Individual, Social, and Environmental Factors Associated with Physical Activity and Walking

By

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Abstract

Background: Participation in physical activity (PA) is influenced by a multitude of factors. Traditionally, research has focused on several theoretical frameworks focusing on the "individual"; however, they do not necessarily take into consideration other influencing factors such as the social environment or the physical or built environment. As such, a comprehensive socio-ecological model considering a multiplicity of factors is useful in explaining behaviour.

Aims: To 1) assess the prevalence of the individual level correlates and their association with PA and walking; 2) assess the prevalence of environmental determinants and neighbourhood characteristics and the association between these and PA and walking behaviours; 3) explore within a comprehensive and socio-ecological approach, the contribution of the individual, social, and environmental factors in predicting PA and walking.

Methods: The studies used in this thesis are national, random-digit dialling telephone-based surveys of a representative population sample within Canada. All research questions and procedures underwent ethics review at York University. The studies incorporated a two-stage probability selection process to select a survey respondent, and included a number of standard self-report measures across the data collection cycles. PA and all-domain walking were measured using the telephone-administered, short International Physical Activity Questionnaire, the neighbourhood environment was measured using an abbreviated version of the Neighbourhood Environment Walkability Scale (NEWS), and individual factors such as knowledge about amount of PA required for guidelines, beliefs about the benefits of PA, self-efficacy, intention, and initial behaviour changes. Walking for transport was measured through the Physical Activity Monitor and walking for recreation were measured through an adapted version of the Minnesota Leisure-Time PA questionnaire (for the 2007 collection only). Complex sampling methods were required to take into account stratification by province or territory within Canada. Complex samples cross-tabulation procedures were used to calculate the prevalence estimates of Canadians meeting the PA and walking guidelines and 95% confidence intervals. The relationship between factors predicting sufficient activity and sufficient walking were examined using complex samples logistic regression procedures that were reflect the sample design. This thesis explored associations and the relative strength of the factors as the independent measures predicting 'sufficient' PA and 'sufficient' walking as the dependent

measures, using age, sex, and education as covariates for each of these models. Chapter Six expands this model by including walking for recreation and transportation, and examining sub-population groups.

Results: Individual factors (e.g., self-efficacy, intention, and some trial behaviours) and social factors were associated with sufficient PA and certain types of walking. Relatively few environmental factors were associated with sufficient walking (all domain and domain-specific) or sufficient PA. The relationship between high density neighbourhoods and higher rates of walking (generally and specific), and the availability of supportive walking facilities with various modes of walking were evident. Proximity of many shops and the presence of sidewalks were associated with the highest quartile of walking for transport. A greater number of the individual factors predicted walking and PA compared to the environmental/neighbourhood factors, within the context of a full socio-ecological model. Findings differed when stratified by age and sex of respondents.

Conclusions: The results suggest that individual factors may be more relevant for predicting activity and walking than environmental factors, or at least should be considered in their inter-relationship with environmental factors when developing environment-based interventions. Although the inter-relationship between individual factors, social factors and the built environment are important, understanding individual factors are critical for determining strategies and interventions to promote PA among certain populations with traditionally lower levels of activity. Findings suggest that within countries like Canada, with a relative abundance of supportive environments, more specific and detailed measures of the perceived and objective physical environment may be required in order to achieve sufficient variation.

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Publications arising from this thesis

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Table of Contents

Table of Tables

Abbreviations

ANEWS – Abbreviated Neighborhood Environment Walkability Scale

CAD – Canadian dollars

CATI - Computer-Assisted Telephone Interviewing

CCHS – Canadian Community Health Survey

CFLRI – Canadian Fitness and Lifestyle Research Institute

CSEP – Canadian Society for Exercise Physiology

GIS – Geographical information systems

GSS – General Social Survey

HOE – Hierarchy of Effects

LTPA – Leisure-time physical activity

MET – Metabolic equivalent unit

MLTPAQ - Minnesota Leisure-Time Physical Activity Questionnaire

NCD – Non-communicable diseases

NEWS - Neighborhood Environment Walkability Scale

NPHS – National Population Health Survey

PA – Physical Activity

PBC – Perceived behavioural control

PAM – Physical Activity Monitor

PASMP – Physical Activity and Sport Monitoring Program

RDD - random digit dialling

TPB – Theory of Planned Behavior

TRA - Theory of Reasoned Action

WHO – World Health Organization

CHAPTER ONE - Introduction

1.1 Physical inactivity as a public health issue

Physical activity (PA) has an important role to play in the prevention of a myriad of diseases and conditions [U.S. Department of Health and Human Services, 1996; Warburton et al., 2006; U.S. Department of Health and Human Services, 2008], and participation is shaped by multiple influences, such as intrapersonal (for example, self-efficacy, behavioural control, intention), social (for example, social support from family, friends, or health care practitioners), and physical environmental factors (for example, a neighbourhood conducive to walking or bicycling, a mix of land use). Physical inactivity is a significant public health issue, as low levels of PA are associated with increased risk of non-communicable diseases (e.g., heart disease, diabetes, certain cancers), chronic disease risk factors (e.g., obesity and hypertension), anxiety and depression, and premature mortality [U.S. Department of Health and Human Services, 1996; Warburton et al., 2006; U.S. Department of Health and Human Services, 2008]. The World Health Organization (WHO) reports that physical inactivity is the fourth leading risk factor of global mortality, estimating 3.2 million deaths globally attributable to inactivity [WHO, accessed September 25, 2013]. In addition to the impact on the lives of the individual, there are societal costs. For example, the economic impact of physical inactivity in Canada in terms of chronic disease, obesity and health care costs is estimated at CAD $6.8 billion per annum [Janssen, 2012].

With this recognition of physical inactivity as a global health issue, the WHO Assembly endorsed the Global Strategy on Diet, Physical Activity and Health in 2004. At this meeting, WHO member states were urged to develop national PA plans, strategies, and policies to increase activity levels of their respective populations [WHO, 2004; WHO, 2010]. A few years later (2008), the WHO endorsed a global strategy and action plan for the prevention and control of non-communicable diseases (NCDs), which recognized inactivity as one of its determinants [WHO, 2008]. The plan recommended the development and implementation of national guidelines for PA which incorporate frequency, duration, intensity, type and total amount of PA for reducing NCDs along with interventions for active transportation policies and ensuring supportive physical environments [WHO, 2010]. The development of guidelines were seen as important for informing policies and interventions, for the development of goals and objectives, for establishing PA promotion and communication initiatives, providing a framework and

evidence-based document, and to facilitate national surveillance to monitor population levels of PA [WHO, 2010]. Canada is a country that has already made significant advances and is considered one of the countries at the forefront in these regards, especially with respect to guideline development [Tremblay et al., 2011] and PA surveillance [Kohl et al., 2012] and their evolution is described in the following sections.

1.2 Development of national physical activity guidelines in Canada

In Canada, as governments and national PA organizations recognized the need for a constant message which informed the population about the dose and types of PA that are required in order to reduce NCDs and to maintain health, national PA guidelines were developed in the late 1990's. The Canadian Society for Exercise Physiology (CSEP) and Health Canada released specific guidelines for adults between 18 to 55 years (released October 1998), for adults 55 years and older (released in November 1999), followed by guidelines specific to children and youth (released in November 2002). These 1998 Canadian guidelines for adults indicated that 18 to 55 year-old adults should accumulate at least 60 minutes of any intensity activity daily for health and as a progression is made to higher intensity, the number of days and duration could be reduced (such as at least 30 minutes of moderate-intensity activity, 4 days a week or 20 minutes of vigorous-intensity activity, 4 days a week) [Health Canada and Canadian Society for Exercise Physiology, 1998]. The guides and accompanying materials were designed to increase positive beliefs about the benefits of PA to motivate people to try to become more active.

A large media strategy was adopted to disseminate the Canadian PA guides for the various age groups, which was to be supplemented by additional dissemination through intermediaries and professionals [Cameron et al., 2007a]. The first step in this strategy was to increase awareness of the issue of physical inactivity. This involved several media releases over the course of about a month. The second phase of the strategy was the media release of the guides and supporting materials including the launch of the website where Canadians could access the guides and supporting materials. Both phases of the media strategy involved press releases, news conferences, television and radio coverage, and articles in newspapers, which

stated that the guides were available on the CSEP and Health Canada websites [Cameron et al., 2007a].

The development of the guides was intended to provide a common basis for interventions when encouraging Canadians to become more active by providing a suggested dose recommendation for an appropriate level of PA. One theory that has been developed to understand health behaviour change and guide the development of intervention strategies to positively change health behaviours, and therefore was considered in the guide development, is the Theory of Planned Behavior (TPB) [Ajzen, 1985; Ajzen, 1991]. A description of this theory follows in Chapter Two of this thesis. In brief, however, the TPB theorizes that a person's *intention* to perform a behaviour such as PA, is the immediate predictor of that behaviour, because it reflects the individual's motivation to engage in the behaviour [Ajzen, 1985; Ajzen, 1991]. Attitudes (e.g., seeing an activity as harmful/beneficial, boring/enjoyable), subjective norm (social pressure to be active), and perceived behavioural control (how easy/difficult it is to be active) is theorized to predict intention [Ajzen, 1985; Ajzen, 1991; Courneya, 1995]. Attitudes can be influenced by personal beliefs about the behaviour, whereas subjective norms are based on beliefs about the normative beliefs within the social environment, and perceived behavioural control is based on opportunities to perform the behaviour [Ajzen, 1985; Ajzen, 1991; Courneya, 1995]. As an individual acts on their intention, they may try a variety of different behaviours in an effort to become more active. The guides were developed as a communication tool that could be used as part of a broader social marketing campaign to increase awareness of PA and educate individuals about the importance of PA [Cameron et al., 2007]. The guides included aspects of this theory into its messaging, as well as reference to a supportive environment to be active. Theories and interventions relevant to this approach are described in Chapter Two. In Canada, researchers updated the PA guides in 2011 [Tremblay et al., 2011] reflecting current evidence. Given the timing of the surveys in this thesis (prior to 2011), the analyses will pertain primarily to the content of the original guidelines for adults (released in October 1998) as described earlier in this section.

1.3 National physical activity surveillance: understanding changes in behavioural influences

As mentioned previously in this Chapter, the WHO had recommended in their global strategy and action plan for the prevention and control of NCDs [WHO, 2008], the development of guidelines for informing policies and interventions; the development of goals and objectives for establishing PA promotion and communication initiatives; the provision of a framework and evidence-based document; and to facilitate national surveillance and monitoring of population levels of PA [WHO, 2010]. Indeed, Canada has been a country at the forefront of PA surveillance [Kohl et al., 2012], as it possesses a long-standing and established national surveillance system, which examines population levels of PA, and the factors associated with activity. The surveillance system was initiated and established by the Canadian Fitness and Lifestyle Research Institute (CFLRI) in the early 1980's. The importance of PA was recognized in the Canadian Parliament by the introduction and adoption of the *Fitness and Amateur Sport Act* (Government of Canada, 1960-1961), which was an Act that intended to advance the well-being of Canadians. This Act was introduced partly due to initiatives in the 1970's which influenced the policy agenda of the federal government, including a Conference on PA and Health in 1972. One of the recommendations from this conference was to conduct a national fitness survey, subsequently known as the 1981 Canada Fitness Survey (CFS) [Craig, 2011].

The CFS was designed to measure relationships between PA and fitness from a health outcomes perspective and collected nationally representative data on over 20,000 Canadians aged 7 and older, and was essentially considered a landmark study of its time. Fitness and body composition were objectively measured and determinants associated with PA were collected through self-report questionnaires. The longitudinal component of the CFS was developed 7 years later using the same principles, but with more of a focus on behaviour change and health outcomes, and was called the Campbell Survey on Well-Being (CSWB). The sample for the longitudinal component was approximately 4,000. These two foundation studies went beyond traditional studies by operationalizing theory (in particular the Theory of Planned Behavior) for predicting activity [Wankel & Mummery, 1993]. In the mid-1990's, the CFLRI initiated a regular comprehensive PA monitoring system, with the purpose of informing policy and strategic plans and practice. In order to do so, a range of information was required from the literature in order to provide the supporting evidence from an intervention perspective.

In addition, systems-based information was required in order to provide information to determine the capacity to accommodate change. Finally, information from population-based and setting-based surveys of the population and settings were required, in order to understand the current situation. This required a comprehensive system in order to address these three components. Therefore, a framework was established to guide the selection of the determinants to be collected through the surveillance system. In order to monitor outcomes relevant to PA, indicators from the literature which recommends an appropriate dose of PA required in order to achieve health benefits were reviewed, and this review was initially used to help build the case for action. In order to monitor the underlying conditions that influence participation, the intervention, determinants, and correlates literature were used in order to develop the indicators to be collected. Within governments at a federal, provincial and territorial, and even local level, a new era that emphasized performance measures was simultaneously occurring. As such, after consultation with governments and with Canadian scientific leaders within the field of PA, the indicators were selected and recommended to government ministers, and an annual surveillance system (known as the CFLRI's Physical Activity and Sport Monitoring Program or PASMP) was established by the CFLRI, in partnership with the federal, provincial and territorial governments. Self-report measures were adopted extensively within the surveillance system. Although practical and relatively cost-effective, limitations to self-report research, when employed in surveillance, can include bias (selection, sample, recall, and response) and reduced response rates over time. However, current research involving the PA surveillance system in Canada, which represent the key data sources used later in this thesis, have shown no clear differential effect on the representativeness of these samples despite declining response rates over time [Craig et al., 2009]. The development of a comprehensive surveillance system as described above, contributes to accountability for policy makers, government officials and non-governmental organizations, contributes to the efficient use of financial investments, provides the information required to inform national PA recommendations, and allows for the evaluation and assessment of interventions and population strategies [Cameron et al., 2007a; Craig et al., 2007; Spence et al., 2009; Craig et al., 2010; Kohl et al., 2012]. Given the comprehensive and long-term nature of the surveillance system using consistent methodology and measures, the Canadian model has been one that has been promoted globally [Kohl et al., 2012]. Further details about the PASMP are described in Chapter Three of this thesis, and three of the

surveys from this surveillance system are the central data sources for the analyses contained in this thesis.

1.4 A focus on the behaviours: physical activity and walking

As described in the opening sections of this thesis, physical activity is a modifiable risk factor for many chronic diseases and conditions [U.S. Department of Health and Human Services, 1996; Warburton et al., 2006; U.S. Department of Health and Human Services, 2008]. Physical inactivity is an important public health priority, as low levels of PA are associated with increased risk of NCDs, chronic disease risk factors, anxiety and depression, and premature mortality [U.S. Department of Health and Human Services, 1996; Warburton et al., 2006; U.S. Department of Health and Human Services, 2008]. The statistics can be considered to be remarkable. The WHO cites physical inactivity as the fourth leading risk factor of global mortality, estimating 3.2 million deaths globally attributable to inactivity [WHO, accessed September 25, 2013], and in Canada, the health care costs were estimated at CAD $6.8 billion per annum [Janssen, 2012]. Despite the known benefits of PA, many adults and children in Canada are not sufficiently active to benefit their health.

Given the prevalence and popularity of walking among the Canadian population [Cameron et al., 2007b], it is important to examine this form of PA more specifically. Walking is a relatively easy and low-cost activity for all age groups, as it is generally considered a convenient activity that involves little skill, equipment, and cost. As a recreational activity, it is one of the most popular activities among both genders and age groups [Cameron et al., 2007b]. It is, therefore, a key activity to promote to those who are less active in order to increase overall activity levels in general. Walking for commuting has the potential of influencing health outcomes, such as contributing to the prevention of increasing obesity rates [Bassett et al., 2005]. Research has shown a relationship between walking and obesity among industrialized nations (Europe and North America), as the proportion of walking trips was inversely related to obesity rates, as was the total percentage of walking, bicycling, and public transit trips [Bassett et al., 2008]. To better understand these influences, this thesis takes a socio-ecological perspective for examining the determinants that predict PA and walking behaviours within a Canadian context.

1.5 Thesis structure and Chapter outlines

The first section in the next Chapter will demonstrate that individual factors play an important role in predicting PA and walking behaviours. It is suggested that perceptions of the neighbourhood are associated with objective measures in the environment such as having many shops and places within walking distance, sidewalks on most streets and crime rate, whereby objective measures may go through a filtering process based on individual characteristics, for example attitudes, beliefs or behavioural control [Brownson et al., 2009]. Given this, the validity of the measures can be affected by individual factors. Therefore, although individual factors may be critical for determining strategies and interventions for modifying behaviours, considering the inter-relationship between these and the social and built environment is also important. As such, the studies contained in this thesis seek to address this issue among the Canadian population, and posits this as the central research of this thesis.

Chapter Three describes the methodological considerations of this thesis. It starts with an overview of recent and current national public health surveillance surveys in Canada, including PA measures and correlates. It also explores the historical development of the PA measures, the specific measures used throughout this thesis, and the process and procedures used for the analyses.

Chapter Four examines correlates at an individual level and social level using the TPB as its theoretical basis. The theoretical framework of the TPB has been used to explain PA and other health behaviours, and it suggests that intention is an immediate determinant of a given behaviour, and attitude, subjective norm, and perceived behavioural control influence intention [Ajzen, 1985; Ajzen, 1991]. Perceived behavioural control may also directly influence behaviour. As people act on their intention to be active, they may try a range of different behaviours in an effort to become more active. The Chapter begins with a brief overview of the central theory and methods that are used in the Chapter, describes the prevalence of these factors and the association between the individual factors with PA and walking more specifically, and follows with an examination of the factors that predict PA and walking. The Chapter concludes with a discussion of the findings.

Chapter Five explores environmental determinants and neighbourhood characteristics to explain PA and walking behaviours. The Chapter starts with a brief overview of the physical

environment correlates literature, a description of the methods used within the 2004 nationally representative study, describes the prevalence of the correlates and the association between the environmental factors with PA and walking, and follows with an analyses of the environmental factors that predict PA and walking. The Chapter concludes with a discussion of the resultant findings.

Chapter Six takes both Chapter Four and Chapter Five into consideration by further exploring the findings within a socio-ecological approach, the contribution of the individual, social, and environmental factors in predicting PA and walking. The Chapter begins with a brief overview of the literature related to a socio-ecological approach, describes the 2007 nationally representative study used to explore the research questions, describes prevalence estimates and associations between factors, then explores the relative contribution of factors in predicting PA and walking. A discussion of findings concludes the Chapter.

Chapter Seven completes the thesis by discussing the findings of earlier Chapters and providing recommendations for actions for increasing PA and walking among the population. Based on these findings, along with current intervention literature, recommendations for actions for increasing PA and walking among the Canadian population are provided.

Summary of Chapter One

Physical activity has an important role to play in the prevention of a myriad of diseases and conditions [Warburton et al., 2006], and participation is shaped by multiple influences, such as intrapersonal, social, and physical environmental factors.

The WHO endorsed a global strategy and action plan for the prevention and control of non-communicable diseases, which recommends the development and implementation of national guidelines for PA, along with interventions for active transportation policies and ensuring supportive physical environments. Guidelines are seen as important for informing policies and interventions, for the development of goals and objectives, for establishing PA promotion and communication initiatives, providing a framework and evidence-based document, and to facilitate national surveillance to monitor population levels of PA [WHO, 2010]. Canada is at the forefront with respect to guideline development [Tremblay et al., 2011] and PA surveillance [Kohl et al., 2012]. The Chapter provides background on the development of PA guidelines in Canada and describes the evolution of the PA surveillance systems, and the latter provides the data used in this thesis.

This Chapter described the approach and structure of the thesis, Chapter by Chapter, and provided a rationale as to the use of the outcome variables (physical activity and walking) in this document.

CHAPTER TWO – An overview of the literature

2.1 Introduction

As referred to in Chapter One, this Chapter explores the literature regarding relevant theories to frame this thesis. The first section of the Chapter (section 2.2) explores theories of behaviour that focus on individual factors related to PA and walking behaviours. The literature suggests that individual factors may be critical for determining strategies and interventions for modifying behaviour. To begin, the Chapter provides a brief description of some of the most relevant behaviour theories, with a more specific focus on the theory and models which are most relevant to this thesis.

Section 2.3 briefly describes the literature which examines factors related to the physical environment and local neighbourhood. The literature base related to these factors has increased substantially since the 1990's [Sallis, 2009]. The section first starts with an overview of the current methods used in studies pertaining to the physical environment and local neighbourhood to provide general context, paying particular attention to the self-report measures of the Neighborhood Environment Walkability Scale (NEWS), which are most appropriate for the analyses contained in this thesis.

Section 2.4 considers the inter-relationship between individual factors, social factors, and the built environment through a socio-ecological lens. As such, this summary will provide context for the studies contained in this thesis within a Canadian population.

Each of the reviews in this Chapter was conducted through PubMed searching on keywords (physical activity or walking, and theory of behaviour, physical environment, built environment). The review was limited to studies conducted after 2000 with the notable exception being key articles that introduced theories. As this was not intended to be a systematic review of the literature on theories of behaviour and environmental factors, generally speaking, review papers and review of reviews have been utilized to inform this section supplemented by other specific studies of relevance.

2.2 Theories of behaviour: a focus on the individual

Early research in the area of PA focused on theories of behaviour, which reflected individual, cognitive, psychological, and social influences of behaviours [Sallis, 2009]. Some of these theories were developed to understand behaviour, whereas others were developed for interventions, however, generally speaking these theories are more applicable for designing community wide interventions [U.S. Department of Health and Human Services, 1996; U.S. Department of Health and Human Services, 2008]. A brief description of some of the most relevant behaviour theories are summarized below.

Learning theories propose that complex behaviour, such as PA participation, is learned or shaped by the accomplishment of smaller milestones of progression towards a larger goal, and that these smaller milestones need to be established and reinforced, and the newly learned behaviours need to replace less desirable behaviours that are habitual or cued [Skinner, 1953; U.S. Department of Health and Human Services, 1996]. Health belief models originally suggested that a health related behaviour depends on the perceived severity of an illness, a person's pre-disposition towards that illness, perceived benefits of preventive behaviours, and barriers to preventive behaviour [Hochbaum, 1958; U.S. Department of Health and Human Services, 1996; U.S. Department of Health and Human Services, 2008]. Self-efficacy was later added as a factor for health belief models [Rosenstock et al., 1998]. The Trans-theoretical model of behaviour theorizes that behaviour change follows stages of an individual's readiness to change [Prochaska et al., 1982]. Individuals may go through different processes when they move between five stages of change, described as pre-contemplation, contemplation, preparation, action and maintenance, and that individuals may move quite fluidly through these changes in several directions. Interventions for successful behaviour change depend on the right process at the right stage, and tailoring the intervention to each stage is important [Marcus et al., 1992; U.S. Department of Health and Human Services, 1996]. Social cognitive theory [Bandura, 1977a; Bandura, 1977b; Bandura, 1986] suggests that behaviour change is influenced by personal factors, environmental factors, and the behaviour. For this theory, self-efficacy, or an individual's confidence in their ability to perform the behaviour, is an important construct [Bandura, 1986]. Bandura proposed that there exists a reciprocal determinism between personal, behavioural and environmental factors. For example, knowledge, expectations and attitudes influence an individual's perceptions of social norms, access to

opportunities and the influence of others; the reverse is also true [Bandura, 2001]. Social norms, access to opportunities and the influence of others can influence the individual's knowledge, expectations and attitudes [Bandura, 2001].

The Theory of Reasoned Action (TRA) was another theory that was used to rationalize behaviour change [Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980]. The theoretical assumptions of the TRA theorize that the best predictor of behaviour is the construct of intention, and the determinants of intention include attitudes and subjective norm [Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980; Blue, 1995]. Attitudes can be influenced by personal beliefs and values attributed to the behaviour, whereas subjective norms are based on the normative beliefs within the social environment and reflect the social pressure to perform the behaviour [Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980; Courneya, 1995; U.S. Department of Health and Human Services, 1996]. The Theory of Planned Behavior (TPB) is similar to, yet an extension of the TRA [Ajzen, 1985; Ajzen, 1988; Ajzen 1991]. The primary difference between the TRA and the TPB was the inclusion of a third independent construct, namely perceived behavioural control, which represents an individual's perceived control of opportunities or skills to perform the behaviour, which may have an indirect effect through intention, and also a direct effect on the behaviour [Ajzen, 1985, 1991; Blue, 1995; Courneya, 1995; U.S. Department of Health and Human Services, 1996; U.S. Department of Health and Human Services, 2008], which is considered important in behavioural change theory. The TPB suggests that positive attitude, subjective norm, and behaviour control will lead to stronger intention to perform the behaviour [Ajzen, 1985; Ajzen, 1991; Blue, 1995]. Essentially, perceived behavioural control (PBC) is considered a similar concept to Bandura's concept of self-efficacy, as described in the social cognitive theory above [Ajzen, 1985; Ajzen, 1991; Ajzen, 1988; Bandura, 1977a; Bandura, 1977b; Armitage, 2005]. As the constructs contained within the TPB are most relevant to the research conducted in this thesis and the factors selected (given that this theory was used in Canada to supplement the direction of the guides and their evaluation and monitoring), the TPB is considered here in more detail compared to the other behavioural theories described.

To this day, the TPB remains an important theory in terms of predicting and understanding behaviour from the perspective of a theory related to intrapersonal constructs, and this is evidenced by the large body of intervention research that has used this theory to examine

health behaviours, and PA more specifically [Godin et al., 1993; Godin, 1994; Blue, 1995; Godin et al., 1996; Hagger et al., 2002]. A review by Blue [1995] indicates that behavioural beliefs are positively correlated with attitude, whereas normative beliefs are correlated with subjective norms and attitude was predictive of intention. In this review, however, Blue found that subjective norm was not correlated with intention in most studies and, was low when it was correlated, compared to the relationship between attitudes and intention. Intention was predictive of behaviour in most studies where this was examined [Blue, 1995]. This review found that PBC increased the prediction of intention, but not as conclusive in predicting the behaviour itself, however, it was noted that the measures for PBC may have affected these results [Blue, 1995]. Hagger and colleagues [2002] note in their research that the TPB is useful for explaining certain behaviours. It is important to recognize that it may not necessarily account for other cognitive influences on attitudes, subjective norm, perceived behavioural control or intentions, such as motive. Hagger, Chatziasarantis, and Biddle [2002] conducted a meta-analysis of the TRA and TRB. They found that there were medium to large effects sizes for intention-behaviour, attitude-intention, and PBC-intention, and a smaller effect for subjective norm-intention [Hagger, Chatziasarantis, & Biddle, 2002]. In addition, the meta-analysis also confirmed other research that showed the importance of PBC to intention, but this study showed that attitude is attenuated by PBC for intention [Hagger, Chatziasarantis, & Biddle, 2002]. PBC also was found to have a direct effect on behaviour, so both an indirect (through intention) and direct effect on PA was evident. The authors note that it would be of interest to determine whether PBC is related to both internal and external influences [Hagger, Chatziasarantis, & Biddle, 2002]. In general, the researchers found that attitudes are important for influencing intention to be active, and although slightly less so than attitudes, albeit still important, PBC and self-efficacy [Hagger, Chatziasarantis, & Biddle, 2002] are also important. They also explored past behaviour, and found that it attenuated the relationships [Hagger, Chatziasarantis, & Biddle, 2002].

It is suggested that the relative influence of each of the TPB constructs vary according to the behaviour and the population [Ajzen, 1991]. Indeed, this theory has been used considerably for explaining participation in PA, exercise or other activity related behaviours (e.g., strength training) among various populations, including older adults [Courneya, 1995; Conn et al., 2003; Benjamin, Edwards, & Bharti, 2005; Dean, 2006], children and youth [Mummery et al., 2000;

Foley et al., 2008; Cottrell et al., 2012], women [Conn, 1998; Conn et al., 2003; Tavares et al., 2009], those from low socio-economic groups [Armitage & Sprigg, 2010], and ethnicity/culture [Trost et al., 2002; Hagger et al., 2007; Martin et al., 2007; Blanchard et al., 2008]. Moreover, Armitage [2005] also extended the use of the theory in looking at *maintenance* of the behaviour using a longitudinal study finding that perceived behavioural control was predictive of intention and behaviour and that success in performance increased PBC.

The Hierarchy of Effects Model [McGuire, 1984] is often used in the planning, and to some extent, the evaluation of communication campaigns [McGuire, 1984; Bauman et al., 2008; Craig et al., 2010]. This model builds on the TPB previously described, and suggests the effects of communication campaigns are sequenced from short-term to long-term effects. The initial reach of a communication strategy is indicated by the level of community awareness (assessed as unprompted and prompted recall of the message). Subsequent impact is assessed through changes in message understanding, beliefs about the benefits of PA, intention to be active and first steps taken toward becoming active through to overall PA level [McGuire, 1984].

The strength of the literature shows fairly consistent findings that self-efficacy, which is an important element of many cognitive theories, is positively associated with adult physical activity [U.S. Department of Health and Human Services, 1996; U.S. Department of Health and Human Services, 2008]. There are limitations, however, with the studies that should be noted. Many studies have a cross-sectional design, which prevents causal inferences [Hagger & Chatzisarantis, 2009]. Longitudinal studies would contribute to the knowledge by providing information on changes in cognitive factors at various stages in the process of changing behaviour, which is important in determining whether they influence maintenance of PA [Hagger & Chatzisarantis, 2009]. In addition, the manner in which the construct is operationalized is also important as well as providing measures of reliability and validity associated with the constructs [U.S. Department of Health and Human Services, 1996; U.S. Department of Health and Human Services, 2008]. As cognitive measures tend to use a self-report methodology, considerations of social desirability must be recognized [Blue, 1995]. Beyond the cognitive measures, the self-report measures representing PA can also involve

inherent measurement issues, such as limitations to single-domain, over-estimation, and the time frame of the instrument.

2.3 Environmental research: considering the potential impact of the physical environment and neighbourhood

Since the late-1990s, there have been an increasing number of studies that explore the relationship between the physical environment and PA [Sallis, 2009]. According to Brownson et al. [2009], the physical environment can include the built and natural environment and transportation system, whereby:

- the built environment represents the "physical form of communities", such as buildings, spaces, and objects created by individuals [Sallis, 2009] and land use.
- the natural environment includes the places people can be active and where nature can change PA behaviours (e.g., climate, weather, geography) [Sallis, 2009].
- the transportation system includes transportation facilities and services available, such as bicycle lanes [Brownson et al., 2009].

Sallis, in examining the history of these measures, indicates that the built environment is typically governed or guided by policy, which in turn influence opportunities in the community [Sallis, 2009]. Brownson and colleagues [2009] state that conceptual models that support research on the built environment indicate that different physical activities with different purposes (or different domains) are influenced by different aspects of the environment (for example, availability of recreation facilities for leisure time activities and availability of sidewalks or bicycle lanes for active transportation). A framework put forward by Pikora et al. [2003] suggests that environmental influences on walking and cycling includes four features: functionality, safety, aesthetics, and destination; as well as the factors that contribute to each of these features of the environment. As such, environmental measures need to reflect this, and a range of measures, are important.

The development of measures assessing the environment have evolved over time, and currently three types of measures are generally used [Brownson et al., 2009; Sallis, 2009]; these include systematic observations or audits, self-report questionnaires, and geographical information systems (GIS). GIS are systems which compile data for managing, analysing, and understanding data based on one or more sources that represent some geographic considerations [ESRI, 2014]. Currently, these types of data sources in the literature may include population density, land-use, street patterns, sidewalks, traffic considerations, access to recreational facilities, public transportation, crime, and other measures which are described further below [Brownson et al., 2009]. In a review of studies using GIS measures, Brownson and colleagues [2009] found that the methodological considerations of these measures were variable from study to study, making it difficult to compare results. In the review, Brownson and colleagues [2009] provided an overview of the GIS measures used in the studies in the review. These are summarized very briefly here. To begin, population density is a popular measure for the built environment and PA within the domain of transportation, and commonly examines population per total land area and housing units per residential acre. Generally speaking, population density has been consistently associated with walking for transportation [Brownson et al., 2009]. Land use mix can include accessibility measures such as distance between residential and non-residential land use, count and density of destinations, proportion of area for different types of land uses, and pattern of land use. In their review, the authors indicated that there are relationships between land use and PA in some studies, however, there was inconsistency as to which yielded the strongest relationship [Brownson et al., 2009]. Duncan and colleagues [2010] suggested that lack of relationships may be due in part to the fact that geographical scale may not be taken into account. Street pattern has also been studied (including the number of intersections per area and per street network, and percentage of 4-way intersections) and although relationships exist, there are inherent methodological considerations with these measures, such as excluding pedestrian networks, or handling certain types of limited access roads [Brownson et al., 2009]. Access to recreational facilities can include measures such as the distance to the nearest facility, number of facilities, proportion of residential areas with recreational facilities, and accessibility to open spaces adjusted for attractiveness of the facility. Variability in findings exists among these measures [Brownson et al., 2009]. Traffic, crime, sidewalks, and other types of measures are also considered, and findings varied among studies. Although valuable in the addition of objective data, limitations which exist with GIS data include a lack of standardization of definitions or

operationalization of measures, cost to collect, access to data, time required to analyse, and variable quality of the features and facilities [Brownson et al., 2009].

Community audit tools measure the environment through personal observation. Generally, these can include data that can be obtained beyond that measured through GIS, and involves coding the environment characteristics in a systematic manner [Brownson et al., 2009]. Typically, a sample segment of a neighbourhood is assessed, and can include land use, streets and traffic, sidewalks, bicycle lanes, facilities in public spaces, building characteristics, parking maintenance, and safety factors [Brownson et al., 2009]. Although this type of measure requires considerable time, effort, training and technical skills, it can provide useful data beyond GIS along with self-report measures that can be useful to researchers and community planners.

Many of the studies in the literature are based on self-report or perceived measures about the environment or neighbourhoods in which people live. Based on the number of studies involving perceived environment, several reviews and meta-analyses have been conducted [Saelens et al., 2003; McCormack et al., 2004; Owen et al., 2004; Duncan et al., 2005b; Gebel et al., 2007; Saelens et al., 2008; Brownson et al., 2009] on environmental influences and findings from this literature varied. Saelens and colleagues conducted a review and concluded that residents within high residential density, greater connectivity, and greater land use had higher rates of walking and bicycling for utilitarian reasons [Saelens et al., 2003]. Another review of 18 studies indicated that aesthetics, convenience of facilities with respect to walking, including sidewalks, accessibility of destinations, and perceptions about traffic were found to be associated with specific reasons for walking – for example, walking for exercise, walking for transport [Owen et al., 2004]. Differences in study findings in the current literature may reflect differences in populations studied and their perceptions, and considerations with geographical information, and ensuring the measures represent the construct being studied (i.e., different types of walking) [Lovasi et al., 2008]. McCormack and colleagues [2004] also reviewed the literature examining relationships between the physical environment and PA. They observed positive associations between availability, accessibility and convenience of destinations/facilities, neighbourhood features and aesthetics and PA. Duncan, Spence and Mummery [2005b] conducted a meta-analysis of 16 studies to explore the relationship of perceived environment and PA. The odds (adjusted odds for some studies) were log-transformed to produce

approximately normally distributed values and weighted by the individual study weights. Recognizing that environmental attributes may influence PA behaviour differently in various sub groups of the population (e.g., safety may be of higher concern to women and, therefore impose more of a perceived barrier to walking among women than among men), adjusted odds were presented and they found that people who reported that heavy traffic explained the least amount of variance, followed by facilities and sidewalks, whereas shops and services explained the most variance [Duncan et al., 2005b]. Ideally, a meta-analysis of this nature that is intended to explain the relationship of various environmental factors to PA would be based on intervention or prospective studies of those who move from one built environment to another of a different type. However, given the relatively early stage of research in this area (e.g., compared to behavioural theory), a meta-analysis of cross-sectional studies is beneficial in synthesizing potential effects and shaping a research agenda. Based on the findings of the meta-analysis, the authors suggested that providing pedestrian friendly modifications and road modifications to reduce traffic, may contribute to sustainable increases in activity levels [Duncan et al., 2005b]. They also suggested that policy level changes may influence activity levels by providing safe environments close to the home, green space and other recreational locations which can be used for PA, active transport routes separate from vehicle traffic, pedestrian friendly modifications, and increases in school physical education, which can help make PA an easier "choice" [Duncan & Mummery, 2005a]. Saelens and Handy [2008] reviewed 13 reviews and 29 original studies involving the relationship between the built environment and transportation and recreational walking. This review of reviews supported the earlier findings about the relationship between walking for transportation and residential density, land use mix, and also distance to non-residential destinations, however, the researchers found that the relationship between these environmental variables and recreational walking were not evident [Saelens & Handy, 2008]. The authors also noted that infrastructure such as sidewalk availability and their condition was less consistently related to walking for transport and more so for walking for recreation [Saelens & Handy, 2008]. A study exploring the association between self-reported walking and environmental perceptions in the U.K. found that although both men and women had generally positive views of their environment with respect to walking, differences existed by gender [Foster et al., 2004]. Based on findings using a logistic regression model, women who felt it unsafe to walk during the day were less likely to walk at least 15 minutes per week in the prior four weeks compared to women who felt more safe, and women who said that they did not have a shop within walking distance were less

likely to walk this much [Foster et al., 2004]. Among men, having a park or open space within walking distance was associated with walking more than 150 minutes per week [Foster et al., 2004]. Another U.K. study explored the relationship between walking and other physical activities by objectively measured environmental measures, such as distance to swimming pools, sport facilities, and public green space, as well as level of traffic and crime [Foster et al., 2009]. Using a multiple regression analysis, it was determined that cycling was associated with traffic level for both men and women, whereby cycling dropped as traffic increased [Foster et al., 2009]. The authors noted limitations in that the analysis was based solely on self-report measures, and there were limitations in assumptions made regarding the environmental variables used in the study when data on the location where the adults were actually active, were not available [Foster et al., 2009].

Brownson et al. [2009] also conducted a review of studies of self-report measures. In their review, the authors indicated that land use, traffic, aesthetics, and safety in the neighbourhood were measured most frequently, and that the Neighborhood Environment Walkability Scale (NEWS) and its abbreviated versions (ANEWS) was the survey instrument most frequently used. This section discusses research associated with these particular self-report measures. The NEWS [Saelens et al., 2003] and the abbreviated NEWS, called ANEWS, [Cerin et al., 2006] are the measurement tools used by the *International Physical Activity and the Environment Network* whose purpose is to provide valid, reliable and consistent measurement tools across countries. A study by Cerin et al. [2006] found acceptable factorial and criterion validity of the NEWS and the ANEWS, where the scales that operationalized differences in access to destinations, residential density, walking infrastructure, aesthetics, safety and crime were positively associated with walking for transport, whereas aesthetics, a mixture of destinations, and residential density were positively associated with recreational walking. A study by Saelens et al. [2003] found that the NEWS items had moderate to high test-retest reliability. In this study it was also observed that those in higher walkable neighbourhoods indicated higher residential density, land use mix, street connectivity, aesthetics, safety, and had more minutes of PA and lower obesity than those in less walkable neighbourhoods.

A study by Gebel and colleagues [2011] looked at the comparison between perceptions (using the NEWS) and objective assessment (GIS) of neighbourhood walkability with walking and weight. This Australian study found that adults that viewed their neighbourhood as highly

walkable and residential density or land mix as low, reported less walking (for transport) and had higher body mass index compared to those whose subjective and objective measures were both high [Gebel et al., 2011]. Moreover, Gebel and colleagues found in a 2009 study that there generally was fair agreement between objective walkability (measured via GIS) and perceived walkability (NEWS). Among those living in highly walkable areas, certain characteristics distinguished those with concordant perceptions of their neighbourhood and those with non-concordant perceptions. Not having a university education, having lower household incomes, being overweight, and walking for transport less often [Gebel et al., 2009] were associated with having non-concordant perceptions of their high walkable environments.

A multi-country study [Sallis, 2009] with the purpose of determining the variability of NEWS items and found that most environmental characteristics were associated with an increased likelihood of sufficient PA (meeting guidelines for PA), including many shops nearby, transit stops in neighbourhood, sidewalks on most streets, bicycle facilities, and low-cost recreational facilities. The study found that single-family homes and perceived crime, however, were not significantly associated with PA. Indeed, the research also found that there was a linear relationship between the number of environmental attributes (those described above) and PA, in that those reporting more supportive attributes were more likely to be active [Sallis, 2009]. The one attribute with the highest odds ratio was the availability of sidewalks on most streets in the neighbourhood [Sallis, 2009], which has the potential for influencing various modes of PA. In Australia, a modified version of the NEWS was used to compare neighbourhoods that differed based on GIS indicators [Leslie et al., 2005]. Those living in highly walkable neighbourhoods reported higher rates of residential density, land use mix, and street connectivity, whereas safety, traffic and crime did not vary. These measures had moderate to high test re-test reliability [Leslie et al., 2005]. A study in the U.S. used the NEWS measures and found that supportive walking and bicycling opportunities, availability of free or low cost recreational facilities, and low neighbourhood crime were positively associated with PA [Ainsworth et al., 2005]. Moreover, the ANEWS was used in a study in the Czech Republic, finding that among men, the type of dwelling (i.e., single family dwellings) were positively correlated, whereas for women, fewer non-sport facilities and less access to shops was negatively associated with step counts using pedometers [Sigmudova et al., 2011]. These researchers also found that those who perceived their neighbourhoods to be pleasant and had better access to shops tended to meet the PA recommendations [Sigmudova et al., 2011].

Spittaels et al. [2009] describes the NEWS as the one set of measures commonly used in European studies. For example, Van Dyck and colleagues [2011] used NEWS measures in their study and found that perceived highly walkable neighbourhoods (high residential density, high land use mix access, and high land use mix diversity), convenient recreation facilities, and available PA equipment at home were the most consistent physical environmental correlates of PA.

There are limitations to the environmental data that should be noted. The majority of studies are cross-sectional in nature; however more longitudinal data is required in order to understand the relationship between environmental factors and changes in behaviour [Ogilvie et al., 2007]. There are also concerns about the interpretation of the scale of neighbourhood being explored, whereby there may be discrepancies between an individual's interpretations of the term "neighbourhood" in a geographical sense of the term, in that it may vary from individual to individual. Indeed, Smith et al. found that respondents typically interpreted a smaller neighbourhood area than that used in definitions in research related to the physical environment [Smith et al., 2010]. The limitations of the NEWS may also include the scope of the measure as it assesses agreement with the presence of PA related facilities in the neighbourhood. In countries where facilities or amenities supporting PA are prevalent (for example, the availability of sidewalks) the lack of variation in neighbourhoods may require the use of additional measures, in order to provide a finer grain of detail. In addition, the questions used in an abbreviated version of the NEWS may not necessarily be appropriate measures for rural [Sallis et al., 2009] or further isolated communities, such as those found in Canada.

Given it is relatively early in the development of research on the environmental impacts on PA, many studies may not have the same degree of rigor as studies involving individual factors, which benefit from a long history of research. This point is discussed by Gebel et al. [2007] who systematically appraised the literature reviews exploring the relationship between PA and the environment (reviews conducted between 2000 and 2005). These researchers reported that many of the reviews omitted studies that could have been included in the review, and at times incorrectly reported study findings, concluding that standardization in the reporting of review methods are important for examining the influence of physical environments on PA. For example, in eleven studies that they reviewed, only two studies were deemed comprehensive for including most relevant studies, where the others included less than two-thirds of the

relevant studies or did not provide any details about them, which could result in biased conclusions [Gebel et al., 2007]. In addition, some study findings were reported inaccurately, or only significant findings were reported [Gebel et al., 2007] Bauman [2005] also states that although many cross sectional studies have indicated small associations between environmental measures, diet and PA, specific "solve-all" correlates which may considerably improve public health interventions, have yet to be determined.

In summary, research in this area has found that many environmental characteristics were associated with an increased likelihood of sufficient PA (meeting guidelines for PA), including many shops nearby, transit stops in the neighbourhood, sidewalks on most streets, bicycle facilities, and low-cost recreational facilities, whereas neighbourhoods consisting of primarily single-family homes, in addition to perceived crime, were not significantly associated with PA [Sallis, 2009]. In essence, perceived highly walkable neighbourhoods could be characterized with higher residential density, greater land use mix, street connectivity, aesthetics, and safety. Given the current gaps in the literature, particularly in informing health interventions, and the need to progress the literature that is relevant to a variety of countries, NEWS was chosen as the measure of the physical environment in this thesis. Despite its limitations noted above, it has reasonable properties (reliability and validity against objective measures) and its adoption by the *International Physical Activity and Environment Network* to serve as a measure for comparison across countries increases the generalizability of the findings from this thesis to other countries with similar environmental characteristics to those in Canada.

2.4 A socio-ecological approach: a framework for understanding multiple influences

With the recognition of the role of the physical environment in influencing activity, more widespread use of ecological models [Giles-Corti et al., 2005; Sallis, 2009] were developed to examine the multiplicity of factors influencing PA and to provide a framework for interventions at an individual level (demographic and psychological factors), a social level, a community level, a physical environmental level, and a policy level [Sallis et al., 2006; Sallis et al., 2009]. These factors interact with each other and need to be considered as such. For example, strategies that are targeted to the community level rely on individual-level factors, and

conversely, those aimed towards the individual are also influenced by community or environmental factors [Satarino & McAuley, 2003; Sallis et al., 2006; Hall & McAuley, 2010]. In 1998, a review of correlates of PA participation found that individual-level variables including socio-economic status and perceived self-efficacy were strongly and consistently related to PA, whereas the association with the physical environment, skills and certain behavioural characteristics varied [Sallis et al., 1999]. A later review supported earlier findings including the relationship with self-efficacy, and in addition found that certain demographic characteristics, behaviours such as smoking, certain barriers (i.e., lack of time), past exercise behaviour, and several environmental measures were associated with PA [Trost et al., 2002].

Since this time, several studies have utilized this approach when looking at PA more broadly. A study based on Canadian data looked at the relationship of individual, social, and environmental factors on PA more generally [Pan et al., 2009]. In that particular study, social support was not related to PA, facility availability was positively associated with PA only among those with a university education, and self-efficacy and intention had the strongest association and largest effect on PA [Pan et al., 2009]. Another Canadian study examined the role of perceived behavioural control in mediating neighbourhood walkability, and moderate- and vigorous-intensity PA [McCormack et al., 2009]. Results from this study indicated that for women, easy access to places to be active was positively associated with participation in moderate- and vigorous-intensity PA, having many shops and places within walking distance was positively associated with moderate intensity PA, whereas sidewalks on most streets and crime rate in the neighbourhood were negatively associated with moderate intensity PA. For men, easy access to places to be active was positively associated whereas crime rate was negatively associated with vigorous-intensity PA [McCormack et al., 2009]. Further, perceived behavioural control mediated the relationship between easy access to places and PA for men and women [McCormack et al., 2009]. In a US study, McNeill and colleagues [2006] used a socio-ecological model of PA in order to look at the direct and indirect effects of these factors. Similar to the Pan et al. study, self-efficacy was found to be strongly related to intensity of PA, physical environment was directly related to PA and social support was indirectly related through motivation and self-efficacy [McNeill et al., 2006]. A Japanese study found that only self-efficacy was directly related to moderate- and vigorous-intensity PA (excluding walking) and that the physical environment indirectly influenced moderate- and vigorous-intensity PA through self-efficacy, social support and outcome expectancies [Ishii et al., 2010]. An Australian

cross-sectional study looked at the contribution of individual, social, and environmental factors to activity level (individual and area level) for socio-economic (SES) groups [Cerin & Leslie, 2008]. Looking at independent effects, these researchers found that for all the SES measures (education, household income, area level household income), self-efficacy, perceived benefits, family social support, mental health, and perceived neighbourhood traffic hazards and crime were also significant in directions that would be expected. Moreover, physical barriers to walking and individual sport facilities for both income measures, social support of friends, presence of open space, team sport facilities, neighbourhood aesthetics were related to area level income, whereas home equipment and physical activity were related to individual level measures [Cerin & Leslie, 2008]. These researchers also found that the effects of income (both household and area level income) on recreational walking were fully explained by self-efficacy, social support, and barriers to walking, and most of the effects of education on this type of walking were explained by self-efficacy and social support from family [Cerin & Leslie, 2008]. Moreover, Duncan and Mummery [2005a] also used a socio-ecological model for PA, finding that connectivity, distance to parks, number of active people within a 1 km radius (middle tertile), and perceptions of cleanliness and tidiness of the neighbourhood were positively associated with increased likelihood of achieving sufficient levels of PA. However, a greater distance to footpaths was associated with lower odds of recreational walking, and disagreement with poor conditions of footpaths, number of dogs within a certain distance (middle tertile), and a greater distance to a news agent were associated with the likelihood of walking for recreational purpose [Duncan & Mummery, 2005a].

More specific research using this type of socio-ecological approach has also investigated PA in specific populations. For example, Cleland and colleagues conducted a study in Australia using a socio-ecological framework to predict PA among women residing in disadvantaged neighbourhoods [Cleland et al., 2010]. Using a multinomial logistic regression, all individual (self-efficacy, enjoyment, intention, outcome expectancy, skills) and social factors (childcare, social support from family and friends, dog ownership) were positively associated with leisure time PA, whereas certain individual factors (self-efficacy, enjoyment, intention), social support, *and* the neighbourhood walking environment were associated with transport related PA [Cleland et al., 2010]. Further, based on a study in Andalusia, Spain, which is characterized by the lowest socio-economic levels and low rates of PA, Bolivar et al. [2010] examined socio-demographic, physical and social environmental factors on PA among an adult population.

These researchers found that individual factors are important, however, for the environmental factors, only perceptions about the amount of green space in the neighbourhood were significant for men and women [Bolivar et al., 2010]. Another study examined individual, social, and environmental barriers for PA among older women [Hall & McAuley, 2010] and found that those who were less active (<10,000 daily steps) had lower self-efficacy ratings, more functional limitations, fewer close walking paths, less street connectivity and reduced perceptions of safety from traffic. Hall and McAuley had hypothesized that the individual factors would be more strongly associated with step counts among their population than the social and environmental factors, and found that indeed, this was the case [Hall & McAuley, 2010]. Blanchard and colleagues [2005] studied socio-ecological correlates of PA in relation to weight status and found that self-efficacy, social support, and access to facilities within a neighbourhood were positively related to PA, however, varied according to weight status of the individual. This type of framework has also been used on youth and found that differences appear between boys and girls, whereby PA of boys was associated with unstructured and social activities and girls' activity was associated with barriers and proximity to schools [Patnode et al., 2010]. Moreover, in a study conducted in New Zealand, Maddison et al. [2009] examined individual factors adopted from the Theory of Planned Behavior and the physical environment in relation to PA among adolescents. Findings from this study indicated that the individual factors, or those related to the Theory of Planned Behavior were the strongest determinants to PA (both subjective and objective), perceived environmental measures were directly related to self-report PA, and the built environment measures were not directly or indirectly related to the measures of activity [Maddison et al., 2009]. In a U.K. study, researchers examined environmental and individual factors in urban areas considered deprived [Cochrane et al., 2009]. These researchers included in a multi-level analysis nine individual factors including, intention and beliefs, access to shops, work, or fast food, weather, and age and gender, and four area level factors related to traffic, road casualties with public transport, damage related to crime, and access to green space [Cochrane et al., 2009]. Cochrane and colleagues found that the largest explanatory contribution to the model was made by intention and beliefs which suggest that cognitive factors may mediate PA, although the variance over these factors also suggest other environmental factors may not be mediated by cognitive factors [Cochrane et al., 2009].

Relatively few studies have taken a socio-ecological approach for predicting walking more specifically. Two studies in Canada took such an approach and found that for walking behaviours, environmental factors were mediated by attitudes and intention [Rhodes et al., 2006, Rhodes et al., 2007], and those with closer perceived proximity to recreation facilities showed a greater intention to walk [Rhodes et al., 2006]. An Australian study by Cerin et al. found that individual, social, and environment factors made a significant contribution to the relation between socio-economic status and walking for transportation [Cerin et al., 2009b]. Moreover, the number of motorized vehicles and aesthetics and greenery were the strongest mediators of the relationship between walking with income. The authors concluded that interventions that increase density of residences, reduce barriers to walking, increase social support, and provide a greener and a more aesthetic environment, especially in disadvantaged areas, may reduce inequities in terms of PA participation [Cerin et al., 2009b].

Looking more broadly at self-rated health status, one Canadian study examined the effect of individual and neighbourhood characteristics on self-rated health and found that individual characteristics (specifically PA, alcohol consumption, community belonging, income and education) had a stronger effect on health status compared to neighbourhood characteristics [Walter Rsugu Omariba, 2010]. Strongegger, Titze and Oja [2010] conducted a study in Austria examining neighbourhood and the association with transport and leisure-time PA and self-rated health, finding that a neighbourhood with a high social environment was associated with higher health status and PA. Further, satisfaction with local infrastructure was associated with PA for transport purposes and the type of transport related PA differed by gender where more men bicycled and more women walked.

Summary of Chapter Two

The purpose of this Chapter was to provide a summary of the relevant literature pertaining to the research questions of this thesis. This includes:

- a brief overview of the literature pertaining to theories of behaviour which focus on an individual, with a particular focus on the Theory of Planned Behavior as a foundation for the research questions and data analysed in this thesis;
- a brief synopsis of the literature involving the physical environment, including a quick summary of the types of measures used to assess the walkability and supportiveness of the physical environment and the neighbourhood;
- a short summary of the literature pertaining to a socio-ecological approach to examining PA and walking, as the integral model as the foundation for this thesis.

The theories of behaviour were originally developed to understand behaviour, and most either incorporate a progression, or else an influence of behaviours on another, towards achieving a given behaviour. To begin, a very brief overview various socio-cognitive theories are summarized. For the purposes of this thesis, however, the Theory of Planned Behavior was integral for providing a framework for the constructs incorporated in the surveillance systems which have been used to inform the analyses in this thesis. Therefore, more detail about this theory is described in this Chapter. In essence, this theory posits that positive attitude, subjective norm, and behaviour control will influence an individual's stronger intention to perform the behaviour [Ajzen, 1985; Ajzen, 1991]. A review indicated that behavioural beliefs are positively correlated with attitude, whereas normative beliefs are correlated with subjective norms, and attitude (and rarely, subjective norms) was predictive of intention. Intention, in turn, was predictive of behaviour in most studies. The Theory of Planned Behavior may not necessarily account for other cognitive influences on the theory's constructs, such as motive; however, as a popular framework for predicting behaviour from an intrapersonal perspective and providing direction for many PA interventions, this theory is used as a basis for conceptualizing constructs for later Chapters (Chapters Four and Six).

More recently, there has been a shift in the research to investigate the relationship between the physical environment and PA. In general terms, activities of varying purposes are influenced by varying aspects of the environment [Brownson, 2009]. For example, some reviews indicate that relationships between residential density, land use mix, and also distance to non-residential destinations are important for transportation related walking, but are not as significant for recreational walking [Saelens & Handy, 2008]. To set the stage, an overview of various measures popular in the literature to assess the physical environment has been provided as background. Despite tremendous evolution of the use of GIS informed measures to assess the physical environment (e.g., population density, land-use, street patterns, presence of sidewalks), much literature in the field is still based on self-report or perceived measures about the environment or neighbourhoods. One of the most common set of self-report measures used in research in this field are derived from the Neighbourhood Environment Walkability Scale, and an adapted version of this set of indicators have been used in this thesis (Chapters Five and Six) due to their popularity internationally, reliability, and validity testing. Research in this area has found that many environmental characteristics were associated with an increased likelihood of sufficient PA (meeting guidelines for PA), including many shops nearby, transit stops in the neighbourhood, sidewalks on most streets, bicycle facilities, and low-cost recreational facilities, whereas neighbourhoods consisting of primarily single-family homes, in addition to perceived crime, were not significantly associated with PA [Sallis, 2009]. In essence, perceived highly walkable neighbourhoods could be characterized with higher residential density, greater land use mix, street connectivity, aesthetics, and safety. Given the relationship of these measures to walking and PA, measures assessing the walkability of the physical environment and neighbourhood are essential components and have shaped the investigation of this thesis.

Finally, the Chapter sums up by exploring the use of ecological models, recognizing the role of the multiplicity of factors influencing PA and to provide a framework for interventions at an individual level (demographic and psychological factors), a social level, a community level, a physical environmental level, and a policy level [Sallis et al., 2009; Sallis et al. 2006]. Several studies have utilized this approach when looking at PA [Pan et al., 2009; McCormack et al., 2009; McNeill et al., 2006; Cerin & Leslie, 2008]. However, there is relatively limited data exploring both the contribution of individual, social, and physical environment level factors on both physical activity and walking behaviours. This thesis will use nationally representative studies to explore the relationship of these factors to physical activity and walking, first through examining prevalence estimates and associations between factors, then exploring the relative contribution of factors in predicting PA and walking.

