the social support from friends scale.

Decisional balance pros, the influence of the potential benefits of being physically active on the decision to be active, and cons, the influence of the potential drawbacks of being physically active on the decision to be active, were identified as potential determinants of meeting HHS guidelines for both men and women, but the associations differed between the sexes. For women, only decisional balance cons had a statistically significant association with meeting these guidelines. Women were estimated to be 27%

less likely to meet HHS guidelines with each increase in score on the decisional balance cons scale (Table 5.6). On the other hand, both decisional balance pros and cons had a statistically significant association among men. Men were estimated to be 1.3 times more likely and 29% less likely to meet HHS guidelines with each increase in decisional balance pros and cons scale scores, respectively (Table 5.7).

There were two possible but statistically insignificant determinants found for women only: marital status and having a companion for physical activity. Marital status was identified as a potential determinant but did not have a statistically significant association with meeting HHS guidelines; therefore, marital status was not considered a potential determinant for this sample (Table 5.6). Having a companion for physical activity, however, did have a statistically significant association to meeting these guidelines. Similar to meeting ACS guidelines, women who had a companion for physical activity were estimated to be 1.5 times more likely to meet HHS guidelines than women who reported not having anyone to do physical activity with (Table 5.6). There were no potential determinants for meeting HHS guidelines that were unique to men. There were also differences in the potential determinants for meeting HHS guidelines for each age group. These results are presented in Table 5.10. Weight status, self-efficacy, stage of change and social support from friends were identified as potential determinants for meeting these guidelines for all three age groups. Participants in the 38 to 48 year old, 49 to 55 year old, and 56 to 64 year old age groups were estimated to be 56%, 40%, and 59%, respectively, less likely to meet HHS guidelines if they were overweight than if they were normal weight. The association between obesity and meeting these guidelines

increased with increasing age group. Obese participants who were 56 to 64 years old were estimated to be 74% less likely to meet these guidelines than if they were normal

Table 5.10 Estimated Odds Ratios* (OR) for meeting HHS guidelines by age group

	38 to 48 years old		49 to 55 years old		56 to 64 years old	
Variable	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Weight Status						
Normal Weight	1.00		1.00		1.00	
Overweight	0.44	(0.29,0.66)	0.60	(0.40,0.92)	0.41	(0.27,0.62)
Obese	0.65	(0.41,1.04)	0.54	(0.33,0.90)	0.26	(0.16,0.43)
Self-efficacy	1.54	(1.13,2.09)	1.49	(1.12,1.98)	1.48	(1.08,2.02)
Stage of Change						
Precontemplation	1.00		1.00		1.00	
Contemplation	1.52	(0.64,3.61)	0.65	(0.30,1.44)	0.49	(0.24,1.01)
Preparation	1.01	(0.42,2.47)	0.68	(0.30,1.52)	0.65	(0.29,1.43)
Action	1.66	(0.65,4.22)	1.01	(0.42,2.44)	1.30	(0.55,3.08)
Maintenance	3.32	(1.35,8.19)	2.57	(1.15,5.76)	1.73	(1.04,2.86)
Decisional Balance						
Pros	1.11	(0.88,1.40)	1.11	(0.88,1.41)	1.08	(0.85,1.37)
Cons	1.01	(0.75,1.36)	0.67	(0.48,0.93)	0.77	(0.58,0.99)
Social Support - Friends	1.22	(1.01,1.47)	1.28	(1.04,1.57)	1.24	(1.03,1.50)

*Adjusted for sex, educational attainment, annual household income, and employment status

weight, compared to being an estimated 35% and 46% less likely to meet these guidelines for those in the 38 to 48 year old and 49 to 55 year old age group.

Unlike for PHAC and ACS guidelines, self-efficacy was a potential determinant for meeting HHS guidelines. Increased self-efficacy score was positively associated with meeting HHS guidelines and this association was consistent across age groups. Regardless of age group, participants were estimated to be approximately 1.5 times more

likely to meet these guidelines with each increase in self-efficacy score. Similarly, social support from friends had a positive association with meeting HHS guidelines consistently across age groups. All participants were estimated to be between 1.2 and 1.3 times more likely to meet these guidelines with each increase in the social support from friends score.

Stage of change was also found to be a potential determinant of meeting HHS guidelines for all three age groups, as it was for meeting PHAC and ACS guidelines; however, the association for meeting HHS guidelines was the weakest. The association between being in the maintenance stage and meeting HHS guidelines also decreased with increasing age. Participants in the 38 to 48 year old age group were estimated to be 3.3 times more likely to meet these guidelines if they were in the maintenance stage compared to the precontemplation stage. Comparatively, participants in the 49 to 55 year old and 56 to 64 year old age groups were estimated to be 2.6 and 1.7 times more likely to meet these guidelines if they were in the maintenance stage.

Lastly, decisional balance pros and cons were identified as potential determinants for meeting HHS guidelines for all three age groups. However, decisional balance pros did not have a statistically significant association with meeting HHS physical activity guidelines for any of the age groups. In contrast, decisional balance cons had a statistically significant association with meeting these guidelines for the middle and older age groups and somewhat stronger in the middle age group. For participants in the 49 to 55 year old age group, each increase in the score for the decisional balance cons scale was estimated to be 33% less likely to meet HHS guidelines, compared to those in the 56 to 64 year old age group who were 23% less likely to meet these guidelines.

5.8.6 Assessment of model fit

The process of cross-validation was closely monitored to help ensure good model fit. The results for test sets across all of the folds for each of the models created were similar, indicating that the resulting sex-specific and age-specific models were a good representation of the data. In addition, there was no indication of influential outliers during the cross-validation processes, which would have resulted in 1 or 2 folds identifying very different potential determinants or having very different logistic regression coefficient estimates from the others.

Results for the Hosmer-Lemeshow (H-L) Test for goodness-of-fit and the c-index from ROC curves to assess predictive value are presented in Table 5.11 for all of the final models. As can be seen, the H-L Test yielded statistically insignificant chi-squared statistics for all models, indicating goodness-of-fit for all models and that all the models are fair representations of the associations for these data. Moreover, the range of c-index values was from 0.73 to 0.83, indicating all models had good predictive value. Predictions for the outcome of the models estimated in this analysis closely matched the outcomes observed in the data. Although the predictive value of the models for meeting HHS guidelines were lower compared to the other guidelines, they were still acceptable.

A link test was also performed for all 15 models to assess the appropriateness of the logit link of the logistic regression for the data. The link test was statistically insignificant for all 15 models, indicating that the logit link was appropriate for these data and that logistic regression was an appropriate approach.

Table 5.11 Assessment of predictive value and goodness-of-fit

Model	ROC c-index	Hosmer-Lemeshow Test	
		χ2 (df=8),	*p* value
Potential determinants of PHAC			
Males	0.7904	7.80	0.4533
Females	0.8235	9.82	0.2781
38 to 48 age group	0.8193	4.76	0.7831
49 to 55 age group	0.8298	9.20	0.3261
56 to 65 age group	0.8069	3.96	0.8611
Potential determinants of ACS			
Males	0.7748	9.01	0.3411
Females	0.7888	9.95	0.2687
38 to 48 age group	0.7748	4.06	0.8130
49 to 55 age group	0.8030	3.66	0.8866
56 to 65 age group	0.7786	3.25	0.9175
Potential determinants of HHS			
Males	0.7266	10.63	0.2235
Females	0.7644	10.03	0.2630
38 to 48 age group	0.7555	6.02	0.6445
49 to 55 age group	0.7486	10.48	0.2329
56 to 65 age group	0.7553	3.90	0.8661

Overall, the sex-specific and age-specific models for each of the three guidelines were considered to be a good fit to the data and to have good predictive value for the potential determinants of meeting each physical activity guideline. Therefore, the models estimated in this analysis can be considered valid.

5.9 Identifying Potential Neighbourhood Level Determinants of Meeting Physical Activity Guidelines

Two-level models were estimated to investigate the influence of neighbourhood environment on meeting PHAC, ACS and HHS physical activity guidelines. Since there was limited availability of data for neighbourhood characteristics, this analysis was

restricted to 1,216 residents of Calgary and Edmonton at the time of data collection. There were 740 participants who resided in 153 of a possible 189 Calgary neighbourhoods, and 476 participants who resided in 198 of a possible 223 Edmonton neighbourhoods.

5.9.1 Collapsing neighbourhoods to neighbourhood groups

A descriptive analysis of the distribution of participants by neighbourhood revealed that the vast majority of neighbourhoods had only one or two participants and only nine neighbourhoods had more than 10 participants. Therefore, neighbourhoods had to be grouped together in order to have adequate group sizes for multilevel modeling (Luke, 2004; Snijders and Bosker, 1999). To accommodate sex- and age-group stratified analysis, grouped neighbourhoods were created to have at least 30 participants.

A total of 41 neighbourhood groups were created, 25 Calgary and 16 in Edmonton. Despite the neighbourhood grouping process, participants' neighbourhood level characteristics appeared unchanged. Neighbourhood group household income was strongly correlated with neighbourhood household income (Pearson correlation coefficient = 0.94, $p<0.001$) (Figure 5-1). Neighbourhood group educational attainment was also closely associated with neighbourhood educational attainment (Spearman's rho =0.96, $p<0.001$) (Figure 5-2).

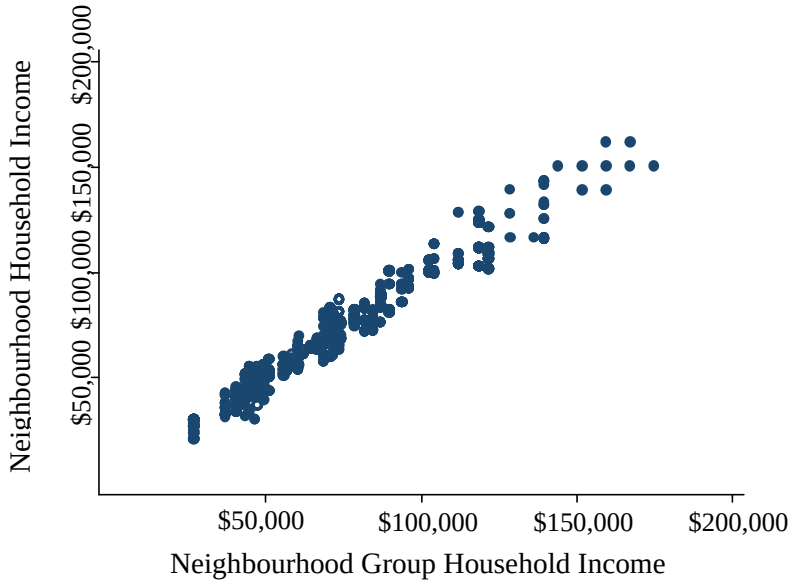

Figure 5.4. Scatterplot of neighbourhood household income versus neighbourhood group household income

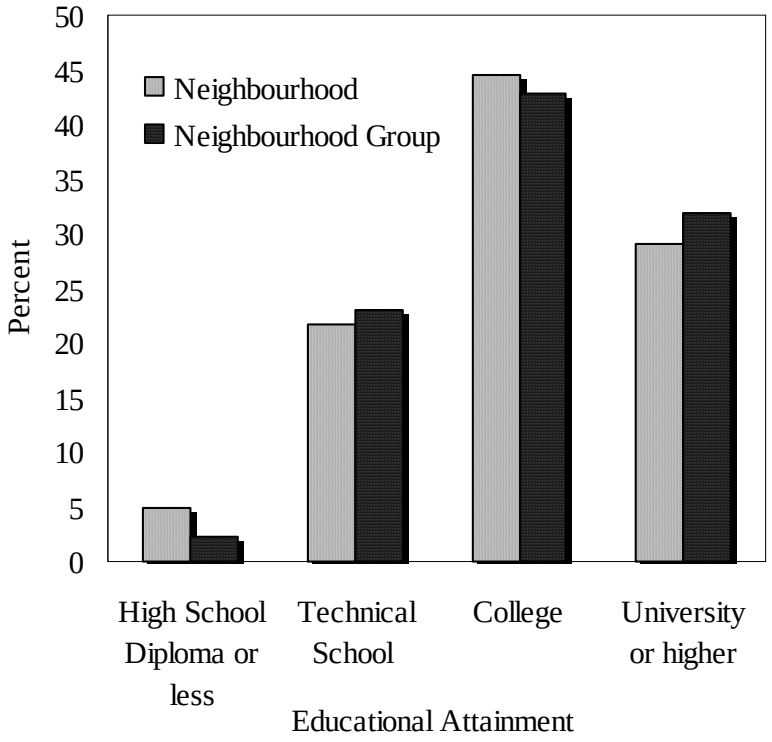

Figure 5.5 Distribution of participants by neighbourhood and neighbourhood educational attainment

5.9.2 Characteristics of sub-sample

The sub-sample contained 60% women and 40% men, similar to the sex distribution of the whole sample (Table 5.12). However, the sub-sample differed in age group distribution. The sub-sample was younger than the whole sample, with 36% of sub-sample participants in the 38 to 48 year old group, compared to 33% in this age group for the whole sample. Similarly, 31% of the sub-sample was in the 56 to 64 year old age group, while 34% of the whole sample was in this age group. The proportion of participants in the 49 to 55 year old group was the same between the sub-sample and the whole sample.

The sub-sample of participants for the multilevel analysis was also more likely to meet physical activity guidelines than the whole study sample. Overall, 78% of the sub-sample met PHAC guidelines (Table 5.11) compared to 74% of the whole samples (Table 5.1). Similarly, participants in the subsample were more likely to meet ACS (67% versus 63%) and HHS guidelines (49% versus 48%) than the whole sample.

A description of neighbourhood characteristics for the sub-sample can be found in Table 5.11. The mean neighbourhood group household income was lower for women than for men. Women were also less likely than men to reside in neighbourhood groups with a median educational attainment of university or higher than men. There were no practical differences in neighbourhood group household income across age groups. However, the 56 to 64 year old age group had the highest proportion of participants with a high school education or lower and a university education or higher. There was no sex or age variation in the mean Neighbourhood Environment and Walkability Scale (NEWS) score.

Table 5.12 Multilevel modeling sub-sample characteristics

			Sex				Age Group(years old)					
Characteristic	**Whole Sample**		**Females (n=721)**		**Males (n=495)**		**38 to 48 (n=435)**		**49 to 55 (n=409)**		**56 to 64 (n=372)**	
Met PHAC guidelines												
No	273	22.5%	160	22.2%	113.0	22.8%	93	21.4%	101	24.7%	79	21.2%
Yes	943	77.6%	561	77.8%	382.0	77.2%	342	78.6%	308	75.3%	293	78.8%
Met ACS guidelines												
No	403	33.1%	248	34.4%	155.0	31.3%	140	32.2%	146	35.7%	117	31.5%
Yes	813	66.9%	473	65.6%	340.0	68.7%	295	67.8%	263	64.3%	255	68.6%
Met HHS guidelines												
No	597	51.1%	350	51.0%	247.0	51.1%	207	49.6%	217	55.4%	173	48.1%
Yes	572	48.9%	336	49.0%	236.0	48.9%	210	50.4%	175	44.6%	187	51.9%
Neighbourhood Group Household Income												
Mean(SD)	$71,663(25,225)		$71,663(25,224)		$79,899(24,655)		$72,844(26,050)		$70,957(25,394)		$71,633(25,225)	
Neighbourhood Group Educational Attainment												
High School Diploma or less	28	2.3%	15	2.1%	13	2.6%	8	1.8%	8	2.0%	3	3.2%
Technical School	280	23.0%	169	23.4%	111	22.4%	100	23.0%	98	24.0%	82	22.0%
College	520	42.8%	320	44.4%	200	40.4%	188	43.2%	180	44.0%	152	40.9%
University	388	31.9%	217	30.1%	171	34.6%	139	32.0%	123	30.1%	126	33.9%
NEWS score												
Mean(SD)	3.1(0.3)		3.1(0.3)		3.1(0.3)		3.1(0.3)		3.1(0.3)		3.1(0.3)	

5.9.3 Multilevel logistic model

5.9.3.1 Neighbourhood group effects

There were no neighbourhood effects found for meeting PHAC or ACS physical activity guidelines. Five random intercepts models that incorporated neighbourhood effects were estimated for meeting each guideline: two sex-specific models and three age groups specific guidelines. For all models corresponding to meeting PHAC or ACS guidelines, the LR test assessing the change in deviance between the random intercepts two-level logistic regression model and the ordinary single level logistic regression was statistically insignificant, indicating the two-level model was uninformative and not necessary.

Similarly, no neighbourhood group effects were found for age group specific models for meeting HHS physical activity guidelines. However, neighbourhood group effects were found for the sex-specific models for meeting HHS guidelines. The LR test statistic was significant for both sexes (p=0.043 for males and p=0.012 for females), indicating a notable difference in variation of meeting HHS guidelines by neighbourhood group for both men and women.

The ICC was estimated for each of the sex-specific models for meeting HHS physical activity guidelines. The estimated neighbourhood group variance for women was 0.386 (SE=0.117). The ICC for women was 0.106, indicating that 11% of the variation in meeting HHS guidelines among women was accounted for by neighbourhood group differences. The neighbourhood group variance estimated for men was 0.279 (SE=0.134) and the corresponding ICC was 0.078, indicating that 8% of the variation in meeting HHS guidelines was accounted for by neighbourhood group differences for men.

Since random intercepts for neighbourhood effects were appropriated only for sex-specific models for meeting HHS, random slopes and intercepts models were considered only for these two models. However, no cross-level interactions were found between either of the neighbourhood group characteristics (educational attainment and household income) and any of the individual level fixed effects. The LR tests assessing the change in deviance between the random intercepts and slopes models for neighbourhood educational attainment as the effect modifier and random intercepts only models for meeting HHS guidelines were statistically insignificant for both men and women (p=0.736 and p=0.343, respectively). Similarly, statistically insignificant LR test statistics were found to the test comparing random intercepts and slopes models for neighbourhood household income as the effect modifier and random intercepts only models for meeting these guidelines for both men and women (p=0.472 and p=0.876, respectively).

Given the above results, a two-level logistic regression model was appropriate only for meeting HHS guidelines for men and women. Therefore, the remainder of the multi-level analysis considered only these two models.

5.9.3.2 Potential neighbourhood determinants of meeting physical activity guidelines

The results from the two- level logistic regression analysis for meeting HHS guidelines are presented in Table 5.13. The potential individual level determinants for meeting these guidelines for both men and women are the same as previously identified and their associations with meeting HHS guidelines for this sub-sample remained largely

Table 5.13 Estimated Odds Ratios*+ (OR) for meeting HHS guidelines by sex, using multilevel modeling

	Females		Males	
Variable	**OR**	**95% CI**	**OR**	**95% CI**
Individual Level				
Marital Status				
Married	1.00			
Divorced, separated or widowed	1.10	(0.65,1.53)		
Single	1.15	(0.67,1.92)		
Weight Status				
Normal Weight	1.00		1.00	
Overweight	0.45	(0.33,0.61)	0.57	(0.34,0.96)
Obese	0.39	(0.26,0.56)	0.36	(0.21,0.60)
Self-efficacy	1.50	(1.17,1.92)	1.27	(1.06,1.51)
Scheduling and Planning	1.27	(1.04,1.56)	1.10	(0.81,1.51)
Stage of Change				
Precontemplation	1.00		1.00	
Contemplation	0.83	(0.42,1.66)	0.76	(0.44,1.94)
Preparation	1.08	(0.83,1.40)	0.73	(0.43,1.24)
Action	1.63	(0.92,2.89)	1.21	(0.51,2.89)
Maintenance	3.48	(1.83,6.62)	2.34	(1.48,3.69)
Decisional Balance				
Pros	1.10	(0.91,1.33)	1.19	(1.04,1.36)
Cons	0.82	(0.68,0.98)	0.79	(0.68,0.92)
Social Support - Friends	1.22	(1.05,1.44)	1.27	(1.04,1.55)
Have a Companion for Physical Activity	1.52	(1.13,2.47)		
Neighbourhood Group Level				
NEWS Score	1.57	(1.06,1.33)	1.02	(0.65,1.62)
Annual Household Income	1.01	(0.94,1.09)	0.99	(0.90,1.08)
Educational Attainment				
High School Diploma or Lower	1.00		1.00	
Technical Certificate/Diploma	0.72	(0.27,1.91)	1.10	(0.83,1.46)
College Degree	0.65	(0.44,0.94)	0.43	(0.31,0.58)
University Degree or Higher	0.88	(0.77,0.98)	0.72	(0.57,0.94)

*Adjusted for age, educational attainment, annual household income, and employment status

+ ORs estimated using two-level logistic regression

the same as estimated previously using the whole sample (Section 5.8). For instance, being overweight or obese was associated with an increased risk of not being sufficiently active enough to meet HHS guidelines for both men and women. Self-efficacy and scheduling and planning were identified as potential determinants for both men and women but the association between these potential determinants and meeting HHS guidelines was stronger for women. Similar to earlier findings, being in the maintenance stage of change and having social support from friends was also estimated to have a positive association with meeting HHS guidelines.

The main purpose, however, of estimating the models presented on Table 5.12 was to investigate possible associations between potential neighbourhood group level determinants and meeting HHS guidelines. Although neighbourhood group annual household income was not associated with meeting these guidelines, there was an association between neighbourhood group educational attainment and meeting HHS guidelines. Both men and women who resided in a neighbourhood with a median educational attainment of a college degree or higher were less likely to meet these physical activity guidelines than those who had attained a technical certificate or diploma or less. However, these associations differed between men and women. Men living in neighbourhood groups with a median education level of a college degree were an estimated 57% (95% CI, 42%–69%) less likely to meet HHS guidelines than men that lived in neighbourhoods with an educational attainment of high school or lower. However, women were only estimated to be 35% (95% CI, 6%-56%) less likely to meet these guidelines than their counterparts. Similarly, men who resided in neighbourhood groups with an educational attainment of university or higher were estimated to be 28%

(95% CI, 6%-43%) less likely to meet these guidelines compared to women, who were an estimated 12% (95% CI, 2%-23%) less likely to meet HHS physical activity guidelines.

Lastly, NEWS scores were associated with meeting HHS guidelines for women but not men. Every increase in score on the NEWS was associated with an estimated 57% increase in the odds of meeting HHS guidelines, meaning that the more women rated their neighbourhoods as walkable, the more likely they were to meet these guidelines. The association between NEWS score and meeting HHS guidelines was not statistically significant for men; therefore, neighbourhood walkability was not considered a potential determinant for men meeting these guidelines.

