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Using the Health Action Process Approach (HAPA) to understand and change sedentary behaviour in office workers: Effects on motivation, behaviour, and health outcomes

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Abstract

Sedentary behaviour (SB) is positively associated with all-cause mortality, as well as numerous chronic diseases, including fatal and non-fatal cardiovascular disease, type 2 diabetes, certain types of cancer, and metabolic syndrome. Interventions targeting reductions in sedentary time among office workers who are an at-risk population for high levels of SB are needed. The main objective of this dissertation was to contribute to the body of knowledge surrounding theory-based behavioural interventions targeting SB among office working adults. First, a systematic review of the literature (study 1, chapter 2) was conducted that highlighted important cognitive and motivational factors associated with SB, which should be targeted in theory-based interventions designed to reduce SB. Using the motivational phase of the Health Action Process Approach (HAPA), a randomized controlled trial (RCT – study 2, chapter 3) demonstrated that SB and diabetes information can be a meaningful source of motivation among preintender office workers (n = 96). Those in the intervention reported significantly higher intentions for reducing daily sedentary time (ps $\leq .05$, η_p^2 values $\geq .08$) than their control counterparts. Using the volitional phase of the HAPA, a subsequent RCT (study 3, chapter 4) showed that action and coping planning, augmented with tailored text messages reduced workplace sitting time and increased specific non-SBs in office workers (n = 60). Relative to the controls, participants who received the intervention reported significantly greater reductions in time spent sitting (87.54 min/workday) and accompanying increases in time spent standing (32.56 min/workday) and stretching (11.34 min/workday) at work over an 8-week period (ps $< .05$, η_p^2 range = .05-.08). Finally, study 3 (chapter 4) also revealed that the intervention targeting reductions in SB can lead to significant improvements in office workers' perceived emotional well-being and role limitations due to emotional health problems (*p*s $< .05$, η_p^2 range = .08-.10). Avenues for future research will be discussed.

Keywords: sedentary behaviour, office workers, Health Action Process Approach, motivation, intervention, health behaviour change

Summary for Lay Audience

Too much sitting is related to premature death, as well as numerous chronic diseases, including fatal and non-fatal heart disease, type 2 diabetes, certain types of cancer, and metabolic problems. Strategies to reduce sitting time among office workers who are an at-risk population for high levels of sitting are needed. The main objective of this dissertation was to contribute to the body of knowledge surrounding theory-based health promotion strategies targeting sitting time among office working adults. First, the literature on whether cognitive and motivational factors (i.e., attitudes, social norms, confidence, intentions, habits, values) influence sitting time was examined (study 1, chapter 2). Findings highlighted important cognitive and motivational factors that are related to how much time individuals spend sitting, which should be targeted in health promotion efforts to reduce sitting. Using a prominent health promotion theory, study 2 (chapter 3) demonstrated that health and diabetes information related to too much sitting can motivate office workers to reduce their daily sitting time. Then, study 3 (chapter 4) showed that providing office workers with a counselling session (encouraging them to form individualized plans to reduce their sitting time), followed by daily text messages is an effective strategy to reduce workplace sitting time and increase time spent standing, and stretching in office workers. Finally, study 3 (chapter 4) also revealed that reductions in sitting time can lead to improvements in office workers' perceived emotional well-being and role limitations due to emotional health problems.

Co-Authorship

Harry Prapavessis

Dr. Prapavessis, supervisor and director of the Exercise and Health Psychology Laboratory, oversaw all research and analyses as well as provided the equipment (licenses and software), which was essential for studies 2 and 3. In addition, Dr. Prapavessis is the co-author of study 1 which is published in *AIMS Public Health* (Rollo, Gaston, & Prapavessis, 2016) and of several other manuscripts that are currently in preparation to be submitted to peer-reviewed academic journals.

Anca Gaston

Anca Gaston is the co-author of a review article entitled "Cognitive and motivational factors associated with sedentary behavior: A systematic review" which is published in *AIMS Public Health* and forms the bulk of Chapter 2 (Rollo, Gaston & Prapavessis, 2016).

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Chapter 1 – General Introduction and Dissertation Objectives

Introduction

According to the Sedentary Behaviour Research Network (SBRN), sedentary behavior (SB) is defined as any waking behavior characterized by an energy expenditure ≤1.5 metabolic equivalents, while in a sitting, reclining, or lying posture (Tremblay et al., 2017). Sedentary behaviors permeate all domains of life, including work, school, transportation, and leisure/recreation pursuits. In addition to the widely accepted health-enhancing behaviours of moderate-to-vigorous physical activity (PA) and sleep, SB has now been recognized as an important 24-hour movement behaviour with its own distinct health repercussions. Numerous countries, including Australia, Canada, Spain, and the United Kingdom, have begun to include statements regarding SB in their public health PA guidelines and recommendations. For instance, Australia is among the first countries to develop national guidelines specific to SB for all age groups. Canada has developed SB Guidelines for children and youth and incorporated statements regarding SB into their PA Guidelines for adults. Worldwide, several non-government organizations (e.g., Active Healthy Kids Global Alliance, ParticipACTION, World Health Organization) have also addressed the topic of SB (Okely, Tremblay, Hammersley, & Aubert, 2018).

Sedentary Behaviour Prevalence

Societal changes have resulted in reduced demands to be active, which in turn has resulted in greater sedentary time. Among both children and adults, high levels of SB have emerged as a new public health issue that needs to be addressed. Population-based studies have indicated that Canadian and US adults spend between 8-11 hours in sedentary pursuits each day (Carson et al., 2014; Colley et al., 2011; Matthews et al., 2008), however, specific segments of the population may demonstrate an even higher prevalence of SB.

Given that the prevalence of adults working office-based jobs that require mostly sitting is high, and occupations are becoming more sedentary and less physically active, the workplace is a key setting for the accumulation of sedentary time (Chau, van der Ploeg, Merom, Chey, & Bauman, 2012; Church et al., 2011). Office-working adults exhibit high sedentary time, both at work and in their leisure time, sitting on average 11 hours per day (Smith et al., 2015; Tudor-Locke, Leonardi, Johnson, & Katzmarzyk, 2011). Evidence suggests that workplace sitting accounts for majority (60%) of office workers' total daily sedentary time (Bennie et al., 2015); further, adults working in office settings may spend up to 77% of their working day sitting with majority of this time accumulated in prolonged bouts ≥ 20 minutes (Thorp et al., 2012).

Sedentary Behaviour and Health

Numerous systematic reviews have reported that irrespective of meeting PA guidelines (i.e., 150 minutes of moderate-to-vigorous PA per week), time spent in SB is positively associated with all-cause mortality, as well as numerous chronic diseases such as fatal and non-fatal cardiovascular disease, type 2 diabetes, certain types of cancer, and metabolic syndrome (de Rezende, Lopes, Rey-López, Matsudo, & do Carmo Luiz, 2014; Edwardson et al., 2012; Thorp, Owen, Neuhaus, & Dunstan, 2011; Wilmot et al. 2012). For example, in a systematic review and meta-analysis, Wilmot et al. (2012) examined the association between sedentary time in adults and four key clinical outcomes, including diabetes, cardiovascular disease, cardiovascular mortality, and all-cause mortality. Findings indicated that when compared to those with the lowest sedentary time, adults with the greatest sedentary time had a 112% increase in the relative risk (RR) of diabetes, 147% increase in the RR of cardiovascular disease, a 90% increase in the risk of cardiovascular mortality, and 49% increase in the risk of all-cause mortality. The authors also noted that the strength of the association between SB and clinical outcomes was most consistent for diabetes. Prolonged, uninterrupted sedentary time has been shown to be particularly detrimental to health demonstrating deleterious associations with a number of cardiometabolic biomarkers (Carson et al., 2014; Healy, Matthews, Dunstan, Winkler, & Owen, 2011; Saunders, Larouche, Colley, & Tremblay, 2012). Among adults, time spent in SB has also been associated with an increased risk of weight gain and obesity (Thorp et al., 2011), as well as mental health problems, including anxiety and depression (Teychenne, Ball, & Salmon, 2010; Teychenne, Costigan, & Parker, 2015).

Despite this evidence, the concept of regarding SB as an independent risk factor that can be adjusted through moderate-to-vigorous PA has been questioned in the literature. In a recent large meta-analysis, for instance, Ekelund et al. (2016) examined the joint and stratified associations of SB and PA with all-cause mortality to investigate if PA can attenuate or even eliminate the detrimental effects of prolonged sitting. Findings indicated that high levels of moderate intensity PA (i.e., 60–75 min per day) seem to eliminate the increased risk of death associated with high sitting time. However, these findings are discouraging as only 15% of adults in society accumulate the recommended guidelines of 150 minutes of moderate-to-vigorous intensity PA per week to obtain health benefits (Colley et al. 2011). Together, this evidence suggests that efforts to promote leisure-time PA alone are insufficient and that health promotion strategies targeting reductions in sedentary time, in addition to greater PA are needed.

Interventions Targeting Sedentary Behaviour among Office Working Adults

Several interventions trials have been conducted to reduce sedentary time and promote health among office workers, which can be broadly classified by whether they target environmental, organizational, individual, or some combination of these behaviour change elements.

Environmental. In a Cochrane review, Shrestha et al. (2018) evaluated the effectiveness of 34 workplace interventions to reduce sitting time at work; the majority of these interventions (16 studies) examined the effects of physical workplace changes for modifying SB. It was found that interventions using sit-to-stand desks reduced workplace sitting time by an average of 57 minutes per workday at medium-term follow-up (3 to 12 months), however, the effects of active workstations (e.g., treadmill desks, cycling desks) on reducing sitting at work were unclear or inconsistent.

Policy/organizational. Specific to the workplace, Coenen et al. (2017) reviewed existing national and international occupational health and safety policies relating to occupational SB. Despite over 100 documents (e.g., legislation, guidelines) retrieved from a search conducted across ten countries and six international/pan-European agencies, not a single state, national, or international occupational policy focusing specifically on SB was found. This is surprising given that in many countries, there is legislation in place (e.g., Australian Work Health and Safety Act; American Fair Labour Standards Act) and a general duty of care on behalf of employers to ensure a safe system of work. Nonetheless, relevant aspects of existing health and safety policies such as the acknowledgement of the risks associated with occupational SB, control measures to eliminate or minimize the risk of sustained postures, and strategies for task variety through substitution or interruption have been identified which may have implications for specific sedentary-related polices to be implemented moving forward. Recently, Okely et al. (2018) published a chapter examining home, workplace, education, transportation, healthcare, and non-home-based leisure settings where reducing SB can be targeted at a policy level and the current evidence for such policies. Examples of relevant policy initiatives include providing employees with height-adjustable or standing desks, discounted health insurance premiums for those who sit for less than a prescribed level daily, providing greater infrastructure to promote active transport, re-thinking community design, and changes to the office policy environment. Okely et al. (2018) suggest that for policies to be effective in these settings, they require shifting strong societal norms to sit and should focus on benefits broader than health, such as increased productivity, economic benefits, or reduced traffic congestion.

Multi-component. A number of multi-component work-based interventions, which integrate individual, environmental, and organizational change elements, have been conducted to reduce sitting time among office workers (Carr et al., 2013; Danquah et al., 2017; Healy et al., 2013; Mackenzie, Goyder, & Eves, 2015; Neuhaus, Healy, Dunstan, Owen, & Eakin, 2014). For instance, in a cluster randomized trial, Danquah and colleagues (2017) examined the effects of a 12-week multi-component work-based intervention aimed at reducing sitting time and improving health outcomes among 317 office workers. Intervention components targeted the organizational (e.g., appointment of local ambassadors, management support), environmental (i.e., installation of standing meeting tables in meeting rooms, offices and corridors), and individual level (i.e., lecture and workshop). Compared to the control group, results indicated that at 1 and 3 months, total sitting time (-71 min/8-h workday), number of prolonged sitting periods (-0.79/8-h workday), and body fat percentage (-0.61%) was significantly lower; and the number of sit-to-stand transitions (+14%/sitting hour) were significantly higher, for those who received the multi-component intervention.

Behavioural. In comparison to interventions incorporating physical workplace changes (e.g., active workstations), behavioural interventions targeting individual elements have yet to be extensively examined. Intervention trials to date have examined the use of behaviour change techniques including provision of health information, point-of-decision prompts and/or cues, and behavioural counselling, self-monitoring, and feedback. For instance, Kozey-Keadle, Libertine, Staudenmayer, and Freedson (2012) examined the effectiveness of a simple information-based intervention for reducing sedentary time in a sample of overweight, non-exercising office workers. Participants were provided with information about the potential health risks associated with sedentary time; strategies to reduce sedentary time and increase light-intensity physical activity across multiple domains; as well as brief counselling on overcoming obstacles that would inhibit reductions in sedentary time. Findings indicated that compared to baseline, participants significantly reduced their sedentary time by 48 minutes over a 16-hour waking day during the 7-day intervention period. In another trial, Evans and colleagues (2012) explored whether computer-delivered point-of-choice prompts and SB education reduced office workers' sedentary time at work and found that, compared to the education only group, the point-of-choice prompt plus education group spent less time in long uninterrupted (>30 minutes) sedentary periods while at work.

Psychological Correlates of Sedentary Behaviour

In order to develop successful interventions to address SB, factors that influence sedentarism need to be identified and better understood. In a systematic review, Rhodes, Mark, and Temmel (2012) examined and appraised the current literature on correlates of SB among adults. In addition to several sociodemographic factors (e.g., age, gender, education, employment status, BMI) and health behaviours (e.g., smoking status, moderate-to-vigorous physical activity) that have been reliably linked to SB, the authors identified several studies that found a significant relationship between cognitive factors (e.g., attitudes, depression, health-related quality of life) and sedentary time. At the same time, the authors acknowledged that literature is limited and recommended that future research focus on modifiable cognitive correlates, which may be better suited for intervention efforts to reduce SB. Since their review was published in 2012, the number of studies examining cognitive factors has certainly increased.

In a more recent systematic review that emphasized the importance of using a socio-ecological approach to understand factors which influence sedentarism, O'Donoghue et al. (2016) sought to identify individual, social, environmental, and policy-related correlates of SBs among adults aged 18-65 years. Again, several sociodemographic (e.g., age, BMI, socio-economic status) and behavioural factors (e.g., PA levels) that were significantly correlated with SB at the individual level were identified. In addition, this review identified several environmental factors as correlates of SB, including proximity to green space, neighbourhood walkability, and safety.

Similar to the findings of Rhodes et al. (2012), several studies were identified that included psychological factors, however, majority of these examined the relationship between mental health (e.g., symptoms of depression, stress, and anxiety) or mood (e.g., tiredness) factors with SB as opposed to more modifiable cognitive and motivational factors. Nonetheless, the authors acknowledged that there is limited evidence to suggest a negative relationship between SB and planned behaviour (e.g., attitudes, intentions) to overcome sedentarism. A more comprehensive understanding of the role that cognitive and motivational factors play in predicting SB represents the first step towards the development of effective behavioural interventions targeting reductions in sedentary time.

The Need for Theory in Health Behaviour Change Research

According to Schwarzer and Luszczynska (2008), health behaviour change refers to the motivational, volitional, and actional processes of abandoning such health-compromising behaviours in favour of adopting and maintaining health-enhancing behaviours. In a systematic review, Gardner, Smith, Lorencatto, Hamer, and Biddle (2016) examined behaviour change strategies used in SB reduction interventions among adults. Findings indicated that behaviour change techniques, including education, self-regulatory skills training, goal setting, self-monitoring and problem solving were most closely associated with promising interventions. Gardner and colleagues (2016) also emphasized that developing effective sedentary reduction interventions depends on identifying intervention components that may contribute to effectiveness. A shared drawback among the behavioural interventions that have been conducted to date is that none have employed a well-established theoretical framework to guide intervention development and evaluation.

Health behaviour change scientists from numerous fields, including PA, have emphasized that theories are needed to explain and predict health behaviour, as well as for the design and evaluation of interventions (Gourlan et al., 2016; Lippke & Ziegelmann, 2008). First, research evidence suggests that theoretically-informed interventions lead to better outcomes than those lacking a theoretical base (Glanz & Bishop, 2010; Gourlan et al., 2016). Second, Michie and Prestwich (2010) specified that theoretical frameworks can be used to inform interventions by identifying constructs that are hypothesized to be causally related to behaviour and can be targeted to promote behaviour change. Third, theory-based interventions allow for the specific mechanisms of behavioural change to be examined to provide a better understanding of an intervention's effectiveness or ineffectiveness (Michie & Prestwich, 2010).

The Health Action Process Approach as a Theoretical Model of Behaviour Change

A theoretical model that has shown promise in the health behaviour change domain and could be used to guide the development of behavioural interventions targeting SB is the Health Action Process Approach (HAPA; Schwarzer, 2008; see Figure 1). The HAPA framework is thought to overcome many of the limitations that are characteristic of other prominent social-cognitive theories by: (a) suggesting the health behaviour change process should be divided into both motivational and volitional phases, (b) allowing for stage-matched interventions (e.g., preintenders versus intenders), (c) including specific post-intentional volitional constructs to translate intentions into action and mediate the intention-behaviour gap, (d) distinguishing between two kinds of planning, and (e) emphasizing the need for phase-specific self-efficacy (Schwarzer, Lippke, & Luszczynska, 2011).

In the pre-intentional motivational phase of HAPA, it is suggested that risk perceptions, outcome expectancies, and task self-efficacy are influential factors in the formation of intentions. Risk perceptions regarding the association between the health behaviour and an absolute or relative health risk are thought to set the stage for contemplation and elaboration of thoughts pertaining to consequences related to the health-compromising behaviour. Outcome expectancies represent another pre-intentional construct concerned with beliefs about the positive and negative outcomes of a specified behaviour. Finally, and perhaps most importantly, perceived task self-efficacy refers to an individual's belief in their capability to perform the desired action or behaviour in a specific context (Sniehotta, Scholz, & Schwarzer, 2005).

Once a behavioural intention has been formed, a series of post-intentional volitional constructs are suggested to promote the initiation and maintenance of actual behaviour change. Action plans outline specific situation parameters (when, where) and a sequence of action (how) for implementing the intended behaviour. Coping planning is a second volitional process that refers to the anticipation of barriers or obstacles that may arise and the development of alternative actions to attain one's goal despite the impediments. Lastly, action control is the most proximal volitional predictor of behaviour and encompasses self-regulatory processes of self-monitoring, awareness of standards, and effort, which help to sustain behaviour change (Schwarzer et al., 2011).

Previous research has demonstrated the utility of the HAPA model for predicting and modifying numerous health behaviours (e.g., PA, diet and nutrition, breast self-examination, and smoking cessation) across a variety of populations (e.g., cardiac rehabilitation patients, pregnant women, type 2 diabetics, persons with chronic illness or disability). To our knowledge, no studies have applied the HAPA model to advance our understanding of SB among office workers.

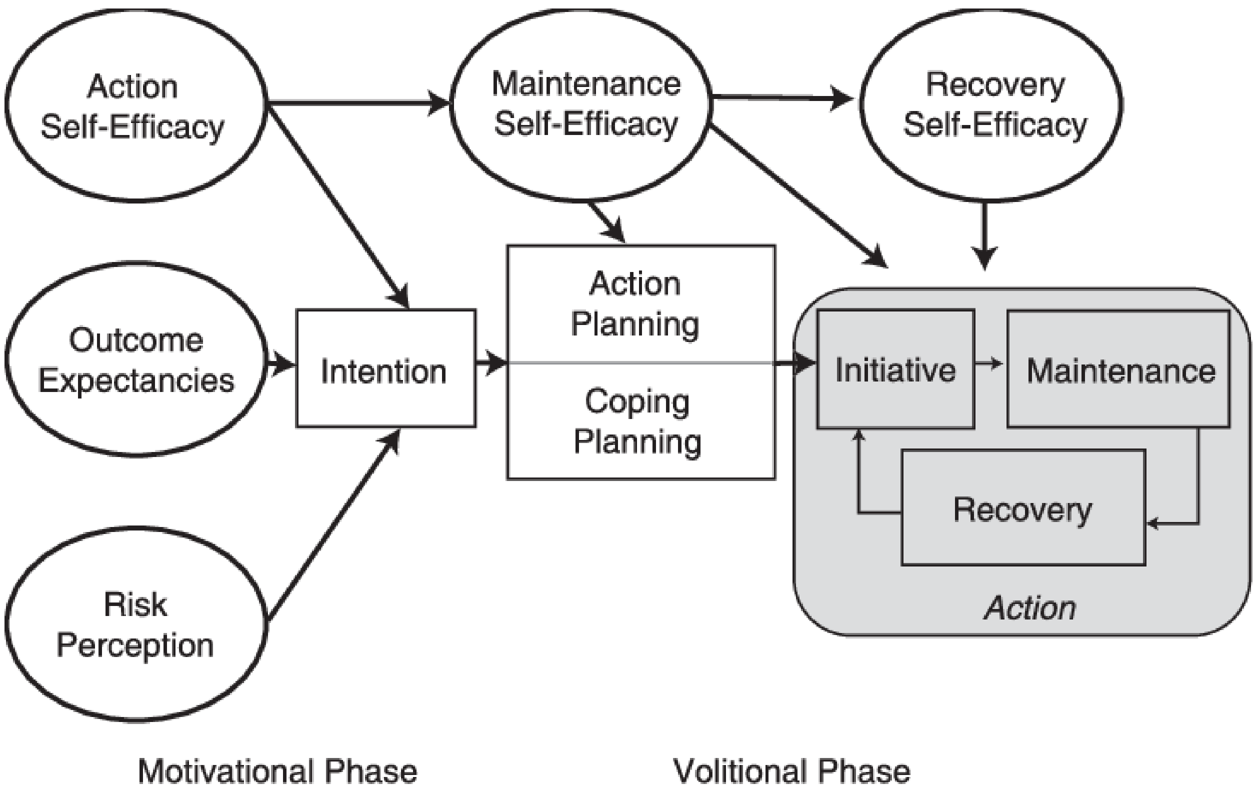

Figure 1. The Health Action Process Approach model.

Dissertation Objectives

Given the increased interest in SB research, the aim of study 1 (chapter 2) was to conduct a systematic review to synthesize and critique the current literature on the association between cognitive and motivational factors and SB, and discuss avenues for future research. This in turn, led to a series of experimental studies that sought to contribute to the current knowledge base surrounding theory-based behavioural interventions targeting SB among office working adults by:

1) Examining whether information about sedentary behaviour and diabetes risk grounded in a Health Action Process Approach (HAPA) framework can serve as a meaningful source of motivation to reduce SB for office workers (study 2, chapter 3).

2) Examining whether a HAPA-based behavioural intervention, specifically action and coping planning, augmented with tailored text messages can reduce workplace sitting time (primary outcome) and produce concurrent increases in specific non-SBs at work (i.e., time spent standing, walking and stretching; frequency and duration of breaks from sitting) over an 8-week period (study 3, chapter 4).

In addition, a secondary objective of study 3 (chapter 4) was to examine whether reductions in workplace sitting time can improve self-rated work performance and several health-related quality of life outcomes (i.e., role limitations due to physical health problems, role limitations due to emotional health problems, emotional well-being, and energy/fatigue) among highly sedentary, full-time office workers.

This series of dissertation studies are presented in an integrated-article format. Therefore, some repetition with respect to rationale and background should be expected.

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Chapter 2 – Cognitive and Motivational Factors Associated with Sedentary Behavior: A Systematic Review[1] (study 1)

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Abstract

Excessive time spent in sedentary behavior (SB) is associated with numerous health risks. These associations remain even after controlling for moderate-to-vigorous physical activity (PA) and body mass index, indicating that efforts to promote leisure time physical activity alone are insufficient. Cognitive and motivation variables represent potentially modifiable factors and have the potential of furthering our understanding of sedentary behavior. Hence, a systematic review was conducted to synthesize and critique the literature on the relationship between cognitive and motivational factors and sedentary behaviors. In April 2016, four electronic databases (Psych info, Pub Med, SPORTDiscus, Web of Science) were searched and a total of 4866 titles and abstracts were reviewed. After meeting inclusion criteria, study characteristics were extracted and the methodological quality of each study was assessed according to the Downs and Black Checklist. PRISMA guidelines for reporting of systematic reviews were followed. Twenty-five studies (16 cross-sectional, 8 longitudinal and one examining two populations and employing both a cross-sectional and prospective design) assessed 23 different cognitive and motivational factors. Seventeen studies were theory-based and 8 did not employ a theoretical model. Results showed that among SB-related cognitions, risk factors for greater sedentary time included having a more positive attitude towards SB, perceiving greater social support/norms for SB, reporting greater SB habits, having greater intentions to be sedentary, and having higher intrinsic, introjected, and external motivation towards SB. Protective factors associated with lower sedentary time included having greater feelings of self-efficacy/control over SB and greater intentions to reduce SB. Among PA-related cognitions, protective factors for lower SB included a more positive attitude towards PA, having greater social support/norms for PA, greater self-efficacy/control for PA, higher PA intentions, and higher intrinsic and identified motivation towards PA. In addition, feeling more supported and empowered in general was related with lower levels of SB. The average methodological quality score for included studies was 69% (SD = 9.15%; range 35–80%). In conclusion, a number of cognitive and motivational factors were identified that were associated with sedentarism. These findings have come from reasonably high quality studies. To further extend our understanding of the relation between cognitive and motivational factors and SB, more longitudinal, theory-driven studies examining cognitions and motivation from a sedentary perspective are required.

Keywords: sedentary behavior, psychological determinants, cognitive factors, motivational factors

Introduction

Excessive time spent in sedentary behavior is associated with numerous health risks. An overview of 27 systematic reviews found that among adults, sedentary time is positively associated with all-cause mortality, fatal and non-fatal cardiovascular disease, type 2 diabetes, metabolic syndrome, and several types of cancers [1]. Among children and youth, the risks include obesity, increased blood pressure and total cholesterol, poorer self-esteem, social behavior problems, poorer physical fitness and lower academic achievement [1]. These associations remain even after controlling for moderate to vigorous physical activity and body mass index (BMI), indicating that efforts to promote leisure time physical activity alone are insufficient.

Sedentary behavior has been defined as “any waking behavior characterized by an energy expenditure ≤1.5 METs while in a sitting or reclining posture” [2]. Sedentary behaviors permeate all domains of life, including work, school, transportation, leisure/recreation, and spiritual/contemplative pursuits. The pervasiveness of sedentarism is evident through population-based studies, which indicate that Canadian and US adults spend an average of 9.7 and 7.7 hours per day, respectively, being sedentary [3,4]. The high prevalence of sedentarism and its adverse outcomes has added a whole new paradigm to the physical activity field focused on understanding and reducing sedentary time.