CHAPTER THREE - Methods

3.1 Introduction

This Chapter describes the research methods and the measurements used in this thesis. The measures span potential influencers of PA and walking at the individual, social, and built environment levels described in Chapter Two. The studies that are analysed in this thesis were conducted within a national PA surveillance system and involve representative samples of the Canadian adult population. This Chapter is divided into the following sections:

Overview of population surveillance of physical activity in Canada (section 3.2) – This section provides a brief overview of some of the recent and current national public health surveillance surveys in Canada that have included PA measures, or their correlates. This section also provides a very brief overview of the historical development of the PA measures that are used throughout this thesis.

Overview of the Physical Activity Monitor (section 3.3) – This section provides a brief overview of the PA surveys used in Canada, known as Physical Activity Monitors (PAM) and these form the primary data sources for this thesis.

Summary of protocols for the Physical Activity Monitors (section 3.4) – This section reviews the sampling, data collection and coding methods utilized in the Physical Activity Monitors; this section includes information on the interview method, sample selection, the protocols for call backs, and the achieved response rate.

Review of measures collected in the Physical Activity Monitor (section 3.5) – This section describes the specific measures [variables] from the Physical Activity Monitors that are used throughout this thesis.

Analytic techniques (section 3.6) – This last section briefly describes the process and procedures used for the analyses presented in this thesis. Included here are the approaches to describing the data, the application of sample weights, and the application of statistical modelling techniques.

3.2 Overview of population surveillance of physical activity in Canada

This section describes some of the recent large scale, regularly-conducted, national surveillance studies that incorporate measures of PA in Canada. The purpose of this section is to provide a background to the population data sets used in this thesis.

Statistics Canada's General Social Survey (GSS), which was originally established in 1985, conducts repeated cycles of surveys of representative samples of Canadians, in order to examine key social issues over time. One of these surveys involved the collection of reported time spent ('time use') in various activities, including time spent in active leisure, sport participation, and sedentary time. The 'time use' data were collected using a 24-hour time diary where participants (Canadians aged 15 years and over) recorded the time that they had spent in each activity during the day. Since the establishment of the GSS, over the years (1985 - current) the sample size has ranged between approximately 8,700 and 17,700 [Hurst, 2009]. Based on trend data from the GSS, participation in active leisure increased from 21% in 1992 to 24% in 2005, averaging 1 hour and 46 minutes of time spent on these types of activities on a given day in 2005 [Hurst, 2009].

Statistics Canada's National Population Health Survey (NPHS) was initiated a decade later (in 1994), with the expressed purpose of increasing the evidence for developing and evaluating health policies and programs in Canada. This survey examined PA as a risk factor for health conditions. Data were collected over a 12-month cycle every two years. These surveys comprised a longitudinal cohort (initially approximately n=17,000) and this has been supplemented with a cross-sectional sample in order to provide a snapshot of health related policies and programs.

Statistics Canada also developed the Canadian Community Health Survey (CCHS) from 2000 onwards with the primary purpose of examining information related to health information systems (health status and determinants, health care utilization and access). This survey is a cross-sectional survey, which now collects data on an annual basis. Previously, data collection occurred every two years between 2000 and 2005, and yielded large samples of approximately 135,000 Canadians in each survey period, in order to provide public health data estimates at a health regional level.

In both the NPHS and CCHS surveys, the PA indicators measure the single domain of "leisure time PA" (LTPA), using an adapted version of the Minnesota Leisure Time Physical Activity Questionnaire (MLTPAQ) [Taylor et al., 1978]. These versions probe recall of participation in physical activities during the previous 3 months. Activity level is calculated by multiplying the occasions by the average time reported for each activity by the metabolic equivalent (MET) which indicates the amount of energy expended on the activity relative to a resting state value for each of these activities [Ainsworth et al., 1993]. Given the question is based on 3 month recall, in order to calculate the yearly total this product is multiplied by 4. This calculation is repeated for each PA reported. Subsequently, the energy expenditure value is summed across each activity then divided by 365 to yield the average energy expenditure from leisure time PA per day.

Based on the trend data from the NPHS and CCHS surveys, leisure time PA of the adult population increased in Canada from 1994 to 2003, and has remained relatively stable since that time. Currently, federal, provincial, and territorial governments use this data source for tracking PA levels of Canadians. Within these Canadian studies, PA has been examined as a risk factor for health surveillance. For example, the GSS surveys examines time spent in active leisure, sport participation, and sedentary time and their relation to other social issues, while the NPHS/CCHS studies look at leisure-time PA as part of policies and programs related to health more generally.

In Canada, there has been a long-standing history of surveillance of PA specifically for the purpose of assisting in the design, development and implementation of policies to increase PA levels among the nation. The Canadian Fitness and Lifestyle Research Institute (CFLRI) is a research organization that has been tracking population PA levels of Canadians, as well as factors associated with PA since 1981. Indeed, the 1981 Canada Fitness Survey was the first large scale national study examining PA levels and measures of fitness in Canada (Stephens et al., 1986a; Stephens et al., 1986b). The long-standing nature of CFLRI's PA surveillance in Canada is a particular strength of this data source, and Canada represents one of few countries that have tracked PA for such an extended period of time with consistent measures.

The CFLRI's current *Physical Activity and Sport Monitoring Program* was established in 1995, and includes: 1) the Physical Activity Monitors (PAM), which are representative annual population-based studies of PA along with associated correlates of PA; 2) representative studies involving objective measures of PA of young people (CANPLAY study); and 3) surveys of settings to determine the policies and practices of the systems to support PA. This set of surveillance measures is comprehensive in nature and represents an additional strength of these data sources. Studies based on the Physical Activity Monitor have shown that leisure time physical activity levels have increased over a twenty year period from the 1980s to 2000 [Craig et al., 2004].

3.3 Overview of the Physical Activity Monitors

This section provides some background on the development of the Physical Activity Monitors (PAMs) as the 2003, 2004, and 2007 PAMs are the central sources for the secondary analyses reported in this thesis. More detailed descriptions of PAM methods are reported in sections below and further background has been published elsewhere [Cameron et al., 2004, Cameron et al., 2005, Craig et al., 2004, Canadian Fitness and Lifestyle Research Institute, 2008].

The PAMs represent annual population-based surveys that form one component of the larger *Physical Activity and Sport Monitoring Program* of the CFLRI, which is described briefly in the preceding section. The PAMs are national, random-digit dialling telephone-based surveys of representative population samples. The surveys are cross-sectional studies and include samples ranging between 4,000 and 11,000, depending on the year conducted.

Content for the PAMs was determined through several sources. To monitor outcomes that are relevant for PA, indicators from the literature summarizing the dose of PA required for health outcomes were reviewed and the findings from these were used to help build the case for action to support the long-standing program. However, to monitor the diverse range of individual, social and environmental factors that might influence participation, the intervention, determinants and correlates (cross-sectional associations) literature were used to develop indicators. The PAMS follow a prescribed rotation of cycle of survey topics, as described in Table 3.1. The cyclical nature of the program in order to provide trend information over time is a

particular strength of this set of studies. In addition, PA information is collected over a full calendar year in order to reduce the potential of seasonal bias on the estimate, given the climate variations in Canada.

Table 3.1: Topic themes for the Physical Activity and Sport Monitoring Program

Population	Data collection cycles	
	1st	2nd
A focus on individual factors related to PA, including awareness, knowledge, beliefs about the benefits, attitudes, intention, changes in behaviour	1998	2003 (trend information compared to 1998 data contained in appendix)
A focus on factors in the community related to PA, including the availability and usage of facilities, opportunities in the community that facilitate or hinder participation, as examples.	1999	2004 (trend information compared to1999 data contained in appendix)
A focus on factors related to PA behaviours of children and youth, including physical education opportunities, local opportunities to be active, parental involvement in child's PA, preferences for types of activities, as examples.	2000	2005
A focus on factors related to PA behaviours of Canadian workers, such as perceived barriers and benefits of PA related to the workplace, fitness opportunities at work, attitude and support from the workplace, as examples	2001	2006
A focus on trends by examining key factors from the preceding surveys	2002	2007 (trend information compared to 1998, 1999, 2003, 2004 data contained in appendix)

3.4 Data collection protocols for the Physical Activity Monitors

The data collection protocols used in the PAMs, including the interview methods, sampling strategy, and response rate, are summarized in this section. Data collected from the surveys conducted in 2003, 2004 and 2007 form the basis for the secondary analyses reported in Chapters Four, Five, and Six.

3.4.1 Collection/sampling: design and strengths and limitations

The PAMs are national, random-digit dialling telephone-based surveys of a representative population sample. Although the national scope of the survey and the fact that the studies are representative of various specific populations (for example by sex, age, and socio-economic

groups) are strengths of the surveys, the surveys are cross-sectional in nature. It is, therefore, only possible to assess associations, and monitor trends among different groups of Canadians.

Interviewing for the PAMs has been conducted by the Institute for Social Research (ISR) at York University, Toronto on behalf of the CFLRI since 1995. This has ensured standard procedures over that period, with no changes in methods that might inadvertently impact secular trends. Through ISR, all research questions comprising the PAMs as well as the procedures undergo ethics review by the York University *Human Participants in Research Committee*, York University's Ethics Review Board. This Review Board conforms to the standards of the Canadian Tri-Council Research Ethics guidelines.

The PAMs are telephone-based surveys that use Computer-Assisted Telephone Interviewing (CATI) software. There are roughly 100-120 survey interviewers trained to interview for each survey. Surveys conducted by telephone interviewing are a relatively cost-effective and efficient way of surveying large samples. CATI software allows immediate data entry in electronic format and facilitates data quality by enabling coding through programmed lists or coding of question order [Choi, 2004]. Additional benefits can include random selection of respondents, computerized scripts, scheduling additional calls, as well as facilitating responses to sensitive questions [Choi, 2004]. Despite benefits of CATI, there are also some limitations associated with this type of interviewing. Some of these limitations have been summarized in the literature [Choi, 2004], including: significant cost required for initial setup of system including the technological system of telephones; the computer equipment as well as personnel costs; time and effort required for computer programming and testing the survey instrument; limitation to households reachable by a telephone; dependent on timing of interview; potential bias towards individuals who are typically at home during interview periods (e.g., retired adults, homemakers); requirement for shorter duration of surveys in order to maintain the focus of the respondents; a recent surge in telemarketing or telephone surveys, impacting response rates; as well as some other new issues such as telephone coverage given cell phone usage [Choi, 2004; Kempf et al., 2007]. In Canada, the overlap between the banks of telephone numbers for cellular phone and landlines may also pose an issue as cellular phone banks are released for interviewing in lots in which only a relatively small number of telephone numbers are actually in service. This adds to the cost of interviewing by increasing the number of calls to non-active numbers.

The PAMs applied a two-stage probability selection process to select a survey respondent. The first stage involved the selection of households by randomly selecting telephone numbers (i.e., constructed based on electronic version of telephone books or other available sampling lists to which additional random numbers are generated associated with the first three digits that represent a known exchange containing households), that is stratified by province and territory using a method of random digit dialling (RDD). A random sample of telephone numbers were selected to be called, however, these RDD samples may have included telephone numbers that may not be in service, business numbers, or other ineligible numbers. The second stage of sample selection involved the random selection of a respondent (18 years of age or older) in the household. Information on the age, as well as the number of adults in the household was obtained. When there was more than one adult living in the household, a respondent was selected based on the nearest birthday, as this method yields a representative sample [Lind et al., 2000].

Households that refused to complete the interview were called again at a later date (several weeks later) by a senior interviewer and an attempt was made to convert the first refusal to participate. Roughly 15% of interviews were completed after a household refused initially. Respondents who are difficult to reach or who initially refuse may have different characteristics from typical survey respondents [Voight et al., 2006], and as such the number of call attempts, the timing of call-backs and attempts to convert initial refusals can help to increase the response rate and representativeness of the sample. Figure 3.1 illustrates the flow of the process. All methods for the 2003, 2004 and 2007 PAMs were approved by the Human Participants Review Committee of York University.

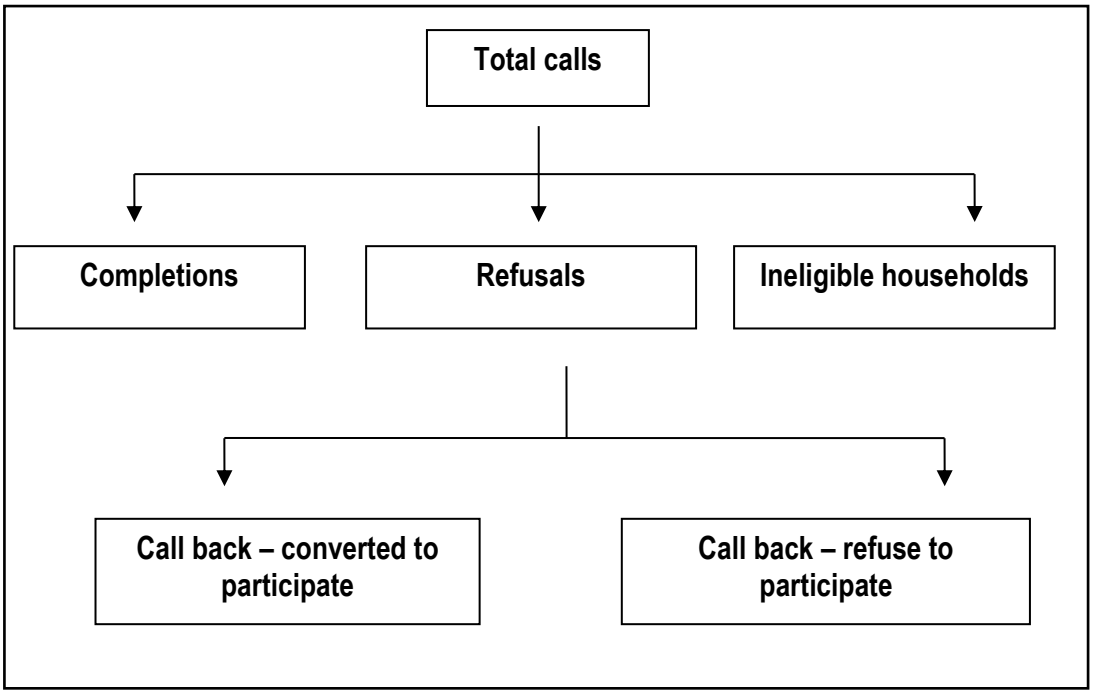

Figure 3.1: Illustration of telephone survey strategy

Sampling by RDD is a strength of the surveys as this method provides a high degree of coverage of the population except in remote areas that are not well serviced or whose population is absent for long periods of time (e.g., during hunting season). The stratification of the sample is both a strength and limitation; it has the benefit of ensuring adequate sample within each province and territory, but requires specific analytical techniques to take the design into account (See Section 3.6.3). With increased cell phone ownership in recent years, a selection bias may have been introduced into the sample as younger adults may be choosing to own cell phones and may have ceased to also subscribe to land lines. Certain groups are also less likely to be reached by RDD methods [Choi, 2004], but calls are made throughout the day and evening, and call backs to unanswered numbers are purposely scheduled during different periods of the day. Data collection by interviewers can exacerbate any potential social desirability bias in the measures. However, the interviewers were trained, provided computerized scripts and observed to ensure data quality. Finally, although RDD telephone surveys are less expensive than face-to-face interviews, they are more costly than mail surveys, but generally have higher response rates, and internet-based surveys, which tend to be pseudo random and akin to convenience samples.

3.4.2 Response rate calculation

Details of the calculation of response rates and final sample size for the 2003, 2004, and 2007 PAMs are described in Table 3.2 [Cameron et al., 2004; Cameron et al., 2005; Canadian Fitness and Lifestyle Research Institute, 2008]. The method for calculating response rate for the PAM is a relatively conservative way of calculating response rates. The calculation of response rate is as follows:

Known eligible households = Completed calls + Refusals + Call-backs

Household eligibility rate = (Known eligible households/ (Known eligible households + total number unknown))*100%

Number of estimated eligible households within the total number of unknown = Number where eligibility could not be determined * household eligibility rate

Response rate = (Completions / (Eligible households + Estimated eligible households))*100%

Table 3.2: Details of recruitment by survey

	PAM 2003 Chapter Four		PAM 2004 Chapter Five		PAM 2007 Chapter Six	
	Sample	Percent	Sample	Percent	Sample	Percent
Completed calls (completed surveys)	9,080	34.9%	9,713	32.0%	5,194	19.3%
Refusals (households refusing to participate in survey)	6,604	25.4%	7,434	24.5%	4,932	18.3%
Call-backs* (Called back for some reason. For details, see table footnote)	1,048	4.0%	1,658	5.5%	1,566	5.8%
Ineligibles (not able to speak English or French, not healthy enough to do survey, non-residential numbers, not in service numbers)	8,015	30.8%	10,041	33.0%	12,856	47.7%
Eligibility unknown (eligibility status could not be determined. An estimate of eligibility needs to be calculated by an eligibility rate)	1,241	4.8%	1,544	5.0%	2,383	8.8%
Total telephone calls made	25,988	100.0%	30,393	100.0%	26,931	100.0%
Summary - Known eligible households	16,732		18,385		11,692	
Summary -Estimated eligible	799		947		1,034	
Summary - Not eligible	8,015		10,041		12,856	
Final response rate	52%		49%		41%	
Final sample size	9,080		9,713		5,129	
Date survey conducted	February 2003 to January 2004		February 2004 to January 2005		February 2007 to March 2008	

* Call-backs refer to an interviewer speaking to an individual, and that individual asking to be called back to complete the interview. There can be several types of call-backs based on progression within the call. For example:
-Call is answered and individual asks to be called back (residential number not confirmed at this point).
-Survey is introduced, a residential number confirmed, and then the individual asks to be called back.
-Survey is introduced, residential number confirmed, the number of adults in the household confirmed, however, respondent not selected but individual asks to be called back.
-Survey is introduced a residential number confirmed, the number of adults in the household confirmed, selected the respondent, and then call back requested while survey being conducted.

For the three surveys used in this thesis, response rates have hovered close to the 50% mark (52% in 2003, 49% in 2004) in 2003 and 2004, then have declined to 41% by year 2007. Research conducted on PAM studies have shown no clear differential effect on the representativeness of these samples despite declining response rates over time [Craig et al., 2009]. Response rates for other health surveillance systems vary. For example, the U.S. based 2011-2012 National Health and Nutrition Examination Survey yielded a 72.6% un-weighted response rate [CDC, accessed May 26, 2014]. The 2009-2010 CCHS yielded a 72.3% combined household and individual response rate, however, this particular study used a combination of in-person and telephone modes of collection [Statistics Canada, accessed May 26, 2014]. The Active for Life study in the U.K. produced a 52% response rate at baseline of this cohort design study [Hillsdon et al., 2001]. A U.S.-based study, the 2012 Behavioral Risk Factor Surveillance System, produced a 49.1% response rate among landline respondents [CDC, accessed May 26, 2014]. In sum, the response rate for the PAMs is lower than some surveys that include some face-to-face interview component (NHANES, CCHS) but compares favourably with the Active for Life study and the BRFSS.

3.5 Summary of measures collected in the Physical Activity Monitor

The PAMs included a number of standard measures across the 2003, 2004 and 2007 data collection cycles and they are discussed in detail in this section. There have been core self-report measures of PA asked in these surveys. In addition to PA measures, additional questions were asked, based on sets of theories about the correlates of PA. Many measures were chosen using an ecological framework in which individual factors, social factors, and environmental factors are considered. In addition to PA measures, there were individual-level measures pertaining to the Theory of Planned Behavior (TPB). These measures include knowledge, beliefs, perceived behavioural control, social norms, intention, self-efficacy (which was added to the TPB from social cognitive theory [Ajzen, 1991; Bandura, 1977a; Bandura, 1977b]), and trialling behaviours as immediate PA-related outcomes. Moreover, measures related to the physical environment or neighbourhood was also included. Literature describing this research is further described in Chapter Two of this thesis. These consistent measures are listed and the year in which they were collected is summarized in Table 3.3.

Table 3.3: Measures collected by year of survey

Measure	Year of survey		
	PAM 2003	PAM 2004	PAM 2007
Physical activity			
PA - IPAQ short, telephone	✔	✔	✔
Walking (based on IPAQ)	✔	✔	✔
Walking for recreation (based on adapted MLTPAQ)			✔
Walking for transport			✔
Demographics			
Age	✔	✔	✔
Sex	✔	✔	✔
Education	✔	✔	✔
Other individual factors			
Awareness of guidelines for PA	✔		✔
Knowledge of guidelines for PA	✔		✔
Beliefs about benefits of PA	✔		✔
Perceived Behavioural Control			✔
Self-efficacy			✔
Intention	✔		✔
Trial behaviours	✔		✔
Social factors			
Social norms for walking			✔
Physical environment factors			
NEWS environment items		✔	✔
Availability of facilities for PA		✔	
Barriers		✔	

IPAQ – International Physical Activity Questionnaire
MLTPAQ – Minnesota Leisure Time Physical Activity Questionnaire
PAM – Physical Activity Monitor
NEWS – Neighbourhood Environment Walkability scale

3.5.1 Measures of physical activity

Two measures of PA are used in this thesis, the International Physical Activity Questionnaire (IPAQ) [Craig et al., 2003] and an adaptation of the Minnesota Leisure-Time Physical Activity questionnaire (MLTPAQ) [Taylor et al., 1978]. The IPAQ assesses the total volume of time spent in moderate- and vigorous-intensity PA, along with walking. The adapted MLTPAQ [Craig et al., 2002] asked participants to recall participation in a relatively comprehensive list of physical activities over the past 12 months.

Despite early work examining leisure-time PA (LTPA) as purposeful activity and a significant contributor to overall PA, the range of survey instruments and methodologies that have been used in the literature and the lack of consistent measures used to estimate activity levels are barriers for producing consistent estimates of PA levels within and between countries. For

example, differences in the definitions of PA (also variety in the number of domains asked about), methodological approaches, content focus within the survey instrument, the location of questions within the survey instrument, and scoring methods have previously precluded the ability for direct international comparisons of PA [Craig et al., 2003]. Therefore, in the late 1990's, researchers from several countries developed a common tool for assessing PA for population surveillance, known as the IPAQ.

Objective devices such as accelerometers and pedometers provide a measure of PA across all domains; however the costs associated with these types of measures are relatively expensive for population surveillance. Therefore, the development of a standard reliable and valid self-report measure was important. In an international study, the reliability and validity of the IPAQ were considered acceptable for population surveillance [Craig et al., 2003]. This questionnaire has been used in several countries (e.g., Canada, United States, Australia, Norway, Brazil, China) [Craig et al., 2003; Bauman et al., 2009] for population estimates. Data collected using the short-form IPAQ are used in this thesis.

The IPAQ enquires about time spent walking, and time spent in moderate and vigorous PA over the past 7 days across all domains (work, leisure, chores and transport) [www.ipaq.ki.se]. In particular, the questionnaire examines the number of days in the previous week that the respondent performed each of these activities for at least 10 minutes at a time, and if applicable, the total time spent per day. For this thesis, scoring of the IPAQ measures were conducted in accordance with IPAQ protocols [www.ipaq.ki.se] and was then categorized into a dichotomous measure of "sufficiently active" or not.

More specifically, total time spent in vigorous activities was calculated by multiplying the number of days by the amount of time spent per occasion. This total time spent was then multiplied by a MET (metabolic equivalent) value of 8. A MET represents a way of describing the energy cost of physical activities as a multiple of the metabolic rate while at rest [Ainsworth et al., 1993]. A similar calculation was conducted for time spent in moderate activities (using a MET value of 4.0) and walking behaviour (using a MET value of 3.3). A total PA energy expenditure score was then calculated by summing the energy expenditure from the vigorous-intensity, moderate-intensity, and walking behaviours. Based on this total energy expenditure score:

- sufficient activity (or sufficient PA) was calculated if (1) any activity was performed daily with a total energy expenditure of 3,000 MET minutes or higher, or (2) vigorous activity was performed at least 3 days a week with a total energy expenditure of 1,500 MET minutes or higher [www.ipaq.ki.se], and
- a lower score was attributed to any lower amounts of activity which was deemed an insufficient amount.

Using these same MET values of 3.3 (walking), 4 (moderate-intensity), and 8 (vigorous-intensity) as described above, the total energy expenditure representing the 1998 Canadian guidelines for adults aged 18 to 55 would be lower that the IPAQ criterion. The 1998 Canadian guidelines state that adults should accumulate at least 60 minutes of any intensity activity every day for health, 30 minutes of moderate-intensity activity, 4 days a week, or 20 minutes of vigorous-intensity activity, 4 days a week [Health Canada and Canadian Society for Exercise Physiology, 1998].

In addition, LTPA was assessed by asking about participation in 25 listed physical activities during the past 12 months, as well as providing respondents with the opportunity to provide 3 additional activities which may not have been specified in this list. The LTPA question used an adaptation of the MLTPAQ. MLTPAQ was one of the first measures used to assess PA in populations. LTPA measures in general appeared in the mid-1960s for specific populations, given the increasing epidemiological evidence for PA and health since that time [Lamb & Brodie, 1991].

Although there were many LTPA instruments [Jacobs et al., 1993], the MLTPAQ, which was first published in 1978 [Taylor et al., 1978] is a popular measure of LTPA [Lamb & Brodie, 1991] and is used to measure PA energy expenditure. Validity studies were conducted, with significant associations noted between LTPA and fitness levels and chronic conditions, prompting the use of LTPA questionnaires in large-scale surveys, such as this one. Research studies have examined the reliability of the MLTPAQ [Folsom et al., 1986; Lamb & Brodie, 1991; Shephard, 2003], and the adapted version of the MLTPAQ used in this thesis has an acceptable test-retest reliability and criterion validity against predicted maximum oxygen uptake [Craig et al., 2002].

Within the probed activities of the adapted MLTPAQ, questions with regard to participation in walking, as well as frequency and average duration were asked. In addition, frequency and duration of walking to work, school and errands were also gathered through an additional set of questions asked after the MLTPAQ. The adapted MLTPAQ questionnaire is used in Chapter Six of this thesis, whereas the IPAQ walking question was used in Chapter Four, Five, and Six. These MLTPAQ and PAM measures were described as recreational walking and walking for transport respectively, and were divided into quartiles. Walking for recreation has often been studied as a popular form of physical activity with respect to the built environment, however, walking for transport has also been considered in some research [Saelens & Handy, 2008; Cleland et al., 2010] in addition to walking for recreation. Moreover, research indicates that aspects of the built environment differ by the type of walking [Owen et al., 2004; Saelens & Handy, 2008], although the relationships may not necessarily be conclusive between studies [Saelens & Handy, 2008]. For the logistic regression and cross-tabulations used in Chapter Six of this thesis, the highest quartile of recreational walking and transport walking is used. Quartiles were used to make the scoring of these consistent with many other variables in the analysis so that they would have a similar distribution (i.e., non-parametric with no assumption of normality or other distribution about the shape of the data).

3.5.2 Measures of individual level correlates/determinants

Measures of known correlates at the individual level were developed using the Theory of Planned Behavior (TPB) [Ajzen, 1985; Ajzen 1988; Ajzen, 1991] and were included in the PAMs. The theoretical framework of the TPB has been used to explain PA and other health behaviours, and suggests that intention is an immediate determinant of a given behaviour, with attitude, subjective norm, and perceived behavioural control influencing intention [Ajzen, 1985; Ajzen 1988; Ajzen, 1991; Blue, 1995]. Moreover, perceived behavioural control may also directly influence behaviour. As people act on their intention to be active, they may try a range of different behaviours in an effort to become more active. These types of measures have been explored in this thesis and are described in further detail in Chapter Two, section 2.2, and are used in the analyses of Chapters Four and Six. Social norms, which are one element of the TPB, are the only social factors explored in this thesis. Table 3.4 lists, and describes, the details of these measures.

Table 3.4: Individual and social factors collected through the PAMs (2003 and 2007 PAMs)

Independent variables	Question	Response options
Individual factors		
Awareness of physical activity guidelines (Purpose: to assess unprompted and prompted awareness of guidelines for physical activity. It is an immediate outcome of health communications related to the guidelines) (PAM 2003, PAM 2007 assessed prompted only)	Unprompted - Have you heard, or do you know of any guidelines about how much physical activity adults should do? Can you tell me the names of any of these guidelines? Prompted - Have you heard of any of the following initiatives in the past 12 months: Canada's Physical Activity Guide" (yes/no/don't know)	Yes/No/Don't know Text responses, categorized Yes/No/Don't know
Knowledge (Purpose: to assess the knowledge of the amount of PA required to meet Canadian guidelines. This is a precursor to more immediate predictors of PA in the TPB) (PAM 2003, 2007)	What is the least number of days each week that a person your age has to be active to get health benefits? On each of these days, how much time in total do you think a person your age has to be active in order to get health benefits? In the situation you've described where someone is active on [stated] days a week for a total of [stated] minutes each time, how much physical effort do you think they need to put into it in order to get health benefits?	Number of day 1 to 7 Don't know Total time Hours, min Don't know Light intensity Moderate intensity Vigorous intensity Don't know
Beliefs about the benefits of PA (Purpose: to assess the individual's beliefs about the health-related benefits of PA. Like knowledge, this is a precursor to more immediate predictors of PA in the TPB) (PAM 2003, 2007)	To what extent do you agree that PA …helps prevent heart disease …helps people maintain the ability to do everyday tasks in older age …helps people to manage stress	7 point: 1 = do not agree at all 7 = very strongly agree Don't know
Perceived behavioural control (Purpose: to assess this precursor to intention within the TPB) (PAM 2007)	How much personal control do you have over whether you are able to fit regular physical activity into your lifestyle?	5-point: 1=no control at all, 5=complete control Don't know
Self-efficacy or self-confidence (Purpose: to assess this precursor to intention within the TPB) (PAM 2007)	How confident are you that you can regularly do a total of thirty minutes or more of moderate physical activity per day at least three or four times a week? How confident are you that you can regularly do a total of sixty minutes of light physical activity each day?	5-point: 1 = not confident at all 5 = very confident Don't know
Intention to be active (Purpose: to assess this immediate precursor to PA within the TPB) (PAM 2003, 2007)	Thinking about the next six months, to what extent do you intend to be physically active?	7-point: 1 = no intention at all 7 = fully intend to Don't know
Initial behaviour change or trial behaviours (Purpose:	Have you done any of the following over the past 12 months with a view to becoming more	Yes No

to assess steps that individuals have taken to become more active. This may be an intermediate step between intention and PA) (PAM 2003, 2007)	active?: -read articles in newspapers, books or magazines about physical activity; -sought advice from friends, family, or co-workers -sought advice from health professional(s) -observed a class, or tried some kind of physical activity -sought information about opportunities in your community, such as trails -made active choices in your usual work routine, like walking part way to work or taking the stairs?	Don't know
Social factors		
Social norms (Purpose: to assess individual's perceptions of social norms for PA) (PAM 2007)	To what extent do you agree that: -most family members walk for at least 30 minutes on almost every day -most friends walk for at least 30 minutes on almost every day -most people you know walk for at least 30 minutes on almost every day	5 point: 1=strongly agree 2= agree 3=unsure 4=disagree 5=strongly disagree Don't know

3.5.3 Measures of environmental attributes

These questions measure reported perceptions of the physical environment and aim to help explain PA behaviour. Certain models, such as an ecological model incorporate the physical environment as an influencer when looking at changes in behaviour. Three sets of measures are used in these surveys to capture perceptions and attributes about the physical environment. The first set of measures assess perceptions about the environment using an adapted subset of questions from the Neighborhood Environment Walkability Scale (NEWS) [Cerin et al., 2006], with the purpose to quantify walkability in a neighbourhood. The NEWS essentially investigates the presence of places to walk in the neighbourhood and potential factors which could influence perceptions of walkability (such as the presence of traffic and crime). In the NEWS the neighbourhood is defined as "the area ALL around your home that you could walk to in 10-15 minutes." A shorter sub set of NEWS items were taken from an international study which had developed the set to explore the associations between activity and the physical environment in 11 countries [Sallis et al., 2009]. In general, perceived highly walkable neighbourhoods could be characterized with higher residential density, greater land use mix, street connectivity, aesthetics, and safety. Given the relationship of these measures to walking and PA, measures assessing the walkability of the physical environment and neighbourhood are considered important components of this thesis and have shaped the

investigation. Details of the items used in PAM are described in Table 3.5, as a smaller set of eight questions were used for this thesis.

Table 3.5: Environmental factors based on the NEWS collected through the PAMs (2004 and 2007 PAMs)

Independent variables	Question	Response options
Residential density (operationalized as main type of neighbourhood housing) (PAM 2004, 2007)	The next set of questions asks about different facilities in and around your neighbourhood. By this we mean the area ALL around your home that you could walk to in 10-15 minutes. What is the main type of housing in your neighbourhood…?	1=Detached single-family residences 2=Townhouses, row houses, apartments, or condos of 2-3 stories 3=Mix of single-family residences and townhouses, row houses, apartments or condos 4=Apartments or condos of 4-12 stories 5=Apartments or condos of more than 12 stories? Don't know
Mixed use	Many shops, stores, markets or other places to buy things I need are within easy walking distance of my home. Would you say that you strongly disagree, somewhat disagree, somewhat agree, or strongly agree?	1=Strongly disagree 2=Somewhat disagree 3=Somewhat agree 4=Strongly agree 6=does not apply to my neighbourhood at all Don't know
Access to transit	It is within a 10-15 minute walk to a transit stop (such as bus, train, trolley, and tram) from my home. Would you say that you strongly disagree, somewhat disagree, somewhat agree or strongly agree?	
Pedestrian infrastructure	There are sidewalks on most of the streets in my neighbourhood. Would you say that you strongly disagree, somewhat disagree, somewhat agree or strongly agree?	
Bicycling infrastructure	There are facilities to bicycle in or near my neighbourhood, such as special lanes, separate paths or trails, or shared use paths for cycles and pedestrians? Would you say that you strongly disagree, somewhat disagree, somewhat agree or strongly agree?	
Recreational infrastructure	My neighbourhood has several free or low cost recreation facilities, such as parks, walking trails, bike paths, recreation centres, playgrounds, public swimming pools, etc. Would you say that you strongly disagree, somewhat disagree, somewhat agree or strongly agree?	
Safety from crime	The crime rate in my neighbourhood makes it unsafe to go on walks at night. Would you say that you strongly disagree, somewhat disagree, somewhat agree or strongly agree?	
Traffic safety	There is so much traffic on the streets that it makes it difficult or unpleasant to walk in my neighbourhood. Would you say that you strongly disagree, somewhat disagree, somewhat agree or strongly agree?	

In addition to the NEWS items, the second set of factors were asked in the 2004 data collection only, as the focus of this particular survey was to explore aspects of the physical environment

and neighbourhood which may be associated with PA and walking. The primary purpose of this second set of indicators was to determine perceived barriers which related to the physical environment and local opportunities to be active. Respondents were asked to rate their level of agreement with a series of statements representing barriers related to the environment (where 1 represents strongly disagreeing and 6 represents strongly agreeing). In addition, don't know and refused categories were included. These variables were developed specifically for the PAM, and although there is no validity testing, the questions have been used consistently over time. The statements assessing perceived barriers were as follows:

- Concerns about your safety keep you from walking or bicycling
- There's too much traffic in your area for walking or bicycling
- In your area there's too much crime on the streets for safe walking or bicycling
- Badly maintained sidewalks and bike lanes in your area keep you from bicycling
- Poorly lit sidewalks and streets in your area keep you from walking or bicycling
- The hours and class times offered by your local centres don't suit you
- It's too hard for you to get to those places where you can be active
- The programs and facilities that are available are not the right type for you
- The dollar costs of doing physical activities are too high for you
- It's too hard to find the right kind of coaching or instruction
- The sport and recreation facilities are not well-maintained in your community.

The third set of measures were developed to assess respondents' perceptions regarding the amount of places in their local community where they can safely walk or bicycle, and the amount of programs in the community. Respondents were asked to rate according to the following categories none, some, many, don't know, respondent doesn't own a bicycle (in the case of the question about the number of places where a person can safely bicycle). This set of questions was only asked in the 2004 PAM.

3.5.4 Demographic variables

Table 3.6 summarizes the demographic covariates used in the analyses in this thesis, namely sex, age and education level of participant.

Table 3.6: Demographic covariates collected through the PAMs

	PAM 2003	PAM 2004	PAM 2007
Age of participant	Age was asked as year of birth and then categorized as -18-24 years -25-44 years -45-64 years -65 years and older		
Sex of participant	Gender of participant was asked -Male -Female		
Education level	Education level of participant was asked as an open-ended question and was coded to a list of possible responses. For analyses, these coded options were categorized as -less than secondary level of education -completed secondary school -attended college -attended university		

3.5.5 Limitations and strengths of measures

This sub-section explores some limitations and strengths associated with the indicators described in this section, and used in the analyses for thesis Chapters Four, Five, and Six. Although the adapted version of the MLTPAQ used in this thesis has an acceptable test-retest reliability and criterion validity against predicted maximum oxygen uptake [Craig et al., 2002], it is based on self-report data, which may not accurately represent PA if measured by a direct measure of PA (through a pedometer or accelerometer). In addition, it is also based on an assessment of physical activities over a long recall period (12 months), which some participants may find difficult to accurately recall due to 1) the exact number of occasions participated in during that time period and 2) a typical duration averaged across these occasions. The measure is also focused on a single-domain, LTPA, therefore does not portray a comprehensive measure of PA. Finally, there is considerable response burden due to the length of the instrument. Despite this, the same measure of PA has been used consistently

over time for the purposes of surveillance allowing for comparisons of secular trends as the potential biases inherent in such a measure is likely to be non-differential over time [Craig et al., 2004].

Therefore, in order to overcome the single domain focus of PA of the MLTPAQ, the IPAQ measure was used in addition to the MLTPAQ. The IPAQ provides a more comprehensive, all-domain measure of physical activity. The IPAQ, however, is based on self-report data which may not necessarily represent the proportion of individuals who would achieve the same level of PA if a direct measure of PA was used [Prince et al., 2008]. Furthermore, IPAQ tends to over-estimate the level of PA even when compared to other self-report measures, although these are typically single domain measures [Bauman et al., 2009]. The reliability and validity of the IPAQ have been explored in an international context and is considered acceptable for population surveillance [Craig et al., 2003].

Measures of known correlates at the individual level were developed using the Theory of Planned Behavior (TPB) and were included in the PAMs. With the exception of social norms, these measures have been developed specifically for the PAM, and although there is no current reliability or validity data on these correlates, they have been used consistently over time. Although this is a limitation, these variables have proven useful in understanding the relationship of these variables as measures of the TPB in predicting long term PA behaviour [Plotnikoff et al., 2012].

In terms of the NEWS items, a subset of questions was developed by a group of experts in the field, for the purpose of shaping public policy related to the physical environment. The full NEWS scales showed acceptable test–retest reliability (≥0.58, and the majority of test–retest values were ≥0.75) [Saelens et al., 2003]. The limitations of the NEWS include the scope of the measure by assessing agreement of the presence of PA related facilities in the neighbourhood. In countries where facilities supporting PA are present, more specific detail on the amount, the quality and maintenance features of the facilities may be of particular importance for informing interventions aimed at increasing and supporting PA. In addition, Smith and colleagues [2010] cite limitations in respondents' interpretations of the term "neighbourhood", whereby the geographical sense of the term may vary from individual to individual. The researchers found that respondents typically interpret a smaller neighbourhood area than that used in definitions

in research related to the physical environment [Smith et al., 2010]. The additional measures assessing the physical environment, that is related to the amount of infrastructure (places to walk and bicycle, and recreational facilities in the neighbourhood) and barriers related to the physical environment have been developed specifically for the PAM. The amount of infrastructure was included to overcome the limitation of assessing mere presence of infrastructure using the NEWS in Canada, where the presence of infrastructure such as sidewalks is pervasive. There are currently no reliability or validity data for these correlates; however, they have been used consistently over time in various iterations of the surveys. When testing the relationship between environmental variables (such as those of NEWS) and PA or walking, it is important to control for the possible effects of clustering in the sample design. One would expect that individuals living in the same neighbourhood would be more likely to rate the environmental items similarly resulting in correlated responses within neighbourhoods. Such correlations violate the assumption of independence of observations and can lead to biased estimates of standard error [Cerin et al., 2009]. The sample design of the PAM involved the selection of telephone numbers within telephone exchanges. In Canada, telephone exchanges span a relatively large geographical area that may encompass more than one neighbourhood. In addition, the sample is dispersed across Canada so the chance of selecting two individuals from the same neighbourhood is small. Finally, the definition of the size of the neighbourhood was left to the interpretation of the respondents. This means that the size might vary depending on the type of infrastructure (e.g., sidewalks as compared to recreation facilities) and differs from that used in much of the research. It should be noted, however, that Smith et al. [2010] concluded that neighbourhood size is smaller than that typically specified in research and is related to the individual's perceptions of his or her neighbourhood.

The covariates used in the model are limited to sex, age, and education attainment of the respondent. Information on other possible covariates such as general health status, income, rural/urban status would be valuable, as these have been shown to affect physical activity related outcomes, but were not included for secondary analysis in this investigation.

3.6 Analytic techniques

The final section presents the analytic techniques used for the analyses reported in subsequent Chapters of this thesis. It includes a brief description of the sample distribution, the application of sample weights, and the approaches taken for analysis.

3.6.1 Description of the sample

Descriptive statistics of sex, age, and education level of respondents within the PAMs have remained fairly consistent over time (i.e., 2003, 2004, and 2007 PAMs). Table 3.7 describes the sample size, un-weighted and weighted distributions of sex, education level, as well as the average age of respondents for all three survey periods used in the analyses. These measures are described here, given that all logistic regression models used in this thesis were adjusted for these measures as covariates.

Table 3.7: Distribution of age, sex, and education within the samples

	PAM 2003			PAM 2004			PAM 2007		
	N	Un-weighted	Weighted	N	Un-weighted	Weighted	N	Un-weighted	Weighted
Sex									
Male	3,909	44.0%	48.4%	3,909	44.0%	48.4%	2,204	43.9%	48.8%
Female	4,983	56.0%	51.6%	4,983	56.0%	51.6%	2,820	56.1%	51.2%
Age									
18 to 24	908	10.2%	13.4%	908	10.2%	13.4%	384	7.7%	13.9%
25 to 44	3,432	38.6%	38.9%	3,432	38.6%	38.9%	1,849	36.9%	35.0%
45 to 64	3,079	34.6%	31.1%	3,079	34.6%	31.1%	2,038	40.7%	33.8%
65 and older	1,471	16.5%	16.6%	1,471	16.5%	16.6%	739	14.8%	17.3%
Education									
< Secondary	1,489	17.0%	16.8%	1,489	17.0%	16.8%	666	13.4%	13.2%
Secondary	2,257	25.8%	26.9%	2,257	25.8%	26.9%	1,211	24.4%	26.3%
College	2,109	24.1%	23.6%	2,109	24.1%	23.6%	1,314	26.4%	25.9%
University	2,907	33.2%	32.7%	2,907	33.2%	32.7%	1,778	35.8%	34.6%

3.6.2 Sample weights

The samples recruited for the PAMs were designed to represent the adult population in Canada as a whole. The household weight is derived based on the number of adults in the household (reported by the participant) taking into account the number of households in the province. The probability of a member of the household being selected for an interview varies inversely with the number of people living in that household. For example, when there is only one person in the household, they have a 100 percent chance of being selected whereas in a two-eligible-persons household, each eligible person has a 50 percent chance of selection, and so on. If analyses were based on un-weighted estimates, there would be an over-representation of households with one eligible person, whereas households with a large number of eligible persons would be under-represented in the weights. Generally, the data are weighted to offset selection bias. In addition, a provincial weight is applied to the record where the data need to be used to represent the provincial or territorial population. The national sample weight is comprised of a household weight multiplied by a provincial weight. Finally, the national sample weight is corrected with a post-stratified age and sex adjustment factor. The adjustment reflected the latest census distributions for age and sex.

3.6.3 Approaches to analyses

All PAMs were entered directly using computer assisted telephone interviewing (CATI) programmed software, which allows for immediate data entry into electronic format and contributes to data quality through standardized programmed lists and coding of questions in specific order [Choi, 2004]. Data provided in electronic format are then verified for accuracy by ensuring through frequency distributions of variables and cross-tabulations of variables by key demographic and other variables to ensure that the survey flow and skip patterns have been followed. Moreover, data is verified to ensure that range values for each variable comply with programmed value limits.

SPSS version 21.0 was used for all analyses. All numbers have a statistical error associated with them by virtue of the random selection of the sample. Given the nature of the PAM datasets, complex sampling methods are required to take into account stratification by province or territory within Canada. The sample designs of the PAMs are not simple random samples

but rather more complex as they are stratified by province and territory and the sample allocation is not proportional across strata. This means that the sample variation is somewhat larger than expected in a self-weighting design. As such, the complex sample cross-tabulation procedure was used to calculate the prevalence estimates. With each estimate, 95% confidence intervals surrounding the estimates were calculated and used to determine the underlying likely distribution of the parameter in the population. 'Don't know' and 'refused' generally amount to less than 3% of responses and were excluded in analyses as they have a negligible effect on estimates.

Where multiple measures were used to explore a construct within each Chapter (for example, three separate questions/measures were used to assess beliefs about the benefits of PA), a Cronbach's alpha score was calculated to determine the internal consistency between the measures. If the internal consistency had an acceptable reliability coefficient for comparing groups according to standards in the literature (>0.70) [Bland & Altman, 1997], a composite score was created to study a given summary score, unless the investigation of the research questions warranted examination of the individual items. These are further described within each Chapter.

To investigate factors associated with PA, statistical models were developed. These models were created to explore associations between key independent measures and dichotomous dependent measures of (1) 'sufficient' PA participation and (2) 'sufficient' walking behaviour (achieving sufficient activity or walking or not). For Chapter Six, the models explored associations between independent measures and the dichotomous dependent measures of (1) 'sufficient' PA participation (achieving sufficient activity or not), (2) 'sufficient' all-domain walking behaviour (achieving sufficient all domain walking or not using IPAQ), (3) highest quartile of recreational walking or not (using the adapted MLTPAQ), and (4) highest quartile of walking for the purpose of transportation or not (using the PAM commute questions). To predict these dichotomous dependent measures, complex samples logistic regression procedure was used to account the sample design. One limitation of performing multiple tests of significance on a series of measures is that the type I effort rate (or α level) is affected. The more tests that are performed the more likely it is to erroneously conclude that a relationship is significant when it is not. An adjustment to the α level (such as sequential Bonferroni or Holms) can be made to

counteract the possibility of accepting a relationship as significant when it has occurred by chance [Zhang et al., 1997]. This adjustment was not conducted as part of the analysis as the main purposes of this thesis are exploratory to shape future policy-oriented and intervention research.

Logistic regression is used to predict the probability of an outcome based on a set of factors. The coefficients produced from the regression equations reflect the contribution of the independent measures to the particular outcome, where a positive coefficient indicates an increased probability of the outcome, and a negative coefficient indicates a decreased probability. The larger the coefficient is from zero, the greater the impact of the independent measures in these directions. In developing the model, attention was paid to potential confounding factors, which could provide alterative explanation of the significance of predictive variables in relation to the outcome variable. For example, it is known that PA is lower amongst women and in addition that women are more likely to view safety as a factor influencing their participation in PA. Therefore, if sex was not included in the model, one might erroneously conclude that safety concerns predicted lower likelihood of involvement in sufficient PA. However, when sex is included in the model, this relationship may no longer remain significant indicating that sex, not safety per se, was predicting lower participation. To account for these types of matters, age, sex, and education were included as covariates. Other possible residual confounders (which could not be adequately measured based on the measures included in these surveys) such as weather, car ownership, chronic conditions, and household level socio-economic status could not be taken into account, as this information was not collected or complete in these surveys. The full model was chosen to determine the relative magnitude of the odds of each of the variables of interest. Similarly, a separate full model predicting sufficient activity was built including the same variables of interest and covariates. This thesis presents exploratory analyses of cross-sectional data to inform policy and guide the development of future prospective and intervention research. As such, the models do not take into account interactions (or effect modifications) between variables (e.g., knowledge and beliefs by age).

Using complex samples, sample weights were applied to the data and 95% confidence intervals were used to determine significance. Specific analytical procedures are described in further detail within each results section of each Chapter.

Summary of Chapter Three

The purpose of this Chapter was to describe the methods and measures used in this thesis. To begin, the Chapter provides a summary of population surveillance of PA in Canada by providing a brief overview of surveillance studies in Canada that either focus on PA as an outcome, or as a correlate to health more generally. Canada is fortunate to have a long-standing and rich source of comprehensive data related to PA. One of the programs at the heart of Canadian surveillance in the Canadian Fitness and Lifestyle Research Institute's Physical Activity and Sport Monitoring Program (PASMP). One component of the PASMP includes the Physical Activity Monitor (PAM) which is designed as a series of representative annual population-based studies of PAM which explores correlates associated with PA.

A detailed discussion of the development and methods associated with the PAM follows in this Chapter, describing its themes of data collection, sampling methods, response rate calculation, and measures used in various iterations of the PAM. These measures outline the PA and walking measures used in the three surveys highlighted in this thesis, the individual level measures, the measures which describe the environmental attributes, and demographic measures. Accordingly, limitations and strengths surrounding these measures are discussed briefly in a following section.

The Chapter then concludes with a description of the analyses protocol of the measures used in this thesis. These protocols include data verification, application of sample weights, approaches to analyses of prevalence data and models to predict behaviour.

CHAPTER FOUR – Individual factors associated with total activity and walking

4.1 Introduction

As described in the opening paragraphs of this thesis, physical inactivity is a public health issue as low levels of PA are associated with increased risk of non-communicable diseases, poor mental health, and premature mortality [U.S. Department of Health and Human Services, 1996; Warburton et al., 2006; U.S. Department of Health and Human Services, 2008]. As such, there has been international recognition of the need to develop national strategies to promote PA. Indeed, sparked by a resolution of the International Assembly of the World Health Organization (WHO) that was introduced by the Canadian delegation, the WHO developed a Strategy for Diet and Physical Activity [WHO, 2004]. One element of this strategy was that countries develop national PA guidelines as a foundation resource to promote PA and to inform surveillance.

As reported in Chapter Two, the original PA guides that were developed in Canada in the late 1990's were conceived as a health communication tool that could be used as part of a broader social marketing campaign to raise awareness of PA, to educate, and to promote activity among the population. The Hierarchy of Effects Model is often used in the planning and to some extent the evaluation of communication campaigns [McGuire, 1984; Bauman et al., 2008; Craig et al., 2010], whereby the model builds on the Theory of Planned Behavior and the constructs contained within that theory [Ajzen, 1985; Ajzen, 1991], and suggests the effects of communication campaigns are sequenced from short-term to long-term effects. As described in Chapter Two, initial reach of a communication strategy is indicated by the level of community awareness and subsequent impact is assessed through changes in message understanding, beliefs about the benefits of PA, intention to be active and first steps taken toward becoming active through to overall PA level. This thesis Chapter presents the results of a study that was conducted within the Canadian PA surveillance system to examine these individual factors and how they are associated with PA and, more specifically, walking which is the most frequently reported type of PA in Canada [CFLRI, 2008].

4.2 Methods

4.2.1 Sampling design

Population surveillance and monitoring of PA has been conducted in Canada by the Canadian Fitness and Lifestyle Research Institute (CFLRI) since the mid-1990s. Details about the development and depth of the Physical Activity and Sport Monitoring Program and more specifically on the annual Physical Activity Monitors (PAM) were provided in Chapter Three. As the primary data source for this Chapter and analyses, however, a very brief summary of the 2003 PAM is included here along with referral to the specific pertinent research questions.

As the primary source of data in this Chapter, the 2003 PAM is a nationally representative population sample of 9,080 Canadian adults aged 15 and older, and a sub-sample of 8,892 adults 18 years and older. The 2003 PAM sample were selected using random-digit dialling from household-based telephone exchanges. The random sample of households contains a minimum sample size of 250 for each province or territory in Canada with the exception of Nunavut. The sample size in Nunavut is smaller and proportional to size, given challenges collecting data in this region due to telephone availability, limited availability during certain seasons (e.g., hunting season), language, and survey burden posed on its small population by multiple large scale annual health surveys. Within each household contacted, one individual over the age of 15 was selected at random, however, only those aged 18 and older were included in the analyses in this Chapter (n=8,892). Therefore, a random sample of Canadian adults was yielded. Survey participants were asked about their PA patterns and individual factors related to PA. Telephone interviewers directly captured the data during the interview using a Computer-Assisted Telephone Interview (CATI) system (see details in Chapter Three). Data were collected from February 2003 to January 2004 by the Institute for Social Research (ISR) located in York University in Ontario, Canada.

The overall response rate obtained in the 2003 PAM was 52%. Information on response rate calculation is provided in Chapter Three. This response rate is reasonable compared to other telephone surveys (see Chapter Three). The sample for this survey is shown in Table 4.1. Sample weights were developed in order to reduce possible bias of over-represented groups in

the sample. The sample weights used for the 2003 PAM data set were adjusted using a post-stratification adjustment factor, which reflected the most current Census distributions for age and sex available at that time in order to correct for the potential bias. All estimates have a statistical error associated with them due to the random selection of the sample.

Table 4.1: Sample by region and province, 2003 PAM

Sample by region and province	
	Adults 18+
Canada	8,892
Atlantic	974
Newfoundland	245
Prince Edward Island	242
Nova Scotia	243
New Brunswick	244
Quebec	1,902
Ontario	3,496
West	1,969
Manitoba	249
Saskatchewan	264
Alberta	685
British Columbia	771
North	551
Yukon	297
Northwest Territories	243
Nunavut	11

Exploring relationships that appear in 2003, in order to determine consistency over time, a sample of 4,689 adults aged 18 and older from the comparable questions asked in the 1998 PAM data are included in comparative trend analysis in Appendix A. The methodology of the 1998 PAM was similar to that described above for the 2003 PAM, and the questions used for comparison were identical, if included in both surveys.

4.2.2 Measures

The measures that were used in the analyses of this Chapter are summarized below, and further details of all measures are also provided in Chapter Three (Methods).

Physical Activity Level and Walking - The short, telephone administered last 7-day recall version of the International Physical Activity Questionnaire (IPAQ) [Craig et al., 2003] was used to measure all-domain PA levels and walking. Questions included days per week and time spent per day participating in vigorous activities, moderate activities and walking. The IPAQ series of questions are described in Chapter Three.

Awareness of guidelines - Awareness was assessed by two questions: one unprompted recall of any acceptable guidelines and one prompted recall of Canadian PA guidelines. Unprompted recall of any acceptable guidelines for PA was determined by asking "Have you heard of any guidelines for physical activity?" (response options yes/no/don't know). Individuals who had heard of guidelines were asked what they were and any acceptable response was coded. Prompted recall was subsequently asked by the question "Have you heard of any of the following initiatives in the past 12 months: Canada's Physical Activity Guide" (yes/no/don't know). Others in a list of prompts included "Healthy Living Strategy" and "Canada's Food Guide".

Knowledge of the amount of PA required for guidelines - Three questions were used to determine knowledge of the amount of PA required that meets Canada's PA guidelines, including:

- *What is the least number of days each week that a person your age has to be active to get health benefits?*
- *On each of these days, how much time in total do you think a person your age has to be active in order to get health benefits?*
- *In the situation you've described where someone is active on [stated] days a week for a total of [stated] minutes each time, how much physical effort do you think they need to put into it in order to get health benefits?* (response options: light, moderate, vigorous, don't know).

Beliefs about PA - Three questions were asked to probe the beliefs about the benefits of PA. Each question used a 7-point Likert rating of agreement (response options 1 through 7 were anchored by 1 "do not agree at all" and 7 "very strongly agree") determining perceptions about the extent to which PA helps people prevent heart disease, maintain the ability to do everyday tasks in older age, and manage stress.

Intention to be active - One question explored respondents' intention to be active; *Thinking about the next six months, to what extent do you intend to be physically active?* Response options were based on a 7-point Likert scale (from 1 to 7 where 1 meant "no intention at all" and 7 meant "fully intend to").