5.9.4 Assessment of fit

The fit of the two-level logistic regression model for meeting HHS guidelines was found to be acceptable. As previously noted, the LR test comparing the deviance between the two-level model and ordinary one-level logistic regression model that did not incorporate neighbourhood effects was statistically significant, indicating that the two-level model for meeting HHS physical activity guidelines were appropriate to the data (Collett, 2003; Snijders and Bosker, 1999). In addition, no influential outliers were found in the data, assessed by examining the plots of deviance residuals versus the fitted values for each of the sex-specific models for meeting HHS guidelines.

Lastly, the ability of each model to predict whether or not an individual met HHS guidelines based on the observed outcome of meeting these guidelines was assessed. The proportion of women correctly predicted to meet HHS guidelines by the two-level model for women was 68%. The proportion of men correctly predicted to meet these guidelines

by the male specific two-level logistic regression model estimated was 66%. Therefore, the sex-specific two-level logistic regression models estimated for meeting HHS guidelines were a reasonably good fit to the data and were considered a valid representation of the associations between the potential determinants and meeting HHS physical activity guidelines for both men and women.

Chapter Six: Discussion

This study used three sets of physical activity guidelines with increasing levels of activity to examine if a sample of Albertans were sufficiently active to achieve general health benefits and, more specifically, cancer prevention. The physical activity guidelines put forth by the Public Health Agency of Canada (PHAC) were used as a minimum measure of physical activity for general health benefits. The guidelines from the American Cancer Society (ACS) recommended higher activity levels than PHAC with the specific focus of achieving adequate physical activity for reduction of cancer risk or cancer prevention. Lastly, the U.S. Department of Health and Human Services (HHS) recommended the highest levels of physical activity of the three guidelines and was most concerned with chronic disease prevention, including cancer, and weight management. In addition, this study investigated the potential individual, social and neighbourhood environment determinants of achieving sufficient physical activity to meet each of the three guidelines.

6.1 Physical Activity in Alberta

Approximately 85% of Albertans 38 to 64 years old were estimated to meet PHAC guidelines through leisure, occupation and transportation activity, from 2001 to 2005. There are currently no other estimates for Alberta nor for meeting PHAC physical activity guidelines based on occupational, active transport and leisure activities with which to compare these results. However, the Canadian Community Health Survey (CCHS) provides an estimate for the proportion of the population meeting PHAC guidelines in Alberta. The CCHS is conducted by Statistics Canada and began in 2000

(Statistics Canada). It consists of a series of nationwide cross-sectional surveys that provide information on health determinants, health status and health system utilization for the Canadian population. Prior to 2007, data were collected every two years from a large sample of respondents and designed to provide reliable estimates at the provincial and health region level (Statistics Canada). In 2003, the CCHS Cycle 2.2 (CCHS 2.2), provided estimates for physical activity by province (Statistics Canada). For Alberta, 52% of residents aged 35 to 65 years were estimated to be physically active at levels recommended by PHAC (Statistics Canada, 2009). In comparison, the current study estimated that 64% of Albertans were sufficiently active to meet PHAC guidelines. This difference in estimates exist even though the estimate was adjusted for age, sex, income and educational attainment, suggesting that the study sample differs from the Alberta population in other factors that need to be adjusted for when estimating a population prevalence for physical activity. Given that participating in physical activity is a complex behaviour, this result is not surprising. The higher estimate derived from this study could also be attributed to a “healthy enrolee” effect. More than 60% of the study sample rated their health as very good or excellent and the sample had a lower prevalence of diabetes than the general population: 3.8% compared to 4.9% for Albertans (Statistics Canada, 2009). The prevalence of daily smokers among study participants was also substantially lower than in the Alberta population. Overall, participants appeared to be healthier than the general Alberta population and may have been more likely to participate in healthy lifestyle behaviours, including physical activity.

However, it is important to consider the differences in how leisure physical activity was measured in the CCHS and in the current study. The CCHS 2.2 questionnaire

measured physical activity utilizing a multi- part item that asked respondents to report the number of times they participated in leisure activities from a given list of moderate and vigorous leisure activities over the past three months and the duration of each session in each activity in 15 minute increments. In contrast, the current study utilized the PYTPAQ to measure leisure activity over the past year using a more detailed approach. In the PYTPAQ, respondents were given a more comprehensive list of possible physical activities and were asked to list which activities they participated in and the duration, frequency and intensity of each session of activity over the past 12 months. It is possible that this detailed approach and longer time reference may have provided a more accurate estimate of leisure physical activity in the PYTPAQ and resulted in a higher estimate of the proportion that met PHAC guidelines trough leisure activity in the current study.

6.2 Defining Physical Activity for Meeting Guidelines

The current study included leisure as well as active transport and occupational activity in the estimate of physical activity that was used to estimate meeting or not meeting physical activity guidelines. This approach was taken because in the recommendations made by PHAC, ACS and HHS it was emphasized that adults should incorporate physical activity into their daily routines by including activities done at home, for transport and in the workplace. Therefore, including all possible types of activities was warranted for the purposes of obtaining estimates of physical activity participation as communicated to the public by the three sets of guidelines.

A considerable proportion of participants were found to participate in household activities for at least 2 hours per day in both Phase 1 and Phase 2. This is evidenced by

the estimate that a vast majority of participants were found to meet physical activity guidelines when household activity was included with leisure, occupation and transportation activities. The high estimates of household activity could be attributed to the fact that the majority of daily household activities that participants were most likely to report fall within the lower range of moderate intensity (3-4 METs) (Ainsworth et al., 2000). However, established evidence for the protective effects of physical activity on cancer risk suggests that significant cancer risk reductions reduction for breast, colorectal, prostate and endometrial cancers occurs when physical activity is undertaken at higher intensities (Friedenreich and Cust, 2008; Monninkhof et al., 2007; DHHS, 2008; Wolin et al., 2009; WCRF/AICR, 2007). Moreover, an association between physical activity and a decrease in inflammatory biomarkers, which have been associated with increased cancer risk, has been found for moderate and vigorous leisure, occupation and transportation activities but not for household activities (Autenrieth et al., 2009). This may reflect that few household activities are performed at vigorous intensities (Autenrieth et al., 2009). As a result, household activities were excluded from the estimate of physical activity used to determine compliance with physical activity guidelines (Autenrieth et al., 2009).

Leisure, occupation and transportation activities were combined to provide an estimate of participation in physical activity. Such a definition for physical activity is in contrast to a large number of studies that have focused exclusively on either leisure activity or occupational activity for cancer risk reduction purposes (Friedenreich and Cust, 2008; DHHS, 2008; Wolin et al., 2009; WCRF/AICR, 2007). The strongest evidence for reduction in premenopausal and postmenopausal breast cancer risk has been

from cohort and case-control controls studies of leisure activity (Friedenreich and Cust, 2008; DHHS, 2008; WCRF/AICR, 2007). Reduction in breast cancer risk has also been consistently associated with occupational activity, especially when comparing active and sedentary occupations (Friedenreich and Cust, 2008; DHHS, 2008; WCRF/AICR, 2007). Similar evidence from numerous cohort and case-control studies exists for colon cancer, with even more evidence for colon cancer risk reduction as a result of occupational activity (DHHS, 2008; Wolin et al., 2009; WCRF/AICR, 2007). The evidence for an association of risk reduction for breast and colorectal cancers with total physical activity (combination of leisure, household, occupation and transport activities) is weaker. Fewer studies have examined total physical activity as a protective factor for breast and colorectal cancers than leisure or occupational activity alone (Monninkhof et al., 2007; DHHS, 2008; Wolin et al., 2009). In addition, the evidence for an association between total physical activity and breast and colorectal cancer risk reduction is mixed and less convincing. Only three out of 11 cohort studies reported statistically significant risk reductions in colorectal cancer (DHHS, 2008). For breast cancer, two out of four cohort studies and 5 out of 11 case-control studies have found statistically significant risk reductions associated with total physical activity (DHHS, 2008).

Combining leisure, occupation and transportation activities to estimate physical activity in the current study is an approach not previously taken. As such, this definition of physical activity should be taken into account when interpreting the data. Since the evidence for cancer risk reduction has been primarily associated with leisure activity, there is a possibility that combining leisure, occupational and transportation activities to measure compliance with physical activity guidelines for cancer prevention may

overestimate such compliance and may not reflect how the guidelines were conceptualized. Although all three guidelines recommend that physical activity be incorporated into all domains of life, including leisure, household, occupation and transportation, it is possible that the conceptualization of the guidelines was based primarily on increasing leisure activity. This possibility is may be likely given that the evidence for cancer risk reduction is largely based on the assessment of leisure activity and that leisure activity is the most modifiable type of activity. In addition, HHS guidelines for cancer prevention through weight loss and management are largely based on observational and intervention studies examining leisure and exercise activity (DHHS, 2008).

However, there is increasing interest in measuring all physical activities and incorporating all activity types in estimates of physical activity behaviour. Focusing solely on leisure or occupational activity may only be valid for younger and healthier individuals, who are more likely to participate in structured leisure activities and to be employed in active occupations (Pettee et al., 2009). On the other hand, women and older adults are more likely to accumulate moderate physical activity through household activities and through walking (Pettee et al., 2009). In response, a combination of leisure, occupation and transportation activities may provide a more comprehensive measure of physical activity in this population, which includes men and women, aged 35 to 65 years. Given the strength of evidence for the protective effects of leisure and occupational activity on cancer risk, a combination of these activity types into one physical activity estimate is still relevant to cancer prevention.

As physical activity research moves towards including all types of activity for estimating physical activity levels, it is increasingly important that population estimates also do the same. The current study provides one of the first estimates, aside from the Tomorrow Project, of physical activity in Alberta within the context of current national physical activity guidelines that include physical activity types beyond leisure activity.

There were no reports in the literature regarding estimates of physical activity for Albertans or Canadians in general within the context of physical activity guidelines related to cancer prevention, such as those set by the ACS and HHS. This study is the first to examine physical activity levels sufficient for cancer prevention among Albertans. Given that very little is known about physical activity behaviour at levels necessary for cancer prevention, there is a need to explore the associations between determinants identified in previous research and achieving physical activity levels for cancer prevention. Once these determinants are identified, it will be possible to begin to conceptualize and design strategies to improve physical activity specifically for cancer prevention.

6.3 Meeting Physical Activity Guidelines

6.3.1 Overview

The three physical activity guidelines considered, from least to most demanding, were the guidelines set forth by PHAC, ACS and HHS. As expected, the proportion of participants who met each guideline was correlated with the levels of activity required to meet each guideline. The PHAC guidelines were met by the largest proportion of participants and HHS guidelines were met by the smallest proportion of the sample,

likely because levels of physical activity required to meet HHS guidelines were roughly double the amount of physical activity required to meet PHAC guidelines. Thus, to participate in sufficient levels of physical activity to meet HHS guidelines participants had to make a larger time and behavioural commitment than they did for meeting PHAC guidelines.

While the decreasing trend for the proportions that met PHAC, ACS and HHS guidelines were consistent in Phase 1 and Phase 2 of this study, the proportions that met each of the guidelines were consistently higher for the Phase 1 sample than for the Phase 2 sample. This difference may have been attributed to a number of reasons. First, physical activity was measured using a different instrument in each Phase: Phase 1 used the PYTPAQ and the IPAQ was used in Phase 2. While both of these instruments are valid and reliable, they each measured physical activity using a different time reference (Craig et al., 2003; Friedenreich et al., 1998). The PYTPAQ, participants were asked to recall their physical activities over the past year, while the IPAQ required respondents to recall their activity over the past seven days. A difference in the time period for recall would have resulted in a difference in the measure of physical activity given that recall error is likely to be greater for recall periods farther in the past.

In addition, the PYTPAQ was more likely to reflect usual activity patterns, while the short time frame of the IPAQ may be more influenced by seasonal variation, acute illness, or time constraints (Pereira et al., 1997). Participants completed the IPAQ in the late summer and fall, typically a time of the year when people are preparing to return to work and school after the summer holidays. If seasonality made a difference in reporting,

then participants may have reported less activity than if they had completed the IPAQ in the summer months (Pereira et al., 1997).

Lastly, there may have been a decrease in physical activity for Albertans between Phase 1 and Phase 2. The CCHS in 2008 estimated a decrease in leisure physical activity among Canadians (Statistics Canada, 2009). For Albertans, 49% were considered physically active at PHAC recommended levels, compared to 52% in 2003, considering leisure activity only (Statistics Canada, 2009). However, the decrease seen in the current study between Phase 1 (2001-2005) and Phase 2 (2008) estimates was much more pronounced. In Phase 1, 81% met PHAC guidelines, 72% met ACS guidelines and 59% met HHS guidelines compared to 74%, 63%, and 48%, respectively, in Phase 2. Therefore, while a decrease in leisure physical activity in the time period between data collection for Phase 1 and for Phase 2 may have occurred, it probably accounts for a small amount of difference. These results suggest Albertans may also be decreasing their physical activity at work and for transportation purposes, thus resulting in a drop in physical activity between the two time periods. More research needs to be done to determine change in physical activity behaviour over time in this population and monitoring of physical activity at the population level including all types of activities is needed.

Regardless of the differences, the trends across guidelines were the same for both phases of the study: the PHAC guidelines were the guidelines met by the largest portion of the sample, followed by the ACS guidelines, and the HHS guidelines were met by the lowest portion of the study samples, regardless of sex or age. This trend highlights the need to focus on increasing physical activity levels to levels sufficient for cancer

prevention. To be able to do so, it is important to identify the determinants that influence physical activity behaviour, especially at the levels relevant to cancer prevention.

6.3.2 Over view of Meeting PHAC Guidelines

The physical activity guidelines from PHAC are the guidelines that have been consistently communicated to Canadians since 1998 (Sharratt and Hearst, 2007). Therefore, it is likely that the physical activity levels recommended by PHAC are what Canadians aiming to be active are striving to achieve for health benefits. Taken together with the fact that these guidelines require the least amount of physical activity of the three guidelines being considered, it is not surprising that these guidelines were much more likely to be met than the ACS or HHS guidelines.

While there were no differences in the proportion of women and men who met PHAC guidelines, there were sex differences in the potential determinants of meeting these guidelines. Sex differences in potential determinants of physical activity were expected and have been widely reported for individual, social and neighbourhood determinants (Bengoechea et al., 2005; Eyler et al., 1999; Phongsavan et al., 2007; Sallis et al., 1992; Sorensen and Gill, 2008; Troped and Saunders, 1998). Women who were more likely to meet PHAC guidelines were non-smokers, had a sense of physical activity self-efficacy, planned for physical activity as part of their schedules, and reported having been physically active for the past six months (corresponding to being in the maintenance stage of change). Women were also more likely to meet these guidelines if they received physical activity-related social support from their family and had a companion to do physical activity with. Similarly, men who did not smoke daily, incorporated physically

activity into their schedules and reported being active for the previous six months were also more likely to meet PHAC guidelines. No social support or other social factors were found to be potential determinants for men meeting these guidelines, implying that at lower levels of physical activity, social factors influence physical activity only in women. However, men who were obese were significantly less likely to meet these guidelines than their normal weight counterparts, while weight status was not a potential determinant for women.

Differences in the potential determinants of meeting PHAC guidelines were also found. Although incorporating physical activity into one's schedule and being in the maintenance stage of change were potential determinants of meeting PHAC guidelines regardless of age, there were other potential determinants that varied by age. Participants in the 38 to 48 years age group were more likely to meet these guidelines if they did not smoke daily, and had familial support for physical activity. In contrast, those in the 49 to 55 year age group were more likely to meet these guidelines if they had a companion for physical activity; social support for physical activity was not a potential determinant for this age group. However, social support from family was also a potential determinant for meeting PHAC guidelines for participants in the 56 to 64 age group, along with having a companion for physical activity, suggesting that having a positive social environment for physical activity is especially important for adults in this oldest age group. In addition, participants in the oldest age group who were obese were also the least likely to meet PHAC guidelines compared to their normal weight counterparts, although obesity was not a potential determinant for meeting PHAC guidelines for the other age groups. A more detailed discussion of the potential determinants identified follows in Section 6.3.

6.3.3 Overview Meeting ACS guidelines

ACS guidelines recommend higher levels of physical activity than PHAC guidelines and are based on levels sufficient for reduction of cancer risk. In contrast to PHAC guidelines, ACS guidelines have not been widely recommended to Canadians. In fact, the Canadian Cancer Society refers to PHAC physical activity guidelines in all of its public communication materials to promote cancer prevention (Canadian Cancer Society, 2009). It is unlikely that adults in this sample were familiar with these recommendations for higher levels of physical activity to reduce cancer risk, and therefore, unlikely that these recommendations are being used as a benchmark for being physically active by most adults. Lack of awareness and the fact these guidelines require more physical activity likely account for the decrease in the proportion of the sample that met ACS guidelines compared to PHAC guidelines.

Notably, there were some differences in the potential determinants of meeting ACS guidelines compared to those for meeting PHAC guidelines. Scheduling and planning for physical activity and having been physically active over the past six months were potential determinants for meeting ACS guidelines, as they were for meeting PHAC guidelines. For women, self-efficacy also remained a potential determinant of meeting ACS guidelines. However, smoking and social support from family were no longer potential determinants for meeting ACS guidelines for any sex or age group. However, having a companion to do physical activity with was a potential determinant of meeting ACS guidelines for women and for the middle and oldest age groups, although the influence of having a companion was less on meeting ACS guidelines than PHAC

guidelines for women but higher for those in the oldest age group. Having a companion for physical activity provides a social environment that both supports physical activity behaviour and provides social interaction and this aspect may be a stronger motivator at higher levels required for cancer prevention.

In addition, having a heart problem and having cardiovascular problems were found to be potential determinants for meeting ACS guidelines for women and men, respectively, although no chronic health conditions were associated with meeting PHAC guidelines. Women who had a heart problem were sufficiently less likely to meet ACS guidelines, perhaps owing to physical limitations on the levels of physical activity that they may be able to participate in because of their condition. On the other hand, men who reported being diagnosed with cardiovascular problems were more likely to meet ACS guidelines than their counterparts. This may reflect an increase in physical activity among men in an effort to reduce their blood pressure and cholesterol levels either directly, or through weight loss, perhaps due to physician recommendations.

Achieving physical activity levels sufficient to meet ACS guidelines requires an increased time commitment and increased motivation than for meeting PHAC guidelines. First and foremost, Albertans should be made aware of these guidelines and the benefits of reducing cancer risk that they confer as one method to increase motivation to participate in physical activity at these higher levels. Therefore, promoting physical activity at levels relevant for cancer prevention will require increasing knowledge about these recommendations among Albertans, as well as a focus on self-efficacy and positive social environments for physical activity through companionship for women, specifically.

6.3.4 Overview of Meeting HHS guidelines

The HHS guidelines recommend the highest level of physical activity among the three guidelines considered in this study. Moreover, these guidelines differ according to weight status with the highest levels of activity recommended for adults who are overweight or obese (USDHHS and USDA, 2005). These guidelines have a strong focus on health benefits and chronic disease prevention through weight loss and maintenance. As such, these guidelines are very relevant to cancer prevention, not only because of a direct benefit from physical activity on cancer risk, but from indirect effects through weight control (USDHHS and USDA, 2005). Given that these guidelines are relatively new and were released by a U.S. institution for consumption by the U.S. public, adults in Alberta would not be expected to have knowledge of HHS guidelines. However, the recommendations from HHS for weight loss are consistent with Canadian clinical practice guidelines for obesity management and prevention for adults (Lau et al., 2007). These guidelines form the basis of physician recommendations to overweight and obese patients for weight loss in Canada.

Given that these are the most demanding guidelines being considered, it is not surprising that these guidelines were the least likely to be met compared to PHAC and ACS guidelines. As with the other guidelines, men were more likely to meet HHS guidelines than women. Interestingly, the proportion of adults in this sample that met these guidelines increased with increasing age. These findings contradict previous research that has found a decrease in physical activity with increasing age (Brownson et al., 1996; King et al., 2000; Nies and Kershaw, 2002; Seefeldt et al., 2002; Trost et al., 2002). It is possible that older participants enrolled in the Tomorrow Project were more

physically active then samples from other studies. The study sample was also generally healthy, with only 5% of people in the oldest age group rating their health as fair or poor. In addition, participants who reported physical limitations for physical activity were excluded from the analyses, thereby producing a sample more physically able to participate in physical activity than in studies where such exclusion criteria was not explicitly applied (Brownson et al., 1996; King et al., 2000). Alternatively, these results may reflect a change of life conditions with age. Participants in the oldest age group who met these guidelines reported fewer hours of occupational activity and more time spent in active transport and leisure activities than participants in the younger age groups. Perhaps older adults are decreasing their work-related commitments and have more time to devote to physical activity, since more than a quarter of the oldest age group was comprised of retirees and this age group also had the highest proportion of those employed part-time.

The potential determinants for meeting HHS guidelines were different than for meeting either PHAC or ACS guidelines, with a stronger focus on psychological and neighbourhood environment factors. Self-efficacy was a potential determinant for meeting these guidelines regardless of sex or age; not just for women as found for meeting PHAC or ACS guidelines. In addition, the influence of the benefits and drawbacks of physical activity on the decision to be active was a potential determinant for HHS guidelines and not for the other guidelines. The influence of the benefits of physical activity was a potential determinant for men only, and the influence of the drawbacks of physical activity was a potential determinant for men, women, and adults 49 to 64 years of age. Most notably, having social support for physical activity from friends was a potential determinant for meeting these guidelines for both men and women

and for those in all three age groups. Not surprisingly, overweight and obesity were negatively associated with meeting these guidelines regardless of sex or age.

Interestingly, participating in sufficient activity to meet HHS guidelines was influenced by neighbourhood characteristics for men and women, while neighbourhood environment did not have an impact on meeting PHAC or ACS guidelines. Specifically, participants who lived in neighbourhoods where most residents had earned a college degree or higher were less likely to meet HHS guidelines than those who lived in neighbourhoods with an educational attainment of high school diploma or lower. Moreover, living in a more walkable neighbourhood was positively associated with meeting HHS guidelines for women, but not for men. This general overview indicates neighbourhood environment becomes an important factor for achieving high levels of physical activity. Potential neighbourhood determinants of meeting these guidelines will be explored more in-depth in Section 6.3.

The recommended levels of physical activity to meet HHS guidelines require the most time and behavioural commitment of all three guidelines. Once again, communicating these guidelines and their benefits to Albertans should be the first step to increasing physical activity to these higher levels. In addition, these results suggest that there is an increased need to focus on facilitating factors such as self-efficacy, decisional balance, and creating a positive social environment for physical activity to help adults achieve these high levels of physical activity. Lastly, efforts to increase physical activity to these levels will also need to consider the neighbourhood environment as an important component.