Over the past few decades, there has been an increase in interest in ecological models as the guiding framework for understanding public health issues, including sedentary behavior [5,6]. According to this approach, human health is viewed as the result of an interplay between a broad range of individual, social, environmental and policy factors [6]. At the individual level, intrapersonal factors such as psychological, biological, and demographical factors have been emphasized; social factors include those related to relationship, culture, and community; environmental factors refer to the organization, safety, attractiveness, and comfort of the physical environment; and policy factors refer to regulations, health care policies or incentives, the economic climate, and any governmental policies which have health implications [6]. Although ecological models emphasize the importance of intervening at multiple levels, a comprehensive understanding of the role of individual factors represents the first step towards a more complete appreciation of the issue in question. One such area of focus is the relationship between psychological factors and sedentary behavior.

Historically, psychological factors have been divided into three distinct faculties: affect, cognition, and conation [7]. The term 'affect' refers to the emotional, or feeling aspects of human nature, and 'cognition' refers to the rational, or intellectual aspects. 'Conation,' the third proposed part of the mind, is concerned with action, or volition, the mental effort and motivation required to carry out a proposed behavior [8]. Various formulations of the latter two aspects of psychological functioning are contained within current social-cognitive and motivational models of health behavior including the Health Belief Model [9], Theory of Reasoned Action [10], Theory of Planned Behavior (TPB) [11], Protection Motivation Theory (PMT) [12], Social Cognitive Theory [13], Health Action Process Approach (HAPA) [14], and Self Determination Theory (SDT) [15]. Individual constructs within these theories include attitudes, beliefs, knowledge, perceived barriers, self-efficacy, intention, and motivation. The link between these psychological variables and a number of health behaviors, including physical activity

[16] is well established. Given the increased interest in sedentary behavior research, the aim of this systematic review was to synthesize and critique the current evidence on the association between cognitive and motivation factors and sedentary behavior and discuss avenues for future research.

The relationship between sedentary behavior and cognitive and motivational factors merits investigation for a number of reasons. First, even a cursory examination of a few studies examining cognitive factors and sedentary behavior shows that a significant link between the two does exist. For example, in a review on the correlates of sedentary behavior, Rhodes, Mark, and Temmel [17] identified several studies which found a significant relationship between psychological factors and sedentary time. At the same time, these authors pointed out the need for more research in this area and since their review was published in 2012, the number of studies examining cognitive factors has certainly grown. Second, cognitive and motivational constructs have proven to be useful for understanding numerous health-related behaviours such as physical activity [58]. Thus, it is likely that an examination of these factors also has the potential to increase our understanding of sedentary behavior. Third, while a number of published reviews have examined sedentary behavior correlates [5, 17–20], none have focused exclusively on psychological determinants from a cognitive and motivational perspective. As such, this review has the potential to identify gaps in the current research and significantly impact future research in this field. Fourth, in contrast to biological (e.g., genetic) or demographic determinants such as age, ethnicity, or socioeconomic status, cognition and motivation variables represent potentially modifiable protective or risk factors. Fifth and finally, while interventions aimed at reducing sedentary behavior are urgently needed, research to identify effective behavior change strategies cannot advance without a more complete understanding of the cognitive and motivational factors underpinning behavior change.

Method

This review was conducted according to PRISMA guidelines for transparent reporting of systematic reviews and meta-analyses [59]. A review of the literature was first carried out by searching the following separate, specific electronic databases from their inception (dates included wherever available in the databases) until May 10, 2016: PsycINFO, PubMed, SPORTDiscus, Web of Science. The keywords used referred to the exposure (cognitive, social-cognitive and motivation) and outcome (sedentary behavior) variables of interest. Specifically, the search strategy was agreed upon by SR, AG and HP and involved entering the following search terms into abovementioned pertinent databases: (sedentary OR sitting) AND (correlate OR predictor OR psychosocial OR theory OR social cognitive OR intention OR motivation OR attitude OR self-efficacy OR barriers OR beliefs). Ethical approval was not required since this was a review and did not involve human subjects. Next to the search in electronic databases, the authors' personal databases, previous published reviews, and references of included publications were checked. As this was the first systematic review to focus exclusively on the relationship between cognitive and motivational factors and sedentary behavior, the search was not limited to specific populations. For the purpose of this specific review, studies that involved populations of any age (e.g., children/youth, adolescents, adults, older adults) were included. After identification of studies through database searching, duplicate publications were removed. The titles and abstracts of all citations derived from the search were screened independently by two of the authors. In case of uncertainty to either include or exclude the study, the full paper was read. For all relevant publications, full-text articles were then read and assessed further for eligibility.

In order to be included in this review, studies had to meet the following criteria: (a) include one or more assessments of sedentary behavior or sedentary time, (b) examine the relationship of at least one cognitive or motivation variable with sedentary behavior or sedentary time, (c) be one of the following types of study: randomized controlled trials, cross-sectional studies, case-control studies and cohort studies (i.e., reviews, editorials and opinion articles were excluded since they did not contain primary data), and (d) be published in English. Studies were excluded if they measured sedentary time but failed to include possible correlates or if they did not measure predictors and behavior within the same individual (e.g., studies examining the relationship between parental beliefs and children's sedentary behavior were excluded). Studies examining mental health outcomes such as affect (e.g., depression, anxiety), quality of life, and physical self-perceptions were also excluded because these constructs are often viewed as consequences rather than antecedents of sedentary behavior. Finally studies that examined personality were excluded as they represent constructs that are considered stable and hence less modifiable.

All selected studies [21-45] were summarized in table format and data were extracted with regards to the author(s) and publication year, study population, sample size, sampling methods, study design, correlates/predictors examined, type and measurement of sedentary behavior or sedentary time, and the results pertaining to the relationship between behavior and significant correlates/predictors. In addition to summarizing the findings in table format and in text, we have visually represented the findings using what we have termed a pinwheel. The purpose of the pinwheel is to illustrate, at a glance, which constructs have been examined in the literature as well as whether a relationship emerged between the constructs. Within the health domain, sedentary behavior is considered a risk behavior. For this reason, the colour green was chosen to indicate a protective effect (i.e., lower sedentariness) due to its association with safety and the word 'go-ahead' (e.g., its use in traffic lights). On the other hand, red is associated with a hazard and the word 'stop'. For this reason, we used the colour red to indicate an association between a factor and increased sedentary behavior. Yellow was chosen to indicate a null effect due to the fact that it is seen as in-between green and red (e.g., on a traffic light signal).

The methodological quality of individual studies was assessed using the Downs and Black checklist [60]. The Downs and Black instrument assessed study quality including strength of reporting, external validity, internal validity (bias), internal validity (confounding), and power. The checklist consists of 27 items with a maximum score of 32 points. A modified version of the checklist was employed with items that were not relevant to non-experimental studies removed (8, 13-15, 17, 19, and 21-24). The adapted checklist consisted of 20 items, including 14 items from the original list (1–3, 6-7, 9–12, 16, 18, 20, and 25-26); three items that were modified (4, 5, and 27); and three items created for purposes of this review. Reporting items 4 and 5 from the original list were reworded to align with non-intervention (i.e., cross-sectional and prospective) studies being examined in this review. Item 27, concerning power from the original list was modified to address the number of participants needed to detect a significant association between an exposure and sedentary behavior. Of the three items created, two were internal validity criteria and one was concerned with study power. We believe that changes made to the original checklist had merit and that modifications held value in assessing the methodological quality of studies included in this review. Each quality criterion was rated as positive (1), negative (0), or unknown/insufficiently described (0). A positive sign (+) was given if the publication provided a sufficient description of the item, per the predefined criteria, and met the quality criteria for the item. A negative sign (-) was allotted if the publication did not provide an adequate description or did not address and/or perform the quality criteria for the item. Finally, if an insufficient or unclear description of the item was provided, a question mark (?) was given. The maximum possible score for the modified checklist was 20 points (higher scores indicate higher quality). The methodological quality of individual studies was independently scored by SR and verified by HP; if disagreements between assessors occurred, consensus was achieved through discussion with a third reviewer (AG). For each study, an overall methodological quality score was calculated. In addition, the percentage of studies meeting each quality criterion was calculated.

Data were not pooled for a number of reasons. First, there was little consistency among studies with respect to exposures and even when the same exposures were examined by multiple studies, they often used different scales. Second, studies used varying methodologies and reported statistics inconsistently. Therefore, to synthesize the evidence and allow conclusions to be drawn regarding the relationship between cognitive and motivational factors and sedentary behavior, a best-evidence synthesis that has been used in previous reviews [61] was implemented. The findings for each cognitive and motivational variable were interpreted on the following basis: there was no evidence of an association if more than 50% of the cross-sectional and prospective studies reported no association; there was inconclusive evidence for an association if 50% of the studies reported no association and 50% reported a positive or negative association; there was some evidence of an association if more than 50% of the studies reported a positive or negative association; and there was consistent evidence of an association if all of the studies reported a positive or negative association.

Results

The electronic search produced 4,866 articles (1298 from PsycINFO, 2595 from PubMed, 699 from SPORTDiscus, and 274 from Web of Science; Figure 2). After removing duplicates (n = 1121), a total of 3745 publications remained. After titles and abstracts were examined, 86 full-text articles were read and assessed further for eligibility. Of those, 21 articles were identified as suitable. The reference lists of studies included for full-text review were then checked for additional relevant references, resulting in four additional studies. A total of 25 studies published between the years 2003 and 2016 met the inclusion criteria and were included in the review [21-45]. The characteristics of these studies are presented in Appendix B.

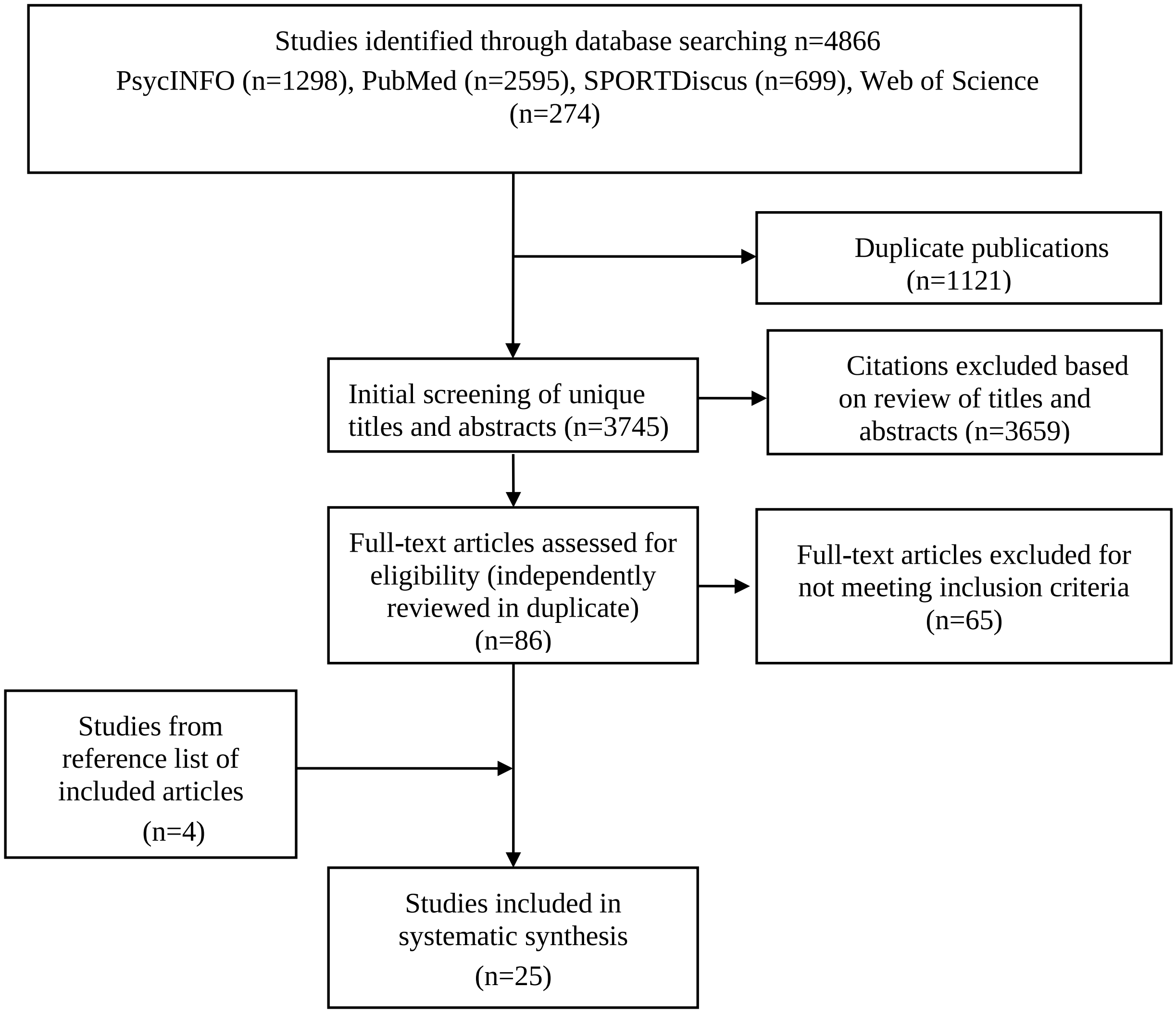

Figure 2. PRISMA flow diagram of study selection process in review of cognitive and motivational factors and sedentary behavior.

Eight [21, 23, 26, 28, 29, 32, 34, 44] of the 25 reviewed studies did not specify a theoretical orientation in their study design and/or in the cognitive and motivational factors examined. Of these, only two [23, 28] were longitudinal or prospective in nature while the remaining six [21, 26, 29, 32, 34, 44] employed an observational, cross-sectional design. Researchers have emphasized the need for more longitudinal, prospective studies to be completed to fully understand temporal changes in sedentary time and corresponding psychological predictors [5, 17]. Five studies [21, 28, 29, 32, 34] examined sedentary behavior in children and/or adolescent populations whereas only three studies [23, 26, 44] investigated cognitive and motivational determinants of sedentary behavior in adult populations. Four studies [21, 28, 29, 34] employed convenience sampling methods and four studies [23, 26, 32, 44] used random sampling methods. Sample sizes ranged from 188 to 1,515 participants (M = 671.88, SD = 419.61). In terms of variables examined, six [23, 26, 28, 29, 32, 44] of the eight studies investigated correlates across multiple levels of influence (i.e., socio-demographic, physical environmental, social environmental, social-cognitive, psychosocial, health-related, work-related, behavioral) and two [21, 34] examined only cognitive variables. Furthermore, only four [23, 26, 34, 44] of the eight studies assessed cognitive factors from a sedentary perspective or in a sedentary-specific manner. One study [21] examined cognitive factors from a general point of view, while three studies [28, 29, 32] assessed the associations between physical activity and/or exercise-specific cognitive factors and sedentary behavior.

Regarding measurement of sedentary behavior, all eight studies employed self-report measurement tools with only one study [21] capturing sedentary behavior both through self-report and objective measures. Despite the majority of studies measuring self-reported sedentary behavior, there was inconsistency between them in terms of specific sedentary pursuits assessed and the domains observed. One study [21] examined total time spent sedentary and time spent in specific leisure sedentary activities; one study [23] investigated determinants of context-specific sedentary time; four studies [28, 29, 32, 34] measured screen time and/or screen-based behaviors; and two studies [26, 44] looked at either occupational or work-related sitting time.

Primary associations of cognitive and motivational factors with sedentary behavior examined through non-theoretical studies are summarized in Appendix B and illustrated in Figure 3. Overall, the associations reported in Appendix B were small to medium in size. Five studies [23, 26, 29, 34, 44] investigated the relationship between attitudes and sedentary behavior. Of these, one study [29] found more positive attitudes towards exercise to be associated with lower sedentary behavior. Four studies [23, 26, 34, 44] found more positive attitudes towards sedentary behavior to be associated with higher sedentary behavior. Contrary to expectations, one study [26] found more positive attitudes towards sedentary behavior to be associated with lower sedentary behavior. Five studies [21, 23, 26, 28, 32] examined the relationship between social support and/or norms and sedentary behavior. One study [21] found greater support in life to be associated with lower sedentary behavior, while one [32] study found greater support for physical activity to be associated with lower sedentary behavior. Three studies [26, 28, 32] found no association between sedentary behavior and greater support and/or norms for sedentary behavior. However, one study [26] found greater norms for sedentary behavior to be associated with lower sedentary behavior and one study [23] found greater support and/or norms to be associated with higher sedentary behavior. Five studies [23, 26, 28, 29, 32] investigated the relationship between self-efficacy and/or control beliefs and sedentary behavior. Two studies [28, 29] found greater self-efficacy for physical activity to be associated with lower sedentary behavior, while one study [32] found this factor to be associated with lower sedentary behavior for boys but higher sedentary behavior for girls. One study [23] found greater self-efficacy for sedentary behavior to be associated with lower sedentary behavior and one study [26] found greater control for sedentary behavior to be associated with lower sedentary behavior. One study [26] showed no association between sedentary behavior and self-efficacy for sedentary behavior. Two studies [23, 34] examined the relationship between sedentary behavior habits and sedentary behavior, both of which found greater sedentary behavior habits to be associated with higher sedentary behavior. Two studies [26, 34] investigated the relationship between intentions and sedentary behavior. One study [34] reported greater sedentary behavior intentions to be associated with higher sedentary behavior. Contrary to expectations, one study [26] found greater intentions to reduce sedentary behavior to be associated with higher sedentary behavior.

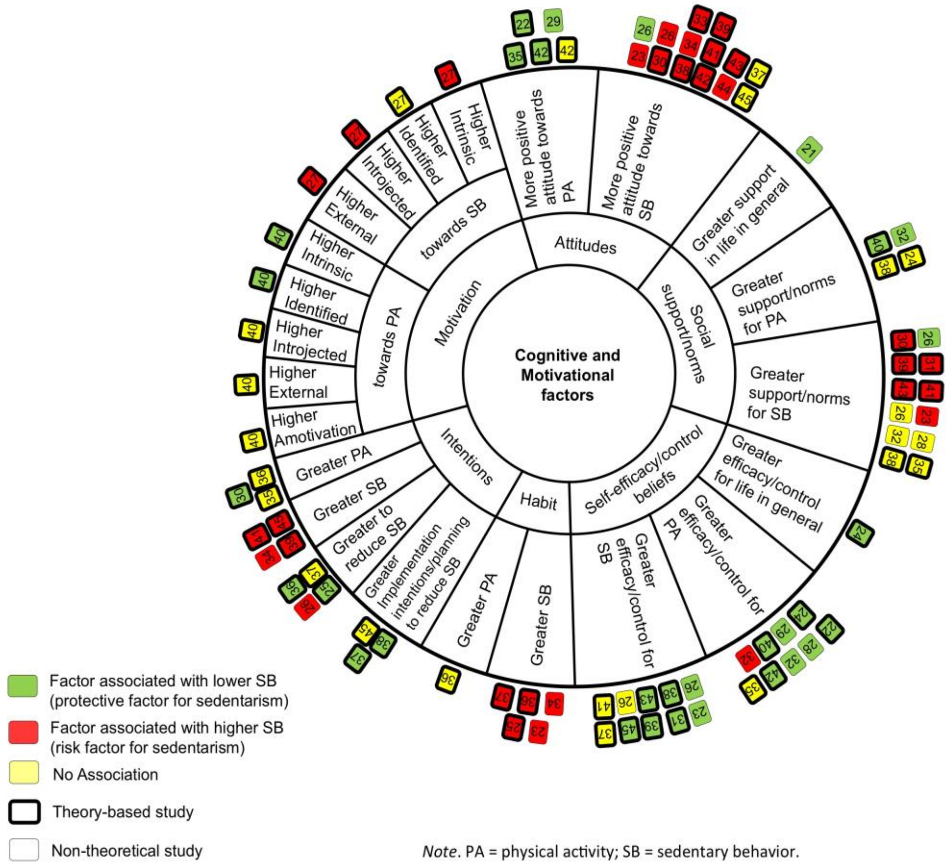

Figure 3. Pinwheel showing the association of cognitive and motivational factors with sedentary behavior.

Of the 25 studies included in this review, 17 were theoretically driven in their approach (see Appendix B). Of these, 10 studies [22, 24, 27, 30, 31, 38, 39, 40, 42, 43] employed an observational, cross-sectional design and six [25, 33, 35, 36, 37, 45] were longitudinal, prospective in nature. One study [41] included samples from two separate populations, and employed both cross-sectional and prospective designs. Timelines for prospective studies ranged from seven days to three years. Five studies [22, 30, 31, 33, 38] examined sedentary behavior in children and/or adolescent populations, five studies [25, 27, 36, 40, 45] examined factors associated with sedentary behavior in college and/or university student populations, and six studies [24, 35, 37, 39, 42, 43] investigated determinants of sedentary behavior in adult populations. One study [41] investigated sedentary behavior in two samples including an adult population and a university student population. Twelve studies [22, 24, 25, 27, 31, 35, 36, 37, 38, 39, 40, 45] employed convenience sampling methods, four studies [30, 33, 42, 43] used random sampling methods, and one study [41] employed both. Sample sizes ranged from 31 to 1,552 participants (M = 520, SD = 410.35). With regards to determinants examined, four studies [24, 33, 38, 43] investigated factors across multiple levels of influence (i.e., socio-demographic, physical environmental, social environmental, social-cognitive, psychosocial, health-related, work-related, behavioral), seven studies [22, 25, 30, 31, 36, 37, 42] examined cognitive variables only, and six [27, 35, 39, 40, 41, 45] were grounded in prominent social-cognitive and motivational theoretical models, such as Theory of Planned Behavior (TPB) [11], Protection Motivation Theory (PMT) [12], and Self-Determination Theory (SDT) [15]. Furthermore, 11 of the 17 studies [25, 27, 30, 31, 33, 37, 38, 39, 41, 43, 45] assessed cognitive and motivational factors from a sedentary perspective or in a sedentary-specific manner whereas four studies [22, 24, 35, 40] assessed physical activity related factors and two studies [36, 42] examined factors from both a sedentary and physical activity perspective.

In terms of sedentary behavior measurement, the majority of studies employed self-report measurement tools, however, two studies [33, 35] measured sedentary behavior objectively and two studies [25, 37] captured sedentary behavior both through self-report and objective measures. Nine studies [22, 24, 25, 33, 35, 36, 37, 38, 40] measured total sedentary time or overall sedentary behavior; five studies [27, 39, 41, 42, 45] investigated determinants of context-specific sedentary time; and three studies [30, 31, 43] measured screen time and/or screen-based behaviors.

Cognitive and motivational factors grounded in a theory-based framework and their respective associations to sedentary behavior are summarized in Appendix B and illustrated in Figure 3. Overall, the associations reported in Appendix B were small to medium in size. Eleven studies [22, 30, 33, 35, 37-39, 41-43, 45] examined the relationship between attitudes and sedentary behavior. Three studies [22, 35, 42] found more positive attitudes towards physical activity to be associated with lower sedentary behavior, however, one study [42] found no association between this factor and sedentary behavior. Seven studies [30, 33, 38, 39, 41-43] found more positive attitudes towards sedentary behavior to be associated with higher sedentary behavior, however, two studies [37, 45] found no association.

Nine studies [24, 30, 31, 35, 38-41, 43] investigated the relationship between social support and/or norms and sedentary behavior. One study [40] found greater support for physical activity to be associated with lower sedentary behavior; however, two studies [24, 38] failed to show an association. Five studies [30, 31, 39, 41, 43] found greater support and/or norms for sedentary behavior to be associated with higher sedentary behavior. Two studies [35, 38] reported no association between this factor and behavior.

Twelve studies [22, 24, 31, 35, 37-43, 45] examined the relationship between self-efficacy and/or control beliefs and sedentary behavior. One study [24] found that greater efficacy and control for life in general was associated with lower sedentary behavior. Four studies [22, 24, 40, 42] found greater self-efficacy and/or control beliefs for physical activity to be associated with lower sedentary behavior, while one study [35] found no association. Five studies [31, 38, 39, 43, 45] reported that greater self-efficacy and/or control for sedentary behavior was associated with lower sedentary behavior; however, two studies [37, 41] failed to show an association between this factor and sedentary behavior.

Three studies [25, 36, 37] investigated the relationship between habits, either towards sedentary behavior or physical activity, and sedentary behavior. Three studies [25, 36, 37] found greater sedentary behavior habits to be associated with higher sedentary behavior. One study [36] failed to show an association between greater physical activity habits and sedentary behavior.

Nine studies [25, 30, 35-39, 41, 45] examined the relationship between intentions and sedentary behavior. Two studies [37, 38] found greater implementations intentions and/or planning to reduce sedentary behavior to be associated with lower sedentary behavior; however, one study [45] found no association. Two studies [25, 36] found greater intentions to reduce sedentary behavior to be associated with lower sedentary behavior. One study [37] showed no association between this factor and behavior. Three studies [39, 41, 45] found greater sedentary behavior intentions to be associated with higher sedentary behavior. One study [30] found greater physical activity intentions to be associated with lower sedentary behavior; however, two studies [35, 36] failed to show an association.

Two studies [27, 40] investigated the relationship between motivational factors and sedentary behavior. One study [40] found higher intrinsic motivation and identified regulation towards physical activity to be associated with lower sedentary behavior.

However, no associations were found between introjected regulation, external regulation, or amotivation and sedentary behavior. One study [27] found higher intrinsic motivation, introjected regulation, and external regulation towards sedentary behavior to be associated with higher sedentary behavior. In this study, no association was found between identified regulation towards sedentarism and behavior.

The modified Downs and Black checklist for assessment of the methodological quality of reviewed studies, including the percentage of studies meeting each item, is presented in Table 1. The overall scores of the quality assessment for each study are presented in Table 2. When the studies were evaluated, the methodological quality score of the publications ranged from 35% to 80%. The average quality score for included studies was 69% (SD = 9.15). Out of the 25 publications (26 reported studies), one study [34] had a score of less than 50%. Three studies [22, 31, 36] had a score of 60%, eight studies [21, 24, 27, 29, 30, 35, 39, 40] had a score of 65%, three studies [38, 41b, 45] had a score of 70%, eight studies [26, 28, 32, 33, 41a, 42-44] had a score of 75%, and three studies [23, 25, 37] had a score of 80%. The average score of the included studies for the quality sub-scales of reporting, external validity, internal validity, and power were 88%, 31%, 71%, and 12%, respectively. Also highlighted through the assessment was the percentage of studies meeting each item on the checklist (Table 1). The majority of studies satisfied the reporting criteria (items 1-9) with >80% of studies meeting each of the items 1-8. However, only 42% of studies reported actual probability values for the main outcomes except where the probability value is less than 0.001 (item 9). In terms of the external validity criteria, items 10 and 11 attempt to address the representativeness of the findings of the study and whether they may be generalized to the population from which the study subjects were derived. Only 35% and 27% of studies met these items, respectively. The proportion of studies meeting the quality items with respect to internal validity (items 12-18) varied considerably per item, with only 35% of studies measuring the cognitive and/or motivation variables at a time prior to the assessment of sedentary behavior (item 13). Further, only 12% of studies scored positive on item 16 and included an objective assessment or some corroboration of the objective and subjective assessment in the measurement of sedentary behavior. For the power criteria (items 19-20), 88% of studies did not report a formal power calculation for determining the association between an exposure and sedentary behaviors (item 19). Because of this, it was unknown whether the sample size used for analysis was sufficiently powered for these studies (item 20).