Initial behaviour change steps - Initial behaviour change or trial behaviours were assessed using a series of six questions: *Have you done any of the following over the past 12 months with a view to becoming more active (yes/no)?*

- read articles in newspapers, books or magazines about physical activity
- sought advice from friends, family, or co-workers
- sought advice from health professional(s)
- observed a class, or tried some kind of PA
- sought information about opportunities in your community, such as trails
- made active choices in your usual work routine, like walking part way to work or taking the stairs?

Socio-demographic factors - Sex, age, education level were used as covariates and are described in Chapter Three (Methods).

4.2.3 Research questions

The purpose of this Chapter is to examine individual factors associated with PA and walking, as well as determining the extent to which these factors predict PA and walking behaviours (taking into consideration the age, sex, and education level of respondents).

Activity levels and walking were explored in the 2003 PAM data set in order to answer the questions:

- What proportion of Canadians meet the criterion for being sufficiently active (based on IPAQ scoring criterion)? Moreover, did this proportion vary by age, sex, and education?
- What proportion of Canadians walk sufficient amounts? Did this differ by age, sex and education?

Individual factors related to PA were also explored and key research questions were probed:

- What was the awareness level of Canadian guidelines for PA? Did this vary by socio-demographic groups (gender, age and education groups based on categories described in Chapter Three)?
- What proportion of Canadians understood the amount of PA that is recommended for health benefits (the 1998 Canadian guidelines for adults indicated that 18 to 55 year old adults should accumulate at least 60 minutes of any intensity activity daily for health and as a progression is made to higher intensity, the number of days and duration could be reduced [Health Canada and Canadian Society for Exercise Physiology, 1998])? Did this proportion vary by age, sex, and education?
- What were the perceptions about the health related benefits of PA? Moreover, did certain age, sex, and education groups differ in their beliefs?
- Did intention to be active vary by age, sex, and education groups?
- Which initial behaviour change steps have Canadians done in order to become more active? Did these proportions vary by age, sex, and education?

Furthermore, this Chapter also explores whether individual factors (awareness of guidelines, knowledge of sufficient amounts of activity, beliefs about the benefits of PA, intention, initial steps for behaviour change) were associated with sufficient PA and walking, and which of these factors were more strongly associated with predicting sufficient walking and sufficient activity, taking into account age, sex, and education.

4.2.4 Data treatment

Physical activity – The IPAQ short questionnaire used in the PAM 2003 asked about the number of days and time spent in vigorous-intensity activity, moderate-intensity activity, and walking. Total time spent in vigorous activity was calculated by asking respondents about the number of days and multiplying it by the amount of time spent per occasion in vigorous activities in the past 7 days, this value was then multiplied by a metabolic equivalent (MET) [Ainsworth et al., 1993] value of 8. A similar calculation was conducted for time spent in moderate activities (using a MET value of 4.0) and walking (using a MET value of 3.3). A total

all-domain PA energy expenditure score was then calculated by summing the energy expenditure from the vigorous-intensity, moderate-intensity, and walking behaviours. Using this total energy expenditure score, sufficient activity was calculated if (1) any activity was performed daily with a total energy expenditure of 3,000 MET minutes or higher, or (2) vigorous activity was performed at least 3 days a week with a total energy expenditure of 1,500 MET minutes or higher [www.ipaq.ki.se]. This amount would represent a more stringent criterion for activity when compared to the 1998 Canadian guidelines which specify that 18 to 55 year old adults should accumulate at least 60 minutes of any intensity activity daily for health, 30 minutes of moderate-intensity activity, 4 days a week, or 20 minutes of vigorous-intensity activity, 4 days a week [Health Canada and Canadian Society for Exercise Physiology, 1998]. If a MET value of 3.3 (walking), 4 (moderate-intensity), and 8 (vigorous-intensity) were respectively assigned to these activities as per the IPAQ values mentioned above, the total energy expenditure representing Canadian guidelines would be lower.

Walking – A score for walking was calculated based on the number of days and the amount of time spent walking in the past 7 days from the IPAQ. Based on this data, sufficient walking was defined as walking 7 days a week for 60 minutes or more. As noted above, this amount represents a conservative amount to represent the Canadian guidelines for adults based on the 1998 guidelines, whereby the guidelines state that 18 to 55 year old adults should accumulate at least 60 minutes of any intensity activity daily for health (as a progression is made to higher intensity, that the number of days and duration can be reduced [Health Canada and Canadian Society for Exercise Physiology, 1998].

Awareness of guidelines - As described previously, unprompted awareness of PA guidelines was assessed by asking “Have you heard of any guidelines for physical activity?” (response options: yes/no/don’t know). Individuals who had heard of guidelines were further asked what the guidelines were. Any acceptable response or source for guidelines, including Canada’s Physical Activity Guides, U.S. Surgeon General’s Report, Health Canada, ParticipACTION, and so on, was coded as “aware”; otherwise, respondents were assigned a code of “unaware”. Prompted recall however, was simply assessed as ‘yes’ or ‘no’ response to the question probed.

Knowledge of the amount of PA required for guidelines – In order to determine knowledge of the amount of PA required to meet the original Canadian PA guidelines, a score for understanding the Canadian PA guidelines was calculated if the respondent stated (1) 7 days of activity per week, for 60 or more minutes per day, at any intensity, or (2) a minimum of 4 days of activity per week for 30 or more minutes per day, at least moderate intensity. This calculation was coded as a dichotomous variable: "has knowledge about the amount of PA for guidelines" or not.

Beliefs about the benefits of PA – Three belief questions assessing the extent to which the respondent believes that PA helps prevent heart disease, helps people maintain the ability to do everyday tasks in older age, and helps people to manage stress were probed. A Cronbach's alpha score was calculated measuring the internal consistency between these three questions and was considered acceptable (0.74). Consequently, the measures were summed into a composite beliefs score and then divided into quartiles based on the distribution where quartile 1 represents the lowest score and quartile 4 represents the highest score.

Intention to be active- Intention to be active was asked using a 7-point Likert scale (from 1 anchored as "no intention at all" to 7, meaning "fully intend to"). Given the skew of the data, the variable was categorized into a dichotomous variable of "high intention" if the respondent answered 6 or 7 on the scale and "lower intention" if the respondent answered with 5 or less on the scale.

4.2.5 Analysis

Statistical analysis

All analyses in this Chapter used the 2003 PAM data set and were conducted using SPSS version 21.0. Complex sampling was used in order to take into account stratification by province or territory within the country. Accordingly, the complex sample cross-tabulation procedure was used to calculate the prevalence estimates in this Chapter for sufficient PA, sufficient walking and individual factors. If multiple measures were used to identify a particular construct (for example, beliefs about the benefits of PA), a Cronbach's alpha score was calculated to determine the internal consistency between the measures. If the internal

consistency had an acceptable reliability coefficient (>0.70) [Bland & Altman, 1997], a composite score was developed.

To answer the key research questions, the relationship between 'sufficient' PA and 'sufficient' walking were explored by socio-demographic factors. In addition, the relationships between individual factors pertaining to PA (awareness of guidelines, knowledge of sufficient amounts of activity, beliefs about the benefits of PA, intention, initial steps for behaviour change) were also explored by socio-demographic factors (age, sex, and education level). The association between 'sufficient' PA and walking by individual factors were also explored. For each of these analyses, sample weights were applied and relationships were tested using 95% confidence intervals surrounding the estimates. Response options of 'don't know' and 'refused' were relatively infrequent, and if less than 3% of responses, they were excluded from the analyses as they had a negligible effect on estimates.

The relationship between individual factors predicting sufficient activity and sufficient walking were examined using complex logistic regression procedures to take into consideration the study design, given that the samples required complex sampling methods. These models explored associations and the relative strength of the individual factors related to PA as the independent measures predicting 'sufficient' PA and 'sufficient' walking as the dependent measures, using age, sex, and education as covariates for each of these models. Further details are also provided in Chapter Three.

4.3 Results

4.3.1 Physical activity and walking

In order to address the research question pertaining to the proportion of Canadian adults who are active enough, information on participation in vigorous and moderate intensity activity and walking was explored. Just over one half (53.1%, weighted) of adults 18 years and older cited sufficient amounts of PA to be considered active (for this Chapter, sufficient activity represents a total energy expenditure of 3,000 MET minutes or higher, or vigorous activity at least 3 days a week with a total energy expenditure of 1,500 MET minutes or higher). Almost one-third (29.6%) indicated that they walked sufficient amounts (for this Chapter, sufficient walking is

defined as walking 7 days a week for 60 minutes or more). The relationship between sufficient walking and activity by socio-demographic factors was also explored in order to determine which population groups met or did not meet the sufficient activity definition. For this purpose, the distribution of sex, age, and education are described below and are further summarized in Table 4.2 (details on the questionnaire wording are provided in Chapter Three).

A greater proportion of women (56.0%, un-weighted) than men (44.0%, un-weighted) participated in the survey. For the analyses in this Chapter, sample weights were applied to the data with an applied post-stratification adjustment which reflected the latest Census distributions for age and sex that were available at the time. Table 4.2 illustrates the differences between un-weighted and weighted proportion for the covariates sex, age, and education.

Table 4.2: Distribution of age, sex, and education, 2003 PAM

		N	Un-weighted %	Weighted %	Lower CI (95%)	Upper CI (95%)
Sex	Male	3,909	44.0%	48.4%	47.2%	49.6%
	Female	4,983	56.0%	51.6%	50.4%	52.8%
Age	18 to 24	908	10.2%	13.4%	12.4%	14.3%
	25 to 44	3,432	38.6%	38.9%	37.7%	40.0%
	45 to 64	3,079	34.6%	31.1%	30.1%	32.3%
	65 and older	1,471	16.5%	16.6%	15.8%	17.5%
Education	< Secondary	1,489	17.0%	16.8%	15.9%	17.7%
	Secondary	2,257	25.8%	26.9%	25.8%	28.0%
	College	2,109	24.1%	23.6%	22.6%	24.7%
	University	2,907	33.2%	32.7%	31.6%	33.9%

Activity level was further explored by these socio-demographic groups, in order to determine which groups did or did not meet sufficient activity levels. More men than women were sufficiently active. Activity level decreased substantially with increasing age group. A lower proportion of adults with less than a secondary school education met the sufficiently active category compared to those with higher levels of education. Interestingly, however, a slightly lower proportion of university educated adults met the sufficiently active category compared to those with a secondary school education. These relationships are summarized in Table 4.3.

Table 4.3: Proportion sufficiently active by age, sex, and education, 2003 PAM

		N	% achieving sufficient amounts of total PA	Lower CI (95%)	Upper CI (95%)
	Total	4,641	53.1%	51.9%	54.3%
Sex	Male	2,328	59.5%	57.7%	61.3%
	Female	2,313	47.1%	45.5%	48.8%
	18 to 24	612	67.7%	64.1%	71.2%
	25 to 44	1,916	55.8%	53.9%	57.7%
Age	45 to 64	1,586	51.6%	49.5%	53.7%
	65 and older	527	38.0%	35.2%	40.9%
	< Secondary	633	44.3%	41.4%	47.3%
	Secondary	1,278	57.7%	55.3%	60.0%
Education	College	1,159	55.7%	53.3%	58.2%
	University	1,520	52.5%	50.3%	54.5%

Almost one-third of adults (29.6%) stated that they walked enough to meet the sufficient walking criteria of 60 minutes daily. Similar to total activity, more men than women walked sufficient amounts and walking sufficient amounts decreased with increasing age. A greater proportion of college educated adults met the walking criteria compared to those with less than a secondary school education or those with a university education. These relationships are summarized in Table 4.4.

Table 4.4: Proportion that walk sufficient amounts by age, sex, and education, 2003 PAM

		N	% walking sufficient amount	Lower CI (95%)	Upper CI (95%)
	Total	2,558	29.6%	28.5%	30.7%
Sex	Male	1,225	31.7%	30.1%	33.4%
	Female	1,333	27.5%	26.1%	29.0%
	18 to 24	354	37.9%	34.3%	41.6%
	25 to 44	1,071	32.1%	30.3%	33.9%
Age	45 to 64	847	27.7%	25.9%	29.6%
	65 and older	286	20.5%	18.2%	22.9%
	< Secondary	369	26.7%	24.1%	29.5%
	Secondary	691	31.5%	29.3%	33.8%
Education	College	661	32.2%	29.9%	34.6%
	University	812	27.8%	25.9%	29.7%

4.3.2 Individual factors

The present study investigates whether individual factors pertaining to PA contribute to PA behaviour. To this end, a series of research questions in this Chapter determines whether individual factors (including awareness of guidelines, knowledge of the amount of PA that is recommended for health benefits, perceptions about the health related benefits of PA, intention to be active, and initial trial behaviours towards becoming more active) are associated with sufficient levels of PA and walking, and whether or not these vary by population groups.

Awareness of guidelines – Awareness of PA guidelines was determined using unprompted and prompted recall. Among adults who indicated that they were aware of guidelines for PA, only 4.5% were able to provide an acceptable unprompted response of the PA guidelines. Unprompted recall of guidelines was more prevalent among those with higher levels of education (i.e., university education compared to those with a college education compared to those with a secondary education). A larger proportion of adults, however, had indicated that they had heard of Canadian PA guidelines when prompted (37.3%). Women were more likely than men to be aware of guidelines when prompted, but there were no significant differences with age. Prompted recall was lower among respondents with the lowest level of education (see Table 4.5).

Table 4.5: Awareness of guidelines by age, sex, and education, 2003 PAM

		Awareness of PA guidelines			
		Unprompted recall	95% CI	Prompted recall	95% CI
Sex	Total	4.5%	4.0-5.0%	37.3%	36.0-38.6%
	Male	3.9%	3.2-4.7%	31.8%	30.0-33.6%
	Female	5.0%	4.3-5.8%	42.6%	40.8-44.3%
Age	18 to 24	-%	-%	34.9%	31.2-38.9%
	25 to 44	5.7%	4.9-6.8%	39.4%	37.4-41.4%
	45 to 64	5.5%	4.5-6.6%	37.1%	35.0-39.3%
	65 or older	-%	-%	34.6%	31.7-37.7%
Education	< Secondary	-%	-%	29.3%	26.5-32.3%
	Secondary	2.6%	1.8-3.6%	37.9%	35.4-40.5%
	College	4.7%	3.7-5.9%	38.2%	35.7-40.8%
	University	7.8%	6.7-9.0%	40.3%	38.1-42.5%

- Data suppressed due to insufficient cell size.

Knowledge of the amount of PA required to meet the guidelines – A derived score representing knowledge of the amount of PA required for guidelines was calculated based on responses to 3 questions (the least number of days each week, the time in total on these days, and the amount of physical effort that a person has to be active for health benefits) to represent amounts equivalent to Canadian guidelines. That is, if the respondent stated that in order for an individual to be active, a person should report 1) 7 days of activity per week, for 60 or more minutes per day, at any intensity, or 2) a minimum of 4 days of activity per week for 30 or more minutes per day, at least moderate intensity. Based on this criterion, 43.1% of Canadians were able to cite a combination that met Canadian guidelines. There were no sex-related differences in the proportion that were knowledgeable of the minimum amount of PA to meet PA guidelines (see Table 4.6). The proportion of adults citing knowledge of the minimum amount of PA to meet guidelines increases with increasing age (over 25) and is lower among those with post-secondary education (compared to those with the lowest level of education).

Table 4.6: Knowledge of minimum amount of PA to meet guidelines by age, sex, and education, 2003 PAM

		Reported minimum amount of PA meets guide criteria				
		N	Aware of minimum amount of PA required for guidelines	95% CI	Not aware of the minimum amount	95% CI
Sex	Total	4,947	43.1%	41.5-44.7	56.9%	55.3-58.5
	Male	2,208	44.9%	42.5-47.3	55.1%	52.7-57.5
	Female	2,739	41.4%	39.3-43.6	58.6%	56.4-60.7
Age	18 to 24	533	40.3%	35.5-45.3	59.7%	54.7-64.5
	25 to 44	1,948	37.5%	35.0-40.0	62.5%	60.0-65.0
	45 to 64	1,729	45.0%	42.3-47.8	55.0%	52.2-57.7
	65 or older	737	56.6%	52.5-60.7	43.4%	39.3-47.5
Education	< Secondary	706	50.9%	46.5-55.2	49.1%	44.8-53.5
	Secondary	1,216	46.9%	43.6-50.2	53.1%	49.8-56.4
	College	1,191	40.3%	37.1-43.6	59.7%	56.4-62.9
	University	1,772	39.0%	36.3-41.7	61.0%	58.3-63.7

Beliefs about the benefits of PA – The beliefs about the benefits of PA were assessed through three questions (for preventing heart disease, managing stress, and helping to maintain functional ability with age). The distributions of each of the three questions are

described in Table 4.7. Overall, almost half of Canadians agreed very strongly with each of these three beliefs about PA.

Table 4.7: Beliefs about the benefits of PA, overall distribution, 2003 PAM

	Regular PA helps					
	Prevent heart disease		Maintain stress		Maintain the ability to do everyday tasks in older age	
	N	Estimate	N	Estimate	N	Estimate
Do not agree (anchor)	102	1.4%	57	0.8%	74	1.1%
2	66	0.9%	40	0.5%	60	1.0%
3	202	2.7%	101	1.4%	150	1.8%
4	391	5.6%	270	3.5%	406	5.6%
5	1,324	18.5%	1,210	17.0%	1,357	19.8%
6	1,497	21.8%	1,872	27.6%	1,599	23.4%
Agree very strongly (anchor)	3,521	49.1%	3,590	49.2%	3,469	47.3%
Total	7,103	100.0%	7,140	100.0%	7,115	100.0%

The internal consistency of the measures was assessed, and given an acceptable reliability of 0.74, the indicators were combined into one score and then further divided into quartiles. Using this derived score, more women than men held the highest belief scores (quartile 4) whereas more men than women held the lowest belief score (quartile 1). Reporting a high belief score (quartile 4) about the benefits of PA increased with increasing age group until the age of 64 then decreased slightly. A low score (quartile 1) was associated with lower levels of education (see Table 4.8).

Table 4.8: Beliefs about the benefits of PA by age, sex, and education, 2003 PAM

		N	Quartile 1 (lowest score of beliefs), 95% CI	Quartile 4 (highest score of beliefs), 95% CI
Sex	Total	7,055	23.7%, 22.5-24.9%	30.0%, 28.8-31.2%
	Male	3,101	28.2%, 26.4-30.1%	24.9%, 23.2-26.7%
	Female	3,954	19.5%, 18.1-21.0%	34.7%, 33.0-36.4%
Age	18 to 24	747	31.7%, 27.9-35.7%	16.6%, 13.7-19.9%
	25 to 44	2,737	21.4%, 19.7-23.2%	30.6%, 28.7-32.6%
	45 to 64	2,458	20.4%, 18.6-22.4%	35.7%, 33.5-38.0%
	65 and older	1,113	28.6%, 25.6-31.7%	28.9%, 26.0-32.1%
Education	< Secondary	1,138	29.3%, 26.2-32.5%	28.4%, 25.5-31.6%
	Secondary	1,779	28.3%, 25.9-30.9%	27.4%, 25.1-29.9%
	College	1,670	21.7%, 19.5-24.1%	30.2%, 27.8-32.8%
	University	2,377	18.5%, 16.7-20.4%	32.2%, 30.1-34.4%

Intention – Canadians are generally positive about their intentions to be active in the near future (see Table 4.9). A low proportion of adults (14%) have a low degree of intention to be active (4 or less on a 7 point scale).

Table 4.9: Intention to be active, overall distribution, 2003 PAM

	N	Estimate	95% CI
1 (No intention at all)	147	2.0%	1.7-2.4%
2	102	1.4%	1.1-1.7%
3	212	3.1%	2.7-3.7%
4	483	7.0%	6.3-7.8%
5	1,625	23.3%	22.1-24.5%
6	1,319	19.5%	18.4-20.6%
7 (Fully intend to be active)	3,174	43.7%	42.3-45.0%

As described in the data treatment section above, given the skew of the data, the intention variable was categorized into a dichotomous variable (63.2% high intention, 36.8% lower intention). When examining the categorized intention variable by socio-demographic factors, there were no significant differences by sex and age, however, there was with education. A high degree of intention was more prevalent among those with a university education compared to those with secondary school education or less (see Table 4.10).

Table 4.10: Intention to be active by age, sex, and education, 2003 PAM

		N	Lower intention (scored 1 to 5), 95% CI	Highest intention (6 and 7), 95% CI
Sex	Total	7,062	36.8%, 35.5-38.2%	63.2%, 61.8-64.5%
	Male	3,116	38.0%, 36.1-40.0%	62.0%, 60.0-63.9%
	Female	3,946	35.7%, 33.9-37.5%	64.3%, 62.5-66.1%
Age	18 to 24	751	34.2%, 30.3-38.3%	65.8%, 61.7-69.7%
	25 to 44	2,750	35.6%, 33.5-37.7%	64.4%, 62.3-66.5%
	45 to 64	2,454	38.6%, 36.3-40.9%	61.4%, 59.1-63.7%
	65 and older	1,107	38.8%, 35.6-42.1%	61.2%, 57.9-64.4%
Education	< Secondary	1,126	41.7%, 38.4-45.1%	58.3%, 54.9-61.6%
	Secondary	1,784	40.2%, 37.6-43.0%	59.8%, 57.0-62.4%
	College	1,676	35.8%, 33.1-38.5%	64.2%, 61.5-66.9%
	University	2,383	32.3%, 30.1-34.6%	67.7%, 65.4-69.9%

Initial behaviour change steps – The 2003 PAM assessed several initial actions or behaviours with the purpose of becoming more active, as summarized in Table 4.11, including:

- reading articles in newspapers, books or magazines about physical activity
- seeking advice from friends, family, or co-workers
- seeking advice from health professional(s)
- observing a class, or trying some kind of physical activity
- seeking information about opportunities in your community, such as trails, and
- making active choices in your usual work routine, like walking part way to work or taking the stairs

Table 4.11: Initial behaviour change steps, overall distribution, 2003 PAM

	Yes		No		Not applicable/don't know/refused	
	N	%	N	%	N	%
Reading articles in newspapers, books or magazines about PA	3,972	54.7%	3,140	44.5%	59	0.7%
Seek advice from friends, family	2,839	39.7%	4,250	59.3%	82	0.9%
Seek advice from health professionals	1,854	24.9%	5,225	73.9%	92	1.2%
Observed or tried activity	3,869	54.5%	3,144	43.5%	158	1.9%
Seeking info about community opportunities	2,596	35.7%	4,346	61.3%	229	3.0%
Making active choices at work	5,096	71.0%	1,771	25.1%	304	3.9%

More women than men have initiated a change in behaviour in the previous year with a view to becoming more active (see Table 4.12a and Table 4.12b). The proportion of adults who sought advice about PA from friends or family members, or who observed or tried a PA class decreased with increasing age. Fewer older adults sought information on community opportunities compared to others, and similarly a lower proportion of older adults made active choices in their work routine compared to 18 to 24 year olds. A lower proportion of 18 to 24 year olds sought information from a health professional compared to those older than 25 years. There is also a relationship between education of the respondent and their attempts to become more active. The proportion of adults that have observed or tried a PA class, made active choices at work, sought advice from friends and family, sought information on PA by reading articles, or sought information on opportunities in their community generally increased with increasing education level. A greater proportion of adults with a university education sought information from a health professional compared to those with less than a secondary school education.

Table 4.12a: Initial behaviour change steps by age, sex, and education, 2003 PAM

	Read articles			Sought advice friends, family			Sought advice from health professionals		
	N	%	95% CI	N	%	95% CI	N	%	95% CI
Sex									
Total	3,972	55.1%	53.8-56.5%	2,839	40.1%	38.7-41.4%	1,854	25.2%	24.1-26.4%
Male	1,431	45.6%	43.6-47.6%	1,028	33.2%	31.3-35.1%	729	23.0%	21.3-24.7%
Female	2,541	64.0%	62.2-65.7%	1,811	46.5%	44.7-48.3%	1,125	27.3%	25.7-28.9%
Age									
18 to 24	374	51.6%	47.4-55.8%	413	55.1%	50.8-59.2%	141	17.0%	14.2-20.3%
25 to 44	1,482	53.5%	51.3-55.6%	1,239	44.2%	42.1-46.4%	681	24.8%	22.9-26.7%
45 to 64	1,423	57.0%	54.7-59.3%	902	36.3%	34.1-38.6%	702	27.7%	25.7-29.8%
65 or older	693	58.6%	55.2-61.8%	285	24.5%	21.7-27.4%	330	28.7%	25.8-31.8%
Education									
< Secondary	531	45.3%	42.0-48.7%	354	30.7%	27.6-34.0%	267	21.6%	19.0-24.5%
Secondary	918	51.9%	49.2-54.6%	659	38.0%	35.4-40.7%	460	24.7%	22.4-27.0%
College	965	55.5%	52.8-58.3%	735	42.4%	39.7-45.2%	450	26.2%	23.8-28.7%
University	1,506	62.3%	60.0-64.6%	1,057	44.8%	42.5-47.2%	659	27.0%	25.0-29.1%

Table 4.12b: Initial behaviour change steps by age, sex, and education, 2003 PAM

	Observe or tried a PA class			Info on community opportunities			Made active choices at work		
	N	%	95% CI	N	%	95% CI	N	%	95% CI
Sex									
Total	3,869	55.7%	54.3-57.0%	2,596	36.8%	35.4-38.1%	5,096	73.9%	72.6-75.1%
Male	1,550	50.5%	48.5-52.6%	1,066	34.6%	32.7-36.6%	2,101	69.6%	67.7-71.5%
Female	2,319	60.4%	58.6-62.2%	1,530	38.8%	37.0-40.6%	2,995	77.8%	76.2-79.3%
Age									
18 to 24	480	65.9%	61.8-69.7%	285	38.2%	34.2-42.4%	586	78.0%	74.4-81.3%
25 to 44	1,652	60.1%	58.0-62.2%	1,170	42.0%	39.9-44.1%	2,033	74.4%	72.4-76.2%
45 to 64	1,290	52.5%	50.2-54.9%	859	34.9%	32.7-37.2%	1,746	72.7%	70.5-74.8%
65 or older	447	41.8%	38.5-45.2%	282	26.2%	23.4-29.3%	731	71.0%	67.8-74.0%
Education									
< Secondary	407	37.9%	34.6-41.3%	259	22.4%	19.6-25.4%	719	64.6%	61.2-67.8%
Secondary	895	51.7%	49.0-54.4%	558	31.6%	29.1-34.2%	1,280	73.1%	70.6-75.5%
College	992	59.4%	56.7-62.2%	668	40.1%	37.4-42.9%	1,214	74.1%	71.5-76.5%
University	1,539	65.7%	63.4-67.9%	1,097	46.3%	44.0-48.7%	1,830	79.4%	77.4-81.2%

4.3.3 Associations between individual factors and physical activity and walking

The relationships between sufficient activity and sufficient walking and individual factors are important research questions presented in this Chapter, and are further described in Table 4.13. A greater proportion of those who were aware of Canadian guidelines for PA when prompted were sufficiently active. Similarly, a greater proportion of adults who have knowledge about the amount of physical activity required to meet guidelines or have a high intention to be active were associated with meeting the sufficient activity and walking criteria. There was no relationship between beliefs and walking in a sufficient amount whereas a low belief score (Quartile 1) was more prevalent among those who were not active enough. Regarding initial behaviour change, a greater proportion of adults who read articles on PA, who sought information from friends and families, sought information on opportunities in the community, and tried or observed a PA class, or made changes in their usual work routine were sufficiently active. Similarly, a greater proportion of adults who sought information on opportunities in the community or made active choices in their usual routine at work met the walking criterion.

Table 4.13: Individual and social factors by sufficient activity and walking, 2003 PAM

	Physical activity				Walking			
	Not sufficiently active		Sufficiently active		Does not walk sufficient amount		Walks sufficient amount	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Unprompted awareness of guidelines								
Not aware of guidelines	96.1%	95.3-96.7	95.1%	94.3-95.8	95.8%	95.1-96.4	95.0%	93.8-95.9
Aware of guidelines	3.9%	3.3-4.7	4.9%	4.2-5.7	4.2%	3.6-4.9	5.0%	4.1-6.2
Prompted awareness of Canadian guidelines								
Not aware of guidelines	65.4%	63.5-67.2	60.4%	58.7-62.2	63.0%	61.5-64.5	62.1%	59.8-64.3
Aware of guidelines	34.6%	32.8-36.5	39.6%	37.8-41.3	37.0%	35.5-38.5	37.9%	35.7-40.2
Knowledge of amount of PA for guidelines								
Does not have knowledge	60.5%	58.1-62.8	54.0%	51.8-56.2	59.8%	57.8-61.7	50.2%	47.1-53.2
Has knowledge of amount of guidelines	39.5%	37.2-41.9	46.0%	43.8-48.2	40.2%	38.3-42.2	49.8%	46.8-52.9
Beliefs about the benefits								
Q1 (lowest)	26.0%	24.2-27.8	21.8%	20.3-23.4	23.9%	22.5-25.3	23.3%	21.2-25.5
Q2	22.3%	20.7-24.1	23.5%	21.9-25.1	22.7%	21.3-24.1	23.6%	21.5-25.8
Q3	22.5%	20.9-24.3	24.1%	22.5-25.7	23.8%	22.5-25.2	22.4%	20.3-24.5
Q4 (highest)	29.1%	27.4-31.0	30.7%	29.0-32.4	29.6%	28.2-31.1	30.8%	28.6-33.1
Intention								
Lower intention (1 to 5)	49.0%	47.0-51.0	26.9%	25.3-28.6	39.4%	37.8-41.0	31.1%	28.8-33.4
High intention (6 and 7)	51.0%	49.0-53.0	73.1%	71.4-74.7	60.6%	59.0-62.2	68.9%	66.6-71.2
Initial behaviour change								
Did not read articles	47.7%	45.7-49.7	42.5%	40.7-44.4	43.8%	42.2-45.4	47.2%	44.8-49.7
Read articles	52.3%	50.3-54.3	57.5%	55.6-59.3	56.2%	54.6-57.8	52.8%	50.3-55.2
Did not seek info	62.8%	60.8-64.7	57.5%	55.7-59.4	60.0%	58.4-61.6	59.6%	57.2-62.1
Sought info from friends/family	37.2%	35.3-39.2	42.5%	40.6-44.3	40.0%	38.4-41.6	40.4%	37.9-42.8
Did not seek info	76.4%	74.6-78.0	73.5%	71.8-75.1	75.0%	73.5-76.3	74.4%	72.2-76.5
Sought info from health professional	23.6%	22.0-25.4	26.5%	24.9-28.2	25.0%	23.7-26.5	25.6%	23.5-27.8
Did not try or observe class	50.2%	48.1-52.2	39.6%	37.8-41.4	44.3%	42.7-46.0	44.4%	41.9-46.9
Trying or observing	49.8%	47.8-51.9	60.4%	58.6-62.2	55.7%	54.0-57.3	55.6%	53.1-58.1
Did not seek info	68.3%	66.4-70.1	59.1%	57.2-60.9	65.0%	63.4-66.6	59.2%	56.7-61.6
Sought info on communities	31.7%	29.9-33.6	40.9%	39.1-42.8	35.0%	33.4-36.6	40.8%	38.4-43.3
Did not change routine	30.2%	28.3-32.1	22.8%	21.3-24.5	27.6%	26.2-29.1	22.8%	20.7-25.0
Making active choices	69.8%	67.9-71.7	77.2%	75.5-78.7	72.4%	70.9-73.8	77.2%	75.0-79.3

Table 4.14 describes how individual factors were associated with sufficient activity and sufficient walking. In order to determine which factors are more strongly related to sufficient activity and sufficient walking, Table 4.14 shows the relationships between individual factors in predicting sufficient activity and walking level in one model when controlling for age, sex, and education. After controlling for age, sex and education, prompted and unprompted awareness of guidelines were not associated with sufficient activity, however knowledge about Canadian guidelines and a high level of intention were associated with higher odds of sufficient PA. In terms of initial behaviour change steps, seeking information about PA opportunities in the community and making active choices during one's daily routine were associated with a higher likelihood of being sufficiently active. In terms of walking, unprompted awareness of any guidelines, knowledge about the amount of activity identified in Canadian guidelines, and high intention to be active were associated with sufficient walking. Seeking information about PA opportunities from a health professional, seeking information in the community and making active choices during one's daily routine were associated with a higher odds of meeting a sufficient criterion for walking, whereas trying or observing a physical activity class were associated with a lower likelihood of meeting the sufficient walking criterion.

Table 4.14: Odds ratios of sufficient activity and daily walking by individual factors, 2003 PAM

	Sufficient activity			Sufficient walking		
	Odds Ratio*	Lower 95% CI	Upper 95% CI	Odds Ratio*	Lower 95% CI	Upper 95% CI
Unprompted Awareness of guidelines						
Not aware of guidelines	Reference			Reference		
Unprompted awareness of guidelines	1.37	0.97	1.93	**1.45**	**1.04**	**2.02**
Prompted Awareness of Canadian guidelines						
Not aware of guidelines	Reference			Reference		
Prompted awareness of guidelines	0.96	0.82	1.12	0.93	0.79	1.09
Knowledge of amount of PA for guidelines						
Does not have knowledge	Reference			Reference		
Has knowledge of amount of PA for guidelines	**1.41**	**1.21**	**1.64**	**1.55**	**1.33**	**1.82**
Beliefs about the benefits of PA						
Q1 (lowest score)	Reference			Reference		
Q2	1.16	0.94	1.43	0.98	0.79	1.23
Q3	1.11	0.89	1.38	0.96	0.77	1.20
Q4 (highest score)	1.12	0.90	1.39	1.06	0.85	1.33
Intention						
Low (5 or lower)	Reference			Reference		
High intention (6 and 7)	**2.30**	**1.97**	**2.70**	**1.43**	**1.20**	**1.70**
Initial behaviour change						
Did not read articles	Reference			Reference		
Read articles	1.08	0.91	1.27	0.90	0.76	1.07
Did not seek info from acquaintances	Reference			Reference		
Sought info from acquaintances	1.07	0.91	1.27	0.95	0.80	1.13
Did not seek info from health professional	Reference			Reference		
Sought info from a health professional	1.09	0.92	1.30	**1.24**	**1.03**	**1.49**
Did not try or observe a PA class	Reference			Reference		
Tried or observed a PA class	1.14	0.97	1.34	**0.81**	**0.68**	**0.97**
Did not seek info on communities	Reference			Reference		
Sought Info on communities	**1.18**	**1.01**	**1.38**	**1.24**	**1.05**	**1.46**
Did not make active choices at work	Reference			Reference		
Made active choices at work	**1.29**	**1.09**	**1.54**	**1.29**	**1.07**	**1.56**

* adjusted for sex, age, education

4.4 Discussion

Roughly half of Canadian adults were sufficiently active in 2003, whereas approximately one-third of the population walked enough. This Chapter found that more men than women were sufficiently active and walked enough; activity level and walking behaviour decreased by increasing age group. A lower proportion of adults with less than secondary school education were active enough, and a somewhat similar relationship appeared for walking. These findings are similar to others found in Canada, and in other westernized countries [Cameron et al., 2007; Bauman et al., 2009].

In order to promote PA among populations with traditionally lower levels of activity, understanding factors at an individual level can help to arm health promoters with the information required in order to tailor their promotional strategies to help engage these populations. As such, a fundamental research question in this Chapter examined the impacts of the communication related aspects involved in promoting PA behaviours. Specifically, this Chapter examined the associations between initial exposure and message knowledge, more distal factors within the communications hierarchy, such as behavioural intention and behavioural trialling [McGuire, 1984; Cavill & Bauman 2004; Bauman et al., 2006] and their impact on PA levels and walking behaviours.

In Canada, PA guidelines have been developed for adults, older adults, and children and youth (1998, 1999, and 2002 respectively) [Health Canada and the Canadian Society for Exercise Physiology, 1998]. These guides were developed in part as a communication tool within a social marketing campaign to raise awareness of, and promote PA [Cameron et al., 2007a]. The effects of a communication strategy can be evaluated by the level of awareness (assessed as unprompted and prompted message recall), message understanding, beliefs about the benefits of PA, intention to be active, and first steps towards being active, through to measures of overall participation in PA. Generally, the impacts are assessed as a hierarchy or cascading effect [McGuire, 1984; Cavill & Bauman 2004; Bauman et al., 2006].

The original Canadian guidelines and their associated resources included the guides themselves for each of the three age populations, a handbook, family and teachers' guides for

children, a magazine for youth, chart and stickers [Health Canada and the Canadian Society for Exercise Physiology, 1998; Cameron et al., 2007a]. Social marketing principles were used to develop and launch the guidelines. The recommendations and messages were formulated to define the product of PA for health and show that it could be obtained at little cost (monetary, effort and in terms of personal time). Places to be active (home, work, school and by commuting) were part of the messages, but there was also an engagement strategy wherein key stakeholders in various sectors endorsed the guidelines and committed to help in their rollout. Finally, the Canadian guidelines were promoted through a two-step dissemination strategy which involved a media campaign for highlighting the issues of physical inactivity and was promoted in newspapers and websites. In addition, the guides were distributed and promoted through intermediaries including governmental and non-governmental organizations interested in PA, and through various settings (for example, these settings can include workplaces, schools, and municipalities) [Cameron et al., 2007a]. Further actions to increase PA, through the release of the guides, was undertaken by the provincial and territorial governments. For example, in Ontario, a series of workshops were held to engage professionals (invited from public health, education, recreation and transportation) to develop new ways to offer and promote opportunities for PA. There was, however, no consistent rollout strategy developed across jurisdictions or new budget allocated to support such activities. In 2011, researchers in Canada updated the PA guidelines for these and other populations [Canadian Society for Exercise Physiology, 2011; Tremblay et al., 2011], however, due to the timing of the surveys in this thesis and in the Chapter more specifically, the original Canadian guidelines are discussed.

Data from this chapter indicates that very low rates of the population as a whole were able to recall any PA guidelines when not asked specifically about them (i.e., when prompted), however, a larger proportion were aware when asked specifically. One reason for the inconsistency between awareness when prompted or prompted may be an overestimate recall of the Canadian guidelines and may suggest a social desirability effect [Cameron et al., 2007a]. This hypothesis is reinforced to some degree by the finding that unprompted recall of guidelines was associated with a greater likelihood of sufficient walking, whereas prompted recall of guidelines was not related to either sufficient activity or walking. A factor related to these lower rates of unprompted awareness may have been the lack of a comprehensive,

coordinated and well-funded strategy to increase PA tied to the release of the guidelines [Cameron et al., 2007a].

These results regarding awareness or recall of guidelines are similar to other studies in Canada [Bauman et al., 2005; Spence et al., 2002]. Bauman and colleagues report a prevalence rate of 7.4% being able to recall any acceptable Canadian guidelines (unprompted) in 1999, and a rate of 5.2% in 2002 [Bauman et al., 2005]. On the contrary, however, awareness of Canadian guidelines when specifically prompted has increased from 26.8% in 2002 [Cameron et al., 2007a] to 37.3% as cited in this Chapter, using a similar methodology. Beyond population studies and based on findings from other Canadian studies, awareness of guidelines also can differ by setting (for example 36% of workplaces reported prompted recall of guidelines) [Cameron et al., 2004]. Less than 10% of adult (6%) had actually report having received a copy of the guidelines [Cameron et al., 2005; Cameron et al., 2007a]. Although prompted awareness has increased, the fairly constant low rates of unprompted awareness over time suggest that these guidelines and their messages may not have adequately reached the majority of the Canadian population [Cameron et al., 2007a]. In Canada, other mass advertising campaigns have yielded similar prompted message recall based on campaign timing followed by decreases following the campaign [Craig et al., 2006], and maintain higher levels of recall following longer campaigns [Bauman et al., 2004]. Understanding how recall varied by population group was also an important part of this study. Women and adults with higher education were more likely to indicate prompted recall guidelines. Among this gender group traditionally, there have been lower rates of PA [Craig et al., 2004], suggesting that perhaps other factors besides a lack of awareness may contribute to disparity or inequity in PA participation among these groups [Cameron et al., 2005b; Cameron et al., 2007a].

As mentioned previously, the original guidelines were disseminated with a communications component, however it was not necessarily a campaign which was well resourced, focused on the population, or used paid media [Bauman et al., 2006; Cameron et al., 2007a]. The guidelines were not disseminated adhering to a comprehensive communications plan but instead distributed through governmental and non-governmental organizations involved in PA, and through settings, each having varying degree of reach [Cameron et al., 2007a]. The original guidelines contain complex messages, including one pertaining to dose: for adults, accumulating at least 60 minutes of PA daily, which may be reduced to a minimum of 30

minutes of moderate-to-vigorous activity four days a week; for older adults, accumulating 60 minutes of moderate activity most days; for children and youth, increasing PA by 60 minutes of moderate plus 30 minutes of vigorous activity daily. There were also messages about the benefits of PA, stories and examples, and suggestions of trial behaviours or initial behaviour change. This study examined these factors in association with and in predicting PA and walking behaviours.

Results from this Chapter indicate that less than half of Canadians correctly cited knowledge of the dose (frequency, intensity and duration) of PA to meet these guidelines. Knowledge of the minimum amount of PA to meet guidelines generally increased with increasing age, interestingly, was lower among those with a post-secondary education, and was associated with PA and walking. Although this represents the minority of Canadians, it does compare in a positive fashion with an evaluation of England's 'Active for Life' campaign [Hillsdon et al., 2001; Cameron et al., 2007a]. It is important to note that knowledge from the 'Active for Life' campaign was assessed based on a prospective longitudinal design, and involved a complex message assessing knowledge based on the number of days, duration per time, and intensity (somewhat similar to the line of questioning asked in this thesis analysis) [Hillsdon et al., 2001]. The baseline data from the 'Active for Life' campaign showed a lower rating of knowledge among the population, and considering that the change in the knowledge measure over the 3 years of prospective study was relatively minor (3%), the Canadian data is relatively more positive. This may be due in part to the complexity of the 'Active for Life' message. On the contrary, the majority of Canadian adults held positive beliefs about the benefits of PA and had high intention to be active, which skews the distribution of the score. Women and adults aged 45 to 64 years were more likely to hold very strong beliefs about activity benefits, yet high beliefs were not associated with sufficient PA or walking. Those with higher levels of education also showed higher intention to be more active; however, in contrast to the findings for beliefs, a high degree of intention was associated with PA and walking. Intention can represent an active decision to initially trial becoming more active which if included in daily life could contribute to active behaviours. As indicated previously, the Canadian guidelines also contained messages related to initial trialling of PA. Data from this Chapter suggest that certain initial behavioural steps were associated with being sufficiently active and walking. Generally, women, younger adults, and those with higher levels of education indicated that they had undertaken initial steps towards behaviour change in the prior year, with a view to becoming

more active. Certain initial behaviour change steps were associated with being sufficiently active and walking. Taken together, these results suggesting that more distal variables in the hierarchy of effects are associated with PA (for example, intention and trial behaviours are associated with PA) are not surprising, as these types of factors are an immediate precursor of PA behaviour [Godin, 1987; Rhodes & Plotnikoff, 2006]. Thus, these findings are consistent with a Hierarchy of Effects communication model and the elements of the TPB that are embedded within that model. It is possible that the model would be more applicable to certain groups than others. Analogous to the findings for recall, women also held higher belief scores and initial changes in behaviour. Women traditionally have had lower levels of PA in national studies [Craig et al., 2004], and the findings are suggestive that other factors may be influencing participation levels among this particular group, and these will be discussed further in both Chapter Five and Six.

The present study has some methodological limitations including the use of self-report data and the cross-sectional design that prevents causal inferences. In addition, the study is limited in that it has a restricted range of demographic variables included in the model, recognizing that other factors such as family income, community size, and general health status may also be influential. However, the study also has a number of strengths, including the use of the 2003 Physical Activity Monitor, which is a nationally representative population survey within the Canadian PA surveillance system described in the previous Chapter. In addition, this survey provides pertinent evidence about awareness of PA guidelines, messaging, and other factors that are important within a communications hierarchy focusing on population PA. This is relevant for improving the focus of communication strategies and providing evidence of their value in terms of impact, and tailoring strategies for particular populations given the expense for development and promotion of guidelines to the wider population. The examination of factors associated with PA and walking was limited to only individual influences. It is recognized that many factors such as the built environment could influence PA overall and walking behaviours, in particular. A study investigating the potential role of the built environment on Canadian PA and walking behaviours is presented in Chapter Five.

Summary of Chapter Four

The literature summary in Chapter Two describes the importance of considering intrapersonal correlates related to PA. This Chapter investigates a study conducted within the Canadian PA surveillance system to examine individual factors and how they are associated with PA, and more specifically, walking. Based on the findings of the literature summary in Chapter Two, it is expected that features that have been assessed in the Theory of Planned Behavior and Hierarchy of Effects (HOE) model, such as intention will be predictive of PA. In addition, factors which are closer to the actual behaviour in the hierarchy of effects (such as intention, initial behaviour change) will be predictive of the outcome variable more so than those further removed from the outcome behaviour or those which are considered more immediate (such as awareness, knowledge, beliefs) or intermediate (perceived behavioural control, self-efficacy).

This Chapter uses data from the 2003 Physical Activity Monitor, which was a random and nationally representative study of adults conducted in Canada, and which primarily investigated intrapersonal correlates associated with PA. These measures are described briefly (as they are described in further detail in Chapter Three, Methods), as is their data treatment protocols, and analysis protocols. As key research questions, this Chapter explores:

- what the prevalence of sufficient PA and walking are, and if they differ by covariates;
- which individual-level correlates of PA are influenced by demographic factors; and,
- which individual-level correlates predict sufficient PA and walking.

Roughly half of adults were sufficiently active, and one-third of adults walked enough to meet the guideline criteria. Both outcome measures varied by sex, age, and education. Although individual factors differed by sex, age, and education, for example, a greater proportion of women indicated prompted awareness of PA guidelines, higher belief scores about the benefits of PA, and initial behaviour change activities. Age was also associated with knowledge, beliefs, and the trial of activities. In addition, education was associated with awareness, intention, and the trial of behaviours to become more active in expected ways, whereas a higher proportion of less educated adults had greater knowledge of the dose of PA required to meet guidelines.

Which individual-level factors predicted sufficient activity? Knowledge about the dose of PA associated with guidelines, a high level of intention, seeking information about PA opportunities in the community and making active choices during one's work routine were associated with a higher likelihood of being sufficiently active. In terms of walking, unprompted awareness of any guidelines, knowledge about the amount of PA identified in guidelines, a high intention score, seeking info about PA from a health professional, seeking information in the community, or making active choices during one's work routine were associated with sufficient walking. In contrast, trying or observing a physical activity class was associated with a lower likelihood of meeting the sufficient walking criteria.

Generally speaking, these findings were consistent with the literature which supports the notion that correlates of the HOE (which are considered closer to behaviour, that is, intention and some initial trial behaviours), consistently predict PA and walking. Those factors which were further distant from the outcome behaviour were less consistent in predicting sufficient walking and PA.

Although a very low proportion of Canadians were able to specify a PA guideline when not specifically prompted to do so, these results were similar to other studies [Bauman et al., 2005; Spence et al., 2002]. Women were more likely to indicate prompted recall of guidelines, women also held higher belief scores and initial changes in behaviour. Women have lower levels of PA in national studies [Craig et al., 2004], suggesting that other factors may be influencing participation levels among this particular group, and these will be further explored in both Chapter Five and Six.

CHAPTER FIVE - Physical environmental factors and total activity and walking

5.1 Introduction

In the earlier years of behaviour change research, individuals were seen primarily as rational beings whose attitudes and perceived social norms shaped their intention and affected their behaviour [Azjen, 1985]. Indeed, the focus of Chapter Four was an investigation into how such individual level factors were associated with the PA levels and walking behaviours of Canadians. Since the 1990's, attention has focused on the role of the physical environment in helping to explain PA behaviour. Chapter Two, section 2.3 provides an overview of the literature with regard to factors within the physical environment or neighbourhood which are associated with PA and walking, however a very brief summary is included below.

Although many studies have been conducted in this area of research over the past 20 years, findings from these studies have varied. Reasons for this may include differences in populations, perceptions, type of information, and the measures used. For example,

- A 2002 Canadian study has shown a higher likelihood of walking to work to be associated with a stronger neighbourhood environment score consisting of items such as the number and variety of destinations, aesthetics and visual interest, social dynamics, time and effort required, traffic threats, obstacles and crime [Craig et al., 2002].
- A 2003 review [Saelens et al., 2003] concluded that residents within neighbourhoods having high residential density, greater connectivity, and greater land use had higher rates of walking and bicycling for utilitarian reasons.
- A 2004 review concluded that aesthetics, convenience of facilities with respect to walking, including sidewalks, accessibility of destinations, and perceptions about traffic were found to be associated with specific types of walking [Owen et al., 2004].
- A 2004 review found positive associations between availability, accessibility and convenience of destinations/facilities, neighbourhood features and aesthetics with PA [McCormack et al., 2004].
- A 2004 article indicated that pedestrian transportation systems (which include the way that streets and pathways are linked and network) may influence PA, and more specifically walking and bicycling. Some of these factors associated with proximity and connectivity may include economic factors such as the financial commitment required

to produce walkable communities (for example, cul-de-sacs designs are generally less costly to construct) and regulations such as zoning [Frank, 2004]. Moreover, Frank indicates that the coordination of active and public transport is also important for increasing PA [Frank, 2004].

- A 2005 meta-analysis found that people who reported the presence of facilities for PA, sidewalks, shops and services, and that heavy traffic was a non-issue, were more likely to be active [Duncan et al., 2005b].
- A 2008 review of reviews and original studies supported earlier findings about the relationship between walking for transportation and residential density, land use mix, and also distance to non-residential destinations, however, the researchers found that the relationship between these environmental variables and recreational walking were not significant [Saelens & Handy, 2008].

In order to understand what factors influence Canadians to be active or not, the proposed research will examine how the physical and neighbourhood factors associated with the built environment are related to PA behaviour. Specifically, this Chapter will examine the relationships between the built environment and PA levels and walking behaviours, and whether the relationships differ between population groups.

5.2 Methods

5.2.1 Sampling design

With the primary purpose of PA surveillance and monitoring among the Canadian population, the Canadian Fitness and Lifestyle Research Institute (CFLRI) have conducted population-based surveys (Physical Activity Monitors or PAMs) since 1995. Considerable detail on the Physical Activity Monitoring Program and the PAMs are provided in Chapter One and Three, however, a brief summary of the data source is provided in this Chapter specific to the research questions in this Chapter.

The 2004 PAM is the primary data set for this analysis and includes a representative sample of 8,790 Canadian adults aged 18 years and older. Data from the PAM were collected from

February 2004 to January 2005 by the Institute for Social Research (ISR) at York University in Ontario, Canada. The sample was selected using random-digit dialling from household-based telephone exchanges. ISR interviewers captured data directly during the interviews using a CATI (computer-assisted telephone interviews) system. The random sample of households selected was roughly proportional to the population in each province and territory with a minimum sample size of 250 in each province and territory (except for Nunavut). For each selected household, one individual over the age of 15 years was selected at random (N=9,713; however, only data on respondents aged 18 years and older were included in these analyses), thus providing a random sample of individuals in Canada. Respondents were asked about their PA patterns and sport participation, information, and availability of local PA and sport opportunities in the local community area.

The overall response rate obtained in the 2004 Physical Activity Monitor was 49%. The sample for the 2004 Physical Activity Monitor is shown in Table 5.1.

Table 5.1: Sample by region and province, 2004 PAM

Sample by region and province	
	Adults 18+
Canada	8,790
Atlantic	1,212
Newfoundland	290
Prince Edward Island	309
Nova Scotia	305
New Brunswick	308
Quebec	1,737
Ontario	3,248
West	2,010
Manitoba	304
Saskatchewan	313
Alberta	664
British Columbia	877
North	583
Yukon	301
Northwest Territories	282

When there is non-response to surveys, there is the possibility of bias if participating adults respond differently to non-participating adults. Potential bias was identified by comparing the

demographic variables to the latest Census data. Respondents to the present survey were more likely to be female and to have a university degree, a common occurrence in telephone surveys [Canadian Fitness and Lifestyle Research Institute, 1996]. The sample weights used for this analysis were adjusted using a post-stratification adjustment to reflect the latest Census distributions for age and sex.

In order to determine if the relationships that appear in 2004 are consistent over time, a sample of 4,427 adults aged 18 and older from the comparable questions asked in the 1999 PAM data are included in comparative trend analysis in Appendix A. Although the response rate was higher (58%), the methodology of the 1999 PAM was similar to that described above for the 2004 PAM, and the questions used for comparison were identical.

5.2.2 Measures

Details about the measures used in this Chapter and the demographic covariates applied are provided in detail in Chapter Three, however a brief summary of the measures follow.

Physical Activity Level and Walking - In the 2004 PAM, the short, telephone-administered last 7-day recall version of the International Physical Activity Questionnaire (IPAQ) [Craig et al., 2003] was employed to assess PA across all domains and walking. Six items included days per week and the amount of time spent per day in vigorous activities, moderate activities and walking. Specific details on the questions used to measure PA and walking are detailed in Chapter Three (Methods).

Physical environment factors - A subset of questions from the Neighborhood Environment Walkability Scale (NEWS) [Cerin et al., 2006] were used to determine perceptions about the environment in which the respondent lives in order to quantify walkability in their neighbourhood. Further details on these measures are described in Chapter Three (Methods). Briefly, residential density was explored by enquiring about the main type of housing in the respondent's neighbourhood. In addition, adapted questions from the NEWS 'minimal' subset were also used [Sallis et al., 2009], whereby respondents were asked to rate their level of agreement with the availability of shops and stores nearby the home, their proximity to a transit stop, and the availability of sidewalks, bicycling facilities, free- or low-cost recreation facilities in

their neighbourhood. Respondents were also asked to state their level of agreement that crime rates in their neighbourhood make it unsafe to go on walks at night, and that too much traffic on the streets makes it difficult or unpleasant to walk in the neighbourhood.

In addition, other questions pertaining to the number of opportunities/facilities to be active in the local community were also developed to probe the relative number of different supports available in the physical environment. These questions are described in detail in Chapter Three. Specifically, respondents were asked about the number of: places where they can safely walk in the local community, places they can safely bicycle in the community, the availability of multi-purpose recreation trails that can be used for different purposes, and other facilities, places, or programs in the community that are designed specifically for doing physical activities and sports.

Perceived barriers to PA - Respondents were asked to rate their level of agreement with a series of statements on a 6 point scale representing barriers related to the environment and local opportunities to be active (see Chapter Three). The statements assessing perceived barriers were as follows:

- Concerns about your safety keep you from walking or bicycling;
- There's too much traffic in your area for walking or bicycling;
- In your area there's too much crime on the streets for safe walking or bicycling;
- Badly maintained sidewalks and bike lanes in your area keep you from bicycling;
- Poorly lit sidewalks and streets in your area keep you from walking or bicycling;
- The hours and class times offered by your local centres don't suit you;
- It's too hard for you to get to those places where you can be active;
- The programs and facilities that are available are not the right type for you;
- The dollar costs of doing physical activities are too high for you;
- It's too hard to find the right kind of coaching or instruction;
- The sport and recreation facilities are not well-maintained in your community.

Socio-demographic factors including sex, age, and education level are described in detail in Chapter Three (Methods).

5.2.3 Research questions

The primary purpose of this Chapter was to assess the associations between environmental factors (NEWS items, other environmental factors) and sufficient activity and walking. In order to do so, an initial step was to understand sufficient activity and walking behaviour by determining:

- How active were Canadians in 2004? What was their overall pattern of activity and how many met the criteria for being sufficiently active? Were there differences in the pattern of activity by different segments of the population according to sex, age, and education?
- What proportions of Canadians were sufficiently active by walking? Did this proportion differ according to age, sex, income and education?

With respect to environmental factors, research questions included:

- What proportion of Canadians agreed that there are many shops, stores near home, that transit stops are near home, that there were sidewalks, bicycling facilities, or free or low cost recreational facilities nearby? Did these opportunities vary by specific groups?
- Were Canadians concerned that the crime rate or traffic in their neighbourhood made it difficult to walk? Did various age, sex, and education groups feel more strongly about these issues than others?
- What were Canadians perceptions about the number of places to be active in the local community (to safely walk, to safely bicycle, multi-purpose trails, and other places to be active)? Did these perceptions vary by population groups?
- To what extent did barriers related to the physical environment and to accessibility prevent Canadians from becoming more active? Moreover, were these barriers more prevalent among certain demographic groups?