6.3.5 Occupational, active transport and leisure activity differences

There was a notable difference between men and women and across age groups in how much time was spent in occupational, active transport and leisure activity each week. In general, men participated in higher amounts of occupational physical activity than women. Occupational activity contributed the largest portion of time spent in moderate and vigorous activity for men for meeting PHAC, ACS, and HHS guidelines and this portion was highest for meeting HHS guidelines. However, men and women who met PHAC and ACS guidelines participated in the similar amounts of active transport and leisure activity. Occupational activity may be an important contributor to physical activity levels in men more so than in women. Interestingly, women who met HHS guidelines participated in more leisure activity than men. These results suggest workplace interventions aimed at increasing daily physical activity may be especially beneficial to women and for achieving high levels of physical activity interventions to increase leisure activity may be especially beneficial for men. Efforts to increase active transport should also be considered, since the lowest portion of time spent in physical activity was devoted to active transport.

Participants in the 56 to 64 year old age group who met each of the three guidelines participated in the least amount of occupational activity but in the highest amounts of active transport. Notably, participants in the oldest age group who met HHS guidelines participated in greater amounts of leisure activity than the two younger age groups. These results suggest individuals older than 55 may be devoting less time to their jobs and more time to other types of activities. If this observation is made, then efforts to increase physical activity in the workplace are likely to be better suited to adults up to 55

years of age, at which point the focus should shift to increasing other types of activities, such as active transport and leisure activities. These results may also reflect the large proportion of those employed part-time and retirees in the oldest age group.

6.4 Potential Determinants of Meeting Physical Activity Guidelines for Cancer Prevention

To increase physical activity levels in Alberta to levels sufficient for cancer prevention, it is important to identify the potential determinants of achieving these levels of physical activity. A number of potential individual level, social and neighbourhood environment determinants were identified for meeting PHAC, ACS and HHS guidelines as summarized in the previous section. A special focus on the potential determinants of engaging in physical activity levels sufficient for meeting ACS and HHS guidelines is warranted to identify potential targets for cancer prevention strategies.

6.4.1 Educational attainment

Educational attainment was inversely associated with meeting HHS guidelines, but only in Phase 1 of this study. Phase 1 participants with an education beyond a University degree were significantly less likely to meet these guidelines. These findings are contradictory to the positive association found between higher educational attainment and physical activity in other studies (Booth et al., 1993; King et al., 2000; Prochaska et al., 2001). However, previous research has been largely based on leisure time activity alone. In this study, the inverse relationship between educational attainment and physical activity behaviour may be attributed to the fact that time spent in occupational activity

accounted for 76% of the total time spent in moderate and vigorous physical activity for those who met HHS guidelines. Since individuals with higher educational attainment are more likely to hold jobs in sedentary occupations, such as in management or executive positions, they are likely to participate in less overall physical activity then their lower educated counterparts (Cerin and Leslie, 2008). Interestingly, educational attainment was not a potential determinant for meeting guidelines with lower levels of physical activity recommendations, perhaps also indicating that occupational activity is important for achieving overall levels of physical activity at the highest levels for cancer prevention.

6.4.2 Overweight and obesity

Obesity was significantly associated with being less likely to meet ACS guidelines for cancer prevention in men and those in the oldest age group, but not women. Research in other populations has also found an inverse relationship between obesity and physical activity; however few explore sex or age differences in this association (Besson et al., 2009; Brownson et al., 2000; Lahti-Koski et al., 2002; DHHS, 2008). Moreover, there is inconsistency between studies that have explored gender differences as some have found a stronger association between physical activity and obesity in women, while others have not observed this relationship between weight status and sex (Ball et al., 2001; Besson et al., 2009; Westerterp and Goran, 1997). The results from this study support an association between physical activity and obesity for men but not for women at the lowest levels of physical activity required for cancer prevention, as recommended by ACS.

However, both men and women who were either overweight or obese were significantly less likely than normal weight individuals to meet HHS physical activity guidelines. Similarly, obese individuals in all three age groups were also less likely to meet these guidelines. Given that these guidelines are especially demanding for those who are overweight or obese, as these individuals are required to participate in higher levels of physical activity then normal weight adults to meet these guidelines, these results are not surprising. A possible explanation is that obese individuals are physically unable to participate in one hour of physical activity per day, or that major lifestyle changes required for these levels of activity to be achieved are very challenging for obese individuals. This explanation is supported by findings that overweight and obese individuals are less likely than normal weight adults to adhere to physical activity programs, even those who involve only walking (Dishman and Sallis, 1994; Levine et al., 2008). In addition, participating in such high levels of physical activity may be especially challenging for obese individuals and may result in pain or discomfort. Emotional or physiological stimulation influences feeling of self-efficacy; therefore, negative experiences may lead to a decreased sense of self-efficacy (De Bourdeauhuij and Sallis, 2002). Since self-efficacy is strongly associated with physical activity, negative affects that decrease self-efficacy could result in a decreased likelihood of participating in physical activities (Bengoechea et al., 2005; Besson et al., 2009; De Bourdeauhuij and Sallis, 2002; Nies and Kershaw, 2002; Trost et al., 2002). Alternatively, these results may reflect that adults who participate in sufficient levels of physical activity to meet HHS guidelines are more likely to be normal weight because participating at these levels of

physical activity aids in weight loss and protects them from unhealthy weight in the first place (Bensimhon et al., 2006; Fox and Hillsdon, 2007; Lau et al., 2007; DHHS, 2008).

It appears that when higher levels of physical activity are considered, overweight and obesity are important potential determinants of physical activity, especially at higher levels required for cancer prevention and weight control, regardless of sex or age. In addition, obese men and obese adults over the age of 55 are the most likely to be inactive at any level of physical activity. Taken together, these findings indicate cancer prevention strategies that involve increasing physical activity may need to be tailored to the needs of the subgroup of the population who are overweight and obese.

6.4.3 Cardiovascular and heart problems

Of the chronic conditions considered, only cardiovascular and heart problems were found to be potential determinants of physical activity in this study. Interestingly, diabetes was not identified as an important potential determinant of physical activity in this study, contrary to other physical activity studies that have found that diabetics are less likely to participate in physical activity than non-diabetics (Di Loreto et al., 2003; Grace et al., 2007). This study sample was relatively healthy and the prevalence of diabetes was low, 4.2% compared to 5.3% for the Alberta population (Alberta Diabetes Survaillance System, 2008). It is possible that diabetics in this study sample were less likely to suffer complications and comorbidities related to diabetes, which can limit a diabetic’s participation in physical activity. Alternatively, these results may be a statistical artefact that resulted from a lack of power to detect potential associations between diabetes and meeting physical activity guidelines in a sample with such low

prevalence of diabetes. Since physical activity plays a major role in diabetes management and symptom improvement, interventions to increase physical activity among diabetics is warranted in this population and further research should be conducted among Albertans to confirm these findings.

Cardiovascular problems, which included high blood pressure and/or high cholesterol, were associated with meeting both guidelines relevant to cancer prevention in this study. Cardiovascular problems were a potential determinant for meeting HHS guidelines in Phase 1, which considered far fewer psychosocial potential determinants than Phase 2 and did not assess sex differences. However, having cardiovascular problems was a potential determinant for meeting ACS guidelines for men only. It is possible that these discrepancies in results occurred because Phase 2 included a number of other potential determinants whose influence on physical activity behaviour may be more direct potential determinants for meeting HHS guidelines. In addition, stratification by sex in Phase 2 allowed for the association in men to be observed, which may have been obscured in the non-stratified analysis done in Phase 1.

Physical activity is a recommendation made to patients with cardiovascular conditions by physicians. Physical activity for weight loss is also recommended by physicians to their overweight/obese patients because they are at increased risk for cardiovascular complications (Lau et al., 2007). Given that cardiovascular problems were more likely for men in this sample, it could be that physician recommendations for physical activity are higher among this group and thus men are more likely to participate in physical activity as a result. These results may also reflect increased motivation for physical activity among this group to avoid adverse complications that may result from

uncontrolled blood pressure and cholesterol. However, these motivators may not be strong enough to encourage levels high enough to meet the most demanding guidelines.

Unfortunately, women who reported having heart problems were less likely to meet guidelines recommended for cancer prevention by ACS, suggesting that having a heart problem is a barrier to physical activity for women but not for men. Women in this sample were 1.5 times more likely to report having been diagnosed with a heart problem than men, thus the association between having a heart problem and meeting ACS guidelines was more important for women. It is also possible that women with heart problems may be more limited than men with heart problems with regards to participation in physical activity.

6.4.4 Scheduling and planning

Self-regulation is a component of the Social Cognitive Theory for behaviour change. Self-regulation involves skills key to achieving physical activity goals, such as planning, organizing and managing physical activities (Rovniak et al., 2002). Similar to a limited number of other studies, scheduling and planning physical activities was a potential determinant for meeting physical activity guidelines relevant for cancer prevention (Anderson et al., 2006; Rovniak et al., 2002). Scheduling and planning was important for both men and women for meeting ACS guidelines and for all three age groups. Individuals who plan their physical activities into their schedules are far more likely to do physical activity than those who do not (Anderson et al., 2006; Rovniak et al., 2002). When physical activity is a priority and is planned for as part of an individual's schedule, it is more likely to happen. Interestingly, the relationship between scheduling

and planning and meeting ACS guidelines was somewhat stronger for men than for women. Time constraints and other commitments have been cited as barriers to physical activity more frequently by women than men (Barrett et al., 2007; Brownson et al., 2000; De Bourdeauhuij and Sallis, 2002; Sorensen and Gill, 2008). Therefore, it is possible that even though physical activity may be a priority and may be planned or made part of their schedule, there may other competing factors that prevent women from following through with planned physical activities. However, there are no previous findings exploring sex differences in scheduling and planning specifically to either support or inform these findings.

Interestingly, scheduling and planning was a potential determinant for meeting the most demanding guidelines only for women. These higher levels of physical activity are also those clinically recommended for weight loss (Lau et al., 2007). Since women are more concerned with weight loss than men, women who set this level of physical activity as part of their schedules may be likely to do so as part of a weight loss priority. In addition, given that Albertans are unlikely to know about HHS guidelines and are, therefore, unlikely to be striving to participate at these higher levels of physical activity, men may not be formally scheduling sufficient amounts of physical activity to meet these guidelines. Alternatively, men are more likely to meet HHS guidelines through occupational activity; therefore scheduling and planning for physical activity is not an important potential determinant for men participating in levels of physical activity sufficient to meet HHS guidelines. However, if the goal is to increase leisure activity in men, scheduling and planning may be an important factor to consider.

These results suggest setting time aside specifically for physical activity facilitates physical activity among adults at levels recommended for cancer prevention. Additionally, scheduling and planning physical activity may help women achieve higher levels of physical activity for cancer prevention through weight management. However, for all others, planning physical activity into one's schedule may facilitate physical activity to some extent but achieving higher levels of physical activity may be more dependent on motivational factors and factors that facilitate participating in physical activity beyond just planning.

6.4.5 Physical activity self-efficacy

Self-efficacy measured participants' confidence to be physically active in a number of different scenarios that may be considered challenging. It is considered the primary determinant of behaviour by the Social Cognitive Theory (Baranowski et al., 2002). Self-efficacy was a predictor of physical activity in this study, in accordance with various other studies (Nies and Kershaw, 2002; Plotnikoff et al., 2008; Rovniak et al., 2002; Yordy and Lent, 1993). Self-efficacy has also been previously found to be an important determinant of physical activity specifically among Albertans (Loitz et al., 2009). Notably, physical activity self-efficacy was an important potential determinant of physical for women to meet ACS and HHS guidelines, consistent with research showing the importance of self-efficacy in women's physical activity behaviour (De Bourdeauhuij and Sallis, 2002; Pan et al., 2009). However, self-efficacy was a potential determinant of meeting HHS guideline for men and women and for all age groups. These results highlight the importance of self-efficacy to achieve higher levels of activity, regardless of

sex or age. Confidence in being able to be active despite the presence of barriers is especially important at higher levels of physical activity because achieving higher levels of activity is more challenging and requires increased motivation and commitment (McAuley and Blissmer, 2000).

Alternatively, self-efficacy may have been associated with meeting HHS guidelines because being physically active increases self-efficacy. Previous research has found that self-efficacy is both a determinant and a consequence on physical activity (Buckworth and Dishman, 2002b; McAuley and Blissmer, 2000). Adults who initiate physical activity successfully gain confidence in their ability to be physically active, thus increasing their sense of self-efficacy leading to continued physical activity (McAuley and Blissmer, 2000). Given the bidirectional association between physical activity and self-efficacy, it is possible especially important to target self-efficacy as a point of intervention. Building confidence to overcome barriers related to higher levels of activity can help individuals who are insufficiently active for cancer prevention benefits initiate a change towards increasing their physical activity and also help maintain physical activity levels among those already active at levels recommended for cancer prevention.

Interestingly, self-efficacy has been shown to also influence physical activity behaviour indirectly through self-regulation. Higher levels of self-efficacy lead to increased self-regulation behaviour, such as scheduling and planning and goal setting, which leads to engagement in physical activity (Anderson et al., 2006; Baranowski et al., 2002; Plotnikoff et al., 2008; Rovniak et al., 2002). In this study, higher levels of self-efficacy in women who met physical activity guidelines for cancer prevention may have

lead to increased scheduling and planning of physical activity, thereby increasing their likelihood of meeting these guidelines.

6.4.6 Decisional Balance: Pros versus Cons

Decisional balance is a component of the Transtheoretical Model (TTM) of behavioural change. Applied to physical activity, the TTM describes adoption of physical activity as a process that occurs through a series of stages: precontemplation, contemplation, preparation, action and maintenance (Prochaska et al., 2001). Women tended to be in the preparation and action stages, while men were more likely to be in the precontemplation, contemplation and maintenance stages, similar to other studies that have noted that men tend to be either active or not while women seem to be in the process of change without being able to establish regular physical activity in the long term (Cardinal et al., 2009; Sorensen and Gill, 2008). Being in the maintenance stage was associated with meeting both guidelines relevant to cancer prevention, regardless of sex or age. These results are consistent with multiple findings of a correlation between physical activity and being in the maintenance stage of change (Cardinal et al., 2009; Marcus et al., 1994; Plotnikoff et al., 2001a; Plotnikoff et al., 2001b). Given the strong correlation between stages of change and physical activity behaviour, most studies use stage of change as a measure of physical activity behaviour and including stages of change as a potential determinant in a model for physical activity behaviour may seem tautological (Booth et al., 1993; Marcus et al., 1994; Sorensen and Gill, 2008). However, stage of change was included as a potential determinant for meeting physical activity guidelines to explore if this construct was indeed associated with higher levels of

physical activity as recommended by HHS. In the assessment of stage of change in the DPAQ questionnaire, participants were asked to identify which stage they were in with respect to being physically active. Being physically active was defined as participating in moderate activity at 30 to 45 minutes on at least 5 days per week. This definition is consistent with physical activity recommendation by PHAC and ACS but not HHS. In this case, investigating an association between stages of change and meeting physical activity guidelines for cancer prevention served to confirm previously reported correlations with physical activity behaviour, especially at higher levels as recommended by HHS, which were not indicated in the initial measure of stage of change in the questionnaire.

These results indicate that participants who had been active longer than six months were likely to participate in sufficient activity to meet ACS and HHS guidelines. Interestingly, being in the action stage of change was only associated with meeting ACS guidelines in women, indicating that women who were regularly active within the past six months were sufficiently active to meet these guidelines but not the more demanding HHS guidelines. Similarly, being in the action stage was also associated with meeting ACS guidelines for those in the middle and older age groups, but this may be attributed to the fact that these age groups had a higher proportion of women than the youngest age group. These results suggest achieving physical activity at levels recommended for cancer prevention takes practice and mastery that may occur only once regular physical activity has been established for some time. As such, those reporting being physically active at levels recommended by PHAC were increasingly likely to meet guidelines set by ACS and HHS. Self-efficacy may play a role. Individuals who are physically active

over time may develop an even greater sense of physical activity self-efficacy, and thus may be more able and motivated to participate in increasingly higher levels of activity (McAuley and Blissmer, 2000).

In physical activity behaviour, decisional balance reflects the balance of pros (advantages) and cons (disadvantages) of being physically active (Prochaska et al., 2001). As an individual moves through the stages of change, this balance shifts from the cons outweighing the pros in the early stages to the pros outweighing the cons in the action and maintenance stages (Marcus et al., 1994; Plotnikoff et al., 2001a; Prochaska et al., 2001). Perceived pros and cons related to decisional balance were potential determinants of meeting only the most demanding guidelines. These results may reflect that these levels of physical activity require more motivation and commitment than lower levels required to meet PHAC or ACS guidelines. Thus, at these higher levels the pros and cons of being active are more influential.

Interesting sex differences on the influences of the perceived pros and cons on physical activity were found. Both pros and cons were associated with meeting HHS guidelines among men. Not surprisingly, perceptions of more pros were associated with being more likely to meet these guidelines, while perceptions of more cons were associated with being less likely to meet these guidelines. However, only perceived cons of being physically active were associated with meeting HHS guidelines for women and those in the middle and older age groups. Men may be more motivated by the benefits of being physically active more so than women or simply more knowledgeable about the potential benefits of physical activity than women. Alternatively, these results may be attributed to women being more likely to perceive barriers to physical activity than men,

and as a result, women may be more influenced with the cons, or potential disadvantages, that reflect these barriers (Barrett et al., 2007; Pan et al., 2009; Ross, 2000; Sorensen and Gill, 2008). The perceptions of barriers such as lack of time, expense or discomfort related to physical activity may also increase a woman's perceptions of the cons of being physically active (Pan et al., 2009; Sorensen and Gill, 2008). For example, lack of time is both a barrier and a disadvantage to being active because being active will take time away from other activities or commitments. Lack of time could be especially pronounced for meeting HHS guidelines, which require a stronger time commitment than any other guidelines. Similarly, adults are more likely to perceive more barriers to physical activity with increasing age and seem to be similarly influenced by the perceived cons of being physically active (Sorensen and Gill, 2008).

The perception of the advantages and disadvantages to being physically active are important potential determinants of participating in sufficient activity for cancer prevention benefits. Increasing physical activity to the highest levels relevant for cancer prevention should include strategies to increase knowledge and perceptions of the advantages of physical activity and incorporate skill building to overcome perceived barriers to reduce their influence on the decision to adopt high levels of physical activity.

6.4.7 Social support for physical activity

Social support for physical activity is an important component of the social environment and has been found to be positively related to physical activity by a number of studies (De Bourdeauhuij and Sallis, 2002; Wendel-Vos et al., 2007). Social support for physical activity, assessed in Phase 2, was found to be a potential determinant of

meeting guidelines relevant to cancer prevention in this study; however, general social support, assessed in Phase 1, was not associated with physical activity behaviour. Social support specific to physical activity differs from general social support because it measures specific actions taken by significant others to facilitate physical activity specifically, such as giving someone a ride to an exercise facility, accompanying someone on a physical activity, or providing praise for being physically active (Eyler et al., 1999; Sallis et al., 1987). On the other hand, general social support measures the availability of support on a daily basis for general life situations (Sherbourne and Stewart, 1991). Since physical activity is a complex behaviour and requires specific motivators and facilitators and this general measure of social support does not incorporate any of these factors, it is not surprising that general social support was not found to be associated with meeting any of the three guidelines (Sallis et al., 1987).

Although social support has been well established as a determinant of physical activity, the effect of the source of social support has been less well studied (De Bourdeauhuij and Sallis, 2002; Wendel-Vos et al., 2007). Social support from family was not found to be a potential determinant of meeting either of the physical activity guidelines relevant to cancer prevention, but was found to be associated with meeting the guidelines for general health benefits recommended by PHAC for women and individuals in the youngest and the oldest age groups. It appears that, although familial support may play a role in physical activity behaviour, its influence may be limited and is not instrumental for achieving higher levels of physical activity recommended for cancer prevention.

Conversely, social support from friends was found to be a significant potential determinant for meeting HHS guidelines for both men and women and across all three age groups. It should be noted that social support from friends was identified as a potential determinant for meeting ACS guidelines for men and women by cross-validation but did not have a statistically significant association with meeting these guidelines. A lack of statistical association may have been attributed to a lack of statistical power. Although social support from friends cannot be said to be associated with meeting ACS guidelines in this study, this source of social support cannot be dismissed as a potential determinant of physical activity at ACS recommended levels and warrants further study.

One study investigating the sex differences in source of social support and physical activity attributed differences in sources of social support to ethnicity rather than sex (Treiber et al., 1991). However, previous research exploring social support as a determinant of physical activity did not assess at the levels for cancer prevention that were the interest of this study. The findings from the current study suggest social support from family influences physical activity at levels commonly recommended for general health benefits but that social support from friends is influential for achieving physical activity at levels for cancer prevention. Additional research is needed to elucidate the different effects of sources of social support on physical activity behaviour.

Social support is thought to influence physical activity through increases in self-efficacy (Anderson et al., 2006; De Bourdeauhuij and Sallis, 2002; Plotnikoff et al., 2008; Rovniak et al., 2002). As a result, individuals in a socially supportive environment are better able to overcome barriers to physical activity and have better self-regulation (Eyler

et al., 1999Rovniak, 2002 #383; Sallis et al., 1992; Treiber et al., 1991). Moreover, social support is important for adopting and maintaining a physically active lifestyle (Courneya et al., 2001). The findings from this study indicate that social support is an important potential determinant of physical activity at levels recommended for cancer prevention and that interventions for increasing physical activity to these levels will need to incorporate strategies that provide a socially supportive environment for physical activity. This may be especially relevant for strategies that aim to increase physical activity through self-efficacy.

6.4.8 Companionship for physical activity

Companionship for physical activity is another component of the social environment that has been shown to influence physical activity behaviour (Giles-Corti and Donovan, 2002a; Plotnikoff et al., 2004). Having a companion to do physical activity with was a potential determinant for being sufficiently active for cancer prevention benefits for women only. Similarly, companionship for physical activity was associated with meeting ACS guidelines for individuals in the 49 to 55 year old and 56 to 64 year old age groups, but this may be attributed to the fact that these age groups had the largest proportion of women, compared to the youngest age group. Having someone to do physical activity with may provide both a supportive environment in which to engage in physical activity and may serve as a motivating factor. Participating in activities with others provides opportunities for modeling skills, support in overcoming barriers, and additional encouragement to be physically active (McNeill et al., 2006). In addition, having companionship for physical activity may provide social contact and opportunities

for affiliation with others, which have been found to be motivators for physical activity (Carron et al., 1988; Reeve and Sickenius, 1994; Wankel and Berger, 1990). In fact, this social aspect of physical activity is more motivating for women than for men, supporting the findings that companionship for physical activity was a determinant for women and not for men.