Table 1. Checklist for assessment of the methodological quality of cross-sectional and prospective studies.

Criteria (rating of criteria: + = yes, – = no, ? = not or insufficiently described)	% studies meeting the item
Reporting	
1. Is the hypothesis/aim/objective of the study clearly described?	100
2. Are the main outcomes to be measured clearly described in the Introduction or Methods section?	100
3. Are the characteristics of the participants included in the study clearly described?	100
4. Is the study design clearly described (i.e., cross-sectional vs. prospective; if prospective, time of assessments)?	89
5. When appropriate, were principal covariates clearly described?	81
6. Are the main findings of the study clearly described?	100
7. Does the study provide estimates of the random variability in the data for the main outcomes?	92
8. Have the characteristics of participants lost to follow-up and/or with missing data been described?	89
9. Have actual probability values been reported (e.g. 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?	42
External Validity	
10. Were the subjects asked to participate in the study representative of the entire population from which they were recruited?	35
11. Were those subjects who were prepared to participate representative of the entire population from which they were recruited?	27
Internal Validity – bias	
12. If any of the results of the study were based on “data dredging”, was this made clear?	100
13. Were the exposure variables assessed at a time prior to the measurement of sedentary behaviour?	35
14. Were the statistical tests used to assess the main outcomes appropriate?	100
15. Were the main outcome measures used accurate (valid and reliable)?	96
16. Did measurement of sedentary behaviour (outcome) include an objective assessment or some corroboration of the objective and subjective assessment?	12
Internal validity - confounding (selection bias)	

17. When appropriate, was there adequate adjustment for confounding (i.e., covariates) in the analyses from which the main findings were drawn?	81
18. Were losses of participants to follow-up and/or with missing data taken into account?	73
Power	
19. Did the study report a formal power calculation for determining the association between an exposure and sedentary behaviours?	12
20. Was the sample size used for analyses reflective of the power calculation?	12

Table 2. Overall scores of the methodological quality assessment for the included studies.

Author/Criteria (1-20)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total/%
[21] Atkin, Corder, Goodyer, et al., 2015	+	+	+	+	+	+	+	+	–	–	?	+	–	+	+	–	+	+	–	?	13 65%
[22] Bai, Chen, Vazou, et al., 2015	+	+	+	–	+	+	+	+	–	–	–	+	–	+	+	–	+	+	–	?	12 60%
[23] Busschaert, De Bourdeaudhuij, Van Cauwenberg, et al., 2016	+	+	+	+	+	+	+	+	–	+	+	+	+	+	+	–	+	+	–	?	16 80%
[24] Chang & Sok, 2015	+	+	+	+	–	+	+	+	+	–	?	+	–	+	+	–	–	–	+	+	13 65%
[25] Conroy, Maher, Elavsky, et al., 2013	+	+	+	+	+	+	+	+	+	–	–	+	+	+	+	+	+	+	–	?	16 80%
[26] De Cocker, Duncan, Short, et al., 2014	+	+	+	–	+	+	+	+	+	+	+	+	–	+	+	–	+	+	–	?	15 75%
[27] Gaston, De Jesus, Markland, et al., 2016	+	+	+	+	+	+	+	+	–	–	?	+	–	+	+	–	+	+	–	?	13 65%
[28] Gebremariam, Totland, Andersen, et al., 2012	+	+	+	+	+	+	+	+	+	–	?	+	+	+	+	–	+	+	–	?	15 75%
[29] Ham, Sung, & Kim, 2013	+	+	+	+	–	+	+	+	+	–	?	+	–	+	+	–	–	–	+	+	13 65%
[30] He, Piché, Beynon, et al., 2010	+	+	+	+	+	+	–	+	–	+	+	+	–	+	+	–	+	–	–	?	13 65%
[31] Hoyos Cillero, Jago, & Sebire, 2011	+	+	+	+	+	+	+	–	+	–	?	+	–	+	+	–	+	–	–	?	12 60%
[32] Huang, Wong, & Salmon, 2013	+	+	+	+	+	+	+	+	–	+	+	+	–	+	+	–	+	+	–	?	15 75%
[33] Janssen, Basterfield, Parkinson, et al., 2015	+	+	+	+	–	+	+	+	–	+	?	+	+	+	+	–	–	+	+	+	15 75%

[34] Kremers & Brug, 2008	+	+	+	+	–	+	–	–	–	–	–	+	–	+	–	–	–	–	–	?	7 35%
[35] Lowe, Danielson, Beaumont, et al., 2015	+	+	+	–	+	+	+	–	+	–	–	+	+	+	+	+	+	–	–	?	13 65%
[36] Maher & Conroy, 2015	+	+	+	+	–	+	+	+	–	–	–	+	+	+	+	–	–	+	–	?	12 60%
[37] Maher & Conroy, 2016	+	+	+	+	+	+	+	+	+	–	?	+	+	+	+	+	+	+	–	?	16 80%
[38] Norman, Schmid, Sallis, et al., 2005	+	+	+	+	+	+	+	+	+	–	?	+	–	+	+	–	+	+	–	?	14 70%
[39] Prapavessis, Gaston, & DeJesus, 2015	+	+	+	+	+	+	+	+	–	–	–	+	–	+	+	–	+	+	–	?	13 65%
[40] Quartiroli & Maeda, 2014	+	+	+	+	+	+	+	+	–	–	?	+	–	+	+	–	+	+	–	?	13 65%
[41] Rhodes & Dean, 2009 (A)	+	+	+	+	+	+	+	+	–	+	+	+	–	+	+	–	+	+	–	?	15 75%
[41] Rhodes & Dean, 2009 (B)	+	+	+	+	+	+	+	+	–	–	–	+	+	+	+	–	+	+	–	?	14 70%
[42] Salmon, Owen, Crawford, et al., 2003	+	+	+	+	+	+	+	+	–	+	+	+	–	+	+	–	+	+	–	?	15 75%
[43] Van Dyck, Cardon, Deforche, et al., 2011	+	+	+	+	+	+	+	+	+	+	–	+	–	+	+	–	+	+	–	?	15 75%
[44] Wallmann-Sperlich, Bucksch, Schneider, et al., 2014	+	+	+	+	+	+	+	+	+	+	+	+	–	+	+	–	+	–	–	?	15 75%
[45] Wong, Gaston, DeJesus, et al., 2016	+	+	+	+	+	+	+	+	–	–	–	+	+	+	+	–	+	+	–	?	14 70%

Discussion

The purpose of this paper was to systematically review and critique the current literature on the role that cognitive and motivational processes play in understanding sedentary behavior. While other reviews have been conducted on socio-demographic and behavioral correlates of sedentary behavior, to our knowledge this is the first to focus exclusively on cognitive and motivational factors.

Primary associations of cognitive and motivational factors with sedentary behavior examined through non-theoretical studies [21, 23, 26, 28, 29, 32, 34, 44] showed that among children and adolescents, a more positive attitude towards watching TV and using a computer [34], a less positive attitude towards exercise [29], greater habit strength for watching TV and using a computer [34], and greater intentions for sedentary behavior [34] were associated with greater time spent in sedentary pursuits. Conversely, a more negative attitude towards screen time [34], a more positive attitude towards exercise [29], greater perceived family and peer support for physical activity [32], better friendship quality [21], greater perceived family functioning [21], and greater self-efficacy to engage in physical activity and overcome barriers [28, 29, 32] were associated with lower sedentary behavior. It is worth noting that the majority of studies (4 out of 5) [28, 29, 32, 34] with children and adolescents specifically examined screen-related sedentary behaviors. This is consistent with findings from past reviews, which found a less-developed research base on correlates of sedentary behavior among adults and highlighted the need to address this issue [5, 17].

Among adults, one study [44] found, for men only, that a more positive attitude towards sitting, measured as indifference towards sitting for long periods of time, was associated with increasing work-related sitting durations. De Cocker and colleagues [26] sought to identity socio-demographic, health-related, work-related and psychosocial correlates of occupational sitting in Australian adult employees. It was found that adults who perceived greater control over how much they sat reported lower occupational sitting time, whereas those who believed that reducing their sitting time would be disadvantageous reported higher occupational sitting time. No associations emerged between self-efficacy or social support to sit less in the next month at work and occupational sitting time. Contrary to expectations, De Cocker and colleagues found that adults who perceived higher social norms towards sitting less at work, reported greater benefits of sitting less, and had greater intentions to sit less at work reported higher occupational sitting time compared to respective comparison counterparts. They also found that employment status and occupational classification had a moderating effect on the association between control to sit less at work and occupational sitting time such that lack of control to sit less at work was positively associated with occupational sitting time among full- and part-time workers and white-collar and professional workers only. These findings suggest that those who are full-time, white-collar and/or professional workers may have positive attitudes towards sitting less and intentions to sit less; however, these individuals are also more likely to be employed in jobs that require prolonged sitting. Thus, in the absence of control, even attitudes and intentions are insufficient to lead to reduced sedentary behavior.

In a longitudinal study, Busschaert and colleagues [23] examined the relationship between changes in social-cognitive variables from baseline to one-year follow-up with changes in context-specific sitting times. They found that positive attitudes towards watching TV and computer use was associated with more sitting while watching TV and more sitting while using a computer, respectively. Higher perceived modeling of sedentary behavior (i.e., time partner spends watching TV) was associated with more sitting while watching TV and higher norms associated with computer use and motorized transport was associated with more sitting in those contexts. Self-efficacy to reduce computer use was associated with less sitting time while using a computer, whereas self-efficacy to use active transportation was associated with less sitting during motorized transport. In contrast to De Cocker and colleagues [26], Busschaert et al.'s [23] findings are in line with the expected relationships between cognitive variables and behavior. The most likely reason for this difference is De Cocker et al. [26] examined occupational sitting, a type of sedentary behavior less under an individual's control, while Busschaert et al. [23] examined leisure time sitting.

For the cognitive factors examined through non-theoretical studies, there is: consistent evidence of an unfavorable association between positive attitudes towards sedentary behavior, sedentary habits, sedentary intentions, and time spent in sedentary pursuits; consistent evidence of a favorable association between positive attitudes towards physical activity, general social support, support/norms for physical activity, and sedentary behavior; some evidence of a favorable association between self-efficacy/control beliefs for sedentary behavior and time spent in sedentary pursuits; and no evidence of an association between support/norms for sedentary behavior and levels of sedentary behavior (see Appendix B and Figure 3). While there was consistent evidence of an association between self-efficacy/control for physical activity and levels of sedentary behavior with majority of studies indicating a favorable association, one study demonstrated an unfavorable association between this factor and behavior. It is important to note that sedentary intentions, attitudes towards physical activity, general social support, and support/norms for physical activity and their relationship with sedentary behavior were only examined in one non-theoretical study each.

Health behavior change scientists from numerous fields, including physical activity, have underscored the superiority of using theory to guide their research [46]. Studies investigating cognitive and motivational factors grounded in a theory-based framework and their respective associations to sedentary behavior are summarized in Appendix B and Figure 3. Attitude, either towards sedentary behavior or physical activity, was one of the most often studied cognitions with 11 studies [22, 30, 33, 35, 37-39, 41-43, 45] including at least one measure of this construct. Seven studies [30, 33, 38, 39, 41-43] revealed that having more positive attitudes towards sedentary behavior was associated with higher levels of sedentary behavior while two studies [37, 45] showed no association between these constructs. Three studies [22, 35, 42] demonstrated having more positive attitudes towards physical activity to be associated with lower levels of sedentary behavior; whereas, one study [42] showed no association between these constructs. These findings are largely consistent with the bulk of the research on the relation between attitude and behavior, which shows that attitude can be a strong predictor of behavior [47]. A common strength of the included studies was the assessment of attitudes towards a single, specific, well-defined behavior. This may be one reason why the majority of studies demonstrated significant findings. Attitude can refer to affective attitudes (e.g., enjoyment of sitting) or instrumental attitudes (e.g., pros or cons associated with sedentary behavior). Among the studies included, three [30, 33, 42] assessed only affective attitudes, three [37, 43, 45] assessed only instrumental attitudes, and two [38, 39] assessed both affective and instrumental attitudes. Among studies examining attitudes towards physical activity, two studies [22, 42] examined affective and one study [35] examined both. For sedentary attitudes, all affective attitude measures and three out of the five instrumental attitude measures significantly predicted behavior. For physical activity attitudes, three out of four measures of affective attitudes and the only instrumental attitude measure were significant correlates of behavior. Taken together, these findings indicate that how individuals *feel* about sedentary behavior, and, to a lower extent physical activity, plays a strong role in affecting how sedentary they are. In summary, there is some evidence of an unfavorable association between positive attitudes towards sedentary behaviors and time spent in sedentary pursuits. There also is some evidence of a favorable association between positive attitudes towards physical activity and levels of sedentary behavior.

With regards to social support and norms as potential factors related to sedentary behavior, five studies [30, 31, 39, 41, 43] demonstrated that greater support/norms for sedentary behavior were associated with higher sedentary behavior. Two studies [35, 38] failed to show an association between these factors and sedentary behavior. Five of these [31, 35, 39, 41, 43] specifically explored the influence of norms towards sedentary behavior as a potential risk factor. For the most part, the results highlight the importance of subjective norms in understanding levels of sedentary behavior. Prapavessis and colleagues [39] suggested that, as the majority of adults spend far more time being sedentary than being active, the role of others appears to be more important in encouraging sedentary than physical activity pursuits. Additionally, decisions to be sedentary are likely to be socially motivated, and socially motivated decisions enhance the recognition of normative perceptions, which in turn may influence behavior through intentions [48]. One study [40] found that greater support/norms for physical activity was associated with lower sedentary behavior; however, two studies [24, 38] found no association between this factor and behavior. Among the studies, which failed to show an association, Chang and Sok [24] examined the relationship between social support for physical activity and sedentary behavior in elderly persons with hypertension and Norman and colleagues [38] examined parent-directed support for physical activity and sedentary behavior in a sample of adolescents. Chang and Sok [24] suggested, from their findings, that predictors of sedentary behavior might be distinct from the well-known powerful predictors of physical activity. Quartiroli and Maeda [40], however, found that scoring higher with respect to the basic psychological need of relatedness in exercise was associated with lower levels of sedentary behavior. It is proposed then that perhaps, the perception of being close and connected to others through physical activity (i.e., relatedness) is a determinant of sedentarism to be explored further. In summary, there is some evidence of an unfavorable association between support/norms for sedentary behavior and time spent in sedentary pursuits. However, presently there is no clear evidence of an association between support/norms for physical activity and levels of sedentary behavior.

In terms of self-efficacy/control beliefs, outcomes assessed included self-efficacy to reduce sedentary behavior and/or screen time, scheduling self-efficacy, response self-efficacy, and perceived behavior control. Five studies [31, 38, 39, 43, 45] showed that greater self-efficacy/control for sedentary behavior was associated with lower sedentary behavior while two studies [37, 41] showed no association. Maher and colleagues [37] failed to show an association between self-efficacy to limit sedentary behavior and sedentary time in older adults; however, task self-efficacy was associated with intentions to limit sedentary behavior. This indicates that efficacy beliefs may be an indirect determinant of sitting time in older adults. The authors also suggested that older adults might have particularly low levels of task self-efficacy to limit sedentary behavior due to pain or functional limitations, aging stereotypes, and previous failed attempts to engage in physical activity. Rhodes and Dean [41] showed no association between perceived behavioral control and sedentary leisure behaviors; this is contrary to findings by Prapavessis and colleagues [39] who found perceived behavioral control to be a protective factor for sedentarism. Rhodes and Dean [41] acknowledged that the absence of perceived behavioral control as a behavioral correlate or even an independent predictor of intention is markedly different from most health behaviors. However, they indicated that this could offer important information on the discriminant motivational structure of sedentary leisure behaviors compared to what is known about a behavior like physical activity, and suggest the difference may be due to high access and ease of use among people who wish to perform these behaviors. Additionally, four studies [22, 24, 40, 42] showed that greater self-efficacy and control for physical activity was associated with lower sedentary behavior; however, one study [35] found no association between sedentary time and greater efficacy/control beliefs towards physical activity. This study was markedly different from the other studies in that it was examining TPB correlates of sedentary behavior in cancer patients with brain metastases. In this population, attitudes towards physical activity were most strongly correlated with sedentary behavior. The authors indicated that although not statistically significant, there were potentially meaningful differences in perceived behavioral control between those who sit or supine less than 20.7 hours per day and those who accumulate 20.7 hours or greater. One study [24] found that feeling more empowered overall (i.e., having greater feelings of efficacy and control for life in general) was associated with lower levels of sedentarism. In summary, there is some evidence of a favorable association between self-efficacy/control for sedentary behavior and time spent in sedentary pursuits. Likewise, there is some evidence of a favorable association between self-efficacy/control for physical activity and levels of sedentary behavior. There is also consistent evidence of a favorable association between self-efficacy/control for life in general and levels of sedentary behavior; however, caution is warranted when interpreting this finding as only one study to date has examined this factor in relation to sedentary behavior.

Recently, due to the sporadic, varied, and unstructured nature of sedentary behavior, researchers have suggested that habit formation may play a role in understanding sedentary pursuits [36, 37]. Dual process theories of motivation propose that both controlled and automatic motivational processes regulate behavior. Controlled processes are conscious, reflective, and volitional and include many of the constructs outlined in social-cognitive theories and this review. Automatic processes, on the other hand, are non-conscious, reflexive, and unintended, and can include constructs such as habits. It has been suggested that these two motivational processes may operate independently or interact to regulate health behaviors [37]. Habits develop through the repeated pairing of a contextual cue with behavior, over time, until the contextual cue automatically elicits the behavioral response [49]. Three studies [25, 36, 37] included in this review found greater sedentary behavior habits to be a risk factor for sedentarism. Maher and Conroy [37] recently showed that habit strength for sedentary behavior was the greatest of all the predictors of behavior, demonstrating that automatic processes, such as habits, represent a crucial component in understanding sedentarism. The findings of these studies demonstrated that the association between habit strength and sedentary behavior appears to be robust for both young and older adults. On the other hand, one study [36] failed to show an association between greater physical activity habits and sedentary behavior. The role of both controlled and automatic motivational processes in regulating sedentary behavior needs to be examined further. Dual-process models incorporating habit formation (i.e., automatic and unreasoned process) into prominent social-cognitive theoretical frameworks could explain a greater proportion of sedentary behavior and be effective in sedentary behavior reduction efforts. There has also been a call for improved measures of habit processes within the health domain, and specifically that of sedentarism [50, 37]. Grove and Zillich [50] proposed a theoretical model of psychological processes associated with habitual exercise, in which they suggest that habitual health behaviors are characterized by several common features, including; strong stimulus response (S-R) bonds (i.e., driven by cues), automaticity, patterning of action, and negative consequences for nonperformance. It is possible that this model may hold value for assessing habits related to sedentary behavior. In summary, there is consistent evidence of an unfavorable association between sedentary behavior habits and time spent in sedentary pursuits, however, there is no evidence of an association between physical activity habits and levels of sedentary behavior.

In many behavior change models, intentions are seen as the principal, predisposing factor as to whether someone will engage in a particular health behavior (or not). With regards to intention as a potential factor associated with sedentary behavior, one study [30] found greater physical activity intentions to be a protective factor for sedentarism; however, two studies [35, 36] found no association. Two studies [25, 36] demonstrated having greater intentions to reduce sedentary behavior to be associated with lower sedentary behavior. In one study [37], no association was found. In terms of intentions as risk factors for sedentarism, three studies [39, 41, 45] found greater sedentary behavior intentions to be associated with higher sedentary behavior. Finally, two studies [37, 38] showed greater implementation intentions or planning to reduce sedentary behavior to be associated with less sedentary behavior, while one study [45] found no association. The abovementioned studies, taken together, provide evidence to support the theoretical construct of both goal and implementation intentions as correlates of sedentary behavior and suggest that engagement in sedentary pursuits may be a controlled motivational process similar to other health behaviors. Future studies examining the role of sedentary goal intentions need to be conducted to determine whether measuring goal intentions towards sedentary behavior itself, or goal intentions to change sedentary behavior is a more viable approach. In summary, there is no clear evidence of a favorable association between physical activity intentions and levels of sedentary behavior. However, there is consistent evidence of an unfavorable association between sedentary behavior intentions and time spent in sedentary pursuits. Additionally, there is some evidence of a favorable association between intentions to reduce sedentary behavior and levels of sedentary behavior. There is also some evidence of a favorable association between implementation intentions and/or planning to reduce sedentary behavior and levels of sedentary behavior.

Two studies [27, 40] examined motivation type within a Self Determination Theory framework as a potential psychological determinant of sedentary behavior. Gaston, De Jesus, Markland, and Prapavessis [27] demonstrated higher external regulation, higher introjected regulation, and high intrinsic motivation towards sedentary behavior to be risk factors for sedentarism. Specifically, Gaston and colleagues found that intrinsic motivation was the strongest predictor of sedentary behavior, followed by external regulation and introjected regulation. These authors examined leisure and work/school activities separately, and found that autonomous motives (i.e., intrinsic motivation) underlied leisure/recreation sedentary pursuits whereas more controlled motives (i.e., external and introjected regulation) influenced work/school sedentary activities. Identified regulation, which occurs when an individual recognizes that a behavior is beneficial for achieving a personally valued goal and consequently adopts the behavior as their own [27], was not related to behavior. Since sitting is typically engaged in not for its own sake but as a means to an end, this finding was surprising. It should also be recognized that this study was the first to adapt the Behavioral Regulation in Exercise Questionnaire (BREQ) [51] for sedentary behavior. Quartiroli and Maeda [40] showed higher intrinsic motivation and higher identified regulation towards physical activity to be associated with lower levels of sedentary behavior. No association was found for introjected regulation, external regulation, and amotivation towards physical activity and sedentary behavior. The finding in both studies that intrinsic motivation is related with sedentary behavior is consistent with the relation on attitudes and behavior. Similarly to measures of affective attitude, intrinsic motivation refers to performing a behavior for its own sake, in other words, for the enjoyment of it. More studies are required to validate the theoretical structure of SDT in explaining sedentary behavior and to identify sedentary-specific motivational factors related to sedentarism. In summary, there is convincing evidence from one study [40] of a favorable association between intrinsic motivation and identified regulation towards physical activity and levels of sedentary behavior. However, there is no evidence of an association between introjected regulation, external regulation, and amotivation towards physical activity and sedentary behavior. There is also convincing evidence from one study [27] of an unfavorable association between external regulation, introjected regulation, and intrinsic motivation towards sedentary behavior and time spent in sedentary pursuits. No evidence of an association between identified regulation towards sedentary behavior and levels of sedentary behavior has been shown.

Given that the associations between cognitive factors, motivational factors and sedentary behavior or sedentary time were small to medium in size, researchers interested in targeting these modifiable variables will need to take this into consideration when using these as agents of change for sedentary behavior interventions. Furthermore, these findings suggest that both physical activity related and sedentary-specific cognitive and motivational factors will play a role in understanding sedentarism. With respect to movement-related factors, research has shown a strong, inverse correlation between sedentary behavior and light-intensity physical activity [62], as well as a small to medium inverse correlation between sedentary behavior and leisure time physical activity [17, 63]. If these behaviors are associated with one another, then it is highly likely that physical activity related cognitions could be associated with time spent sedentary. The findings, herein, serve to confirm this rationale and demonstrate that physical activity related cognitive and motivational factors are correlates of sedentary behavior. In order to maximize the contribution of studies examining physical activity related factors to our understanding of sedentary behavior determinants; researchers might need to measure these cognitions as they pertain to specific types of physical activity (i.e., total physical activity, light-intensity physical activity).

Based on the Downs and Black checklist [60] for assessment of the methodological quality, the findings from the included studies in this systematic review come from reasonably high quality studies (see Tables 1 and 2). For instance, 22 of the 26 reported studies had overall quality scores ≥65% and 11 of the 26 studies had overall quality scores ≥75%. We found no difference between the average quality scores (i.e., percentages) of theoretically-driven (M = 68.9%, SD = 6.4) versus non-theory based studies (M = 68.1%, SD = 13.5). Furthermore, studies that demonstrated an association between cognitive and/or motivational variables and sedentary behavior (M = 69%, SD = 9.2) were of similar quality to those studies that found no association between these constructs (M = 71%, SD = 5.8). The two major weaknesses with the included studies are that: only 35% of them measured the cognitive and/or motivational variables prior to the assessment of SB and only 12% of them included an objective measure or some corroboration of the objective and subjective measure of SB.

A number of future recommendations should be considered with respect to the findings presented herein. There is a need for more longitudinal, prospective studies to be completed examining cognitive and motivational determinants of sedentary behavior. Only nine of the 25 reviewed studies were prospective in design and majority of these had relatively acute timelines (i.e., 7 to 14 day period). Studies that examine the association between cognitive and motivational factors and context-specific sedentary behavior over longer durations are required. The majority of the reviewed studies (i.e., 20 out of 25) employed solely self-reported estimates of sedentary behavior through a range of questionnaires, which differed in their outcomes assessed. Because of its high prevalence and habitual nature, sedentary behavior may be very difficult to recall accurately. It is recommended for future research in this field of inquiry to use accelerometers and/or inclinometers in conjunction with self-report methods. There was widespread variability between studies in the analytical methods used to identify correlates of sedentary behavior, as well as in the effect sizes reported. Consistent with the recommendations made by Rhodes et al. [17], researchers are encouraged to report standardized effect sizes along with the significance criterion when presenting their findings regarding cognitive and motivational factors related to sedentary behavior. This will allow for a meta-analysis to be conducted in this domain so the magnitude of cognitive and motivational constructs related to sedentary behavior can be evaluated and understood.

Replication of theory-based studies measuring sedentary-specific cognitive and motivational factors in high sedentary populations and contexts where sedentary behaviors are dominant is strongly recommended. These studies should also work on refining and validating instruments used to assess cognitions and conations (i.e., motivation) related to sedentarism. As noted in this review, a number of studies adapted physical activity scales or used non-validated tools to assess cognitive and motivational factors. The development of psychometrically validated tools and testing of theory is important for identifying and differentiating between protective and risk factors for sedentarism at varying life stages and across sedentary domains. This will allow researchers to identify the important cognitive and motivational correlates that should be targeted in interventions designed to reduce sedentary behavior. Owen and colleagues [5] suggested that the "primary strategic goal for research on sedentary behavior determinants and interventions is to integrate evidence to identify effective or promising strategies to reduce sitting time." Further, Rhodes et al. [17] proposed that cognitive, social, and environmental correlates seem better suited for intervention efforts to reduce sedentary behavior. Theoretical behavior change models have been useful in identifying cognitive and motivational factors that have been shown to be associated with sedentary behavior, however, the manipulation of these variables for purposes of behavior change interventions to reduce sedentary behavior has yet to be extensively examined. For instance, Carr and colleagues [52] conducted a randomized controlled trial and demonstrated that an intervention grounded in Social Cognitive theory led to reduced sedentary time among middle-aged, sedentary and overweight adults working in sedentary jobs. In another successful study, Gardiner and colleagues [53] demonstrated that an intervention to reduce and break up sedentary time in older adults using Social Cognitive theory and behavior choice theory led to decreased sedentary time, increased breaks, and increased light-intensity physical activity and moderate-to-vigorous physical activity. While promising, further inquiry into the development of theory-based interventions targeting cognitive and motivational constructs with the goal of sedentary behavior reduction is needed.