Finally, this Chapter explored whether sufficient PA and walking were associated with environmental factors, such as: having many shops or stores nearby; being close to transit stops; availability of sidewalks, local bicycling facilities, and free and low cost recreation facilities; crime and traffic in the neighbourhood, the number of places to be active, and barriers pertaining to the environment. The following research questions were therefore addressed:

- Did the proportion of Canadians who were sufficiently active and who engaged in sufficient walking vary according to environmental factors; namely having many shops, stores nearby; being close to transit stops; availability of sidewalks, local bicycling facilities; free and low cost recreation facilities; crime and traffic in the neighbourhood, and the number of places to be active?
- Did the proportion of Canadians who were sufficiently active and who engaged in sufficient walking differ by barriers pertaining to the environment?
- Which of the environmental factors and which barriers predicted sufficient walking and sufficient activity, taking into account age, sex and education?

5.2.4 Data treatment

Physical activity - All-domain PA level (IPAQ short questions) for vigorous activity was calculated by asking respondents about the number of days and the amount of time spent in vigorous activities in the past 7 days. Total time spent in vigorous activities was calculated by multiplying the number of days by the amount of time spent per occasion. This total time spent was then multiplied by a MET [Ainsworth et al., 1993] value of 8. A similar calculation was conducted for time spent in moderate activities (using a MET value of 4.0) and walking behaviour (using a MET value of 3.3). A total PA energy expenditure score was then calculated by summing the energy expenditure from the vigorous-intensity, moderate-intensity, and walking behaviours. Based on this total energy expenditure score:

- sufficient activity was calculated if (1) any activity was performed daily with a total energy expenditure of 3,000 MET minutes or higher, or (2) vigorous activity was performed at least 3 days a week with a total energy expenditure of 1,500 MET minutes or higher [www.ipaq.ki.se], and
- a lower score was attributed to any lower amounts of activity which was deemed an insufficient amount.

Using these same MET values of 3.3 (walking), 4 (moderate-intensity), and 8 (vigorous-intensity) as described above, the total energy expenditure representing the 1998 Canadian guidelines for adults aged 18 to 55 would be lower that the IPAQ criterion. The 1998 Canadian guidelines state that adults should accumulate at least 60 minutes of any intensity activity every day for health, 30 minutes of moderate-intensity activity, 4 days a week, or 20 minutes of

vigorous-intensity activity, 4 days a week [Health Canada and Canadian Society for Exercise Physiology, 1998].

Walking – A separate score was calculated for walking based on the number of days and the amount of time spent walking in the past 7 days. Based on this data, sufficient walking was defined as walking 7 days a week for 60 minutes or more, representing a conservative amount to represent the Canadian guidelines for adults based on the 1998 guidelines, whereby the guidelines state that 18 to 55 year old adults should accumulate at least 60 minutes of any intensity activity daily for health [Health Canada and Canadian Society for Exercise Physiology, 1998].

Physical environment – With the exception of the main type of housing in the respondent's neighbourhood, each NEWS item was recoded as agree (strongly agree/agree) and disagree (strongly disagree/disagree). As the "does not apply" category generally represented less than 4% of the distribution, these were incorporated into the disagree category.

Barriers – Each of the barrier statements were asked with a 6 point scale, where 1 represents strongly disagree and 6 represents strongly agree. Each variable was then re-grouped as follows: disagree (1 to 3), agree (4 to 6), and don't know. The variables assessing perceived barriers are described earlier in this Chapter.

5.2.5 Statistical analysis

SPSS version 21.0 was used for all analyses. Given the nature of the 2004 Physical Activity Monitor, complex sampling methods were required to take into account stratification by province or territory within the country. Accordingly, the Complex sample cross-tabulation procedure was used to calculate the prevalence estimates in this Chapter.

The associations between 'sufficient' PA participation and 'sufficient' walking behaviour with the socio-demographic factors of sex, age, and education were examined, as well as the relationships between environmental factors and barriers with these socio-demographic factors. In addition, the differences in the prevalence of 'sufficient' PA and walking by environmental factors and by perceived environmental barriers were investigated. Differences in prevalence

rates were estimated by weighting responses to the population and tested using 95% confidence intervals surrounding the estimates. 'Don't know' and 'refused' generally amount to less than 3% of responses and were excluded in analyses as they had a negligible effect on estimates.

The relationship between environmental variables, barriers, and socio-demographic factors in predicting sufficient activity and walking levels were examined using complex samples logistic regression procedure, given that the samples required complex sampling methods. These models were created to explore associations between key independent measures relating to the physical environment and dichotomous dependent measures of 'sufficient' PA and 'sufficient' walking. Age, sex, and education were included as covariates. Further details are provided in Chapter Three (Methods).

5.3 Results

5.3.1 Physical activity and walking

The first research question in this Chapter asks "How active are Canadians?", and in particular, which demographic groups are more or less active. This section describes the PA levels of Canadians, including their participation in vigorous activity, moderate activity and walking behaviour. It is then followed by a description of the population groups of interest and how activity levels vary by these groups.

In terms of sufficient activity, roughly half (52.2%) of adults 18 years and older reported adequate amounts of total daily PA to be considered sufficiently active (here, sufficient activity incorporated a total energy expenditure of 3,000 MET minutes/week or higher, or vigorous activity at least 3 days a week with a total energy expenditure of 1,500 MET minutes/week or higher). The prevalence of sufficient walking (here defined as walking 7 days a week for 60 minutes or more) was lower at 31.0%.

In order to study the research question about who was more active, the association of socio-demographic factors with PA and walking were explored. As indicated in the Methods section, a higher proportion of females (55.7%) responded to the survey compared to males (44.3%).

The sample weights used for this analysis were adjusted using a post-stratification adjustment to reflect the latest Census distributions for age and sex. When the sample weights were applied, 51.5% of the sample were female compared to 48.5% male. The unadjusted mean age of the sample in the 2004 PAM was 46.9 years, however, when the sample weight was applied to the data, the mean age decreased very slightly to 45.6 years.

For the purpose of analyses, age was categorized into 4 age groups: 18 to 24 year olds (10.3% un-weighted, 13.0% weighted); 25 to 44 year olds (37.2% un-weighted, 39.1% weighted); 45 to 64 year olds (35.7% un-weighted, 31.1% weighted); and 65 years and older (16.8% un-weighted, 16.8% weighted). Within this sample, 15.8% held less than a secondary school level of education, 26.3% had a secondary school education, and 57.8% had post-secondary education (25.5% weighted had a college and 32.3% weighted had a university education). These distributions were similar un-weighted and weighted.

Table 5.2: Proportion sufficiently active by age, sex, and education, 2004 PAM

		N	% achieving sufficient amounts of total PA	Lower CI (95%)	Upper CI (95%)
Sex	Total	4,493	52.2%	51.1%	53.4%
	Male	2,253	58.4%	56.7%	60.0%
	Female	2,240	46.5%	45.0%	47.9%
Age	18 to 24	593	66.9%	63.6%	70.0%
	25 to 44	1,827	56.2%	54.4%	58.0%
	45 to 64	1,559	50.2%	48.3%	52.1%
	65 and older	514	35.6%	33.0%	38.3%
Education	< Secondary	585	43.9%	41.1%	46.7%
	Secondary	1,239	56.8%	54.6%	58.9%
	College	1,192	55.1%	52.8%	57.3%
	University	1,408	50.8%	48.9%	52.8%

More men than women met the sufficient PA criteria. An inverse relationship was observed between sufficient PA and age. Relative fewer adults with less than a secondary school education met the sufficient activity criteria compared to those with higher education. These relationships are described in Table 5.2.

Table 5.3: Proportion that walk sufficient amounts by age, sex, and education, 2004 PAM

		N	% walking sufficient amount	Lower CI (95%)	Upper CI (95%)
	Total	2,666	31.0%	29.9%	32.0%
Sex	Male	1,274	32.9%	31.4%	34.5%
	Female	1,392	29.1%	27.8%	30.5%
	18 to 24	374	42.4%	39.0%	45.8%
Age	25 to 44	1,066	32.6%	30.9%	34.3%
	45 to 64	946	30.5%	28.8%	32.2%
	65 and older	280	19.3%	17.2%	21.6%
	< Secondary	379	27.8%	25.3%	30.4%
Education	Secondary	775	35.4%	33.3%	37.5%
	College	710	32.9%	30.8%	35.0%
	University	755	27.5%	25.8%	29.3%

As noted above, 31.0% of adults reported enough walking to meet the sufficient walking criteria of 60 minutes daily. More men than women achieve this criterion. An inverse relationship was observed between sufficient walking and age. Prevalence of sufficient walking is lower among university graduates than those with a secondary school or college education (see Table 5.3).

5.3.2 Physical environment

Factors related to aspects of the physical environment as they pertain to PA and walking behaviours are a key research interest. Within this, a research question in this Chapter is whether perceptions of the physical environment differ between socio-demographic groups (by sex, age, and education).

Neighbourhood environment walkability – A subset of questions from the NEWS were used to determine perceptions about the environment in which the respondents live in order to quantify walkability in a neighbourhood. As noted earlier, specific details about these measures are described briefly in the Methods section above and in detail in Chapter Three (Methods).

In terms of residential density, the majority of respondents reported that they live in neighbourhoods of primarily single-family, detached homes, followed by a mixture of single

family dwellings, town or row houses, and apartments or condominiums. Table 5.4 describes the prevalence of primary dwelling in the neighbourhood.

Table 5.4: Main type of housing in neighbourhood, 2004 PAM

		95% Confidence Interval		
	% agree	Lower	Upper	N
Detached single-family residences	63.8%	62.7%	65.0%	5,092
Town/row houses, apartments, condos of 2-3 stories	8.5%	7.8%	9.1%	633
Mix single-family, town/row houses, apartments or condos	19.8%	18.9%	20.7%	1,568
Apartments/condos 4-12 stories	2.9%	2.5%	3.3%	226
Apartments/condos more than 12 stories	2.1%	1.8%	2.5%	154
Don't know/Refused	2.8%	2.5%	3.2%	236

When examining residential dwelling by key demographic variables, type of dwelling did vary by age (see Table 5.5). Slightly more women than men indicated that they live in neighbourhoods with a mix of dwellings. Living in neighbourhoods consisting of primarily townhouses, row houses or low rise apartment buildings was more prevalent among young adults compared to those aged 25 years and older, whereas living in single detached housing was less prevalent among young adults compared to those aged 25 years and older. Living in neighbourhoods consisting of primarily mid-rise apartments or condos (4 to 12 stories) was more prevalent among 18 to 24 year olds and adults 65 years and older compared to those 25 to 64 years of age, and similarly, residing in neighbourhoods of high-rise apartments/condos was more prevalent among this younger age group compared to 45 to 64 year olds. A greater proportion of university educated adults resided in neighbourhoods of primarily high-rise apartments compared to those with a secondary school or college education, whereas a greater proportion of adults with a secondary school education indicated living in neighbourhoods of primarily detached single-family dwelling compared to university educated adults. Living in neighbourhoods of primarily town houses, row houses, and low-rise apartments was more prevalent among adults with less than a secondary education compared to those with a university education.

Table 5.5: Type of dwelling by age, sex, and education, 2004 PAM

		Detached single-family housing	Townhouses, row houses, apts or condos of 2-3 stories	Mix of single-family, town or row houses, apts or condos	Apts or condos of 4-12 stories	Apts, condos more than 12 stories
		%, 95% CI	%, 95% CI	%, 95% CI	%, 95% CI	%, 95% CI
Sex	Total	65.7%, 64.6-66.8	8.7%, 8.0-9.4	20.4%, 19.4-21.3	3.0%, 2.6-3.4	2.2%, 1.9-2.6
	Male	66.5%, 64.8-68.1	8.8%, 7.9-9.9	19.0%, 17.6-20.4	3.1%, 2.6-3.8	2.6%, 2.1-3.3
	Female	65.0%, 63.4-66.5	8.6%, 7.7-9.6	21.8%, 20.5-23.1	2.9%, 2.4-3.5	1.8%, 1.4-2.3
Age	18 to 24	54.8%, 51.3-58.2	15.3%, 13.0-18.0	21.8%, 19.1-24.7	4.7%, 3.5-6.3	3.4%, 2.4-4.8
	25 to 44	64.6%, 62.8-66.3	9.0%, 8.0-10.1	21.2%, 19.7-22.7	2.6%, 2.1-3.2	2.6%, 2.1-3.3
	45 to 64	71.6%, 69.8-73.2	6.0%, 5.1-6.9	18.8%, 17.4-20.3	2.4%, 1.9-3.0	1.3%, 1.0-1.8
	65 and older	66.5%, 62.0-70.6	7.0%, 4.9-9.8	20.2%, 16.8-24.1	4.8%, 3.3-7.0	-
Education	< Secondary	67.1%, 63.8-70.2	11.5%, 9.5-13.8	18.2%, 15.7-20.9	-	-
	Secondary	67.9%, 65.7-70.1	8.5%, 7.2-9.9	18.1%,16.3-19.9	3.7%, 2.9-4.7	1.9%, 1.3-2.6
	College	66.8%, 64.6-69.0	8.3%, 7.1-9.7	21.0%, 19.2-22.9	2.0%, 1.5-2.8	1.8%, 1.3-2.6
	University	62.8%, 60.8-64.7	8.0%, 6.9-9.2	22.4%, 20.8-24.2	3.5%, 2.8-4.3	3.3%, 2.7-4.2

- Data suppressed due to cell size

Respondents were also asked to rate their level of agreement with the availability of different facilities in the neighbourhood (within a 10-15 minute walk):

- many shops, stores, markets or other places are within easy walking distance of home;
- a 10-15 minute walk to a transit stop (such as bus, train, trolley, tram) from home;
- there are facilities to bicycle in or near the neighbourhood, such as special lanes, separate paths or trails, or shared use paths for cycles and pedestrians, and
- Neighbourhood has several free or low cost recreation facilities, such as parks, walking trails, bike paths, recreation centres, playgrounds, public swimming pools, etc.

They were also asked to rate their level of agreement that:

- the crime rate in the neighbourhood made it unsafe to go on walks at night,
- Too much traffic on the streets that it makes it difficult or unpleasant to walk in their neighbourhood.

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Based on the distribution of these variables (see Table 5.6), data were generally skewed towards the extreme values (strongly agree or disagree). As a result, for analysis purposes, the

values were combined into two categories of "agree" (combining agree and strongly agree) and "disagree" (combining disagree, strongly disagree, and does not apply).

Table 5.6: Distribution of neighbourhood facilities, NEWS, 2004 PAM

	N	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Does not apply	Don't know/ refused
Shops, stores, markets or places nearby	7,909	22.4%	13.3%	24.1%	36.9%	2.3%	0.9%
Transit stop nearby	7,909	24.3%	3.5%	9.1%	55.6%	6.3%	1.3%
Sidewalks on most of the streets in neighbourhood	7,909	22.0%	5.5%	10.2%	58.3%	3.6%	0.5%
Facilities to bicycle in neighbourhood	7,909	26.5%	8.4%	18.5%	42.2%	3.1%	1.3%
Neighbourhood has several free or low cost recreation facilities	7,909	13.1%	7.9%	26.9%	49.3%	1.9%	0.8%
Neighbourhood crime rate makes it unsafe to walk	7,909	58.9%	20.0%	10.7%	7.7%	1.1%	1.7%
Traffic on the streets make it difficult or unpleasant to walk in neighbourhood	7,909	56.9%	22.6%	11.7%	6.8%	1.2%	0.8%

Table 5.7a, 5.7b, and 5.7 shows the prevalence of the NEWS factors by key demographic characteristics: sex, age, and education. Generally speaking, there were virtually no differences in the prevalence of the NEWS factors by gender, with one exception; more women than men agree to some extent that the crime rate in their neighbourhood makes it unsafe to go on walks at night (23.1% for women agreeing versus 14.1% for men). Table 5.7b demonstrate that relatively more adults aged 18 to 24 years compared to those aged 25 years or older agreed to some extent that there are nearby shops or stores in the neighbourhood, transit stops near home, and sidewalks on most streets. Compared to adults 45 years and older, relatively more 18 to 24 year olds indicated that there are several free or low cost recreation facilities in the neighbourhood. The proportion of adults 65 years and older who agreed to some extent that the crime rate in the neighbourhood makes it unsafe to go on walks at night was higher than for 25 to 64 year olds. Table 5.7c shows that compared to adults with a post-secondary education, fewer adults with less than a secondary school education agreed to some extent that transit stops are nearby, that there are sidewalks on most streets, that there are facilities to bicycle,

and that there are several free or low cost recreation facilities in the neighbourhood, yet more agreed to some extent that crime rate makes it unsafe to walk.

Table 5.7a: Availability of neighbourhood facilities, NEWS, overall and by sex, 2004 PAM

	N	Estimate, 95% CI	Sex	
			Male %, 95% CI	Female %, 95% CI
Many shops, stores, other places within walking distance				
Agree	4,771	61.6%, 60.5-62.8	61.2%, 59.5-62.9	62.1%, 60.5-63.6
Transit stop 10-15 minute walk from home				
Agree	4,951	65.5%, 64.4-66.6	65.5%, 63.8-67.1	65.6%, 64.1-67.1
There are sidewalks on most of the streets in my neighbourhood				
Agree	5,316	68.8%, 67.7-69.9	68.6%, 67.0-70.2	69.0%, 67.5-70.5
There are facilities to bicycle in neighbourhood				
Agree	4,717	61.5%, 60.4-62.7	63.0%, 61.3-64.7	60.1%, 58.6-61.7
Neighbourhood has several free or low cost recreation facilities				
Agree	5,960	76.9%, 75.9-77.8	78.1%, 76.7-79.6	75.6%, 74.2-76.9
Neighbourhood crime rate makes it unsafe to go on walks at night				
Agree	1,481	18.6%, 17.7-19.5	14.1%, 12.9-15.3	23.1%, 21.8-24.5
Too much traffic makes it difficult or unpleasant to walk				
Agree	1,386	18.6%, 17.7-19.6	18.3%, 16.9-19.7	19.0%, 17.7-20.3

Table 5.7b: Availability of neighbourhood facilities, NEWS, by age, 2004 PAM

	Age			
	18 to 24 %, 95% CI	25 to 44 %, 95% CI	45 to 64 %, 95% CI	65 and older %, 95% CI
Many shops, stores, other places within walking distance				
Agree	72.6%, 69.4-75.6	62.3%, 60.6-64.1	57.3%, 55.4-59.1	56.1%, 51.5-60.7
Transit stop 10-15 minute walk from home				
Agree	73.5%, 70.3-76.4	66.7%, 65.0-68.4	61.6%, 59.7-63.3	61.2%, 56.7-65.5
There are sidewalks on most of the streets in my neighbourhood				
Agree	76.5%, 73.5-79.3	70.0%, 68.3-71.6	64.7%, 63.0-66.5	65.7%, 61.1-70.0
There are facilities to bicycle in neighbourhood				
Agree	64.9%, 61.5-68.1	63.6%, 61.8-65.3	58.2%, 56.3-60.0	58.7%, 54.1-63.1
Neighbourhood has several free or low cost recreation facilities				
Agree	83.1%, 80.4-85.5	79.1%, 77.6-80.6	72.8%, 71.1-74.4	70.3%, 66.0-74.2
Neighbourhood crime rate makes it unsafe to go on walks at night				
Agree	18.5%, 16.0-21.3	18.0%, 16.6-19.4	18.1%, 16.7-19.5	25.0%, 21.3-29.2
Too much traffic makes it difficult or unpleasant to walk				
Agree	17.2%, 14.8-19.9	19.4%, 17.9-20.9	17.7%, 16.3-19.2	21.6%, 17.9-25.8

Table 5.7c: Availability of neighbourhood facilities, NEWS, by education, 2004 PAM

	Education			
	< Secondary %, 95% CI	Secondary %, 95% CI	College %, 95% CI	University %, 95% CI
Many shops, stores, other places within walking distance				
Agree	58.8%, 55.5-62.0	60.9%, 58.6-63.2	61.7%, 59.4-63.9	63.2%, 61.2-65.2
Transit stop 10-15 minute walk from home				
Agree	54.6%, 51.3-57.9	60.5%, 58.2-62.8	66.3%, 64.1-68.4	73.3%, 71.5-75.1
There are sidewalks on most of the streets in my neighbourhood				
Agree	60.5%, 57.3-63.7	65.3%, 63.1-67.5	70.0%, 67.9-72.0	74.1%, 72.3-75.8
There are facilities to bicycle in neighbourhood				
Agree	56.0%, 52.8-59.2	57.6%, 55.2-59.8	62.6%, 60.3-64.8	65.9%, 63.9-67.8
Neighbourhood has several free or low cost recreation facilities				
Agree	70.6%, 67.6-73.5	74.3%, 72.2-76.2	77.0%, 75.0-78.9	81.1%, 79.5-82.7
Neighbourhood crime rate makes it unsafe to go on walks at night				
Agree	24.4%, 21.7-27.3	19.4%, 17.6-21.3	17.5%, 15.9-19.4	16.3%, 14.8-17.8
Too much traffic makes it difficult or unpleasant to walk				
Agree	20.5%, 17.9-23.4	19.6%, 17.8-21.5	18.5%, 16.7-20.4	17.1%, 15.6-18.7

Number of places to be active – In addition, respondents were asked about the number of places in their local community where they can safely walk, safely bicycle, the number of multi-purpose trails, and other facilities, places or programs in the community. Table 5.8 shows the distribution of these factors. Overall, Canadians generally reported having access to safe places to walk (<10% report none at all) and at least some facilities, places and programs for PA. Access to places to safely bicycle and multi-purpose trails were less prevalent.

Table 5.8: Number of places in the community to be active, 2004 PAM

	Places to safely walk		Places to safely bike		Multi-purpose trails		Other facilities, places, programs	
	N	%	N	%	N	%	N	%
None at all	848	9.1%	2,323	25.4%	2,435	27.5%	910	9.7%
Some	3,404	38.6%	3,996	46.0%	4,629	53.0%	4,829	55.0%
Many	4,458	51.4%	2,193	25.6%	1,360	15.4%	2,913	33.7%
Doesn't ride bike			144	1.6%				
Don't know/refused	80	.9%	134	1.4%	366	4.1%	138	1.6%
Total	8,790	100.0%	8,790	100.0%	8,790	100.0%	8,790	100.0%

Table 5.9a and Table 5.9b show that more men than women cite many places in the local community where they could safely walk and bicycle, however, there were no sex-related

differences regarding the number of multi-purpose trails, and other facilities, places or programs in the community. Interestingly, relatively more adults who were 45 years or older stated that there are *no* places to safely walk, *no* places to safely bicycle, *no* other types of programs, facilities, or places to be active (the latter is significant versus adults 24 years and younger) compared those less than 45 years of age. Conversely, a higher percentage of younger adults (less than 45) than older adults (65 years and older) said that there are *many* places to safely walk. There is a linear increase in the proportion that reported that there are *many* places to safely walk in the community with education level. Those with less than secondary education more frequently said that there were *no* places to safely walk or bicycle in the community, or said that there were no other types of facilities, places or programs to be active. This group also less frequently said that there were *many* places to safely walk, bicycle, multi-purpose recreation trails, or other facilities, places, or programs in the community compared to those with post-secondary education (see Table 5.9a and Table 5.9b).

Table 5.9a: Number of places in the community to be active by sex, age, and education, 2004 PAM

	To safely walk		To safely bike	
	% none %, 95% CI	% many %, 95% CI	% none %, 95% CI	% many %, 95% CI
Sex				
Male	8.9%, 8.0-9.9	54.4%, 52.7-56.0	25.0%, 23.6-26.5	27.8%, 26.4-29.4
Female	9.5%, 8.7-10.4	49.4%, 47.9-50.9	26.4%, 25.2-27.7	24.2%, 22.9-25.5
Age				
18 to 24	5.1%, 3.8-6.8	55.8%, 52.3-59.2	20.6%, 18.0-23.5	26.0%, 23.1-29.1
25 to 44	7.9%, 7.0-8.9	52.5%, 50.7-54.3	23.6%, 22.1-25.2	27.8%, 26.2-29.4
45 to 64	10.7%, 9.7-11.9	51.3%, 49.5-53.2	29.7%, 28.0-31.4	25.4%, 23.8-27.1
65 and older	12.7%, 11.0-14.7	47.9%, 45.1-50.6	27.5%, 25.1-30.1	22.6%, 20.4-25.0
Education				
< Secondary	16.9%, 14.9-19.1	41.4%, 38.5-44.2	31.9%, 29.3-34.6	20.3%, 18.0-22.7
Secondary	11.1%, 9.8-12.5	47.7%, 45.5-49.9	29.6%, 27.6-31.6	24.7%, 22.9-26.7
College	7.8%, 6.7-9.0	54.5%, 52.2-56.7	24.2%, 22.4-26.1	29.0%, 27.0-31.1
University	4.9%, 4.2-5.8	58.8%, 56.8-60.7	20.9%, 19.4-22.5	27.4%, 25.7-29.2

* The remainder represents the category “some”

Table 5.9b: Number of places in the community to be active by sex, age, and education, 2004 PAM

	Multi-purpose recreation trails		Other facilities, places, program	
	% none %, 95% CI	% many %, 95% CI	% none %, 95% CI	% many %, 95% CI
Sex				
Male	28.2%, 26.7-29.8	16.6%, 15.4-17.9	9.8%, 8.9-10.9	33.2%, 31.6-34.8
Female	29.1%, 27.7-30.5	15.5%,14.4-16.6	10.0%, 9.1-10.9	35.3%, 33.9-36.7
Age				
18 to 24	26.8%, 23.9-30.0	14.7%, 12.4-17.3	7.3%, 5.7-9.2	39.3%, 36.0-42.7
25 to 44	28.1%, 26.4-29.7	16.5%, 15.2-17.9	9.0%, 8.0-10.2	34.1%, 32.4-35.8
45 to 64	30.4%, 28.7-32.1	15.6%, 14.3-17.1	11.4%, 10.3-12.6	31.8%, 30.1-33.6
65 and older	28.3%, 25.8-31.0	17.0%, 15.0-19.2	11.2%, 9.6-13.1	35.4%, 32.8-38.1
Education				
< Secondary	31.8%, 29.2-34.6	11.9%, 10.1-13.9	14.8%, 12.9-16.8	23.8%, 21.4-26.4
Secondary	30.2%, 28.1-32.3	14.4%, 12.9-16.0	11.4%, 10.0-12.9	31.4%, 29.4-33.5
College	26.7%, 24.8-28.8	18.3%, 16.6-20.2	8.7%, 7.5-10.0	37.4%, 35.3-39.6
University	27.6%, 25.9-29.4	17.5%, 16.1-19.1	7.3%, 6.3-8.3	39.0%, 37.1-40.9

* The remainder represents the category "some"

Barriers to physical activity related to the environment – Another key research question in this Chapter examines barriers related to the environment and local opportunities to be active, and determining if barriers are more prevalent among particular groups.

Overall, roughly half of Canadian adults strongly *disagreed* that safety concerns, traffic, badly maintained sidewalks, and poorly lit sidewalks were concerns for them (Table 5.10a). Slightly more than this (63.5%) strongly disagreed that crime is a concern. Regarding opportunities to be active, among those strongly *agreeing* that these potential barriers were a concern, cost was the most prevalent barrier (16.4%) followed by unsuitable hours and times for PA programs and facilities (13.5%), difficulty getting to places to be active (11.3%), programs and facilities are not the right type (10.0%), difficultly finding the right type of coaching (9.8%), and then facility maintenance (8.9%) (see Table 5.10b).

Table 5.10a: Barriers related to the environment and PA, 2004 PAM

	Safety concerns (n=8,790)	Traffic (n=7,157)	Crime (n=7,156)	Badly maintained sidewalks (n=7,156)	Poorly lit sidewalks (n=7,156)
1 anchored as strongly disagree	51.5%	52.3%	63.5%	50.3%	47.3%
2	14.8%	19.1%	17.4%	17.4%	19.2%
3	9.5%	10.4%	6.7%	8.7%	11.6%
4	6.3%	5.4%	3.8%	4.8%	6.2%
5	6.0%	5.2%	2.8%	4.6%	5.5%
6 anchored as strongly agree	9.5%	6.3%	4.2%	7.1%	6.2%
don't know	2.2%	1.3%	1.6%	6.8%	3.9%
refused	.1%	.0%	.1%	.3%	.2%

Table 5.10b: Barriers related to the environment and PA, 2004 PAM

	Unsuitable hours and times (n=8,790)	Difficulty getting to places (n=8,790)	Program/ facilities not the right type (n=8,790)	Dollar cost too high (n=8,790)	Hard to find right coaching (n=8,790)	Facilities not well maintained (n=8,790)
1 anchored as strongly disagree	24.1%	40.9%	19.8%	24.6%	23.2%	35.2%
2	15.8%	18.2%	18.6%	14.9%	18.2%	19.9%
3	16.3%	12.0%	21.5%	17.0%	19.3%	13.4%
4	10.8%	7.5%	15.3%	11.5%	11.6%	8.3%
5	10.1%	7.5%	10.4%	10.7%	9.5%	6.7%
6 anchored as strongly agree	13.5%	11.3%	10.0%	16.4%	9.8%	8.9%
don't know	9.1%	2.4%	4.4%	4.9%	8.2%	7.4%
refused	.3%	.1%	.2%	.2%	.3%	.2%

Table 5.11a and Table 5.11b summarizes the relationships between perceived barriers to activity and socio-demographic factors, specifically sex, age, and education. More women than men agreed that safety concerns, traffic concerns, crime in the neighbourhood, poorly lit sidewalks, high cost of participation, difficulty getting to places to be active, and unsuitable hours and times of facilities and programs limit their activity. A greater proportion of older adults (65 years and older) cited traffic, crime, poorly lit sidewalks, difficulty in getting to places, programs and facilities not being the right type, facilities not being well maintained, high costs of participating, and difficulty in finding the right type of coaching as barriers to PA participation compared to some younger adults. Generally speaking, concerns about safety increased with increasing age. There is an inverse relationship between education and certain barriers, such as in the proportion who cite safety concerns, traffic, crime in the neighbourhood, badly maintained sidewalks, poorly lit sidewalks, difficulty getting to places to be active, programs and facilities not being the right type, hours and times not being suitable, dollar costs being too high, difficulty finding the right type of coaching, and facilities not being well maintained.

Table 5.11a: Prevalence of barriers by sex, age, and education, 2004 PAM

	Safety concerns %, 95% CI	Traffic %, 95% CI	Crime %, 95% CI	Badly maintained sidewalks %, 95% CI	Poorly lit sidewalks %, 95% CI	Unsuitable hours and times %, 95% CI
Sex						
Male	18.4%, 17.1-19.7	15.7%, 14.5-17.1	9.3%, 8.3-10.4	16.4%, 15.0-17.8	16.8%, 15.5-18.3	35.5%, 33.8-37.1
Female	26.2%, 24.9-27.5	18.6%, 17.3-20.0	12.6%, 11.5-13.8	19.2%, 17.8-20.6	20.5%, 19.1-22.0	40.5%, 39.0-42.0
Age						
18 to 24	14.5%, 12.3-17.1	14.0%, 11.7-16.7	8.4%, 6.5-10.6	17.5%, 14.8-20.6	17.7%, 15.1-20.8	37.2%, 33.9-40.6
25 to 44	18.2%, 16.9-19.7	15.9%, 14.5-17.4	9.0%, 7.9-10.2	16.3%, 14.9-17.8	18.0%, 16.5-19.6	38.4%, 36.6-40.2
45 to 64	23.0%, 21.5-24.6	16.6%, 15.1-18.2	10.6%, 9.4-12.0	18.3%, 16.7-20.0	17.6%, 16.0-19.2	36.6%, 34.7-38.5
65 and older	38.3%, 35.5-41.0	25.3%, 22.5-28.3	19.9%, 17.3-22.9	21.4%, 18.5-24.5	23.9%, 21.0-27.0	41.0%, 37.9-44.1
Education						
< Secondary	36.2%, 33.5-39.1	25.2%, 22.4-28.3	21.1%, 18.4-24.1	25.8%, 22.7-29.1	27.4%, 24.3-30.7	44.3%, 41.2-47.4
Secondary	25.8%, 23.9-27.8	18.5%, 16.7-20.5	12.4%, 10.8-14.2	18.9%, 16.9-21.0	20.9%, 18.9-23.0	39.8%, 37.6-42.1
College	18.6%, 17.0-20.3	15.4%, 13.7-17.2	8.9%, 7.6-10.4	16.4%, 14.6-18.3	17.6%, 15.8-19.6	39.8%, 37.6-42.1
University	16.2%, 14.9-17.7	14.1%, 12.7-15.6	7.3%, 6.2-8.5	14.9%, 13.4-16.5	14.1%, 12.6-15.6	32.1%, 30.3-34.1

Table 5.11b: Prevalence of barriers by sex, age, and education, 2004 PAM

	Difficulty getting to places %, 95% CI	Programs/ facilities not the right type %, 95% CI	Dollar cost too high %, 95% CI	Hard to find right coaching %, 95% CI	Facilities not well maintained %, 95% CI
Sex					
Male	24.1%, 22.7-25.6	35.8%, 34.2-37.4	35.1%, 33.5-36.7	32.2%, 30.6-33.8	25.9%, 24.4-27.4
Female	29.7%, 28.4-31.1	38.9%, 37.4-40.4	45.9%, 44.4-47.4	35.2%, 33.7-36.7	25.8%, 24.4-27.1
Age					
18 to 24	22.2%, 19.5-25.2	33.9%, 30.8-37.2	45.9%, 42.5-49.4	33.5%, 30.4-36.9	19.8%, 17.2-22.7
25 to 44	23.3%, 21.8-24.8	35.5%, 33.8-37.3	39.8%, 38.0-41.6	32.3%, 30.6-34.0	23.6%, 22.1-25.2
45 to 64	26.0%, 24.4-27.7	37.2%, 35.4-39.0	36.8%, 35.0-38.6	33.0%, 31.2-34.8	24.9%, 23.2-26.6
65 and older	42.5%, 39.7-45.3	45.7%, 42.8-48.6	46.0%, 43.0-49.0	39.6%, 36.6-42.7	39.4%, 36.5-42.3
Education					
< Secondary	42.0%, 39.1-44.9	45.8%, 42.8-48.7	48.9%, 45.9-51.9	41.7%, 38.7-44.7	39.5%, 36.6-42.5
Secondary	31.3%, 29.3-33.4	41.0%, 38.8-43.3	45.8%, 43.6-48.1	38.2%, 36.0-40.4	29.8%, 27.8-32.0
College	23.2%, 21.4-25.1	36.3%, 34.1-38.5	41.4%, 39.2-43.7	31.1%, 29.0-33.3	22.5%, 20.6-24.4
University	19.2%, 17.7-20.8	31.3%, 29.5-33.1	31.8%, 30.0-33.7	28.1%, 26.3-30.0	18.7%, 17.2-20.3

5.3.3 Predicting physical activity and walking

A key research question in this Chapter explored whether sufficient activity and sufficient walking differ according to the environmental variables and by perceived environmental barriers. Table 5.12a and Table 5.12b shows that there were little significant differences between the NEWS items and either sufficient activity or sufficient walking when looking at the prevalence estimates, with two exceptions. A greater proportion of individuals living in neighbourhoods primarily consisting of high rise apartments (12 stories or higher), and those agreeing that neighbourhood crime made it unsafe to walk at night did not achieve the sufficient activity criterion.

Table 5.12a: NEWS items by sufficient activity, 2004 PAM

	Physical activity					
	Meeting sufficient activity criteria			Not meeting activity criteria		
	N	%	95% CI	N	%	95% CI
Primary type of housing						
Detached single family residences	2,750	66.8%	65.2-68.3	2,342	64.5%	62.8-66.1
Town/row houses, apartments, or condos of 2-3 stories	336	8.6%	7.7-9.6	297	8.8%	7.9-9.9
Mixed single-family, town/row houses, apartments or condos	819	20.2%	19.0-21.6	749	20.5%	19.2-22.0
Apartments/condos 4 to 12 stories	113	2.8%	2.3-3.4	113	3.2%	2.7-3.9
Apartments/condos more than 12 stories	59	1.6%	1.2-2.1	95	2.9%	2.4-3.6
Many shops, stores, other places within walking distance						
Disagree	1,619	38.1%	36.6-39.7	1,443	38.7%	37.0-40.4
Agree	2,563	61.9%	60.3-63.4	2,208	61.3%	59.6-63.0
Transit stop 10-15 minute walk from home						
Disagree	1,567	35.9%	34.4-37.5	1,286	32.7%	31.1-34.4
Agree	2,598	64.1%	62.5-65.6	2,353	67.3%	65.6-68.9
There are sidewalks on most of the streets in my neighbourhood						
Disagree	1,393	32.3%	30.8-33.8	1,162	29.9%	28.3-31.5
Agree	2,802	67.7%	66.2-69.2	2,514	70.1%	68.5-71.7
There are facilities to bicycle in neighbourhood						
Disagree	1,651	38.8%	37.3-40.4	1,441	38.0%	36.3-39.7
Agree	2,518	61.2%	59.6-62.7	2,199	62.0%	60.3-63.7
Neighbourhood has several free or low cost recreation facilities						
Disagree	977	22.8%	21.5-24.1	905	23.6%	22.1-25.1
Agree	3,207	77.2%	75.9-78.5	2,753	76.4%	74.9-77.9
Neighbourhood crime rate makes it unsafe to go on walks at night						
Disagree	3,441	83.1%	81.9-84.3	2,853	79.3%	77.9-80.7
Agree	717	16.9%	15.7-18.1	764	20.7%	19.3-22.1
Too much traffic makes it difficult or unpleasant to walk						
Disagree	3,234	81.3%	80.0-82.6	2,760	81.4%	79.9-82.7
Agree	745	18.7%	17.4-20.0	641	18.6%	17.3-20.1

Table 5.12b: NEWS items by sufficient walking, 2004 PAM

	Walking					
	Meet sufficient walking criteria			Not meeting walking criteria		
	N	%	95% CI	N	%	95% CI
Primary type of housing						
Detached single family residences	1,623	66.2%	64.2-68.2	3,496	65.5%	64.1-66.8
Town/row houses, apartments, or condos of 2-3 stories	196	8.3%	7.2.-9.6	437	8.9%	8.1-9.8
Mixed single-family, town/row houses, apartments or condos	485	20.0%	18.4-21.7	1,083	20.6%	19.4-21.8
Apartments/condos 4 to 12 stories	83	3.4%	2.8-4.3	143	2.8%	2.4-3.3
Apartments/condos more than 12 stories	45	2.0%	1.5-2.7	109	2.3%	1.9-2.8
Many shops, stores, other places within walking distance						
Disagree	928	36.4%	34.4-38.4	2,134	39.3%	37.9-40.7
Agree	1,567	63.6%	61.6-65.6	3,204	60.7%	59.3-62.1
Transit stop 10-15 minute walk from home						
Disagree	946	36.3%	34.4-38.3	1,907	33.6%	32.3-34.9
Agree	1,538	63.7%	61.7-65.6	3,413	66.4%	65.1-67.7
There are sidewalks on most of the streets in my neighbourhood						
Disagree	827	32.3%	30.4-34.3	1,728	30.7%	29.4-32.0
Agree	1,674	67.7%	65.7-69.6	3,642	69.3%	68.0-70.6
There are facilities to bicycle in neighbourhood						
Disagree	952	37.9%	35.9-39.9	2,140	38.7%	37.4-40.1
Agree	1,532	62.1%	60.1-64.1	3,185	61.3%	59.9-62.6
Neighbourhood has several free or low cost recreation facilities						
Disagree	567	22.2%	20.5-24.0	1,315	23.6%	22.4-24.8
Agree	1,928	77.8%	76.0-79.5	4,032	76.4%	75.2-77.6
Neighbourhood crime rate makes it unsafe to go on walks at night						
Disagree	2,051	82.9%	81.3-84.4	4,243	80.6%	79.5-81.8
Agree	431	17.1%	15.6-18.7	1,050	19.4%	18.2-20.5
Too much traffic makes it difficult or unpleasant to walk						
Disagree	1,885	80.8%	79.0-82.4	4,109	81.6%	80.5-82.8
Agree	454	19.2%	17.6-21.0	932	18.4%	17.2-19.5

Table 5.13a and Table 5.13b shows that the number of places to be active was associated with both sufficient activity and walking. More specifically, a greater proportion of adults who reported that there were *many* multi-purpose trails, places to safely walk, and other places to be active in the community were active and walked sufficient amounts. A greater proportion of Canadians that met the sufficiently walking criterion indicated that there were *many* places to bicycle compared to those who did not walk enough. Relatively more adults who did not meet the sufficiently active criteria did not ride a bicycle compared to those who are sufficiently active.

Table 5.13a: Number of places to be active by sufficient activity, 2004 PAM

	Physical activity					
	Meeting sufficient activity criteria			Not meeting activity criteria		
	N	%	95% CI	N	%	95% CI
Places to safely walk						
None	409	8.8%	8.0-9.7	439	9.7%	8.8-10.6
Some	1,656	37.2%	35.7-38.7	1,748	40.9%	39.4-42.5
Many	2,407	54.0%	52.5-55.5	2,051	49.4%	47.8-51.0
Places to safely bike						
None	1,158	25.0%	23.7-26.4	1,165	26.6%	25.2-28.0
Some	2,055	46.9%	45.4-48.5	1,941	46.3%	44.7-48.0
Many	1,203	27.1%	25.8-28.5	990	24.7%	23.3-26.1
Does not ride a bike	37	1.0%	0.6-1.4	107	2.4%	2.0-2.9
Multi-purpose recreation trails						
None	1,196	27.4%	26.0-28.8	1,239	30.1%	28.6-31.6
Some	2,390	55.2%	53.6-56.8	2,239	55.4%	53.7-57.0
Many	783	17.4%	16.3-18.6	577	14.5%	13.4-15.8
Other places to be active in the community						
None	440	9.5%	8.6-10.4	470	10.4%	9.4-11.4
Some	2,408	54.2%	52.7-55.8	2,421	57.6%	56.0-59.2
Many	1,612	36.3%	34.8-37.8	1,301	32.0%	30.5-33.5

Table 5.13b: Number of places to be active by sufficient walking, 2004 PAM

	Walking					
	Meet sufficient walking criteria			Not meeting walking criteria		
	N	%	95% CI	N	%	95% CI
Places to safely walk						
None	239	8.6%	7.6-9.8	609	9.5%	8.7-10.3
Some	958	36.4%	34.5-38.4	2,446	40.1%	38.8-41.5
Many	1,458	55.0%	53.0-57.0	3,000	50.4%	49.1-51.7
Places to safely bike						
None	675	24.7%	23.0-26.5	1,648	26.2%	25.1-27.4
Some	1,165	44.4%	42.4-46.5	2,831	47.6%	46.3-49.0
Many	776	29.8%	28.0-31.7	1,417	24.2%	23.1-25.4
Does not ride a bike	25	-	-	119	1.9%	1.6-2.3
Multi-purpose recreation trails						
None	703	26.8%	25.1-28.7	1,732	29.5%	28.3-30.8
Some	1,411	54.9%	52.9-57.0	3,218	55.4%	54.1-56.8
Many	476	18.2%	16.7-19.9	884	15.1%	14.1-16.1
Other places to be active in the community						
None	262	9.3%	8.2-10.6	648	10.2%	9.4-11.0
Some	1,413	54.1%	52.1-56.1	3,416	56.6%	55.3-58.0
Many	968	36.6%	34.6-38.5	1,945	33.2%	32.0-34.5

- Data suppressed due to insufficient cell size

Perceived barriers related to the physical environment were also associated with sufficient activity and walking, as described in Table 5.14a and Table 5.14b. In particular, those who did not meet the sufficient activity criteria were more likely to agree that concerns about safety, traffic, and crime kept them from being more active, found it too hard to get to places to be more active, said that the facilities and programs are not the right type for them, said the sport and recreation facilities are not well-maintained, reported that the hours and times did not suit, found the cost too high, and found it difficult to find the right type of coaching or instruction. Moreover, those who did not meet the sufficient walking criteria were more likely to agree that concerns about safety prevent them from being more active and that too much crime prevented them from walking or bicycling, and to agree that the sport and recreation facilities are not well maintained.

Table 5.14a: Barriers related to the physical environment by achieving or not achieving the sufficient activity criterion, 2004 PAM

	Physical activity					
	Meeting sufficient activity criterion			Not meeting activity criterion		
	N	%	95% CI	N	%	95% CI
Concerns about your safety keep you from walking or bicycling						
Disagree	3556	80.6%	79.3-81.7	3049	74.3%	72.9-75.7
Agree	891	19.4%	18.3-20.7	1080	25.7%	24.3-27.1
There's too much traffic in your area for walking or bicycling						
Disagree	3118	84.3%	83.0-85.5	2715	81.1%	79.7-82.5
Agree	585	15.7%	14.5-17.0	642	18.9%	17.5-20.3
In your area there's too much crime on the streets for safe walking or bicycling						
Disagree	3338	90.2%	89.1-91.2	2916	87.7%	86.5-88.9
Agree	362	9.8%	8.8-10.9	415	12.3%	11.1-13.5
Badly maintained sidewalks and bike lanes in your area keep you from bicycling						
Disagree	2909	82.7%	81.4-84.0	2513	81.7%	80.2-83.1
Agree	623	17.3%	16.0-18.6	576	18.3%	16.9-19.8
Poorly lit sidewalks and streets in your area keep you from walking or bicycling						
Disagree	2966	82.2%	80.8-83.5	2591	80.4%	78.9-81.9
Agree	642	17.8%	16.5-19.2	649	19.6%	18.1-21.1
The hours and class times offered by your local centres don't suit						
Disagree	2638	63.5%	62.0-65.1	2260	60.2%	58.5-61.8
Agree	1533	36.5%	34.9-38.0	1503	39.8%	38.2-41.5
It's too hard for you to get to those places where you can be active						
Disagree	3339	75.7%	74.3-77.0	2868	70.0%	68.5-71.5
Agree	1089	24.3%	23.0-25.7	1261	30.0%	28.5-31.5
The programs and facilities that are available are not the right type for you						
Disagree	2802	64.5%	63.0-66.0	2408	60.5%	58.9-62.1
Agree	1568	35.5%	34.0-37.0	1603	39.5%	37.9-41.1
The dollar costs of doing physical activities are too high for you						
Disagree	2643	61.1%	59.6-62.7	2293	57.4%	55.7-59.0
Agree	1698	38.9%	37.3-40.4	1694	42.6%	41.0-44.3
It's too hard to find the right kind of coaching or instruction						
Disagree	2879	68.4%	66.9-69.9	2411	63.8%	62.2-65.5
Agree	1341	31.6%	30.1-33.1	1388	36.2%	34.5-37.8
The sport and recreation facilities are not well-maintained in your community						
Disagree	3207	75.7%	74.3-77.0	2797	72.4%	70.9-73.9
Agree	1038	24.3%	23.0-25.7	1075	27.6%	26.1-29.1

Table 5.14b: Barriers related to the physical environment by achieving or not achieving the sufficient walking criterion, 2004 PAM

	Walking					
	Meet sufficient walking criterion			Not meeting walking criterion		
	N	%	95% CI	N	%	95% CI
Concerns about your safety keep you from walking or bicycling						
Disagree	2106	80.7%	79.1-82.2	4499	76.2%	75.1-77.3
Agree	521	19.3%	17.8-20.9	1450	23.8%	22.7-24.9
There's too much traffic in your area for walking or bicycling						
Disagree	1862	84.8%	83.1-86.3	3971	81.9%	80.8-83.1
Agree	340	15.2%	13.7-16.9	887	18.1%	16.9-19.2
In your area there's too much crime on the streets for safe walking or bicycling						
Disagree	2009	91.4%	90.1-92.6	4245	88.0%	87.0-89.0
Agree	195	8.6%	7.4-9.9	582	12.0%	11.0-13.0
Badly maintained sidewalks and bike lanes in your area keep you from bicycling						
Disagree	1741	82.8%	81.0-84.5	3681	82.0%	80.7-83.1
Agree	360	17.2%	15.5-19.0	839	18.0%	16.9-19.3
Poorly lit sidewalks and streets in your area keep you from walking or bicycling						
Disagree	1777	82.9%	81.1-84.5	3780	80.6%	79.4-81.8
Agree	368	17.1%	15.5-18.9	923	19.4%	18.2-20.6
The hours and class times offered by your local centres don't suit you						
Disagree	1493	60.9%	58.8-62.9	3405	62.5%	61.1-63.9
Agree	960	39.1%	37.1-41.2	2076	37.5%	36.1-38.9
It's too hard for you to get to those places where you can be active						
Disagree	1941	74.6%	72.8-76.3	4266	72.3%	71.1-73.5
Agree	671	25.4%	23.7-27.2	1679	27.7%	26.5-28.9
The programs and facilities that are available are not the right type for you						
Disagree	1603	62.4%	60.4-64.3	3607	62.7%	61.4-64.1
Agree	978	37.6%	35.7-39.6	2193	37.3%	35.9-38.6
The dollar costs of doing physical activities are too high for you						
Disagree	1512	58.8%	56.8-60.9	3424	59.6%	58.3-61.0
Agree	1039	41.2%	39.1-43.2	2353	40.4%	39.0-41.7
It's too hard to find the right kind of coaching or instruction						
Disagree	1690	67.2%	65.3-69.2	3600	65.9%	64.5-67.2
Agree	812	32.8%	30.8-34.7	1917	34.1%	32.8-35.5
The sport and recreation facilities are not well-maintained in your community						
Disagree	1931	76.8%	75.0-78.5	4073	73.0%	71.7-74.2
Agree	575	23.2%	21.5-25.0	1538	27.0%	25.8-28.3

The previous results described how sufficient activity and sufficient walking varies by environmental variables and by perceived environmental barriers. Considering all of the environmental factors and perceived environmental barriers, which were more strongly related to sufficient activity and sufficient walking? Table 5.15 shows that there were relatively few relationships between the NEWS environmental factors in predicting sufficient activity and walking levels when controlling for age, sex, and education. Adults living in neighbourhoods

with predominately high-rise apartments (12 stories or higher) are less likely to achieve the sufficient activity criterion. Adults who *agreed* that there are many shops, stores, markets within easy walking distance of their home had a greater likelihood of achieving sufficient walking levels. Adults that agreed that neighbourhood crime made it unsafe to go on walks at night, had a lower likelihood of achieving the sufficient activity.

Table 5.15: Odds ratios of sufficient activity and sufficient daily walking by NEWS factors, 2004 PAM

NEWS environmental factors	Sufficient activity			Sufficient walking		
	Odds Ratio*	95% CI		Odds Ratio*	95% CI	
Primary type of housing						
Detached single family residences	Reference			Reference		
Town/row houses, condos, apartments of 2-3 stories	0.91	0.74	1.12	0.86	0.70	1.07
Mixed single-family, town/row houses, condos, apartments	0.99	0.86	1.14	0.94	0.82	1.09
Apartments/condos 4-12 stories	0.81	0.59	1.10	1.15	0.83	1.59
Apartments/condos more than 12 stories	**0.50**	**0.34**	**0.73**	0.88	0.59	1.33
Many shops, stores, market or other places are within walking distance						
Disagree or not applicable	Reference			Reference		
Agree	1.13	1.00	1.28	**1.24**	**1.08**	**1.42**
Transit stop is 10-15 minute walk from home						
Disagree or not applicable	Reference			Reference		
Agree	.88	.77	1.01	.88	.76	1.01
There are sidewalks on most of the streets in my neighbourhood						
Disagree or not applicable	Reference			Reference		
Agree	.90	.77	1.04	.94	.81	1.09
There are facilities to bicycle in or near neighbourhood						
Disagree or not applicable	Reference			Reference		
Agree	1.01	.89	1.14	1.02	.90	1.16
Neighbourhood has several free or low cost recreation facilities						
Disagree or not applicable	Reference			Reference		
Agree	1.03	.89	1.19	1.05	.90	1.23
Crime rate in neighbourhood makes it unsafe to go on walks at night						
Disagree or not applicable	Reference			Reference		
Agree	**.86**	**.75**	**1.00**	.87	.74	1.01
Too much traffic on streets making it difficult or unpleasant to walk						
Disagree or not applicable	Reference			Reference		
Agree	1.13	.98	1.30	1.09	.94	1.26

* adjusted for age, sex, education level

Table 5.16 indicates that based on 2004 PAM data, ratings about the amount of the availability of multi-purpose recreation trails predicts sufficient PA. There were few significant relationships

between the availability of opportunities in the community and sufficient walking and activity, with one exception; citing many multi-purpose trails in the community was associated with a higher likelihood of sufficient activity.

Table 5.16: Odds ratios of sufficient activity and walking by availability of opportunities, 2004 PAM

Availability of an environment supporting PA	Sufficient activity			Sufficient walking		
	Odds Ratio*	95% CI		Odds Ratio*	95% CI	
Amount of places to safely walk (sidewalks, trails, and so on)						
None at all	Reference			Reference		
Some	.88	.73	1.06	.95	.78	1.17
Many	.98	.80	1.19	1.04	.84	1.29
Amount of places to safely ride a bike (designated bike lanes, paths)						
None at all	Reference			Reference		
Some	.96	.84	1.09	.89	.77	1.02
Many	.92	.78	1.08	1.09	.92	1.30
Does not ride bike	.61	.31	1.22	.98	.46	2.07
Amount of multi-purpose recreation trails						
None at all	Reference			Reference		
Some	1.08	.95	1.21	1.05	.92	1.19
Many	**1.23**	**1.03**	**1.46**	1.17	.97	1.40
Amount of other facilities, places or programs in the community						
None at all	Reference			Reference		
Some	1.00	.84	1.18	1.01	.84	1.22
Many	1.17	.96	1.41	1.10	.90	1.36

* adjusted for age, sex, education level

Table 5.17 examines the association between barriers to participation and meeting the sufficient walking and activity criteria. Generally speaking, there were very few significant relationships, with one exception. Adults who agreed that safety concerns keep them from walking or bicycling were less likely to meet the sufficient activity criterion; however there were no significant relationships with sufficient walking.

Table 5.17: Odds ratios of sufficient activity and walking by barriers, 2004 PAM

Ratings of barriers	Sufficient activity			Sufficient walking		
	Odds Ratio*	95% CI		Odds Ratio*	95% CI	
Concerns about your safety keep you from walking or bicycling						
Disagree	Reference			Reference		
Agree	**.74**	**.59**	**.92**	.80	.63	1.02
There's too much traffic in your area for walking or bicycling						
Disagree	Reference			Reference		
Agree	.95	.78	1.15	.93	.76	1.13
In your area there's too much crime on the streets for safe walking or bicycling						
Disagree	Reference			Reference		
Agree	1.17	.93	1.47	.85	.66	1.09
Badly maintained sidewalks and bike lanes in your area keep you from bicycling						
Disagree	Reference			Reference		
Agree	1.09	.90	1.31	1.16	.96	1.41
Poorly lit sidewalks and streets in your area keep you from walking or bicycling						
Disagree	Reference			Reference		
Agree	1.06	.87	1.28	.85	.70	1.03
The hours and class times offered by your local centres don't suit you						
Disagree	Reference			Reference		
Agree	.94	.82	1.07	1.12	.98	1.29
It's too hard for you to get to those places where you can be active						
Disagree	Reference			Reference		
Agree	.94	.81	1.10	1.04	.89	1.23
The programs and facilities that are available are not the right type for you						
Disagree	Reference			Reference		
Agree	1.01	.88	1.15	1.06	.92	1.22
The dollar costs of doing physical activities are too high for you						
Disagree	Reference			Reference		
Agree	.91	.80	1.04	1.01	.88	1.15
It's too hard to find the right kind of coaching or instruction						
Disagree	Reference			Reference		
Agree	.90	.78	1.04	.99	.86	1.15
The sport and recreation facilities are not well-maintained in your community						
Disagree	Reference			Reference		
Agree	.98	.83	1.15	.91	.77	1.08

* adjusted for age, sex, education level

Table 5.18 subsequently examines the NEWS items, the number of places in the community to be active, and barriers in a full model, while adjusting for sex, age, and education. Based on this model, adults who *agreed* that there are many shops, stores, markets within easy walking distance of their home had a greater likelihood of achieving sufficient walking levels. Canadians who *agreed* that a transit stop is within a 10 to 15 minute walk or that there were facilities to bicycle in the neighbourhood, were less likely to be active. In addition, those who agreed that there was too much traffic on the streets were more likely to be sufficiently active. One barrier was associated with activity and walking; adults who agreed that they had concerns about safety for walking and bicycling were less likely to be sufficiently active.