Companionship for physical activity may be an important aspect of a supportive social environment for achieving physical activity levels sufficient for cancer prevention. Women, specifically, may benefit from interventions that incorporate opportunities for social interaction.

6.4.9 Neighbourhood environment: walkability and educational attainment

According to the ecological framework, neighbourhood environment contributes to the overall supportive or non-supportive environment for individual physical activity behaviour (Ross, 2000). Neighbourhood environment was found to influence engagement in sufficient physical activity for cancer prevention benefits at levels recommended by HHS but had no bearing on achieving physical activity sufficient to meet guidelines set by ACS. These results suggest neighbourhood environment is important for participating in high levels of physical activity, as recommended by HHS, because these higher levels require increased motivation that the neighbourhood environment may contribute to. Several studies have found a positive association between neighbourhood environment and physical activity but none have assessed the neighbourhood environment influence at these specific high levels of physical activity; instead using continuous measures of physical activity such as weekly time spent in physical activity (McNeill et al., 2006;

Saelens et al., 2003; Sallis et al., 1997). Further investigation of influence of neighbourhood environment on physical activity at higher levels than commonly recommended is also required (Giles-Corti and Donovan, 2002a).

Neighbourhood environment may influence physical activity in two ways. First, neighbourhoods provide structural facilities for physical activity, such as access to amenities within walking distance, walking or cycle paths, safety from crime and aesthetically pleasing environment that encourages residents to participate in activities outside their homes (Ross, 2000; Saelens et al., 2003). Secondly, the neighbourhood environment may foster certain cultural or normative beliefs that can encourage residents to be physically active. People are influenced by others around them, who can serve as role models for physical activity behaviour and can shape the normative beliefs about physical activity (Ross, 2000). A neighbourhood in which residents are physically active will foster a positive environment for physical activity because residents can be observed being physically active, thus modeling the behaviour for inactive residents and creating an environment where physical activity is the norm (McNeill et al., 2006; Ross, 2000). Much of the research to date on physical activity and neighbourhood environment has focused on the structural aspects and very little is known about the social influence of the neighbourhood environment on physical activity behaviour (McNeill et al., 2006).

6.4.9.1 Neighbourhood Walkability

Walkable neighbourhoods are those who have positive attributes that have been found to encourage walking, such as walking and cycling facilities, street connectivity, aesthetics, safety from traffic and safety from crime (Saelens et al., 2003).

Neighbourhood walkability was found to be a potential determinant of meeting physical activity levels recommended by HHS for women. This may reflect that women may be more likely to participate in walking than men; therefore, an environment that encourages walking influences physical activity levels in women (Azevedo et al., 2007; Barrett et al., 2007). In contrast, men who meet HHS guidelines were more likely than women to participate in occupational activity. Consequently, men achieving these guidelines are doing so largely through occupational activity, which is independent of neighbourhood environment. However, previous research suggests that men are also more likely to be physically active in walkable neighbourhoods (Leslie et al., 2005; Saelens et al., 2003). Therefore, neighbourhood walkability may be of benefit for increasing leisure time physical activity to levels recommended by HHS for both men and women, thus helping more men to meet these guidelines.

6.4.9.2 Neighbourhood educational attainment

Neighbourhood income and education are indicators of the socioeconomic context of neighbourhoods (McNeill et al., 2006). Previous research has found associations between neighbourhood deprivation, indicated by low socioeconomic standing, and low physical activity levels (Cubbin et al., 2001; McNeill et al., 2006; Sundquist et al., 1999). It is not clear why an association between neighbourhood income and meeting HHS guidelines did not emerge when other studies have reported this association (Fisher et al., 2004). However, these studies considered only walking and leisure activities (Cubbin et al., 2001; Humpel et al., 2002; Sundquist et al., 1999). Including occupational activity may have accounted for this difference, since there was a strong contribution of

occupational activity to total physical activity in the current study. Moreover, a lack of association between neighbourhood educational attainment and meeting guidelines may also reflect a lack of association between individual annual household income and meeting guidelines in this study, since individuals are likely to live in neighbourhoods that mimic their income status where they can afford housing costs.

An association was found between neighbourhood educational attainment and engaging in sufficient activity to meet HHS guidelines, but the association was the reverse of what was expected. Other studies have found residents of neighbourhoods with higher educational attainment are more likely to be physically active (Saelens et al., 2003; Wen et al., 2007). However, neighbourhood educational attainment was negatively associated with physical activity in the current study. Residents of neighbourhoods where median education was a college degree were the least likely to meet HHS guidelines, followed by residents of neighbourhoods with median educational attainment of a university degree or higher. These results may be attributed to the contribution of occupational activity to total physical activity. Physical activity is typically highest in occupations that require lower levels of formal education, which results in an inverse association between education and physical activity. Since individuals are likely to reside in neighbourhoods with others similar to themselves then this inverse association between physical activity and educational attainment may have extended to neighbourhood education in the current study (McNeill et al., 2006). It is unlikely that this inverse relationship would persist if only leisure activity was considered for measuring activity levels. This will be a direction for future study.

6.5 Study Strengths and Limitations

This study had some limitations that should be considered. Firstly, the study design was cross-sectional. Given that temporality cannot be established, none of the associations found can be interpreted as cause and effect. However, the associations reported still serve to identify factors that warrant further investigation and may be important intervention targets.

All data used regarding physical activity and psychosocial explanatory variables were collected by self-report. Self-report can be problematic as it can be subject to recall error and social desirability bias, which can lead to measurement error. Previously validated instruments to measure physical activity and all other variables were used to minimize potential measurement error, although measurement error could not be completely eliminated. In addition, all of the data regarding physical activity determinants identified in the literature were was collected on one questionnaire (DPAQ) that did not include a time reference relevant to HHS guidelines. To include such a time reference was not feasible given that these guidelines are BMI dependent, and would have required a separate questionnaire.

Social desirability bias may have also been reduced since participants were not asked to report any self-identifying information (names, addresses, birthdates) on the questionnaires and since their identity was linked to barcodes attached prior to delivery. Any social desirability that may have occurred may have lead to over reporting of physical activity. Over-reporting of physical activity may have resulted in attenuation of associations with potential determinants through misclassification. Misclassification

would have included those who were not truly physically active with those who were truly active into groups that were classified as meeting each of the guidelines.

Recall error was a potential concern for reporting of physical activity participation. There is evidence that recall error of physical activity may be especially problematic for habitual unstructured activities, such as housework, compared to structured activities that are planned and intentional behaviours (Fransson et al., 2008; Pettee et al., 2009). Recall of household activity was found to have the lowest reliability in the PYTPAQ, similar to reliabilities for household activity in other measures (Fransson et al., 2008; Friedenreich et al., 2006). Indeed, over-reporting of household activity was observed in both Phase 1 and Phase 2 of this study. In order to minimize misclassification, household activity was excluded from measures of total physical activity. Given that women are generally more likely to participate in household activity than men, not including household activity may have served to underestimate total physical activity in women more so than for men (Azevedo et al., 2007; Pettee et al., 2009). However, it was deemed preferable to underestimate total physical activity than to include a possible overestimation of activity and falsely conclude that sufficient levels of activity were being achieved. The latter could lead to inaction, which would be detrimental to an overall cancer prevention strategy.

Similarly, there was some indication of over-reporting of occupational activity in Phase 2 using the IPAQ. To minimize misclassification attributed to measurement error in occupational activity, occupational activity was only included in measures of total activity for participants who reported being employed in an active occupation. Any misclassification that may have occurred was likely to be non-differential between those

who were classified as meeting guidelines and those who were classified as not meeting guidelines. Non-differential misclassification may have attenuated the estimates of associations between meeting guidelines and potential determinants. However, the direct measurement of physical activity is not feasible for large samples and the associations between potential determinants and physical activity behaviour in this study are largely consistent with previous studies.

The findings regarding proportions that meet each of the guidelines assessed have limited generalizability to the general adult Alberta population. The 45% response rate for Phase 2 was low, thus response bias cannot be precluded. The samples used for Phase 2 had higher educational attainment, higher annual household incomes, and were generally healthier than the Alberta population. Consequently, estimates of physical activity levels sufficient for cancer prevention in Phase 2 are likely overestimates of the physical activity levels of Albertans. However, the association between potential determinants and meeting physical activity guidelines are unlikely to be different in the general population than what those found in this study. Therefore, the potential determinants of physical activity at levels recommended for cancer prevention that have been identified may serve as important targets for cancer prevention strategies developed for Albertans.

In addition, the unique way in which physical activity was defined, as a combination of leisure, occupation and transportation activity, may limit the ability of the estimates of compliance with physical activity guidelines to be compared with other studies that have largely focused solely on leisure activity. Moreover, this broader definition of physical activity could have resulted in overestimates of meeting physical

activity guidelines, since physical activity guidelines were conceptualized largely with the intention of modifying leisure activity. Lastly, including occupational activity may have attenuated the association between meeting guidelines and potential psychosocial determinants given that these determinants have been identified largely for participation on leisure activity.

Despite its limitations, this study made a contribution to physical activity research by utilizing an ecological framework to identify potential determinants at the individual, social and neighbourhood level. While this approach is in keeping with more current physical activity research, most research has focused on one level of influence at a time; therefore this study used a relatively novel approach. Consequently, the findings of this study can be used to identify targets for intervention beyond the traditional psychosocial targets for individual change and help move intervention research towards creating positive environments that can facilitate physical activity behaviour for the long term. Moreover, this study investigated the potential multidimensional determinants of physical activity by sex and age; such investigations have been limited in the past. Not much is known about sex and age differences in the determinants of physical activity, especially when multiple levels of influenced are considered together. These results help to highlight the different needs of men and women and among age groups that may facilitate the development of effective physical activity interventions in the future.

This study also aimed to make valuable contributions to cancer prevention research by focusing on levels of physical activity that were higher than traditionally recommended for health benefits but have been shown to confer cancer prevention benefits. Additionally, there have not been any efforts in the past to estimate physical

activity in Alberta at these higher levels; therefore this study provides the first estimate of the proportion of Albertans that may be participating in sufficient physical activity for cancer prevention and highlights the need to increase physical activity targets. Lastly, this study is the first to explore potential determinants for physical activity levels specifically for cancer prevention benefits. These findings provide potential target determinants for the development of cancer prevention strategies that include physical activity.

Chapter Seven: Implications for Cancer Prevention

7.1 Conclusions and Recommendations

Most Albertans appear to be insufficiently active to gain the cancer prevention benefits that physical activity can confer. More than a third of participants were unable to meet the minimal guidelines for sufficient activity for cancer prevention recommended by ACS and less than half of participants were sufficiently active to meet HHS guidelines, which confer cancer prevention benefits through weight management. Women and obese individuals seem to be at even higher risk for insufficient activity for cancer prevention benefits. Women were less likely to meet either ACS or HHS guidelines than men. Obese Albertans were less physically active at levels sufficient for cancer prevention than normal weight individuals. In particular, obese men and adults 56 to 64 years of age were less likely to be physically active at the minimum levels for cancer prevention recommended by ACS. Women and obese individuals, especially obese men and older adults, should be made a special focus for any cancer prevention strategies in Alberta that incorporate physical activity.

Since a large majority of Albertans seem to be sufficiently active for general health benefits as recommended by PHAC, physical activity promotion should now focus on encouraging the population to meet higher levels of physical activity. In Canada, the agency to take leadership on this issue would the Canadian Cancer Society (CCS). Unfortunately, current CCS recommendations for physical activity are based on PHAC recommendations, despite existing evidence that physical activity levels required for cancer prevention are higher (Canadian Cancer Society, 2009). These recommendations also exclude recommendations that consider the need for weight loss among overweight

or obese individuals. There is ample evidence that obesity contributes to cancer risk and is therefore an important target for cancer prevention. Current PHAC guidelines are not sufficient for weight loss; therefore, it is possible beneficial for CCS to consider updating their physical activity recommendations for cancer prevention to a minimum of 45 minutes of moderate to vigorous activity most days of the week (as recommended by ACS), working towards 60 minutes most days of the week for weight maintenance and everyday for overweight or obese individuals (as recommended by HHS). Importantly, any new recommendations for physical activity will not only need to appeal to those who are currently active at insufficient levels but also to those who are currently sedentary. For this purpose, promoting a gradual increase of physical activity to higher levels will be important. Advocates of increasing physical activity to levels required for cancer prevention will need to work with CCS to modify current recommendations and to find effective ways of disseminating and promoting these new guidelines.

Before new recommendations can be communicated, it would be important to assess the current level of awareness regarding recommended guidelines among Albertans. Such an assessment would serve to provide a baseline measure of current awareness, useful for evaluation of intervention efforts, and verification of a lack of awareness in Alberta of levels of physical activity required for cancer prevention. It would also be helpful to identify segments of the population for whom the knowledge gap is greater and may need special attention when communication strategies are developed.

One strategy that has been used in the past to communicate physical activity recommendations has been the use of mass media campaigns. Mass media campaigns

typically use a number of communications channels, including television, radio, newspapers, and more recently the internet, to communicate messages to the general public (Kahn et al., 2002). The goal of mass media campaigns is to change behaviour by increasing knowledge and influencing attitudes and beliefs. There is little evidence that mass media campaigns are effective for increasing physical activity behaviour in the long term on their own, but they can be effective as part of a multidimensional intervention strategy that incorporates psychosocial and environmental determinants (Kahn et al., 2002). As such, mass media campaigns may be useful for increasing awareness about levels of physical activity required for cancer prevention, which is important for initiating physical behaviour change, but only as part of a more complex strategy that can support behavioural change and maintenance through additional components (Kahn et al., 2002; Prochaska et al., 2001).

In order to begin development of multidimensional interventions to increase physical activity for cancer prevention in Alberta, determinants that are potential targets of intervention need to be identified. Through the application of an ecological framework, a number of potential determinants for participating in sufficient physical activity for cancer prevention benefits were identified that encompassed the individual and the social and neighbourhood environments. At the level of the individual, decisional balance pros and cons, scheduling and planning, and self-efficacy have been identified as important potential determinants of physical activity for cancer prevention.

Decisional pros and cons refer to the perceived benefits and disadvantages to being active and were identified as potential determinants of being active at the levels recommended by HHS for cancer prevention and weight management for Albertans

(Buckworth and Dishman, 2002d). The perception of both benefits and disadvantages of being active were important for men who were sufficiently active, but only the perception of the disadvantages of being active were important for women. Considering the differences between men and women, communicating the benefits and disadvantages of physical activity may not be enough, since it is possible that men and women place value on potential benefits and disadvantages of being physically active differently. For example, men, but not women, with cardiovascular conditions were more likely to participate in the minimum levels of physical activity for cancer prevention, suggesting that the benefits of physical activity may provide motivation for men to be physically active at higher levels than traditionally recommended. More research is needed to elucidate what the salient benefits and disadvantages of being physically active are for women so that these can be emphasized. These results further support different intervention strategies tailored for men and women.

Scheduling and planning of physical activity appears to facilitate participation in minimum levels of physical activity for cancer prevention benefits. However, scheduling and planning seems to facilitate physical activity at higher levels recommended for cancer prevention and weight control for women, but not for men. Helping individuals intentionally plan for and incorporate physical activity into their schedules appears to be a potential approach. Strategies may be as simple as providing suggestions on how to incorporate physical activity into one's day and providing a worksheet to plan and track one's time spent in physical activity, as provided in Canada's Physical Activity Guide for Healthy Living (Public Health Agency of Canada, 2003). Alternatively, a more complex approach that incorporates both tools for weekly planning of activities and email or

mobile phone reminders might be needed (Hurling et al., 2007). Successful attempts at being physically active require skills to overcome barriers to physical activity. Research needs to be done to examine strategies specific for helping adults to plan or schedule physical activity into their daily routines and to evaluate existing strategies. If an effective tool for planning physical activity can be identified, it can then be incorporated into a multifaceted intervention to increase physical activity.

Self-efficacy was also identified as a potential determinant for physical activity. Self-efficacy appeared to be important for women to participate at the minimum levels recommended by ACS. However, self-efficacy was important for both men and women for achieving higher levels of activity recommended by HHS. These findings suggest self-efficacy is an important target for interventions aimed at increasing physical activity for cancer prevention. Physical activity self-efficacy is improved by successful attempts at being physically active, overcoming barriers to being active, observing and modeling others who are physically active, and receiving encouragement or positive feedback related to physical activity behaviour; therefore, identifying salient barriers to engaging in levels of physical activity necessary for cancer prevention is important for the development of future interventions (Buckworth and Dishman, 2002d). Barriers to physical activity have been identified by previous research but there has not been a current assessment of barriers perceived by Albertans. An updated examination of perceived barriers to physical activity among women may be beneficial, given the changing roles of men and women in the past decade. Once the perceived barriers to physical activity in this population have been identified, interventions to provide Albertans with skills specific to overcoming these barriers can be developed.

Furthermore, observing and modeling others who are active and receiving encouragement are factors that can be achieved through social environments that are supportive of physical activity. Indeed, the results of this study suggest a supportive social environment is important for Albertans to achieve levels of physical activity recommended by HHS. Moreover, that sources of social support relevant to achieve higher levels of physical activity are not limited to familial support is encouraging because it suggests that interventions that incorporate social support from other sources may be successful in this population.

Evidence suggests that physical activity social support interventions can increase physical activity levels; however, the applicability to levels sufficient for cancer prevention benefits is undetermined (Kahn et al., 2002). The focus of such interventions is to build, strengthen and maintain supportive relationships. Strategies included in successful social support interventions include contracting with others to complete specified physical activity goals, buddy systems, telephone calls from others to praise progress and encourage continuation and discussion groups to discuss ways to overcome barriers (Kahn et al., 2002). These strategies provide opportunities to observe and model others engaged in physical activity and receive encouragement, which serve to increase self-efficacy and provide motivation for being physically active (Buckworth and Dishman, 2002d). Additionally, these strategies also provide companionship for physical activity, a factor that was found to determine engagement in sufficient levels for cancer prevention for women. As a result, strategies that increase social support aim to create supportive social environments for physical activity and may be important components of

a multidimensional strategy for increasing physical activity levels for cancer prevention benefits in Alberta.

Neighbourhood environment also had an influence on physical activity in this study, although only for achieving the high levels of physical activity recommended by HHS. Physical aspects of the neighbourhood environment, known as the built environments, have been found to influence physical activity behaviour in residents (Handy et al., 2002; Li et al., 2005; Saelens et al., 2003; Sundquist et al., 1999). In particular, neighbourhood built environments seem to have a strong influence on walking as a physical activity (Ross, 2000; Saelens et al., 2003; Van Dyck et al., 2010). Walking is a low-risk and simple physical activity that many adults in engage in (Lee, 2005). As such, walking lends itself as a useful type of activity to promote.

The walkability of neighbourhoods has been associated with safety from traffic, safety from crime, amenities within walking distance, walking paths or safe sidewalks, and an aesthetically pleasing environment (Saelens et al., 2003). Such neighbourhood attributes are largely related to decisions and changes made at the community level. For example, creating walking or cycling paths or ensuring that sidewalks are maintained and safe require changes in the infrastructure of the neighbourhood. There is also a role for municipalities and government here, since funding that supports such changes is fundamental for communities, especially those who are economically disadvantaged. Municipalities and governments can support communities through direct funds for upgrading neighbourhoods with more walkability attributes and though policies that impact community planning, such as zoning requirements for areas to engage in physical

activity in (parks and green spaces) or walking and bicycle paths (Brownson et al., 2001; Sallis et al., 1998).

Consistent with the ecological framework, the results of this study suggest important potential determinants for physical activity extend beyond the levels of the individual to social and neighbourhood environments. Therefore, cancer prevention strategies in Alberta should include a multidimensional approach to increasing physical activity that reflects an ecological framework. Multidimensional strategies to promote physical activity have been shown to work at the community and population levels, although physical activity levels high enough to gain cancer prevention benefits have not been assessed (Kahn et al., 2002). Multidimensional strategies include communication, social environment, physical environment and policy interventions. Communication interventions are used to increase awareness of physical activity and the recommended levels. Communications interventions can also be used to provide education about physical activity, such as the benefits, potential barriers and how to overcome them, ways to incorporate physical activity and information about different types of activities (Buckworth and Dishman, 2002c; Kahn et al., 2002). Typically, communication can take place through mass media campaigns delivered through diverse channels, including television, radio, newspaper, direct mailings and paid advertising at various public places, such as transit stops (Kahn et al., 2002). More recently, the internet has also been used as a communications channel, with limited evidence that internet communication can increase physical activity (Hurling et al., 2007).

Other components of a multidimensional strategy to increase physical activity for cancer prevention would include social interventions that provide social support and

policy changes that affect the built environment. Social support interventions, as previously discussed, build, strengthen and maintain supportive relationships, which in turn lead to increased self-efficacy and increased levels of activity. Policy interventions can include policies related to land use and urban design, policies related to the allocation of funds for retrofitting or remodelling neighbourhoods to improve walkability, and policies that encourage active transport (Heath et al., 2006; Kahn et al., 2002). Creating built environments that support physical activity may serve to provide places to be physically active in, but also may contribute to a supportive social environment by positively changing norms related to physical activity (Heath et al., 2006).

7.2 Future Directions for Research

A number of gaps in research have been identified through this study. Potential determinants of physical activity sufficient for cancer prevention were identified, but there are a number of potential determinants for which additional information is needed before they can be targeted by interventions to increase physical activity to levels for cancer prevention. There is a need to update our knowledge about the perceived barriers to physical activity among women. More research is also needed in the area of scheduling and planning for physical activity, especially in identifying effective strategies to help individuals plan for physical activity. In addition, more research needs to focus on sex differences in the perceived benefits and disadvantages of physical activity and how decisional balance may differ between men and women.

Sex differences were found to be important to physical activity behaviour in this study. However, more research is needed to understand how intervention designs and

delivery need to be modified to ensure increased physical activity in both men and women. There is also a need to gain a deeper understanding of the different social roles for men and women and how they may be changing. Recognizing these differing roles would help in the development of sex-specific strategies that compliment and facilitate these roles. Moreover, there may be interactions between sex and age that could not be explored because of power limitations. Similar studies need to include a larger sample so that stratification by age and sex together can be done.