Another potential theoretical model of interest for use in the sedentary behavior domain is the Health Action Process Approach [14] (HAPA). The HAPA model includes many variables that are similar to those shown in this review to be associated with sedentary behavior. This model holds several advantages over other models for intervention design and delivery in that it is a dynamic rather than static model. According to the HAPA model, successful behavior change involves both a pre-intentional motivational phase in which intention is formed and a post-intentional volitional phase in which intention is translated into action. To this end, the HAPA attempts to bridge the 'intention–behavior gap' inherent with other behavior change models (e.g., PMT, TPB) with action planning, coping planning, and action control components [54]. The HAPA model's effectiveness to explain the adoption and maintenance of numerous health behaviors has been demonstrated [14]. It is anticipated that the HAPA will also be of value in the sedentary behavior domain. It is recommended that the same line of inquiry be followed with HAPA as with previous behavior change models. First, valid and reliable HAPA sedentary constructs must be developed and then show an association to sedentary behavior. If relationships are found, the constructs must be targeted and modified through action and coping planning interventions with the goal of sedentary behavior reduction. Maher and Conroy [37], to our knowledge, are among the first to test a HAPA-based model of sedentary behavior and directly link planning, a key component of the HAPA model, with sedentary behavior. Maher and Conroy [37] highlighted that with other health behaviors, planning has been shown to be a crucial factor for bridging the goal intention-behavior gap. Their findings suggest that planning context-specific substitutes for sedentary behavior may be a promising approach for overcoming strong sedentary habits.

For purposes of this review, studies examining cognitive and motivational correlates of sedentary behavior from a qualitative approach were excluded. However, it is important to acknowledge that qualitative studies in this field of study exist and may potentially contribute to a deeper understanding of the role that cognitive and motivational factors play in sedentarism. For instance, Deliens, Deforche, De Bourdeaudhuij, and Clarys [55] used focus group discussions to examine a range of determinants of physical activity and sedentary behavior in university students, including perceived enjoyment, modeling, social support, and self-discipline. Similarly, this review was interested in the role of cognitive and motivational factors as determinants of sedentary behavior; as a result, studies examining affect (e.g., feelings, mood, stress, depression, coping behavior), physical self-perceptions (e.g., physical conditioning), health-related quality of life (e.g., physical function), and personality (e.g., traits, resilience) factors were excluded. It is recognized that these factors may also hold importance for a complete understanding of sedentary behavior determinants. For example, Uijtdewilligen, Singh, Chinapaw, Twisk, and van Mechelen [56] investigated the role of problem-focused coping, emotion-focused coping, and personality traits (i.e., inadequacy, social inadequacy, rigidity, self-esteem, self-sufficiency/recalcitrance, dominance, hostility) as person-related determinants of TV viewing and computer time in a cohort of young Dutch adults. They found that higher rigidity and self-sufficiency/recalcitrance were positively associated with TV time, whereas higher scores on self-esteem were significantly associated with higher computer time. Further, Breland, Fox, and Horowitz [57] examined the relationship between daily screen time and depression in a cross-sectional sample of overweight or obese minority women. Independent of physical activity, findings showed that engaging in high levels of daily screen time was associated with increased depression risk. These types of studies are warranted if we are to gain a more comprehensive understanding of the role psychological factors play in sedentarism.

In conclusion, a number of cognitive and motivational factors were identified that were associated with sedentarism. Among sedentary behavior-related cognitions, risk factors for greater sedentary time included having a more positive attitude towards sedentary behavior, perceiving greater social support/norms for sedentary behavior, reporting greater sedentary behavior habits, having greater intentions to be sedentary, and having higher intrinsic, introjected, and external motivation towards sedentary behavior. Protective factors associated with lower sedentary time included having greater feelings of self-efficacy/control over sedentary behavior and greater intentions to reduce sedentary behavior. Among physical activity-related cognitions, protective factors for lower sedentary behavior included a more positive attitude towards physical activity, having greater social support/norms for physical activity, greater self-efficacy/control for physical activity, higher physical activity intentions, and higher intrinsic and identified motivation towards physical activity. In addition, feeling more supported and empowered in general was related with lower levels of sedentary behavior. To further extend our understanding of the relation between cognitive and motivational factors and sedentary behavior, more longitudinal, theory-driven studies examining cognitions and motivation from a sedentary perspective are required.

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Chapter 3 – Sedentary Behaviour and Diabetes Information as a Source of Motivation to Reduce Daily Sitting Time in Adult Office Workers: A Randomized Controlled Trial using the Motivational Phase of the Health Action Process Approach (study 2)

Abstract

Background: Using the motivational phase of the Health Action Process Approach (HAPA), this study examined whether sedentary behaviour and diabetes information is a meaningful source of motivation to reduce daily sitting time among preintending office workers. **Methods:** Participants (N = 218) were randomized into either HAPA-intervention (SB), HAPA-attention control (PA), or control (no treatment) conditions. The intervention group viewed an online slide-show that targeted pre-intentional motivational constructs related to sitting by presenting research on SB and diabetes risk markers, the effectiveness of breaking up prolonged sitting, and providing strategies to break up sitting. The attention-control group's slide-show focused exclusively on PA. Following treatment, purpose-built sedentary-related HAPA motivational constructs (i.e., risk perception [RP], outcome expectancies [OE], self-efficacy [SE]) and goal intentions [GI] were assessed. Only participants who had given little thought to how much time they spent sitting (i.e., preintenders) were used in subsequent analyses (n = 96). **Results:** Compared to the control groups, the intervention group reported significantly higher GIs: to increase both number and length of daily breaks from sitting at work; to reduce daily sitting time outside of work; to increase daily time spent standing outside of work, as well as greater OE (p values $\leq .05$; η_p^2 values $\geq .08$). Only SE (β range = .39 - .50) made significant and unique contributions to both work and leisure-time related GIs, explaining between 11-21% of the response variance. **Conclusions:** A brief, HAPA-based online intervention providing information regarding SB and diabetes risk may be an effective source of motivation.

Keywords: sedentary behaviour, health action process approach, intervention, motivation, intention, self-efficacy, outcome expectancies, risk perceptions

Acronyms:
Sedentary Behaviour (SB)
Physical Activity (PA)
Light-intensity Physical Activity (LIPA)
Health Action Process Approach (HAPA)
Risk Perceptions (RP)
Outcome Expectancies (OE)
Self-Efficacy (SE)
Goal Intentions (GI)

Introduction

Sedentary behaviour (SB) is defined as any waking behaviour characterized by an energy expenditure ≤1.5 metabolic equivalents, while in a sitting, reclining, or lying posture (Tremblay et al., 2017). The pervasiveness of sedentarism is evident through population-based studies, which indicate that Canadian and American adults spend upwards of 10 hours per day being sedentary (Colley et al., 2011). The workplace can be a key setting for prolonged sedentary time. Research has shown that almost 60% of office-based employees' total daily sitting time is accrued in the work setting and that office workers spend up to 77% of their working hours sitting, with approximately half of this time accumulated in prolonged bouts of 20 minutes or more (Bennie et al., 2015; Thorp et al., 2012). It also has been shown that office based-workers demonstrate high levels of sitting both at work (weekdays) and in their discretionary leisure time (evenings and weekends; Smith et al., 2015).

There is now convincing evidence that SB is a distinct risk factor, independent of moderate-to-vigorous physical activity (PA), for multiple adverse health conditions (Ekelund et al., 2016). An overview of 27 systematic reviews found that among adults, sedentary time is positively associated with all-cause mortality, as well as numerous chronic diseases including fatal and non-fatal cardiovascular disease, type 2 diabetes, metabolic syndrome, and certain types of cancer (de Rezende, Lopes, Rey-López, Matsudo, & do Carmo Luiz, 2014). Researchers, for instance, have found an unfavourable association between total sedentary time and insulin sensitivity, fasting insulin, insulin resistance, and triglycerides (Brocklebank, Falconer, Page, Perry, & Cooper, 2015). Importantly, uninterrupted SB lasting ≤7 days has been shown to result in moderate and deleterious changes in insulin sensitivity, glucose tolerance, and plasma triglyceride levels (Saunders, Larouche, Colley, & Tremblay, 2012). Recently, Davies et al. (2018) reported that a short-term (i.e., 14 day) reduction in PA with increased SB leads to a reversible reduction in multi-organ insulin sensitivity and cardiorespiratory fitness, with concomitant increases in central and liver fat and dyslipidaemia. These findings support the proposed association between sedentary time and the development of Type 2 diabetes—a health outcome germane to the present investigation.

Given the relationship between sitting time and adverse health consequences, it is important to promote strategies, which can help mitigate this risk. Research on the biological effects of sedentarism has shown that many detrimental sitting-related health effects can be reduced by displacing and disrupting prolonged sedentary time. In a large representative sample of Canadian adults, it was shown that each additional 10 breaks per day is beneficially associated with improvements in waist circumference, systolic blood pressure, HDL-cholesterol, triglycerides, glucose and insulin, indicating that breaking up sedentary time may be particularly important for cardiometabolic health (Carson et al., 2014). Healy et al. (2008), for instance, reported that increased breaks in sedentary time were related to lower adiposity measures, triglycerides, and 2h plasma glucose. With respect to what constitutes an effective break, researchers have found that both standing and light-intensity physical activity (LIPA) benefit cardio-metabolic health over sitting, but only LIPA benefits BMI and waist circumference (Healy et al., 2015). For example, a meta-analysis by Chastin, Egerton, Leask, and Stamatakis (2015) showed that breaks in sedentary periods of at least LIPA may have a positive effect on glycemic control, with breaks significantly lowering blood glucose response and insulin levels in adults, by 17%

and 15%, respectively. Substituting LIPA for sedentary time may be a practical and achievable preventive strategy to reduce the risk of type 2 diabetes. As beneficial metabolic associations have been observed with breaks that are relatively short in duration and light in intensity, advice to regularly break up or interrupt sustained sedentary time may be feasible to implement across numerous settings, including the workplace.

Many intervention studies targeting the feasibility and effectiveness of displacing and/or disrupting sedentary time as a new health behaviour change goal, in adult populations, have been conducted (Gardner, Smith, Lorencatto, Hamer, & Biddle, 2016). Most interventions targeting SB in the occupational or office setting have employed environmental manipulations (e.g., sit-to-stand desks; Shrestha et al., 2016) or have been multi-component in nature (Carr et al., 2013; Danquah et al., 2017; Healy et al., 2013; Healy et al., 2017; Mackenzie, Goyder, & Eves, 2015; Neuhaus, Healy, Dunstan, Owen, & Eakin, 2014), whereas, behavioural interventions target modifiable cognitive factors (i.e., what the person can do).

Behavioural interventions offer a feasible and accessible alternative for displacing and disrupting SB among office workers (Cooley & Pedersen, 2013; Evans et al., 2012; Kozey-Keadle, Libertine, Staudenmayer, & Freedson, 2012; Lang, McNeil, Tremblay, & Saunders, 2015; Swartz et al., 2014). In comparison to interventions incorporating solely physical workplace changes (e.g., active workstations), behavioural interventions may be more effective by targeting the self-regulatory skills needed to sustain behaviour change.

While the above-mentioned studies have shown some success in reducing office workers’ SB through a behavioral intervention, a shared drawback is that the interventions were not grounded in a particular theoretical framework of behaviour change. To explain, predict, and effectively improve the self-regulation of individuals, theories of health behaviour change are needed (Dunn & Elliot, 2008). Health behavior change scientists from numerous fields, including PA, have underscored the superiority of interventions developed with an explicit theoretical foundation compared to those lacking a theoretical base (Glanz & Bishop, 2010). To this end, Rollo, Gaston, and Prapavessis (2016) in a systematic review identified important cognitive and motivational correlates that should be targeted in theory-based interventions designed to decrease sitting time. For instance, Prapavessis, Gaston, and DeJesus (2015) found that Theory of Planned Behaviour (TPB) constructs predicted sedentary intentions, and subsequent sedentary time whereas Wong, Gaston, DeJesus, and Prapavessis (2016) provided support for the utility of a sedentary-derived Protection Motivation Theory (PMT) model in predicting both goal and implementation intentions with regards to sitting time, as well as actual SB. Using self-determination theory, Gaston, DeJesus, Markland, and Prapavessis (2016) demonstrated that motivational constructs are related to sedentary pursuits in both the occupational and leisure domains. In a related study, Conroy, Maher, Elavsky, Hyde, and Doerksen (2013) tested a dual-process theory of motivation to SB and showed that daily SB was regulated by both automatic (habits) and controlled (intentions) motivational processes. Although these theoretical behavior change models have been useful in identifying cognitive and motivational factors that are associated with SB, the manipulation of these variables for purposes of behavior change interventions to reduce SB in office-working populations is unknown.

One suitable framework for predicting and modifying SB is the Health Action Process Approach (HAPA; Schwarzer, 2008). This is a dynamic model, which attempts to bridge the intention-behaviour gap inherent in other health behaviour change models by suggesting successful behaviour change involves both a pre-intentional motivational and post-intentional volitional phase. It is suggested through HAPA that risk perception (RP), outcome expectancies (OE), and task self-efficacy (SE) are predisposing factors for intention formation in the motivational phase, whereas, a number of post-intentional or volitional factors, including action/coping planning, action control, and maintenance/recovery SE, are viewed as influential for translating intention into action.

The HAPA framework has been used to explain the adoption and maintenance of numerous health-related behaviours including dental flossing, breast self-examination, seatbelt use, fruit and vegetable intake, and PA. To our knowledge, only two studies have examined the use of HAPA as a theoretical framework to advance our understanding of SB. Maher and Conroy (2016) were among the first to test a HAPA-based model of SB and directly link both intentions and plans to limit SB, key components of the HAPA model, with SB in older adults. In another study, Sui and Prapavessis (2017) conducted a pilot intervention to examine the effects of a HAPA-based intervention, specifically action and coping planning, for targeting SB, providing preliminary evidence for the potential of a domain-specific planning intervention to increase break frequency in full-time university students.

To date, no interventions have been developed to increase intentions to reduce SB and/or reduce SB in office working adults using HAPA as a theoretical framework. As described above it is asserted through the motivational phase of the model that the key determinant for influencing behaviour is intention. Hence, examining and developing methods to increase intentions is therefore imperative among high-risk groups such as office workers that could greatly benefit from a decrease in SB levels. An important public health promotion issue is whether information about the relationship between SB and disease risk (i.e., diabetes), as well as the protective benefits of displacing and disrupting SB for disease risk will have any impact on intentions (i.e., motivation) to reduce sedentary time. To maximize effectiveness of interventions targeting actual SB reduction, motivational interventions are first required to prime individuals, particularly preintenders to become intenders, which in turn will position them to become successful actors in the volitional phase of the HAPA model.

Using the motivational phase of the HAPA framework, the purpose of this study was to determine whether SB and diabetes information is a meaningful source of motivation to increase intentions to reduce daily sitting time among preintending office workers. Sedentary office-workers who had given little thought to how much they sit were targeted to discriminate preintenders from intenders. Research has demonstrated the benefits of matching self-help manuals and other motivational materials to a person's stage of readiness or change (e.g., Graham, Prapavessis, & Cameron, 2006; Pope, Pelletier, & Guertin, 2017).

It was hypothesized that participants in the HAPA intervention group would report greater goal intentions (GI) to reduce both occupational and leisure-time SB, as well as higher OE regarding reducing sitting time, higher RP regarding SB and diabetes risk, and higher SE to reduce both occupational and leisure-time SB, compared to their control group counterparts. It also was hypothesized that OE, RP, and SE would predict GI.

Methods

Study Design

Data for this three-arm, randomized controlled trial (RCT) were collected between August and December 2017 and analyzed in January 2018. The study was approved by the institutional Research Ethics Board (see Appendix C), and the protocol was registered and made publicly available through ClinicalTrials.gov (Identifier # NCT03091686). A between-group design was utilized to examine differences in outcome measures based on treatment received. Participants were blinded to group allocation and were unaware of the existence of the other treatment conditions at the time of study participation. However, research staff were not blinded to group allocation. A flow diagram of the study design is illustrated in Figure 4.

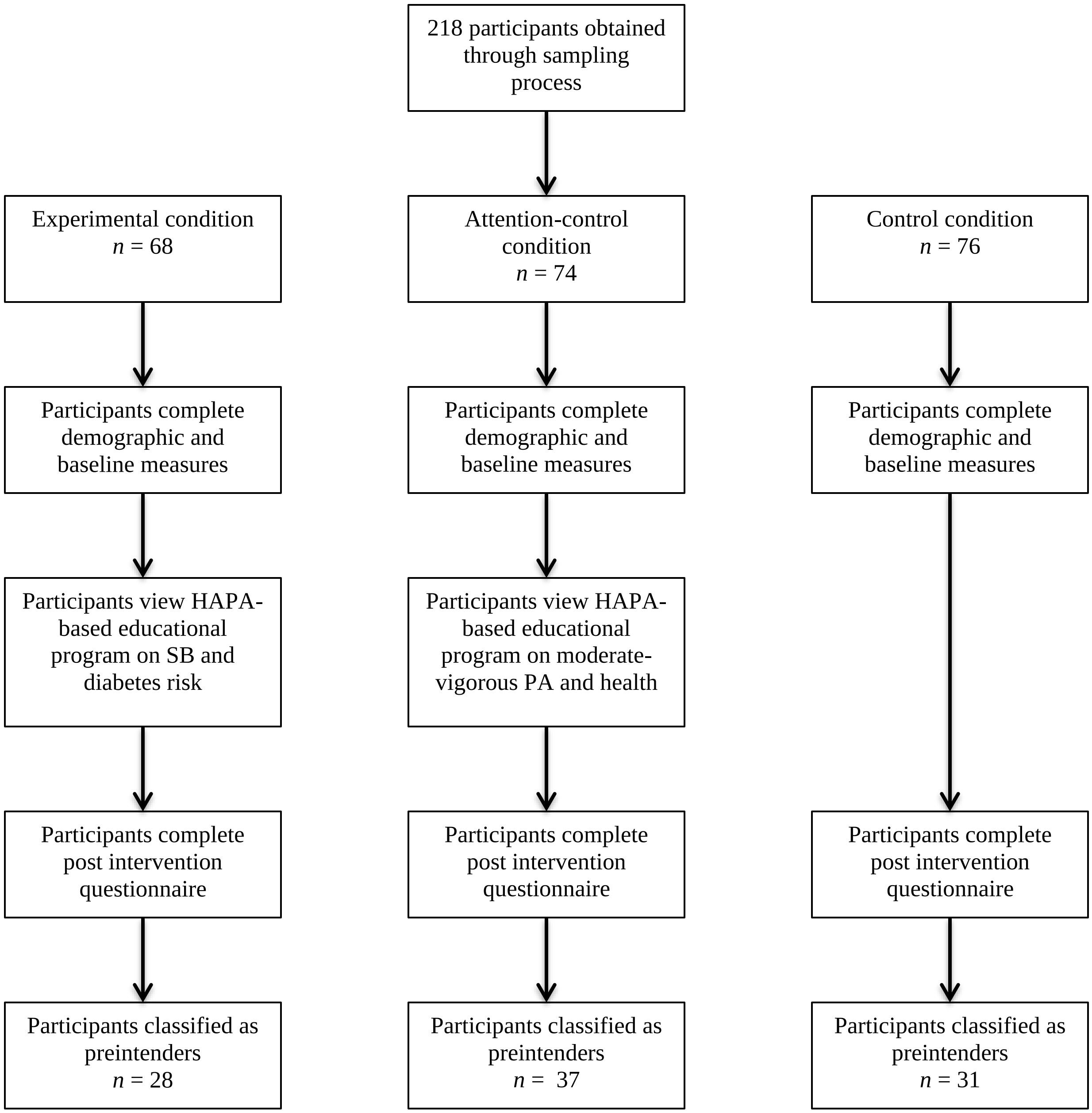

Figure 4. Flow diagram of design and overall procedure.

Participants

Participants were full-time adult office workers recruited from large businesses and office spaces across Canada between August 2017 and December 2017. Relevant contacts/liaisons and/or senior executives (e.g., Head of Human Resources, President, Chief Executive Officer, Office Manager) at potential businesses of interest were contacted via email. Individuals who accepted the study invitation by informing the researchers that he/she was willing to facilitate the recruitment process were then asked to email all full-time employees in the respective office/business and offer them the opportunity to participate. The recruitment email included brief study details and a recruitment poster (see Appendix D), as well as a hyperlink, for those interested to access the letter of information and online survey. Individuals were eligible to participate provided they were 18 years of age or older, a full-time worker/employee in an office setting, able to read and write in English, and had access to a computer with Internet. Exclusion criteria included individuals who were suffering from a medical condition or physical limitation that prevented them from being physically active. All relevant demographic characteristics are presented according to group in Tables 3 and 4.

Measures

HAPA preintentional motivational processes and goal intention. A questionnaire was designed to measure purpose-built, sedentary-derived HAPA pre-intentional motivational constructs (RP, OE, and SE) and GI. The sedentary-derived items used to measure the motivational phase of the HAPA model (Schwarzer, 2008) were adapted from existing HAPA scales used in previous studies of dietary behavior and PA (Schwarzer, 2008; Schwarzer & Luszczynska, 2008; Schwarzer, Luszczynska, Ziegelmann, Scholz, & Lippke, 2008). The response format for all scales, with the exception of SE, was a 5-point Likert-scale that ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). Diabetes was chosen as the disease risk term for both the OE and RP constructs because of its proxy nature relative to other health conditions and established relationship with SB (de Rezende et al., 2014).

Goal intentions. Distinct GIs across two major domains (occupational and leisure-time SB) were assessed prospectively by 10 questions. GIs were categorized into five behavioural subcategories (i.e., reducing daily sitting time, increasing daily time spent standing, increasing daily time spent in activities of light movement, increasing the number and duration of breaks from sitting). This allowed for a comprehensive examination of intentions, which are specific and multifaceted and cannot be captured by general constructs. Ten parcels of three items each were used as indicators for GI. The stem for the questions was, "Over the next four weeks …", which was followed by the recommended activities, for example, "…I intend to reduce the amount of time that I spend sitting at work", or "My goal is to increase the amount of time that I spend standing outside of work". Further rationale for this measurement approach was as follows: (a) office based-workers demonstrate high levels of sitting both at work and in their discretionary leisure time (Smith et al., 2015), (b) sedentary time in one segment of life predicts time spent sitting in other areas of life (Walsh, Meyer, Stamatis, & Morgan, 2015), (c) both total sedentary time and patterns of sedentary time (i.e., uninterrupted sitting) have health repercussions (Tremblay, Colley, Saunders, Healy, & Owen, 2010), and (d) there are health benefits to concurrently displacing and disrupting daily sedentary time (Dunstan, Howard, Healy, & Owen, 2012). Internal consistency Cronbach's alpha values (α) for GI constructs ranged from 0.94 to 0.96.

Outcome expectancies.[2] OE with respect to reducing daily sedentary time were assessed with four items, employing measurement techniques commonly used in the

[2] A principal axis factor analysis with oblique rotation was conducted to examine the factor structure and composition of the OE and RP constructs. Exploratory factor analysis results showed that the 8 items grouped into two factors readily interpretable as OE (4 items; factor loadings ranged from .91-1.0) and RP

HAPA literature (Sniehotta, Scholz, & Schwarzer, 2005; Schwarzer, 2008). The stem for the items was, “If I reduce my daily sitting time (i.e., at work and outside of work) over the next four weeks, then I would expect to . . .” followed by positive consequences such as, “… improve my blood sugar profile” or “… improve my body’s ability to maintain normal blood sugar levels”. Cronbach’s alpha (α) for OE was 0.98.

Risk perceptions.[2] RP related to sedentary time and diabetes risk were assessed with four items, using the stem, “If I spend too much time sitting (i.e., at work and outside of work) over the next four weeks, I will be at greater risk for . . .” followed by statements concerning metabolic consequences, such as, “… having high blood sugar” or “having poor insulin sensitivity (i.e., how effective the body is at using insulin to reduce high blood sugar levels)”. Cronbach’s alpha (α) for RP was 0.95.

Task self-efficacy. SE was assessed prospectively by 10 questions that measured participants’ confidence related to displacing and disrupting both occupational and leisure-time SB. Task SE was categorized into five behavioural subcategories (i.e., reducing daily sitting time, increasing daily time spent standing, increasing daily time spent in activities of light movement, increasing the number and duration of breaks from sitting) and two domains (occupational and leisure). Example questions included, “Over the next four weeks, how confident are you that you can reduce your daily sitting time at work by … ” and “Over the next four weeks, how confident are you that you can increase the number of breaks you take in the course of a day from sitting outside of work …”. Consistent with recommendations by McAuley and Mihalko (1998), each SE question assessed confidence about displacing or disrupting sedentary time in increasing durations.

(4 items; factor loadings ranged from .82-.97). These two factors accounted for approximately 88% of the total response variance.

The SE subcategories of reducing daily sitting time, increasing daily time spent standing, and increasing daily time spent in activities of light movement were each measured by 12 items (15 min, 30 min, 45 min, 1 h, 1 h 30 min, 2 h, 2 h 30 min, …, 5h or more). The SE subcategories, increasing the number and duration of breaks from sitting, were measured with 10 items (1-10+ additional breaks per day) and nine items (30 s, 1 min, …, 5 min, 6-10 min, 11-15 min, 15 min or more), respectively. All items were rated on a scale from 0% (*no confidence*) to 100% (*complete confidence*). Internal consistency Cronbach's alpha values (α) for SE constructs ranged from 0.94 to 0.96.

Other Measures

Demographics. Participants provided demographic information: gender, age, ethnicity, employment status, height and weight for calculation of BMI, number of hours worked per week, and employment sector.

Sedentary behavior questionnaire. SB was assessed using a 12-item modified Sedentary Behavior Questionnaire (SBQ; Rosenberg et al., 2010). The same modifications Prapavessis et al. (2015) made to the SBQ (i.e., addition of three items, extended response items) were also employed in the current study. The stem of the SBQ was as follows: "Over the past 7 days, on average, how much time did you spend (from when you woke up until you went to bed) doing the following?". Ten items assessed leisure-specific, volitional sedentary activities and two items assessed occupational-specific, non-volitional sedentary activities. Participants selected the duration of time (none, 15 min or less, 30 min, 1 h, 2 h, …, 9 h or more) they spent per day in various forms of sedentary pursuits. The leisure-specific model computed a daily score from the sum of the ten volitional items, whereas the occupational-specific model computed a daily score from the sum of the two non-volitional items. The general model computed a daily score from the sum of all 12 items. The original SBQ demonstrated good internal consistency (α ranges from 0.48 to 0.93) and excellent test-retest reliability (r = 0.51 to 0.93; Rosenberg et al., 2010).