Table 5.18: Odds ratios of sufficient activity and walking by environmental factors, 2004 PAM

	Sufficient activity			Sufficient walking		
	Odds ratio*	95% CI		Odds ratio*	95% CI	
Neighbourhood Environment Walkability Scale						
Primary type of housing						
Detached single family residences	Reference			Reference		
Town/row houses, low rise condos, apts	0.93	0.72	1.20	0.80	0.62	1.04
Mix of housing	1.08	0.91	1.28	0.90	0.76	1.07
Mid-rise apts	1.14	0.77	1.68	1.05	0.70	1.58
High rise apts	0.69	0.43	1.11	1.08	0.65	1.80
Many shops, stores, market or other places are within walking distance						
Disagree*	Reference			Reference		
Agree	1.10	.94	1.28	**1.25**	**1.06**	**1.47**
Transit stop is 10-15 min walk from home						
Disagree*	Reference			Reference		
Agree	**.85**	**.72**	**.99**	.92	.78	1.09
There are sidewalks on most of the streets in my neighbourhood						
Disagree*	Reference			Reference		
Agree	.92	.77	1.10	.88	.73	1.06
There are facilities to bicycle in or near neighbourhood						
Disagree*	Reference			Reference		
Agree	**.83**	**.70**	**1.00**	.85	.71	1.03
Neighbourhood has several free or low cost recreation facilities						
Disagree*	Reference			Reference		
Agree	.93	.76	1.13	1.01	.83	1.25
Crime rate in neighbourhood makes it unsafe to go on walks at night						
Disagree*	Reference			Reference		
Agree	.93	.77	1.14	.87	.70	1.07
Too much traffic on streets making it difficult or unpleasant to walk						
Disagree*	Reference			Reference		
Agree	**1.28**	**1.05**	**1.56**	1.20	.98	1.46
Availability of facilities supporting physical activity						
Amount of places to safely walk (sidewalks, trails, and so on)						
None at all	Reference			Reference		
Some	.92	.68	1.25	.92	.67	1.26
Many	1.04	.76	1.44	1.03	.74	1.45
Amount of places to safely ride a bike (designated bike lanes, paths)						
None at all	Reference			Reference		
Some	1.16	.95	1.42	1.05	.85	1.30
Many	1.08	.84	1.40	1.24	.95	1.61
Does not ride	.39	.12	1.23	.93	.25	3.44
Amount of multi-purpose recreation trails						
None at all	Reference			Reference		
Some	1.05	.89	1.24	.96	.81	1.13
Many	1.17	.93	1.48	1.08	.85	1.36

Amount of other facilities, places or programs in the community						
None at all	Reference			Reference		
Some	.96	.74	1.26	.97	.73	1.29
Many	1.14	.85	1.52	1.07	.79	1.46
Barriers for physical activity						
Concerns about your safety keep you from walking or bicycling						
Disagree	Reference			Reference		
Agree	**.72**	**.56**	**.92**	.81	.62	1.06
There's too much traffic in your area for walking or bicycling						
Disagree	Reference			Reference		
Agree	.89	.71	1.12	.86	.68	1.09
In your area there's too much crime on the streets for safe walking or bicycling						
Disagree	Reference			Reference		
Agree	1.23	.94	1.60	.89	.67	1.18
Badly maintained sidewalks and bike lanes in your area keep you from bicycling						
Disagree	Reference			Reference		
Agree	1.00	.81	1.23	1.10	.88	1.38
Poorly lit sidewalks and streets in your area keep you from walking or bicycling						
Disagree	Reference			Reference		
Agree	1.09	.88	1.35	.91	.73	1.13
The hours and class times offered by your local centres don't suit you						
Disagree	Reference			Reference		
Agree	.90	.77	1.04	1.16	1.00	1.35
It's too hard for you to get to those places where you can be active						
Disagree	Reference			Reference		
Agree	.96	.81	1.15	1.08	.90	1.30
The programs and facilities that are available are not the right type for you						
Disagree	Reference			Reference		
Agree	1.05	.91	1.22	1.08	.92	1.26
The dollar costs of doing physical activities are too high for you						
Disagree	Reference			Reference		
Agree	.93	.81	1.08	1.06	.91	1.23
It's too hard to find the right kind of coaching or instruction						
Disagree	Reference			Reference		
Agree	.91	.78	1.07	1.04	.88	1.22
The sport and recreation facilities are not well-maintained in your community						
Disagree	Reference			Reference		
Agree	1.03	.86	1.23	.93	.77	1.12

* adjusted for age, sex, education level

5.4 Discussion

A central research question of this Chapter asked how active are Canadians? Results from this survey indicate that in 2004, slightly more than half of Canadian adults (52.2%) accumulated enough PA to be considered sufficiently active and 31.0% walked enough to do sufficient walking. Given the relatively low proportions of adults who reported enough walking to meet the

sufficient walking criteria of 60 minutes daily, and the moderate proportion of adults who reported that they perform enough daily PA to be considered sufficiently active, understanding the role of the physical environment in helping to explain PA behaviour, or the lack thereof, is important. Strengths of the 2004 PAM, as a data source, was that the survey content permitted the examination of the relationships between environmental supports and barriers to PA levels and walking behaviours, and the determination as to whether these differed between population groups. Similar questions on PAMs over time, permit a comparison of trend data to ensure consistent findings (see Appendix A).

Findings from this Chapter indicated that key populations are more likely to perceive barriers to being active, such as women, older adults, and lower educated adults. It is interesting to note that these are also the same population groups who are less likely to be active [Cameron et al., 2005]. One of the limitations of this survey data is that it is cross-sectional and as such, causal relationships cannot be construed. However, one can speculate that the increased prevalence of barriers can mediate PA behaviour. Further research probing the relationship between key population groups and potential enabling factors is warranted. Understanding the relationships between these key population groups and enabling factors, or the prevalence of barriers for PA or walking behaviours, may be particularly important for promotional or social marketing campaigns in order to increase PA. For example, some research has shown that residents of low socio-economic areas were more likely to report walking, potentially due to greater density within these neighbourhoods, however, participation in vigorous activity was lower among this population leading to speculation that it may be due in part to cost and low visibility of opportunities [Ross, 2000; Giles-Corti & Donovan, 2002]. Indeed, neighbourhood density also appears to be associated with the demographics of the population within the 2004 PAM, whereby more young adults who lived in higher density neighbourhoods (more young adults lived in townhouses, row houses or low rise apartment buildings compared to those aged 25 and older, or living in apartments or condos of 4 to 12 stories), generally reported more amenities. Interestingly, a higher percentage of young adults than older adults said that there are *many* places to safely walk. More adults 45 years and older lived in single-detached housing, and stated that there are *no* places to safely walk, *no* places to safely bicycle, and that there were *no* other types of programs, facilities, places to be active in the community, compared to their younger counterparts.

Walking is a relatively easy and low-cost activity for all age groups. It is a relatively convenient activity that involves little skill. It is therefore a key activity to promote to those who are less active in order to increase overall activity levels either on its own or through a combination of activities in which walking may play a greater role. As with bicycling, walking for commuting has the potential of influencing health outcomes, such as contributing to the prevention of increasing obesity rates [Bassett et al., 2005]. Research has shown a relationship between walking and obesity among industrialized nations (Europe and North America), where the proportion of walking trips was inversely related to obesity rates, as was the total percentage of walking, bicycling, and public transit trips [Bassett et al., 2008].

Neighbourhood walkability, including factors such as mixed land use, networking of streets, and residential density, has been found to be related to PA, however, these relationships varied among different population groups [Sallis et al., 2005]. Indeed, results from this Chapter also indicated that disparities exist by age, education, and gender. Younger adults cited more amenities in the neighbourhood, whereas older adults cited crime as an issue. In addition, results from this Chapter showed that a lower proportion of individuals with lower education levels indicated that there were transit stops nearby, that there were sidewalks on most streets, that there were facilities to bicycle, that there were several free or low cost recreational facilities, yet more agreed that crime rate made it unsafe. Similarly, a greater proportion of those with lower education said that there were *no* places to walk or bicycle, *no* other types of facilities and programs in their communities compared to higher educated individuals. Again, increasing the "visibility" of physical activities opportunities in low socio-economic areas may contribute to the social norms of that area, potentially affecting behaviour change or increased activity participation [Giles-Corti & Donovan, 2002].

Other studies in the United States have used the NEWS measures and found that supportive walking and bicycling environments, availability of free or low cost recreational opportunities, and low neighbourhood crime rates were associated with higher levels of PA [Ainsworth et al., 2005] whereas in this study we examined both total activity and walking behaviours in relation to these measures. In an international study examining the NEWS variables in relation to walking and activity level, it was found that the housing type, nearby shops, the availability of sidewalks, bicycling facilities and low cost recreational facilities were associated with walking

[Sallis et al., 2009]. In this Canadian study, the relationships found with walking varied slightly from those described above. Similar to the other studies, the availability of nearby shops was positively associated with walking and neighbourhood crime was associated with lower levels of activity (in one model, not the larger model), but not walking. The international study found that the availability of sidewalks was associated with sufficient activity, whereas in this study, it was not associated with sufficient walking or activity [Sallis et al., 2009]. In addition, the international studies found supportive bicycling environments and availability of free or low cost recreational opportunities were associated with higher levels of PA and walking [Sallis et al., 2009]. In this study, low cost-recreational facilities were not associated with walking or PA, however, facilities to bicycle were associated with lower likelihood of activity. Understanding the differences between Canadian perceptions' about their local environment and perceptions' by residents of other countries is warranted to explain the differences in these findings. The majority of Canadians generally rated aspects of the physical environment as supportive of PA. According to the results presented in this Chapter, Canadians seem to have good access to facilities and opportunities to be active in their communities. As examples, Canadians generally reside in close proximity to PA amenities or facilities, the majority report that PA opportunities are available, and crime and traffic are not generally perceived as major barriers to PA in neighbourhoods. Perhaps the lack of many significant associations between the environmental variables in predicting walking and activity behaviour -- this is clearly evident for the number of places to be active, and somewhat so for the NEWS items -- may result from the skewed data in which Canadians perceive environmental supports and facilities as pervasive. Furthermore, findings from this Chapter showed that Canadians' perceptions about the amount of places to be active in the local environment, specifically the availability of safe walking areas were related with sufficient walking and activity when looking at the prevalence data, however, in the model adjusting for age, sex and education, the availability of multi-purpose recreational trails predicted sufficient activity only (however, was not significant in the full model). The findings in this Chapter somewhat supports other studies that found that access to facilities such as trails, was positively correlated with PA and walking or activity (specific types such as recreational walking or higher odds of regular activity) [Librett et al., 2006; Dunton et al., 2009]. However, given that the amount of safe places to walk and to bicycle was not predictive of sufficient walking or sufficient activity when tested in conjunction with trails and other places and programs and the overall prevalence of safe places to walk, it may be the overall amount or combination of opportunities that defines an activity friendly environment. Given the data used

in these analyses are self-reported and as such, may therefore reflect perceptions of the amount rather than an absolute rating of availability, further research understanding dose responses regarding environmental considerations in a country with such abundant opportunities, is warranted.

In this study, reporting that the programs and facilities that are available are not the right type, or that class hours and timing are barriers was associated with sufficient activity when examining the prevalence data (however, was not related in the logistic regression model). This suggests that other factors such as perceived behavioural control, self-efficacy or intentions may be more important predictors of sufficient PA and walking, when environmental supports are lacking. Considering the findings from the previous Chapter on individual level factors related to PA and the relationships that appear in this Chapter regarding the environmental correlates and the associations regarding barriers to PA and walking, it appears that the use of a full ecological model is warranted in order to examine interpersonal, social, and environmental (physical and policy level) factors associated with PA and walking behaviours. The next Chapter will examine each of these types of factors independently and in a fully adjusted model in predicting sufficient levels of walking and activity.

Summary of Chapter Five

Chapter Two provided a very brief review of the literature in the area of the physical environment. This research has evolved tremendously in the past 20 years, incorporating new objective tools of measurement in addition to more subjective instruments. Generally speaking, associations between availability, accessibility and convenience of destinations/facilities, neighbourhood features and aesthetics have been found in the literature to be associated to some degree with PA in general and some types of walking.

Based on a study conducted within the broader Canadian PA surveillance system, factors concerning the physical environment in relation to PA and walking were examined. Based on the findings of the literature summary in Chapter Two, it is expected that certain neighbourhood features will be predictive of PA and walking.

This Chapter analyses data from the 2004 Physical Activity Monitor, which is a random and nationally representative study of adults conducted in Canada. These measures are described briefly in this Chapter in terms of data treatment and analysis protocols. As a sum of the research questions, this Chapter investigates:

- the prevalence of sufficient PA and walking, and do they differ by covariates;
- which environmental-level correlates of PA are influenced by demographic factors; and,
- which environmental-level correlates predict sufficient PA and walking.

Three sets of measures were used in this Chapter to explore the physical environment: the presence of places to be active, the amount of places to be active, and perceived barriers pertaining to the environment. Firstly, the survey asked the primary type of housing which attempts to assess density of neighbourhood, and this measure was associated with age, sex, and education. A greater proportion of middle-aged and older individuals reside in neighbourhoods characterized primarily by single dwelling homes, whereas mixed housing neighbourhoods are

more prevalent among younger adults. The availability of places to be active in order to assess mixed land use, availability, and access was assessed. More women than men agree that neighbourhood crime makes it unsafe to walk. Relatively more young adults cite nearby shops, transit stops, sidewalks on most streets, and that there are several free or low cost recreation facilities in the neighbourhood. Older adults, however, agree that neighbourhood crime affects their walking compared to younger adults (25 to 64 years). Fewer less educated adults say that transit stops are nearby, that there are sidewalks on most streets, that there are facilities to bicycle, and several free or low cost recreation facilities in the neighbourhood, yet more agreed that crime rate was an issue.

Secondly, information on the amount of places to be active was assessed. More men than women said that there are many places in the local community where they could safely walk and bicycle. Relatively more older adults stated that there are *no* places to safely walk, *no* places to safely bicycle, *no* other types of programs, facilities, or places to be active in the community compared to younger counterparts. There is a linear increase in the proportion that reported that there are *many* places to safely walk in the community with education level. Those with less than secondary education more frequently said that there were *no* places to safely walk or bicycle in the community, or said that there were *no* other types of facilities, places or programs to be active.

More women and older adults cite many of the barriers to participation. Concerns about safety generally increased with increasing age. An inverse relationship existed between education and many barriers.

Relatively few relationships between the NEWS environmental factors existed in predicting sufficient activity and walking levels when controlling for age, sex, and education. Adults living in neighbourhoods with predominately high-rise apartments (12 stories or higher) were less likely to achieve the sufficient activity criterion. Adults who *agreed* that there are many shops, stores, markets within easy walking distance had a greater likelihood of achieving sufficient walking levels. Adults who agreed that neighbourhood crime made it unsafe to go on walks at night, had a lower likelihood of achieving the sufficient activity.

Similarly, there were very few significant relationships in terms of the number of places available in the community and perceived barriers preventing PA. Adults who reported that there are 'many' multi-purpose recreation trails had a greater likelihood of being sufficiently active. Adults who agreed that safety concerns kept them from walking or bicycling were less likely to meet the sufficient activity criterion; however there were no significant relationships with sufficient walking.

Neighbourhood walkability, including factors such as mixed land use, networking of streets, and residential density, has been found to be related to PA, however, these relationships varied among different population groups [Sallis et al., 2005]. Indeed, results from this Chapter also indicated that disparities exist by age, sex, and education. Understanding the differences between Canadian perceptions' about their local environment and perceptions' by residents of other countries is warranted to explain the differences in findings between this study and those internationally. Canadians generally rated aspects of the physical environment as supportive of PA, they seem to have good access to facilities and opportunities to be active in their communities, and crime and traffic are not generally perceived as major barriers to PA in neighbourhoods. Perhaps the lack of significant associations in predicting walking and activity behaviour may result from the skewed data in which Canadians perceive environmental supports and facilities as pervasive. Access to facilities such as trails, was positively correlated with PA and walking or activity (specific types such as recreational walking or higher odds of regular activity) [Librett et al., 2006; Dunton et al., 2009] and supports findings from this Chapter to a certain degree. Considering the findings from Chapter Four and Chapter Five, a full ecological model is warranted in order to examine interpersonal, social, and environmental factors associated with PA and walking behaviours.

CHAPTER SIX - An ecological approach to factors associated with total activity and walking

6.1 Introduction

In an earlier Chapter of this thesis, the individual factors related to walking and PA was examined. The individual factors explored in Chapter Four built on the Theory of Planned Behavior (TPB) [Ajzen, 1985; Ajzen, 1988; Ajzen, 1991]. The theoretical assumptions in the TPB state that intention is a direct determinant for the behaviour. Moreover, determinants of intention include attitudes, subjective norm (which reflects the social pressure to perform the behaviour) and perceived behavioural control. Attitudes can be influenced by personal beliefs about the behaviour, whereas subjective norms are based on beliefs about the normative beliefs within the social environment, and perceived behavioural control is based on opportunities to perform the behaviour [Ajzen, 1985; Ajzen, 1991; Courneya, 1995]. As described in Chapter Two, much literature supports the validation of theory for explaining intention to be active [Godin & Kok, 1996; Hagger, Chatzisarantis & Biddle, 2002], and is used extensively in research, however, less research is available for predicting intention to walk [Rhodes et al., 2007]. Many of the elements of the TPB are consistent with the Hierarchy of Effects (HOE) Model developed for health communication campaigns, which suggests a hierarchical series of effects from immediate impacts (awareness) to more proximal impacts (i.e., increased knowledge, saliency, attitudes and health beliefs, self-efficacy, and intention) to longer term effects including the trial of PA, and the long term maintenance of activity [McGuire, 1984; Cavill & Bauman, 2004]. Limited support for the HOE model is found among the adult population [Craig et al., 2010] but not among youth [Bauman et al., 2008]. For this reason, the analyses in Chapter Four expanded on the TPB, and as such included elements from the HOE to examine individual factors for predicting PA and walking.

Furthermore, Chapter Five examined the role of environmental factors in predicting PA and walking. As discussed in the overview of literature in Chapter Two, over the past decade there have been an increasing number of studies that explore the relationship between environmental factors and PA, as perhaps measures previously were focused more on psychological or cognitive determinants [Sallis, 2009]. Many of the studies in the literature are based on self-report measures about the environment or neighbourhoods in which people live. A review of 18 studies indicated that aesthetics, convenience of facilities with respect to walking, including sidewalks, accessibility of destinations, and perceptions about traffic were found to be associated with specific reasons for walking – for example, walking for exercise, walking for transport, and so on [Owen et al., 2004]. Differences in findings in the current literature may also reflect differences in populations,

perceptions, considerations with geographical information, and the measures representing the construct (i.e., variety of types of walking) being studied [Lovasi et al., 2008].

With the recognition of the role of the physical environment in influencing activity, the use of an ecological model in order to explain behaviour [Giles-Corti et al., 2005; Sallis, 2009] has been more widely established. An ecological model is one that takes into consideration multiple determinants or influences on behaviours, such as those at an individual level (demographic and psychological factors), a social level, a community level, a physical environmental level, and a policy level [Sallis et al., 2008]. These factors interact with each other and need to be considered as such. For example, strategies that are targeted to the community level rely on individual-level factors, and conversely, those aimed towards the individual are also influenced by community or environmental factors [Satarino & McAuley, 2003; Hall & McAuley, 2010]. Chapter Two provides an overview of the current literature regarding the use of a socio-ecological approach towards examining PA.

This current study takes a socio-ecological approach as it examines the relative contribution of individual, social, and environmental factors to both walking behaviours and to PA more generally among adults, and among younger and older men and women. It also builds on models that were developed in Chapters Four and Five and provides an examination of these factors over time. The findings yielded in this Chapter will help to inform policy and strategies to effectively communicate and promote PA among the Canadian population.

6.2 Methods

6.2.1 Sampling design

The Canadian Fitness and Lifestyle Research Institute (CFLRI) has conducted population-based surveys (Physical Activity Monitors or PAM) for the purpose of population surveillance and monitoring since 1995. A brief synopsis of the 2007 data source appears below with reference to the specific research questions in this Chapter, however, details about the development and comprehensiveness of its Physical Activity and Sport Monitoring Program and the PAMs are provided in the Methods Chapter (Chapter Three).

The 2007 PAM is the primary data set used in the analyses presented in this Chapter. The 2007 PAM was a nationally representative population sample of 5,129 Canadian adults aged 15 years and older. The sample was selected using random-digit dialling from household-based telephone exchanges. Interviewers captured data directly during the interviews using a CATI (computer-assisted telephone interviews) system (see details in Chapter Three for details on this interviewing method). The random sample of households was selected roughly proportional to the population in each province and territory with a minimum sample size of 250 for each jurisdiction except Nunavut (Note: data collection is more challenging in this Territory due to the availability of telephones, hunting season, language barriers, and survey burden posed by multiple large scale surveys on its very small population). For each selected household, one individual over the age of 15 years was selected at random. Only data on respondents aged 18 years and older were included in these analyses, thereby providing a random sample of Canadian adults. Survey participants were asked about their PA patterns, sport participation, individuals factors related to PA, and availability of local PA and sport opportunities in the community. Data were collected from February 2007 to March 2008 by the Institute for Social Research (ISR) which is housed at York University in Ontario, Canada.

The overall response rate obtained in the 2007 PAM was 41% and details are provided in Chapter Three. Table 6.1 describes the sample by province and territory for the 2007 PAM. Sample weights were applied to the data and were adjusted using a post-stratification adjustment based on the latest Census distributions for age and sex. The sample weights were applied to correct for a potential non-response bias to surveys, and if some groups who are over-represented in the sample respond differently to under-represented groups.

Table 6.1: Sample by region and province, 2007 PAM

Sample by region and province	Adults 18+
Canada	5,024
Atlantic	1,275
Newfoundland	300
Prince Edward Island	346
Nova Scotia	329
New Brunswick	300
Quebec	636
Ontario	1,177
West	1,301
Manitoba	307
Saskatchewan	360
Alberta	340
British Columbia	294
North	635
Yukon	311
Northwest Territories	321
Nunavut	3

6.2.2 Measures

The measures and demographic covariates used in this Chapter are described in considerable detail in Chapter Three, however, a brief summary of the measures is provided below.

Physical Activity Level and Walking

In the 2007 PAM, the short telephone administered, last 7-day recall version of the International Physical Activity Questionnaire (IPAQ) [Craig et al., 2003] was used to measure PA across all domains along with walking behaviour. Questions included days per week and time spent per day participating in vigorous activities, moderate activities and walking. The IPAQ series of questions used to measure PA and walking are described in Chapter Three.

A second set of measures related to walking (and PA) are used in this Chapter based on an adaptation of the Minnesota Leisure-Time Physical Activity questionnaire (MLTPAQ [Taylor et al., 1978]). The adapted MLTPAQ [Craig et al., 2002] asked participants to recall participation in a

relatively comprehensive list of 25 physical activities over the past 12 months, plus the opportunity to provide 3 additional activities which may not have been specified in this list. Within the probed activities of the adapted MLTPAQ, questions with regard to participation in walking, as well as frequency and average duration were asked. The adapted MLTPAQ questionnaire is used in this Chapter, as well as the IPAQ walking question that was also used in Chapter Four and Five. These MLTPAQ measures are described as recreational walking, and are divided into quartiles. Walking for recreation has often been studied as a popular form of physical activity with respect to the built environment, however, walking for transport has also been considered in this research [Saelens & Handy, 2008]. Frequency and duration of walking to work, school and errands were also asked using the PAM measure. The PAM measure for walking for transport was divided into quartiles. Moreover, research indicates that aspects of the built environment differ by the type of walking [Owen et al., 2004; Saelens & Handy, 2008], although the relationships may not necessarily be conclusive between studies [Saelens & Handy, 2008].

Individual factors

Awareness of guidelines - Awareness was assessed by prompted recall of Canadian PA guidelines. This measure was used in Chapter Four.

Knowledge of appropriate guidelines - Knowledge of Canada's PA guidelines was assessed through 3 questions: "What is the least number of days each week that a person *your age* has to be active to get health benefits?"; "On each of these days, how much time in total do you think a person *your age* has to be active in order to get health benefits?"; "In the situation you've described where someone is active on [stated] days a week for a total of [stated] minutes each time, how much physical effort do you think they need to put into it in order to get health benefits?" (response options: light, moderate, vigorous, don't know). This measure was used in Chapter Four.

Beliefs about PA - Beliefs about the benefits of PA were assessed through 3 questions, using a 7-point Likert rating of agreement (response options 1 through 7 were anchored by 1 "do not agree at all" and 7 "very strongly agree") that PA helps prevent heart disease, helps people maintain the ability to do everyday tasks in older age, and helps people to manage stress. These measures were used in Chapter Four.

Perceived behavioural control - An individual's perceived behaviour control regarding PA was asked as how much personal control participants have over whether they are able to fit regular PA into their lifestyle. Responses were obtained using a 5-point scale from 1, no control at all to 5 complete control, and don't know.

Self-efficacy - An individual's self-efficacy or confidence to meet the Canadian guidelines for PA was assessed using two questions, asking about the degree of confidence that they can regularly do a total of sixty minutes of any PA each day or do a total of 30 minutes or more of moderate PA per day at least three times a week. Responses were obtained using a 5-point scale from 1 which is not confident at all to 5 very confident, and an interviewer assigned category for volunteered responses of don't know.

Intention to be active - Intention to be active was asked by the question "Thinking about the next six months, to what extent do you intend to be physically active?" Responses were rated on a 7-point scale (from 1 to 7 where, 1 meant "no intention at all" and 7, meant "fully intend to"). This measure was used in Chapter Four.

Initial behaviour change steps - Initial behaviour change or trial behaviours were determined using a series of questions: "Have you done any of the following over the past 12 months with a view to becoming more active (yes/no)?

- read articles in newspapers, books or magazines about physical activity;
- sought advice from friends, family, or co-workers;
- sought advice from health professional(s);
- observed a class, or tried some kind of PA;
- sought information about opportunities in your community, such as trails, and
- made active choices in your usual work routine, like walking part way to work or taking the stairs?"

These measures were used in Chapter Four.

Social factors

Social norms - were assessed through three questions, asking level of agreement (specifically stated as strongly agree, agree, unsure, disagree, strongly disagree, don't know) with statements that:

- most family members walk for at least 30 minutes on almost every day,
- most friends walk for at least 30 minutes on almost every day, and
- most people they know walk for at least 30 minutes on almost every day.

Physical environment factors

Neighbourhood environment - An adapted subset of questions from the Neighborhood Environment Walkability Scale (NEWS) [Cerin et al., 2006] was used to determine perceptions about the environment in which they live in order to quantify walkability in a neighbourhood. Further details on these measures are described in Chapter Three (Methods). However, in brief, residential density was explored by asking the main type of housing in the respondent's neighbourhood and questions from NEWS 'minimal' subset were used [Sallis et al., 2009] in order to assess level of agreement with the availability of shops and stores nearby the home, the proximity to a transit stop, and the availability of sidewalks, bicycling facilities, and free- or low-cost recreation facilities in the neighbourhood. In addition, respondents were also asked to state their level of agreement that the crime rate in the neighbourhood makes it unsafe to go on walks at night, and that too much traffic on the streets makes it difficult or unpleasant to walk in the neighbourhood. This minimal subset was employed in the earlier study presented in Chapter Five.

Socio-demographic factors including sex, age, and educational level are described in detail in Chapter Three (Methods). These measures were used in Chapter Four and Five.

6.2.3 Research questions

Previous Chapters examined research questions including:

- individual factors (Chapter Four) independently along with their association with sufficient activity and walking, and
- environmental factors (Chapter Five) independently along with their relationship with sufficient activity and walking.

The primary purpose of this Chapter, therefore, was to build on previous Chapters by taking a socio-ecological approach for examining individual, social and environmental factors in one model along with their relation to sufficient activity and walking. These models are all adjusted for age, sex, and educational level of respondents.

More specifically, as per Chapters Four and Five, walking and activity levels in 2007 were explored in order to understand the proportion of Canadians that met the criteria for being sufficiently active and the proportion of Canadians who walked sufficient amounts in 2007, and whether these proportions varied by age, sex, and education. Further, a key purpose was to determine what individual, social, and physical factors were related to PA. Similar to Chapter Four, this Chapter first examined individual factors related to PA and walking, including: prompted awareness of guidelines, knowledge of the amount of PA that is recommended for health benefits; what were the perceptions about the health related benefits of PA; what were the perceptions about the perceived control over their choice to be active and the level of self-efficacy among Canadians; what was the degree of intention to be active; and what attempts Canadians had made towards becoming more active. In addition, these findings were explored by age, sex, and education level. Moreover, they were reviewed in comparison to findings from Chapter Four (also see data from both time periods in Appendix A). In order to thoroughly explore the Theory of Planned Behavior, this Chapter also explored the construct of subjective norms, by examining the extent to which Canadians feel that family, friends, and neighbours walk on a regular basis and whether this varies by socio-demographic and -economic factors.

Similar to Chapter Five, this Chapter then explores the environmental factors related to walking and to PA, including Canadians' perceptions of their level of agreement that there were many shops and stores near home, nearby transit stops, availability of sidewalks, bicycling facilities, or

free or low-cost recreational facilities nearby. Moreover, an understanding of perceptions of whether crime rate or traffic in the neighbourhood was a concern for Canadians was also explored. Each of these questions was assessed to determine differences by sex, age, and education groups.

Different from the two previous Chapters, this Chapter also explores whether sufficient PA and sufficient walking is associated with individual, social, and environmental factors *as a whole*. As such, the Chapter explores whether sufficient PA and sufficient walking are associated with individual and social factors (prompted awareness of guidelines, knowledge of sufficient amounts of activity, beliefs about the benefits of PA, perceived behavioural control, self-efficacy, intention, trial behaviours, and social norms); and whether the proportion of Canadians who were sufficiently active or walking sufficient amounts varied according to physical environmental factors (e.g., having many shops, stores nearby; being close to transit stops; availability of sidewalks, local bicycling facilities, and free and low cost recreation facilities; presence of crime and traffic in the neighbourhood). The unique contribution of this Chapter compared to the previous asks which of the individual, social, and environmental factors were more strongly associated with predicting sufficient walking and sufficient activity. It further expands previous Chapters by investigating specific modes of walking such as walking for the purposes of recreation and transportation [Owen et al., 2004; Cleland et al., 2010]. Initially, this is examined taking into account age, sex, and education, and then explored subsequently by looking independently for younger women and men, and older women and men given research that has found differences by age and sex groups [McCormack et al., 2009; Foster et al., 2004].

6.2.4 Data treatment

Physical activity - Using data from the IPAQ short telephone questionnaire, total time spent in vigorous activities was calculated by multiplying the number of days respondents reported engaging in vigorous-intensity activities over the past 7 days, by the amount of time spent per occasion. This value was multiplied by a metabolic equivalent (MET) [Ainsworth et al., 1993] value of 8, to provide an estimate of total MET minutes per week spent in vigorous activities. A similar calculation was conducted for time spent in moderate activities (using a MET value of 4.0) and walking behaviour (using a MET value of 3.3). A total PA energy expenditure score was calculated

by summing the PA energy expenditure from the vigorous-intensity, moderate-intensity, and walking behaviours. Based on this total PA energy expenditure score:

- sufficient activity was calculated if (1) any activity was performed daily with a total energy expenditure of 3,000 MET minutes or higher, or (2) vigorous activity was performed at least 3 days a week with a total energy expenditure of 1,500 MET minutes or higher, and
- a lower score was attributed to any lower amounts of activity and were deemed an insufficient amount of activity.

Using these same MET values of 3.3 (walking), 4 (moderate-intensity), and 8 (vigorous-intensity) as described above, the total energy expenditure representing the 1998 Canadian guidelines for adults aged 18 to 55 would be lower than the IPAQ criterion. The 1998 Canadian guidelines state that adults should accumulate at least 60 minutes of any intensity activity every day for health, 30 minutes of moderate-intensity activity, 4 days a week, or 20 minutes of vigorous-intensity activity, 4 days a week [Health Canada and Canadian Society for Exercise Physiology, 1998].

Walking – A separate score was calculated for walking based on the number of days and the amount of time spent walking in the past 7 days. Based on this data, sufficient walking was defined as walking 7 days a week for 60 minutes or more, in keeping with a conservative equivalent of the 1998 Canadian PA guidelines [Health Canada and the Canadian Society for Exercise Physiology, 1998].

The adapted MLTPAQ also included a question pertaining to walking. Leisure-time or recreational walking was assessed by asking participants to recall participation in a comprehensive list of 25 physical activities over the past 12 months. Frequency and average duration were asked for each of the reported activities. In addition, respondents were asked whether they walked to work, school and errands, and also frequency and duration. These measures are used in this Chapter as recreational walking and walking for transport. For each of these two variables, time spent on each type of walking was multiplied by the occasions. For the logistic regression and cross-tabulations used this Chapter, the highest quartiles of recreational walking and transport walking were used.

Knowledge of appropriate guidelines – Knowledge of the amount of required activity for health was based on the three questions:

- "What is the least number of days each week that a person *your age* has to be active to get health benefits?"
- "On each of these days, how much time in total do you think a person *your age* has to be active in order to get health benefits?"
- "In the situation you've described where someone is active on [stated] days a week for a total of [stated] minutes each time, how much physical effort do you think they need to put into it in order to get health benefits?" (response options: light, moderate, vigorous, don't know).

A score for understanding the appropriate guidelines was calculated as understanding the guidelines if the respondent stated (1) 7 days of activity per week, for 60 or more minutes per day, at any intensity, or (2) a minimum of 4 days of activity per week for 30 or more minutes per day, at least moderate intensity (Canadian) [Health Canada and Canadian Society for Exercise Physiology, 1998]. This calculation was coded as a dichotomous variable: "has knowledge about the amount of PA for guidelines" or not.

Beliefs about the benefits of PA – The three belief questions assessed the extent to which PA helped prevent heart disease, helped people maintain the ability to do everyday tasks in older age, and helped people to manage stress were considered. In order to identify the single construct of beliefs, a Cronbach's alpha score was calculated measuring the internal consistency between the questions and was considered acceptable (0.72). Consequently, the measures were summed into a composite score and then divided into quartiles based on the distribution where quartile 1 represents the lowest score and quartile 4 represents the highest score.

Self-efficacy – Self-efficacy or the confidence in one's ability to be active was assessed through two questions which assessed the respondents' degree of confidence that they can meet two guidelines outlined in Canadian PA guidelines [Health Canada and Canadian Society for Exercise Physiology, 1998]. To determine the single construct representing self-efficacy, a Cronbach's alpha score was calculated on the two questions and was considered acceptable (0.78). Consequently, the measures were summed into a composite score and then divided into quartiles based on the distribution (quartile 1 represents the lowest score and quartile 4 represents the highest score).

Perceived behavioural control and Intention to be active – Perceived behavioural control regarding PA was asked using a 5-point scale from 1, no control at all to 5 complete control, and don't know. Intention to be active was asked using a 7-point scale (from 1, no intention at all to 7, meaning fully intend to). Both scales were then categorized into quartiles based on their population distribution of responses.

Social norms – Three social norm questions asked about the level of agreement with statements, allowing for responses on a scale of strongly agree, agree, unsure, disagree, strongly disagree. In order to create a sole construct representing social norms, a Cronbach's alpha was calculated and yielded an acceptable level of 0.73. Consequently, the scores from the three questions were combined into one derived score and were then divided into quartiles (quartile 1 represents the lowest score and quartile 4 represents the highest score).

Physical environment – Except when examining the main type of housing in the respondent's neighbourhood where all categories were examined separately, each NEWS item was recoded as agree (strongly agree/agree) and disagree (strongly disagree/disagree). The category 'does not apply' was also included with the 'disagree' category, when the proportion was less than 3%. When above this value, it was included as a separate category.

6.2.5 Statistical Analysis

SPSS version 21.0 was used for all analyses. Complex sampling methods were required for the 2007 Physical Activity Monitor, in order to take into account stratification by province or territory within the country. Accordingly, the Complex sample cross-tabulation procedure was used to calculate the prevalence estimates in this Chapter for sufficient PA, sufficient walking and individual, social and environmental factors.

The associations between 'sufficient' PA participation and 'sufficient' walking behaviour with the socio-demographic factors of sex, age, and education were examined, as well as the relationships between the individual, social, and environmental factors with the socio-demographic factors. In addition, the differences in the prevalence of 'sufficient' PA and walking by individual, social, and environmental factors were explored. Differences in prevalence rates were estimated by weighting responses to the population and tested using 95% confidence intervals surrounding the estimates.

The relationship between individual, social, environmental variables, and socio-demographic factors in predicting sufficient activity and walking levels were examined in this Chapter. To investigate factors associated with PA, statistical models were developed. Models in the previous two chapters explored associations between key independent measures and dichotomous dependent measures of (1) 'sufficient' PA participation and (2) 'sufficient' walking behaviour (achieving sufficient activity or walking or not). The models are enhanced in this Chapter by investigating four dependent measures, namely, the dichotomous variables of (1) 'sufficient' PA participation (achieving sufficient activity or not), (2) 'sufficient' all-domain walking behaviour (achieving sufficient all domain walking or not using IPAQ), (3) highest quartile of recreational walking (using the adapted MLTPAQ), and (4) highest quartile of walking for the purpose of transportation (using the PAM commute questions). To predict these dichotomous dependent measures, the complex sample logistic regression procedure was used to take into account the sample design.

The potential confounding variables of age, sex, and education were included as covariates in the first set of models. Initially, the individual and social factors were assessed as an independent model predicting the four dependent activity variables and were broken into three models representing immediate and intermediate factors of activity, along with the amount of variation explained within each of these three model components. Next, the environment factors were assessed in an independent model predicting the four dependent variables. A full model was selected to determine the relative magnitude of the odds of each of the variables of interest within an ecological framework. As an exploratory analysis, each of the individual, social, and environmental factors were incorporated into a full model, with age, sex, and education as covariates. The steps in building the model are illustrated in Figure 6.1. Additional details on the procedure are provided in Chapter Three.

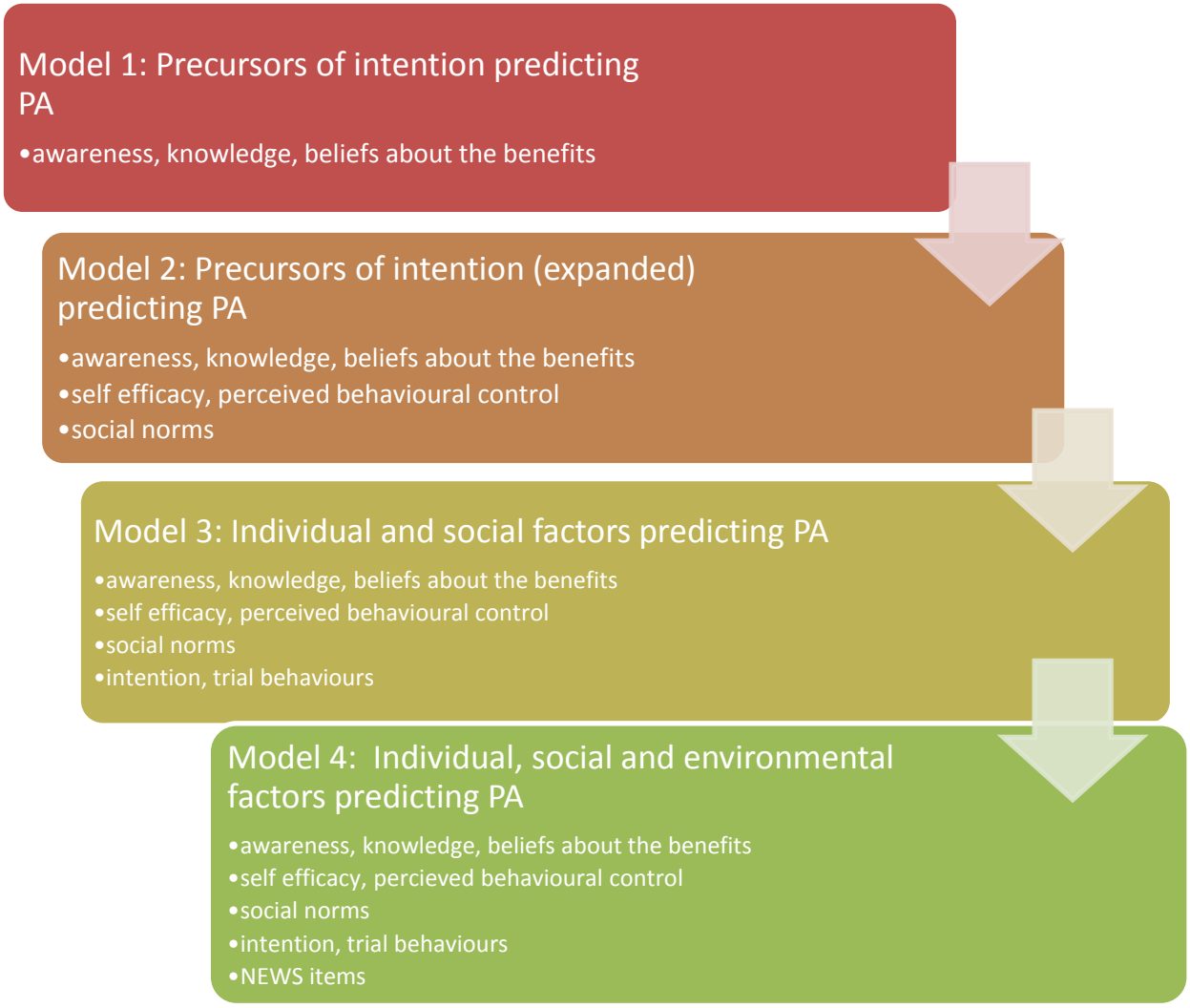

Figure 6.1 Steps in building the full model with individual, social, environmental factors predicting sufficient PA, all-domain walking, highest quartiles of recreational and transport walking

Given the body of literature that shows differences in an ecological approach when looking independently for younger women and men, and older women and men, the full model was then stratified and run by 4 age and sex groups (women, less than 45 years old; men, less than 45 years old; women, 45 years and older; men, 45 years and older) [McCormack et al., 2009; Foster et al., 2004]. The age category of 45 years was used as the cut-point as a considerable number of relationships were found in Chapter Four and Five between adults older than 45 years and younger than 45 years. This is illustrated in Figure 6.2.

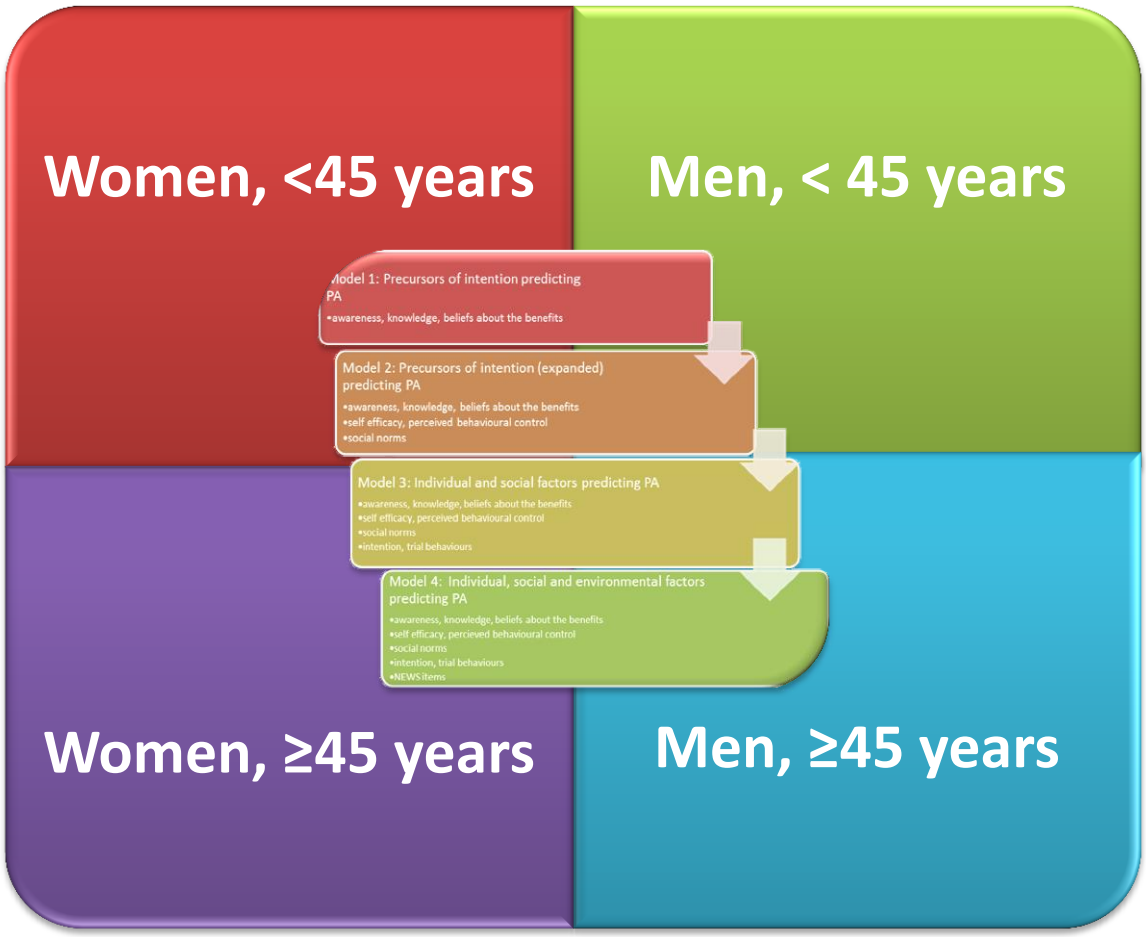

Figure 6.2 Full model with individual, social, environmental factors predicting sufficient PA, all-domain walking, highest quartiles of recreational, and transport walking, stratified by age and sex groups

6.3 Results

6.3.1 Physical activity and walking

This section describes the PA levels of Canadians, including participation in vigorous and moderate intensity activity, as well as walking behaviour. More than half (56.6%) of adults 18 years and older reported adequate amounts of total daily PA to be considered sufficiently active (for this purpose, sufficient activity represents a total PA energy expenditure of 3,000 MET minutes/week or higher, or vigorous activity at least 3 days a week with a total energy expenditure of 1,500 MET minutes/week or higher). Fewer adults (31.0%) indicated that they walked sufficient amounts (here defined as walking 7 days a week for 60 minutes or more). The association

between sufficient walking and activity with socio-demographic factors was explored in order to determine which population groups are most and least active.

Prior to examining PA and walking in detail, the characteristics of these population groups are described below and summarized in Table 6.2 (details on the demographic variables are provided in Chapter Three). More women (56.1%) than men (43.9%) responded to the survey. For this analysis, sample weights, with an applied post-stratification adjustment which reflected the latest Census distributions for age and sex, were used. When the sample weights were applied, 51.2% of the sample were female compared to 48.8% male. The unadjusted mean age of the sample in the 2007 PAM was 47.0 years, however, when the sample weight was applied, the mean age decreased to 44.9 years. Table 6.2 describes the un-weighted and weighted distributions by age, sex, and education within this study.

Table 6.2: Distribution of age, sex, and education, 2007 PAM

		N	Un-weighted %	Weighted %	Lower CI (95%)	Upper CI (95%)
Sex	Male	2,204	43.9%	48.8%	46.8%	50.7%
	Female	2,820	56.1%	51.2%	49.3%	53.2%
Age	18 to 24	384	7.7%	13.9%	12.2%	15.8%
	25 to 44	1,849	36.9%	35.0%	33.2%	36.9%
	45 to 64	2,038	40.7%	33.8%	32.1%	35.6%
	65 or older	739	14.8%	17.3%	15.9%	18.8%
Education	< Secondary	666	13.4%	13.2%	11.9%	14.6%
	Secondary	1,211	24.4%	26.3%	24.6%	28.2%
	College	1,314	26.4%	25.9%	24.2%	27.6%
	University	1,778	35.8%	34.6%	32.8%	36.4%

Using these socio-demographic factors, certain population groups which were most and least active were explored. More men than women were sufficiently active. In addition, activity levels declined with increasing age. Education level was not significantly associated with meeting the sufficient activity criteria within the 2007 data set. These relationships are summarized in Table 6.3.

Table 6.3: Proportion sufficiently active by age, sex, and education, 2007 PAM

		N	% achieving sufficient amounts of total PA	Lower CI (95%)	Upper CI (95%)
	Total	2,798	56.6%	54.7%	58.5%
Sex	Male	1,373	62.0%	59.2%	64.8%
	Female	1,425	51.4%	48.8%	54.0%
	18 to 24	271	72.1%	65.3%	78.0%
Age	25 to 44	1,127	60.0%	56.9%	63.0%
	45 to 64	1,088	53.4%	50.5%	56.3%
	65 or older	305	43.8%	39.1%	48.5%
	< Secondary	304	49.5%	44.0%	55.1%
Education	Secondary	701	58.8%	54.9%	62.7%
	College	774	57.8%	54.1%	61.5%
	University	996	57.2%	54.0%	60.4%

As mentioned previously, 31.0% of adults reported enough walking to meet the sufficient walking criteria of 60 minutes daily. There were no significant gender differences in the proportions that walk sufficient amounts in the 2007 data set. Walking sufficient amounts generally decreased with increasing age. Fewer adults with less than secondary school education and those with a university education walked sufficient amounts compared to those with a secondary or college education. These relationships are summarized in Table 6.4.

Table 6.4: Proportion that walk sufficient amounts by age, sex, and education, 2007 PAM

		N	% walking sufficient amount	Lower CI (95%)	Upper CI (95%)
	Total	1,490	31.0%	29.1%	32.8%
Sex	Male	688	32.0%	29.3%	34.8%
	Female	802	30.0%	27.6%	32.4%
	18 to 24	148	40.0%	33.2%	47.3%
Age	25 to 44	617	34.5%	31.5%	37.5%
	45 to 64	577	29.2%	26.6%	31.9%
	65 or older	144	20.0%	16.5%	23.9%
	< Secondary	168	24.5%	20.2%	29.4%
Education	Secondary	397	35.9%	31.9%	40.0%
	College	440	35.8%	32.2%	39.5%
	University	476	26.4%	23.7%	29.4%

6.3.2 Individual factors

Some theoretical models, such as a socio-ecological approach are multi-faceted in that they take into account individual factors as well as the physical and social environment when examining changes in behaviour. To this end, a series of research questions in this Chapter determined whether individual factors (including prompted awareness of guidelines, knowledge of the amount of PA that is recommended for health benefits, perceptions about the health related benefits of PA, intention to be active and initial trial behaviours towards becoming more active) vary by population groups.

Awareness of guidelines – Awareness of PA guidelines was determined using recall. Just over one quarter (27.3%) of adults had indicated that they had heard of Canadian PA guidelines when prompted. There were no significant differences with sex and education. Prompted awareness is more prevalent among those who are older (65 years and older) compared to younger adults (18 to 24 years).

Table 6.5: Awareness of guidelines by age, sex, and education, 2007 PAM

		N	Prompted awareness of PA guidelines %, 95% CI	
Sex	Total	1,466	27.3%	25.6-29.1%
	Male	630	26.8%	24.4-29.4%
	Female	836	27.8%	25.6-30.2%
Age	18 to 24	100	22.0%	16.7-28.4%
	25 to 44	542	27.5%	24.8-30.3%
	45 to 64	576	25.9%	23.4-28.4%
	65 or older	243	34.5%	30.2-39.2%
Education	< Secondary	194	28.5%	23.9-33.7%
	Secondary	316	25.2%	21.8-28.9%
	College	368	24.7%	21.7-28.0%
	University	570	30.4%	27.6-33.5%

Knowledge of appropriate guidelines Based on the three questions which assessed participants knowledge of the Canadian PA guidelines (see description earlier in this Chapter), a score for understanding the guidelines was derived if the respondent cited an appropriate combination to yield 1) 7 days of activity per week, for 60 or more minutes per day, at any intensity, or 2) a minimum of 4 days of activity per week for 30 or more minutes per day, at least moderate intensity. Based on this criterion, 56.9% of Canadians were able to cite a combination that met Canadian guidelines. There were no significant variations in the proportion that were aware of the minimum amount of PA needed to meet the PA guidelines by age, sex, and education (see Table 6.6).

Table 6.6: Knowledge of minimum amount of PA to meet guidelines by age, sex, and education, 2007 PAM

		Reported minimum amount of PA meets guide criteria				
		N	Aware of minimum amount of required PA for guidelines	95% CI	Not aware of the minimum amount of PA required	95% CI
Sex	Total	4,952	56.9%	54.9-58.8%	43.1%	41.2-45.1%
	Male	2,169	55.3%	52.3-58.2%	44.7%	41.8-47.7%
	Female	2,783	58.4%	55.8-60.9%	41.6%	39.1-44.2%
Age	18 to 24	381	61.2%	54.0-67.9%	38.8%	32.1-46.0%
	25 to 44	1,842	54.4%	51.3-57.5%	45.6%	42.5-48.7%
	45 to 64	2012	58.0%	55.1-60.9%	42.0%	39.1-44.9%
	65 or older	704	56.1%	51.2-60.8%	43.9%	39.2-48.8%
Education	< Secondary	644	56.6%	51.0-62.1%	43.4%	37.9-49.0%
	Secondary	1,192	58.7%	54.7-62.7%	41.3%	37.3-45.3%
	College	1,303	56.5%	52.7-60.2%	43.5%	39.8-47.3%
	University	1,762	55.3%	52.0-58.5%	44.7%	41.5-48.0%

Beliefs about the benefits of PA - Beliefs about the benefits of PA were assessed through three questions (for preventing heart disease, managing stress, and helping to maintain functional ability with age). The distributions of each of the three questions are described in Table 6.7. Overall, the majority of Canadians agreed very strongly with each of these three beliefs about the benefits of PA.

Table 6.7: Beliefs about the benefits of PA, overall distribution, 2007 PAM

	Regular PA helps to					
	Prevent heart disease		Manage stress		Maintain the ability to do everyday tasks in older age	
	N	Estimate	N	Estimate	N	Estimate
Do not agree (anchor)	35	1.0%	37	1.0%	30	.6%
2	8	.1%	11	.3%	21	.4%
3	32	.6%	49	1.3%	37	.7%
4	89	1.8%	109	2.1%	120	2.7%
5	385	7.8%	508	10.6%	522	11.1%
6	621	12.0%	765	15.3%	907	17.3%
Agree very strongly (anchor)	3835	76.7%	3528	69.4%	3355	67.2%
Total	5005	100.0%	5007	100.0%	4992	100.0%

The internal consistency of the measures was assessed, and given an acceptable reliability of 0.72, the indicators were combined into one score and then further divided into quartiles. Given

the skew of the data towards high belief scores, the third and fourth quartiles were combined. Using the categorical derived score, more women than men held high belief scores (quartile 3 and 4) whereas more men than women held a low belief score (quartile 1). Young adults (age 18 to 24) were least likely to hold high beliefs (quartile 3 and 4) about the benefits of PA. A high belief score (quartile 3 and 4) was associated with higher levels of education whilst a low score (quartile 1) was more prevalent among those with lower levels of education (see Table 6.8).