There is also a need for more research regarding aspects of the social environment. It would be beneficial for intervention development to understand sex differences in the influence of social support on physical activity and the importance of different sources of social support. Moreover, very little research has involved assessing social networks and their impact on physical activity. A social network is the collective structure of social relationships that surround an individual (McNeill et al., 2006). Characteristics of a social network include the number of individuals, frequency of contact between network members, and the homogeneity of network membership (McNeill et al., 2006). Knowing what aspects of a social network are most influential for physical activity could identify targets for effective interventions.

This study also suggests that the neighbourhood environment has an influence on participation in physical activity, especially at higher levels. However, there was not enough power in this study to assess the different aspects that make a neighbourhood walkable separately, so composite score for the NEWS had to be used instead. In future, it would be interesting to assess each component of the NEWS separately, such as safety from crime, safety from traffic, access to amenities within walking distance and street

connectivity, so efforts can be focused on the most important neighbourhood characteristics. In addition, very little research has investigated the social environment in neighbourhoods and how any potential implications this may have for physical activity behaviour. Future research on social networks should include the potential role of the neighbourhood in the social environment and investigate what neighbourhood characteristics create a supportive social environment for physical activity at sufficient levels for cancer prevention.

This study was unable to study the impact, if any, that city of residence played in determining physical activity. Each city has its own culture and norms that may influence the physical activity of its residents. However, this study lacked power to conduct a three-level analysis to include city as a third level. Future research may explore the influence of different cities in Alberta on physical activity and its potential determinants.

Lastly, future research should aim to investigate the influences of other socio-cultural and physical environment influences on physical activity behaviour. For example, very little is known about interactions between policies that promote physical activity with individual level characteristics and social environments. Elucidating the effect of individual characteristics and social influences on the success of physical activity policy could be extremely beneficial when planning a multidimensional strategy to promote physical activity for cancer prevention.

Importantly, no previous cancer prevention or physical activity research has focused on physical activity levels sufficient for cancer prevention, as was done in this study. There is a need to replicate this study among other populations so that the role of different potential determinants can be further elucidated. Physical activity research may

benefit from including these higher levels of physical activity than traditionally recommended. Moreover, there are no interventions that have been developed or evaluated with a focus on achieving physical activity at levels sufficient for cancer prevention. Therefore, it is unknown if physical interventions that have been successful in the past will be effective for cancer prevention. Such a gap in knowledge indicates a great need for population intervention research specifically involving physical activity at levels for cancer prevention.

Lastly, this study was the first to estimate physical activity levels specific for cancer prevention in Alberta. Efforts need to be made to produce additional estimates for physical activity at cancer prevention levels for Alberta in the future so that progress in this area can be monitored. To do so, there will need to be increased monitoring of the population's level of physical activity. The measure of physical activity should include not only leisure, but also occupational, transportation and household related physical activities in future research and surveillance.

7.3 Summary

The findings from this study support an ecological approach to cancer prevention in Alberta. There are individual, social and neighbourhood level factors that work together to determine physical activity behaviour. Applying an ecological framework will require the development of multidimensional intervention strategies that work together to promote physical activity at sufficient levels for cancer prevention. These strategies will need to involve various sectors, including communities, municipalities, worksites and the government. There is evidence that multidimensional interventions can increase physical

activity in at community levels, but few interventions have been undertaken at the population level (McNeill et al., 2006). Furthermore, none have been undertaken to specifically promote physical activity levels high enough to confer cancer prevention benefits. As such, there is ample need for population intervention research focused on physical activity at levels higher than traditionally recommended and sufficient for cancer prevention benefits.

Given the economic impact of cancer in Alberta, cancer prevention is not only important for improving the health of citizens but a financial investment for Alberta, which could save millions in cancer care costs in the long term. Since physical activity has been shown to have a beneficial impact on reducing cancer risk, it should be an integral component of any cancer prevention strategy. Additionally, physical activity is beneficial to a number of other chronic conditions other than cancer, thus a focus on increasing physical activity would likely have additional benefits related to improving cardiovascular disease and Type 2 diabetes in Alberta. Given the complexity of physical activity behaviour, a multidimensional approach may be the best way to comprehensively address the challenges of increasing physical activity to levels sufficient for cancer prevention for the population. Moreover, women and obese individuals may require special consideration because they are the least likely to be active at levels sufficient for cancer prevention and may have unique intervention needs. Therefore, future cancer preventions strategies in Alberta should implement a multidimensional approach to increase physical activity levels from what is currently recommended for general health benefits to higher levels recommended for cancer prevention benefits among Albertans, with a special focus on women and the obese population.

References

Ainsworth, B. E., W. L. Haskell, et al. (2000). "Compendium of physical activities: an update of activity codes and MET intensities." Medicine & Science in Sports & Exercise **32**(9 Suppl): S498-504.

Alberta Diabetes Survaillance System. (2008). Retrieved 2010, March 25, from http://www.albertadiabetes.ca/pubs.php.

American Cancer Society. (2010). "About the American Cancer Society." Retrieved March 17, 2010, from http://www.cancer.org/docroot/AA/AA_0.asp.

Andersen, R. E., S. N. Blair, et al. (1997). "Encouraging patients to become more physically active: the physician's role." Annals of Internal Medicine **127**(5): 395-400.

Anderson, E. S., J. R. Wojcik, et al. (2006). "Social-Cognitive Determinants of Physical Activity: The Influence of Social Support, Self-Efficacy, Outcome Expectations, and Self-Regulation Among Participants in a Church-Based Health Promotion Study. [Article]." Health Psychology July **25**(4): 510-520.

Autenrieth, C., A. Schneider, et al. (2009). "Association between different domains of physical activity and markers of inflammation." Medicine & Science in Sports & Exercise **41**(9): 1706-1713.

Azevedo, M. R., C. L. Araujo, et al. (2007). "Gender differences in leisure-time physical activity." International Journal of Public Health **52**(1): 8-15.

Ball, K., N. Owen, et al. (2001). "Associations of physical activity with body weight and fat in men and women." International Journal of Obesity & Related Metabolic

Disorders: Journal of the International Association for the Study of Obesity **25**(6): 914-919.

Baranowski, T., C. Perry, et al. (2002). How individuals, environments, and health behaviour interact. Social Cognitive Theory. . Health Behaviour and Health Education: Theory, Research, and Practice. K. Glanz, B. K. Rimer and F. M. Lewis. San Francisco, CA, Jossey-Bass**:** 165-184.

Barrett, J. E., R. C. Plotnikoff, et al. (2007). "Physical activity and type 2 diabetes: Exploring the role of gender and income." The Diabetes Educator **33**(1): 128-143.

Beland, Y. (2002). "Canadian community health survey--methodological overview." Health Reports **13**(3): 9-14.

Bengocchea, E. G. and J. C. Spence (2003). 2002 Alberta Survey on Physical Activity: A Concise Report. Edmonton, Alberta, The Alberta Centre for Active Living.

Bengoechea, E., J. Spence, et al. (2005). "Gender differences in perceived environmental correlates of physical activity." International Journal of Behavioral Nutrition and Physical Activity **2**(1): 12.

Bensimhon, D. R., W. E. Kraus, et al. (2006). "Obesity and physical activity: a review." American Heart Journal **151**(3): 598-603.

Besson, H., U. Ekelund, et al. (2009). "A cross-sectional analysis of physical activity and obesity indicators in European participants of the EPIC-PANACEA study." International Journal of Obesity **33**(4): 497-506.

Bewick, V., L. Cheek, et al. (2004). "Statistics review 13: Receiver operating characteristic curves." Critical Care **8**(6): 508 - 512.

Bianchini, F., R. Kaaks, et al. (2002). "Weight control and physical activity in cancer prevention." Obesity Reviews **3**(1): 5-8.

Biddle, S. J. H. and N. Mutrie (2008). Introduction and rationale: why you should take your dog for a walk even if you don't have one. Psychology of Physical Activity: Determinants, well-being and interventions. New York, NY, Routledge**:** 3-32.

Blanchard, C. M., R. E. Rhodes, et al. (2003). "Ethnicity and the Theory of Planned Behavior in the Exercise Domain." American Journal of Health Behavior **27**(6): 579-591.

Booth, M. L., A. Bauman, et al. (1997). "Physical Activity Preferences, Preferred Sources of Assistance, and Perceived Barriers to Increased Activity among Physically Inactive Australians." Preventive Medicine **26**(1): 131-137.

Booth, M. L., P. Macaskill, et al. (1993). "Population prevalence and correlates of stages of change in physical activity." Health Education Quarterly **20**(3): 431-440.

Brownson, R. C., E. A. Baker, et al. (2001). "Environmental and policy determinants of physical activity in the United States." American Journal of Public Health. **91**(12): 1995-2003.

Brownson, R. C., A. A. Eyler, et al. (2000). "Patterns and correlates of physical activity among US women 40 years and older." American Journal of Public Health **90**(2): 264-270.

Brownson, R. C., C. A. Smith, et al. (1996). "Preventing cardiovascular disease through community-based risk reduction: the Bootheel Heart Health Project." American Journal of Public Health **86**(2): 206-213.

Bryant, H., P. J. Robson, et al. (2006). "Population-based cohort development in Alberta, Canada: a feasibility study." Chronic Diseases in Canada **27**(2): 51-59.

Buckworth, J. and R. K. Dishman (2002a). Basic concepts in exercise psychology. Exercise Psychology. Champaign, Illinois, Human Kinetics Publishers, Inc.**:** 17-41.

Buckworth, J. and R. K. Dishman (2002b). Determinants on Exercise and Physical Activity. Exercise Psychology. Champaign, Illinois, Human Kinetics Publishers, Inc.**:** 191-209.

Buckworth, J. and R. K. Dishman (2002c). Interventions to change physical activity behaviour. Exercise Psychology. Champaign, Illinois, Human Kinetics Publishers, Inc.**:** 229-254.

Buckworth, J. and R. K. Dishman (2002d). Theories of behaviour change. Exercise Psychology. Champaign, Illinois, Human Kinetics Publishers, Inc.**:** 211-228.

Burton, L. C., S. Shapiro, et al. (1999). "Determinants of physical activity initiation and maintenance among community-dwelling older persons." Preventive Medicine. **29**(5): 422-430.

Byers, T., M. Nestle, et al. (2002). "American Cancer Society guidelines on nutrition and physical activity for cancer prevention: Reducing the risk of cancer with healthy food choices and physical activity." Cancer Journal for Clinicians **52**(2): 92-119.

Canada Post. (2010). "Addressing Guidelines - Postal Code." Retrieved March 27, 2010, from http://www.canadapost.ca/tools/pg/manual/PGaddress-e.asp#1413985.

Canadian Cancer Society (2009). CCS: Canadian Cancer Statistics 2009. Toronto, Canadian Cancer Society.

Canadian Cancer Society. (2009). "Nutrition and Fitness: Goals to work towards." Retrieved February 8, 2010, from http://www.cancer.ca/Alberta-NWT/Prevention/Eat%20well/Fitness%20and%20health/Goals%20to%20work%20towards.aspx?sc_lang=en&r=1.

Canadian Fitness and Lifestyle Research Institute (CFLRI) (2009). Bulletin 2: Physical activity levels in Canadians. 2008 Physical Activity Monitor., Canadian Fitness and Lifestyle Research Institute.

Cardinal, B. J., J.-Y. Lee, et al. (2009). "Behavioral, demographic, psychosocial, and sociocultural concomitants of stage of change for physical activity behavior in a mixed-culture sample." American Journal of Health Promotion **23**(4): 274-278.

Carron, A. V., W. Widmeyer, et al. (1988). "Group cohesion and individual adherence to physical activity." Journal of Sport & Exercise Psychology **10**(2): 127-138.

Castro, C. M., J. F. Sallis, et al. (1999). "A prospective study of psychosocial correlates of physical activity for ethnic minority women." Psychology & Health **14**(2): 277-293.

Catlin, T. K., E. J. Simoes, et al. (2003). "Environmental and policy factors associated with overweight among adults in Missouri." American Journal of Health Promotion. **17**(4): 249-258.

Cerin, E. and E. Leslie (2008). "How socio-economic status contributes to participation in leisure-time physical activity." Social Science & Medicine **66**(12): 2596-2609.

Chogahara, M., S. O. Cousins, et al. (1998). "Social influences on physical activity in older adults: a review." Journal of Aging & Physical Activity. **6**(1): 1-17.

Conn, V. S. (1998). "Older adults and exercise: path analysis of self-efficacy related constructs." Nursing Research. **47**(3): 180-189.

Courneya, K. S. and E. McAuley (1994). "Are there different determinants of the frequency, intensity, and duration of physical activity?" Behavioral Medicine **20**(2): 84-90.

Courneya, K. S. and E. McAuley (1995). "Reliability and discriminant validity of subjective norm, social support, and cohesion in an exercise setting." Journal of Sport & Exercise Psychology **17**(3): 325-337.

Courneya, K. S., R. C. Plotnikoff, et al. (2001). "Predicting exercise stage transitions over two consecutive 6-month periods: A test of the theory of planned behaviour in a population-based sample." British Journal of Health Psychology **6**(2): 135-150.

Craig, C. L., A. L. Marshall, et al. (2003). "International physical activity questionnaire: 12-country reliability and validity." Medicine & Science in Sports & Exercise **35**(8): 1381-1395.

Cubbin, C., W. C. Hadden, et al. (2001). "Neighborhood context and cardiovascular disease risk factors: the contribution of material deprivation." Ethnicity & Disease **11**(4): 687-700.

De Bourdeauhuij, I. and J. Sallis (2002). "Relative contribution of psychosocial variables to the explanation of physical activity in three population-based adult samples." Preventive Medicine **34**(2): 279-288.

Di Loreto, C., C. Fanelli, et al. (2003). "Validation of a counseling strategy to promote the adoption and the maintenance of physical activity by type 2 diabetic subjects." Diabetes Care. **26**(2): 404-408.

Dishman, R. K. and J. F. Sallis (1994). Determinants and interventions for physical activity and exercise. Bouchard, Claude (Ed); Shephard, Roy J (Ed); et al (1994) Physical activity, fitness, and health: International proceedings and consensus statement. Champaign, IL, England, Human Kinetics Publishers**:** 214-238.

Dishman, R. K., J. F. Sallis, et al. (1985). "The determinants of physical activity and exercise." Public Health Reports **100**(2): 158-171.

Division of Education Studies at Emory University. (2004). "Exercise Self-Efficacy Scale." Retrieved April 5, 2004, from http://www.des.emory.edu/mfp/ExerciseSEChinese.pdf.

Duda, J. L. and M. K. Tappe (1988). "Predictors of personal investment in physical activity among middle-aged and older adults." Perceptual & Motor Skills **66**(2): 543-549.

Epstein, L. H. and J. N. Roemmich (2001). "Reducing sedentary behavior: role in modifying physical activity." Exercise & Sport Sciences Reviews **29**(3): 103-108.

Estabrooks, P. A. and A. V. Carron (1999). "Group cohesion in older adult exercisers: Prediction and intervention effects." Journal of Behavioral Medicine **22**(6): 575-588.

Eyler, A. A., R. C. Brownson, et al. (1999). "Physical activity social support and middle- and older-aged minority women: results from a US survey." Social Science & Medicine **49**(6): 781-789.

Eyler, A. A., D. Matson-Koffman, et al. (2002). "Environmental, policy, and cultural factors related to physical activity in a diverse sample of women: the Women's

Cardiovascular Health Network Project -- summary and discussion." Women & Health. **36**(2): 123-134.

Fisher, K., F. Li, et al. (2004). "Neighborhood-Level Influences on Physical Activity Among Older Adults: A Multilevel Analysis." Journal of Aging and Physical Activity **12**(1): 45-63.

Fox, K. R. and M. Hillsdon (2007). "Physical activity and obesity." Obesity Reviews **1**: 115-121.

Fransson, E., A. Knutsson, et al. (2008). "Indications of recall bias found in a retrospective study of physical activity and myocardial infarction." Journal of Clinical Epidemiology **61**(8): 840-847.

Frederick, C. M. and R. M. Ryan (1993). "Differences in motivation for sport and exercise and their relations with participation and mental health." Journal of Sport Behavior **16**(3): 124-146.

Friedenreich, C. M. (2001). "Physical activity and cancer prevention: from observational to intervention research." Cancer Epidemiology, Biomarkers & Prevention **10**(4): 287-301.

Friedenreich, C. M., K. S. Courneya, et al. (1998). "The lifetime total physical activity questionnaire: development and reliability." Medicine & Science in Sports & Exercise **30**: 266-274.

Friedenreich, C. M., K. S. Courneya, et al. (2006). "Reliability and validity of the Past Year Total Physical Activity Questionnaire." American Journal of Epidemiology ***163***: 959-970.

Friedenreich, C. M. and A. E. Cust (2008). "Physical activity and breast cancer risk: impact of timing, type and dose of activity and population subgroup effects." British Journal of Sports Medicine **42**(8): 636-647.

Friedenreich, C. M. and M. R. Orenstein (2002). "Physical activity and cancer prevention: etiologic evidence and biological mechanisms." Journal of Nutrition **132**(11 Suppl): 3456S-3464S.

Gammage, K. L., K. A. Ginis, et al. (2004). "Self-presentational efficacy: Its influence on social anxiety in an exercise context." Journal of Sport & Exercise Psychology **26**(2): 179-190.

Giles-Corti, B. and R. J. Donovan (2002a). "The relative influence of individual, social and physical environment determinants of physical activity." Social Science & Medicine **54**(12): 1793-1812.

Giles-Corti, B. and R. J. Donovan (2002b). "Socioeconomic status differences in recreational physical activity levels and real and perceived access to a supportive physical environment." Preventive Medicine **35**(6): 601-611.

Godin, G. (1993). "The theories of reasoned action and planned behavior: Overview of findings, emerging research problems and usefulness for exercise promotion." Journal of Applied Sport Psychology **5**(2): 141-157.

Godin, G. (1994). "Theories of reasoned action and planned behavior: Usefulness for exercise promotion." Medicine & Science in Sports & Exercise **26**(11): 1391-1394.

Grace, S. L., S. Barry-Bianchi, et al. (2007). "Physical activity behavior, motivational readiness and self-efficacy among Ontarians with cardiovascular disease and diabetes." Journal of Behavioral Medicine **30**(1): 21-29.

Handy, S. L., M. G. Boarnet, et al. (2002). "How the built environment affects physical activity: views from urban planning." American Journal of Preventive Medicine **23**(2 Suppl): 64-73.

Harrell, F. E. J. (2001a). Binary Logistic Regression. Regression Modeling Strategies. New York, NY, Springer-Verlag Inc.**:** 215-268.

Harrell, F. E. J. (2001b). Missing Data. Regression Modeling Strategies. New York, NY, Springer-Verlag Inc.**:** 41-52.

Harrell, F. E. J. (2001c). Resampling, Validating, Describing, and Simplifying the Model. Regression Modeling Strategies. New York, NY, Springer-Verlag Inc.**:** 87-104.

Hartman-Stein, P. E. and E. S. Potkanowicz (2003). "Behavioral determinants of healthy aging: good news for the baby boomer generation." Online Journal of Issues in Nursing **8**(2): 6.

Haveman-Nies, A., L. C. De Groot, et al. (2003). "Relation of dietary quality, physical activity, and smoking habits to 10-year changes in health status in older Europeans in the SENECA study." American Journal of Public Health **93**(2): 318-323.

Health Canada (1998). Economic Burden of Illness in Canada 1998, Health Canada.

Heath, G. W., R. C. Brownson, et al. (2006). "The Effectiveness of Urban Design and Land Use and Transport Policies and Practices to Increase Physical Activity: A Systematic Review." Journal of Physical Activity & Health **3**: S55-S76.

Humpel, N., N. Owen, et al. (2002). "Environmental factors associated with adults' participation in physical activity." American Journal of Preventive Medicine **22**(3): 188-199.

Hurling, R., M. Catt, et al. (2007). "Using Internet and mobile phone technology to deliver an automated physical activity program: Randomized controlled trial." Journal of Medical Internet Research **9**(2): 1-12.

International Agency for Research on Cancer. (2010). "EPIC Project." Retrieved March 4, 2010, from http://epic.iarc.fr/about.php.

International Agency for Research on Cancer (IARC) (2002). IARC Handbooks of Cancer Prevention, Vol 6. Weight control and physical activity. Lyon, France, IARC Press.

Kahn, E. B., L. T. Ramsey, et al. (2002). "The effectiveness of interventions to increase physical activity. A systematic review." American Journal of Preventive Medicine **22**(4 Suppl): 73-107.

King, A. C., C. Castro, et al. (2000). "Personal and environmental factors associated with physical inactivity among different racial-ethnic groups of U.S. middle-aged and older-aged women." Health Psychology **19**(4): 354-364.

Kleinbaum, D. G. and M. Klein (2002a). Introduction to Logistic Regression. Logistic Regression: A Self-Learning Text. New York, NY, Springer-Verlag**:** 1-37.

Kleinbaum, D. G. and M. Klein (2002b). Modeling Strategy Guidelines. Logistic Regression: A Self-Learning Text. New York, NY, Springer-Verlag**:** 161-190.

Kohavi, R. (1995). A study of cross-validation and bootstrap for accuracy estimation and model selection. International Joint Conference on Artificial Intelligence, Hainan Island, China, IEEE Computer Society.

Kushi, L. H., S. A. Kaye, et al. (1988). "Accuracy and reliability of self-measurement of body girths." American Journal of Epidemiology **128**(4): 740-748.

Lahti-Koski, M., P. Pietinen, et al. (2002). "Associations of body mass index and obesity with physical activity, food choices, alcohol intake, and smoking in the 1982-1997 FINRISK Studies." American Journal of Clinical Nutrition **75**(5): 809-817.

Laitakari, J. and S. Miilunpalo (1998). "How can physical activity be changed -- basic concepts and general principles in the promotion of health-related physical activity." Patient Education & Counseling **33Suppl 1**: S47-59.

Latikka, P., E. Pukkala, et al. (1998). "Relationship between the risk of breast cancer and physical activity. An epidemiological perspective." Sports Medicine **26**(3): 133-143.

Lau, D. C., J. D. Douketis, et al. (2007). "2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children." CMAJ Canadian Medical Association Journal **176**(8): 117.

Laurin, D., R. Verreault, et al. (2001). "Physical activity and risk of cognitive impairment and dementia in elderly persons." Archives of Neurology **58**(3): 498-504.