Godin leisure-time exercise questionnaire. Self-reported leisure-time PA was assessed using the Godin Leisure-Time Exercise Questionnaire (Godin & Shephard, 1997), which is a four-item assessment that measures intensity and frequency of PA. Participants were asked to estimate how many times they performed strenuous, moderate, and mild/light exercises that lasted more than 15 minutes during a typical 7-day period (a week). The weekly frequencies of each intensity level were assessed.

Intervention

Treatment group. Participants randomized into the HAPA intervention group of the study received a HAPA-based informational intervention in the form of an online slide show delivered via SurveyMonkey. The slide show aimed to educate office-working adults about SB as a public health concern, the association between SB and diabetes and cardiometabolic risk, as well as the health benefits of regularly breaking up sedentary time; and provide effective suggestions on how to reduce and break up both occupational and leisure sedentary time. Microsoft® PowerPoint® software (Microsoft Office, 2011) was used to create the intervention slide show entitled Sedentary Behaviour: The Truth About Too Much Sitting (25 slides; see Appendix F). Based on the HAPA framework (Schwarzer, 2008), the intervention was designed to influence the three major HAPA pre-intentional motivational constructs and GIs towards displacing and disrupting SB across both occupational and leisure domains using factual information supported by academic references. For the HAPA intervention group, the slide show material targeted participants' RP related to excessive, prolonged sitting by presenting research evidence on the prevalence of SB (e.g., "Canadian adults spend a whopping 9.7 hours of their waking day being sedentary"), diabetes as a global health concern (e.g., "With a global prevalence of 8.5% among the adult population, diabetes is one of the leading causes of death worldwide"), and SB and diabetes risk (e.g., "there is evidence of an unfavourable association between total sedentary time and insulin sensitivity, triglycerides, and insulin levels"); OE by presenting research on the effectiveness of breaking up sedentary time for improving blood sugar and insulin levels (e.g., "substituting light-intensity activity for sedentary time may be a practical and achievable preventive strategy to reduce the risk of type 2 diabetes"); and SE by providing tips and strategies on how to reduce and break up sitting time (e.g., "take regular breaks from sitting by standing up every 30 min"). Sedentary behaviour was defined (Tremblay et al., 2017) and types of SBs in both the occupational and leisure domains were highlighted.

Attention-control group. Participants randomized into the attention-control group of the study received a HAPA-based intervention in the form of an online slide show delivered via SurveyMonkey, featuring information on moderate-to-vigorous PA and health. Microsoft® PowerPoint® software (Microsoft Office, 2011) was used to create an intervention slide show entitled Physical Activity: Everything You Need to Know About Physical Activity and Health (20 slides; see Appendix G). The attention-control slide show took the same approach but the slides were geared towards meeting moderate-to-vigorous PA guidelines. First, PA and exercise definitions were provided and the Canadian Physical Activity Guidelines for adults (Tremblay et al., 2011) were outlined (3 slides). The slideshow material targeted participants' RP related to not achieving the recommended levels of moderate-to-vigorous PA by presenting research evidence on a lack of moderate-to-vigorous PA and health consequences (5 slides); OE by presenting evidence on the effectiveness of engaging in recommended levels of moderate-to-vigorous PA for health benefits (6 slides); and SE by providing strategies on how to increase levels of moderate-to-vigorous PA (6 slides).

Control group. Participants randomly assigned to the control group received no information or intervention of any kind.

Procedures

Ethical approval was granted by the Research Ethics Board at the authors' institution prior to commencing the study and informed consent (see Appendix E) was obtained from all participants. Office-working adults were sent a recruitment email, which included brief study details, a recruitment poster and a link to an online survey (i.e., including the Letter of Information, Informed Consent, and online questionnaire). Adult office-workers who chose to participate were asked to complete the online SurveyMonkey questionnaire (see Appendix H). After viewing the Letter of Information and providing informed consent to participate in the study, participants were asked to complete a brief demographics questionnaire. All participants were then automatically randomized to one of three treatment groups: Control (outcome questionnaire without any slides), Attention-Control (same outcome questionnaire but with slides focusing on benefits of moderate-to-vigorous PA), or HAPA Intervention (same outcome questionnaire but with slides focusing on SB and diabetes risk). A slide show was chosen for several reasons, including cost efficiency (i.e., did not require the printing of materials or handouts), and the ability to present a standardized intervention to all participants. Immediately following intervention delivery, all participants completed the same post-intervention questionnaire measuring sedentary-related pre-intentional motivational constructs (RP, OE, SE) and GI. Participants randomly assigned to the control group were only asked to complete the outcome measures questionnaire. As a manipulation check participants in both the intervention and attention-control groups were asked four content-derived multiple-choice questions based on the information they had just received. The study procedures, in their entirety (i.e., letter of information, informed consent, demographics questionnaire, intervention delivery, post-intervention outcome questionnaire) were administered online via a survey website (https://www.surveymonkey.com, Palo Alto, CA, USA).

Only participants who responded 'somewhat' or below in response to the baseline screening question, which asked whether they had given any thought to how much time they spent sitting, were used in subsequent analyses (n = 96) to test the major hypotheses generated for the present study. The rationale for this (i.e., including only participants who had given little thought to how much they sit) was that there was no point in providing an intervention designed to influence sedentary beliefs and intentions to people who are already motivated and likely to have intentions regarding the targeted behaviour. In short, this question discriminated preintenders from intenders.

Data Analysis

Statistical analyses were performed using IBM SPSS version 24.0 software. Several statisticians have recommended that the following issues be examined and reported in RCTs to determine missingness of data: (a) document the reasons for missing data, (b) investigate the types of missing data, (c) fully report the extent and pattern of missing data, (d) examine differences between individuals with incomplete and complete data, and (e) discuss whether data are missing at random (Altman, 2009; Osborne, 2013). For the preintenders' subsample (n = 96), a total of 32 participant questionnaires were incomplete (i.e., missing data for one or more primary outcomes). Seven of the 28 (25.0%) questionnaires for the intervention group; 12 of the 37 (32.43%) questionnaires for the attention-control group; and 13 of the 31 (41.94%) questionnaires for the control group were incomplete. On any given variable, the maximum percentage of missing data/responses for the intervention, attention-control, and control groups was 17.86%, 29.73%, and 35.48%, respectively. There was no significant differential loss between treatment groups for those who provided complete versus missing primary outcome data (all p values > .05). Further, significant differences were found on the demographic variables of BMI ($p = .026$) and leisure-time moderate PA ($p = .035$) for those that provided complete versus missing primary outcome data, where non-completers had lower BMI and higher moderate PA than completers. One-way ANOVAs also revealed significant differences between those who gave complete data versus incomplete data on several HAPA motivational and GI constructs (p values < .05), where non-completers scored lower than completers. Taken together, missing data was considered to be missing not at random. Hence, it was deemed inappropriate to use an intent-to-treat analysis and imputation method to handle missing data in this cross-sectional examination. Only complete data were used for the primary group analyses (i.e., participants missing data for a particular outcome were omitted from the analysis).[3]

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[3] A multiple imputation intent-to-treat analysis was also conducted as a sensitivity analysis. Findings were similar to those represented in the manuscript. These data have been made available in Appendix U.

A total of 77 data points out of 2,112 HAPA pre-intentional motivational construct (RP, OE, and SE) and GI data points for the preintenders subsample were identified as extreme outliers and removed (39 in the intervention group, 22 in the attention-control group, and 16 in the control group) (Osborne & Overbay, 2004). A P value < 0.05 was regarded as significant for all statistical tests and a partial-eta squared (η^2) of 0.01, 0.06, and 0.14 represented small, medium, and large effect sizes, respectively (Stevens, 1996).

Power analyses. Due to the exploratory nature of the present study (i.e., unable to determine how many participants would be screened as preintenders for subsequent analysis), no formal power calculation was computed.

Results

Demographic Statistics

Demographic statistics across treatment groups for the entire sample (N = 218) of office-working adults who responded to the study invitation can be found in Table 3 whereas demographic statistics for the screened preintenders subsample (n = 96) can be found in Table 4.

Table 3. Demographic and behavioural characteristics across treatment conditions for the entire sample (N = 218).

Variable	Experimental (*n* = 68)	Attention-control (*n* = 74)	Control (*n* = 76)	Entire sample (*N* = 218)	Statistic	*p*-level
Age (years)	40.53 (SD = 12.76)	43.24 (SD = 30.59)	39.78 (SD = 11.49)	41.19 (SD = 20.32)	$F(2,215) = 0.595$	0.55
Gender					X^2 (4) = 4.64	0.33
Male	27	33	40	100		
Female	41	41	35	117		
Ethnicity					X^2 (10) = 16.53	0.09
White	88.2%	81.1%	89.5%	86.2%		
Asian	7.4%	9.5%	6.6%	7.8%		
Black	0.0%	2.7%	0.0%	0.9%		
Hispanic	0.0%	1.4%	0.0%	0.5%		
Other	4.4%	2.7%	0.0%	2.3%		
BMI (kg/m^2)	27.72 (SD = 5.29)	25.60 (SD = 5.46)	25.58 (SD = 3.87)	26.26 (SD = 4.99)	$F(2,213) = 4.39$	0.01
Employment Sector					X^2 (6) = 8.34	0.21
Private	57.4%	70.3%	65.8%	64.7%		
Public	30.9%	21.6%	23.7%	25.2%		
Charity	5.9%	5.4%	0.0%	3.7%		
Hours worked per week					$F(2,214) = 0.960$	0.38
≤10	1.5%	0.0%	1.3%	0.9%		
11-20	0.0%	0.0%	0.0%	0.0%		
21-30	0.0%	1.4%	2.6%	1.4%		
31-40	45.6%	43.8%	50.0%	46.3%		
≥40	52.9%	54.8%	46.1%	50.9%		
Weekly Leisure-time Physical Activity[a]						
Mild	5.21 (SD = 5.07)	3.92 (SD = 3.00)	4.58 (SD = 4.67)	4.56 (SD = 4.33)	$F(2,169) = 1.30$	0.27
Moderate	3.21 (SD = 3.16)	3.14 (SD = 3.38)	3.18 (SD = 3.26)	3.17 (SD = 3.25)	$F(2,169) = 0.007$	0.99
Strenuous	2.48 (SD = 4.16)	2.39 (SD = 2.44)	2.64 (SD = 2.16)	2.50 (SD = 3.05)	$F(2,169) = 0.094$	0.91
Sedentary Behaviour (hours/day)						
Total	14.07 (SD = 4.53)	13.22 (SD = 4.46)	13.95 (SD = 6.54)	13.74 (SD = 5.21)	$F(2,170) = 0.460$	0.63
Leisure	6.45 (SD = 3.87)	6.39 (SD = 3.50)	6.66 (SD = 4.86)	6.50 (SD = 4.07)	$F(2,170) = 0.070$	0.93
Work	7.62 (SD = 1.87)	6.84 (SD = 2.43)	7.34 (SD = 2.48)	7.26 (SD = 2.29)	$F(2,172) = 1.78$	0.17

[a] Number of times strenuous, moderate, and mild/light exercises (that lasted more than 15 minutes) were performed during a typical 7-day period (a week)

Table 4. Demographic and behavioural characteristics across treatment conditions for the screened preintenders subsample (n = 96)

Variable	Experimental (*n* = 28)	Attention-control (*n* = 37)	Control (*n* = 31)	Entire sample (*n* = 96)	Statistic	*p*-level
Age (years)	42.64 (SD = 13.12)	41.43 (SD = 14.47)	40.94 (SD = 11.53)	41.63 (SD = 13.07)	$F(2,93) = 0.130$	0.88
Gender					X^2 (4) = 2.48	0.65
Male	14	21	17	52		
Female	14	16	13	43		
Ethnicity					X^2 (10) = 16.18	0.095
White	92.9%	75.7%	87.1%	84.4%		
Asian	7.1%	10.8%	6.5%	8.3%		
Black	0.0%	5.4%	0.0%	2.1%		
Hispanic	0.0%	2.7%	0.0%	1.0%		
Other	0.0%	5.4%	0.0%	2.1%		
BMI (kg/m^2)	28.13 (SD = 5.02)	25.72 (SD = 6.06)	25.90 (SD = 4.23)	26.48 (SD = 5.28)	$F(2,93) = 1.98$	0.14
Employment Sector					X^2 (4) = 7.06	0.13
Private	46.4%	73.0%	74.2%	65.6%		
Public	39.3%	24.3%	19.4%	27.1%		
Charity	7.1%	2.7%	0.0%	3.1%		
Hours worked per week					$F(2,92) = 1.14$	0.32
≤10	3.6%	0.0%	0.0%	1.0%		
11-20	0.0%	0.0%	0.0%	0.0%		
21-30	0.0%	2.7%	3.2%	2.1%		
31-40	46.4%	29.7%	38.7%	37.5%		
≥40	50.0%	64.9%	58.1%	58.3%		
Weekly Leisure-time Physical Activity[a]						
Mild	4.61 (SD = 4.34)	4.04 (SD = 3.39)	6.25 (SD = 6.81)	4.86 (SD = 4.89)	$F(2,67) = 1.23$	0.30
Moderate	3.04 (SD = 2.27)	2.85 (SD = 3.84)	3.25 (SD = 3.37)	3.03 (SD = 3.22)	$F(2,67) = 0.09$	0.92
Strenuous	1.65 (SD = 1.97)	2.56 (SD = 2.83)	1.90 (SD = 1.94)	2.07 (SD = 2.34)	$F(2,67) = 1.00$	0.37
Sedentary Behaviour (hours/day)						
Total	13.36 (SD = 2.38)	12.58 (SD = 4.48)	13.08 (SD = 3.02)	12.98 (SD = 3.46)	$F(2,67) = 0.316$	0.73
Leisure	6.18 (SD = 2.25)	6.03 (SD = 3.14)	6.28 (SD = 2.25)	6.15 (SD = 2.60)	$F(2,67) = 0.054$	0.95
Work	7.17 (SD = 1.53)	6.56 (SD = 2.49)	6.80 (SD = 2.17)	6.83 (SD = 2.11)	$F(2,67) = 0.530$	0.59

[a] Number of times strenuous, moderate, and mild/light exercises (that lasted more than 15 minutes) were performed during a typical 7-day period (a week)

Group Equivalency

One-way ANOVAs and chi-square analyses were used to test for group equivalency on demographic characteristics, baseline levels of SB and leisure-time PA, and other factors that could influence beliefs about SB and diabetes risk or sedentary GIs.

Intenders vs. preintenders. Preintenders and intenders were equivalent at baseline for all measures (all *p* values > .05), except for work SB levels, $F(1,172) = 4.31$, $p = .039$, $\eta_\rho^2 = .02$, where preintenders had slightly lower work SB than intenders.

Preintenders. No significant differences emerged (all *p* values > .05), indicating that there was group equivalency between groups with respect to demographic variables, baseline sedentary time and baseline leisure-time PA scores (see Table 4). Due to equivalency between groups, it was deemed unnecessary to use demographic variables as covariates in the subsequent group analyses.

Manipulation Check

As a manipulation check, participants in the intervention and attention-control groups were asked four content-derived multiple-choice questions based on the information they had just received. The percentage of intervention participants who answered each of the four questions correctly was 92.9%, 100%, 100%, and 100%, respectively. The percentage of attention-control participants who answered each of the four questions correctly was 86.5%, 89.2%, 97.3%, and 100%, respectively.

Intervention Effects

Separate univariate ANOVAs followed by planned comparisons tests were conducted to determine if the HAPA intervention group differed from the other two groups on sedentary-derived HAPA pre-intentional motivational constructs (RP, OE, SE) and GI. Descriptive data for the primary outcomes are presented in Table 5.

Table 5. Means, standard deviations, and 95% confidence intervals for HAPA motivational constructs and goal intentions post-intervention.

Outcome	Group					
	Intervention		Attention-Control		Control	
	M (SD)	95% CI	M (SD)	95% CI	M (SD)	95% CI
Outcome Expectancies	4.05 (.22)	[3.81, 4.28]	3.76 (.42)	[3.58, 3.95]	3.55 (.76)	[3.36, 3.74]
Risk Perceptions	3.74 (.51)	[3.51, 3.97]	3.71 (.43)	[3.51, 3.90]	3.63 (.75)	[3.42, 3.84]
Self-Efficacy (Work)						
Sitting Time	30.00 (19.15)	[21.66, 38.34]	29.74 (22.09)	[22.32, 37.17]	26.74 (18.15)	[18.40, 35.08]
Break Frequency	36.58 (22.51)	[26.62, 46.55]	27.07 (23.17)	[18.00, 36.14]	28.96 (27.66)	[19.20, 38.73]
Break Duration	66.06 (19.24)	[53.62, 78.51]	60.49 (31.54)	[49.26, 71.73]	53.52 (33.83)	[41.60, 65.43]
Standing Time	20.23 (17.24)	[10.81, 29.65]	28.58 (24.87)	[20.08, 37.09]	28.48 (22.90)	[19.26, 37.69]
Light Movement	22.84 (14.36)	[15.35, 30.33]	24.51 (21.04)	[17.74, 31.27]	20.87 (15.89)	[13.54, 28.20]
Self-Efficacy (Leisure)						
Sitting Time	35.36 (19.81)	[25.83, 44.89]	42.60 (24.60)	[34.03, 51.16]	32.06 (20.12)	[22.53, 41.59]
Break Frequency	43.87 (34.83)	[31.10, 56.64]	42.46 (31.08)	[30.45, 54.47]	31.11 (23.91)	[17.06, 45.16]
Break Duration	58.70 (35.18)	[46.14, 71.25]	69.23 (31.80)	[57.42, 81.04]	80.06 (18.18)	[65.87, 94.25]
Standing Time	33.98 (19.41)	[24.17, 43.78]	38.11 (26.87)	[29.09, 47.13]	33.89 (21.27)	[23.85, 43.92]
Light Movement	38.08 (24.95)	[28.34, 47.82]	40.48 (24.25)	[31.32, 49.64]	35.17 (20.17)	[24.72, 45.61]
Intention (Work)						
Sitting Time	3.87 (.91)	[3.50, 4.24]	3.55 (.79)	[3.21, 3.90]	4.07 (.95)	[3.67, 4.46]
Break Frequency	4.11 (.62)	[3.75, 4.47]	3.53 (.69)	[3.21, 3.85]	3.70 (1.12)	[3.34, 4.06]
Break Duration	3.90 (.65)	[3.50, 4.31]	3.21 (.99)	[2.86, 3.57]	3.56 (1.09)	[3.15, 3.96]
Standing Time	3.97 (.66)	[3.60, 4.34]	3.41 (.73)	[3.08, 3.74]	3.76 (1.11)	[3.39, 4.13]
Light Movement	3.57 (.87)	[3.20, 3.93]	3.44 (.67)	[3.09, 3.78]	3.63 (1.12)	[3.24, 4.03]
Intention (Leisure)						
Sitting Time	4.18 (.60)	[3.93, 4.42]	3.83 (.55)	[3.60, 4.05]	4.39 (.54)	[4.12, 4.67]
Break Frequency	4.13 (.65)	[3.73, 4.52]	3.68 (.70)	[3.32, 4.04]	3.76 (1.27)	[3.37, 4.16]
Break Duration	3.83 (.97)	[3.42, 4.23]	3.71 (.65)	[3.32, 4.09]	3.65 (1.24)	[3.23, 4.07]

Standing Time	4.11 (.69)	[3.75, 4.47]	3.45 (.71)	[3.13, 3.78]	3.68 (1.04)	[3.32, 4.05]
Light Movement	4.03 (.69)	[3.76, 4.30]	4.00 (.59)	[3.74, 4.26]	4.51 (.58)	[4.21, 4.81]

Goal intentions (work). Significant differences between groups were found for GI to increase number of daily breaks from sitting at work, $F(2,66) = 3.01$, $p = .056$, $\eta_{\rho}^2 = .08$, and GI to increase length of breaks from sitting at work, $F(2,67) = 3.28$, $p = .044$, $\eta_{\rho}^2 = .09$. Planned comparisons tests revealed that GIs to increase number and length of daily breaks from sitting at work were significantly higher for the intervention group, compared to the attention-control group (GINBW: $p = .018$, $\eta_{\rho}^2 = .17$; GILBW: $p = .013$, $\eta_{\rho}^2 = .14$) but not the control group (GINBW: $p = .109$, $\eta_{\rho}^2 = .05$; GILBW: $p = .231$, $\eta_{\rho}^2 = .04$). For GI to increase daily time spent standing at work, a trend towards a significant difference between groups also emerged favouring the intervention group, $F(2,65) = 2.63$, $p = .08$, $\eta_{\rho}^2 = .08$. No significant group differences were found for GI to reduce daily sitting time at work, $F(2,66) = 2.02$, $p = .140$, $\eta_{\rho}^2 = .06$, or GI to increase daily time spent in light movement at work, $F(2,66) = .299$, $p = .742$, $\eta_{\rho}^2 = .009$.

Goal intentions (leisure). Significant differences between groups were found for GI to reduce daily sitting time outside of work, $F(2,60) = 5.33$, $p = .007$, $\eta_{\rho}^2 = .15$, and GI to increase daily time spent standing outside of work, $F(2,63) = 3.74$, $p = .029$, $\eta_{\rho}^2 = .11$. Planned comparisons tests revealed that GIs to reduce daily time spent sitting and increase time spent standing outside of work were significantly higher for the intervention group, compared to the attention-control group (GITSTL: $p = .043$, $\eta_{\rho}^2 = .09$; GISTL: $p = .009$, $\eta_{\rho}^2 = .19$) but not the control group (GITSTL: $p = .245$, $\eta_{\rho}^2 = .04$; GISTL: $p = .099$, $\eta_{\rho}^2 = .06$). A significant difference between groups was found for GI to increase daily time spent in light movement outside of work, $F(2,58) = 3.89$, $p = .026$, η_{ρ}^2

= .12. Planned comparisons test revealed that GI to increase time spent in light movement outside of work were significantly lower for the intervention group, compared to the control group (p = .022, η_ρ^2 = .13). No differences emerged between the intervention and attention-control groups (p = .866, η_ρ^2 = .001). No significant group differences were found for GI to increase number of daily breaks from sitting outside of work, $F(2,64)$ = 1.52, p = .226, η_ρ^2 = .05, or GI to increase length of breaks from sitting outside of work, $F(2,66)$ = .191, p = .827, η_ρ^2 = .006.

Outcome expectancies. A significant difference between groups for OE regarding reducing daily sitting time and improved health was found, $F(2,84)$ = 5.41, p = .006, η_ρ^2 = .11. Planned comparisons revealed that OE were significantly higher for the intervention group, compared to the control group (p = .001, η_ρ^2 = .15). Borderline significant differences were found between the intervention and attention-control groups (p = .059, η_ρ^2 = .13).

Risk perceptions. No significant group differences were found for RP regarding sitting time and diabetes risk, $F(2,88)$ = .282, p = .755, η_ρ^2 = .006.

Self-efficacy (work). No significant differences between groups were found for SE (work) constructs (F range from .194 - 1.07, p range from .347 - .824, η_ρ^2 range from .005 - .03).

Self-efficacy (leisure). No significant differences between groups were found for SE (leisure) constructs (F range from .266 - 2.55, p range from .086 - .767, η_ρ^2 range from .008 - .07).

Relationships among HAPA Motivational Phase Constructs

In order to examine the utility of the HAPA model's constructs as predictors of GI to reduce SB, linear regression analyses were conducted for each of the ten models with sedentary-related GIs serving as the criterion variables. To improve correspondence, matching SE and GI constructs (e.g., SE towards reducing total sitting time at work and GI towards reducing daily sitting time at work) were entered into each model. Both leisure-time and non-leisure (i.e., work) SB HAPA models were tested. Each regression model was assessed by the R^2, adjusted R^2, R^2 change, and the standardized beta (β) associated with each individual construct (see Tables 6 and 7). For non-leisure (i.e., work) time sedentary-related GIs (Models 1-5), corresponding SE constructs (β range from .396 - .499) significantly predicted intention in all five models. OE and RP did not significantly predict intention. The percent of variance explained ranged from 13% in Model 2 (GI to increase number of daily breaks from sitting at work) to 21% in Model 4 (GI to increase daily time spent standing at work). For leisure-time sedentary-related GIs (Models 6-10), corresponding SE constructs (β range from .392 - .459) were significant predictors of intention in all five models. OE and RP were not found to be significant predictors of intention. The percent of variance explained ranged from 11% in Model 8 (GI to increase length of breaks from sitting outside of work) to 17% in Models 7 (GI to increase number of daily breaks from sitting outside of work) and 9 (GI to increase daily time spent standing outside of work).

Table 6. Linear regression analyses predicting goal intentions towards occupational sedentary behaviour.

Variable	Model 1 (Sitting Time) (n = 68)		Model 2 (Break Frequency) (n = 68)		Model 3 (Break Duration) (n = 67)		Model 4 (Standing Time) (n = 67)		Model 5 (Light Movement) (n = 67)	
	B (SE *B)*	β	*B* (SE *B)*	β	*B* (SE *B)*	β	*B* (SE *B)*	β	*B* (SE *B)*	β
OE	0.06 (0.22)	0.04	-0.03 (0.20)	-0.02	0.34 (0.22)	0.23	-0.03 (0.20)	-0.02	0.09 (0.21)	0.06
RP	0.16 (0.22)	0.10	0.19 (0.20)	0.13	0.02 (0.21)	0.01	0.12 (0.20)	0.08	0.32 (0.22)	0.21
SE	0.02*** (0.005)	0.50	0.01*** (0.004)	0.41	0.02*** (0.004)	0.49	0.02*** (0.004)	0.50	0.02*** (0.006)	0.40
R^2	0.19		0.13		0.18		0.21		0.15	

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$. OE = Outcome expectancies; RP = Risk perception; SE = Self-efficacy

Table 7. Linear regression analyses predicting goal intentions towards leisure sedentary behaviour.