Table 6.8: Beliefs about the benefits of PA by age, sex, and education, 2007 PAM

		N	Quartile 1 (lowest score) %, 95% CI	Quartile 2, %, 95% CI	Quartile 3 and 4 (highest score) %, 95% CI
Sex	Total	4,974	36.1%, 34.2-38.0	11.4%, 10.2-12.7	52.5%, 50.6-54.5
	Male	2,172	41.5%, 38.6-44.5	11.6%, 9.8-13.7	46.9%, 43.9-49.8
	Female	2,802	31.0%, 28.5-33.5	11.2%, 9.7-12.9	57.8%, 55.2-60.4
Age	18 to 24	381	47.5%, 40.3-54.8	14.1%, 9.8-19.9	38.4%, 31.6-45.7
	25 to 44	1,835	33.6%, 30.8-36.7	12.3%, 10.4-14.5	54.0%, 50.9-57.1
	45 to 64	2,025	32.8%, 30.1-35.7	10.3%, 8.6-12.3	56.8%, 53.9-59.7
	65 or older	720	38.4%, 33.9-43.1	9.5%, 7.2-12.5	52.1%, 47.3-56.8
Education	< Secondary	655	50.3%, 44.8-55.9	11.4%, 8.1-15.8	38.3%, 33.2-43.6
	Secondary	1,201	40.5%, 36.5-44.6	10.3%, 8.0-13.1	49.2%, 45.2-53.3
	College	1,301	32.7%, 29.3-36.4	11.2%, 9.2-13.6	56.0%, 52.3-59.7
	University	1,765	29.5%, 26.6-32.6	12.7%, 10.7-15.1	57.8%, 54.5-61.0

Self-efficacy – Canadians generally held high levels of self-efficacy or confidence that they can perform levels of PA similar to that of Canadian guidelines, as shown in Table 6.9, as roughly 50% were 'very confident'. Based on acceptably reliability and the skew of the distribution of these variables, the two variables were combined into one score and then categorized into quartiles.

Table 6.9: Self-efficacy for regular PA, 2007 PAM

	Level of confidence that respondent can regularly do at least 30 min of moderate PA at least 3 or 4 times a week		Level of confidence that respondent can regularly do 60 min of light PA each day	
	N	%	N	%
1 (Not at all confident)	216	4.6%	308	6.5%
2	575	12.2%	798	16.8%
3	742	15.9%	711	14.1%
4	729	14.3%	676	12.9%
5 (Very confident)	2,715	53.0%	2,479	49.6%
Total	4,977	100.0%	4,972	100.0%

More men than women indicated the highest level of self-efficacy (quartile 4). A greater proportion of young adults (18 to 24 years) reported the highest level of self-efficacy, whereas relatively more older adults (65 years and older) indicated the lowest level (quartile 1). Relatively more adults with less than secondary school education reported the lowest quartile of self-efficacy compared to those with a post-secondary education (see Table 6.10).

Table 6.10: Self-efficacy by age, sex, and education, 2007 PAM

		N	Quartile 1 (lowest score), %, 95% CI	Quartile 2, %, 95% CI	Quartile 3, %, 95% CI	Quartile 4 (highest score), %, 95% CI
	Total	4,942	19.7%, 18.2-21.3	31.0%, 29.2-32.8	9.3%, 8.2-10.5	40.1%, 38.2-42.0
Sex	Male	2,169	17.9%, 15.8-20.2	29.9%, 27.3-32.6	8.6%, 7.1-10.4	43.7%, 40.7-46.6
	Female	2,773	21.4%, 19.3-23.6	32.0%, 29.7-34.5	9.9%, 8.3-11.8	36.7%, 34.2-39.2
Age	18 to 24	381	12.2%, 8.3-17.7	24.9%, 19.3-31.5	11.7%, 7.5-18.0	51.1%, 43.9-58.3
	25 to 44	1,833	19.2%, 16.8-21.9	30.7%, 27.9-33.6	9.7%, 8.1-11.6	40.4%, 37.4-43.5
	45 to 64	2,009	20.2%, 17.9-22.7	32.7%, 30.0-35.6	8.2%, 6.7-9.9	38.9%, 36.1-41.8
	65 or older	706	25.9%, 21.9-30.3	33.0%, 28.6-37.7	8.7%, 6.4-11.8	32.4%, 28.0-37.1
Education	< Secondary	636	26.1%, 21.5-31.2	33.3%, 28.2-38.8	7.1%, 4.1-11.8	33.6%, 28.3-39.3
	Secondary	1,199	21.4%, 18.4-24.8	28.4%, 24.9-32.1	9.3%, 7.0-12.3	40.9%, 36.9-45.0
	College	1,292	17.2%, 14.5-20.3	30.3%, 26.9-33.9	10.2%, 8.3-12.6	42.2%, 38.6-46.0
	University	1,763	17.7%, 15.4-20.3	32.3%, 29.4-35.4	9.5%, 7.8-11.5	40.5%, 37.3-43.7

Perceived Behavioural Control – Canadians generally stated that they had considerable ("a lot") or complete control over their ability to be active, as shown in Table 6.11, as two out of five Canadians indicated 'complete' control and a further 26.1% said that they have 'a lot' of control.

Table 6.11: Perceived behavioural control, 2007 PAM

	N	%
1 (No control)	96	1.9%
2 (A bit)	304	5.7%
3 (A moderate amount)	1,295	26.5%
4 (A lot)	1,246	26.1%
5 (Complete control)	2,055	39.9%

Perceived behavioural control (PBC) was categorized into quartiles based on the distribution of the score. Although a high degree of PBC (quartile 4) was not associated with either sex or education, it increased significantly with increasing age (See Table 6.12). Furthermore, the proportion that cited a moderate amount of PBC (quartile 3) decreased with increasing age. In addition, the proportion citing a moderate amount of PBC (quartile 3) increased with increasing education. More women than men cited the lowest levels of PBC (quartile 1).

Table 6.12: Perceived behavioural control by age, sex, and education, 2007 PAM

		N	Quartile 1 (lowest score), %,95% CI	Quartile 2, %, 95% CI	Quartile 3, %, 95% CI	Quartile 4 (highest score), %, 95% CI
	Total	4,996	7.6%, 6.7-8.6	26.4%, 24.7-28.2	26.1%, 24.3-27.9	39.9%, 38.0-41.9
Sex	Male	2,193	6.1%, 4.9-7.4	25.5%, 23.0-28.2	27.7%, 25.0-30.5	40.8%, 37.9-43.7
	Female	2,803	9.1%, 7.7-10.6	27.3%, 25.0-29.7	24.6%, 22.4-26.9	39.1%, 36.6-41.7
Age	18 to 24	382	-	28.7%, 22.5-35.8	36.5%, 29.8-43.8	29.9%, 23.7-37.0
	25 to 44	1,845	8.2%, 6.8-10.0	29.1%, 26.3-31.9	29.2%, 26.4-32.2	33.5%, 30.6-36.5
	45 to 64	2,031	7.6%, 6.2-9.3	25.4%, 22.9-28.1	23.6%, 21.2-26.2	43.4%, 40.5-46.3
	65 or older	725	8.5%, 6.3-11.3	20.9%, 17.3-25.0	16.4%, 13.2-20.2	54.2%, 49.4-58.9
Education	< Secondary	653	14.3%, 10.8-18.6	32.3%, 27.3-37.7	17.7%, 13.4-22.9	35.8%, 30.7-41.3
	Secondary	1,204	8.4%, 6.6-10.6	26.0%, 22.6-29.7	23.8%, 20.4-27.5	41.8%, 37.8-45.9
	College	1,309	7.0%, 5.5-9.0	26.6%, 23.3-30.2	27.7%, 24.3-31.3	38.7%, 35.2-42.3
	University	1,776	4.9%, 3.8-6.3	24.1%, 21.4-27.0	30.1%, 27.2-33.1	41.0%, 37.8-44.2

- Data suppressed due to insufficient cell size.

Intention to be active –Canadians were generally positive about their intentions to be active in the near future, as shown in Table 6.13. Very few adults (12%) had a low degree of intention to be active (4 or less on a 7 point scale).

Table 6.13: Intention to be active, overall distribution, 2007 PAM

	N	%
1 (No intention at all)	61	1.2%
2	48	0.9%
3	132	2.9%
4	340	7.1%
5	931	18.7%
6	895	18.4%
7 (Fully intend to be active)	2,574	50.8%

The intention variable was categorized into quartiles (due to the skew of the data quartile 3 and 4 are combined). When examining the categorized intention variable by socio-demographic factors, there were no significant differences by sex or age. A greater proportion of adults with the lowest level of education reported the lowest quartile of intention compared to those with a post-secondary education (see Table 6.14).

Table 6.14: Intention to be active by age, sex, and education, 2007 PAM

		N	Quartile 1 (lowest score) %, 95% CI	Quartile 2 %, 95% CI	Quartile 3 and 4 (highest score) %, 95% CI
Sex	Total	4,981	30.7%, 29.0-32.6	18.4%, 16.9-20.0	50.8%, 48.9-52.8
	Male	2,182	31.4%, 28.7-34.1	17.7%, 15.5-20.1	51.0%, 48.0-53.9
	Female	2,799	30.2%, 27.8-32.6	19.1%, 17.1-21.3	50.7%, 48.1-53.3
Age	18 to 24	384	26.1%, 20.4-32.8	25.1%, 19.6-31.7	48.8%, 41.6-56.0
	25 to 44	1,847	29.5%, 26.7-32.4	18.4%, 16.1-21.0	52.1%, 49.0-55.2
	45 to 64	2,020	32.3%, 29.6-35.1	17.0%, 14.9-19.4	50.7%, 47.8-53.6
	65 or older	718	34.4%, 30.1-39.0	15.8%, 12.4-19.8	49.8%, 45.1-54.6
Education	< Secondary	649	39.4%, 34.2-44.9	14.8%, 11.1-19.4	45.8%, 40.1-51.5
	Secondary	1,203	34.4%, 30.7-38.3	17.6%, 14.7-20.9	48.0%, 44.0-52.1
	College	1,304	29.0%, 25.7-32.6	19.7%, 16.8-22.9	51.3%, 47.5-55.0
	University	1,771	26.1%, 23.3-29.0	19.4%, 17.0-22.2	54.5%, 51.2-57.7

Steps towards initial behavioural change– Canadians initiated several actions or behaviours with a view to becoming more active, including seeking information on PA through reading articles (60.8%), or seeking information from acquaintances (44.7%) or health professionals (29.4%), or information on activity opportunities in the community (37.0%). In addition, Canadians also performed more active behaviours including trying or observing a class (53.2%) or making changes in their usual routine (72.5%).

When examining these factors by socio-demographic indicators (see Table 6.15a and Table 6.15b), more women than men had attempted to become more active, with the exception of seeking information on opportunities in their community (where there were no sex-related differences). Generally speaking, the proportion of adults that sought advice about PA from friends or family members, observed or tried a PA class, or made active choices in their work routine decreased with increasing age. Fewer older adults sought information on community opportunities compared to adults aged 25 to 64 years. There was also a relationship between education of the respondent and their attempts to become more active. A greater proportion of adults with a university education made active choices at work, observed or tried a PA class, sought information on opportunities in their community, or read articles on PA compared to those with secondary or less education. A greater proportion of adults with a post-secondary education sought advice from friends and family compared to those with less than a secondary school education.

Table 6.15a: Initial behaviour change by age, sex, and education, 2007 PAM

	Read articles (n=3,147) %, 95% CI		Sought advice friends, family (n=2,312) %, 95% CI		Sought advice from health professionals (n=1,486) %, 95% CI	
Sex						
Total	60.8%	58.9-62.7	44.7%	42.8-46.7	29.4%	27.6-31.2
Male	52.6%	49.6-55.5	38.8%	35.9-41.7	25.4%	22.9-28.1
Female	68.7%	66.2-71.0	50.4%	47.8-53.0	33.1%	30.7-35.6
Age						
18 to 24	55.8%	48.5-62.8	58.3%	51.0-65.3	28.1%	21.8-35.3
25 to 44	60.3%	57.2-63.3	53.1%	50.0-56.2	26.4%	23.8-29.3
45 to 64	60.7%	57.8-63.5	39.8%	37.0-42.6	31.2%	28.6-33.9
65 or older	66.2%	61.6-70.5	26.0%	21.9-30.5	33.0%	28.7-37.6
Education						
< Secondary	48.5%	42.9-54.1	29.7%	24.9-35.0	28.4%	23.8-33.5
Secondary	56.0%	51.9-60.0	44.8%	40.7-48.9	30.6%	26.9-34.6
College	62.4%	58.6-66.0	50.4%	46.7-54.2	28.8%	25.5-32.3
University	67.7%	64.6-70.7	46.4%	43.2-49.6	29.2%	26.3-32.2

Table 6.15b: Initial behaviour change by age, sex, and education, 2007 PAM

	Observe or tried class (n=2,589) %, 95% CI		Info on community opportunities (n=1,889) %, 95% CI		Made active choices (n=3,464) %, 95% CI	
Sex						
Total	53.2%	51.3-55.2	37.0%	35.1-39.0	72.5%	70.7-74.3
Male	47.2%	44.3-50.2	34.7%	31.9-37.7	67.8%	65.0-70.6
Female	58.9%	56.3-61.5	39.2%	36.7-41.8	77.0%	74.7-79.1
Age						
18 to 24	67.6%	60.5-74.0	35.9%	29.2-43.1	81.1%	74.7-86.1
25 to 44	56.6%	53.5-59.7	41.8%	38.7-44.9	71.5%	68.5-74.3
45 to 64	50.3%	47.4-53.3	37.1%	34.3-40.0	73.8%	71.1-76.4
65 or older	39.7%	35.1-44.6	27.5%	23.3-32.2	63.7%	58.6-68.5
Education						
< Secondary	39.5%	34.0-45.4	25.5%	20.7-31.0	64.3%	58.4-69.7
Secondary	50.2%	46.1-54.3	34.1%	30.2-38.2	68.7%	64.7-72.4
College	55.2%	51.4-58.9	37.2%	33.6-40.8	74.3%	71.0-77.4
University	59.1%	55.9-62.3	43.6%	40.4-46.9	77.0%	74.1-79.6

6.3.3 Factors related to the social environment

For the purpose of this thesis, the social environment related PA and walking behaviours is measured through social norms, which examined respondents' perceptions about their social network and their walking behaviour. As per Tables 6.16, 6.17, 6.18 participants were asked whether most of their family members, friends, or most people that they know walk on a regular basis (for at least 30 minutes almost every day). As such, this Chapter determined whether perceptions about the availability of a supportive social environment varies by socio-demographic groups (that is, by sex, age, and education).

Table 6.16: Social norms (most of family members walk at least 30 minutes almost daily), 2007 PAM

	N	%
Strongly agree	936	20.7%
Agree	1,836	37.6%
Unsure	578	11.2%
Disagree	1,148	24.0%
Strongly disagree	344	6.5%
Total	4,842	100.0%

Table 6.17: Social norms (most friends walk at least 30 minutes almost daily), 2007 PAM

	N	%
Strongly agree	524	12.6%
Agree	1,524	31.4%
Unsure	1,280	26.6%
Disagree	1,243	23.4%
Strongly disagree	290	6.1%
Total	4,861	100.0%

Table 6.18: Social norms (most people known walk at least 30 minutes daily), 2007 PAM

	N	%
Strongly agree	436	9.6%
Agree	1,534	32.1%
Unsure	1,159	24.8%
Disagree	1,467	28.4%
Strongly disagree	269	5.2%
Total	4,865	100.0%

Based on the scores from these three questions, the responses were combined into one derived score and then divided into quartiles (quartile 1 represents the lowest score and quartile 4 represents the highest score). Although no gender differences exist, a greater proportion of young adults (18 to 24 years) and those with less than a secondary level of education fell within the highest quartile for social norms score compared to those between 25 and 64 years, and those with a university education respectively (see Table 6.19).

Table 6.19: Social norms by age, sex, and education, 2007 PAM

		N	Quartile 1, (lowest score) %, 95% CI	Quartile 2 %, 95% CI	Quartile 3 %, 95% CI	Quartile 4, (highest score) %,95% CI
	Total	4,722	21.5%, 19.9-23.1	21.0%, 19.4-22.6	27.9%, 26.1-29.8	29.6%, 27.7-31.5
Sex	Male	2,073	23.0%, 20.6-25.6	22.0%, 19.7-24.5	26.4%, 23.7-29.2	28.7%, 25.9-31.6
	Female	2,649	20.1%, 18.1-22.2	20.0%, 18.0-22.2	29.4%, 27.0-32.0	30.5%, 28.0-33.1
Age	18 to 24	378	15.1%, 10.6-21.1	14.2%, 10.3-19.2	31.2%, 24.6-38.6	39.5%, 32.6-46.9
	25 to 44	1,796	22.2%, 19.7-24.9	21.7%, 19.2-24.5	27.5%, 24.7-30.4	28.6%, 25.9-31.6
	45 to 64	1,913	25.5%, 22.9-28.2	22.4%, 20.1-25.0	25.6%, 23.1-28.3	26.5%, 23.9-29.3
	65 or older	621	17.3%, 14.0-21.3	22.6%, 18.6-27.1	30.7%, 26.1-35.6	29.4%, 24.8-34.5
Education	< Secondary	603	15.5%, 11.8-20.2	19.0%, 15.1-23.6	30.6%, 25.3-36.5	34.9%, 29.4-40.9
	Secondary	1,136	19.5%, 16.5-23.0	20.9%, 18.0-24.3	25.1%, 21.6-29.0	34.4%, 30.4-38.7
	College	1,248	21.8%, 19.0-25.0	20.5%, 17.6-23.8	28.5%, 25.1-32.2	29.1%, 25.7-32.7
	University	1,688	24.9%, 22.1-27.8	21.9%, 19.3-24.7	28.9%, 25.9-32.0	24.4%, 21.6-27.4

6.3.4 Factors related to the physical environment

One aspect of the socio-ecological model involves the association of the physical environment to PA and walking behaviours. As such, a key research question in this Chapter determined whether perceptions about the availability of a supportive physical environment vary by socio-demographic groups (by sex, age, and education).

Neighbourhood environment walkability – A subset of questions from the Neighborhood Environment Walkability Scale (NEWS) was used in this research to determine perceptions about the availability of a supportive physical environment for walking in the neighbourhood. Details about the questions used are summarized in the Methods section above and in more detail within Chapter Three (Methods).

To assess residential density (see Table 6.20), respondents were asked about the primary type of dwelling in the neighbourhood. Most respondents reported that they live in neighbourhoods of primarily single-family, detached homes, followed by those who indicated a mixture of single family dwellings, town or row houses, and apartments or condominiums, a mix of town or row houses

and low rise apartments, followed by those who indicated mid-rise or high-rise apartments as the primary dwelling in the neighbourhood.

Table 6.20: Main type of dwelling in the neighbourhood, overall, 2007 PAM

	Estimate	95% Confidence Interval		N
		Lower	Upper	
Detached single-family residences	69.8%	68.0%	71.6%	3,450
Townhouses, row houses, apartments, or condos of 2-3 storeys	8.1%	7.0%	9.4%	383
Mix of single-family residences and townhouses, row houses, apartments or condos	14.8%	13.5%	16.1%	850
Apartments or condos of 4-12 stories	2.5%	2.0%	3.2%	119
Apartments or condos of more than 12 stories	1.1%	.8%	1.6%	47
Don't know	3.6%	2.8%	4.5%	165
Total	100.0%	100.0%	100.0%	5,014

The type of residential dwelling did not differ by gender or education level; however, similar to findings in Chapter Five, the type of residential dwelling did vary with age (see Table 6.21). Compared to those in other age groups, living in townhouses, row houses or low rise apartment buildings was most prevalent among young adults, whereas living in single detached housing was most prevalent among those aged 45 to 64 years.

Table 6.21: Main type of dwelling by age, sex, and education, 2007 PAM

		Detached single-family housing (n=3,450)	Townhouses, row houses, apts or condos of 2-3 stories (n=383)	Mix of single-family, town or row houses, apts or condos (n=850)	Mid-rise or high-rise apartment (n=166)
Sex	Total	72.5%, 70.7-74.2	8.4%, 7.3-9.7	15.3%, 14.0-16.7	3.8%, 3.1-4.6
	Male	73.7%, 70.9-76.2	9.1%, 7.3-11.2	13.9%, 12.0-16.0	3.4%, 2.6-4.4
	Female	71.3%, 68.9-73.6	7.8%, 6.5-9.4	16.7%, 14.9-18.6	4.2%, 3.2-5.4
Age	18 to 24	63.0%, 55.7-69.8	16.4, 11.3-23.3	16.0%, 11.7-21.4	4.6%, 2.6-8.2
	25 to 44	70.7%, 67.8-73.4	8.5%, 6.9-10.3	17.2%, 15.0-19.6	3.6%, 2.6-5.0
	45 to 64	79.2%, 76.7-81.4	5.7%, 4.5-7.3	13.5%, 11.7-15.5	1.6%, 1.1-2.5
	65 or older	70.4%, 65.9-74.6	7.4%, 5.3-10.3	14.5%, 11.4-18.1	7.7%, 5.6-10.5
Education	< Secondary	70.2%, 64.4-75.4	13.0%, 9.0-18.5	10.7%, 7.9-14.3	6.1%, 3.9-9.7
	Secondary	71.0%, 67.2-74.6	8.1%, 6.0-10.8	16.5%, 13.7-19.7	4.4%, 3.0-6.3
	College	73.0%, 69.5-76.2	7.9%, 5.9-10.4	16.3%, 13.8-19.2	2.8%, 1.8-4.2
	University	74.1%, 71.2-76.8	7.3%, 5.7-9.2	15.4%, 13.3-17.8	3.2%, 2.3-4.5

In addition, respondents were also asked to rate their level of agreement with the availability of different facilities in the neighbourhood (within a 10-15 minute walk):

- many shops, stores, markets or other places to buy things they need are within easy walking distance of home;
- a 10-15 minute walk to a transit stop (such as bus, train, trolley, tram) from their home;
- there are facilities to bicycle in or near my neighbourhood, such as special lanes, separate paths or trails, or shared use paths for cycles and pedestrians, and
- neighbourhood has several free or low cost recreation facilities, such as parks, walking trails, bike paths, recreation centres, playgrounds, public swimming pools.

They were also asked to rate their level of agreement that:

- the crime rate in the neighbourhood made it unsafe to go on walks at night, and
- too much traffic on the streets that it makes it difficult or unpleasant to walk in their neighbourhood.

The distribution of these variables (see Table 6.22) were generally skewed towards the extreme values (strongly agree or disagree). Consequently, the values were categorized into “agree” (combining agree and strongly agree) and “disagree” (combining disagree, strongly disagree, and

does not apply). Given the "does not apply" category generally represented less than 3% of the distribution, these were incorporated into a "disagree" category, where appropriate (if 3% or higher, the 'does not apply' category was retained).

Table 6.22: Distribution of NEWS items, 2007 PAM

	N	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Does not apply	Don't know/ Refused
Shops, stores, markets or places nearby	5,024	26.6%	12.8%	23.4%	34.2%	2.2%	0.8%
Transit stop nearby	5,024	27.0%	4.9%	10.2%	52.0%	4.8%	1.1%
Sidewalks on most of the streets in neighbourhood	5,024	25.7%	4.8%	9.8%	55.8%	3.5%	0.4%
Facilities to bicycle in neighbourhood	5,024	28.2%	8.1%	18.1%	41.3%	2.6%	1.7%
Neighbourhood has several free or low cost recreation facilities	5,024	15.5%	9.3%	26.3%	46.2%	1.7%	1.1%
Neighbourhood crime rate makes it unsafe to walk	5,024	57.2%	19.7%	11.4%	8.7%	1.2%	1.7%
Traffic on the streets make it difficult or unpleasant to walk in neighbourhood	5,024	53.7%	22.1%	14.2%	8.1%	1.2%	0.8%

When examining the NEWS factors by key socio-demographic factors (see Table 6.23a), there were essentially no sex-related differences, with the exception that more women than men agreed to some extent that the crime rate in their neighbourhood made it unsafe to go on walks at night (24.9% for women agreeing versus 16.5% for men). Table 6.23b indicated that relatively more adults aged 18 to 44 years compared to those aged 45 to 64 years agreed to some extent that there were sidewalks on most streets in the neighbourhood. Older adults (65 years and older) were most likely to agree to some extent that the crime rate in the neighbourhood made it unsafe to go on walks at night. Moreover, compared to those with post-secondary education, fewer adults with a low level of education (less than secondary school) agreed to some extent that transit stops existed nearby. Similarly, a greater proportion of university educated individuals indicated that there were sidewalks on most streets compared to adults with less than secondary school; however this latter group was more likely to agree that crime rate or traffic made it unsafe to walk.

Table 6.23a: NEWS items overall and by sex, 2007 PAM

	N	Estimate 95% CI	Sex	
			Male % 95% CI	Female % 95% CI
Many shops, stores, other places within walking distance				
Disagree*	2,057	40.7%, 38.7-42.6	41.3%, 38.3-44.3	40.1%, 37.5-42.7
Agree	2,808	59.3%, 57.4-61.3	58.7%, 55.7-61.7	59.9%, 57.3-62.5
Transit stop 10-15 minute walk from home				
Disagree	1,801	32.3%, 30.5-34.1	31.1%, 28.5-33.9	33.4%, 31.0-35.9
Agree	2,828	62.9%, 61.0-64.7	64.6%, 61.8-67.3	61.2%, 58.7-63.7
Does not apply	329	4.8%, 4.1-5.6	4.3%, 3.3-5.4	5.3%, 4.4-6.5
There are sidewalks on most of the streets in my neighbourhood				
Disagree	1,654	30.6%, 28.8-32.4	31.6%, 28.9-34.5	29.6%, 27.2-32.0
Agree	3,151	65.9%, 64.0-67.8	64.6%, 61.7-67.4	67.2%, 64.7-69.6
Does not apply	197	3.5%, 2.9-4.2	3.8%, 2.9-4.9	3.3%, 2.5-4.3
There are facilities to bicycle in neighbourhood				
Disagree*	1,998	37.9%, 36.0-39.8	36.1%, 33.3-39.0	39.6%, 37.0-42.2
Agree	2,789	62.1%, 60.2-64.0	63.9%, 61.0-66.7	60.4%, 57.8-63.0
Neighbourhood has several free or low cost recreation facilities				
Disagree*	1,346	25.4%, 23.8-27.2	24.9%, 22.4-27.6	26.0%, 23.8-28.3
Agree	3,524	74.6%, 72.8-76.2	75.1%, 72.4-77.6	74.0%, 71.7-76.2
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree*	3,790	79.3%, 77.7-80.8	83.5%, 81.4-85.5	75.1%, 72.9-77.3
Agree	1,089	20.7%, 19.2-22.3	16.5%, 14.5-18.6	24.9%, 22.7-27.1
Too much traffic makes it difficult or unpleasant to walk				
Disagree*	3,822	77.3%, 75.6-78.9	77.7%, 75.2-80.1	76.9%, 74.6-79.0
Agree	1,092	22.7%, 21.1-24.4	22.3%, 19.9-24.8	23.1%, 21.0-25.4

* includes “does not apply”

Table 6.23b: NEWS items by age and education, 2007 PAM

	Age				Education			
	18 to 24 %, 95% CI	25 to 44 %, 95% CI	45 to 64 %, 95% CI	65 or older %, 95% CI	< Secondary %, 95% CI	Secondary %, 95% CI	College %, 95% CI	University %, 95% CI
Many shops, stores, other places within walking distance								
Disagree"	37.1%, 30.2-44.5	38.3%, 35.3-41.3	43.6%, 40.7-46.6	43.0%, 38.3-47.9	44.9%, 39.1-50.7	39.4%, 35.5-43.5	39.5%, 35.8-43.3	40.6%, 37.5-43.8
Agree	62.9%, 55.5-69.8	61.7%, 58.7-64.7	56.4%, 53.4-59.3	57.0%, 52.1-61.7	55.1%, 49.3-60.9	60.6%, 56.5-64.5	60.5%, 56.7-64.2	59.4%, 56.2-62.5
Transit stop 10-15 minute walk from home								
Disagree	33.3%, 26.8-40.6	31.2%, 28.4-34.0	33.5%, 30.8-36.3	31.6%, 27.3-36.3	40.6%, 35.1-46.3	34.5%, 30.8-38.5	31.9%, 28.6-35.5	28.1%, 25.4-31.1
Agree	66.3%, 59.1-72.9	65.1%, 62.2-67.9	60.3%, 57.4-63.1	60.4%, 55.7-65.0	51.5%, 45.8-57.1	59.9%, 55.9-63.8	63.0%, 59.3-66.5	69.2%, 66.2-72.1
Does not apply	-	3.7%, 2.8-5.0	6.2%, 5.0-7.7	7.9%, 5.8-10.7	7.9%, 5.7-11.0	5.6%, 4.2-7.4	5.1%, 3.8-6.9	2.6%, 1.9-3.6
There are sidewalks on most of the streets in my neighbourhood								
Disagree	28.0%, 21.5-35.5	28.1%, 25.4-31.0	35.6%, 32.9-38.5	27.8%, 23.7-32.3	34.4%, 29.2-40.1	30.8%, 27.0-34.8	29.2%, 25.9-32.6	29.9%, 27.0-32.9
Agree	71.6%, 64.1-78.1	69.2%, 66.3-71.9	60.5%, 57.6-63.3	65.3%, 60.6-69.7	59.3%, 53.7-64.8	65.3%, 61.2-69.1	67.7%, 64.1-71.0	68.0%, 64.9-70.9
Does not apply	-	2.7%, 1.9-3.9	3.8%, 2.9-5.1	6.9%, 4.9-9.7	6.2%, 4.2-9.3	4.0%, 2.8-5.6	3.2%, 2.2-4.6	2.1%, 1.4-3.3
There are facilities to bicycle in neighbourhood								
Disagree"	37.4%, 30.5-44.9	37.3%, 34.3-40.4	39.9%, 37.0-42.7	35.6%, 31.2-40.3	41.2%, 35.6-47.1	38.9%, 34.9-43.1	39.0%, 35.4-42.7	35.4%, 32.4-38.5
Agree	62.6%, 55.1-69.5	62.7%, 59.6-65.7	60.1%, 57.3-63.0	64.4%, 59.7-68.8	58.8%, 52.9-64.4	61.1%, 56.9-65.1	61.0%, 57.3-64.6	64.6%, 61.5-67.6
Neighbourhood has several free or low cost recreation facilities								
Disagree"	25.9%, 20.0-32.8	22.9%, 20.4-25.6	27.9%, 25.3-30.5	25.7%, 21.8-30.1	29.3%, 24.3-34.8	27.4%, 23.9-31.2	25.4%, 22.3-28.7	22.6%, 20.1-25.4
Agree	74.1%, 67.2-80.0	77.1%, 74.4-79.6	72.1%, 69.5-74.7	74.3%, 69.9-78.2	70.7%, 65.2-75.7	72.6%, 68.8-76.1	74.6 71.3-77.7	77.4%, 74.6-79.9
Neighbourhood crime rate makes it unsafe to go on walks at night								
Disagree"	85.8%, 80.8-89.7	80.2%, 77.6-82.5	79.6%, 77.1-81.9	71.4%, 66.9-75.6	67.6%, 62.3-72.5	79.3%, 76.1-82.2	79.6%, 76.5-82.4	83.1%, 80.6-85.4
Agree	14.1%, 10.3-19.2	19.8%, 17.5-22.4	20.4%, 18.1-22.9	28.6%, 24.4-33.1	32.4%, 27.5-37.7	20.7%, 17.8-23.9	20.4%, 17.6-23.5	16.9%, 14.6-19.4
Too much traffic makes it difficult or unpleasant to walk								
Disagree"	80.7%, 74.7-85.6	76.6%, 73.8-79.1	79.0%, 76.5-81.3	72.1%, 67.4-76.4	69.2%, 63.7-74.2	76.1%, 72.5-79.3	80.4%, 77.4-83.1	78.7%, 75.8-81.3
Agree	19.3%, 14.4-25.3	23.4%, 20.9-26.2	21.0%, 18.7-23.5	27.9%, 23.6-32.6	30.8%, 25.8-36.3	23.9%, 20.7-27.5	19.6%, 16.9-22.6	21.3%, 18.7-24.2

- Data suppressed due to insufficient cell size.

6.3.5 Associations between individual factors, social factors and the physical environment and physical activity and walking

One research question in this Chapter asked whether sufficient activity and sufficient walking differ according to individual factors and the social environment. Table 6.24a and Table 6.24b outline the relationships between the individual and social factors with sufficient walking and activity. Prompted awareness of guidelines and knowledge about the amount of PA required to meet guidelines was associated with being sufficiently active. Similarly, knowledge of the amount of PA required was also associated with meeting the walking criteria (all domain walking and highest quartile of recreational walking).

A greater proportion of adults with the highest belief score (quartile 3 and 4) were sufficiently active and met the highest quartile of recreational walking. A greater proportion of adults with the highest self-efficacy and intention scores met the sufficient activity criterion, and the all-domain walking criterion, and highest recreational walking quartile. Similarly, higher levels of perceived behavioural control were associated with sufficient activity and recreational walking. In terms of trial behaviours, a greater proportion of adults who sought information on PA from friends and families, sought information in the community, tried or observed a PA class, or made active choices at work, were sufficiently active. Moreover, a greater proportion of adults who made active choices in their usual routine at work met each of the walking criteria. Other relationships also exist with initial behaviour changes, such as:

- a greater proportion of adults who read articles on PA or sought out information on PA in the community reported the highest quartile of recreational walking;
- relatively more adults who sought information on PA from family and friends met the highest quartile for walking for transport;
- a greater proportion of adults who tried or observed a PA class met the highest quartile of both recreational walking and walking for transport; and,
- relatively more adults who sought information on community activities met the highest quartile of recreational walking.

Regarding the social environment, a greater proportion of adults reporting a higher score for social norms met the sufficient activity and all-domain walking criteria.

Table 6.24a: Prevalence rates of sufficient PA and walking by individual and social factors, 2007 PAM

	N	Physical activity		All-domain walking	
		Insufficient	Sufficient	Insufficient	Sufficient
		%, 95% CI	%, 95% CI	%, 95% CI	%, 95% CI
Prompted awareness of guidelines					
Not aware of guidelines	3,451	76.2%, 73.7-78.5	70.0%, 67.5-72.3	73.4%, 71.4-75.4	71.0%, 67.6-74.1
Aware of guidelines	1,466	23.8%. 21.5-26.3	30.0%, 27.7-32.5	26.6% 24.6-28.6	29.0%, 25.9-32.4
Knowledge of PA for guidelines					
Does not have knowledge	1,970	48.7%, 45.8-51.6	39.0%, 36.4-41.6	45.7%, 43.4-48.0	37.6%, 34.1-41.1
Has knowledge of amount of PA for guidelines	2,982	51.3%, 48.4-54.2	61.0%, 58.4-63.6	54.3%, 52.0-56.6	62.4%, 58.9-65.9
Beliefs about the benefits of PA					
Q1 (lowest)	1,749	39.5%, 36.7-42.4	33.5%, 30.9-36.1	36.0%, 33.8-38.3	36.2%, 32.7-39.8
Q2	575	11.5%, 9.7-13.5	11.3%, 9.7-13.1	11.2%, 9.8-12.8	11.7%, 9.6-14.3
Q3 and 4 (highest)	2,650	49.0%, 46.1-51.9	55.2%, 52.5-57.9	52.8%, 50.4-55.1	52.0%, 48.4-55.6
Self-efficacy					
Q1 (lowest)	904	34.2%, 31.5-37.1	8.7%, 7.4-10.2	24.4%, 22.5-26.5	9.2%, 7.4-11.5
Q2	1,555	37.4%, 34.6-40.2	26.1%, 23.9-28.5	33.9%, 31.8-36.2	24.4%, 21.5-27.5
Q3	459	6.7%, 5.5-8.2	11.2%, 9.5-13.2	8.6%, 7.3-10.0	10.9%, 8.7-13.4
Q4 (highest)	2,024	21.7%, 19.4-24.2	54.0%, 51.3-56.6	33.1%, 30.9-35.3	55.5%, 51.9-59.0
Social norms					
Q1 (lowest)	1,091	26.4%, 24.0-29.1	17.8%, 15.8-19.9	25.8%, 23.8-28.0	12.0%, 10.0-14.3
Q2	1,023	23.0%, 20.6-25.6	19.5%, 17.5-21.6	22.7%, 20.8-24.7	17.3%, 14.8-20.1
Q3	1,276	27.2%, 24.6-30.1	28.4%, 26.0-31.0	27.9%, 25.8-30.2	27.9%, 24.7-31.4
Q4 (highest)	1,332	23.3%, 20.8-26.1	34.3%, 31.7-37.0	23.6%, 21.5-25.7	42.8%, 39.2-46.6
Perceived behavioural control					
Q1 (lowest)	400	11.8%, 10.1-13.6	4.4%, 3.5-5.5	8.8%, 7.7-10.1	4.8%, 3.6-6.4
Q2	1,295	31.1%, 28.4-33.9	22.8%, 20.7-25.1	26.8%, 24.7-28.9	25.6%, 22.6-28.8
Q3	1,246	21.6%, 19.3-24.1	29.5%, 27.1-32.0	25.4%, 23.3-27.5	27.7%, 24.5-31.1
Q4 (highest)	2,055	35.5%, 32.8-38.3	43.3%, 40.7-45.9	39.1%, 36.8-41.3	41.9%, 38.4-45.5
Intention					
Q1 (lowest)	1,512	47.1%, 44.2-50.0	18.4%, 16.4-20.5	36.6%, 34.4-38.9	17.8%, 15.3-20.5
Q2	895	18.7%, 16.5-21.1	18.2%, 16.2-20.4	18.0%, 16.3-19.9	19.3%, 16.5-22.4
Q3 and 4 (highest)	2,574	34.2%, 31.5-37.0	63.5%, 60.9-66.0	45.4%, 43.1-47.7	63.0%, 59.4-66.4
Initial behaviour change					
Did not read articles	1,839	41.7%, 38.9-44.6	37.2%, 34.7-39.9	38.3%, 36.0-40.6	41.1%, 37.6-44.8
Read articles	3,147	58.3%, 55.4-61.1	62.8%, 60.1-65.3	61.7%, 59.4-64.0	58.9%, 55.2-62.4
Did not seek info	2,659	59.9%, 57.0-62.7	51.7%, 49.0-54.4	57.0%, 54.7-59.3	51.4%, 47.7-55.0
Sought info, friends/family	2,312	40.1%, 37.3-43.0	48.3%, 45.6-51.0	43.0%, 40.7-45.3	48.6%, 45.0-52.3
Did not seek info	3,485	71.9%, 69.3-74.3	69.7%, 67.1-72.1	70.1%, 67.9-72.2	71.9%, 68.4-75.1
Sought info, health professional	1,486	28.1%, 25.7-30.7	30.3%, 27.9-32.9	29.9%, 27.8-32.1	28.1%, 24.9-31.6
Did not try or observe class	2,343	53.5%, 50.6-56.4	41.6%, 39.0-44.3	47.6%, 45.3-50.0	44.9%, 41.3-48.5
Tried or observed class	2,589	46.5%, 43.6-49.4	58.4%, 55.7-61.0	52.4%, 50.0-54.7	55.1%, 51.5-58.7
Did not seek info	3,007	66.4%, 63.6-69.2	60.3%, 57.6-62.9	64.2%, 61.9-66.5	60.1%, 56.5-63.6
Sought community activity info	1,889	33.6%, 30.8-36.4	39.7%, 37.1-42.4	35.8%, 33.5-38.1	39.9%, 36.4-43.5
Did not change routine	1,261	32.9%, 30.1-35.7	23.4%, 21.2-25.8	30.6%, 28.4-32.8	20.6%, 17.9-23.7
Made active choices	3,464	67.1%, 64.3-69.9	76.6%, 74.2-78.8	69.4%, 67.2-71.6	79.4%, 76.3-82.1

Table 6.24b: Prevalence rates of walking by individual and social factors, 2007 PAM

	Recreational walking		Transportation walking	
	Lowest quartile	Highest quartile	Lowest quartile	Highest quartile
	%, 95% CI	%, 95% CI	%, 95% CI	%, 95% CI
Prompted awareness of guidelines				
Not aware of guidelines	73.3%, 69.6-76.8	69.8%, 65.4-73.9	72.5%, 69.7-75.1	70.7%, 65.6-75.4
Aware of guidelines	26.7%, 23.2-30.4	30.2%, 26.1-34.6	27.5%, 24.9-30.3	29.3%, 24.6-34.4
Knowledge of PA for guidelines				
Does not have knowledge	49.6%, 45.4-53.7	32.8%, 28.7-37.3	44.6%, 41.6-47.7	38.4%, 33.4-43.7
Has knowledge of amount of PA for guidelines	50.4%, 46.3-54.6	67.2%, 62.7-71.3	55.4%, 52.3-58.4	61.6%, 56.3-66.6
Beliefs about the benefits of PA				
Q1 (lowest)	41.6%, 37.5-45.8	29.5%, 25.2-34.1	36.5%, 33.4-39.6	31.2%, 26.5-36.3
Q2	12.2%, 9.6-15.4	9.1%, 6.8-12.0	9.2%, 7.5-11.1	14.2%, 10.9-18.3
Q3 and 4 (highest)	46.3%, 42.1-50.4	61.5%, 56.7-66.0	54.4%, 51.2-57.5	54.6%, 49.3-59.8
Self-efficacy				
Q1 (lowest)	23.2%, 19.9-26.8	6.6%, 4.8-9.0	22.0%, 19.5-24.6	12.1%, 9.3-15.7
Q2	32.1%, 28.3-36.1	26.9%, 23.0-31.3	30.7%, 27.9-33.6	32.8%, 28.0-38.0
Q3	10.1%, 7.7-13.1	9.3%, 7.0-12.3	10.1%, 8.3-12.3	12.8%, 9.5-17.0
Q4 (highest)	34.7%, 30.8-38.7	57.2%, 52.5-61.7	37.3%, 34.4-40.3	42.3%, 37.2-47.6
Social norms				
Q1 (lowest)	24.1%, 20.7-27.9	15.2%, 12.3-18.8	25.5%, 23.0-28.3	17.9%, 14.1-22.6
Q2	20.6%, 17.5-24.1	20.6%, 17.3-24.5	22.8%, 20.4-25.5	21.7%, 17.8-26.2
Q3	26.7%, 23.0-30.8	32.5%, 28.2-37.1	25.6%, 22.9-28.6	30.8%, 26.0-36.0
Q4 (highest)	28.5%, 24.7-32.7	31.6%, 27.2-36.4	26.0%, 23.2-28.9	29.5%, 24.8-34.7
Perceived behavioural control				
Q1 (lowest)	10.2%, 8.2-12.7	3.7%, 2.4-5.8	7.8%, 6.4-9.5	5.3%, 3.5-8.1
Q2	29.8%, 26.0-33.8	20.1%, 16.6-24.1	28.4%, 25.7-31.4	25.0%, 20.6-30.0
Q3	21.9%, 18.5-25.8	28.9%, 24.7-33.5	24.4%, 21.7-27.3	30.1%, 25.5-35.3
Q4 (highest)	38.1%, 34.2-42.2	47.3%, 42.7-52.0	39.3%, 36.4-42.4	39.5%, 34.5-44.8
Intention				
Q1 (lowest)	38.1%, 34.1-42.3	16.7%, 13.6-20.3	35.3%, 32.4-38.4	25.6%, 21.0-30.7
Q2	15.8%, 13.1-19.0	19.5%, 15.8-23.8	17.1%, 14.9-19.6	19.2%, 15.4-23.5
Q3 and 4 (highest)	46.0%, 41.9-50.2	63.8%, 59.2-68.3	47.5%, 44.4-50.6	55.3%, 49.9-60.5
Initial behaviour change				
Did not read articles	50.1%, 46.0-54.3	31.1%, 26.9-35.5	40.6%, 37.5-43.7	36.6%, 31.6-41.8
Read articles	49.9%, 45.7-54.0	68.9%, 64.5-73.1	59.4%, 56.3-62.5	63.4%, 58.2-68.4
Did not seek info	61.8%, 57.6-65.8	53.2%, 48.5-57.9	60.4%, 57.4-63.4	50.3%, 45.0-55.6
Sought info, friends family	38.2%, 34.2-42.4	46.8%, 42.1-51.5	39.6%, 36.6-42.6	49.7%, 44.4-55.0
Did not seek info	73.6%, 69.8-77.1	67.0%, 62.4-71.4	70.9%, 68.1-73.7	67.6%, 62.3-72.6
Sought info, health profession	26.4%, 22.9-30.2	33.0%, 28.6-37.6	29.1%, 26.3-31.9	32.4%, 27.4-37.7
Did not try or observe class	57.8%, 53.6-61.9	46.6%, 41.9-51.3	54.5%, 51.3-57.6	40.5%, 35.5-45.7
Tried or observed class	42.2%, 38.1-46.4	53.4%, 48.7-58.1	45.5%, 42.4-48.7	59.5%, 54.3-64.5
Did not seek info	71.9%, 68.0-75.6	58.6%, 53.9-63.2	66.4%, 63.4-69.3	58.6%, 53.2-63.7
Sought info in community	28.1%, 24.4-32.0	41.4%, 36.8-46.1	33.6%, 30.7-36.6	41.4%, 36.3-46.8
Did not change routine	36.5%, 32.4-40.8	20.0%, 16.5-24.1	36.8%, 33.7-40.0	14.7%, 11.4-18.8
Made active choices	63.5%, 59.2-67.6	80.0%, 75.9-83.5	63.2%, 60.0-66.3	85.3%, 81.2-88.6

Table 6.25a and Table 6.25b shows that there were very few significant differences between the NEWS items and either sufficient activity or sufficient walking when looking at the prevalence estimates. A greater proportion of those living in neighbourhoods consisting of primarily single-family dwellings met the lowest quartile of walking for transportation, whereas a greater proportion of adults living in neighbourhoods with a mixture of all types of housing met the highest quartile for walking for transport. A greater proportion of adults who agreed that there are many shops, stores, or other places within walking distance within their neighbourhood, who agreed that a transit stop is close to their home (10-15 minute walk), who agreed that there are sidewalks on most of the streets in their neighbourhood, or who agreed that their neighbourhood has several free or low cost recreational facilities met the highest quartile of walking for transport. A higher proportion of adults who agreed that neighbourhood crime made it difficult to walk at night did not meet the sufficient PA and walking (all-domain) criteria, whereas a greater proportion who disagreed with the statement met these criteria. A greater proportion of adults who agreed that too much traffic made it difficult or unpleasant to walk reported the lowest quartile of recreational walking.

Table 6.25a: Prevalence rates of sufficient PA and walking by environmental factors, 2007 PAM

Neighbourhood Environmental Walkability Scale (NEWS) items	N	Physical activity		All-domain walking	
		Insufficient	Sufficient	Insufficient	Sufficient
		%, 95% CI	%, 95% CI	%, 95% CI	%, 95% CI
Type of primary dwelling in neighbourhood					
Detached single-family residences	3,450	71.2%, 68.5-73.8	73.4%, 71.0-75.7	72.5%, 70.3-74.5	72.5%, 69.0-75.6
Townhouses, row houses, low rise apts	383	8.8%, 7.1-10.8	8.2%, 6.7-10.0	8.6%, 7.2-10.2	8.1%, 6.2-10.5
Mix	850	15.3%, 13.4-17.3	15.3%, 13.6-17.3	14.6%, 13.1-16.1	17.0%, 14.5-19.9
Mid- to high-rise apt	166	4.7%, 3.7-6.1	3.0%, 2.3-4.1	4.4%, 3.5-5.4	2.4%, 1.6-3.7
Availability of many shops, stores, other places within walking distance					
Disagree	2,057	39.7%, 36.9-42.6	41.4%, 38.7-44.1	40.1%, 37.8-42.5	41.9%, 38.3-45.5
Agree	2,808	60.3%, 57.4-63.1	58.6%, 55.9-61.3	59.9%, 57.5-62.2	58.1%, 54.5-61.7
Transit stop 10-15 minute walk from home					
Disagree	1,801	30.0%, 27.4-32.6	34.1%, 31.6-36.6	30.6%, 28.5-32.7	36.1%, 32.7-39.7
Agree	2,828	65.4%, 62.7-68.0	61.0%, 58.4-63.5	64.4%, 62.2-66.6	59.5%, 55.9-63.0
Not applicable	329	4.6%, 3.7-5.8	4.9%, 4.0-6.1	5.0%, 4.2-5.9	4.4%, 3.2-6.0
There are sidewalks on most of the streets in my neighbourhood					
Disagree	1,654	28.4%, 25.9-31.0	32.3%, 29.8-34.9	29.2%, 27.1-31.4	33.6%, 30.2-37.1
Agree	3,151	68.4%, 65.8-71.0	64.0%, 61.4-66.6	67.7%, 65.5-69.8	62.0%, 58.4-65.5
Not applicable	197	3.2%, 2.4-4.3	3.7%, 2.9-4.8	3.1%, 2.4-3.9	4.4%, 3.2-6.1
There are facilities to bicycle in neighbourhood					
Disagree	1,998	36.3%, 33.6-39.1	39.1%, 36.5-41.8	37.6%, 35.4-39.9	38.4%, 34.9-42.0
Agree	2,789	63.7%, 60.9-66.4	60.9%, 58.2-63.5	62.4%, 60.1-64.6	61.6%, 58.0-65.1
Neighbourhood has several free or low cost recreation facilities					
Disagree	1,346	26.3%, 23.9-28.9	24.8%, 22.5-27.2	25.1%, 23.2-27.2	26.1%, 23.0-29.4
Agree	3,524	73.7%, 71.1-76.1	75.2%, 72.8-77.5	74.9%, 72.8-76.8	73.9%, 70.6-77.0
Neighbourhood crime rate makes it unsafe to go on walks at night					
Disagree	3,790	76.3%, 73.8-78.6	81.5%, 79.5-83.4	77.8%, 75.8-79.6	82.5%, 79.9-84.9
Agree	1,089	23.7%, 21.4-26.2	18.5%, 16.6-20.5	22.2%, 20.4-24.2	17.5%, 15.1-20.1
Too much traffic makes it difficult or unpleasant to walk					
Disagree	3,822	76.0%, 73.3-78.4	78.3%, 76.0-80.4	76.5%, 74.5-78.5	78.9%, 75.9-81.7
Agree	1,092	24.0%, 21.6-26.7	21.7%, 19.6-24.0	23.5%, 21.5-25.5	21.1%, 18.3-24.1

- Data not released due to insufficient sample size

Table 6.25b: Prevalence rates of walking by environmental factors, 2007 PAM

Neighbourhood Environmental Walkability Scale (NEWS) items	Recreational walking		Transportation walking	
	Lowest quartile, %, 95% CI	Highest quartile, %, 95% CI	Lowest quartile, %, 95% CI	Highest quartile, %, 95% CI
Type of primary dwelling in neighbourhood				
Detached single-family residences	70.1%, 66.1-73.8	75.5%, 71.4-79.2	77.7%, 74.9-80.3	65.2%, 60.1-69.9
Townhouses, row houses, low rise apts	9.1%, 6.9-11.9	6.9%, 4.9-9.6	7.1%, 5.4-9.1	9.2%, 6.7-12.6
Mix	16.9%, 14.2-20.0	14.7%, 11.7-18.3	12.3%, 10.5-14.3	21.3%, 17.4-25.8
Mid- to high-rise apt	4.0%, 2.5-6.2	-	3.0%, 2.0-4.4	4.3%, 2.8-6.6
Availability of many shops, stores, other places within walking distance				
Disagree	41.5%, 37.3-45.8	38.2%, 33.6-43.0	49.7%, 46.5-52.8	28.5%, 23.9-33.6
Agree	58.5%, 54.2-62.7	61.8%, 57.0-66.4	50.3%, 47.2-53.5	71.5%, 66.4-76.1
Transit stop 10-15 minute walk from home				
Disagree	31.4%, 27.7-35.3	28.3%, 24.3-32.6	34.3%, 31.5-37.2	25.0%, 20.7-29.8
Agree	63.8%, 59.8-67.6	66.0%, 61.5-70.2	59.9%, 56.8-62.8	70.6%, 65.6-75.1
Not applicable	4.8%, 3.6-6.5	5.8%, 4.0-8.2	5.8%, 4.7-7.3	4.4%, 2.9-6.6
There are sidewalks on most of the streets in my neighbourhood				
Disagree	27.6%, 24.0-31.5	28.5%, 24.5-32.9	34.3%, 31.4-37.4	20.6%, 16.5-25.4
Agree	67.9%, 63.9-71.6	67.6%, 63.0-71.8	60.5%, 57.5-63.5	77.4%, 72.6-81.6
Not applicable	4.5%, 3.2-6.3	3.9%, 2.4-6.3	5.1%, 4.0-6.6	-
There are facilities to bicycle in neighbourhood				
Disagree	38.4%, 34.4-42.6	41.4%, 36.8-46.1	40.5%, 37.5-43.6	35.4%, 30.4-40.6
Agree	61.6%, 57.4-65.6	58.6%, 53.9-63.2	59.5%, 56.4-62.5	64.6%, 59.4-69.6
Neighbourhood has several free or low cost recreation facilities				
Disagree	26.9%, 23.2-30.8	24.5%, 20.7-28.8	29.4%, 26.6-32.4	20.0%, 16.2-24.4
Agree	73.1%, 69.2-76.8	75.5%, 71.2-79.3	70.6%, 67.6-73.4	80.0%, 75.6-83.8
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree	77.0%, 73.4-80.2	79.9%, 76.2-83.2	77.1%, 74.5-79.6	80.0%, 75.7-83.7
Agree	23.0%, 19.8-26.6	20.1%, 16.8-23.8	22.9%, 20.4-25.5	20.0%, 16.3-24.3
Too much traffic makes it difficult or unpleasant to walk				
Disagree	73.8%, 70.0-77.3	81.5%, 77.9-84.7	76.6%, 73.8-79.1	77.5%, 72.8-81.6
Agree	26.2%, 22.7-30.0	18.5%, 15.3-22.1	23.4%, 20.9-26.2	22.5%, 18.4-27.2

- Data not released due to insufficient cell size

The previous results described how sufficient activity and sufficient walking varied by individual, social and environmental variables. This section presents results that determine which factors were more strongly related to sufficient activity and all-domain walking. Building on the models contained in Chapter Four and Five, models in this Chapter explore factors which predict two additional types of walking: the highest quartile of recreational walking and the highest quartile of walking for transport.

The individual and social factors were assessed as an independent model predicting these four dependent activity variables (illustrated in Figure 6.1 shown earlier in this Chapter) and are broken into three models representing the precursors of intention. Table 6.26a and Table 6.26b illustrate the relationships between certain individual factors (specifically, prompted awareness, knowledge, beliefs about the awareness) in predicting sufficient activity and walking levels.

As depicted in Table 6.26a, when controlling for other individual level factors, prompted awareness of guidelines, knowledge about the amount of PA required, and the highest scores of beliefs about the benefits of PA (3rd and 4th quartile) were associated with higher odds of meeting the sufficient physical activity criterion. Knowledge about the amount of PA required was associated with the all-domain walking criterion. Moderate scores about the beliefs about the benefits of PA (quartile 2) was associated with the highest quartile of walking for transport, however this was not significant for the highest quartiles of beliefs. Knowledge about the amount of PA required and the highest scores of beliefs about the benefits of PA (3rd and 4th quartile) were associated with higher odds of meeting the highest quartile of walking for recreation. The amount of variation explained by this model is 5.9% for sufficient PA, 2.3% for sufficient all-domain walking, 8.8% for transportation walking, 12.2% for recreational walking, using the Nagelkerke pseudo R-square.

Table 6.26a: Odds ratios of sufficient activity level and all-domain walking by individual factors, 2007 PAM

	Sufficient physical activity			Sufficient all-domain walking		
	Odds Ratio*	Lower 95% CI	Upper 95% CI	Odds Ratio*	Lower 95% CI	Upper 95% CI
Prompted awareness of guidelines						
Not aware of guidelines	Reference			Reference		
Aware of guidelines	**1.42**	**1.18**	**1.71**	1.17	0.97	1.43
Knowledge of PA for guidelines						
Does not have knowledge	Reference			Reference		
Has knowledge of amount of guidelines	**1.37**	**1.16**	**1.63**	**1.32**	**1.10**	**1.58**
Beliefs about the benefits of PA						
Q1 (lowest)	Reference			Reference		
Q2	1.08	0.81	1.45	0.85	0.61	1.17
Q3 and 4 (highest	**1.41**	**1.17**	**1.70**	0.97	0.79	1.18

* adjusted for age, sex, education level

Table 6.26b: Odds ratios of walking by individual factors, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odd ratio*	95% CI	Odd ratio*	95% CI
Prompted awareness for guidelines				
Not aware of guidelines	Reference		Reference	
Awareness of guidelines	0.96	0.72-1.29	1.16	0.87-1.54
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	**1.77**	**1.34-2.34**	1.25	0.97-1.62
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	0.85	0.51-1.42	**1.63**	**1.07-2.47**
Q3 and 4 (highest)	**1.47**	**1.08-2.00**	0.99	0.74-1.33

* adjusted for age, sex, education level

Next, the model incorporates additional individual factors (adding in self-efficacy, PBC, and social norms to the previous model), and describes the amount of variation explained within this model. Table 6.27a and Table 6.27b illustrate the relationships between these six individual factors in predicting the four dependent variables: sufficient PA, sufficient all-domain walking, the highest score of recreational walking, and the highest score of walking for transport.