Lavrakas, P. J. (1993). Random Digit Dialing. Telephone Survey Methods. Sampling, Slelction, and Supervision. Thousand Oaks, CA, SAGE Publications**:** 33-48.

Leary, M. R., L. R. Tchividijian, et al. (1994). "Self-presentation can be hazardous to your health: Impression management and health risk." Health Psychology **13**(6): 461-470.

Lee, I. M. (2003). "Physical activity and cancer prevention--data from epidemiologic studies." Medicine & Science in Sports & Exercise **35**(11): 1823-1827.

Lee, Y.-S. (2005). "Gender Differences in Physical Activity and Walking Among Older Adults." Journal of Women & Aging **17**(1-2): 55-70.

Leslie, E., B. Saelens, et al. (2005). "Residents' perceptions of walkability attributes in objectively different neighbourhoods: a pilot study." Health & Place **11**(3): 227-236.

Levine, J. A., S. K. McCrady, et al. (2008). "The role of free-living daily walking in human weight gain and obesity." Diabetes **57**(3): 548-554.

Li, F., K. Fisher, et al. (2005). "Neighborhood Influences on Physical Activity in Middle-Aged and Older Adults: A Multilevel Perspective." Journal of Aging and Physical Activity **13**(1): 87-114.

Loitz, C., T. R. Berry, et al. (2009). 2009 Alberta Survey on Physical Activity: A Concise Report. Edmonton, AB, Alberta Centre for Active Living.

Loland, N. W. (1998). "Body image and physical activity: A survey among Norwegian men and women." International Journal of Sport Psychology **29**(4): 339-365.

Luke, D. A. (2004). Multilevel Modeling. London, UK, Sage Publications.

Marcus, B. H., C. A. Eaton, et al. (1994). "Self-efficacy, decision-making, and stages of change: An integrative model of physical exercise." Journal of Applied Social Psychology **24**(6): 489-508.

Martin, K. A., A. R. Sinden, et al. (2000). "Inactivity may be hazardous to your image: The effects of exercise participation on impression formation." Journal of Sport & Exercise Psychology **22**(4): 283-291.

Marttila, J., J. Laitakari, et al. (1998). "The versatile nature of physical activity: On the psychological, behavioural and contextual characteristics of health-related physical activity." Patient Education & Counseling **33**(Suppl 1): S29-S38.

McAuley, E. and B. Blissmer (2000). "Self-efficacy determinants and consequences of physical activity." Exercise & Sport Sciences Reviews **28**(2): 85-88.

McDermott, L. (2000). "A qualitative assessment of the significance of body perception to women's physical activity experiences: Revisiting discussions of physicalities." Sociology of Sport Journal **17**(4): 331-363.

McNeill, L. H., M. W. Kreuter, et al. (2006). "Social environment and physical activity: A review of concepts and evidence." Social Science & Medicine **63**(4): 1011-1022.

Mills, C., T. Stephens, et al. (1994). "Summary report of the workshop on data for monitoring tobacco use." Health Reports **6**(3): 377-387.

Mitchell, S. and R. Olds (1999). "Psychological and perceived situational predictors of physical activity: A cross-sectional analysis." Health Education Research **14**(3): 305-313.

Monninkhof, E. M., S. G. Elias, et al. (2007). "Physical activity and breast cancer: a systematic review." Epidemiology **18**(1): 137-157.

Moore, M. A., C. B. Park, et al. (1998). "Physical exercise: a pillar for cancer prevention?" European Journal of Cancer Prevention **7**(3): 177-193.

Motano, D. E. and D. Kasprzyk (2001). The theory of reasoned action and the theory of planned behavior. Health behavior and health education: Theory, research and practice. K. Glanz, B. K. Rimer and F. M. Lewis. San Francisco, CA, Jossey-Bass**:** 67-98.

National Cancer Institute. "Prostate, Lung, Colorectal and Ovarian Cancer Screening Trial (PLCO)." Retrieved March 4, 2010, from http://www.cancer.gov/clinicaltrials/PLCO-1.

Nies, M. A. and T. C. Kershaw (2002). "Psychosocial and environmental influences on physical activity and health outcomes in sedentary women." Journal of Nursing Scholarship **34**(3): 243-249.

Norman, G. R. and D. L. Streiner (2000). Multiple Regression. Biostatistics: The Bare Essentials. Hamilton, ON, B.C. Decker**:** 127-138.

Pan, S. Y., C. Cameron, et al. (2009). "Individual, social, environmental, and physical environmental correlates with physical activity among Canadians: a cross-sectional study." BMC Public Health **9**(21): 21.

Parsons, E. M. and N. E. Betz (2001). "The relationship of participation in sports and physical activity to body objectification, instrumentality, and locus of control among young women." Psychology of Women Quarterly **25**(3): 209-222.

Pereira, M. A., S. J. FitzerGerald, et al. (1997). "A collection of Physical Activity Questionnaires for health-related research." Medicine & Science in Sports & Exercise **29**(6 Suppl): S1-205.

Pettee, K. K., K. L. Storti, et al. (2009). Measurement of Physical Activity and Inactivity in Epidemiological Studies. Epidemiologic Methods in Physical Acitivity Studies. I. M. Lee. New York, NY, Oxford University Press**:** 15-33.

Phongsavan, P., G. McLean, et al. (2007). "Gender differences in influences of perceived environmental and psychosocial correlates on recommended level of physical activity among New Zealanders." Psychology of Sport and Exercise **8**(6): 939-950.

Pikora, T., B. Giles-Corti, et al. (2003). "Developing a framework for assessment of the environmental determinants of walking and cycling." Social Science & Medicine **56**(8): 1693-1703.

Plonczynski, D. J. (2003). "Physical activity determinants of older women: what influences activity?" MEDSURG Nursing. **12**(4): 213-222.

Plotnikoff, R. C., C. M. Blanchard, et al. (2001a). "Validation of the Decisional Balance Scales in the Exercise Domain From the Transtheoretical Model: A Longitudinal Test." Measurement in Physical Education & Exercise Science **5**(4): 191.

Plotnikoff, R. C., S. B. Hotz, et al. (2001b). "Exercise and the transtheoretical model: a longitudinal test of a population sample." Preventive Medicine **33**(5): 441-452.

Plotnikoff, R. C., S. Lippke, et al. (2008). "Physical Activity and Social Cognitive Theory: A Test in a Population Sample of Adults with Type 1 or Type 2 Diabetes." Applied Psychology: An International Review **57**(4): 628-643.

Plotnikoff, R. C., A. Mayhew, et al. (2004). "Age, gender, and urban-rural differences in the correlates of physical activity." Preventive Medicine: An International Journal Devoted to Practice and Theory **39**(6): 1115-1125.

Poulton, R., J. Trevena, et al. (2002). "Physical health correlates of overprediction of physical discomfort during exercise." Behaviour Research & Therapy **40**(4): 401-414.

Prochaska, J. O., C. A. Redding, et al. (2001). The transtheoretical model and stages of change. Health behavior and health education: Theory, research and practice. K. Glanz, B. K. Rimer and F. M. Lewis. San Francisco, CA, Jossey-Bass**:** 99-120.

Prorok, P. C., G. L. Andriole, et al. (2000). "Design of the Prostate, Lung, Colorectal and Ovarian (PLCO) Cancer Screening Trial." Controlled Clinical Trials **21**((6 Suppl)): 273S-309S.

Public Health Agency of Canada (2003). "Canada's Physical Activity Guide to Healthy Living." Retrieved October 14, 2003, from http://www.phac-aspc.gc.ca/pau-uap/paguide/index.html.

Reeve, J. and B. Sickenius (1994). "Development and validation of a brief measure of the three psychological needs underlying intrinsic motivation: The AFS scales." Educational & Psychological Measurement **54**(2): 506-515.

Resnick, B., S. I. Zimmerman, et al. (2000). "Outcome Expectations for Exercise Scale: utility and psychometrics." Journals of Gerontology Series B-Psychological Sciences & Social Sciences. **55B**(6): S352-356.

Rodriguez, G. (2009). "Regrssion Diagnostics for Binary Data." Retrieved September 3, 2009, from http://data.princeton.edu/wws509/stata/c3s8.html.

Rogers, C. J., L. H. Colbert, et al. (2008). "Physical activity and cancer prevention : pathways and targets for intervention." Sports Medicine **38**(4): 271-296.

Ross, C. E. (2000). "Walking, exercising, and smoking: Does neighborhood matter?" Social Science & Medicine **51**(2): 265-274.

Rovniak, L. S., E. S. Anderson, et al. (2002). "Social cognitive determinants of physical activity in young adults: A prospective structural equation analysis." Annals of Behavioral Medicine **24**(2): 149-156.

Saelens, B. E., J. F. Sallis, et al. (2003). "Neighborhood-based differences in physical activity: an environment scale evaluation." American Journal of Public Health **93**(9): 1552-1558.

Sallis, J. F., A. Bauman, et al. (1998). "Environmental and policy interventions to promote physical activity." American Journal of Preventive Medicine **15**(4): 379-397.

Sallis, J. F., R. M. Grossman, et al. (1987). "The development of scales to measure social support for diet and exercise behaviors." Preventive Medicine **16**(6): 825-836.

Sallis, J. F., M. F. Hovell, et al. (1992). "Predictors of adoption and maintenance of vigorous physical activity in men and women." Preventive Medicine **21**(2): 237-251.

Sallis, J. F., M. F. Hovell, et al. (1989). "A multivariate study of determinants of vigorous exercise in a community sample." Preventive Medicine **18**(1): 20-34.

Sallis, J. F., M. F. Johnson, et al. (1997). "Assessing perceived physical environmental variables that may influence physical activity." Research Quarterly for Exercise & Sport **68**(4): 345-351.

Sallis, J. F. and N. Owen (1999). Measuring Physical Activity. Physical Activity and Behavioral Medicine. Thousand Oaks, CA, SAGE Publications, Inc.**:** 71-91.

Sallis, J. F. and N. Owen (2001). Ecological models of health behavior. Health behavior and health education: Theory, research and practice. K. Glanz, B. K. Rimer and F. M. Lewis. San Francisco, CA, Jossey-Bass**:** 462-484.

Salmon, J., N. Owen, et al. (2003). "Physical activity and sedentary behavior: A population-based study of barriers, enjoyment, and preference." Health Psychology **22**(2): 178-188.

Schroll, M. (2003). "Physical activity in an ageing population." Scandinavian Journal of Medicine & Science in Sports **13**(1): 63-69.

Seefeldt, V., R. M. Malina, et al. (2002). "Factors affecting levels of physical activity in adults." Sports Medicine. **32**(3): 143-168.

Seltzer, V. (2003). "Smoking as a risk factor in the health of women." International Journal of Gynaecology & Obstetrics **82**(3): 393-397.

Sharratt, M. T. and W. E. Hearst (2007). "Canada's physical activity guides: background, process, and development." Canadian Journal of Public Health **98**(2): S9-15.

Sherbourne, C. D. and A. L. Stewart (1991). "The MOS social support survey." Social Science & Medicine **32**(6): 705-714.

Snijders, T. A. B. and R. J. Bosker (1999a). Discrete Dependent Variables. Multilevel Analysis: An introduction to basic and advanced multilevel modeling. London, UK, Sage Publications**:** 207-238.

Snijders, T. A. B. and R. J. Bosker (1999b). Multilevel Theories, Multi-stage Sampling, and Multilevel Models. Multilevel Analysis: An introduction to basic and advanced multilevel modeling. London, UK, Sage Publications**:** 6-12.

Sorensen, M. and D. Gill (2008). "Perceived barriers to physical activity across Norwegian adult age groups, gender and stages of change." Scandinavian Journal of Medicine & Science in Sports **18**(5): 651-663.

Spence, J. C. and R. E. Lee (2003). "Toward a comprehensive model of physical activity." Psychology of Sport & Exercise **4**(1): 7-24.

Stahl, T., A. Ruetten, et al. (2001). "The importance of the social environment for physically active lifestyle--results from an international study." Social Science & Medicine **52**(1): 1-10.

StataCorp (2001). STATA Release 10.0. College Station, TX, Stata Corporation.

Statistics Canada. "Canadian Community Health Survey (CCHS): Cycle 1.1: extending the wealth of health data in Canada." from http://www.statcan.ca/english/concepts/health/cchsinfo.htm.

Statistics Canada. (2009). "Table-105-501-Health indicator [profile, annual estimates, by age group and sex, Canada, provinces, terrotories, health regions (2007 boundaries) and peer groups, occasional, CANSIM database." Retrieved March 18, 2009, from http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm.

Steptoe, A., E. Rink, et al. (2000). "Psychosocial predictors of changes in physical activity in overweight sedentary adults following counseling in primary care." Preventive Medicine **31**(2 Pt 1): 183-194.

Stutts, W. C. (2002). "Physical activity determinants in adults: perceived benefits, barriers, and self efficacy." AAOHN Journal. **50**(11): 499-507.

Sundquist, J., M. Malmstrom, et al. (1999). "Cardiovascular risk factors and the neighbourhood environment: a multilevel analysis." International Journal of Epidemiology **28**(5): 841-845.

The Tomorrow Project. (2009). "The Tomorrow Project. Albertans for a Healthier Future." Retrieved Fecruary 18, 2010, from http://www.cancerboard.ab.ca/tomorrow/index.html.

The Women's Health Initiative Study Group (1998). "Design of the Women's Health Initiative clinical trial and observational study." Controlled Clinical Trials **19**(1): 61-109.

Thompson, A. M., M. Humbert, et al. (2003). "A Longitudinal Study of the Impact of Childhood and Adolescent Physical Activity Experiences on Adult Physical Activity Perceptions and Behaviors." Qualitative Health Research **13**(3): 358-377.

Treiber, F. A., T. Baranowski, et al. (1991). "Social support for exercise: relationship to physical activity in young adults.[Erratum appears in Prev Med 1992 May;21(3):392]." Preventive Medicine **20**(6): 737-750.

Troped, P. J. and R. P. Saunders (1998). "Gender differences in social influence on physical activity at different stages of exercise adoption." American Journal of Health Promotion **13**(2): 112-115.

Trost, S. G., N. Owen, et al. (2002). "Correlates of adults' participation in physical activity: review and update." Medicine & Science in Sports & Exercise **34**(12): 1996-2001.

U.S. Department of Health and Human Services (DHHS) (2008). Physical Activity Guidelines Advisory Committee Report, 2008. Washington, DC, U.S. Department of Health and Human Services.

U.S. Department of Health and Human Services (DHHS) and U.S. Department of Agriculture (USDA) (2005). Dietary Guidelines for Americans, 2005. Washington, DC, U.S. Department of Health and Human Services and U.S. Department of Agriculture,.

UCLA Academic Technology Services Logistic Regression Diagnostics. Logistic Regression with STATA. os Angeles, CA.

United States Department of Labor, Employment and Training Administration (USDL). "The Occupational Information Network O*NET." Retrieved August 16, 2009, from http://online.onetcenter.org/.

Van Dyck, D., G. Cardon, et al. (2010). "Neighborhood SES and walkability are related to physical activity behavior in Belgian adults." Preventive Medicine **50**(Supplement 1): S74-S79.

Visser, M., S. M. Pluijm, et al. (2002). "Physical activity as a determinant of change in mobility performance: the Longitudinal Aging Study Amsterdam." Journal of the American Geriatrics Society **50**(11): 1774-1781.

Wallace, J. P., J. S. Raglin, et al. (1995). "Twelve month adherence of adults who joined a fitness program with a spouse vs without a spouse." Journal of Sports Medicine & Physical Fitness **35**(3): 206-213.

Wankel, L. M. (1985). "Personal and situational factors affecting exercise involvement: The importance of enjoyment." Research Quarterly for Exercise & Sport **56**: 275-282.

Wankel, L. M. (1993). "The importance of enjoyment to adherence and psychological benefits from physical activity." International Journal of Sport Psychology **24**(2): 151-169.

Wankel, L. M. and B. G. Berger (1990). "The psychological and social benefits of sport and physical activity." Journal of Leisure Research **22**(2): 167-182.

Wen, M., C. R. Browning, et al. (2007). "Neighbourhood Deprivation, Social Capital and Regular Exercise during Adulthood: A Multilevel Study in Chicago." Urban Studies **44**(13): 2651 - 2671.

Wendel-Vos, W., M. Droomers, et al. (2007). "Potential environmental determinants of physical activity in adults: a systematic review." Obesity Reviews **8**(5): 425-440.

Westerterp, K. R. and M. I. Goran (1997). "Relationship between physical activity related energy expenditure and body composition: a gender difference." International Journal of Obesity & Related Metabolic Disorders: Journal of the International Association for the Study of Obesity **21**(3): 184-188.

Wolin, K. Y., Y. Yan, et al. (2009). "Physical activity and colon cancer prevention: a meta-analysis." British Journal of Cancer **100**(4): 611-616.

World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) (2007). Food, Nutrition, Physical Activity and the Prevention of Cancer: A Global Perspective. Washington, D.C., American Institute for Cancer Research.

Yordy, G. A. and R. W. Lent (1993). "Predicting aerobic exercise participation: Social cognitive, reasoned action, and planned behavior models." Journal of Sport & Exercise Psychology **15**(4): 363-374.

Zunft, H. J., D. Friebe, et al. (1999). "Perceived benefits and barriers to physical activity in a nationally representative sample in the European Union." Public Health Nutrition **2**(1A): 153-160.

APPENDIX A: ETHICS APPROVAL FROM THE CONJOINT HEALTH RESEARCH ETHICS BOARD (CHREB)

FACULTY OF MEDICINE | UNIVERSITY OF CALGARY

OFFICE OF MEDICAL BIOETHICS
Room 93, Heritage Medical Research Bldg
3330 Hospital Drive NW
Calgary, AB, Canada T2N 4N1
Telephone: (403) 220-7990
Fax: (403) 283-8524
Email: omb@ucalgary.ca

2006-06-01

Dr. Heather E. Bryant
Division of Epidemiology, Prevention and Screening
Alberta Cancer Board
Tom Baker Cancer Centre
Calgary, Alberta

Dear Dr. Bryant:

RE: Individual, social, and environmental determinants of physical activity in Alberta

Ethics ID: E-20205

Student: Fabiola Aparicio-Ting

The above-noted proposal including the Research Proposal (dated August 17, 2005), Physical Activity Determinants Questionnaire Outline, and the Consent Form (Version 1 dated May 16, 2006) has been submitted for Board review and found to be ethically acceptable.

Please note that this approval is subject to the following conditions:
(1) appropriate procedures for consent for access to identified health information have been approved;
(2) a copy of the informed consent form must have been given to each research subject, if required for this study;
(3) a Progress Report must be submitted by June 1, 2007, containing the following information:

i) the number of subjects recruited;
ii) a description of any protocol modification;
iii) any unusual and/or severe complications, adverse events or unanticipated problems involving risks to subjects or others, withdrawal of subjects from the research, or complaints about the research;
iv) a summary of any recent literature, finding, or other relevant information, especially information about risks associated with the research;
v) a copy of the current informed consent form;
vi) the expected date of termination of this project.

4) a Final Report must be submitted at the termination of the project.

Please note that you have been named as the principal collaborator on this study because students are not permitted to serve as principal investigators. Please accept the Board's best wishes for success in your research.
Yours sincerely,

Glenys Godlovitch, BA(Hons), LLB, PhD
Chair, Conjoint Health Research Ethics Board

GG/gk
c.c. Dr. C. J. McKierman (information) Research Services Fabiola Aparicio-Ting (Student)
Office of Information & Privacy Commissioner

CREATING THE FUTURE OF HEALTH *An innovative medical school committed to excellence and leadership in education, research and service to society.*

APPENDIX B: ETHICS APPROVAL FROM THE ALBERTA CANCER BOARD RESEARCH ETHICS BOARD

Alberta Cancer Board

ALBERTA CANCER BOARD

Provincial Office
1220, Standard Life Building
10405 Jasper Avenue
Edmonton, Alberta
Canada T5J 3N4
Tel: (780) 412-6300

ACB Provincial Office
Edmonton

Tertiary Cancer Centres
Cross Cancer Institute
Tom Baker Cancer Centre

Associate Cancer Centres
Central Alberta Cancer Centre (Red Deer)
Grande Prairie Cancer Centre
Lethbridge Cancer Centre
Medicine Hat Cancer Centre

Community Cancer Centres
Barrhead
Bonnyville
Camrose
Canmore
Drayton Valley
Drumheller
Ft. McMurray
High River
Hinton
Lloydminster
Peace River

Division of Population Health and Information
Calgary

Medical Affairs and Community Oncology
Edmonton

Research
Edmonton

Alberta Cancer Foundation
Accepts donations in support of ACB facilities and programs.
Toll-free: 1-866-412-4222

www.cancerboard.ab.ca

28 June 2006

Dr. Heather Bryant
Population Health and Information
Tom Baker Cancer Centre

Dear: Dr. Bryant,

RE: ETH-22098: Individual, social, and environmental determinants of physical activity in an Alberta cohort

Thank you for submitting the above named study for review. I am pleased to grant approval to your participation in the above noted study on behalf of the Research Ethics Board (REB). The following documents have been reviewed and approved as of 28 June 2006:

- Application (received 19 June 2006)
- Consent Form (dated 28 June 2006)
- Approval letter from Conjoint Health Research Ethics Board (dated 1 June 2006)

Please note that this approval is based on the following conditions:

- a copy of the informed consent form must be given to each research subject and consent obtained prior to enrollment on the study;
- if there are any other changes to the protocol or consent form during the year, a letter describing the changes must be forwarded to the REB as per the Alberta Cancer Board Policy 8.I.2 together with an updated consent form;
- an Annual Renewal form must be submitted two months prior to the deadline date of **28 June 2007** (one year from date of approval), containing the information as per our annual renewal form;
- a Final Report must be submitted at the termination of the project.

The deliberations of the REB include all elements described in Section 50 of the Health Information Act, and this study was found to be in compliance with all the applicable requirements of the Act. I have determined that consent will be obtained from study participants for disclosure of the health information to be used in the research.

The Alberta Cancer Board REB, complies with the following guidelines and regulations:

- Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans;
- Health Information Act which has been proclaimed on April 25, 2001 in Alberta;

- Health Canada, as defined in C.05 (Part C Division 5) (1024-Clinical Trials) of the Food And Drug Regulations-Amendment and the Therapeutic Products Directorate Guidelines/ICH Harmonized Tripartite Guidelines-Good Clinical Practice: Consolidate Guidelines;
- National Institutes of Health-Code of Federal Regulations (USA); and
- Our institution has been approved by the Office for Human Research Protections in the United States.