Variable	Model 6 (Sitting Time) (n = 65)		Model 7 (Break Frequency) (n = 65)		Model 8 (Break Duration) (n = 64)		Model 9 (Standing Time) (n = 65)		Model 10 (Light Movement) (n = 65)	
	B (SE *B)*	β	*B* (SE *B)*	β	*B* (SE *B)*	β	*B* (SE *B)*	β	*B* (SE *B)*	β
OE	-0.02 (0.23)	-0.01	0.07 (0.24)	0.04	0.26 (0.25)	0.16	0.25 (0.23)	0.15	0.21 (0.24)	0.13
RP	0.25 (0.23)	0.16	0.26 (0.24)	0.15	0.05 (0.25)	0.03	0.17 (0.24)	0.10	0.01 (0.24)	0.01
SE	0.02** (0.005)	0.39	0.02*** (0.004)	0.46	0.01** (0.004)	0.40	0.02*** (0.005)	0.45	0.02*** (0.005)	0.45
R^2	0.12		0.17		0.11		0.17		0.15	

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$. OE = Outcome expectancies; RP = Risk perception; SE = Self-efficacy

Discussion

The main purpose of this study was to examine the effects of an internet-delivered HAPA-based intervention on preintender office workers' motivation to displace and disrupt their occupational and leisure-time SB. Our results provided partial support for the hypothesis that the intervention group would have greater positive scores on the HAPA motivational constructs. As expected, the intervention group reported greater scores for several sedentary-related GI constructs, compared to their control group counterparts. Specifically, the intervention group reported significantly greater GIs to increase both number and length of daily breaks from sitting at work. Potentially meaningful, non-significant positive effects in favour of the intervention group were also found for GIs to increase daily time spent standing at work. Unfortunately, no intervention effects were found for GIs to reduce daily sitting time or to increase daily time spent in light movement at work. In the occupational domain, a closer examination of the data indicates that GIs towards specific non-SBs (i.e., increase number of breaks, break length, standing time) favour treatment whereas GIs towards non-specific SB (i.e., reduce sitting time) do not favour treatment. It is possible that in the workplace, office workers can identify more with specific non-SBs (e.g., more frequently disrupting sedentary periods with bouts of standing) than non-specific SB (e.g., reducing total amount of sitting time).

With regards to leisure-time sedentary-related GIs, the intervention group reported significantly greater GIs to reduce daily time spent sitting and to increase daily time spent standing outside of work. Unfortunately, no intervention effects were found for GIs to increase number or length of daily breaks from sitting outside of work. One counterintuitive result was found with GIs to increase daily time spent in light movement outside of work, in that control participants reported greater GIs for this construct than those who received the HAPA intervention. Given that GIs towards reducing sitting time outside of work favoured treatment, it is possible that office workers may be able to identify more with non-specific SB (i.e., reducing sitting time) in the leisure domain when they have greater volition over their sedentary activities.

Overall, these findings are encouraging for two reasons. First, it is asserted through the HAPA model that intention formation (i.e., motivation) is a key prerequisite for successful behaviour change. Second, numerous observational studies incorporating theories of health behaviour change have found that stronger intentional goals for SB are associated with less self-reported sedentary time, as well as greater plans to limit SB, among adults (Conroy et al., 2013; Maher & Conroy, 2016; Wong et al., 2016). For example, Prapavessis et al. (2015) found that intention to engage in sedentary time was the strongest and most consistent predictor of both volitional and non-volitional SB among a large sample of adults (n = 372), explaining between 8-43% of the variance in behaviour.

Conroy et al. (2013) suggested that one barrier to effective SB intervention development may be the absence of basic intervention research targeting motivational processes underlying SB among these individuals; the latter of which are needed to facilitate and maintain behavior change. This study was among the first to manipulate motivational variables towards reducing SB in a preintender office-working population. This intervention targeted motivational constructs for reducing both occupational and leisure sedentary time for several reasons. First, it has been shown that sedentary time in one segment of life predicts time spent sitting in other areas of life (Walsh et al., 2015). Second, it has been suggested that interventions targeting the working day and the evenings (weekday and weekend) to displace sitting with activity may offer the most promise for reducing levels of SB and increasing PA levels, in office-based workers (Smith et al., 2015).

Results for the HAPA pre-intentional motivational constructs were unexpected and less consistent than our previously noted positive intervention effects on GIs. As expected, the intervention group reported significantly higher OE regarding reducing daily sitting time and improved health, compared to their control group counterparts. Unfortunately, no intervention effect was found for RP regarding sitting time and diabetes risk. There were also no statistically significant differences found between groups for sedentary-related SE constructs. This suggests that the intervention material was not successful in manipulating participants' risk perceptions or beliefs regarding their confidence and control to reduce their sitting time in either the occupational or leisure domain.

Overall, the HAPA-based motivational intervention developed for the present study was effective in enhancing preintending office working adults' GIs to disrupt and displace sedentary time; however, the mechanistic pathway through which GIs were influenced could not be disentangled. The failure to strongly manipulate all HAPA pre-intentional variables, specifically participants' SE, was unfortunate because only corresponding SE constructs made significant and unique contributions to both occupational and leisure-time sedentary-related GI scores. These findings are in line with previous research using theoretical models of behaviour change to examine social-cognitive correlates associated with SB in adults. Wong et al. (2016) found that coping appraisal constructs (SE and response efficacy) made significant and unique contributions to sedentary-related GIs whereas threat appraisal constructs (perceived severity and perceived vulnerability) did not. Similarly, Maher and Conroy (2016) reported that SE, but not OE and RP, was positively associated with intentions to limit SB.

There are several possible reasons – both methodological and practical – for why SE constructs were not manipulated to a greater extent. One plausible reason is that the intervention material was not strong enough to positively influence SE beliefs. Given that most occupational and leisure-time sedentary-related SE scores were found to be low across preintender groups (range 20%-44%, excludes break duration) and SEs strong relationship with GI scores, it appears that SE may be a particularly important (and challenging) construct to target for improving office workers' motivation to disrupt and displace sedentary time. Numerous studies have explored office workers' perceived barriers and facilitators for reducing SB in the work setting and found that major barriers included: workplace social and cultural norms, the pressure of 'getting the job done', productivity concerns, personal factors and preferences for the use of time at and after work, job scope, the nature of their work requiring sitting at a computer, the habitual nature of sitting, and physical building/office infrastructure (Cole, Tully, & Cupples, 2015; De Cocker et al., 2015; Nooijen et al., 2018; Waters et al., 2016). All of these factors may negatively impact office workers' confidence (and control) in their ability to reduce sedentary time at work. While the current intervention was designed to provide participants with realistic and effective strategies on how to displace and disrupt sitting time, it is evident that future interventions targeting motivation to reduce occupational sedentary time will need to find ways to address factors that may act as barriers to behavioural change.

Response bias may be a second possibility. For example, the intervention was designed to target participants' SE by providing realistic recommendations for sitting time, as well as tips and strategies on how to displace and disrupt sedentary time in their daily lives. Based on descriptive data, it appears that participants in the two control groups felt just as confident in their ability to displace and disrupt SB (all three groups reported low levels of confidence – see Table 5). Perhaps participants in the control groups did not want to convey lower levels of confidence in order to protect their self-worth and self-esteem.

Another possible explanation as to why the motivational constructs of RP and SE were not manipulated successfully is that the message strategy used for the intervention was not tailored to individual office-workers. Message tailoring approaches assume that messages are not equally effective for all individuals, but rather should be tailored to pre-existing psychosocial characteristics of the recipient to which the message is intended (Latimer, Brawley, & Bassett, 2010).

The HAPA is a self-regulation framework that makes a distinction between pre-intentional motivational (goal setting) and post-intentional volitional (goal pursuit) phases involved in successful behaviour change. As mentioned earlier, some theorists have suggested a stage-matched intervention approach to health behaviour change (Graham et al., 2006; Pope et al., 2017; Prochaska & Marcus, 1993). In the present study the majority of participants (n = 122) were classified as intenders as they reported that they had given 'quite a bit' or 'a lot' of thought to how much time they spent sitting and hence were not included in the subsequent analyses. This raises the question: 'what would happen to our findings if we included the full sample?' To shed light on this issue we re-analyzed our data using the entire sample (N = 218). The most salient difference we found was that the intervention effects found for sedentary-related GIs (i.e., motivation) between groups were washed out and no significant group differences emerged.

These post hoc findings, together with the main findings reported for the preintenders sub sample, allow the following statements to be made. A simple, online

HAPA-built information-based intervention may be an effective health promotion tool to enhance GIs (motivation) and OE for reducing SB among preintender office-workers (i.e., predominantly in individuals who have given little thought to how much time they spend sitting). For this targeted subsample, SE is the most salient factor influencing GIs to disrupt and displace SB across both occupational and leisure domains. Accordingly, an intervention using the motivational phase of the HAPA may be a simple way to increase intentions and OE in individuals (preparation) prior to subjecting them to an actual behaviour change intervention. For office workers who have already established intentions to reduce their sitting time, interventions should instead focus on initiating behaviour change and sustaining this over the long-term by targeting post-intentional constructs including planning and self-regulation strategies.

Strengths and Limitations

There are several strengths associated with the current study. To our knowledge, this was the first study to examine a theory-based internet-delivered intervention targeting motivational variables related to SB among preintender office-working adults. Incorporating the HAPA model—an evidence-based behavior change framework—into our intervention and testing the utility of the motivational phase of the HAPA model for furthering our understanding of SB among office workers were both seen as strengths. Also, the use of a baseline screening question which asked participants whether they had given any thought to how much time they spent sitting in attempt to discriminate preintenders from intenders was a strength in our design. Other strengths include the use of a RCT design, which allowed for any observed effects in the intervention group to be compared to a control group, and the inclusion of an equal contact attention-control group to separate specific vs. non-specific intervention effects. Further, assessing the effects of the intervention on established HAPA motivational constructs, establishing correspondence between SE and GI constructs, and measuring confidence and motivation towards five different behaviours across both leisure and occupational domains were also strengths of this study. Due to the chosen mode of intervention delivery, this allowed us to recruit a sample of office-working adults from several different businesses and/or workplaces. Accordingly, the findings should have greater generalizability to office working adults at-large. A final strength is the study's scalability. This study was conducted using a sample of office workers; however, it could easily be replicated using many other at-risk populations with high sedentary time.

There also are a number of limitations that should be acknowledged with this work. First, the failure to successfully manipulate all HAPA motivational variables, particularly SE, is problematic. To adequately test HAPA in facilitating motivation to reduce sedentary time through SB and diabetes information, all components of the model need to be manipulated. Second, sedentary-related beliefs and motivation were not assessed pre-intervention, which prevents conclusions to be drawn about actual change in the HAPA motivational constructs. A third limitation is the potential selection bias of the sample recruited. Although participants were only told that the purpose of the study was to examine thoughts and beliefs related to both occupational and leisure time movement patterns and efforts were made to blind participants to group allocation and the existence of different treatment conditions through advertising and study procedures, it is still possible that individuals motivated to engage in a SB-related research study were more likely to participate. This may partially explain why larger net differences were not observed between the intervention and control group participants. Fourth, the study would have been strengthened with a larger sample of office-working adults who had given little thought to how much time they spent sitting (i.e., preintenders) as it would have increased our statistical power to detect small to medium effects that consistently favored the experimental group. Recruiting preintenders remains a challenge of health-related intervention studies. Finally, the influence of the motivational intervention on initial behaviour change cannot be inferred since this study did not include a self-report and/or objective measure of SB post-intervention.

Future Directions

A number of future recommendations should be considered with respect to the findings of the present study. For instance, while this study attempted to discriminate preintenders from intenders through the use of a baseline screening item, better ways of stage-matching (or identifying) those with low intentions (those who would benefit most) need to be explored in order to maximize intervention effectiveness (Pope et al., 2017). It is important that future intervention studies using the motivational phase of the HAPA model to target SB examine alternative forms and intensity of delivery (e.g., in-person, via phone call and online presentation platform). Future research is also needed to explore more effective methods of operationalizing motivational messaging towards reducing SB for office workers. Graham et al. (2006) suggested that interventions incorporating message tailoring that corresponds with an individual's style of processing health-relevant information may be more effective in promoting motivation and actual behaviour change than those using generic messages. Further, Pope et al. (2017) recommended that interventions employ a messaging strategy that includes tailoring messages to peoples' stage of change and framing them to focus on self-determined motives and intrinsic goals in order to facilitate more in-depth processing of information and increase the likelihood that the behavior is internalized and maintained long-term. Although diabetes was chosen as a risk factor because of its proxy nature compared to most other health problems and reasonably well-established relationship with SB, the possibility of framing SB as a risk factor for other chronic health conditions needs to be examined. Finally, it is imperative that interventions designed to influence office workers' sedentary-related beliefs and motivation towards reducing SB identify ways to improve office workers confidence in their ability to disrupt and displace their sitting time.

The present study was designed to only address motivational constructs and GIs to reduce sedentary time, hence future intervention work is needed to determine whether the volitional phase of the HAPA model can be used to target actual behaviour change in office workers. Although Maher and Conroy (2016) and Sui and Prapavessis (2017) have provided preliminary evidence for the use of the volitional phase of the HAPA in predicting and modifying SB among older adults and university students, respectively, little is known regarding its potential as a framework to target reductions in SB among office-working adults. For instance, it is likely that interventions targeting volitional HAPA constructs such as action and coping planning, as well as action control components (i.e., self-monitoring, awareness of standards, and self-regulatory effort) may be effective in translating intentions into action and reducing SB among office-workers.

Conclusion

This RCT reports preliminary evidence of an internet-delivered, HAPA-based intervention on motivational constructs and behavioural intentions towards disrupting and displacing both occupational and leisure-time SB among a sample of preintender office-working adults. Our findings suggest that the brief online intervention had positive effects on GIs to increase both number and length of daily breaks from sitting at work, and GIs to reduce daily time spent sitting and to increase daily time spent standing outside of work, as well as OE regarding reducing daily sitting time and improved health, a main motivational variable of the HAPA. To elucidate the aforementioned findings, intervention opportunities to modify the HAPA-based motivational constructs are warranted.

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Chapter 4 – A combined Health Action Process Approach and mHealth Intervention to Increase Non-Sedentary Behaviours in Office-Working Adults – A Randomized Controlled Trial (study 3)

Abstract

Background: Office working adults represent an at-risk population for high levels of sedentary behaviour (SB), which has been associated with an increased risk for numerous chronic diseases. The purpose of this study was to determine the effectiveness of a Health Action Process Approach (HAPA) based action and coping planning intervention augmented with tailored text messages to reduce workplace sitting time (primary outcome) and increase specific non-SBs (i.e., standing time, walking time, stretching time, break frequency, break duration). A secondary purpose was to examine (1) intervention effects on health-related outcomes and work performance and (2) relationships among HAPA volitional constructs, sedentary and non-SBs, and work and health-related outcomes. **Methods:** Sixty office workers (M_{age} = 45.18 ± 11.33 years) were randomly assigned into either a HAPA intervention (n = 29) or control (n = 31) condition. The intervention group received a single behavioural counselling (planning) session, as well as daily sedentary-related text messages over a 6-week period. Workplace sitting time, time spent in specific non-SBs, and HAPA volitional constructs were assessed at baseline, week 2, week 4, week 6 (post-intervention), and week 8 (follow-up) using self-report questionnaires. Work and health-related outcomes were assessed at two time points (baseline, week 6). **Results:** Significant group by time interaction effects, that favoured the intervention group, were found for workplace sitting time (p = .003, η_p^2 = .07), standing time (p = .019, η_p^2 = .05), and stretching time (p = .001, η_p^2 = .08). Significant interaction effects favouring the intervention group were also found for action planning (p < .001, η_p^2 = .20), coping planning (p < .001, η_p^2 = .18), and action control (p < .001, η_p^2 = .15), as well as role limitations due to emotional health problems ($p = .031$, $\eta_p^2 = .08$) and emotional well-being ($p = .014$, $\eta_p^2 = .10$). Significant relations, in the expected direction, were found between the HAPA volitional constructs and sitting time, standing time, walking time, and break frequency (p values $< .05$), which in turn, were related to specific health-related outcomes (p values $< .05$).

Conclusions: Augmenting a HAPA-based planning intervention with text messages can reduce workplace sitting time in office workers.

Keywords: sedentary behaviour, intervention, health action process approach, planning, text messages, workplace, randomized controlled trial

Acronyms:
Sedentary Behaviour (SB)
Non-Exercise Activity Thermogenesis (NEAT)
Light-intensity Physical Activity (LIPA)
Health Action Process Approach (HAPA)
Action Planning (AP)
Coping Planning (CP)
Action Control (AC)
Physical Activity (PA)
Mobile Health (mHealth)
Randomized Controlled Trial (RCT)

Introduction

Excessive time spent in sedentary behaviour (SB) is an important 24-hour movement (or non-movement) behaviour that is associated with increased risk for multiple chronic health outcomes, including premature mortality, cardiovascular disease, type 2 diabetes, metabolic syndrome, obesity, and specific cancers (de Rezende, Lopes, Rey-López, Matsudo, & do Carmo Luiz, 2014; Thorp, Owen, Neuhaus, & Dunstan, 2011). Further, prolonged sedentary time is associated with detrimental changes in a number of cardiometabolic risk factors (Brocklebank, Falconer, Page, Perry, & Cooper, 2015). In addition to physical health outcomes, recent evidence has suggested a relationship between greater SB and adverse mental health outcomes, including increased risk of anxiety and depression, and lower health-related quality of life (Balboa-Castillo, León-Muñoz, Graciani, Rodriguez-Artalejo, & Guallar- Castillón, 2011; Gibson, Muggeridge, Hughes, Kelly, & Kirk, 2017; Teychenne, Ball, & Salmon, 2010; Teychenne, Costigan, & Parker, 2015).

Fortunately, many detrimental sitting-related health effects can be attenuated by disrupting prolonged sedentary time more frequently and displacing SB with non-sedentary or non-exercise activity thermogenesis (NEAT) behaviours, including standing, walking, and light-movement, which may in turn have positive effects on glycemic control and a number of cardiometabolic biomarkers (Carson et al., 2014; Dunstan et al., 2012; Healy et al., 2015). For instance, Thorp et al. (2014b) found that alternating 30-min bouts of sitting and standing can have beneficial effects on glucose responses in overweight/obese office workers.

Recent experimental evidence also demonstrated that breaking up workplace sitting time with intermittent standing bouts every 30 minutes significantly improved fatigue, musculoskeletal discomfort, and work productivity in office workers (Thorp, Kingwell, Owen, & Dunstan, 2014a); further, frequently interrupting prolonged sitting with micro bouts of walking has been shown to improve mood, energy, vigour and fatigue in adults (Bergouignan et al., 2016). Using objective measurement of SB, Gibson et al. (2017) found that engaging in <8 hours of SB per day on weekdays is associated with better perceived mental health (lower levels of anxiety and depression) and quality of life (higher levels of vitality and mental health).

Office-working adults represent an at-risk population burdened by high sedentary time, both at work and in their leisure time (Smith et al., 2015). Evidence suggests that workplace sitting accounts for majority (60%) of office-based employees total daily sedentary time (Bennie et al., 2015); further, adults working in office settings may spend up to 77% of their working day sitting with majority of this time accumulated in uninterrupted bouts (Thorp et al., 2012). Numerous interventions targeting SB in the workplace have been conducted – the vast majority of which have used environmental manipulations or been multi-component in nature. In a Cochrane review that evaluated the effects of interventions to reduce sitting at work, Shrestha et al. (2018) found that among those incorporating physical workplace changes, there is low quality evidence that sit-stand desks may decrease workplace sitting by an average of 57 minutes per day at medium-term follow-up (3 to 12 months), however, the effects of active workstations (e.g., treadmill desks) are inconsistent.

A number of studies have examined the effects of multi-component work-based interventions to reduce sitting time among office workers (Carr et al., 2013; Danquah et al., 2017; Healy et al., 2013; Healy et al., 2017; Mackenzie, Goyder, & Eves, 2015; Neuhaus, Healy, Dunstan, Owen, & Eakin, 2014). Neuhaus and colleagues (2014), for instance, compared the efficacy of a multi-component intervention targeting workplace sitting time, to a height-adjustable workstations-only intervention, and to a comparison group over three months. Intervention strategies targeted the organizational (e.g., management consultation to foster workplace culture and norms), environmental (e.g., height-adjustable workstation), and individual level (e.g., face-to-face coaching and telephone support) with the key message of "stand up, sit less, and move more". Results indicated that workplace sitting time in the multi-component group was reduced by 89 minutes/8-hour workday relative to the comparison group and nearly an hour (56 min) compared to the workstations-only group. These findings suggest that multi-component interventions, which comprise organizational and individual, in addition to environmental elements, may achieve more substantial reductions in office workers' sitting time than the provision of height-adjustable desks alone.

Successful health behaviour change involves motivational, volitional, and actional processes to abandon the health-compromising behaviour in favour of adopting and maintaining health-enhancing behaviours (Schwarzer & Luszczynska, 2008). Incorporating environmental changes targeting SB are domain-specific (i.e., restricted to one setting), are either purchased for/by the individual, and do not address motivational or volitional processes involved in sustaining behaviour change over the long-term. While effective, multi-component interventions are resource- and cost- dependent, require buy-in at the organizational level, and are not scalable from a public health promotion standpoint. Behavioural interventions targeted at the individual level represent an alternative and more pragmatic approach to reduce sedentary time that could prove to be more effective in promoting reductions in SB over the long-term.

With respect to behavioral interventions, Kozey-Keadle, Libertine, Staudenmayer, and Freedson (2012) examined the effectiveness of a simple information-based intervention for reducing sedentary time in a sample of overweight, non-exercising office workers. Participants were provided with information about the potential health risks associated with sedentary time, as well as strategies to reduce sedentary time and increase light-intensity physical activity (LIPA) across multiple domains. Participants also received brief counseling on overcoming barriers that would inhibit reductions in sedentary time. Compared to baseline, it was found that participants significantly reduced their sedentary time by 48 minutes over a 16-hour waking day during the 7-day intervention period. Interventions employing point-of-decision prompts to promote behaviour change have also been effective in reducing workplace sitting time (Cooley & Pedersen, 2013; Evans et al., 2012; Lang, McNeil, Tremblay, & Saunders, 2015; Swartz et al., 2014). For instance, Evans and colleagues (2012) assessed whether computer-delivered point-of-choice prompts and SB education reduced office workers' sedentary time at work. Findings indicated that, compared to the education only group, the point-of-choice prompt plus education group spent less time in long uninterrupted (>30 minutes) sedentary periods while at work. A shared limitation among the behavioural interventions that have been conducted to date is that none have employed a well-established behavioural theory to guide the development of such evidence-based interventions. Research has shown that interventions grounded in prominent health behaviour change theories are more effective (Lippke & Ziegelmann, 2008). They also allow for the specific mechanisms of behavioural change to be examined (Michie & Prestwich, 2010).

One model that has shown promise in recent behaviour change research and could be used to guide the development of behavioural interventions targeting SB is the Health Action Process Approach (HAPA; Schwarzer, 2008). The HAPA framework distinguishes between a motivational phase, in which individuals develop an intention to act, and a subsequent volitional phase, in which they strive to initiate and maintain the intended health behaviour. Within the volitional phase of the HAPA model, it is suggested that various post-intentional factors, including action planning (AP), coping planning (CP), and action control (AC), play an important role in translating intentions into action, thereby helping to overcome the intention-behaviour gap (Schwarzer, 2008). Often used conjointly, AP promotes action initiation whereas; CP stabilizes ongoing goal pursuits. Action plans specify specific situation parameters ("when," "where") and a sequence of action ("how") for implementing the intended behaviour. By linking behavioural responses to situational cues, AP has been shown to improve individuals' perceptual readiness for the specified cues, increase the automaticity by which the intended behaviour is enacted, and foster goal attainment (Gollwitzer, 1999; Schwarzer, 2008). Coping planning is a second self-regulatory strategy that refers to the anticipation of barriers or obstacles that may arise and the development of appropriate strategies or alternative behaviours to overcome such barriers (Sniehotta, Schwarzer, Scholz, & Schüz, 2005). Coping plans promote the effects of AP on behaviour change by helping individuals cope with difficulties and challenges. Action control is the most proximal volitional predictor of behaviour and encompasses self-regulatory processes of self-monitoring, awareness of standards, and effort, which help to sustain behaviour change. Action control is thought to mediate the effects of planning on actual behaviour (Schwarzer, 2008; Sniehotta, Scholz, & Schwarzer, 2005). Together, these volitional constructs have been shown to be effective for promoting health behaviour change in several domains, including physical activity (PA), dietary behaviours, breast self-examination, seat-belt use, and smoking cessation (Schwarzer, 2008; Schwarzer & Luszczynska, 2008).

To our knowledge, only two studies have employed the HAPA model to predict or modify SB. Maher and Conroy (2016) examined if HAPA constructs were associated with SB levels in older adults. Findings indicated that greater plans to reduce SB were related to lower levels of SB. In a pilot randomized controlled trial, Sui and Prapavessis (2017) found that a HAPA-based intervention, specifically AP and CP, was successful in significantly increasing frequency of breaks from sitting in full-time university students. These findings suggest that a HAPA-based intervention may be effective for changing SB in office-workers.

Another potentially viable option to reduce SB is to utilize screen-based technology and mobile health (mHealth) interventions. Recent data suggests that 95% of US adults owned a mobile phone in 2018 (Pew Research Center, 2019). In Canada, there were 31.7 million mobile subscribers in 2017, with slightly more households who owned mobile phones (87.9%) than home computers (84.1%) as of 2016 (CRTC, 2019). Numerous studies have utilized mobile phones to create text message-based interventions for other health behaviours, including smoking cessation, diabetes management, diet and increasing PA levels (Brendryen, Drozd, & Kraft, 2008; Fjeldsoe, Miller, & Marshall, 2010; Head, Noar, Iannarino, & Harrington, 2013; Patrick et al., 2013; Schwerdtfeger, Schmitz, & Warken, 2012; Shapiro et al., 2008). Text messages enable researchers to conveniently reach large populations, across diverse settings, cost effectively and without requiring large amounts of time by either the researchers or the participants.

In a recent systematic review and meta-analysis to determine the effectiveness of mHealth interventions to promote PA and reduce SB, Direito, Carraça, Rawstorn, Whittaker, and Maddison (2017) reported that mHealth PA/SB interventions promote small decreases in free-living individuals' SB. To date, most mHealth interventions were based on SMS and/or mobile phone messages and frequently employed behaviour change techniques such as goal setting, self-monitoring, feedback, health information, and prompts/cues. We are only aware of two studies that have examined the use of text and/or mobile phone messages as an intervention to specifically reduce SB, however, these were not completed with an office-working population and were not grounded in a prominent health behaviour change framework (Cotten & Prapavessis, 2016; Kendzor et al., 2016). For instance, Kendzor et al. (2016) evaluated the short-term impact of a mobile phone intervention that targeted sedentary time through education, self-monitoring, and prompting in a community sample of adults. They found that participants who received the mobile phone intervention had significantly fewer daily minutes of sedentary time and more daily minutes of active time than control participants. Cotten and Prapavessis (2016) examined whether a text message-based intervention would increase non-SBs in university students. Results demonstrated small-to-moderate effects favouring the text intervention group at 6 weeks for break frequency (-14.64 min), break duration (+.59 min), standing (+24.30 min/day), LIPA (+74.34 min/day), and moderate-intensity PA

(+9.97 min/day), compared to a control group. It was also found that the text messages led to increased self-efficacy beliefs to take more breaks and reduce sitting time, which predicted actual SB and PA levels. Together, these findings suggest that a text message-based intervention may be a practical and promising approach to reduce SB in office workers.