After controlling for individual level factors, prompted awareness of guidelines was associated with sufficient PA, whereas knowledge about the amount of PA required and beliefs about the benefits of PA were not associated, as they were in Table 6.26a. Increasingly higher scores of self-efficacy

and social norms were also associated with sufficient PA; however PBC was not a significant predictor. For sufficient all-domain walking, knowledge about the amount of PA required was no longer significant in this model as it was in Table 6.26b, however higher scores of self-efficacy and social norms were associated with higher odds of meeting this criterion. Knowledge about the amount of PA required, the highest beliefs quartile, increasing quartiles of self-efficacy and social norms were associated with the highest quartile of walking for recreation. Moderate scores about the beliefs about the benefits of PA (quartile 2), the 2nd and 3rd quartiles of self-efficacy, and the higher scores of social norms were associated with a greater likelihood of walking for transport (see Table 6.27b).

The amount of variation explained by this model as a delta between this and the previous model are 17% for sufficient PA, 11.4% for sufficient all-domain walking, 2.6% for transportation walking, 10.7% for recreational walking, using the Nagelkerke pseudo R-square.

Table 6.27a: Odds ratios of sufficient activity level and daily walking by individual and social factors, 2007 PAM

	Sufficient physical activity			Sufficient all-domain walking		
	Odds Ratio*	Lower 95% CI	Upper 95% CI	Odds Ratio*	Lower 95% CI	Upper 95% CI
Prompted awareness of guidelines						
Not aware of guidelines	Reference			Reference		
Aware of guidelines	**1.34**	**1.09**	**1.65**	1.09	0.88	1.34
Knowledge of PA for guidelines						
Does not have knowledge	Reference			Reference		
Has knowledge of amount of guidelines	1.02	0.85	1.24	1.07	0.88	1.31
Beliefs about the benefits of PA						
Q1 (lowest)	Reference			Reference		
Q2	0.96	0.70	1.32	0.82	0.58	1.15
Q3 and 4 (highest	1.11	0.89	1.37	0.83	0.67	1.03
Self-efficacy						
Q1 (lowest)	Reference			Reference		
Q2	**2.41**	**1.83**	**3.17**	**1.59**	**1.14**	**2.20**
Q3	**4.88**	**3.35**	**7.11**	**2.58**	**1.71**	**3.90**
Q4 (highest)	**7.71**	**5.79**	**10.26**	**3.42**	**2.48**	**4.71**
Social norms						
Q1 (lowest)	Reference			Reference		
Q2	1.24	0.94	1.62	**1.56**	**1.15**	**2.12**
Q3	**1.46**	**1.13**	**1.89**	**2.04**	**1.53**	**2.72**
Q4 (highest)	**1.74**	**1.33**	**2.28**	**3.36**	**2.53**	**4.47**
Perceived behavioural control						
Q1 (lowest)	Reference			Reference		
Q2	1.03	0.70	1.50	1.18	0.77	1.80
Q3	1.34	0.90	1.98	1.15	0.75	1.77
Q4 (highest)	1.30	0.90	1.88	1.19	0.78	1.81

* adjusted for age, sex, education level

Table 6.27b: Odds ratios of walking by individual and social factors, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odd ratio*	95% CI	Odd ratio*	95% CI
Prompted awareness of guidelines				
Not aware of guidelines	Reference		Reference	
Aware of guidelines	0.95	0.70-1.27	1.15	0.86-1.54
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	**1.47**	**1.09-1.99**	1.18	0.90-1.54
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	0.74	0.42-1.30	**1.60**	**1.04-2.46**
Q3 and 4 (highest)	**1.44**	**1.04-2.00**	0.91	0.67-1.24
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	**2.42**	**1.42-4.11**	**1.80**	**1.19-2.71**
Q3	**3.04**	**1.62-5.71**	**2.07**	**1.22-3.51**
Q4 (highest)	**5.19**	**3.11-8.65**	1.46	0.96-2.22
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	**1.70**	**1.10-2.62**	1.41	0.96-2.08
Q3	**2.03**	**1.34-3.07**	**1.82**	**1.25-2.65**
Q4 (highest)	**1.73**	**1.15-2.61**	**1.56**	**1.06-2.30**
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	1.06	0.53-2.14	0.91	0.51-1.62
Q3	1.72	0.87-3.43	1.05	0.58-1.88
Q4 (highest)	1.37	0.71-2.67	1.21	0.69-2.13

* adjusted for age, sex, education level

The third model takes into account all the individual and social factors for predicting the four dependent activity variables. This model expands on the factors already considered in Table 6.27a and Table 6.27b (by adding in intention and initial behaviour change), along with the amount of variation explained within this model's components. Table 6.28a shows the association between the individual and social factors in predicting sufficient activity and all-domain walking. Prompted awareness of guidelines, higher scores of self-efficacy, social norms, and intention, were associated with higher odds of achieving the sufficient PA criterion. The highest score of beliefs and reading articles pertaining to PA were associated with lower odds of sufficient all-domain walking, whereas higher self-efficacy, social norms, intention, and active choices at work were associated with a higher likelihood of achieving the sufficient all-domain walking criterion. Table 6.28b examines the relationship between individual and social factors for predicting a high quartile of recreational and transportation walking. Knowledge about the benefits of the amount of PA required, higher scores of self-efficacy, social norms, and making active choices at work were associated with higher odds of reporting the highest quartile of recreational walking. Moderate scores of self-efficacy (quartile 2) and social norms (quartile 3), the highest intention score, and making active choices at work were associated with a greater likelihood of walking for transportation.

The amount of variation explained by this model as the deltas from the previous model are 2.7% for sufficient PA, 1.7% for sufficient all-domain walking, 5.1% for transportation walking, 3.7% for recreational walking, using the Nagelkerke pseudo R-square.

Table 6.28a: Odds ratios of sufficient activity level and walking by individual, social factors, 2007 PAM

	Sufficient physical activity			Sufficient all-domain walking		
	Odds Ratio*	Lower 95% CI	Upper 95% CI	Odds Ratio*	Lower 95% CI	Upper 95% CI
Prompted awareness of guidelines						
Not aware of guidelines	Reference			Reference		
Aware of guidelines	**1.36**	**1.09**	**1.71**	1.08	0.87	1.35
Knowledge of PA for guidelines						
Does not have knowledge	Reference			Reference		
Has knowledge of amount of PA	1.02	0.84	1.24	1.04	0.85	1.28
Beliefs about the benefits of PA						
Q1 (lowest)	Reference			Reference		
Q2	0.92	0.66	1.28	0.73	0.51	1.04
Q3 and 4 (highest	0.94	0.74	1.19	**0.78**	**0.62**	**0.98**
Self-efficacy						
Q1 (lowest)	Reference			Reference		
Q2	**2.00**	**1.48**	**2.70**	1.25	0.88	1.76
Q3	**3.87**	**2.57**	**5.80**	**2.06**	**1.34**	**3.18**
Q4 (highest)	**4.74**	**3.44**	**6.55**	**2.37**	**1.67**	**3.36**
Social norms						
Q1 (lowest)	Reference			Reference		
Q2	1.21	0.91	1.60	**1.54**	**1.13**	**2.11**
Q3	**1.39**	**1.07**	**1.82**	**1.98**	**1.47**	**2.67**
Q4 (highest)	**1.66**	**1.25**	**2.22**	**3.26**	**2.44**	**4.36**
Perceived behavioural control						
Q1 (lowest)	Reference			Reference		
Q2	0.96	0.64	1.43	1.14	0.73	1.79
Q3	1.13	0.75	1.72	1.08	0.69	1.70
Q4 (highest)	1.05	0.71	1.56	1.05	0.67	1.64
Intention						
Q1 (lowest)	Reference			Reference		
Q2	**1.36**	**1.01**	**1.84**	**1.40**	**1.01**	**1.93**
Q3 and 4 (highest)	**2.54**	**1.96**	**3.29**	**1.91**	**1.45**	**2.53**
Initial behaviour change						
Did not read articles	Reference			Reference		
Read articles	0.95	0.75	1.19	**0.74**	**0.59**	**0.93**
Did not seek info	Reference			Reference		
Sought info, friends/family	1.17	0.93	1.47	1.10	0.88	1.38
Did not seek info	Reference			Reference		
Sought info, health professional	0.96	0.76	1.20	0.90	0.71	1.14
Did not try or observe class	Reference			Reference		
Tried or observed class	1.23	0.99	1.53	0.90	0.72	1.12
Did not seek info	Reference			Reference		
Sought info in community	0.94	0.75	1.16	0.95	0.77	1.18
Did not change routine	Reference			Reference		
Made active choices	1.23	0.98	1.54	**1.39**	**1.10**	**1.76**

* adjusted for age, sex, education level

Table 6.28b: Odds ratios of walking by individual and social factors, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odd ratio*	95% CI	Odd ratio*	95% CI
Prompted awareness of guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of PA	0.92	0.67-1.26	1.02	0.75-1.39
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	**1.46**	**1.05-2.02**	1.18	0.89-1.57
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	0.63	0.34-1.14	1.46	0.94-2.27
Q3 and 4 (highest)	1.24	0.86-1.77	0.81	0.58-1.13
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	**2.11**	**1.17-3.83**	**1.56**	**1.00-2.41**
Q3	**2.61**	**1.30-5.26**	1.64	0.93-2.88
Q4 (highest)	**4.40**	**2.42-8.00**	1.09	0.68-1.74
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	**1.75**	**1.11-2.78**	1.22	0.82-1.81
Q3	**2.11**	**1.35-3.29**	**1.75**	**1.18-2.58**
Q4 (highest)	**1.59**	**1.02-2.46**	1.35	0.90-2.02
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	0.84	0.41-1.75	0.74	0.40-1.37
Q3	1.28	0.63-2.62	0.78	0.42-1.45
Q4 (highest)	1.10	0.55-2.19	0.84	0.46-1.54
Intention				
Q1 (lowest)	Reference		Reference	
Q2	1.42	0.86-2.36	1.18	0.77-1.81
Q3 and 4 (highest)	1.46	0.95-2.26	**1.54**	**1.05-2.25**
Initial behaviour change				
Did not read articles	Reference		Reference	
Read articles	1.35	0.94-1.95	0.87	0.64-1.19
Did not seek info	Reference		Reference	
Sought info, friends/family	0.95	0.68-1.32	1.07	0.79-1.43
Did not seek info	Reference		Reference	
Sought info, health professional	1.11	0.77-1.60	1.01	0.73-1.39
Did not try or observe class	Reference		Reference	
Tried or observed class	1.18	0.86-1.61	1.33	1.00-1.76
Did not seek info	Reference		Reference	
Sought info in community	1.25	0.91-1.73	1.06	0.79-.1.42
Did not change routine	Reference		Reference	
Made active choices	**1.52**	**1.06-2.17**	**2.68**	**1.88-3.82**

* adjusted for age, sex, education level

Tables 6.29a examine environmental factors in predicting sufficient activity and all-domain walking, controlling for sex, age and education. Residing in neighbourhoods with predominately high-rise apartments was associated with a lower likelihood of all-domain walking. Otherwise, there were no significant differences with respect to sufficient PA or sufficient all-domain walking.

Table 6.29a: Odds ratios of sufficient activity level and daily walking by NEWS factors, 2007 PAM

	Sufficient physical activity			Sufficient all-domain walking		
	Odds ratio*	Lower 95% CI	Upper 95% CI	Odds ratio*	Lower 95% CI	Upper 95% CI
Type of dwelling						
Single dwelling home	Reference			Reference		
Row house, townhouse, low rise apartments	0.86	0.60	1.22	0.89	0.61	1.31
Mix	1.05	0.83	1.33	1.28	0.99	1.63
Mid- and high-rise apartments	0.71	0.45	1.11	**0.54**	**0.32**	**0.89**
Many shops, stores, market or other places are within walking distance						
Disagree**	Reference			Reference		
Agree	1.03	0.83	1.26	0.98	0.79	1.23
Transit stop is 10-15 minute walk from home						
Disagree	Reference			Reference		
Agree	0.89	0.71	1.10	0.86	0.68	1.09
Does not apply	1.03	0.64	1.66	0.63	0.33	1.18
There are sidewalks on most of the streets in my neighbourhood						
Disagree	Reference			Reference		
Agree	0.87	0.69	1.08	0.87	0.68	1.12
Does not apply	1.16	0.45	3.00	2.14	0.85	5.41
There are facilities to bicycle in or near neighbourhood						
Disagree**	Reference			Reference		
Agree	0.87	0.72	1.07	1.07	0.86	1.33
Neighbourhood has several free or low cost recreation facilities						
Disagree**	Reference			Reference		
Agree	1.23	0.98	1.54	1.01	0.78	1.31
Crime rate in neighbourhood makes it unsafe to go on walks at night						
Disagree**	Reference			Reference		
Agree	0.95	0.76	1.19	0.83	0.66	1.05
Too much traffic on streets making it difficult or unpleasant to walk						
Disagree**	Reference			Reference		
Agree	0.97	0.78	1.21	0.96	0.76	1.21

* adjusted for age, sex, education level
** includes 'does not apply' category

Table 6.29b explores neighbourhood factors in predicting walking for recreation and for transport. Only one factor predicts walking for recreation; agreeing that too much traffic makes it difficult or unpleasant to walk was associated with lower odds of achieving the highest quartile of recreational walking. A greater likelihood of achieving the highest quartile of walking for transportation was seen among those who reside in neighbourhoods with a mixture of dwelling type and among those who agree that there are many shops, stores, and other places within walking distance. Agreeing that neighbourhood crime makes it unsafe to go on walks at night was associated with lower odds of walking for transport.

Table 6.29b: Odds ratios of walking by NEWS factors, 2007 PAM

Neighbourhood Environmental Walkability Scale (NEWS) items	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	0.79	0.47-1.32	1.19	0.73-1.93
Mix	0.82	0.56-1.20	**1.65**	**1.17-2.34**
Mid- to high-rise apt	0.97	0.47-2.01	1.73	0.82-3.65
Many shops, stores, market or other places are within walking distance				
Disagree**	Reference		Reference	
Agree	1.27	0.91-1.77	**2.19**	**1.55-3.08**
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	1.21	0.86-1.72	1.01	0.72-1.43
Does not apply	1.54	0.73-3.28	1.06	0.46-2.42
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	1.02	0.70-1.47	1.38	0.94-2.02
Does not apply	0.86	0.24-3.05	1.44	0.44-4.70
There are facilities to bicycle in neighbourhood				
Disagree**	Reference		Reference	
Agree	0.82	0.60-1.13	0.93	0.68-1.28
Neighbourhood has several free or low cost recreation facilities				
Disagree**	Reference		Reference	
Agree	1.11	0.76-1.63	1.14	0.77-1.70
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree**	Reference		Reference	
Agree	0.88	0.62-1.25	**0.65**	**0.46-0.93**
Too much traffic makes it difficult or unpleasant to walk				
Disagree**	Reference		Reference	
Agree	**0.69**	**0.48-0.97**	1.17	0.84-1.63

* adjusted for age, sex, education level
** includes 'does not apply' category

Table 6.30a and Table 6.30b summarize the individual, social, and physical environment factors in a full model, while adjusting for sex, age, and education. Similar to the independent models, higher scores of self-efficacy, social norms, and intention were associated with higher odds of sufficient activity and all-domain walking. In addition, prompted awareness of guidelines also predicted sufficient PA. Making active choices at work and living in a neighbourhood with a mix of single dwelling homes, row houses, townhouses, and low rise apartments predicted sufficient all-domain walking, whereas living in neighbourhoods with predominately mid- to high-rise apartments predict a lower odds of sufficient all domain walking.

As shown in Table 6.30b, moderate self-efficacy score (quartile 2), highest score of intention, trying or observing a class, making active choices at work, moderate social norm scores (quartile 3), all types of housing (in comparison to adults who reside in neighbourhoods with primarily a single-family dwelling), having many shops and stores nearby, having sidewalks on most streets are associated with higher odds of achieving the highest quartile of walking for the purpose of transportation. Knowledge about the amount of PA required, higher self-efficacy and social norm scores, and making active choices at work are associated with the highest quartile of recreational walking. No physical environment or neighbourhood factors, however, are significantly associated with the highest quartile of recreational walking.

Using the Nagelkerke pseudo R-square, the amount of variation explained by the addition of the NEWS items this model as a delta of the earlier model is 0.5% for sufficient PA, 1.7% for sufficient all-domain walking, 5.7% for transportation walking, and 0.9% for recreational walking.

Table 6.30a: Individual, social and environmental factors by sufficient activity and walking, 2007 PAM

	Sufficient physical activity		Sufficient all-domain walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Prompted awareness of guidelines				
Not aware	Reference		Reference	
Aware of guidelines	**1.36**	**1.07-1.73**	1.01	0.80-1.28
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	1.01	0.82-1.24	1.04	0.84-1.30
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	1.00	0.70-1.41	0.75	0.51-1.08
Q3 and 4 (highest)	0.98	0.77-1.26	0.81	0.64-1.04
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	**2.04**	**1.49-2.79**	1.34	0.93-1.93
Q3	**4.08**	**2.66-6.27**	**2.00**	**1.26-3.19**
Q4 (highest)	**4.70**	**3.35-6.60**	**2.41**	**1.66-3.51**
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	1.26	0.94-1.69	**1.59**	**1.14-2.22**
Q3	**1.36**	**1.03-1.81**	**1.92**	**1.41-2.63**
Q4 (highest)	**1.83**	**1.35-2.48**	**3.42**	**2.52-4.63**
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	0.92	0.59-1.42	1.03	0.64-1.66
Q3	1.10	0.71-1.73	0.95	0.58-1.55
Q4 (highest)	1.03	0.67-1.57	0.91	0.56-1.46
Intention				
Q1 (lowest)	Reference		Reference	
Q2	**1.44**	**1.04-1.98**	**1.40**	**1.00-1.96**
Q3 and 4 (highest)	**2.60**	**1.98-3.41**	**2.02**	**1.50-2.72**
Initial behaviour change				
Did not read articles	Reference		Reference	
Read articles	0.99	0.78-1.27	0.79	0.62-1.01
Did not seek info	Reference		Reference	
Sought info from friends/family	1.22	0.96-1.55	1.12	0.88-1.43
Did not seek info	Reference		Reference	
Sought info from health professionals	0.93	0.73-1.18	0.96	0.75-1.22
Did not try or observe class	Reference		Reference	
Tried or observed class	1.21	0.96-1.52	0.90	0.71-1.13
Did not seek info	Reference		Reference	
Sought info on community activities	0.98	0.78-1.23	0.95	0.75-1.19
Did not change routine	Reference		Reference	
Made active choices	1.26	0.99-1.60	**1.43**	**1.12-1.84**

Table 6.30a: Individual, social and environmental factors by sufficient activity and walking, 2007 PAM

	Sufficient physical activity		Sufficient all-domain walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Neighbourhood Environmental Walkability Scale (NEWS) items				
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	1.02	0.68-1.52	1.16	0.78-1.71
Mix	1.07	0.80-1.43	**1.43**	**1.08-1.90**
Mid- to high-rise apt	0.76	0.43-1.34	**0.55**	**0.31-0.95**
Many shops, stores, market or other places are within walking distance				
Disagree**	Reference		Reference	
Agree	0.94	0.73-1.20	0.95	0.74-1.21
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	0.87	0.66-1.14	0.86	0.66-1.14
Not applicable	1.20	0.64-2.24	**0.45**	**0.23-0.86**
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	0.87	0.66-1.15	0.83	0.63-1.11
Not applicable	0.92	0.36-2.34	2.90	0.97-8.70
There are facilities to bicycle in neighbourhood				
Disagree**	Reference		Reference	
Agree	0.89	0.69-1.14	0.90	0.70-1.17
Neighbourhood has several free or low cost recreation facilities				
Disagree**	Reference		Reference	
Agree	0.92	0.70-1.22	0.92	0.69-1.23
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree**	Reference		Reference	
Agree	1.12	0.84-1.50	0.99	0.75-1.30
Too much traffic makes it difficult or unpleasant to walk				
Disagree**	Reference		Reference	
Agree	1.11	0.83-1.49	0.97	0.73-1.27

* adjusted for age, sex, education level

** includes the 'does not apply' category

Table 6.30b: Individual, social and environmental factors by sufficient walking, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Prompted awareness of guidelines				
Not aware of guidelines	Reference		Reference	
Aware of guidelines	0.80	0.58-1.11	1.07	0.76-1.50
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	**1.42**	**1.00-2.01**	1.23	0.90-1.67
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	0.68	0.36-1.27	1.52	0.94-2.45
Q3 and 4 (highest)	1.25	0.85-1.83	0.81	0.56-1.17
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	**2.44**	**1.27-4.69**	**1.69**	**1.04-2.74**
Q3	**2.94**	**1.37-6.27**	1.65	0.87-3.14
Q4 (highest)	**4.58**	**2.37-8.86**	1.07	0.64-1.78
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	**2.04**	**1.24-3.34**	1.25	0.80-1.94
Q3	**2.40**	**1.50-3.83**	**1.78**	**1.15-2.75**
Q4 (highest)	**1.86**	**1.17-2.96**	1.26	0.81-1.97
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	0.83	0.39-1.80	0.67	0.32-1.37
Q3	1.10	0.52-2.35	0.74	0.36-1.52
Q4 (highest)	1.03	0.49-2.14	0.80	0.39-1.63
Intention				
Q1 (lowest)	Reference		Reference	
Q2	1.46	0.86-2.48	1.25	0.77-2.01
Q3 and 4 (highest)	1.49	0.93-2.39	**1.60**	**1.05-2.45**
Initial behaviour change				
Did not read articles	Reference		Reference	
Read articles	1.30	0.88-1.92	0.83	0.59-1.18
Did not seek info				
Sought info from friends/family	0.95	0.66-1.36	1.00	0.73-1.37
Did not seek info				
Sought info from health professionals	1.09	0.74-1.60	1.00	0.71-1.41
Did not try or observe class				
Tried or observed class	1.12	0.80-1.56	**1.50**	**1.10-2.05**
Did not seek info				
Sought info on community activities	1.10	0.79-1.54	0.95	0.69-1.31
Did not change routine				
Made active choices	**1.72**	**1.16-2.54**	**2.58**	**1.76-3.79**

Table 6.30b: Individual, social and environmental factors by sufficient walking, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Neighbourhood Environmental Walkability Scale (NEWS) items				
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	0.83	0.47-1.47	**1.64**	**1.00-2.70**
Mix	0.77	0.50-1.18	**1.56**	**1.04-2.34**
Mid- to high-rise apt	1.37	0.57-3.32	**2.22**	**1.01-4.85**
Many shops, stores, market or other places are within walking distance				
Disagree	Reference		Reference	
Agree	0.88	0.60-1.29	**1.83**	**1.27-2.65**
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	1.09	0.72-1.65	1.02	0.71-1.47
Not applicable	0.81	0.33-1.97	1.07	0.40-2.87
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	1.09	0.70-1.67	**1.56**	**1.03-2.35**
Not applicable	1.60	0.62-4.13	2.23	0.57-8.76
There are facilities to bicycle in neighbourhood				
Disagree	Reference		Reference	
Agree	0.78	0.51-1.17	0.95	0.67-1.33
Neighbourhood has several free or low cost recreation facilities				
Disagree	Reference		Reference	
Agree	0.90	0.56-1.45	0.93	0.62-1.41
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree	Reference		Reference	
Agree	1.04	0.68-1.59	0.74	0.51-1.08
Too much traffic makes it difficult or unpleasant to walk				
Disagree	Reference		Reference	
Agree	0.75	0.49-1.15	1.18	0.80-1.72

* adjusted for age, sex, education level
** includes the 'does not apply' category

Table 6.31a, Table 6.31b, Table 6.32a, and Table 6.32a stratifies the individual, social, and physical environment factors that predict sufficient walking separately for men and women aged 44 and younger respectively, adjusting for education level. Among men less than 45 years of age, higher scores of self-efficacy, social norms, and intention were associated with higher odds of sufficient activity and all-domain walking. The highest scores of beliefs about the benefits of PA were associated with a higher likelihood of meeting the highest quartile of recreational walking. Reading articles about PA was associated with a lower likelihood of sufficient all-domain walking. Making active choices during the work routine and trying or observing a class was associated with a greater likelihood of achieving the highest quartile of

walking for transportation. Younger men who sought information about PA from family and friends had a lower likelihood of achieving the highest quartile of walking for recreation. Among men of this age group, no significant relationships existed between environmental factors and meeting the sufficient activity criterion or walking for recreation or transport, with the exception that younger men who reside in neighbourhoods with a mix of dwelling types were more likely to walk in general (all-domain).

For women less than 45 years of age, higher scores of self-efficacy and intention were associated with higher odds of sufficient activity, all-domain walking, and higher quartiles of recreational walking, but not walking for transportation. Higher social norm scores were also associated with a greater likelihood of all-domain walking and walking for recreation purposes. Similarly, a moderate social norms score (quartile 3) predicted a higher odds of walking for transportation. Trying or observing a PA class was associated with greater odds of walking for recreation and transport, whereas seeking information from health professionals predicted lower odds of reporting the highest quartile of recreational walking. Making active choices during the daily work routine was associated with a greater likelihood of all-domain walking and walking for the purposes of transportation. Among women of this age group, there was only one significant relationship with environmental measures; living in neighbourhoods consisting of a mix of dwellings was associated with lower odds of all-domain walking.

Table 6.31a: Individual, social and environmental factors by sufficient activity and walking, Males <45 years, 2007 PAM

	Sufficient physical activity		Sufficient all-domain walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Prompted awareness of guidelines				
Not aware of guidelines	Reference		Reference	
Aware of guidelines	1.42	0.80-2.53	0.82	0.47-1.44
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	1.40	0.85-2.31	1.14	0.73-1.79
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	1.12	0.51-2.47	1.00	0.47-2.12
Q3 and 4 (highest)	0.73	0.42-1.27	0.96	0.58-1.58
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	**4.69**	**2.25-9.77**	**3.21**	**1.40-7.37**
Q3	**10.15**	**3.86-26.73**	**4.05**	**1.49-11.03**
Q4 (highest)	**13.52**	**6.37-28.71**	**3.94**	**1.81-8.61**
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	1.94	0.98-3.85	**2.97**	**1.34-6.56**
Q3	1.71	0.88-3.34	**3.77**	**1.81-7.86**
Q4 (highest)	**3.24**	**1.56-6.73**	**9.01**	**4.38-18.55**
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	0.78	0.27-2.27	0.76	0.24-2.33
Q3	0.74	0.25-2.18	0.68	0.22-2.12
Q4 (highest)	1.02	0.34-3.08	0.81	0.25-2.62
Intention				
Q1 (lowest)	Reference		Reference	
Q2	**2.00**	**1.04-3.83**	**2.02**	**1.00-4.08**
Q3 and 4 (highest)	**4.24**	**2.21-8.13**	**2.87**	**1.51-5.49**
Initial behaviour change				
Did not read articles	Reference		Reference	
Read articles	1.07	0.63-1.83	**0.60**	**0.37-0.95**
Did not seek info	Reference		Reference	
Sought info from friends/family	1.17	0.69-1.98	1.53	0.95-2.45
Did not seek info	Reference		Reference	
Sought info from health professionals	1.01	0.55-1.88	1.04	0.61-1.77
Did not try or observe class	Reference		Reference	
Tried or observed class	0.85	0.50-1.45	0.69	0.43-1.10
Did not seek info	Reference		Reference	
Sought info on community activities	0.95	0.56-1.61	1.02	0.65-1.61
Did not change routine	Reference		Reference	
Made active choices	1.39	0.79-2.44	1.18	0.73-1.90

Table 6.31a: Individual, social and environmental factors by sufficient activity and walking, Males <45 years, 2007 PAM

	Sufficient physical activity		Sufficient all-domain walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Neighbourhood Environmental Walkability Scale (NEWS) items				
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	0.58	0.27-1.24	1.33	0.64-2.77
Mix	1.12	0.60-2.11	**3.70**	**2.09-6.53**
Mid- to high-rise apt	0.42	0.14-1.21	0.75	0.26-2.10
Many shops, stores, market or other places are within walking distance				
Disagree	Reference		Reference	
Agree	0.95	0.53-1.70	0.91	0.55-1.53
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	0.71	0.37-1.38	0.74	0.41-1.33
Not applicable	0.52	0.14-1.97	0.20	0.04-1.05
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	0.94	0.48-1.86	0.73	0.40-1.30
Not applicable	1.97	0.32-12.20	4.14	0.83-20.58
There are facilities to bicycle in neighbourhood				
Disagree	Reference		Reference	
Agree	1.37	0.76-2.46	0.90	0.51-1.59
Neighbourhood has several free or low cost recreation facilities				
Disagree	Reference		Reference	
Agree	0.62	0.33-1.20	0.55	0.29-1.04
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree	Reference		Reference	
Agree	0.87	0.43-1.74	1.13	0.62-2.07
Too much traffic makes it difficult or unpleasant to walk				
Disagree	Reference		Reference	
Agree	1.32	0.74-2.36	1.02	0.58-1.77

* adjusted for education level

** includes the 'does not apply' category

Table 6.31b: Individual, social and environmental factors by sufficient walking, Males <45 years, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Prompted awareness of guidelines				
Not aware of guidelines	Reference		Reference	
Aware of guidelines	0.81	0.35-1.92	1.03	0.49-2.15
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	0.92	0.41-2.03	1.02	0.51-2.05
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	0.61	0.17-2.17	2.28	0.85-6.07
Q3 and 4 (highest)	**3.88**	**1.64-9.17**	0.71	0.32-1.56
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	1.12	0.23-5.41	1.30	0.43-3.92
Q3	1.51	0.21-10.70	2.51	0.70-8.95
Q4 (highest)	1.85	0.40-8.44	0.77	0.24-2.49
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	2.30	0.66-8.00	0.78	0.32-1.89
Q3	3.09	0.94-10.16	1.05	0.43-2.56
Q4 (highest)	2.85	0.85-9.54	1.14	0.46-2.83
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	0.64	0.15-2.76	0.53	0.12-2.32
Q3	0.65	0.15-2.93	0.76	0.18-3.23
Q4 (highest)	0.37	0.09-1.47	0.79	0.20-3.17
Intention				
Q1 (lowest)	Reference		Reference	
Q2	0.59	0.20-1.76	0.95	0.36-2.47
Q3 and 4 (highest)	0.83	0.29-2.40	1.72	0.68-4.30
Initial behaviour change				
Did not read articles	Reference		Reference	
Read articles	2.25	0.96-5.27	0.66	0.33-1.30
Did not seek info	Reference		Reference	
Sought info from friends/family	**0.38**	**0.15-0.95**	0.76	0.40-1.46
Did not seek info	Reference		Reference	
Sought info from health professionals	1.15	0.47-2.84	0.64	0.29-1.39
Did not try or observe class	Reference		Reference	
Tried or observed class	0.75	0.35-1.61	**2.13**	**1.06-4.27**
Did not seek info	Reference		Reference	
Sought info on community activities	1.06	0.50-2.28	0.69	0.34-1.40
Did not change routine	Reference		Reference	
Made active choices	2.20	0.89-5.41	**4.09**	**1.80-9.29**

Table 6.31b: Individual, social and environmental factors by sufficient walking, Males <45 years, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Neighbourhood Environmental Walkability Scale (NEWS) items				
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	0.95	0.25-3.61	1.29	0.46-3.59
Mix	0.55	0.20-1.53	2.21	0.98-5.00
Mid- to high-rise apt	1.33	0.32-5.50	0.35	0.05-2.37
Many shops, stores, market or other places are within walking distance				
Disagree	Reference		Reference	
Agree	0.67	0.25-1.81	2.02	0.87-4.65
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	1.46	0.54-3.94	0.80	0.34-1.89
Not applicable	0.26	0.04-1.85	4.29	0.34-53.45
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	2.08	0.61-7.04	1.64	0.59-4.57
Not applicable	2.88	0.41-20.24	3.52	0.45-27.41
There are facilities to bicycle in neighbourhood				
Disagree	Reference		Reference	
Agree	0.65	0.26-1.63	1.07	0.52-2.22
Neighbourhood has several free or low cost recreation facilities				
Disagree	Reference		Reference	
Agree	1.19	0.39-3.63	0.99	0.39-2.49
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree	Reference		Reference	
Agree	0.76	0.28-2.04	1.21	0.53-2.78
Too much traffic makes it difficult or unpleasant to walk				
Disagree	Reference		Reference	
Agree	1.00	0.39-2.55	1.80	0.79-4.08

* adjusted for education level

** includes the 'does not apply' category

Table 6.32a: Individual, social and environmental factors by sufficient activity and walking, Females <45 years, 2007 PAM

	Sufficient physical activity		Sufficient all-domain walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Prompted awareness of guidelines				
Not aware of guidelines	Reference		Reference	
Aware of guidelines	0.91	0.55-1.48	0.85	0.52-1.37
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	0.70	0.46-1.06	0.66	0.43-1.01
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	0.72	0.38-1.36	0.51	0.25-1.04
Q3 and 4 (highest)	0.85	0.53-1.38	0.64	0.39-1.06
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	**2.22**	**1.21-4.06**	1.15	0.60-2.21
Q3	**3.81**	**1.75-8.30**	2.07	0.92-4.64
Q4 (highest)	**5.87**	**3.01-11.45**	**2.21**	**1.12-4.36**
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	1.03	0.57-1.88	1.33	0.70-2.54
Q3	1.20	0.69-2.08	1.56	0.86-2.85
Q4 (highest)	1.65	0.91-3.01	**2.92**	**1.59-5.35**
Perceived Behavioural Control				
Q1 (lowest)	Reference		Reference	
Q2	0.71	0.33-1.50	1.39	0.63-3.07
Q3	0.99	0.45-2.20	1.56	0.69-3.53
Q4 (highest)	0.85	0.40-1.84	1.46	0.66-3.23
Intention				
Q1 (lowest)	Reference		Reference	
Q2	1.50	0.82-2.75	0.94	0.49-1.81
Q3 and 4 (highest)	**3.21**	**1.83-5.62**	**1.98**	**1.11-3.54**
Initial behaviour change				
Did not read articles	Reference		Reference	
Read articles	0.72	0.44-1.18	0.69	0.43-1.10
Did not seek info	Reference		Reference	
Sought info from friends/family	1.35	0.85-2.16	0.78	0.48-1.25
Did not seek info	Reference		Reference	
Sought info from health professionals	1.17	0.73-1.87	1.30	0.81-2.09
Did not try or observe class	Reference		Reference	
Tried or observed class	1.25	0.79-1.98	1.20	0.73-1.97
Did not seek info	Reference		Reference	
Sought info on community activities	1.01	0.66-1.53	0.89	0.58-1.38
Did not change routine	Reference		Reference	
Made active choices	1.58	0.94-2.63	**1.99**	**1.15-3.44**

Table 6.32a: Individual, social and environmental factors by sufficient activity and walking, Females <45 years, 2007 PAM

	Sufficient physical activity		Sufficient all-domain walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Neighbourhood Environmental Walkability Scale (NEWS) items				
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	1.25	0.66-2.37	0.74	0.35-1.55
Mix	0.94	0.51-1.72	**0.56**	**0.32-0.99**
Mid- to high-rise apt	1.05	0.38-2.89	0.32	0.10-1.02
Many shops, stores, market or other places are within walking distance				
Disagree	Reference		Reference	
Agree	0.91	0.56-1.49	0.85	0.52-1.39
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	1.08	0.63-1.85	1.14	0.66-1.95
Not applicable	1.75	0.48-6.34	0.98	0.27-3.58
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	0.70	0.38-1.30	1.04	0.57-1.88
Not applicable	0.01	0.00-0.20	2.28	0.03-166.48
There are facilities to bicycle in neighbourhood				
Disagree	Reference		Reference	
Agree	0.62	0.37-1.04	0.81	0.49-1.34
Neighbourhood has several free or low cost recreation facilities				
Disagree	Reference		Reference	
Agree	0.79	0.46-1.38	1.14	0.64-2.02
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree	Reference		Reference	
Agree	1.59	0.87-2.93	1.31	0.77-2.24
Too much traffic makes it difficult or unpleasant to walk				
Disagree	Reference		Reference	
Agree	0.83	0.47-1.47	0.72	0.41-1.28

* adjusted for education level
** includes the 'does not apply' category

Table 6.32b: Individual, social and environmental factors by sufficient walking, Females <45 years, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Prompted awareness of guidelines				
Not aware of guidelines	Reference		Reference	
Aware of guidelines	0.93	0.42-2.06	0.77	0.36-1.66
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	1.15	0.50-2.63	0.87	0.46-1.64
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	1.78	0.54-5.86	2.00	0.73-5.45
Q3 and 4 (highest)	1.89	0.82-4.37	0.90	0.41-2.01
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	**6.47**	**1.35-31.01**	2.03	0.82-5.04
Q3	**9.95**	**1.86-53.28**	1.16	0.35-3.85
Q4 (highest)	**14.30**	**3.41-59.99**	1.09	0.39-2.99
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	**4.47**	**1.08-18.52**	1.86	0.75-4.58
Q3	**4.06**	**1.20-13.78**	**4.75**	**1.99-11.35**
Q4 (highest)	**6.11**	**1.77-21.03**	1.68	0.66-4.29
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	0.18	0.03-1.02	1.36	0.42-4.32
Q3	0.19	0.03-1.13	0.93	0.28-3.14
Q4 (highest)	0.29	0.05-1.60	1.14	0.35-3.72
Intention				
Q1 (lowest)	Reference		Reference	
Q2	1.56	0.51-4.81	1.59	0.63-4.05
Q3 and 4 (highest)	**3.44**	**1.12-10.52**	1.10	0.47-2.59
Initial behaviour change				
Did not read articles	Reference		Reference	
Read articles	2.11	0.98-4.58	0.84	0.44-1.61
Did not seek info	Reference		Reference	
Sought info from friends/family	1.50	0.65-3.46	1.78	0.95-3.35
Did not seek info	Reference		Reference	
Sought info from health professionals	**0.32**	**0.13-0.80**	1.17	0.58-2.37
Did not try or observe class	Reference		Reference	
Tried or observed class	**2.80**	**1.24-6.36**	**2.32**	**1.24-4.34**
Did not seek info	Reference		Reference	
Sought info on community activities	0.46	0.21-1.02	1.29	0.69-2.39
Did not change routine	Reference		Reference	
Made active choices	2.56	0.83-7.89	**3.91**	**1.57-9.78**

Table 6.32b: Individual, social and environmental factors by sufficient walking, Females <45 years, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Neighbourhood Environmental Walkability Scale (NEWS) items				
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	0.49	0.14-1.75	2.48	0.78-7.83
Mix	0.75	0.31-1.83	1.32	0.58-2.98
Mid- to high-rise apt	1.81	0.16-20.83	4.93	0.92-26.37
Many shops, stores, market or other places are within walking distance				
Disagree**	Reference		Reference	
Agree	0.81	0.38-1.73	1.71	0.91-3.20
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	0.99	0.40-2.45	1.29	0.62-2.66
Not applicable	0.48	0.09-2.54	1.17	0.20-6.87
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	-	-	-	-
Not applicable	-	-	-	-
There are facilities to bicycle in neighbourhood				
Disagree	Reference		Reference	
Agree	0.97	0.43-2.23	0.88	0.44-1.79
Neighbourhood has several free or low cost recreation facilities				
Disagree**	Reference		Reference	
Agree	0.49	0.18-1.39	0.94	0.43-2.07
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree**	Reference		Reference	
Agree	0.60	0.24-1.51	1.22	0.60-2.48
Too much traffic makes it difficult or unpleasant to walk				
Disagree**	Reference		Reference	
Agree	1.37	0.50-3.74	0.60	0.29-1.23

- Data not released due to insufficient sample size
* adjusted for education level
** includes the 'does not apply' category

Table 6.33a, Table 6.33b, Table 6.34a and Table 6.34b looks at factors that predict sufficient walking and activity, among adults who are 45 years and older, stratifying for gender and adjusting for educational level. Among men who were 45 years or older, higher scores of self-efficacy and high scores of intention predicted higher odds of being sufficiently active. The highest score of self-efficacy (quartile 4), intention, and social norms were associated with higher odds of sufficient all-domain walking. Having a nearby transit stop predicted a lower likelihood of being sufficiently active among older men. Knowledge of the amount of PA required for guidelines, a high self-efficacy score (quartile 4) and a moderate score for social norms (quartile 2) were associated with a higher quartile of recreational walking, whereas a lower belief score (quartile 2) predicted lower odds. A high intention score and living in neighbourhoods comprised primarily of mid- to high-rise apartments predicted a higher likelihood of transport walking, whereas crime was associated with lower odds. For men 45 years and older, living in a neighbourhood with primarily town homes, row houses, or low-rise apartments and condos was associated with a greater likelihood of all-domain walking.

The situation is somewhat different for older women. For this group, prompted awareness of guidelines, higher scores of self-efficacy and intention, and trying or observing a class, were associated with a greater likelihood of meeting sufficient amounts of PA, whereas high intention and social norms scores also predicted all-domain walking. Knowledge of the dose of PA contained within the guidelines was associated with all three walking criteria. A low-to-moderate self-efficacy score (quartile 2) was associated with meeting the highest quartile of walking for transportation, whereas low-to-moderate social norm scores were associated with the highest quartile of recreational walking and highest quartile of walking for transportation (quartile 2 and 3 of the social norms score, respectively). Seeking information about PA from health professionals and seeking information about community activities were associated with a greater likelihood of meeting the highest quartile of recreational walking. Among women of this age group, living in neighbourhoods of primarily mid-to-high rise apartments and condos was associated with a greater likelihood of meeting the highest quartile of walking for transport. Citing a transit stop within 10 to 15 minute walk from home predicted lower odds of all-domain walking. Reporting that there are many shops, stores, markets, and other places within walking distance was associated with a higher likelihood of walking for transportation purposes, whereas neighbourhood crime is associated with lower odds of this type of walking.

Table 6.33a: Individual, social and environmental factors by sufficient activity and walking, Males ≥45 years, 2007 PAM

	Sufficient physical activity		Sufficient all-domain walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Prompted awareness of guidelines				
Not aware of guidelines	Reference		Reference	
Awareness of guidelines	1.43	0.90-2.25	0.76	0.48-1.20
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	1.17	0.76-1.80	1.32	0.84-2.09
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	1.79	0.91-3.51	0.71	0.35-1.45
Q3 and 4 (highest)	0.97	0.60-1.57	0.66	0.40-1.09
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	1.43	0.77-2.66	1.40	0.67-2.95
Q3	**2.97**	**1.23-7.17**	2.09	0.80-5.50
Q4 (highest)	**2.35**	**1.22-4.50**	**2.71**	**1.27-5.76**
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	0.98	0.57-1.70	0.97	0.52-1.83
Q3	1.39	0.78-2.48	1.39	0.76-2.55
Q4 (highest)	1.51	0.80-2.82	**2.10**	**1.13-3.89**
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	0.93	0.38-2.32	0.72	0.27-1.90
Q3	1.79	0.71-4.48	1.04	0.39-2.79
Q4 (highest)	1.73	0.72-4.18	0.84	0.32-2.20
Intention				
Q1 (lowest)	Reference		Reference	
Q2	1.81	0.89-3.69	1.43	0.68-3.04
Q3 and 4 (highest)	**2.31**	**1.35-3.96**	**1.89**	**1.07-3.33**
Initial behaviour change				
Did not read articles	Reference		Reference	
Read articles	1.14	0.73-1.77	0.95	0.60-1.51
Did not seek info	Reference		Reference	
Sought info from friends/family	1.03	0.64-1.67	1.30	0.78-2.16
Did not seek info	Reference		Reference	
Sought info from health professionals	0.68	0.42-1.11	0.88	0.52-1.48
Did not try or observe class	Reference		Reference	
Tried or observed class	1.25	0.78-1.99	0.75	0.47-1.21
Did not seek info	Reference		Reference	
Sought info on community activities	1.14	0.70-1.85	1.05	0.64-1.72
Did not change routine	Reference		Reference	
Made active choices	1.14	0.73-1.78	1.58	0.95-2.62

Table 6.33a: Individual, social and environmental factors by sufficient activity and walking, Males ≥45 years, 2007 PAM

	Sufficient physical activity		Sufficient all-domain walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Neighbourhood Environmental Walkability Scale (NEWS) items				
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	1.56	0.65-3.76	**3.13**	**1.36-7.19**
Mix	1.04	0.54-2.03	1.77	0.88-3.53
Mid- to high-rise apt	0.64	0.21-1.98	0.89	0.30-2.64
Many shops, stores, market or other places are within walking distance				
Disagree	Reference		Reference	
Agree	0.64	0.38-1.07	0.72	0.43-1.18
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	**0.60**	**0.37-0.99**	1.02	0.59-1.77
Not applicable	1.49	0.33-6.82	1.01	0.30-3.35
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	0.99	0.58-1.69	0.59	0.33-1.04
Not applicable	0.97	0.20-4.71	2.50	0.53-11.73
There are facilities to bicycle in neighbourhood				
Disagree	Reference		Reference	
Agree	0.81	0.51-1.28	0.77	0.46-1.28
Neighbourhood has several free or low cost recreation facilities				
Disagree	Reference		Reference	
Agree	0.96	0.57-1.63	0.95	0.57-1.59
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree	Reference		Reference	
Agree	0.91	0.51-1.64	0.69	0.37-1.29
Too much traffic makes it difficult or unpleasant to walk				
Disagree	Reference		Reference	
Agree	1.07	0.57-2.03	1.06	0.58-1.92

* adjusted for education level
** includes the 'does not apply' category

Table 6.33b: Individual, social and environmental factors by sufficient walking, Males ≥45 years, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Prompted awareness of guidelines				
Not aware of guidelines	Reference		Reference	
Aware of guidelines	0.58	0.29-1.18	1.15	0.60-2.23
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	**2.60**	**1.32-5.13**	1.63	0.81-3.26
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	**0.26**	**0.09-0.76**	1.75	0.69-4.43
Q3 and 4 (highest)	0.64	0.27-1.50	0.52	0.24-1.13
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	2.86	0.85-9.62	1.29	0.37-4.50
Q3	2.76	0.72-10.64	1.60	0.41-6.20
Q4 (highest)	**9.88**	**3.06-31.89**	0.85	0.27-2.67
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	**3.46**	**1.32-9.10**	1.52	0.60-3.84
Q3	2.22	0.83-5.90	1.38	0.57-3.35
Q4 (highest)	1.15	0.43-3.06	2.04	0.79-5.26
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	1.21	0.26-5.63	0.25	0.04-1.73
Q3	1.70	0.38-7.57	0.76	0.14-4.22
Q4 (highest)	1.47	0.33-6.61	0.67	0.13-3.62
Intention				
Q1 (lowest)	Reference		Reference	
Q2	2.86	0.85-9.71	1.03	0.35-3.07
Q3 and 4 (highest)	1.74	0.68-4.44	**2.47**	**1.01-6.06**
Initial behaviour change				
Did not read articles	Reference		Reference	
Read articles	1.06	0.51-2.23	0.64	0.31-1.32
Did not seek info	Reference		Reference	
Sought info from friends/family	0.75	0.33-1.70	1.03	0.47-2.30
Did not seek info	Reference		Reference	
Sought info from health professionals	2.05	0.94-4.49	1.10	0.52-2.34
Did not try or observe class	Reference		Reference	
Tried or observed class	1.04	0.49-2.20	1.48	0.73-3.02
Did not seek info	Reference		Reference	
Sought info on community activities	1.13	0.53-2.41	1.32	0.63-2.78
Did not change routine	Reference		Reference	
Made active choices	1.30	0.60-2.83	2.13	0.99-4.59

Table 6.33b: Individual, social and environmental factors by sufficient walking, Males ≥45 years, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Neighbourhood Environmental Walkability Scale (NEWS) items				
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	1.31	0.34-5.01	2.07	0.65-6.65
Mix	0.80	0.30-2.12	2.13	0.77-5.94
Mid- to high-rise apt	2.22	0.18-27.47	**4.15**	**1.00-17.21**
Many shops, stores, market or other places are within walking distance				
Disagree	Reference		Reference	
Agree	1.61	0.77-3.37	1.08	0.54-2.16
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	0.82	0.39-1.75	1.35	0.63-2.89
Not applicable	**0.03**	**0.00-0.51**	2.74	0.31-24.16
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	0.65	0.30-1.44	2.03	0.91-4.53
Not applicable	5.16	0.69-38.76	3.01	0.36-25.30
There are facilities to bicycle in neighbourhood				
Disagree	Reference		Reference	
Agree	0.81	0.40-1.66	0.92	0.46-1.84
Neighbourhood has several free or low cost recreation facilities				
Disagree	Reference		Reference	
Agree	1.63	0.73-3.62	1.11	0.51-2.45
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree	Reference		Reference	
Agree	0.54	0.21-1.39	**0.37**	**0.16-0.86**
Too much traffic makes it difficult or unpleasant to walk				
Disagree	Reference		Reference	
Agree	0.67	0.27-1.66	1.77	0.76-4.10

* adjusted for education level

** includes the 'does not apply' category

Table 6.34a: Individual, social and environmental factors by sufficient activity and walking, Females ≥45 years, 2007 PAM

	Sufficient physical activity		Sufficient all-domain walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Prompted awareness of guidelines				
Not aware of guidelines	Reference		Reference	
Aware of guidelines	**1.72**	**1.17-2.55**	1.52	1.00-2.31
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	1.11	0.78-1.59	**1.75**	**1.13-2.70**
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	0.82	0.41-1.66	1.11	0.55-2.26
Q3 and 4 (highest)	1.33	0.86-2.04	1.07	0.67-1.73
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	1.51	0.84-2.71	0.88	0.45-1.75
Q3	**3.74**	**1.66-8.39**	1.42	0.59-3.39
Q4 (highest)	**2.86**	**1.52-5.35**	1.93	0.94-3.97
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	1.05	0.61-1.83	1.28	0.68-2.43
Q3	1.09	0.66-1.80	1.77	0.99-3.19
Q4 (highest)	1.40	0.84-2.32	**2.89**	**1.70-4.91**
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	2.66	0.98-7.21	0.84	0.31-2.27
Q3	**3.09**	**1.13-8.45**	0.65	0.23-1.80
Q4 (highest)	1.86	0.71-4.89	0.56	0.20-1.51
Intention				
Q1 (lowest)	Reference		Reference	
Q2	0.96	0.54-1.70	**2.05**	**1.04-4.06**
Q3 and 4 (highest)	**1.83**	**1.13-2.96**	**2.06**	**1.11-3.85**
Initial behaviour change				
Did not read articles	Reference		Reference	
Read articles	0.87	0.56-1.35	1.21	0.72-2.01
Did not seek info	Reference		Reference	
Sought info from friends/family	1.16	0.78-1.71	1.21	0.78-1.87
Did not seek info	Reference		Reference	
Sought info from health professionals	0.98	0.66-1.46	0.84	0.54-1.30
Did not try or observe class	Reference		Reference	
Tried or observed class	**1.49**	**1.02-2.19**	0.83	0.55-1.25
Did not seek info	Reference		Reference	
Sought info on community activities	1.09	0.75-1.58	0.89	0.59-1.35
Did not change routine	Reference		Reference	
Made active choices	1.42	0.90-2.22	1.20	0.70-2.03

Table 6.34a: Individual, social and environmental factors by sufficient activity and walking, Females ≥45 years, 2007 PAM

	Sufficient physical activity		Sufficient all-domain walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Neighbourhood Environmental Walkability Scale (NEWS) items				
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	1.03	0.50-2.10	0.85	0.37-1.98
Mix	1.06	0.62-1.80	1.20	0.70-2.03
Mid- to high-rise apt	0.89	0.35-2.24	0.56	0.17-1.83
Many shops, stores, market or other places are within walking distance				
Disagree	Reference		Reference	
Agree	1.30	0.85-2.00	1.24	0.76-2.01
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	1.01	0.64-1.60	**0.52**	**0.31-0.89**
Not applicable	1.00	0.36-2.77	**0.09**	**0.02-0.39**
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	0.83	0.52-1.34	1.11	0.67-1.85
Not applicable	4.86	1.18-20.04	4.79	0.87-26.31
There are facilities to bicycle in neighbourhood				
Disagree	Reference		Reference	
Agree	0.89	0.55-1.41	1.18	0.73-1.92
Neighbourhood has several free or low cost recreation facilities				
Disagree	Reference		Reference	
Agree	1.32	0.78-2.23	1.18	0.68-2.03
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree	Reference		Reference	
Agree	1.14	0.73-1.78	1.07	0.67-1.72
Too much traffic makes it difficult or unpleasant to walk				
Disagree	Reference		Reference	
Agree	1.05	0.65-1.70	0.92	0.57-1.50

* adjusted for education level
** includes the 'does not apply' category

Table 6.34b: Individual, social and environmental factors by sufficient walking, Females ≥45 years, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Prompted awareness of guidelines				
Not aware of guidelines	Reference		Reference	
Aware of guidelines	1.24	0.63-2.42	0.76	0.42-1.38
Knowledge of PA for guidelines				
Does not have knowledge	Reference		Reference	
Has knowledge of amount of guidelines	**1.91**	**1.01-3.63**	**1.84**	**1.06-3.21**
Beliefs about the benefits of PA				
Q1 (lowest)	Reference		Reference	
Q2	0.38	0.11-1.30	0.84	0.30-2.35
Q3 and 4 (highest)	1.19	0.57-2.50	0.89	0.43-1.82
Self-efficacy				
Q1 (lowest)	Reference		Reference	
Q2	1.36	0.41-4.45	**3.38**	**1.34-8.56**
Q3	2.52	0.57-11.19	2.08	0.58-7.48
Q4 (highest)	2.14	0.57-8.01	2.56	0.98-6.65
Social norms				
Q1 (lowest)	Reference		Reference	
Q2	**2.76**	**1.03-7.39**	2.37	0.98-5.73
Q3	2.19	0.90-5.35	**2.65**	**1.14-6.18**
Q4 (highest)	0.89	0.41-1.98	1.84	0.82-4.14
Perceived behavioural control				
Q1 (lowest)	Reference		Reference	
Q2	-	-	0.52	0.12-2.24
Q3	-	-	0.47	0.11-2.06
Q4 (highest)	-	-	0.41	0.10-1.72
Intention				
Q1 (lowest)	Reference		Reference	
Q2	2.68	0.92-7.78	1.49	0.58-3.78
Q3 and 4 (highest)	2.29	0.90-5.82	1.67	0.77-3.61
Trial behaviours				
Did not read articles	Reference		Reference	
Read articles	1.10	0.50-2.42	1.09	0.51-2.33
Did not seek info from friends/family	Reference		Reference	
Sought info, friends/family	1.17	0.59-2.33	0.70	0.41-1.19
Did not seek info health professionals	Reference		Reference	
Sought info, health professionals	**2.33**	**1.15-4.70**	0.87	0.49-1.55
Did not try or observe class	Reference		Reference	
Tried or observed class	0.52	0.25-1.08	1.35	0.73-2.50
Did not seek info on community activities	Reference		Reference	
Sought info on community activities	**2.01**	**1.07-3.78**	1.15	0.66-1.99
Did not change routine	Reference		Reference	
Made active choices	0.76	0.34-1.70	1.31	0.66-2.61

Table 6.34b: Individual, social and environmental factors by sufficient walking, Females ≥45 years, 2007 PAM

	Highest quartile recreation walking		Highest quartile transport walking	
	Odds ratio*	95% CI	Odds ratio*	95% CI
Neighbourhood Environmental Walkability Scale (NEWS) items				
Type of dwelling				
Detached single-family residences	Reference		Reference	
Townhouses, row houses, low rise apts	0.29	0.07-1.14	2.12	0.77-5.79
Mix	0.77	0.32-1.87	1.62	0.79-3.32
Mid- to high-rise apt	0.78	0.14-4.47	**7.04**	**1.51-32.86**
Many shops, stores, market or other places are within walking distance				
Disagree	Reference		Reference	
Agree	0.96	0.46-2.00	**2.62**	**1.33-5.14**
Transit stop 10-15 minute walk from home				
Disagree	Reference		Reference	
Agree	2.00	0.93-4.31	1.14	0.57-2.28
Not applicable	3.01	0.50-18.23	0.41	0.07-2.28
There are sidewalks on most of the streets in my neighbourhood				
Disagree	Reference		Reference	
Agree	1.00	0.46-2.16	1.95	1.00-3.83
Not applicable	**8.32**	**1.17-59.34**	0.47	0.02-11.19
There are facilities to bicycle in neighbourhood				
Disagree	Reference		Reference	
Agree	0.60	0.30-1.17	0.73	0.36-1.51
Neighbourhood has several free or low cost recreation facilities				
Disagree	Reference		Reference	
Agree	0.95	0.43-2.10	1.01	0.39-2.61
Neighbourhood crime rate makes it unsafe to go on walks at night				
Disagree	Reference		Reference	
Agree	1.06	0.49-2.26	**0.44**	**0.22-0.87**
Too much traffic makes it difficult or unpleasant to walk				
Disagree	Reference		Reference	
Agree	0.58	0.28-1.22	1.60	0.79-3.26

- Data not released due to insufficient sample size
* adjusted for education level
** includes the 'does not apply' category

6.4 Discussion

The primary objectives of this Chapter were to:

- understand the proportion of Canadians that met the criteria for being sufficiently active and the proportion of Canadians who walked sufficient amounts in 2007;

- independently explore the contribution of individual, social and environmental factors in relation to physical activity and walking; and,
- take a socio-ecological approach for examining individual, social and environmental factors in predicting sufficient activity and walking.