Members of the REB who are named as investigators or co-investigators in research studies do not participate in discussion related to, nor vote on, such studies when they are presented to the REB.

Please accept the Board's best wishes for success in your research.

Sincerely,

Scott North, MD
Chair, Research Ethics Board

/br

PC: Fabiola Aparicio-Ting
CPA
Brenda Bird-Cantelon
OIPC

APPENDIX C: PAST YEAR TOTAL PHYSICAL ACTIVITY QUESTIONNAIRE (PYTPAQ)

the tomorrow PROJECT
Albertans Studying the Connection Between Lifestyle and Cancer

The Physical Activity Questionnaire is one of three questionnaires that will describe your past and current health as you begin to participate in *The Tomorrow Project* cancer research study.

The questions are about your **physical activities in the past 12 months**, including:

- **Employment & Volunteer** activities
- **Household & Do-it-yourself** activities
- **Recreation & Leisure** activities

This questionnaire may take about 15-20 minutes to answer.

If you are not sure of how to answer a question, please feel free to contact us:

- Call our toll free number: 1.877.919.9292
- Email us: tomorrow@cancerboard.ab.ca
- OR, for answers to commonly asked questions, check our website: www.thetomorrowproject.org

Physical Activity Questionnaire

Directions:

- First, record the types of activities you took part in over the past 12 months.
- Next, record how often you took part in each activity, for how long, and at what intensity level.
- The timing and intensity of your activities may have varied over the 12 months. Do your best to estimate your average or usual activity pattern.
- Do not "double-count" hours – your total activity hours should add up to no more than the hours you are awake.
- In each section, the top pages provide examples of how to fill in the charts. Read through the examples and then fill in your activities on the bottom pages.
- **If a whole page does not apply to you, please write NA in the first column. We will then know you did not miss the page.**

Alberta Cancer Board | ALBERTA CANCER FOUNDATION

A research initiative of the Alberta Cancer Board, funded by The Alberta Cancer Foundation

Employment & Volunteer Activities

PHYSICAL INTENSITY LEVELS: *Choose the one that best describes your experience.*

1 = Activities done mainly **sitting** down
2 = Activities done mainly **standing**, that **do not increase your heart rate** & cause **no sweating**
3 = Activities that cause **your heart rate to increase slightly** & cause **some light sweating**
4 = Activities that cause **your heart rate to increase substantially** & cause **heavy sweating**

EXAMPLE:

Activity 1

- In the past 12 months, Joe's job has been **farming. He took 2 weeks of holidays.**
- His main physical activities = **drive** equipment**, walk** & **shovel.**
- He farms **11.5** months a year, **6** days a week, **9.5** hours a day.
- He **drives** and **walks 8.5** hours a day and rates his physical intensity level for those activities as **2.**
- He **shovels 1.0** hours a day and rates his physical intensity level for shoveling as **4.**

Activity 2

- In the past 12 months, Joe has also been **volunteering for a 4H Club.**
- His physical activities are **sitting** and **standing.**
- He volunteers **10** months a year, **1** day a week, **2** hours a day.
- He rates his physical intensity level as **1** because his main activity is sitting.

	Job Title employment and volunteer work	**Main Physical Activities** List up to 3 **main** activities that you did on the job in the past 12 months. *e.g. sit, stand, walk, carry loads*	**Months** per year	**Days** per week	**Hours** per day	**Physical Intensity Level 1,2,3,4** *Choose the level for you*
1	*farmer*	*drive, walk*	*11.5*	*6*	*8.5*	*2*
2	*farmer*	*shovel*	*11.5*	*6*	*1.0*	*4*
3	*4H Club volunteer*	*sit, stand*	*10*	*1*	*2*	*1*

Your Employment & Volunteer Activities

(1) Start a new line for each job that you did in the past 12 months (paid or volunteer).
(2) Start a new line when the pattern changed, such as when the activities, intensity level, or the number of months, days or hours of the job changed.
(3) Remember to deduct weeks or months you were on vacation.
(4) If you are involved in a volunteer or work activity less than once a week, record the days and the appropriate interval in the "Days per week" column, e.g. "Bingo 1 day/month".

	Job Title employment and volunteer work	**Main Physical Activities** List up to 3 **main** activities that you did on the job in the past 12 months *e.g. sit, stand, walk, carry loads*	**Months** per year	**Days** per week	**Hours** per day	**Physical Intensity Level 1,2,3,4** *Choose the level for you*
1						
2						
3						
4						
5						
6						
7						
8						

Walking, biking to and from employment & volunteer activities

PHYSICAL INTENSITY LEVELS: *Choose the one that best describes your experience.*

2 = Activities (walking, biking etc.) that **do not increase your heart rate** & cause **no sweating**
3 = Activities that cause **your heart rate to increase slightly** & cause **some light sweating**
4 = Activities that cause **your heart rate to increase substantially** & cause **heavy sweating**

EXAMPLE:

Activity 1

- Sandra works part-time as a **nurse** in a community health centre near her home.
- She **walks** to and from work **5** months of the year, **3** days a week, (**15 minutes each way**); the rest of the year she drives.
- She rates her physical intensity level for **walking** as **2**.

Activity 2

- Sandra also **volunteers** 1 day a week at her children's school 10 months per year.
- **4** months of the year she **bikes** to and from the school (**30 minutes each way**); the rest of the year she drives.
- She rates her physical activity level for **biking** as **3**.

	Job Title employment and volunteer work from page 3	**Type of activity** to go to and from work or volunteer activity *e.g. walk, bike, in-line skate etc.*	**Months** per year	**Days** per week	**Minutes** per day	**Physical Intensity Level** **2,3,4** *Choose the level for you*
1	Nurse	Walk	5	3	30 min	2
2	School volunteer	Bike	4	1	60 min	3

Your walking, biking to and from employment & volunteer activities

(1) Start a new line for each job from page 3 (paid or volunteer) that involves walking or biking to and/or from work in the past 12 months.
(2) Do not include walking that is part of your job *at* work. (Walking *at* work should be recorded on page 3.)
(3) Include any other means of transportation you use for getting to work, like in-line skating etc.
(4) Include the time you walk to and from the bus or your car.
(5) Record your time in minutes. (This is the only section that asks for your answer in minutes – continue to enter your time in hours in the rest of the questionnaire.)
(6) **OR: If this section does not apply to you, please write NA on the first line.**

	Job Title employment and volunteer work from page 3	**Type of activity** to go to and from work or volunteer activity *e.g. walk, bike, in-line skate etc.*	**Months** per year	**Days** per week	**Minutes** per day	**Physical Intensity Level** 2,3,4 *Choose the level for you*
1					min	
2					min	
3					min	
4					min	
5					min	
6					min	
7					min	
8					min	

Household, Childcare & Do-It-Yourself Activities

INCLUDING:

HOUSEWORK (e.g. cook, clean, do laundry, iron, vacuum, shop for groceries)
CHILDCARE (e.g. dress, feed, play with own children)
YARD WORK (e.g. cut grass, shovel snow, wash the car, garden)
DO-IT-YOURSELF JOBS (e.g. do renovations & repairs at home or at a cabin)

For this category, DO NOT include activities that are done **SEATED** (e.g. sewing, paying bills).

PHYSICAL INTENSITY LEVELS: *Choose the one that best describes your experience.*

2 = Activities done mainly **standing**, that **do not increase your heart rate** & cause **no sweating**
3 = Activities that cause **your heart rate to increase slightly** & cause **some light sweating**
4 = Activities that cause **your heart rate to increase substantially** & cause **heavy sweating**

EXAMPLE:

Activities 1 and 2

- Sandra shares the **housework** (meals, dishes & laundry) and **childcare** (feeding, dressing, playing) with her family.
- She does housework **12** months a year, **7** days a week for an average of **2** hours a day at an intensity level of **2.**
- She cares for her children **12** months a year, **7** days a week for an average of **3** hours a day at an intensity level of **3.**

Activity 3

- Sandra also shares the yard work with her husband (**gardening**, **cutting grass**).
- She does yard work **5** months a year, **3** days a week, and averages about **1.5** hours a day.
- She rates her physical intensity level for **yard work** as **3.**

	Type of Activity	**Months** per year	**Days** per week	**Hours** per day	**Physical Intensity Level 2,3,4** *Choose the level for you*
1	*meals, dishes, laundry*	*12*	*7*	*2*	*2*
2	*feed, dress, play with kids*	*12*	*7*	*3*	*3*
3	*garden, cut grass*	*5*	*3*	*1.5*	*3*

Your Household, Childcare & Do-It-Yourself Activities

(1) Start a new line when the pattern changed, such as when the intensity level, or the number of months, days or hours changed in the past 12 months.
(2) Report seasonal activities like gardening or snow shoveling separately from year round activities.
(3) If you are being paid to provide childcare, report this activity on page 3.

	Type of Activity	**Months** per year	**Days** per week	**Hours** per day	**Physical Intensity Level 2,3,4** *Choose the level for you*
1					
2					
3					
4					
5					
6					
7					
8					
9					

Recreation & Leisure Activities

For this category, **DO NOT** include activities that are done **SEATED** (playing cards, reading, etc.).

PHYSICAL INTENSITY LEVELS: *Choose the one that best describes your experience.*

2 = Activities done mainly **standing**, that **do not increase your heart rate** & cause **no sweating**
3 = Activities that cause **your heart rate to increase slightly** & cause **some light sweating**
4 = Activities that cause **your heart rate to increase substantially** & cause **heavy sweating**

EXAMPLE:

Activity 1
- Greg went on a **fishing** trip this past year.
- He went on a **10 day** trip.
- He fished about **4 hours** each day.
- For him, fishing is a level **2.**

Activity 2
- Greg also **walks** regularly.
- He walks for **6** months of the year.
- He walks **4** days a week, for **30** minutes.
- For him, walking is a level **3**

Activity 3
- Greg also **cycles** regularly.
- He cycles **8** months of the year.
- He cycles **4** days a month, for **3** hours.
- For him, cycling is a level **4.**

	Recreation or Leisure Activity	**Months** per year	**Frequency** Please specify how many days **•per week •per month** or **•per year**	**Hours** per day	**Physical Intensity Level 2,3,4** *Choose the level for you*
1	*fishing*	--	*10 days per year*	*4*	*2*
2	*walking*	*6*	*4 days per week*	*0.5*	*3*
3	*cycling*	*8*	*4 days per month*	*3*	*4*

Your Recreation & Leisure Activities

(1) Start a new line when the pattern changed, such as when the activity, intensity level, or the number of months, days or hours of your recreational activities in the past 12 months changed.

(2) Do not include walking that you did as part of your job or volunteer activities – this type of walking should be recorded on page 3.

(3) See next page for examples before you start…

	Recreation or Leisure Activity Please be specific when possible	**Months** per year	**Frequency** Please specify how many days and whether the activity is •per week •per month or •per year	**Hours** per day	**Physical Intensity Level** 2,3,4 *Choose the level for you*
1			____ days per _____		
2					
3					
4					
5					
6					
7					
8					
9					
			Please check! Did you record whether your activity was weekly, monthly or yearly in the column above?		

Examples of Recreation & Leisure Activities

Aerobics
Aquacize
Archery
Backpacking
Badminton
Basketball
Bicycling
Billiards
Boating
Bowling
Boxing
Broomball
Calisthenics
Canoeing
Circuit training
Climbing (rock, wall)
Coaching
Cricket
Curling
Dancing
Darts
Deepwater running
Diving
Fishing
Football
Frisbee
Golf
Gymnastics
Handball
Hang gliding
Hiking
Hockey
Horseback riding
Horseshoe pitching
Hunting
Ice-skating
Jogging
Judo
Jujitsu
Karate
Kayaking
Lacrosse
Motor cross
Orienteering
Paddleball
Ping-pong
Racquetball
Rowing
Rugby
Running
Sailing
Scuba diving
Shuffleboard
Skateboarding
Skiing, downhill
Skiing, cross-country
Sledding
Snorkeling
Snow shoeing
Snowboarding
Soccer
Softball
Squash
Stair climber
Stationary bicycling
Stretching
Surfing
Swimming
Tai chi
Telemarking
Tennis
Tobogganing
Track & field
Treadmill
Volleyball
Walking
Water polo
Water volleyball
Water skiing
Weight lifting
Whitewater rafting
Wrestling
Yoga

APPENDIX D: MEDICAL OUTCOMES (MOS) SOCIAL SUPPORT SURVEY

Section **L**

Some studies have shown that the level of support we get from our friends and relatives can affect our physical health. Next are some questions about the support that is available to you.

SPT 1 **About how many close friends and close relatives do you have (people you feel at ease with and can talk to about what is on your mind)?**

Write in the number of close friends and close relatives Include your spouse and immediate family, if appropriate: ☐☐

How often is each of the following kinds of support available to you?		None Of The Time	A Little Of The Time	Some Of The Time	Most Of The Time	All Of The Time
SPT 2	Someone to help you if you were confined to bed	O	O	O	O	O
SPT 3	Someone you can count on to listen to you when you need to talk	O	O	O	O	O
SPT 4	Someone to give you advice about a crisis	O	O	O	O	O
SPT 5	Someone to take you to the doctor if you needed it	O	O	O	O	O
SPT 6	Someone who shows you love and affection	O	O	O	O	O
SPT 7	Someone to have a good time with	O	O	O	O	O
SPT 8	Someone to give you information in order to help you understand a situation	O	O	O	O	O
SPT 9	Someone to confide in and talk to about yourself or your problems	O	O	O	O	O
SPT 10	Someone to hug	O	O	O	O	O
SPT 11	Someone to get together with for relaxation	O	O	O	O	O
SPT 12	Someone to prepare your meals if you were unable to do it yourself	O	O	O	O	O
SPT 13	Someone whose advice you really want	O	O	O	O	O
SPT 14	Someone to do things with to help you get your mind off things	O	O	O	O	O
SPT 15	Someone to help you with daily chores if you were sick	O	O	O	O	O
SPT 16	Someone to share your most private worries and fears with	O	O	O	O	O
SPT 17	Someone to turn to for suggestions about how to deal with a personal problem	O	O	O	O	O
SPT 18	Someone to do something enjoyable with	O	O	O	O	O
SPT 19	Someone who understands your problems	O	O	O	O	O
SPT 20	Someone to love you and make you feel wanted	O	O	O	O	O

CHECKPOINT! Did you answer SPT 1 at the top of the page?

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APPENDIX E: INVITATION LETTER AND CONSENT FORM

Alberta CANCER BOARD
Population Health and Information
Tom Baker Cancer Centre 1331 29 Street NW Calgary, Alberta T2N 4N2

Population Health Research
Phone: (403) 521-3594 Fax: (403) 270-8003

July 30, 2008

Dear Sir/Madam,

We would like to invite you to take part in a new study investigating the factors that influence physical activity for cancer prevention by completing the enclosed *Determinants of Physical Activity Questionnaire*. This questionnaire is not part of the Tomorrow Project. This is a different and separate study that Tomorrow Project participants are being invited to take part in if they are interested.

The *Determinants of Physical Activity Questionnaire* is being used to collect information about healthy lifestyle factors that play a role in cancer prevention, such as physical activity. Physical activity is a protective factor in the prevention of cardiovascular disease, type 2 diabetes, and some cancers. Through our research, we hope to learn more about the types of personal, social, and environmental factors that influence adult physical activity. Specifically, the *Determinants of Physical Activity Questionnaire* is part of a PhD thesis project being conducted to identify and measure the factors that influence physical activity behaviour in adults. Ultimately, this study will help develop programs to better the health of Albertans and to work towards a cancer-free future.

Your participation in this study is strictly voluntary and will not influence your involvement in the Tomorrow Project. Please read the enclosed consent form and, if you wish to take part, complete the *Determinants of Physical Activity Questionnaire* and mail it back with your completed Tomorrow Project Survey 2008 in the enclosed postage-paid envelope.

We recognize that you have already generously volunteered your time to the Tomorrow Project and appreciate your valuable contribution to this additional study. Please feel free to contact our project coordinator, Fabiola Aparicio-Ting, at (403) 521-3594 or *fabiolaa@cancerboard.ab.ca* with any questions about this project or the *Determinants of Physical Activity Questionnaire*. Thank you, in advance, for your contribution to our research!

Sincerely,

Heather Bryant, MD, PhD, CCFP, FRCPC
Principal Investigator
Department of Community Health Sciences
Faculty of Medicine, University of Calgary
Vice-President, Cancer Control
Canadian Partnership Against Cancer

Fabiola Aparicio-Ting, BSc, MPH
PhD Candidate, Community Health Sciences
Faculty of Medicine, University of Calgary
Population Health & Information
Tom Baker Cancer Centre, Alberta Cancer Board

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Phone: (403) 521-3594 Fax: (403) 270-8003

TITLE: INDIVIDUAL, SOCIAL, AND ENVIRONMENTAL DETERMINANTS OF PHYSICAL ACTIVITY IN AN ALBERTA COHORT

INVESTIGATORS: Dr. Heather E. Bryant

SPONSOR: Alberta Cancer Foundation

This information sheet is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Take the time to read this carefully and to understand any accompanying information.

This study is being conducted by researchers at the Tom Baker Cancer Centre and will take place in Calgary, Alberta.

Your participation in this study is entirely voluntary. Please take your time to make your decision.

BACKGROUND

The *Determinants of Physical Activity Questionnaire* is being done to help identify and measure the factors that influence physical activity behaviour among adults in Alberta.

WHAT IS THE PURPOSE OF THE STUDY?

Physical activity is a protective factor in the prevention of cardiovascular disease, type 2 diabetes, and some cancers. Through this study, we hope to learn more about the types of personal, social, and environmental factors that influence adult physical activity. Ultimately, this study will help develop programs to better the health of Albertans.

The purpose of the *Determinants of Physical Activity Questionnaire* is to identify and measure factors that influence physical activity behaviour in adults that can be used in future studies.

WHAT WOULD I HAVE TO DO?

In this study, you will be asked to complete a questionnaire about your habits and attitudes regarding physical activity. If you choose to take part in this study, you will be invited to:

1. Complete a questionnaire that has been developed by the researchers. The *Determinants of Physical Activity Questionnaire* will ask you about your physical activity habits, how you feel about physical activity, and about some of the things that encourage you and discourage you from participating in physical activities.
2. Mail back the completed questionnaire in the pre-addressed postage paid envelope provided to you.

WHAT ARE THE RISKS?

There are no risks to your health or health care from your participation in this study. However, you may be asked to answer questions that you do not want to, and it is your right to refuse to answer these questions.

WILL I BENEFIT IF I TAKE PART?

Participation in this study may or may not be of personal benefit to you. However, the information that we collect from you will help researchers gain knowledge about the reasons that Albertans are and are not physically active that can be used in future development of programs to encourage physical activity.

DO I HAVE TO PARTICIPATE?

Taking part in this study is voluntary; you may choose not to complete the *Determinants of Physical Activity Questionnaire* if you do not wish to do so.

WILL I BE PAID FOR PARTICIPATING, OR DO I HAVE TO PAY FOR ANYTHING?

There will be no costs to you related to your participation in this study. If you loose the postage paid envelope to return your completed questionnaire in, contact the project coordinator and another one will be sent to you.

WILL MY RECORDS BE KEPT PRIVATE?

Your response to the questionnaire will be kept confidential in a secure Alberta Cancer Board facility at the Tom Baker Cancer Centre. No one outside of this project will have access to this information except the University of Calgary Conjoint Health Research Ethics Board and the Alberta Cancer Board Ethics Board.

The researchers who are directly involved in your study may share information about you with other researchers, but you will not be identified in that shared information except by a number. The key that indicates what number you have been assigned will be kept secure by the researchers directly involved with you study and will not be released.

Although absolute confidentiality can never be guaranteed, the Alberta Cancer Board and the University of Calgary will make every effort to keep your identifiable information confidential, and to follow the ethical and legal rules about collecting, using and disclosing this information in accordance with the Health Information Act and other regulatory requirements.

AGREEMENT TO PARTICIPATE

Your decision to complete and return the *Determinants of Physical Activity Questionnaire* will be interpreted as an indication of your agreement to participate. In no way does this waive your legal rights nor release the investigators, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time.

If you have further questions concerning matters related to this research, please contact:

Dr. Heather Bryant 1-877-360-1665
or
Fabiola Aparicio-Ting (403) 521-3594

If you have any questions concerning your rights as a possible participant in this research, please contact the Associate Director, Internal Awards, Research Services, University of Calgary, at (403) 220-3782 or the Patient Representative, Tom Baker Cancer Centre, Alberta Cancer Board at (403) 521-3168.

The University of Calgary Conjoint Health Research Ethics Board and the Alberta Cancer Board Ethics Board have approved this research study.

APPENDIX F: DETERMINANTS OF PHYSICAL ACTIVITY QUESTIONNAIRE (DPAQ)

Determinants of Physical Activity Questionnaire

Please write your unique study number in the boxes.
Your study number is the six digit number on the front of your Survey 2008

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This questionnaire is about how people think and feel about physical activity. There are no right or wrong answers to any of these questions and your information will be kept confidential.

DIRECTIONS FOR COMPLETING THIS QUESTIONNAIRE

- This questionnaire may take about 20 minutes to answer.
- **Read the questions carefully and choose the best possible answer for you.**
- Please follow the directions carefully.
- Use a ballpoint pen, **not a felt pen or pencil.**
- Shade in the bubbles completely like this: ○ ● ○
- Write the numbers in boxes like this: | 2 | 1 |
- If you make an error, put an X through the incorrect bubble like this: ○ ● ○

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Section A: Physical Limitations for Physical Activity

First, we would like to know if you have any health limitations which might affect your ability to do physical activity.

1. How often do you have any difficulty walking, climbing stairs, bending, leaning or doing any similar activities?

   O Often
   O Sometimes
   O Never

2. How often does a health condition, injury or disability currently limit the amount or the kind of activity you can do:

   A... at home?
   O Often
   O Sometimes
   O Never

   B ... at work or at school?
   O Often
   O Sometimes
   O Never
   O Not applicable

   C ... in other activities, for example, transportation or leisure?
   O Often
   O Sometimes
   O Never

3. If you currently have difficulty or are physically limited in activities, which one of the following is the best description of the cause of this condition?