Therefore, the primary purpose of this study was to examine whether a HAPA-based intervention, specifically action and coping planning, augmented with tailored text messages can reduce workplace sitting time (primary outcome). A secondary aim was to examine the effects of the intervention on specific non-sedentary behaviours that might explain reductions in workplace sitting time (i.e., time spent standing, time spent walking, time spent stretching, frequency and duration of breaks from sitting), as well as work performance, role limitations due to physical and emotional health problems, emotional well-being, and energy/fatigue. Another secondary aim was to examine relationships among all the variables of interest (i.e., HAPA volitional constructs, sedentary and non-SBs, and work and health-related outcomes).

Methods

Study Design

Data for this prospective, two-arm, repeated measure, randomized controlled trial (RCT) were collected between January and May 2019 and analyzed in June 2019. A 2 (Condition: HAPA Intervention and Control) x 5 (Time: Baseline, Weeks 2, 4, 6, and 8 assessments) mixed model design was utilized to assess differences between treatment conditions across time. The study was approved by the institutional research ethics board (see Appendix I), and the protocol was registered and made publically available through

ClinicalTrials.gov (Identifier # NCT03461926). The study used the Consolidated Standards for Reporting of Trials (CONSORT) statement guidelines to help improve the quality of reports of RCTs. A flow diagram of the study design is illustrated in Figure 5. Research staff and assessors were not blinded to group allocation. Participants were unaware of the existence of separate treatment conditions at the time of study participation.

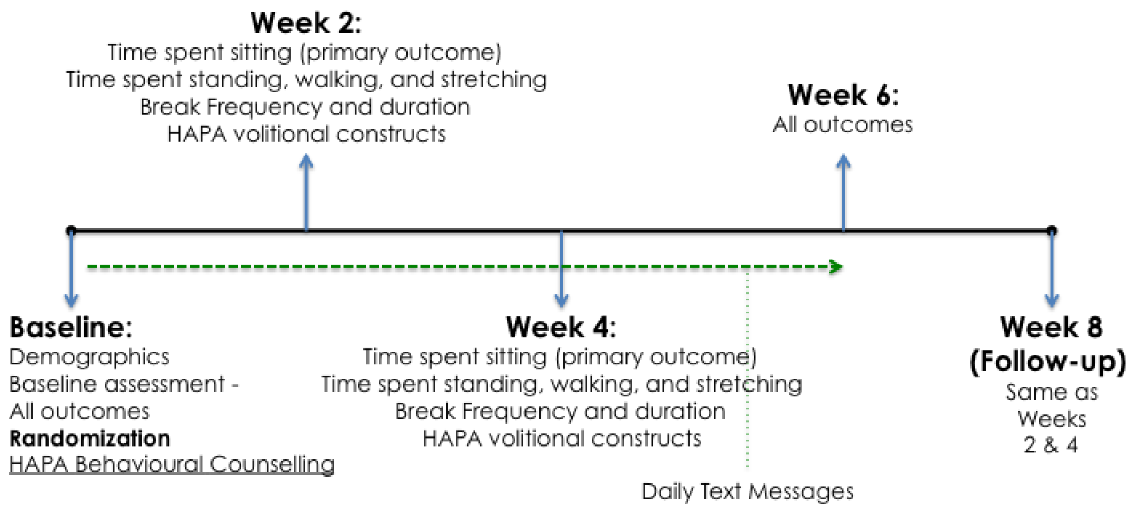

Figure 5. Design and timeline of overall procedure.

Participants

Participants were full-time adult office workers recruited from large businesses, office spaces, and universities across Ontario between January and May 2019. Three recruitment approaches were utilized. A first was to contact relevant liaisons and/or senior executives (e.g., Head of Human Resources, President, Chief Executive Officer, Office Manager) at potential businesses of interest via email. Individuals who accepted the study invitation by informing the researchers that they were willing to facilitate the recruitment process were then asked to email all full-time employees in the respective office/business offering them the opportunity to participate. A second recruitment approach involved sending recruitment emails directly to office working employees whose contact information was publicly listed and available. A third recruitment approach included recruiting office workers through recruitment posters distributed via social media platforms. The recruitment email included brief study details and a recruitment poster (see Appendix J), and instructed interested individuals to contact the researcher via email and/or phone if they wished to participate or receive additional details prior to making a decision as to whether to participate (see Appendix K). Individuals were eligible to participate provided they were 18 years of age or older, a full-time worker/employee in an office setting, able to read and write in English, had access to a computer with Internet, and owned a mobile phone with free unlimited incoming text messages. Exclusion criteria included individuals who had a medical condition or physical limitation that prevented them from being physically active.

Sedentary and Non-Sedentary Outcome Measures

Time spent sitting, standing, walking, and stretching. Time spent sitting, standing, walking, and stretching at work were measured using a validated three-item modified Occupational Sitting and Physical Activity Questionnaire (OSPAQ; Chau, Van Der Ploeg, Dunn, Kurko, & Bauman, 2012). The OSPAQ is a brief instrument reported to have excellent test-retest reliability (intraclass correlation coefficients = 0.73 – 0.90), moderate criterion validity for time spent sitting and standing (*r* = 0.65 and 0.49, respectively), and lower validity for time spent walking (*r* = 0.29; Chau et al., 2012). First, participants were asked to record both the number of days they were at work and total number of hours they worked in the last 14 days. Participants were then asked to record a percentage of time spent sitting, standing, walking and stretching (cumulative total of 100%) at work on a typical workday in the last 14 days. Stretching replaced "heavy labor or physically demanding tasks" due to the office setting and intervention objectives. Time spent sitting per workday (minutes) (primary outcome) was calculated as follows: [Minutes worked in the last 14 days/Days at work in the last 14 days] x [Percentage of sitting on a workday/100]. Similar calculations were done for time (minutes) spent standing, walking, and stretching at work. Time spent sitting was the primary outcome whereas standing, walking, and stretching served as secondary outcomes.

Frequency and duration of breaks from sitting. Participants' frequency and duration of breaks at work were measured using a modified version of the SIT-Q 7d (Sui & Prapavessis, 2017; Wijndaele et al., 2014). Sui and Prapavessis (2017) modified the base questionnaire to include domain-specific break frequency and duration scores, which were the only items assessed for purposes of this study. The frequency of breaks taken from sitting at work was measured through the following question: "In the last 14 days, on average, how often did you interrupt your sitting time during work hours?" Response options for the question included: Less than every 30 min, Every 30–45 min, Every 45 min–1 hour, Every 1–1.5 hours, Every 1.5–2 hours, Every 2–3 hours, Every 3–4 hours, Every 4–5 hours, Every 5-6 hours, Every 6-7 hours, Over every 7 hours, No interruption. Results were coded to correspond with the upper limit for break frequency; for example, the option "Less than every 30 minutes" corresponded to a break frequency of every 30 minutes, whereas the options "Over every 7 hours" and "No interruption" were represented by a break frequency of every 8 hours. Since previous research has suggested that office workers may spend up to 77% (i.e., 6.6 hours/8-hr workday) of their working hours sitting (Thorp et al., 2012), a break frequency of every 8 hours would equate to no break during occupational sedentary time. The duration of breaks taken from sitting at work was measured through the following question: "In the last 14 days, on average, how long were your breaks from sitting during work hours?" Response options for the question included: Less than 30 sec, 30 sec–1 min, 1–2 min, 2–3 min, 3–4 min, 4–5 min, 5–10 min, 10–15 min, 15–30 min, Over 30 min. Results were coded to correspond with the lower limit for break duration; for example, the option "Less than 30 seconds" corresponded to a break duration of 0 minutes (i.e., no break), while the option "Over 30 minutes" was represented by a break duration of 30 minutes. This approach to coding was implemented to keep estimates of break frequency and duration conservative (Wijndaele et al., 2014) and account for the non-linear intervals between response options. Both frequency and duration of breaks from sitting served as secondary outcomes.

Other Secondary Outcome Measures

Action planning (AP), coping planning (CP), and action control (AC) constructs. AP, CP, and AC constructs were assessed using four-, five-, and 6-item purpose-built questionnaires, respectively. These were created to measure AP, CP and AC towards reducing workplace sitting time as outlined by Schwarzer (2008) and Sniehotta et al. (2005). The items for AP included, "During the last two weeks, I had a detailed plan regarding (when/where/how/how often) to break up my sitting time at work". An example item for CP was, "During the last two weeks, I had a detailed plan regarding what to do if something interferes with my plans to break up my sitting time at work". An example item for AC was, "During the last two weeks, I have constantly monitored myself whether I break up my sitting time at work often enough". Responses were measured on a five-point Likert scale that ranged from 1 (*completely disagree*) to 5 (*totally agree*).

Health-related outcomes. Role limitations due to physical health, role limitations due to emotional health, energy/fatigue, and emotional well-being were measured using the RAND 36-item Short Form Survey (SF-36; Ware & Sherbourne, 1992), which is a health survey that assesses eight health concepts. For purposes of this study, a modified 16-item version was used in order to only assess the outcomes listed above. Four-items assessed participant's perceived role limitations due to physical health problems and three-items assessed role limitations due to personal or emotional problems; responses options were "Yes" or "No". Five- and four-items assessed perceived emotional well-being and perceived energy/fatigue, respectively, using a five-point Likert scale (1 = *all of the time*) to (5 = *none of the time*). Higher scores indicated better health outcomes.

Work performance. Self-rated work performance (Sundstrom, Town, Rice, Osborn, & Brill, 1994) was assessed with one-item, "How would you rate your overall work performance?", using an 11-point Likert scale that ranged from 0 (*absolutely unacceptable*) to 10 (*absolutely ideal*). Higher scores indicated better performance.

Other Measures

Demographics. Participants provided demographic information: age, gender, ethnicity, physical health status, height and weight for calculation of BMI, employment status, employment sector, and number of hours worked per week.

Baseline sedentary behaviour. SB was assessed using a 12-item modified Sedentary Behavior Questionnaire (SBQ; Rosenberg et al., 2010). The same modifications Prapavessis, Gaston, and DeJesus (2015) made to the SBQ (i.e., addition of three items, extended response items) were also employed in the current study. The stem of the SBQ was as follows: "On a typical weekday, how much time do you spend (from when you wake up until you go to bed) doing the following?". Ten items assessed leisure-specific, volitional sedentary activities (e.g., sitting and watching TV) and two items assessed occupational-specific, non-volitional sedentary activities (e.g., sitting for work. Participants selected the duration of time (None, 15 min or less, 30 min, 1 hr, 2 hrs, …, 9 hrs or more) they spent per day in each sedentary pursuit. The leisure-specific model computed a daily score from the sum of the ten volitional items, whereas the occupational-specific model computed a daily score from the sum of the two non-volitional items. The general model computed a daily score from the sum of all 12 items. The original SBQ demonstrated good internal consistency (α ranges from 0.48 to 0.93) and excellent test-retest reliability ($r = 0.51$ to 0.93; Rosenberg et al., 2010).

Intervention

Treatment group. Participants randomized into the HAPA intervention group received a single, one-on-one behavioural counselling session (formation of action and coping plans), informational booklet on SB, and planning sheet (i.e., table) as reference for developing strategies as part of their action/coping planning (see Appendices Q-R). The informational booklet outlined SB as a health risk, benefits of reducing and breaking up SB, helpful strategies, and target behaviours. The table included headings drawn from the FITT principle: Frequency, Intensity, Time, and Type. Frequency is how often a strategy should be used; Intensity is the duration of breaks from sitting; Time is when the strategy should be enacted; and Type is the activity done during the break from sitting. Participants were asked to form 3-4 actions plans specifying when, where, how, and for how long they would reduce and/or break up workplace sitting time over the next 6-weeks. In addition, in line with the HAPA model there was a section titled "Coping Strategies", in which participants were asked to anticipate potential barriers and identify ways they could be overcome. As an example, a participant may develop a strategy of utilizing computer-based prompts as reminders to get up every 30 minutes, and stand for 2–4 minutes when prompted. The frequency of this strategy would be every 30 minutes, the intensity would be the duration of the break from sitting (i.e., 2–4 minutes), the time would be during work/office hours, and type would be either standing or walking. Strategies explicitly focused on the intervention objectives of increasing break frequency to every 30–45 minutes, achieving a break duration of 2–4 minutes, and increasing time spent standing and engaged in light-intensity PA (i.e., walking, stretching), in the occupational domain (i.e., as an office worker; during work hours). As planning is an ongoing process, participants were also reminded via text message to revise and/or formulate new action and coping plans at the beginning of weeks 3 and 5. The planning intervention was modeled after previous work (Gaston & Prapavessis, 2014; Sui & Prapavessis, 2017).

Participants in the HAPA intervention group also received daily SB-related text messages, at a specified time of day, based on their schedule and preferences. Text-messages were intended as mini-booster interventions and meant to reinforce study objectives and the action and coping plans participants formed. These were also meant to promote elements of AC. The messages included various sedentary-related facts, as well as tips, challenges, and reminders to reduce their workplace sitting time. Participants received two challenges each week, one regarding breaking up sedentary time and one regarding reducing sedentary time; these started out relatively easy and progressed in difficulty until participants were challenged to get up every 30 minutes for at least a 4-minute break and try to reduce their total sitting time at work by 2 hours or greater. Example tips and reminders included, “There are a number of easy ways to reduce & break up your sitting time at work! To name a few: Use prompts or reminders or try standing during phone calls” and “Keep up with those 2-4 min breaks every 45 min and on top of that try to replace 60 min of sitting a day with standing”. See Appendix S for a list of text-messages.

Control group. Participants randomly assigned to the control group received no information or intervention of any kind.

Procedures

Office-working adults who chose to participate in this study received a second recruitment email with a link that directed them to the online Letter of Information, Informed Consent, and Baseline questionnaire (see Appendices L-M). After providing informed consent, participants were asked to complete a brief demographics questionnaire, followed by a questionnaire for baseline assessment of primary and secondary outcomes (see Appendix N).

Upon completion of the baseline assessment, all participants were randomized, using an online research randomization program, into either a 6-week HAPA-treatment (SB-related planning + text messages intervention) or waitlisted control (no treatment) condition. At this point, all participants were sent a specific email depending on group assignment (see Appendices O-P). For those in the HAPA-intervention condition, the post-baseline email asked them to provide a day and time (within 3 days of completing the baseline assessment) that they would be available to receive the behavioural counselling session. For those in the control condition, the email simply reminded participants that they would receive a link to a questionnaire every two weeks for an 8-week period in their email and to complete these upon receiving them.

For those in the HAPA intervention group, the intervention objectives were to reduce workplace sitting time by increasing non-sedentary or NEAT behaviours (i.e., increase break frequency to a break every 30-45 minutes, with each break having a duration of 2–4 minutes, and increase time spent standing, walking, and stretching). At the agreed upon and scheduled time, the researcher delivered the one-on-one behavioural counselling session (AP and CP intervention) either in person or electronically via phone and an online presentation platform (www.zoho.com/show/). The method of delivery entirely depended on the participant’s availability, preference, and whether they lived within driving distance of the investigator. To ensure standardization between participants, the principal investigator implemented all HAPA-based counselling sessions.

During the counseling session, the researcher first asked if the participant had any strategies that he/she would like to try or think would be effective to reduce and/or break up sitting time at work. As much as possible, strategies were kept as original and specific to the participant's lifestyle as possible, while still fulfilling the intervention objectives. Upon creation of each strategy, the researcher asked the participant if they thought that the strategy they came up with was realistic. Similarly, coping strategies were created alongside each action plan in order to boost the adherence to the developed strategies. When an action plan strategy was developed, the researcher asked the participant "what are some challenges you foresee with executing this strategy?", followed by "what do you think is something you can do in order to overcome these challenges?" Participants were reminded that the more precise, concrete, and personal the plans were, the more effective they would be. Overall, the behavioral counseling sessions took between 20-30 minutes to complete. Participants were given the planning sheet with their action plan and coping strategies and told to display it somewhere prominent so they would be reminded of the strategies. The principal investigator conducted the planning portion of the session in a non-interfering manner by providing brief instructions and then remaining available to answer any questions.

All participants in the HAPA-treatment condition were then entered into a contact list on the text-messaging website called "Oh Don't Forget." "Oh Don't Forget," is a Web-based application (http://ohdontforget.com) that works through "Recess Mobile" to send messages from a computer to mobile phone numbers that are programmed into the application. All participants began receiving tailored text messages the day after receiving their one-on-one counselling session for a 6-week period. Every participant received the same order of daily texts as each other participant in their group; however, the time of day received was individualized for each participant based on their schedule and preferences. Upon completion of the intervention period at 6 weeks, participants were notified that they would no longer be receiving text messages and that the study was completed.

Regardless of group assignment, all participants completed the same outcome measures at Week 2, Week 4, Week 6, and a 2-week follow-up (Week 8). All primary and secondary outcome questionnaires were completed online and administered through a survey website called SoSci (www.soscisurvey.de). Participants received an email with a link to access the questionnaire every two weeks for an 8-week period. Those in the HAPA-treatment condition were also reminded via text to complete these.

A fidelity check was performed in numerous ways. All outcome questionnaires sent to participants were tracked for: if/when it was sent, if/when the participant had started, and if/when the participant completed the questionnaire. During the one-on-one counseling session, participants developed personal strategies for their target behaviors on their own, with guidance from the researcher. Upon inception of each strategy, participants were asked to describe their plans and if they thought their strategies were "realistic and specific", implying aspects of task self-efficacy, AP, and CP. The assessment of AP, CP, and AC constructs also served as a fidelity check to determine if participant's planning cognitions changed as a result of the intervention received.

Upon study completion, all participants randomized into the waitlisted control group were offered the same intervention as those who were initially assigned to the treatment condition (see Appendix T). It was entirely up to them as to whether they would like to accept the offer. All participants were entered into a draw for a chance to win a $100 Tim Hortons or Starbucks gift certificate at study completion. The conduct of the trial followed the ethical principles of research outlined in the Declaration of Helsinki (World Medical Association, 2018) and the World Health Organization's (WHO) Handbook for Good Clinical Research Practice (WHO, 2005).

Statistical Analyses

Univariate ANOVAs and Chi-square analyses were used to ensure that there were no systematic differences between groups on demographic characteristics, levels of total, occupational, and leisure SB, leisure-time PA or the primary and secondary outcomes at baseline. For any variables where baseline group differences were found, separate ANOVA or Pearson's correlation analyses were conducted with these as the independent factor to examine effects on the primary and secondary outcomes. If significant, moderate to large effects were found for the variable, it was treated as a covariate for the subsequent analyses.

For AP, CP, and AC variables, a series of 2 (groups) x 5 (time) repeated measures ANOVAs were used to determine if there were any significant group by time interaction effects. Separate 2 (groups) x 5 (time) repeated measures ANOVAs were conducted for each of the six sitting-related behavioural outcomes (time spent sitting [primary outcome], time spent standing, time spent walking, time spent stretching, frequency and duration of breaks from sitting) to identify possible group by time interaction effects. For health-related outcomes and work performance (secondary outcomes), a series of 2 (group) x 2 (time – baseline, week 6) repeated measures ANOVAs were used to identify possible interaction effects. A P value < 0.05 was regarded as significant for all statistical tests and a partial-eta squared (η^2) of 0.01, 0.06, and 0.14 represented small, medium, and large effect sizes, respectively (Stevens, 1996).

Finally, bivariate correlations were conducted to examine relationships between AP, CP, and AC constructs and sedentary and non-SBs, as well as relationships between target behaviours and work and health-related outcomes. All analyses were conducted using IBM SPSS version 25.0 software.

Results

Missing and Outlier Data

On any given variable at a single assessment point, the maximum percentage of missing data/responses was 3.33%. Participants were considered to have "dropped out" if they failed to complete a questionnaire, and did not respond to one of three email reminders to do so. Of the 300 total participant questionnaires that could have been completed, 10 questionnaires (3.33%) were either unanswered or missing. Of the 145 possible questionnaires for the intervention group, 4 (2.76%) were either unanswered or missing. Two participants dropped out of the intervention group during the study. Of the 155 possible questionnaires for the control group, 6 (3.87%) were either unanswered or missing. Two participants dropped out of the control group during the study. Figure 6 shows the flow of participants and dropouts for each group. Independent samples t-tests revealed no significant differences (all p values $> .05$) in the demographic variables for those that completed the study vs. those who dropped out. There was also no differential loss (i.e. greater loss in one group) between treatment groups for those that completed the study vs. those that dropped out. Taken together, all missing data were considered random. Hence, an intent-to-treat last observation carried forward approach was used to handle missing data (Hollis & Campbell, 1999).

For any outliers in the data, a winsorization technique was used to replace any data points over the 95^{th} percentile with the value of the 95^{th} percentile. A total of 160 data points out of 3300 primary and secondary outcome data points were imputed this way (86 in the intervention group and 74 in the control group). This method has been shown to be a valid approach to treat outliers (Dixon & Tukey, 1968; Guttman & Smith, 1969).

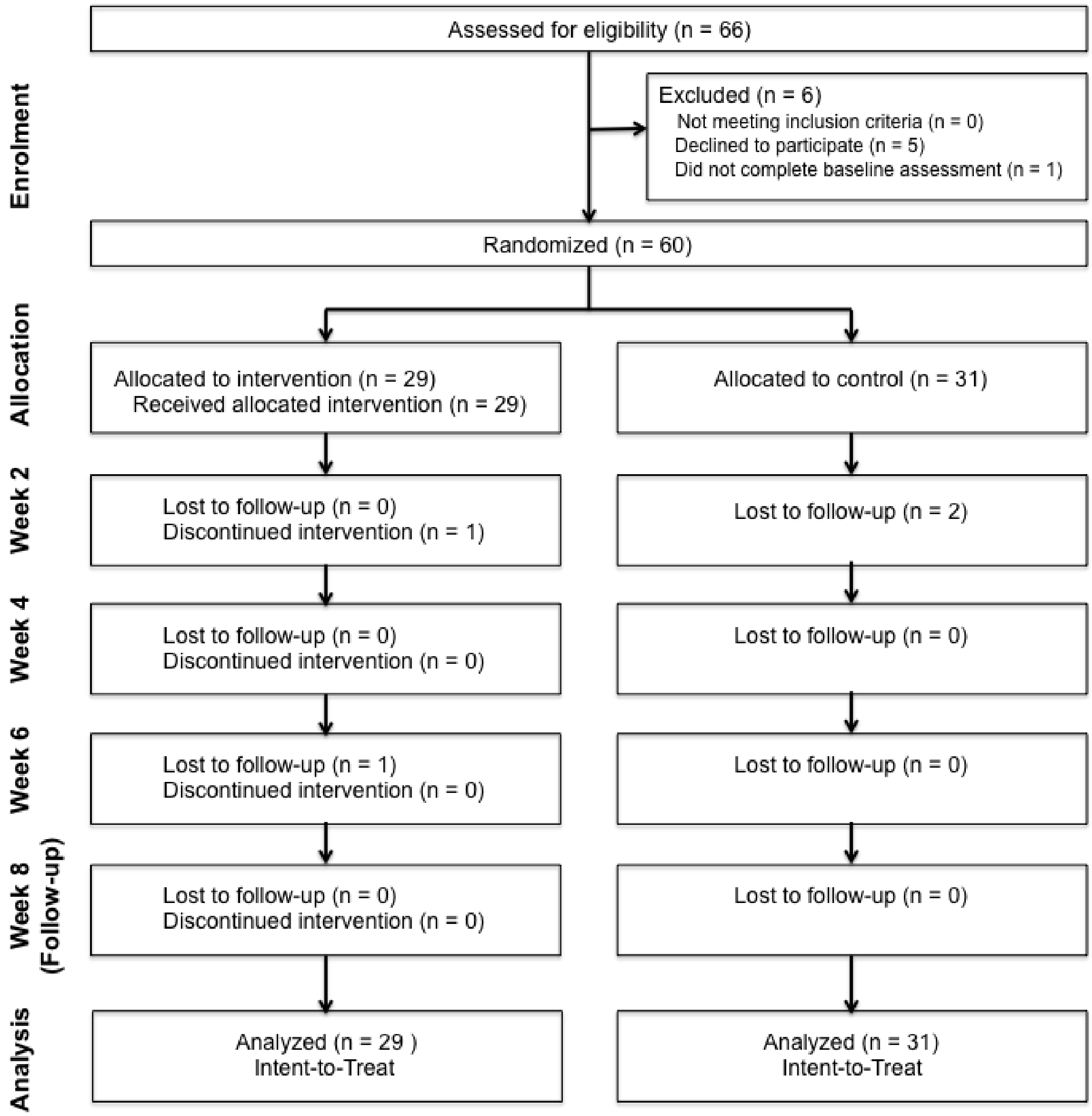

Figure 6. Flow of participants through the study.

Group Equivalency

Sixty healthy office-working adults (5 men, mean age = 45.18 ± 11.33 years) were recruited to participate in the study. Twenty-nine participants were randomized to the HAPA intervention group (93.1% women, mean age = 46.59 ± 11.13 years), and 31 participants were randomized to the control group (90.3% women, mean age = 43.87 ± 11.54). Descriptive statistics for the demographic variables, and baseline levels of SB and leisure-time PA are shown in Table 8. No significant differences emerged, indicating groups were equivalent at baseline for all measures (all *p* values > .05). Due to these results, it was deemed unnecessary to use demographic variables as covariates in the subsequent analyses.

For the primary and secondary outcomes, significant group differences were found for break frequency, $F(1, 58) = 5.70$, $p = .02$, $\eta_{\rho}^2 = .09$, break duration, $F(1, 58) = 4.00$, $p = .05$, $\eta_{\rho}^2 = .06$, and stretching time, $F(1, 58) = 4.51$, $p = .038$, $\eta_{\rho}^2 = .07$, at baseline. Due to these differences, an ANCOVA controlling for these baseline scores was also conducted and reported for stretching, break frequency and break duration.

Table 8. Baseline characteristics by group, presented as mean (SD) or count (%) of group.