The unique contribution of this Chapter compared to the previous Chapters is the investigation into which of the individual, social, and environmental factors were more strongly associated with predicting sufficient walking and activity. This was first explored by taking into account age, sex, and education, and then subsequently examined by looking independently for younger women and men, and older women and men.

Inactivity is prevalent among the Canadian population, with only one-third of adults undertaking sufficient amounts of walking to meet the guidelines of 60 minutes daily (walking for any purpose). In addition, just over half of adults reported that they perform enough daily PA to be considered sufficiently active. A multi-faceted and ecological approach examining the contribution of individual, social, and environmental factors to these behaviours is important. Earlier Chapters have demonstrated the influence of individual factors (such as knowledge, intention, certain trial behaviours - see Chapter Four) and environmental factors (such as access and availability of opportunities – see Chapter Five) on activity and walking, however, this Chapter examined all of these factors simultaneously, and their relative contribution to activity and walking.

Compared to 2003, there were no statistically significant differences in the proportions meeting the walking criteria in 2004 or 2007. In 2007, the percentage who were active enough (56.6%) was slightly higher than that in 2003 and 2004. Findings from this Chapter indicate that sufficient amounts of PA and walking behaviours vary with demographic groups, namely

- more men than women were sufficiently active according to the PA criteria; there are were no gender differences for walking,
- sufficient levels of activity and walking decrease with increasing age,
- activity level did not vary by education, whereas differences with education level appear for walking.

These relationships with activity were generally consistent over time (see Chapter Four, Chapter Five), with a few notable exceptions: in 2003 and 2004, greater proportions of men

compared to women walked sufficient amounts whereas in 2007, there were no significant gender differences with walking; and, a relationship between activity level or walking and education appeared in 2003 and 2004 but was not significant in 2007.

Individual factors related to PA and walking were explored in this Chapter, such as prompted awareness, knowledge of guidelines, beliefs about the benefits of PA, personal behavioural control, intention to be active, and steps towards initial behaviour change. Interestingly, there have been changes in overall proportions and relationships with covariates over time with respect to the factors. There has been a decline over time in awareness (prompted) of guidelines. A previous relationship with education and sex no longer exist, whereas a new relationship with age emerged in 2007. There has been a substantial increase over time in the proportion of Canadian adults who had knowledge of the PA guidelines (56.9% in 2007 and 43.1% in 2003), and although there is no relationship with covariates in 2007, there were significant relationships with age and with education in 2003 (see Chapter Four). Similarly, the prevalence estimates for the beliefs about the benefits of PA have also increased significantly in 2007 compared to 2003 (see Chapter Four), and the relationships between these beliefs and the covariates have remained consistent over time. Although perceived behavioural control was not measured in 2003, intention to be active was. Similar to other factors, the proportion scoring the highest value of the scale for intention is slightly higher in 2007 compared to 2003 (see Chapter Four), and again the relationship to the socio-demographic variables have persisted over time, with the exception that the association with education differs slightly in 2007. In terms of steps taken towards initial behavioural change, there have been some slight increases between 2003 and 2007 in the proportion who indicate that they have taken these steps, such as reading articles (55.1% in 2003 compared to 60.8% in 2007), seeking information from family and friends (40.1% in 2003 vs. 44.7% in 2007), and obtaining information from health professionals (25.2% in 2003 vs. 29.4% in 2007). Generally speaking, however, relationships with the covariates have remained consistent over time (see Chapter Four).

This Chapter also looked at specific factors describing the neighbourhood characteristics or physical environment in which Canadians live. The Chapter specifically used and examined a subset of the Neighbourhood Environment Walkability Scale, shown to be a valid and reliable measure of the neighbourhood environment [Brownson, 2004; Cerin, 2006]. The same

measures were used consistently over the two time periods of data collection (that is, 2004 and 2007). There have been very few changes over time in the overall distribution of the environmental measures for these two data collection periods. For example, there was a greater proportion in 2007 who said that their neighbourhoods were primarily made up of single-family, detached homes compared to 2004, whereas fewer indicated that they lived in neighbourhoods with a mixture of single family homes, townhouses, row houses, apartments and condominiums. Furthermore, compared to 2004, a slightly higher proportion agreed that too much traffic made it difficult or unpleasant to walk. There were also differences over time in the relationship between the environmental factors and the covariates. In 2004, relatively more young adults (i.e., 18 to 24 years) agreed that their neighbourhood had many places to shop, transit stops, sidewalk on streets, and low cost or free recreational facilities, however, in 2007 these relationships were either not statistically significant or not as clear. Although too much traffic in the neighbourhood was not related to education level of the respondent in 2004, there was a relationship with education in 2007. The reverse was true for bicycling facilities.

In looking at the changes in the individual and environmental factors, there have been substantial changes in individual factors whereas less variation in the environmental factors. Intuitively, it makes sense that one would see the most change in prevalence rates among attitudinal or individual factors towards PA more so than concrete or tangible factors, such as physical infrastructure. For example, attitudinal shifts could possibly reflect changing cultural or social norms towards physical activity, and greater coverage in the media regarding obesity and overweight reflecting a general shift in awareness and knowledge, as examples. However, one would expect that factors related to infrastructure would have much less fluctuation over time especially in a relatively short time period (such as over three years, 2004 to 2007), unless significant changes or modifications were made to the environment during that time period. This is supported by what was found with data in this Chapter in comparison to findings in Chapter Five, where there have been very little shifts over time in the prevalence of environmental factors. It is important to note, that the general methods of the studies for both time periods have remained consistent (i.e., time frame for data capture, ethics procedures, data collection method, and sample frame selection), therefore, it is probable that the reason for the change would tend to be extraneous to the survey protocol and methods themselves. Future surveys examining these factors are warranted to determine if these changes in

prevalence, particularly among the attitudinal and other individual factors, are sustained over time.

In addition to looking at the factors by covariates, a key research question examined the relationship between these factors and their relative contribution in predicting PA and walking. Considering the findings from Chapter Four, similar findings have appeared in 2007 when looking at individual and interpersonal factors associated with PA and walking behaviours. For example, knowledge about the amount of PA required, higher scores of intention to be active, and certain initial behaviours towards becoming more active, were associated with a greater likelihood of overall walking sufficient amounts and sufficient PA in 2003. Intention and knowledge about the amount of PA required were predictors of activity in both 2003 and 2007, however in 2007, knowledge is only significant in early models, but is not significant in the full models. Self-efficacy was added to the 2007 model, and is an important predictor of behaviour as posited in social cognitive theories (see Chapter Two). PBC was also added in 2007, however, is less significant as a predictor. When considering the results of Chapter Five, similar findings were observed when looking at cross-tabulations between environmental factors and activity and walking, in that very few significant differences appeared in both time periods. In 2004, there were relationships between having shops nearby and sufficient walking, and neighbourhood crime predicting lower odds of sufficient activity, however, these relationships were not significant in 2007 for all-domain walking, yet were significant for walking for transportation purposes. The similarities and general persistence of many relationships across the years is reassuring given the fluctuations in some of the prevalence rates over time.

Expanding the focus from all-domain walking, this Chapter also explored more purposeful walking, namely, walking for recreation and walking for transport. Differing relationships to those found for all-domain walking were found when considering walking for transportation purposes. For example, slightly more environmental factors were significant among walking for transportation purposes, as opposed to recreational and all-domain walking. Dwelling type was associated with all-domain walking and transportation walking, however, having shops nearby and sidewalks on most streets predicted the highest quartile of active transportation (yet were not significantly associated with either recreational walking or all-domain walking). These relationships with transport walking are supported somewhat by the literature, whereby Saelens and Handy [2008] found a relationship between walking for transportation and residential

density, land use mix, and also distance to non-residential destinations in a review of reviews, but did not find this relationship for recreational walking. The authors note though that infrastructure such as sidewalk availability and their condition was less consistently related to walking for transport and more so for walking for recreation [Saelens & Handy, 2008]. Cerin et al. [2006] found in their validity and development work of a short version of the NEWS that the scales developed to measure variation in access to destinations, residential density, walking infrastructure, aesthetics, safety and crime were positively associated with walking for transport, whereas aesthetics, mixed destinations, and residential density were positively associated with recreational walking. Moreover, Brownson et al. [2009] found that PA with different purposes (or domains) is influenced by different aspects of the environment (such as the availability of recreation facilities for leisure time activities and availability of sidewalks or bicycle lanes for active transportation).

This Chapter differs from the previous two by taking a more ecological approach to understanding all of these factors where they were examined in one model to determine the relative contribution of each to PA and walking, when taking into account age, sex, and education level. The analyses in this Chapter indicate that many individual factors were associated with both activity and walking. Higher scores of self-efficacy, social norms, and intention were associated with higher odds of sufficient activity and all-domain walking. In addition, prompted awareness of guidelines also predicted sufficient PA. Making active choices at work and dwelling predicted sufficient all-domain walking. Knowledge about the amount of PA required, higher self-efficacy and social norms scores, and making active choices at work were associated with the highest quartile of recreational walking. These findings once again suggest, similarly to Chapter Four, that more distal variables from campaigns [McGuire, 1984; Cavill & Bauman, 2004] including intention and initial attempts at becoming more active are associated with PA, and these factors are an immediate precursor of PA behaviour [Godin, 1987; Rhodes & Plotnikoff, 2006]. Compared to the individual and social factors, relatively few environmental factors were associated with sufficient walking or being active. The type of neighbourhood dwelling predicted various types of walking, whereas having shops nearby and sidewalks on most streets were associated with a greater likelihood of walking for transportation. These particular relationships, however, do not necessarily hold when considering younger men and women independently, or when comparing older men and women independently.

When examining the socio-ecological model for younger men and women separately, there were similar general relationships with the individual factors with sufficient activity and walking for both sexes. Self-efficacy and social norms were important for both sexes for varying types of activities. Making active changes in their daily routine, and trying or observing a PA class were associated with being active for transport walking for both sexes. Intention to be active was associated with higher odds of activity for men but not for women. Reading about PA was associated with lower all-domain walking for men, whereas seeking advice from health professionals predicted lower all-domain walking among younger women. Interestingly, neighbourhoods with mixed dwellings predicted higher all-domain walking among men, but lower odds among women. For older adults, some relationships persisted for both genders, namely: higher self-efficacy and intention predicting sufficient PA; higher social norm scores for predicting all-domain walking; living in neighbourhoods with primarily high-rise apartments increasing walking for transportation; and the presence of crime lowering the odds of walking for transportation reasons. Despite these similarities, the Chapter describes considerable differences between older men and women in factors which increased or decreased the odds of PA and walking. Although overall relationships are important when considering a population approach for developing marketing or communications strategies for increasing active behaviour, the stratified models are also important to take into consideration when looking for more targeted strategies for particular groups.

Research has indicated that the "visibility" of PA opportunities in certain areas may contribute to the social norms of that area, and may in turn potentially affect behaviour change [Giles-Corti & Donovan, 2002]. As the only social factors considered in this particular study, and given the role of social norms on walking and activity in this thesis, an approach which incorporates positive changes within communities can help promote changes in larger community populations, through the provision of cues, increased 'visibility' and readily available opportunities [Giles-Corti & Donovan, 2002]. Strategies and interventions, which aim to affect individual-level change, can work in conjunction with these wider changes to the social environment to increase activity levels. Interventions considering the multiplicity of factors at the individual, social, community, and environmental level may be the most effective for positive change, given the complex inter-relationship between these factors. Higher social norm scores in this thesis were associated with higher levels of walking (and in some cases for

activity overall) for younger and older men and women, especially in relation to all-domain walking. Stage-based individual interventions based on the TPB [Courneya et al., 2001] and marketing or communication strategies for promoting activity at a community or national level are warranted [Craig et al., 2010].

The ecological model yields a key finding in this study. Looking at the factors together, along with their relative contribution in predicting PA level and sufficient walking, individual factors and the only social factors (social norms) may be more salient for predicting sufficient PA and walking than environmental factors. This replicates the findings of studies examining PA and walking [McNeill et al., 2006; Cleland et al., 2010; Ishii et al., 2010]. There are several plausible explanations for these findings.

The presence of, and the dose-response relationship between many of the individual and the social factors with walking and activity, suggests that these factors may be more important considerations when trying to change the behaviour. This finding has also been found in other studies [Cleland et al., 2010]. Cleland and colleagues examined these factors for women (18 to 45 years of age) living in socioeconomically disadvantaged neighbourhoods, and found that individual and social factors were most important for leisure time PA, whereas individual, social and neighbourhood factors were associated with transport related PA [Cleland et al., 2010]. However, the examination of environmental factors is limited when interpreting transport-related findings. It was not stratified by location and as environmental characteristics may differ between types of neighbourhoods, in particular as it relates to transportation-related PA. Finally, it should be noted that the measures of neighbourhood environment included two items that could be classified as social norms, confounding the environment level measures with social level measures. These factors may skew the observed relationships, particularly in comparison to those obtained in this thesis. The findings in this thesis also replicate the findings of an earlier Canadian study [Pan et al., 2009], which used a similar ecological framework. Demonstrating that these relationships between factors and PA are stable is important from a policy perspective as it substantiates the need for multi-level (e.g., national communication strategies through local level provision of access to supportive facilities) and multi-sectoral (e.g., public health, education, transportation) strategies. Limitations with both the Pan et al. [2009] study and with this thesis are that they did not assess mediation between factors and therefore were not able to ascertain potential pathways between variables with the

outcome measures [Pan et al., 2009]. This is further discussed in Section 7.3 of this thesis. Also, Pan et al. [2009] did not examine the degree to which the addition of environmental factors improved the fit of the model. The analyses in Chapter Six, however, does expand on the research by Pan et al. [2009] by testing the relative contribution of individual, social and environmental factors in terms of the amount of variation explained by the various models and by exploring walking for varying purposes and by looking at particular sub-groups among the population.

Findings from this Chapter indicated that very few environmental factors were associated with increases in walking and activity. Perhaps in countries that have prevalent opportunities, changing attitudes, perceptions of self-efficacy, control and intentions are essential overall and when targeting particular population groups. Indeed, based on findings in this Chapter and Chapter Four, Canadians generally do seem to provide positive ratings about the availability of opportunities supporting activity in their neighbourhood and, conversely, negative ratings about possible barriers, such as traffic and crime. Perhaps the skew in these responses of the prevalence of opportunities has reduced the ability to detect differences related to the NEWS environmental items within this thesis. For example, a multi-country study [Sallis et al., 2009] was designed to capture a greater range in these across countries than likely apparent in any one country in order to increase the variability of NEWS items and it found that most environmental characteristics were associated with an increased likelihood of sufficient PA; however, that study did not include individual level factors. In addition, it found a positive gradient between the number of positive environmental attributes and sufficient PA, however within Canada such a scale may have lower reliability. It may be that within countries, a finer grained measure of the perceived and objective measures of the actual physical environment are required to achieve sufficient variation (e.g., amount, distance to, and quality of supportive facilities).

The strength of the 2007 PAM as a data source was that the survey content permitted the examination of the relationships of individual, social, and environmental factors to activity and walking behaviour. Despite the cross-sectional nature of the study precluding the ability to infer causal relationships, it is interesting to note the associations that appear that could be used to guide the conceptualization of longitudinal studies pertinent to the Canadian context. The Monitor was national in scope, and although cross-sectional, contributes to the knowledge base

when informing policy and practice related to PA. In addition, consistent questions and methodology on each of the Monitors over time allows the comparison of trend data by ensuring consistent findings. The individual factors were drawn from theory, and the environmental factors used a valid and reliable measure, namely, an abbreviated version of NEWS. The study did have certain limitations in that it relies on self-reported measures of a complex behaviour and was subject to recall error. The skew of the data may have reduced the ability to detect relationships between the measures and PA and walking. Nonetheless, the overall results with respect to the relative contribution of individual and environmental factors were consistent with earlier findings, which support the conclusion that ecological approaches to developing interventions and strategies are warranted. Given this, the results from these three Canadian studies are synthesized in Chapter Seven to provide overall conclusions and recommendations to guide such interventions and strategies.

Summary of Chapter Six

Chapter Four explored intrapersonal factors associated with PA and walking, whereas Chapter Five delved into factors pertaining to the physical environment and their relationship with these two outcome behaviours. The purpose of Chapter Six is to take an ecological approach and combine these multiple factors, along with social factors, to explore the contribution of these to walking and PA more generally. Based on the findings of the literature summarized in this Chapter and findings from earlier Chapters of this thesis, it is hypothesized that intrapersonal factors will play an integral role in the model to predict PA and walking more so than environmental measures.

This Chapter summarizes data from the 2007 Physical Activity Monitor, which was a random and nationally representative study of adults conducted in Canada. These measures are described briefly in this Chapter in terms of data treatment and analysis protocols. The key research questions in this Chapter investigate:

- individual factors independently, by covariates, along with their association with PA and walking;
- environmental-level factors, by covariates, along with their with their association with PA and walking
- individual, social, and environmental factors predicting PA and walking; and,
- individual, social, and environmental factors predicting PA and walking stratified by age and sex group.

Unique to this Chapter is the exploration of walking for recreation and walking for transportation independently as the literature has shown that factors differ on the type of walking undertaken.

First, individual factors varied by covariates. For example: more women, older, and higher educated adults held higher beliefs about the benefits of PA; more men, younger, and higher educated adults cited the highest level of self-efficacy; generally more women and those with higher levels of education had made attempts to become more active, whereas these types of attempts generally were less prevalent among older adults. Only one set of measures were used to assess the social environment, which is described as social norms supporting walking. Relatively more young adults and those with lower levels of education fell within the highest quartile of the social norms score. The individual and social factors were combined into one model to explore relative contribution to predicting PA and walking. Awareness of guidelines, higher scores of self-efficacy, social norms, and intention were associated with higher odds of meeting the sufficient PA criteria. Higher scores of self-efficacy, social norms, intention, and making active choices at work were associated with higher odds of sufficient all-domain walking. Many individual and social factors were also associated with higher levels of both recreational and transportation related walking.

Similar to Chapter Five, a greater proportion of older individuals live in neighbourhoods with predominantly single family dwellings, whereas younger adults tend to report residing in mixed dwelling neighbourhoods (higher density). Other relationships include: more women, older adults, and those with lower levels of education agreed that neighbourhood crime made it unsafe to walk; relatively more young adults cited the availability of sidewalks; and fewer adults with a low level of education cited the availability of nearby transit stops and sidewalks on most streets. In terms of predicting PA and walking, living in neighbourhoods consisting of primarily high-rise apartments was associated with a lower likelihood of all-domain walking. Factors varied depending on the type of walking undertaken. For example, only one factor predicted walking for recreation (i.e., too much traffic was associated with lower odds of high recreational walking). A greater likelihood of achieving the high transport walking was seen among those who reside in mix-dwelling neighbourhoods and where there are many shops, stores, and other places within walking distance. Neighbourhood crime, however, was associated with lower odds of walking for transport.

This Chapter differs from the previous two by taking a more ecological approach to understanding all of these factors where they were examined in one model to determine the relative contribution of each to PA and walking. Many individual factors were associated with both activity and walking: prompted awareness of guidelines predicted sufficient activity; living in mixed dwelling neighbourhoods and making active choices at work predicted

sufficient all-domain walking; knowledge, higher self-efficacy, higher social norm scores, and making active choices also predicted recreational walking. These findings suggest that more distal variables, which are used to plan and assess campaigns results, including intention and initial attempts at becoming more active were associated with PA or walking, and these factors are an immediate precursor of PA behaviour [Godin 1987; Rhodes & Plotnikoff, 2006]. Compared to the individual and social factors, relatively few environmental factors were associated with sufficient walking or being active. Specifically, the type of neighbourhood dwellings predicted various types of walking, whereas having many shops and stores nearby and sidewalks on most streets was associated with a higher quartile of transportation walking. These particular relationships, however, do not necessarily hold when considering younger men and women independently, or when comparing older men and women independently. The stratified models are also important to take into consideration when looking for more targeted strategies for particular group. This is a unique contribution of this Chapter, compared to earlier Chapters.

Employing the ecological model yields a key finding in this study. Looking at the factors together, along with their relative contribution in predicting PA level and sufficient walking, individual factors and the only social factor examined (social norms) may be more salient for predicting sufficient PA and walking than environmental factors.

CHAPTER SEVEN - Conclusions and Recommendations

7.1 Concluding remarks

This thesis revealed that both leisure-time PA and walking were related to a diverse range of factors at the individual and environmental levels in Canada. As with other complex behaviours, an individual's decision to participate in PA is influenced by a multitude of factors. Consequently, in order to examine these behaviours in a comprehensive manner, and to affect change in behaviour, it is important to consider these together. As discussed in Chapter Two, several theoretical frameworks, which explain participation in PA, focus on the "individual", including elements such as knowledge, attitudes, beliefs, and behaviour within an individual. Although these frameworks, such as the Theory of Planned Behavior or the Hierarchy of Effects model (factors included in these theories and models are covered in Chapters Two, Four, and Six) are commonly used, they do not necessarily take into consideration other factors which influence participation such as the social environment or the physical or built environment. It is theorized that individual behaviours are modified when an environment is supportive. As such, a socio-ecological model, which considers multiple factors, is useful in explaining behaviour, and is used in this thesis. These types of models assist in identifying factors that can help inform more effective policies or strategies to increase PA levels.

Chapter Three described the methodological considerations of this thesis. It described public health surveillance surveys in Canada that are national in scope, including PA measures and correlates. Moreover, the Chapter explored the historical development of the PA measures and the specific measures used throughout the thesis. Chapter Four examined correlates at an individual level using the TPB as its theoretical basis and described the prevalence of these factors and the association between the individual factors with PA and walking. Chapter Five followed with an exploration of the environmental determinants and neighbourhood characteristics to explain PA and walking behaviours. Chapter Six took both Chapter Four and Chapter Five into consideration by further exploring the findings within a socio-ecological approach, the contribution of the individual, social, and environmental factors in predicting PA and walking.

Supporting the main research hypothesis of this thesis, individual factors and social norms were found to be associated with sufficient PA and certain types of walking. The findings in Chapters Four and Six suggest that individual factors such as knowledge about the amount of

PA required for guidelines, self-efficacy, intention, and some trial behaviours are important correlates of PA and walking, and this is supported by other studies [McNeill et al., 2006; Maddison et al., 2009; Pan et al., 2009]. Findings in Chapters Five and Six, however, indicate that relatively few environmental factors were associated with sufficient walking (all domain and domain-specific) or sufficient PA. In general, these results support some findings in the current literature and our research hypotheses regarding the relationships between environmental factors and PA. More specifically, the relationship between high density neighbourhoods and higher rates of utilitarian walking [Saelens et al., 2003], and the relationship between convenient walking facilities (sidewalks, accessibility of destinations, perceptions about traffic) with various modes of walking are apparent [Owen et al., 2004]. Specifically, two reviews [Brownson et al., 2009; Saelens & Handy, 2008] concluded that residential density within a neighbourhood was consistently associated with walking for transport, and in this thesis, neighbourhood density was associated with transport walking in that adults living in neighbourhoods of mixed dwellings predict the highest quartile of transportation walking. There are some inconsistencies between the literature and the findings in this thesis. Saelens et al. [2008] found that walking for transport was associated with distance to non-residential destinations and that infrastructure such as the availability of sidewalks and their condition was less consistently related to walking for transport but was for recreational walking. Findings from one model in Chapter Six also found that proximity of many shops and the availability of sidewalks were associated with the highest quartile of walking for transport, but this was not significant for recreational walking. A review by Brownson et al. [2009] found that activity with different purposes is influenced by various aspects of the environment, which generally agrees with the findings of this thesis.

The general lack of relationships between PA, walking, and self-reported environmental measures in this thesis may be explained, in part, by the generally high proportion of respondents that indicate the availability of opportunities supporting activity in their neighbourhood coupled with the low proportion indicating barriers, such as traffic and crime. This lack of variability may have reduced the ability to detect differences related to the environmental factors. Findings suggest that perhaps within countries like Canada, which are fortunate to have a relative abundance of support within the physical environment, more specific and detailed measures of the perceived and objective physical environment are required in order to achieve sufficient variation (e.g., amount, distance to, and quality of

supportive facilities). Other research has hypothesized that individual level interventions may be more effective when the environment is high in resources and low in barriers [King et al., 2006; Kerr et al., 2010].

Chapter Six examined individual, social, and environmental items within an ecological framework. The findings from Chapter Six suggest that individual factors may be more relevant for predicting activity and walking than environmental factors, or at least should be considered in their inter-relationship with environmental factors when developing environment-based interventions. This finding confirms the first research hypothesis of this study and replicates the findings of an earlier Canadian study examining leisure-time PA [Pan et al., 2009] which used a similar ecological framework. Demonstrating that these relationships between factors and PA are stable is important from a policy perspective as it substantiates the need for multi-level (e.g., national communication strategies through local level provision of access to supportive facilities) and multi-sectoral (e.g., public health, education, transportation) interventions. Indeed, demonstrating the continuing relationship between individual factors and PA from the 2003 PAM was one reason that ParticipACTION, Canada's national social marketing agency for PA, was re-established in 2007 [Tremblay et al., 2009]. Furthermore, this thesis expands the work of Pan and colleagues [2009] by extending the results from considering only LTPA to overall PA across all domains and by examining walking behaviour in Canada. The extension to examine walking specifically is important as messages in the Canadian guidelines emphasized starting slowly and building up the amount of PA to reach a sufficient amount, and walking was frequently promoted as an activity that everyone could do to accomplish this. Additional counselling materials focused on identifying barriers (e.g., time constraints) and overcoming them (e.g., national campaigns promoting active commuting such as walking under the national Commuter Challenge[1] and Winter Walk Day[2]). One would, therefore, expect to see a link between the factors in the ecological model and walking as was found to be the case in this thesis. This finding is consistent with relationships that have been observed previously by other studies examining PA and walking [Giles-Corti et al., 2002; McNeill et al., 2006; Cleland et al., 2010]. One explanation of this finding may be that perceptions of the neighbourhood go through a filtering process based on personal characteristics or a cognitive-environmental interaction. For example, some studies have found that environmental factors were mediated

[1] http://commuterchallenge.ca/ (accessed May 31, 2014)
[2] http://www.participaction.com/february-5-is-winter-walk-day/ (accessed May 31, 2014)

by attitudes and intention [Rhodes et al., 2006; Rhodes et al., 2007]. Therefore, although the inter-relationship between individual factors, social factors and the built environment are important, understanding individual factors are critical for determining strategies and interventions to modify behaviours, and to promote PA among certain populations with traditionally lower levels of activity. To illustrate, strategies to change individual behaviours involve modifying intra-personal characteristics such as knowledge, attitudes, beliefs, and feelings of control, as described by the Theory of Planned Behavior and the Hierarchy of Effects model in Chapter Two. In addition, societal changes can be modified by public awareness and education [Sallis, 1998] and changing social norms. Sallis [1998] suggests that strategies focusing on the built environment should be put in place before educational or awareness interventions; for example, social marketing campaigns encouraging people to walk may not be as effective if there are no or poorly maintained walking paths or where safety is an issue. The next section summarizes the key findings from this thesis, and based on the current literature on interventions, recommendations are made for further work which aims to increase overall PA levels and walking.

7.2 Recommendations for consideration

As described in Chapter One, the World Health Organization endorsed a global strategy and action plan for the prevention and control of non-communicable diseases (NCDs), while recognizing physical inactivity as one of the key determinants of NCDs [WHO, 2008]. This plan recommended the development and implementation of national guidelines for PA, along with interventions for active transportation policies and ensuring supportive physical environments [WHO, 2010]. National guidelines are seen as important for informing policies and interventions, for the purpose of

- establishing goals and objectives,
- establishing PA promotion and communication initiatives,
- providing a framework and evidence-based document, and
- facilitating national surveillance and monitoring to monitor population levels of PA.

Canada had established national guidelines for PA in 1998, 1999, and 2002, and then revised these guidelines based on existing literature in 2011 [Tremblay et al., 2011]. In addition,

Canada is relatively unique (besides Finland) in having a long-history of PA surveillance [Kohl et al., 2012], as described in detail in Chapters One and Three. The evidence provided by the surveillance system, along with the national guidelines which were established based on the literature, and provided the necessary foundation to establish benchmarking indicators as a baseline on which to develop goals and objectives. The ongoing consistency in methodology and the annual collection of data within the surveillance system permits the assessment of the progression of these goals. Despite early trends showing increases in activity levels, later data showed that since about 2003, there has been a general plateau of activity levels in Canada [Craig et al., 2004]. Findings from this thesis are important for providing further evidence about the underlying factors associated with sufficient PA and walking to help inform strategies and interventions that can contribute to increasing activity levels and walking within the Canadian population. Given the popularity of walking among the population [Cameron et al., 2007], an obvious choice of activity to incorporate into this type of strategy or intervention would be increased walking (and therefore activity levels). The promotion of walking is generally applicable among virtually all segments of the population, particularly those least active, due to its ease, convenience, and its ability to be undertaken for a variety of purposes. Walking is, therefore, the focus of the recommendations in this section.

Reviews of walking interventions [Ogilvie et al., 2007; Williams et al., 2008; Bird et al., 2013] found that certain components of interventions have been useful in increasing walking. It was suggested from the Williams review that prescribing moderate intensity walking for 5 to 7 days per week in either single or multiple sessions, and applying theory based interventions, should be considered [Williams et al., 2008]. This is consistent with other recommendations on the amount of walking required for health [Boone-Heinonen et al., 2009]. In this review, Williams and colleagues found some initial evidence that telephone prompts to increase walking behaviour may be useful among some groups, but they express that more research is required [Williams et al., 2008]. A systematic review underscored the importance of prompts for self-monitoring and building intention in increasing walking [Bird et al., 2013]. As an example provided in this review, the use of pedometers or phone apps may be one way of self-monitoring walking behaviours [Merom et al., 2007; Bird et al., 2013], whereas another review found less consistent findings [Williams et al., 2008], suggesting further research on the use of devices for self-motivation is warranted. These are suggestions for further research, as caution in reviews cite differences in varying characteristics of the sample, size of sample, age of

participants, study design, type of measures, and lack of international data provide limitations. One intervention study cited in the review that was successful for increasing walking combined mass media with an individualized approach (e.g., face-to-face approach such as a worksite and physician based programs, public relations) and could be considered for increasing walking at a population level [Reger-Nash et al., 2005; Williams et al., 2008]. This idea is further examined below.

Such multi-prong strategies require the understanding and incorporation of theory-based (such as the Theory of Planned Behavior) elements for well-developed communication campaigns when promoting healthy behaviours, including PA. The elements comprising the Hierarchy of Effects Model [McGuire, 1984; Cavill & Bauman, 2004], which was developed for the purpose of campaign development and evaluation, contains factors that are very consistent with the Theory of Planned Behavior. This model suggests that a cascading series of effects from immediate impacts (awareness) to more proximal and distal impacts (i.e., increased knowledge, saliency, attitudes, beliefs, self-efficacy, and intention) to longer term effects (e.g., trial of PA and maintenance of activity) are involved in promoting behaviours through campaigns. Community campaigns or mass media campaigns are interventions used to encourage population-level behaviour change. A review of the literature by Cavill [1998], found three studies examining the effectiveness of mass media usage in national health promotion campaigns encouraging PA. These studies showed limited short-term behaviour change, but influenced knowledge and attitudes towards PA [Cavill, 1998]. Mass media campaigns are useful for increasing awareness; however, a tailored approach at an individual level may be more useful for changing the behaviour factors and initiating the first steps for behaviour change. This may assist health promoters by providing the necessary information required in order to tailor their promotional, educational, or communication strategies to help engage these populations to become more active. In a 2007 review, Ogilvie and colleagues found that interventions that tailored their approach to suit needs of participants and delivered at individual, household or group levels were more likely to increase walking [Ogilvie et al., 2007]. Examples of these can be face-to-face advice within the workplace or by clinicians, education sessions, or telephone and internet delivery of interventions [Ogilvie et al., 2007]. Pratt and colleagues reviewed internet-based physical activity trials and found that web-based interventions indicate small but positive effects, but few are theoretically based [Pratt et al., 2012]. In addition, Ferney and colleagues [2009] explored in a pilot study an 'ecological'

approach to focus on walking within a specific setting (that is, the neighbourhood) among inactive, middle-aged adults. The study, a 26-week randomized trial, found that a local neighbourhood environment-focused activity website was more effective than a motivational information-based website. The focused website content was based on an ecological model of individual and environmental influences for both PA and walking, was interactive, and included eleven areas of content (i.e., 'fact sheets' emphasizing strategies, activity examples, links to websites, self-monitoring tools, searchable database of opportunities for PA, an event calendar, a walking trails map, suburb profiles, personalized email advice, bulletin board, and informational 'news' items) [Ferney et al., 2009]. The comparison website had minimal interactivity with non-individualized emailed information on cognitive or behavioural strategies [Ferney et al., 2009]. Results found that the 'neighbourhood group' had increased unprompted recall, felt that the website would help them be more active, recalled emails, and logged in 3 times more likely to the website [Ferney et al., 2009]. Although there were differences in PA in the 'neighbourhood' group and this increase was maintained to the end of the treatment, there were no within or between differences with the motivational group. Despite limitations with the study including the inability to determine whether other extraneous factors influenced the study (such as seasonal variation, the higher rates of PA at baseline among the motivational group, the study took place in a highly walkable neighbourhood, a relatively small sample size, and the relatively limited research in the area), the use of the internet and various other communications technology for public education and increased public awareness certainly warrants further investigation. A combination of approaches, therefore, may be considered—community wide campaigns or mass media in combination with individual-based interventions.

The use of a combination of approaches should move beyond individual-based approaches towards a multi-level or broader ecological approach incorporating the complex inter-relationship between individual, social, and physical environment factors. Giles-Corti and colleagues [2005] stress the need to use ecological models for understanding the factors influencing PA. In addition, these researchers discuss the need to look at the behaviour of walking in a variety of contexts [Giles-Corti et al., 2005]. They suggest that the predictive ability of ecological models may be improved if the measures match the behaviour and the setting of the behaviour. One example of this may be the appropriateness of measuring certain environmental measures in predicting walking for transport and walking for recreation separately. To address this issue, Chapter Six explored all-domain walking, recreational

walking, and walking for transport. A key finding from this thesis showed individual factors as important correlates of PA and various types of walking, whereas relatively few environmental factors were associated with specific walking and activity. Notably, the highest quartile of walking for transport was associated with the proximity of shops and sidewalk availability, yet was not significant for recreational walking. This is a finding that has also been observed in other literature [Giles-Corti et al., 2003; McCormack et al., 2011]. Two of the recommendations from the WHO NCD prevention plan were the inclusion of interventions for active transportation policies and ensuring supportive physical environments, and data from this thesis indicate a relationship between transport walking and an environment that supports active transportation. Hallal and colleagues [2012] provide a summary of the prevalence of active transportation in several countries and report prevalence of walking or bicycling to work was very low in North American countries. In countries with higher rates of active transportation, such as Denmark, there has been a considerable evolution of supportive infrastructure over the past two decades which have resulted in a substantial increase in participation (that is, a 50% increase in Denmark) [Hallal et al., 2012]. Understanding the development of policies and a supportive infrastructure in countries that demonstrate higher rates of active transportation may be an effective way of increasing the currently low prevalence rates which are seen in Canada.

Given the finding in the thesis that initial steps related to changes in activity at the workplace were associated with walking, promoting initial steps or point-of-decision prompts for active transportation to work may be an effective way to increase the proportion meeting recommended levels of activity [Centers for Disease Control and Prevention, 2002]. Signage motivating individuals to take the stairs rather than elevators or escalators, signage on public transportation encouraging riders to exit public transit one or two stops earlier and walking the remaining distance are examples of these types of prompts [Giles-Corti et al., 2003]. Clearly, however, based on the findings in Chapters Five and Six, characteristics that are supportive within the built environment increase the likelihood of walking for the purpose of transport, therefore, ensuring these exist prior to such a promotional campaign would be necessary.

Based on surveys conducted within Canadian communities, environmental supports such as the provision of multi-purpose trails (particularly among trails that do not permit motorized vehicles), designated bicycle lanes, and supports for active transportation on public transit (such as bicycle racks) has increased considerably in recent years [Canadian Fitness and

Lifestyle Research Institute, 2010]. Moreover, given that environmental conditions are generally favourable to PA and prevalent in Canada, policy efforts should focus on ensuring that this remains the case during urban development and renewal. Despite the above advances in environmental infrastructure in Canada, it still appears that policy in this area is lacking. Based on a fairly recent survey of Canadian communities, relatively few communities have policies requiring safe pedestrian and bicycle routes when developing new areas (19%), reconstructing roads (15%), and retrofitting existing communities (10%) [Canadian Fitness and Lifestyle Research Institute, 2010]. Indeed, given the general shift in development plans for land use to greater distance between destinations and urban sprawl [McCormack & Shield, 2011] and the negative association of this with PA and health [Frumkin, 2002; McCormack & Shield, 2011], urban sprawl will become an important consideration for Canadian communities when determining policies regarding land development. Therefore, despite the relatively more important influence of individual factors in explaining current PA and walking levels, a multi-sectoral approach will become increasingly important in addressing environmental trends and environmental influences on these behaviours in the future.

Many professionals and policy-makers have a major role in implementing the types of interventions outlined above. The following table summarizes some of the implications of the major findings in this thesis to guide policy and strategic actions by those working in public health, recreation, municipal/city planning, education, transportation and research.

Table 7.1 Implications of selected findings for policy, practice and research

Audience	Findings	Implication
Policy makers	Prompted awareness, self-efficacy, intention and certain trial behaviours predict activity (Chapter Six).	Mass media campaigns are still required and could focus more on increasing knowledge on the amount of PA required than on knowledge about the benefits of PA. Certain trial behaviours (such as the importance of making active choices) should be featured as ways to increase walking. These campaigns should be coupled with community strategies to increase walking and PA.
Policy makers	Certain population groups are concerned about traffic (Chapter Five).	Neighbourhood audits are required to determine where traffic issues may be reducing walking. Traffic calming measures could then be introduced to reduce the impact of

		traffic speed and volume. This would also benefit cyclists in addition to pedestrians.
Policy makers	Concerns about neighbourhood crime are associated with lower amounts of walking (Chapter Five).	Women and older adults should be consulted (e.g., in focus groups) about areas of the city that they feel are of particular concern. Solutions such as increased street lighting, or developing buddy systems should be considered. In addition, zoning could specify that houses should have porches and windows rather than garages facing the street ("eyes on the street") to increase feelings of safety.
Policy makers and coalitions concerned with increasing PA	The specific factors that predict overall PA and walking differ to some extent by age-sex group (Chapter Six).	Strategies and programs should be tailored to take into account the differences in factors influencing PA levels and walking among different segments of the population. Specific interventions could include be face-to-face counselling at the workplace or telephone and internet delivery of stage-based materials.
Educators	Knowledge of amount of PA required, intention and certain trial behaviours predict walking and PA (Chapter Four).	Physical and health education classes should teach youth and young adults the amount of PA required for health, self-monitoring methods and how to overcome barriers as means of increasing knowledge, and intention to be active.
Researchers	Knowledge of amount of PA required predicts PA and walking (Chapter Four).	As the research continues into the amount of PA required for health benefits, researchers should periodically systematically review the literature and update guidelines as necessary.
Researchers	Individual factors may be more relevant for predicting activity and walking than environmental factors (Chapter Six).	Further research is needed to understand PA and walking behaviour in a variety of contexts and within an ecological framework (e.g., relative efficacy of workplace efforts to increase motivation to walk to work versus the addition of safe pedestrian and bicycle routes when developing new areas).

7.3 Strengths and Limitations

One key limitation of the studies analysed in this thesis is the potential of bias in the use of the measures in the survey. Although this is discussed in more detail in section 3.5.5, a brief overview will also be provided here.

Given the limitations of findings found in Chapter Four and Six, and the literature in Chapter Two, consideration of the use of objective measures or the use of GIS measures in future studies could be explored independently or in conjunction with the subjective measures of the perceived environment. These types of measures include population density, mixture of land use including the distance between residential and non-residential land use, counts of destinations, street pattern, access to recreational facilities within the neighbourhood, availability of open or green spaces, aesthetic value, traffic, crime, and sidewalk availability along with objective measurements of the surrounding neighbourhood and environment. Although relatively costly for population monitoring, the detail provided by these measures may assist in clarifying relationships within environments that are considered "rich" in environmental supports, as is the case in the Canadian context. It must be recognized, however, that there are limitations in collecting GIS measures in addition to the cost involved, such as the differences in the researcher's definition of neighbourhood and that of individual's perception of what area constitutes their neighbourhood [Smith et al., 2010]. Moreover, the data can be time consuming to analyse, and there is no standardization of processes [Brownson et al., 2009]. In addition, Cochrane et al. suggests that it is important to consider the scale of the area being explored, which can reduce the ability to determine associations between an individual and their immediate environments [Cochrane et al., 2009]. Findings may be variable based on the buffer size used in the measurement of the environment [Brownson et al., 2009].

The PAM studies are limited in that they rely on self-reported measures of a complex behaviour (PA) which is subject to recall error. The adapted MLTPAQ used in Chapter Six has an acceptable test-retest reliability and criterion validity [Craig et al., 2002], however, it is based on self-report data, which may not accurately represent PA compared to if measure by a direct measure of PA. The measure of physical activities includes a long recall period of 12 month, which may be difficult for participants to accurately recall. The measure is restricted to LTPA,

and as such does not provide a comprehensive measure of PA. In addition, the question list is long, therefore, is subject to response burden. The strength of the measure is its consistent use over time for the purposes of surveillance allowing for comparisons of the measure over time, as the potential biases inherent with the measure is likely to be non-differential over time [Craig et al., 2004].

The IPAQ was introduced to the study in order to provide a more comprehensive, all-domain measure of physical activity. It is, however, based on self-report data which may not necessarily be comparable to a direct measure of PA. IPAQ tends to over-estimate the level of PA even when compared to other self-report measures, although these are typically single domain measures [Bauman et al., 2009]. The reliability and validity of this measure has been investigated in an international context and has been considered acceptable for population surveillance [Craig et al., 2003].

In addition, given Canadian trends over time in PA [Craig et al., 2004], there is the potential response or social desirability bias regarding PA, or decreasing response rates contributing to differential non-response bias in estimates over time [Craig et al., 2009; Katmarzyk et al., 2007]. However, Craig and colleagues examined this using the PAMs and found no significant impact on PA estimates due to differential non response rates [Craig et al., 2009]. Furthermore, the skew of the data may have reduced the ability to detect relationships between the measures and PA and walking, and be considered a limitation of this study. Other limitations of the measures have been previously discussed in Chapter Three.

There are also a number of potential sample related biases with these studies, including lack of complete coverage due to the emergence of cell phone use. The impact of increasing rates of cell phone usage among young people and the number of houses using cell phones rather than landlines is a potential limitation. In the U.S., the percentage of households increased from less than 1% in 2000 to over 6% by 2004 [Tucker et al., 2007] and to almost 13% by 2009. Ehlen and Ehlen predicted that by 2009, 40% of adults less than 30 years old in the United States would own only cell phones [Ehlen & Ehlen, 2007]. A study comparing cell phone and landline survey results found that under-coverage of this group did not pose a problem for overall population estimates based solely on landline data provided that the characteristics of the two

groups were similar [Brick et al., 2007]. The incidence of this has not risen as quickly in Canada, however, may have considerations on future surveys.

This thesis provided an exploratory analysis of cross-sectional data in order to inform policy and guide the development of future prospective and intervention research. As such, the models do not take into account interactions (or effect modifications) between variables, which can be considered a limitation. Further investigation exploring these interactions of the intrapersonal, social, and environmental factors would provide additional information to add to the literature base regarding an ecological approach to walking and PA behaviours.

Strengths of the PAM, and the broader Monitoring Program, is that the survey content permits the examination of the relationships of factors associated with PA levels and walking behaviours, and determination as to whether these differed between population groups. Similar questions on PAMs and the ongoing consistency in methodology over time, and the annual collection of data within the Canadian surveillance system permits a comparison of trend data to ensure consistent findings, which are essential to inform the judicious investment of scare resources and assess progress in changing the factors that influence PA.

An additional strength lies in the national scope of the PAMs. Although the studies, themselves, are cross-sectional, they contribute to the evidence base for informing policy and practice related to PA and walking. The factors are drawn from theory, and some of the environmental factors use a valid and reliable measure. Findings from this thesis are important for providing further evidence about the underlying factors associated with sufficient PA and walking to help inform strategies and interventions that can contribute to increasing activity levels and walking within the Canadian population. For example, the findings suggest that mass media interventions continue to be important and should focus on both proximal factors (knowledge of the amount of PA required) and more distal factors (building intention and providing examples of trial behaviours) and that traffic calming policies are a key element in encouraging walking. This research also expands on other Canadian studies, by exploring an ecological approach not only to PA, but to all-domain, recreational, and transportation related walking, for the population and sub-populations.

7.4 Summary

The findings form this thesis are consistent with the results of an earlier Canadian study focusing solely on leisure-time PA, but extend its finding to all domain PA and to walking specifically. Understanding the individual and environmental factors associated with walking is particularly important as walking is popular, convenient, low cost and can be performed into older age [Morris, 1997]. Results from the studies presented in this thesis clearly demonstrate that individual factors may be more pertinent than environmental factors in explaining PA and walking patterns in Canada. Nonetheless, environmental infrastructure is an important consideration when developing mass communication and community-wide interventions so that the interventions respect the environmental context in which individuals live, work and commute. Furthermore, at least part of the reason that environmental factors were not found to be as important overall as individual factors, may be the lack of variability observed in the environmental measures. Given the shift towards urban sprawl in Canada, as elsewhere, environmental policies may become increasingly important as a focus in community-wide interventions. Therefore, the broader ecological approach employed in the last investigation of this thesis was important in understanding the relationship of individual and environmental factors to current PA and walking patterns of Canadians. In addition, it was also important in framing mass communication and community-wide interventions to increase population levels of sufficient walking and PA in the future.

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Appendix A

Trends over time

Physical Activity

According to the sufficient PA definition used in this thesis, the proportion meeting this criterion increased slightly in 2007 when compared to 2003. These relationships between socio-demographic factors and activity level were generally consistent over time. One exception is the relationship between activity level and education which appeared in 2003 and 2004 was not significant in 2007.

Appendix Table 1: Proportion achieving sufficient amounts of PA, 2003, 2004, 2007 PAMs

	% achieving sufficient amounts of total PA	Lower CI (95%)	Upper CI (95%)
2003 PAM	53.1%	51.9%	54.3%
2004 PAM	52.2%	51.1%	53.4%
2007 PAM	56.6%	54.7%	58.5%

Walking

There were no statistically significant differences in the proportions meeting the walking criteria between 2003 and 2007. Sufficient amounts of walking behaviours vary by covariates, whereby, walking decreases with increasing age, and differences with education level appear for walking. These relationships persisted over time except that more men than women walked in 2003 but this is no longer significant in 2007.

Appendix Table 2: Proportion that walk sufficient amounts, 2003, 2004, 2007 PAMs

	% all-domain walking sufficient amount	Lower CI (95%)	Upper CI (95%)
2003 PAM	29.6%	28.5%	30.7%
2004 PAM	31.0%	29.9%	32.0%
2007 PAM	31.0%	29.1%	32.8%

Individual factors

Individual factors related to PA and walking were examined, such as prompted awareness of guidelines, knowledge of guidelines, beliefs about the benefits of PA, personal behavioural control, intention to be active, and steps towards initial behaviour change.

Prompted awareness of guidelines

There has been a substantial decrease over time in the proportion of Canadian adults who were aware of guidelines when prompted. In 2003, a greater proportion of women than men recalled guidelines; however, this is not significant in 2007. There was a previous relationship between recall and education which is no longer significant, whereas a new relationship with age is evident.

Appendix Table 3: Prompted recall of guidelines, 2003, 2007 PAMs

	Prompted recall of guidelines	95% CI
2003 PAM	37.3%	36.1-38.6%
2007 PAM	27.3%	25.6-29.1%

Knowledge of the amount of PA required to meet the guidelines

Based on the definition of knowledge about the amount of PA required to meet guidelines (see Chapter Three), there has been a substantial increase over time in the proportion of Canadian adults who had knowledge of the PA guidelines (56.9% in 2007 compared to 43.1% in 2003), and although there is no relationship with covariates in 2007, there were significant relationships with age and with education in 2003.

Appendix Table 4: Knowledge of minimum amount of PA to meet guidelines, 2003, 2007 PAMs

	Reported minimum amount of PA meets guide criteria	
	% aware of minimum amount of PA required to meet guidelines	95% CI
2003 PAM	43.1%	41.5-44.7%
2007 PAM	56.9%	54.9-58.8%

Beliefs about the benefits of PA

The beliefs about the benefits of PA were assessed through three questions (for preventing heart disease, maintaining stress, and helping to maintain functional ability with age). Generally speaking, the rates in 2003 are lower than those in 1998 and 2007. The relationships between these beliefs and the covariates have remained consistent over time.

Appendix Table 5a: Beliefs about the benefits of PA, 1998 PAM*

	Regular PA helps			
	Maintain stress		Maintain the ability to do everyday tasks in older age	
	N	Estimate	N	Estimate
Do not agree (anchor)	59	1.2%	48	0.8%
2	30	0.8%	20	0.5%
3	65	1.7%	63	1.5%
4	127	2.8%	163	3.7%
5	634	14.7%	707	16.1%
6	830	18.4%	954	20.6%
Agree very strongly (anchor)	3,003	60.5%	2,800	57.0%

* Preventing heart disease not collected.

Appendix Table 5b: Beliefs about the benefits of PA, 2003 PAM

	Regular PA helps					
	Prevent heart disease		Maintain stress		Maintain the ability to do everyday tasks in older age	
	N	%	N	%	N	%
Do not agree (anchor)	102	1.4%	57	0.8%	74	1.1%
2	66	0.9%	40	0.5%	60	1.0%
3	202	2.7%	101	1.4%	150	1.8%
4	391	5.6%	270	3.5%	406	5.6%
5	1,324	18.5%	1,210	17.0%	1,357	19.8%
6	1,497	21.8%	1,872	27.6%	1,599	23.4%
Agree very strongly (anchor)	3,521	49.1%	3,590	49.2%	3,469	47.3%

Appendix Table 5c: Beliefs about the benefits of PA, 2007 PAM

	Regular PA helps to					
	Prevent heart disease		Manage stress		Maintain the ability to do everyday tasks in older age	
	N	%	N	%	N	%
Do not agree (anchor)	35	1.0%	37	1.0%	30	.6%
2	8	.1%	11	.3%	21	.4%
3	32	.6%	49	1.3%	37	.7%
4	89	1.8%	109	2.1%	120	2.7%
5	385	7.8%	508	10.6%	522	11.1%
6	621	12.0%	765	15.3%	907	17.3%
Agree very strongly (anchor)	3,835	76.7%	3,528	69.4%	3,355	67.2%

Intention

The proportion scoring the highest value of the scale for intention is higher in 2007 compared to 1998 and again the relationship to the socio-demographic variables have persisted over time with the exception that education differs slightly in 2007.

Appendix Table 6: Intention to be active, 1998, 2003, 2007 PAMs

	1998 PAM		2003 PAM		2007 PAM	
	Highest intention (score of 6 or 7)					
	N	%	N	%	N	%
Anchored at 1 (no intention at all)	91	1.9%	147	2.0%	61	1.2%
2	66	1.8%	102	1.4%	48	0.9%
3	197	4.5%	212	3.1%	132	2.9%
4	397	9.2%	483	7.0%	340	7.1%
5	1,173	25.8%	1,625	23.3%	931	18.7%
6	776	17.7%	1,319	19.5%	895	18.4%
Anchored at 7 (fully intend to be active)	1,907	39.0%	3,174	43.7%	2,574	50.8%

Initial behaviour change

Based on the variables described in Chapter Three, there have been some slight increases in the proportion citing steps taken towards initial behavioural change between 1998 and 2007. For example, there has been an increase in the proportion who indicate that they have reading articles on PA (53.3% in 1998 compared to 60.8% in 2007), sought information from family and friends (34.8% in 1998 vs. 44.7% in 2007), obtained information from health professionals (23.3% in 1998 vs. 29.4% in 2007), observed or tried a physical activity class (46.1% in 1998 vs. 53.2% in 1998), and made active choices at work (68.7% in 1998 vs. 72.5% in 2007). On the contrary there has been a slight decrease in the proportion indicating that there is information about PA in the community (44.0% in 1998 vs. 37.0% in 2007). Generally speaking, however, relationships with the covariates have remained consistent over time.

Appendix Table 7: Initial behaviour change, 1998, 2003, 2007 PAMs

	1998 PAM			2003 PAM			2007 PAM		
	N	%	95% CI	N	%	95% CI	N	%	95% CI
Read article on PA	2,622	53.3	51.3-55.4	3,972	55.1	53.8-56.5	3,147	60.8	58.9-62.7
Sought advice friends, family	1,676	34.8	32.9-36.8	2,839	40.1	38.8-41.4	2,312	44.7	42.8-46.7
Sought advice from health professionals	1,088	23.3	21.5-25.0	1,854	25.2	24.1-26.4	1,486	29.4	27.6-31.2
Observe or tried class	2,136	46.1	44.1-48.2	2,869	55.7	54.3-57.0	2,589	53.2	51.3-55.2
Info on community opportunities	2,192	44.0	42.0-46.1	2,596	36.8	35.5-38.1	1,889	37.0	35.1-39.0
Made active choices	3,187	68.7	66.7-70.6	5,096	73.9	72.6-75.1	3,464	72.5	70.7-74.3

Appendix B

Personal contributions to the thesis

This section documents the personal contribution that this author (Christine Cameron) has made to the conduct of the studies utilized in this thesis, the research and analyses, and writing of this thesis.

Study Design – This author been involved in the initial development of the Physical Activity Monitor studies, developed by the Canadian Fitness and Lifestyle Research Institute. Although survey questions were previously developed based on a needs assessment of government officials and researchers, I have been involved in inputting and guiding the survey sampling frame utilized by the data collection company, ensuring ethics approval (university housing the data collection company), and ensuring data collection is completed as per the research plan and schedule.

Data integrity and analyses – This author has full responsibility for ensuring that the data file is clean and verified for accuracy. This includes screening based on range of values, adherence to skip patterns within the survey instrument, and analysing the distribution of variables. I was responsible for the development of the analysis plan for this thesis, and responsible for conducting all analyses in fulfilment of this analysis plan for this thesis using statistical software.

Dissemination – This author was responsible for the writing of this thesis document and articles and presentations associated with this thesis. Discussion of content of the article and presentations was conducted in collaboration with co-investigators, and content of the thesis under the guidance of thesis supervisors.