   O Condition existed at birth
   O Injury - at home
   O Injury - sports or recreation
   O Injury - work-related
   O Injury - motor vehicle
   O Hazardous work environment
   O Disease or illness - Please specify (optional): _____
   O Natural aging process
   O I have no physical limitations
   O Other - Please specify _____

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Section B: Participation in Activities

We would like to know a little about the types of physical activities that you participate in during your leisure time. Below, please indicate if you have done the following activities over the past month and rate how much enjoyment you get from doing each activity. If you don't currently participate in some of them, tell us how much you think you would enjoy them

	a.) Do you do this activity?		b.)How much do you enjoy this activity?				
	Yes	No	Don't Enjoy		Enjoy		Enjoy A lot
1. Aerobics or exercise class	O	O	O	O	O	O	O
2. Organized group sports (hockey, volleyball, baseball/softball, basketball, etc.)	O	O	O	O	O	O	O
3. Training with weights and equipment in the gym	O	O	O	O	O	O	O
4. Racquet sports	O	O	O	O	O	O	O
5. Cycling	O	O	O	O	O	O	O
6. Running or jogging	O	O	O	O	O	O	O
7. Swimming or water sports	O	O	O	O	O	O	O
8. Alpine or cross-country skiing	O	O	O	O	O	O	O
9. Inline or ice skating	O	O	O	O	O	O	O
10. Dancing	O	O	O	O	O	O	O
11. Yard care (gardening, mowing the lawn, raking leaves, etc.)	O	O	O	O	O	O	O
12. Walking	O	O	O	O	O	O	O
13. Shovelling snow	O	O	O	O	O	O	O
14. Washing a car	O	O	O	O	O	O	O
15. Other, specify: _____	O	O	O	O	O	O	O

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Section C: Participation in Other Recreational Activities

For this question, we would like you to recall your participation in other recreational activities. Over the past month, how much time did you do the following activities during your free time on an average week?

	Average hours/minutes per week	
1. Hobbies (arts and crafts, work on car, play musical instruments	☐☐ hrs	☐☐ min
2. Reading (books, papers, magazines)	☐☐ hrs	☐☐ min
3. Sitting and socializing with friends and family (at home, pubs, restaurants)	☐☐ hrs	☐☐ min
4. Sitting or lying and listening to music/radio	☐☐ hrs	☐☐ min
5. Talking on the telephone	☐☐ hrs	☐☐ min
6. Watching television/videos (including video games)	☐☐ hrs	☐☐ min
7. Using the computer (including games)	☐☐ hrs	☐☐ min
8. Going for a drive	☐☐ hrs	☐☐ min
9. Relaxing, thinking, resting (NOT including sleep)	☐☐ hrs	☐☐ min
10. Other non-physical recreational activity: _____	☐☐ hrs	☐☐ min

How much do you enjoy each of the following recreational pastimes? If you don't currently participate in some of them, tell us how much you think you would enjoy them.

Please fill in the appropriate bubble for each item

	Don't Enjoy		Enjoy		Enjoy a lot
11. Hobbies (eg. arts and crafts, work on car, play musical instruments)	○	○	○	○	○
12. Reading (books, papers, magazines)	○	○	○	○	○
13. Sitting and socializing with friends and family (at home, pubs, restaurants)	○	○	○	○	○
14. Sitting or lying and listening to music/radio	○	○	○	○	○

	Don't Enjoy		Enjoy		Enjoy A lot
15. Talking on the telephone	O	O	O	O	O
16. Watching television/videos (including video games)	O	O	O	O	O
17. Using the computer (including games)	O	O	O	O	O
18. Going for a drive	O	O	O	O	O
19. Relaxing, thinking, resting (NOT including sleep)	O	O	O	O	O

For the remaining sections in this study we ask about your beliefs and behaviours on doing *"regular physical activity"*.

According to American Cancer Society, ***"regular physical activity"*** is defined as doing activities such as brisk walking, recreation, and sporting activities (e.g. jogging, swimming, bicycling, skiing) all at a moderate intensity of a brisk walking pace or faster that makes your heart beat faster and causes light perspiration.

For moderate activity to be **regular**, your activity must:

- **add up to a total of 45 minutes or more per day**
- **be done at least 5 days per week**

There are a number of ways that you could reach your 45 minute total. You could, for example:

- take a 45 minute brisk walk or bicycle ride

or

- take three, 15-minute periods of activities; such as a brisk walk for 15 minutes, swimming for 15 minutes and climbing stairs for exercise for 15 minutes, all in the same day

CONTINUE ON NEXT PAGE

Section D: Your Thoughts and Feelings about Regular Physical Activity

1. Do you plan to participate in regular physical activity for at least the next 6 months?

- O Definitely not
- O Probably not
- O Unsure
- O Probably yes
- O Definitely yes

A number of situations are described below that can make it hard to stick to a regular physical activity routine. On the items below, please rate how confident you are that you can be physically active on a regular basis (as defined on page 10) in the following situations.

I am confident that I can be regularly physically active, even...

	Not at all confident	Not very confident	Moderately confident	Very confident	Extremely confident
2. ...when I am feeling tired.	O	O	O	O	O
3. ...when I am feeling under pressure from work.	O	O	O	O	O
4. ...during bad weather.	O	O	O	O	O
5. ...after recovering from an injury that caused me to stop being physically active.	O	O	O	O	O
6. ...during or after experiencing personal problems.	O	O	O	O	O
7. ...when I am feeling depressed.	O	O	O	O	O
8. ...when I am feeling anxious.	O	O	O	O	O
9. ...after recovering from an illness that caused me to stop being physically active.	O	O	O	O	O
10....when I feel physical discomfort when I am active.	O	O	O	O	O
11....after a vacation.	O	O	O	O	O
12....when I have too much work to do at home.	O	O	O	O	O
13....when house guests are present.	O	O	O	O	O
14....when there are other interesting things to do.	O	O	O	O	O
15....if I don't reach my physical activity goals.	O	O	O	O	O

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I am confident that I can be regularly physically active, even...

	Not at all confident	Not very confident	Moderately confident	Very confident	Extremely confident
16....without support from my family or friends.	O	O	O	O	O
17....during a vacation.	O	O	O	O	O
18....when I have other time commitments.	O	O	O	O	O
19....after experiencing family problems.	O	O	O	O	O

For the following statements, please indicate by filling in the appropriate bubble if you agree or disagree with the stated outcomes of being physically active.

Being physically active...	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
20....will make me feel better physically.	O	O	O	O	O
21....will make my mood better in general.	O	O	O	O	O
22....will help me meet people.	O	O	O	O	O
23....will help me feel less tired.	O	O	O	O	O
24....will make my muscles stronger.	O	O	O	O	O
25....will be something I enjoy doing.	O	O	O	O	O
26....will give me a sense of personal accomplishment.	O	O	O	O	O
27....will make me more alert mentally.	O	O	O	O	O
28....will make me feel more energized.	O	O	O	O	O
29....will help me satisfy my need to spend time with family or friends.	O	O	O	O	O
30....will improve my endurance in performing my daily activities.	O	O	O	O	O
31....will help to strengthen my bones.	O	O	O	O	O
32....will be too time consuming.	O	O	O	O	O
33....will make me feel tired.	O	O	O	O	O

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Being physically active...

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
34....will be difficult to find friends to do activities with me.	O	O	O	O	O
35....will take away from the time I have to do other things.	O	O	O	O	O
36....will feel physically uncomfortable while doing the activity (out of breath, in pain, etc).	O	O	O	O	O
37....will leave me feeling refreshed.	O	O	O	O	O

For me to accumulate 45 minutes of moderate intensity exercise at least 4 days per week would be:

	Quite **Useless**	Slightly **Useless**	Neither **Useless nor Useful**	Slightly **Useful**	Quite **Useful**
38. Useless or useful?	O	O	O	O	O

	Quite **Harmful**	Slightly **Harmful**	Neither **Harmful nor Beneficial**	Slightly **Beneficial**	Quite **Beneficial**
39. Harmful or beneficial?	O	O	O	O	O

	Quite **Unenjoyable**	Slightly **Unenjoyable**	Neither **Unenjoyable nor Enjoyable**	Slightly **Enjoyable**	Quite **Enjoyable**
40. Unenjoyable or enjoyable?	O	O	O	O	O

	Quite **Stressful**	Slightly **Stressful**	Neither **Stressful nor Relaxing**	Slightly **Relaxing**	Quite **Relaxing**
41. Stressful or relaxing?	O	O	O	O	O

	Quite **Boring**	Slightly **Boring**	Neither **Interesting nor Boring**	Slightly **Interesting**	Quite **Interesting**
42. Boring or Interesting?	O	O	O	O	O

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Remember:
Regular physical activity" is defined as doing activities such as brisk walking, recreation, and sporting activities (e.g. jogging, swimming, bicycling, skiing) all at a moderate intensity of a brisk walking pace or faster that makes your heart beat faster and causes light perspiration.

For moderate activity to be **regular**, your activity must:

- add up to a total of 45 minutes or more per day

- be done at least 5 days per week

There are no right or wrong answers to any of these questions and your information will be kept confidential.

For each of the following statements, please indicate how much each has influenced your decision about whether or not to get regular physical activity.

	Not at all	A little	Somewhat	Quite a lot	Very much
43. Physical activity would help me reduce tension or manage stress.	O	O	O	O	O
44. I would feel more confident about my health by getting regular physical activity.	O	O	O	O	O
45. By doing regular physical activity, other people will think that I have good physical coordination.	O	O	O	O	O
46. I would sleep better.	O	O	O	O	O
47. Physical activity would take too much of my time.	O	O	O	O	O

Remember, we are not asking you how much you agree or disagree with these statements, but rather how much each may influence your decision to do regular physical activity.

48. By doing regular physical activity, other people will think that my body is fit and toned.	O	O	O	O	O
49. I would have less time for my family and friends if I participated in physical activity.	O	O	O	O	O
50. I'd be too tired to get physical activity because of my other daily responsibilities.	O	O	O	O	O
51. By doing regular physical activity, other people will think that I have good stamina.	O	O	O	O	O

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	Not at all	A little	Somewhat	Quite a lot	Very much
52. Physical activity would help me have a more positive outlook.	O	O	O	O	O
53. Physical activity would help me control my weight.	O	O	O	O	O
54. I'd worry about looking awkward if others saw me being physically active.	O	O	O	O	O
55. By doing regular physical activity, other people will think of me as someone who works out regularly.	O	O	O	O	O
56. Participating in physical activity would cost too much money.	O	O	O	O	O
57. Regular physical activity would cause me injury.	O	O	O	O	O
58. By doing regular physical activity, other people will think that I am in good shape.	O	O	O	O	O

The following questions refer to how you fit regular physical activity into your lifestyle. Please indicate the extent to which each of the statements below <u>describes you</u>:

	Does not describe me		Describes me moderately		Describes me completely
59. I never seem to have enough time for regular physical activity.	O	O	O	O	O
60. Regular physical activity is generally not a high priority when I plan my schedule.	O	O	O	O	O
61. Finding time for regular physical activity is difficult for me.	O	O	O	O	O
62. I schedule events in my life around my regular physical activity routine.	O	O	O	O	O
63. I schedule my physical activity at specific times each week.	O	O	O	O	O
64. I plan a weekly physical activity schedule.	O	O	O	O	O
65. When I am very busy, I don't do much physical activity.	O	O	O	O	O

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	Does not describe me		Describes me moderately		Describes me completely
66. Everything is scheduled around my regular physical activity routine.	O	O	O	O	O
67. I try to do physical activity at the same time and same day each week to keep a routine going.	O	O	O	O	O
68. I write my planned activity sessions in an appointment book or calendar.	O	O	O	O	O

In your opinion, how likely or unlikely are each of the following people to <u>think you should</u> do regular physical activity?

	Very unlikely	Unlikely	Neither unlikely nor likely	Likely	Very likely	Not applicable
69. Your spouse or partner	O	O	O	O	O	O
70. A family member	O	O	O	O	O	O
71. A friend	O	O	O	O	O	O
72. A co-worker	O	O	O	O	O	O
73. A neighbour	O	O	O	O	O	O
74. Your doctor	O	O	O	O	O	O
75. Most people important to me think that I should do regular physical activity	O	O	O	O	O	O

CONTINUE ON NEXT PAGE

How often over the last month, did the following people do physical activity?

	Never	Once or twice	3 times	Weekly (once a week)	More than once a week	Not applicable	Don't know
76. Your spouse or partner	O	O	O	O	O	O	O
77. Close family members	O	O	O	O	O	O	O
78. People at work	O	O	O	O	O	O	O
79. Close friends	O	O	O	O	O	O	O
80. People in your neighbourhood	O	O	O	O	O	O	O

81. Please check the description that best describes your physical activity. Remember, regular physical activity refers to doing physical activity at least 4 days a week, for 45 minutes each day, at a moderate intensity of a brisk walking pace or faster.

- O I presently ***do not get*** regular physical activity and do not plan to do so in the next six months.
- O I presently ***do not get*** regular physical activity, but I have been thinking about doing so in the next six months.
- O I presently ***do not get*** regular physical activity, but I plan to in the next 30 days.
- O I presently ***get*** regular physical activity, but I have only begun doing so within the past six months.
- O I presently ***get*** regular physical activity and I have been doing so for longer than six months.

CONTINUE ON NEXT PAGE

Section E: Social Support for Regular Physical Activity

Below is a list of things that people might do or say to someone who is trying to get regular physical activity. If you do not do regular physical activity, then some of the statements may not apply to you, but please read and try to give an answer to every question.

Please rate how often anyone in your **family** has said or done what is described. Family refers to your spouse/partner and any relative that you have frequent contact with. Choose **"Not Applicable"** when family is **not** available to you.

During the past month, a family member…

	Never	Rarely	Occasionally	Often	Very Often	Not applicable
1. …did physical activity with me	O	O	O	O	O	O
2. …offered to do physical activity with me	O	O	O	O	O	O
3. …gave me helpful reminders to do regular physical activity	O	O	O	O	O	O
4. …gave me encouragement to stick to doing regular physical activity.	O	O	O	O	O	O
5. …changed their schedule so we could do physical activities together	O	O	O	O	O	O
6. …discussed physical activity with me	O	O	O	O	O	O
7. …complained about the time I spent doing regular physical activity	O	O	O	O	O	O
8. …criticized me or made fun of me for doing regular physical activity	O	O	O	O	O	O
9. …gave me rewards for doing regular physical activity	O	O	O	O	O	O
10….planned for physical activities on recreational outings	O	O	O	O	O	O
11….helped plan activities around my regular physical activity routine	O	O	O	O	O	O

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	Never	Rarely	Occasionally	Often	Very Often	Not applicable
12....gave me ideas on how I can get more physical activity	O	O	O	O	O	O
13....talked about how much they liked doing regular physical activity	O	O	O	O	O	O

Please rate how often any of your **friends or co-workers** have said or done what is described during the last month. **Choose "Not Applicable" when friends or co-workers are not available to you.**

During the past month, friends or co-workers...

	Never	Rarely	Occasionally	Often	Very Often	Not applicable
14....did physical activity with me	O	O	O	O	O	O
15....offered to do physical activity with me	O	O	O	O	O	O
16....gave me helpful reminders to do regular physical activity	O	O	O	O	O	O
17....gave me encouragement to stick to doing regular physical activity	O	O	O	O	O	O
18....changed their schedule so we could do physical activities together	O	O	O	O	O	O
19....discussed physical activity with me	O	O	O	O	O	O
20....planned for physical activities on recreational outings	O	O	O	O	O	O
21....helped plan activities around my regular physical activity routine	O	O	O	O	O	O
22....gave me ideas on how I can get more physical activity	O	O	O	O	O	O
23....talked about how much they liked doing regular physical activity	O	O	O	O	O	O

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Please rate how often **your physician** has said or done what is described during the past year. **Choose "Not Applicable" is you have not seen your physician in the past year.**

During the past year, my physician…

	Never	Rarely	Occasionally	Often	Very Often	Not applicable
24....gave me helpful reminders to do regular physical activity	O	O	O	O	O	O
25....gave me encouragement to stick to doing regular physical activity.	O	O	O	O	O	O
26....discussed physical activity with me	O	O	O	O	O	O
27....gave me ideas on how I can get more physical activity	O	O	O	O	O	O

Over the last month, which of these people, if any, did physical activity **with you**, including walking?

	Never	Once or twice	3 times	**Weekly** (4 or more times)	Not applicable
28. your spouse or partner	O	O	O	O	O
29. a family member	O	O	O	O	O
30. someone from work	O	O	O	O	O
31. a friend	O	O	O	O	O
32. someone from your neighbourhood	O	O	O	O	O

This is the end of the questionnaire.

Please indicate the date that you completed this questionnaire below:

	D D	M M	Y Y Y Y
Date questionnaire completed:			

Thank you very much taking the time to complete this questionnaire.
Please return your questionnaire in the postage paid envelope at your earliest convenience.

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APPENDIX G: NEIGHBOURHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)

The following is the Neighbourhood Environment Walkability Scale (NEWS) as it was used in *Survey 2008*.

BUILT ENVIRONMENT

NEW

This section asks about the way that you perceive or think about your neighbourhood. Please answer the following questions about your neighbourhood and yourself. Your neighbourhood is the local area around your home and can include the transportation, housing and public facilities in your area. Some factors affecting your health may be related to some of the characteristics of the area where you live. Please answer the questions as best as you can, whether you live in a large city, small town or in the country.

Types of residences in your neighbourhood: Choose the answer that best applies to you and your neighbourhood.

NEW 1 How common are detached single-family residences in your immediate neighbourhood?

○ None ○ Most
○ A few ○ All
○ Some

NEW 2 How common are townhouses or row houses of 1-3 stories in your immediate neighbourhood?

○ None ○ Most
○ A few ○ All
○ Some

NEW 3 How common are apartments or condos 1-3 stories in your immediate neighbourhood?

○ None ○ Most
○ A few ○ All
○ Some

NEW 4 How common are apartments or condos 4-6 stories in your immediate neighbourhood?

○ None ○ Most
○ A few ○ All
○ Some

NEW 5 How common are apartments or condos 7-12 stories in your immediate neighbourhood?

○ None ○ Most
○ A few ○ All
○ Some

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NEW 6 How common are apartments or condos more than 13 stories in your immediate neighbourhood?

○ None ○ Most

○ A few ○ All

○ Some

Stores, facilities, and other things in your neighbourhood

About how long would it take to get from your home to the nearest businesses or facilities listed below if you walked to them? Please shade only one bubble for each business or facility.

		1- 5 min	6- 10 min	11- 20 min	21- 30 min	30+ min	Don't Know / NA
NEW 7	convenience/small grocery store	○	○	○	○	○	○
NEW 8	supermarket	○	○	○	○	○	○
NEW 9	hardware store	○	○	○	○	○	○
NEW 10	fruit/vegetable market	○	○	○	○	○	○
NEW 11	laundry/dry cleaners	○	○	○	○	○	○
NEW 12	clothing store	○	○	○	○	○	○
NEW 13	post office	○	○	○	○	○	○
NEW 14	library	○	○	○	○	○	○
NEW 15	elementary school	○	○	○	○	○	○
NEW 16	other schools	○	○	○	○	○	○
NEW 17	book store	○	○	○	○	○	○
NEW 18	fast food restaurant	○	○	○	○	○	○
NEW 19	coffee place	○	○	○	○	○	○
NEW 20	bank/credit union	○	○	○	○	○	○
NEW 21	non-fast food restaurant	○	○	○	○	○	○
NEW 22	video store	○	○	○	○	○	○
NEW 23	pharmacy/drug store	○	○	○	○	○	○
NEW 24	hair salon/barber shop	○	○	○	○	○	○
NEW 25	your job or school	○	○	○	○	○	○
NEW 26	bus or train stop	○	○	○	○	○	○
NEW 27	park	○	○	○	○	○	○
NEW 28	recreation centre	○	○	○	○	○	○
NEW 29	gym or fitness facility	○	○	○	○	○	○

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Access to services

Please shade the bubble for the answer that best applies to you and your neighbourhood. Both local and within walking distance mean within a 10-15 minute walk from your home.

		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
NEW 30	Stores are within easy walking distance of my home.	○	○	○	○
NEW 31	Parking is difficult in local shopping areas.	○	○	○	○
NEW 32	There are many places to go within easy walking distance of my home.	○	○	○	○
NEW 33	It is easy to walk to a transit stop (bus, train) from my home.	○	○	○	○
NEW 34	The streets in my neighbourhood are hilly, making my neighbourhood difficult to walk in.	○	○	○	○
NEW 35	There are major barriers to walking in my local area that make it hard to get from place to place (for example, freeways, railway lines, rivers).	○	○	○	○

Streets in my neighbourhood

Please shade the bubble for the answer that best applies to you and your neighbourhood.

		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
NEW 36	The streets in my neighbourhood do not have many cul-de-sacs (dead end streets).	○	○	○	○
NEW 37	The distance between intersections in my neighbourhood is usually short (100 metres or less; the length of a football field or less).	○	○	○	○
NEW 38	There are many alternative routes for getting from place to place in my neighbourhood. (I don't have to go the same way every time).	○	○	○	○

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Places for walking and cycling

Please shade the bubble for the answer that best applies to you and your neighbourhood.

		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
NEW 39	There are sidewalks on most of the streets in my neighbourhood.	○	○	○	○
NEW 40	Sidewalks are separated from the road/traffic in my neighbourhood by parked cars.	○	○	○	○
NEW 41	There is a grass/dirt strip that separates the streets from sidewalks in my neighbourhood.	○	○	○	○

Neighbourhood surroundings

Please shade the bubble for the answer that best applies to you and your neighbourhood.

		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
NEW 42	There are trees along the streets in my neighbourhood.	○	○	○	○
NEW 43	There are many interesting things to look at while walking in my neighbourhood.	○	○	○	○
NEW 44	There are many attractive natural sights in my neighbourhood (such as landscaping, views).	○	○	○	○
NEW 45	There are attractive buildings/ homes in my neighbourhood.	○	○	○	○

Neighbourhood safety

Please shade the bubble for the answer that best applies to you and your neighbourhood.

		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
NEW 46	There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighbourhood.	○	○	○	○
NEW 47	The speed of traffic on most nearby streets is usually slow (50 km/h or less).	○	○	○	○
NEW 48	Most drivers exceed the posted speed limits while driving in my neighbourhood.	○	○	○	○
NEW 49	My neighbourhood streets are well lit at night.	○	○	○	○
NEW 50	Walkers and bikers on the streets in my neighbourhood can be easily seen by people in their homes.	○	○	○	○
NEW 51	There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighbourhood.	○	○	○	○
NEW 52	There is a high crime rate in my neighbourhood.	○	○	○	○
NEW 53	The crime rate in my neighbourhood makes it unsafe to go on walks during the day.	○	○	○	○
NEW 54	The crime rate in my neighbourhood makes it unsafe to go on walks at night.	○	○	○	○