Variable	HAPA Intervention (n = 29)	Control (n = 31)	Entire Sample (N = 60)	Statistic	p-level
Age (years)	46.59 (SD = 11.13)	43.87 (SD = 11.54)	45.18 (SD = 11.33)	$F(1,58) = 0.858$	0.36
Gender				X^2 (1) = 0.152	0.70
Male	2 (6.9%)	3 (9.7%)	5 (8.3%)		
Female	27 (93.1%)	28 (90.3%)	55 (91.7%)		
Ethnicity				X^2 (3) = 3.27	0.35
White	27 (93.1%)	27 (87.1%)	54 (90.0%)		
Asian	1 (3.4%)	2 (6.5%)	3 (5.0%)		
Black	1 (3.4%)	0 (0.0%)	1 (1.7%)		
Hispanic	0 (0.0%)	2 (6.5%)	2 (3.3%)		
Other	0 (0.0%)	0 (0.0%)	0 (0.0%)		
BMI (kg/m^2)	27.86 (SD = 5.73)	25.70 (SD = 4.18)	26.75 (SD = 5.07)	$F(1,58) = 2.82$	0.10
Employment Sector				X^2 (3) = 3.40	0.33
Private	4 (13.8%)	5 (16.1%)	9 (15.0%)		
Public	21 (72.4%)	25 (80.6%)	46 (76.7%)		
Charity	3 (10.3%)	0 (0.0%)	3 (5.0%)		
Other	1 (3.4%)	1 (3.2%)	2 (3.3%)		
Hours Worked Per Week				$F(1,58) = 0.004$	0.95
≤10	0 (0.0%)	0 (0.0%)	0 (0.0%)		
11-20	0 (0.0%)	0 (0.0%)	0 (0.0%)		
21-30	1 (3.4%)	1 (3.2%)	2 (3.3%)		
31-40	24 (82.8%)	26 (83.9%)	50 (83.3%)		
≥40	4 (13.8%)	4 (12.9%)	8 (13.3%)		
Weekly Leisure-time Physical Activity[a]					
Mild	4.55 (SD = 4.39)	2.81 (SD = 2.64)	3.65 (SD = 3.67)	$F(1,58) = 3.54$	0.07
Moderate	1.48 (SD = 1.68)	2.52 (SD = 2.69)	2.02 (SD = 2.30)	$F(1,58) = 3.13$	0.08
Strenuous	0.97 (SD = 1.30)	1.26 (SD = 1.63)	1.12 (SD = 1.47)	$F(1,58) = 0.586$	0.45
Sedentary Behaviour (hours/day)					
Total	13.57 (SD = 2.67)	14.11 (SD = 2.55)	13.85 (SD = 2.60)	$F(1,57) = 0.637$	0.43
Leisure	6.12 (SD = 2.40)	6.44 (SD = 2.42)	6.29 (SD = 2.39)	$F(1,57) = 0.261$	0.61
Work	7.59 (SD = 1.16)	7.49 (SD = 1.67)	7.54 (SD = 1.44)	$F(1,57) = 0.066$	0.80

[a] Number of times strenuous, moderate, and mild/light exercises (that lasted more than 15 minutes) were performed during a typical 7-day period (a week)

Fidelity Check

Descriptive data for the HAPA volitional constructs are presented in Table 9.

Table 9. Descriptive data ($M \pm SD$) for HAPA volitional constructs at baseline, week 2, week 4, week 6, and week 8.

	HAPA Intervention Mean (SD)					Control Mean (SD)				
	Baseline	Week 2	Week 4	Week 6	Week 8	Baseline	Week 2	Week 4	Week 6	Week 8
Action planning	2.14 (1.02)	3.82 (.62)	3.56 (.81)	3.62 (.87)	3.58 (.81)	2.25 (1.22)	2.25 (1.13)	2.23 (1.03)	2.57 (1.12)	2.56 (1.21)
Coping planning	1.77 (.70)	2.91 (.63)	3.07 (.68)	3.30 (.68)	3.26 (.67)	1.94 (.96)	2.06 (.86)	2.15 (.96)	2.34 (.95)	2.39 (1.06)
Action control	2.57 (.92)	3.82 (.49)	3.75 (.66)	3.79 (.34)	3.75 (.41)	2.49 (1.12)	2.48 (.94)	2.60 (.98)	2.94 (1.08)	2.89 (1.14)

Action planning. There was a significant group by time interaction effect for AP towards reducing workplace sitting time, $F(2.59, 149.99) = 14.25$, $p < .001$, $\eta_\rho^2 = .20$. The observed power was 1.00. Participants in the HAPA intervention group reported significantly higher AP at all time points compared to those in the control group.

Coping planning. There was a significant group by time interaction effect for CP towards reducing workplace sitting time, $F(3.31, 191.80) = 12.53$, $p < .001$, $\eta_\rho^2 = .18$. The observed power was 1.00. Participants in the HAPA intervention group reported significantly higher CP at all time points compared to those in the control group.

Action control. There was a significant group by time interaction effect for AC towards reducing workplace sitting time, $F(2.54, 147.51) = 10.53$, $p < .001$, $\eta_\rho^2 = .15$. The observed power was 1.00. Participants in the HAPA intervention group reported significantly higher AC at all time points compared to those in the control group.

Intervention Effects

Descriptive data for primary sitting-related behavioural outcomes are presented in Table 10.

Table 10. Descriptive data ($M \pm SD$) for sitting-related behavioural outcomes at baseline, week 2, week 4, week 6, and week 8.

	HAPA Intervention Mean (SD)					Control Mean (SD)				
	Baseline	Week 2	Week 4	Week 6	Week 8	Baseline	Week 2	Week 4	Week 6	Week 8
Sitting time (min/workday)	353.55 (80.65)	285.02 (102.64)	278.21 (97.58)	269.40 (115.83)	266.01 (104.01)	358.75 (78.26)	337.14 (106.94)	329.69 (95.61)	355.77 (74.21)	341.85 (76.40)
Standing time (min/workday)	41.52 (35.11)	60.23 (40.67)	67.14 (44.14)	65.18 (36.18)	74.08 (55.15)	30.30 (24.21)	30.74 (18.28)	33.49 (28.07)	35.68 (25.47)	34.36 (23.49)
Walking time (min/workday)	48.09 (34.15)	59.82 (37.52)	55.83 (31.61)	61.70 (38.15)	62.42 (33.57)	40.43 (23.40)	41.14 (27.60)	36.84 (22.01)	46.54 (27.80)	40.33 (20.65)
Stretching time (min/workday)	2.84 (4.57)	7.70 (8.90)	12.63 (12.99)	13.43 (16.57)	14.18 (13.87)	7.16 (10.03)	8.89 (12.21)	7.63 (10.06)	7.23 (8.94)	10.32 (13.17)
Break frequency (min)	97.38 (52.01)	71.45 (26.24)	68.90 (26.49)	66.21 (29.60)	63.86 (29.74)	136.71 (73.02)	125.32 (62.28)	127.74 (64.21)	127.94 (65.26)	98.71 (40.02)
Break duration (min)	5.76 (4.20)	3.79 (5.59)	2.95 (1.64)	2.71 (1.33)	3.26 (2.25)	4.00 (2.45)	3.81 (1.99)	3.15 (1.44)	3.76 (1.99)	3.65 (2.12)

Sitting time. A significant group by time interaction effect was obtained for time spent sitting at work, $F(4, 232) = 4.07$, $p = .003$, $\eta_{\rho}^2 = .07$. The observed power was 0.91. Within-subjects contrasts revealed that relative to baseline, decreases in sitting time were significantly greater at all time points for the HAPA intervention group compared to those in the control group.

Compared to baseline, the HAPA intervention group decreased sitting by 68.53 min/day at week 2, 75.34 min/day at week 4, 84.15 min/day at week 6, and 87.54 min/day at week 8 (follow-up). The control group decreased sitting by 21.61 min/day at week 2, 29.06 min/day at week 4, 2.98 min/day at week 6, and 16.90 min/day at week 8 (see Figure 7).

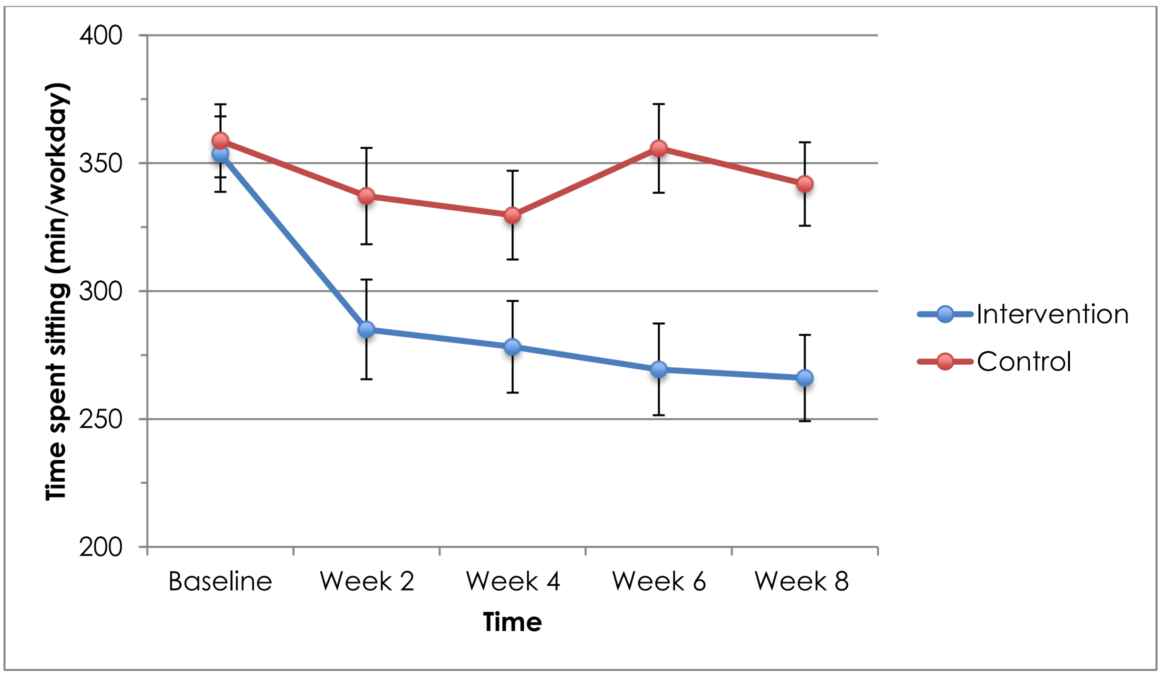

Figure 7. Mean and standard error scores between groups across time for sitting time at work.

Standing time. A significant group by time interaction effect was obtained for time spent standing at work, $F(3.26, 189.13) = 3.28$, $p = .019$, $\eta_{\rho}^2 = .05$. The observed power was 0.77. Within-subjects contrasts revealed that relative to baseline, increases in standing time were significantly greater at all time points for the HAPA intervention group compared to those in the control group.

Compared to baseline, the HAPA intervention group increased standing by 18.71 min/day at week 2, 25.62 min/day at week 4, 23.66 min/day at week 6, and 32.56 min/day at week 8. The control group increased standing by 0.44 min/day at week 2, 3.19 min/day at week 4, 5.38 min/day at week 6, and 4.06 min/day at week 8 (see Figure 8).

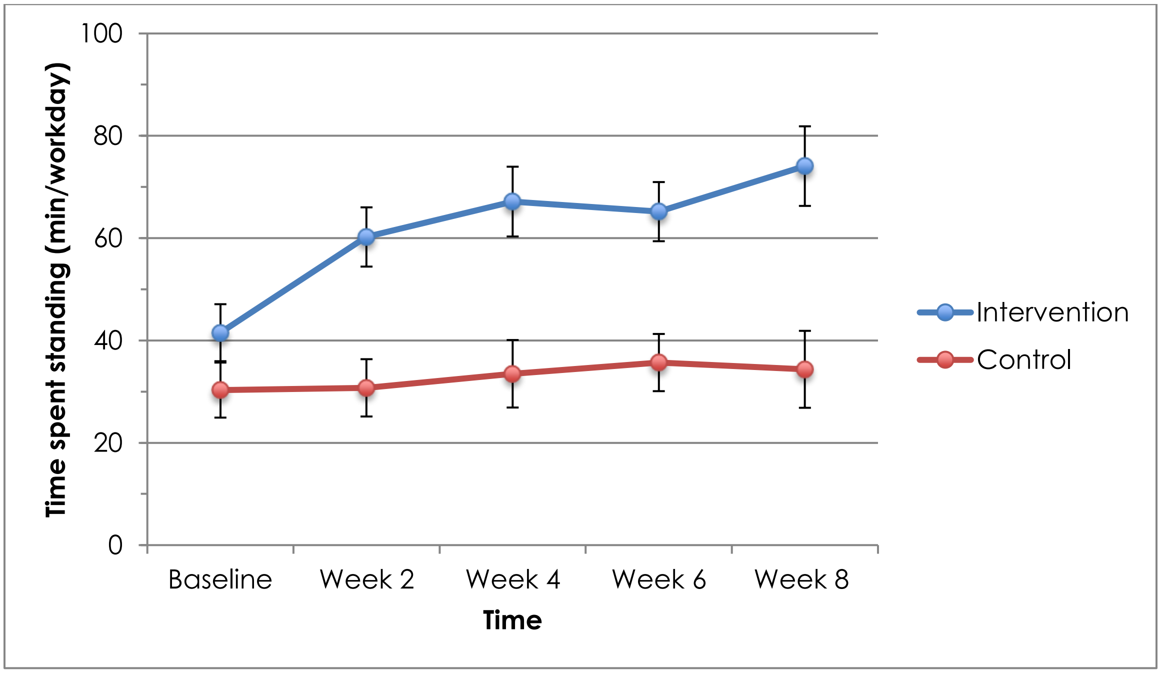

Figure 8. Mean and standard error scores between groups across time for standing time at work.

Walking time. A significant time effect was found for time spent walking at work, $F(3.75, 217.74) = 2.55$, $p = .044$, $\eta_\rho^2 = .04$. The observed power was 0.69. No significant interaction effect emerged, $F(3.75, 217.74) = 1.23$, $p = .298$, $\eta_\rho^2 = .02$.

Compared to baseline, the HAPA intervention group increased walking by 11.73 min/day at week 2, 7.74 min/day at week 4, 13.61 min/day at week 6, and 14.33 min/day at week 8. The control group remained relatively the same across time (see Figure 9).

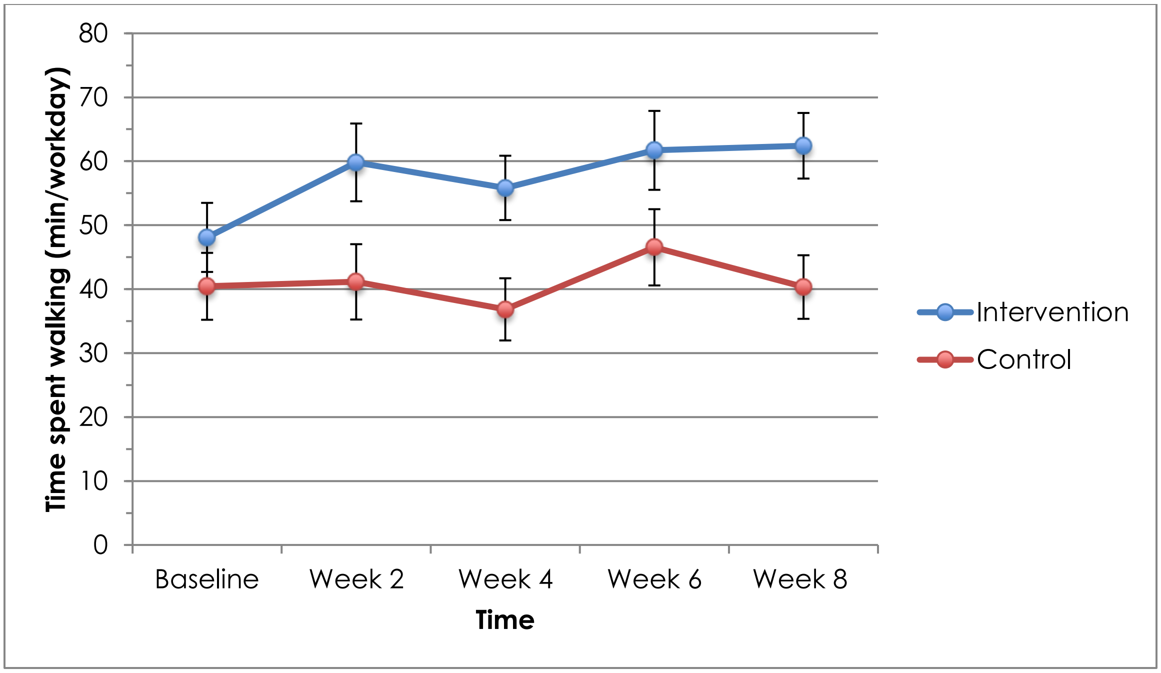

Figure 9. Mean and standard error scores between groups across time for walking time at work.

Stretching time. A significant group by time interaction effect was obtained for time spent stretching at work, $F(4, 232) = 4.97$, $p = .001$, $\eta_\rho^2 = .08$. The observed power was 0.96. Within-subjects contrasts revealed that relative to baseline, increases in stretching time were significantly greater at week 4, week 6, and week 8 for the HAPA intervention group compared to those in the control group. Controlling for baseline time spent stretching, the interaction effect remained, $F(3, 171) = 2.59$, $p = .054$, $\eta_\rho^2 = .04$.

Compared to baseline, the HAPA intervention group increased stretching by 4.86 min/day at week 2, 9.79 min/day at week 4, 10.59 min/day at week 6, and 11.34 min/day at week 8. The control group increased stretching by 1.73 min/day at week 2, 0.47 min/day at week 4, 0.07 min/day at week 6, and 3.16 min/day at week 8 (see Figure 10).

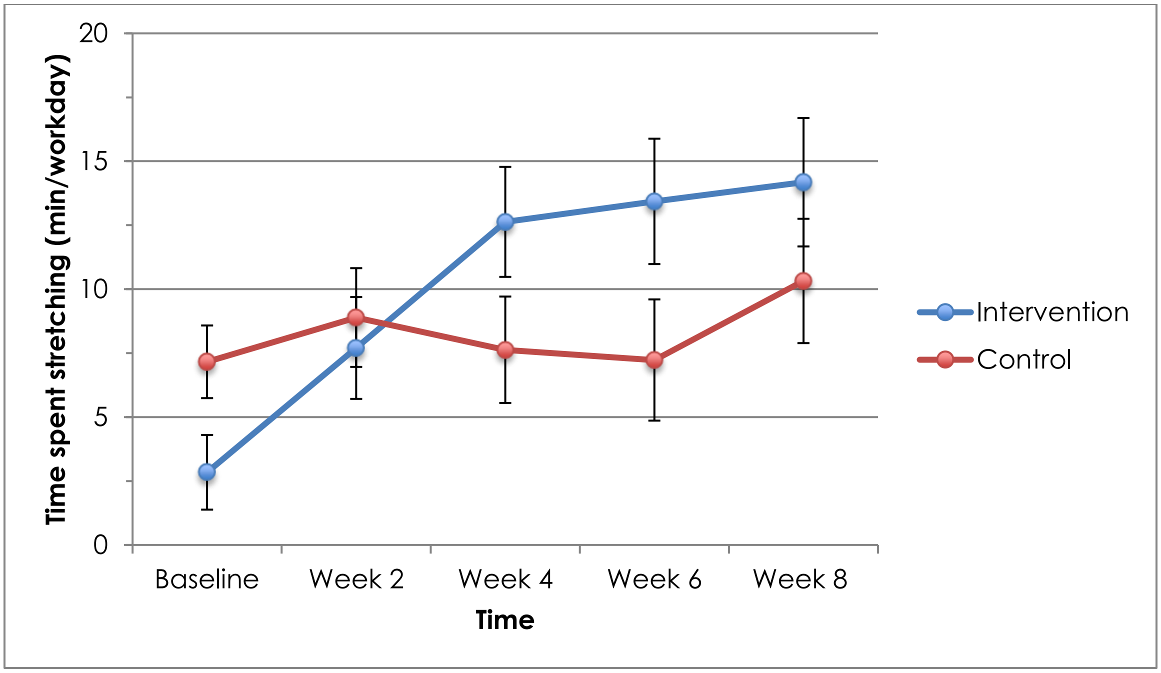

Figure 10. Mean and standard error scores between groups across time for stretching time at work.

Break frequency. A significant time effect was found for frequency of breaks from sitting at work, $F(3.17, 183.55) = 6.52$, $p < .001$, $\eta_\rho^2 = .10$. The observed power was 0.98. No significant interaction effect emerged, $F(3.17, 183.55) = 1.46$, $p = .226$, $\eta_\rho^2 = .03$. Controlling for baseline break frequency, the interaction effect remained non-significant, $F(3, 171) = 2.10$, $p = .102$, $\eta_\rho^2 = .04$.

The HAPA intervention group increased break frequency from every 97.38 min at baseline to every 71.45 min at week 2, every 68.90 min at week 4, every 66.21 min at week 6, and every 63.86 min at week 8. The control group increased break frequency from every 136.71 min at baseline to every 125.32 min at week 2, every 127.74 min at week 4, every 127.94 min at week 6, and every 98.71 min at week 8 (see Figure 11).

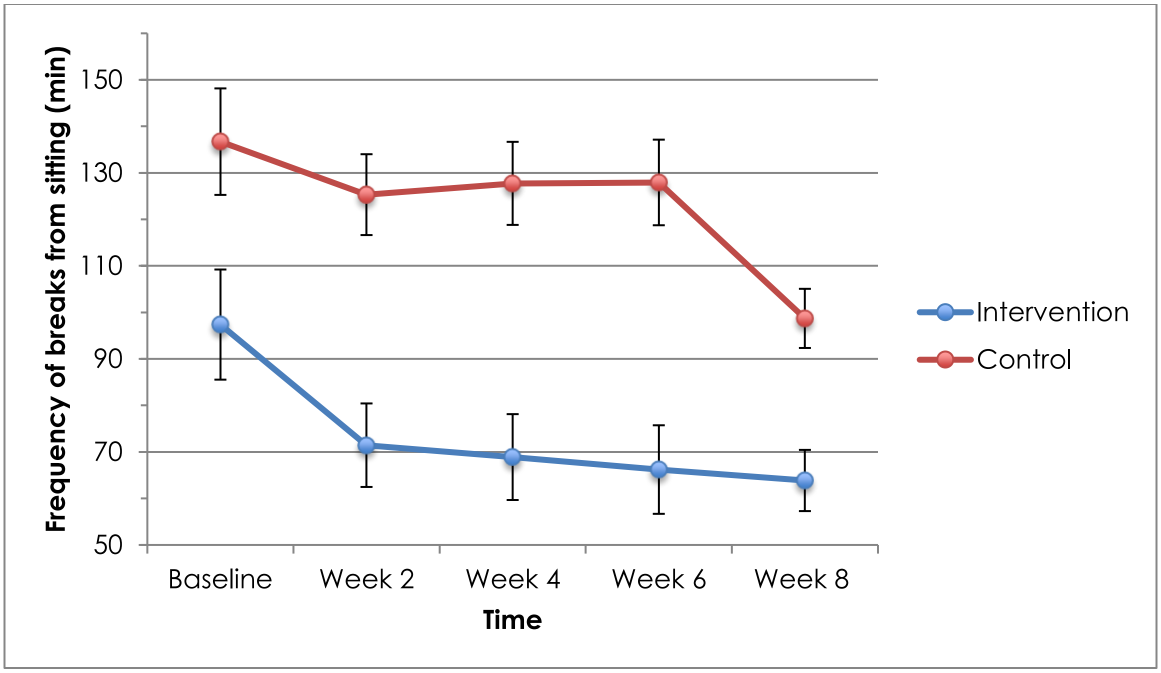

Figure 11. Mean and standard error scores between groups across time for frequency of breaks from sitting at work.

Break duration. A significant group by time interaction effect was obtained for duration of breaks from sitting at work, $F(2.37, 137.69) = 3.55$, $p = .024$, $\eta_\rho^2 = .06$. The observed power was 0.70. Within-subjects contrasts revealed that relative to baseline, decreases in break duration were significantly greater at week 4, week 6, and week 8 for the HAPA intervention group compared to those in the control group. Controlling for baseline break duration, the interaction effect was no longer significant, $F(1.48, 84.25) = .482$, $p = .562$, $\eta_\rho^2 = .01$.

The HAPA intervention group decreased break duration from 5.76 min at baseline to 3.79 min at week 2, 2.95 min at week 4, 2.71 min at week 6, and 3.26 min at week 8. The control group decreased break duration from 4.00 min at baseline to 3.81 min at week 2, 3.15 min at week 4, 3.76 min at week 6, and 3.65 min at week 8 (see Figure 12).

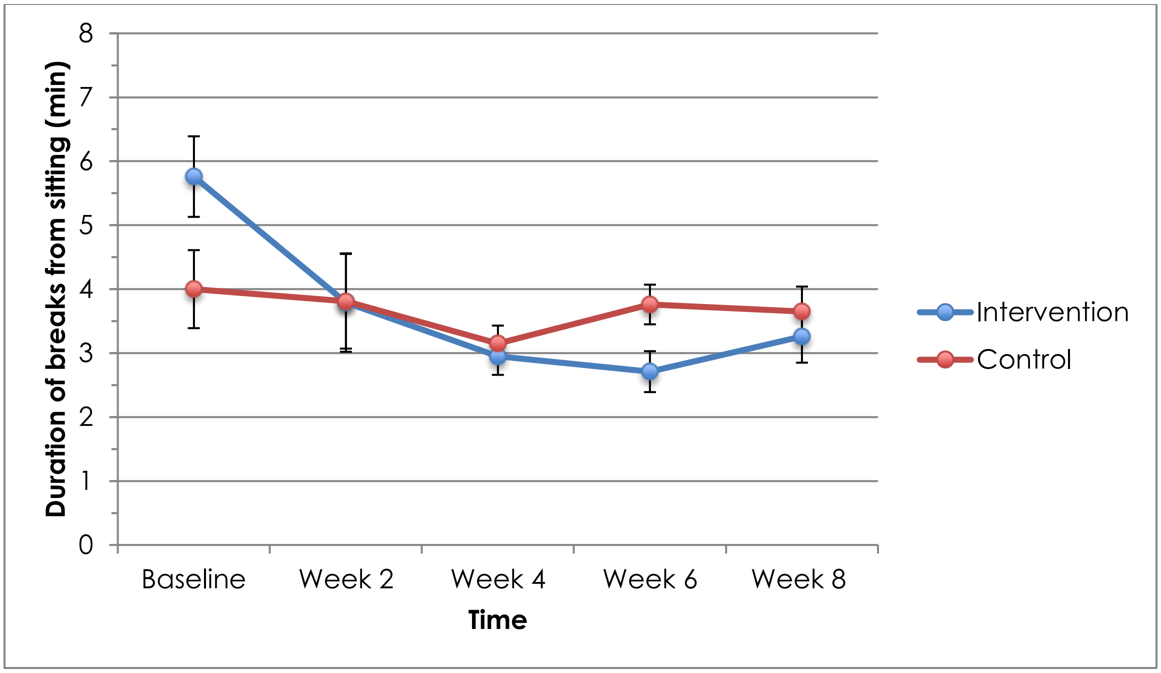

Figure 12. Mean and standard error scores between groups across time for duration of breaks from sitting at work.

Secondary Outcomes – Work and Health-related Outcomes

Descriptive data for work and health-related outcomes are presented in Table 11.

Table 11. Descriptive data ($M \pm SD$) for work and health-related outcomes at baseline and week 6.

	HAPA Intervention Mean (SD)		Control Mean (SD)	
	Baseline	Week 6	Baseline	Week 6
Work performance	7.55 (1.24)	8.72 (.92)	8.08 (.95)	8.87 (1.06)
Role limitations due to physical health problems	81.03 (28.07)	95.23 (9.50)	67.74 (40.41)	88.14 (17.09)
Role limitations due to emotional health problems	81.38 (29.12)	97.09 (7.41)	81.22 (28.65)	80.09 (27.26)
Emotional well-being	72.07 (14.73)	80.52 (9.55)	74.68 (16.22)	75.75 (15.09)
Energy/Fatigue	52.16 (16.13)	60.44 (14.23)	53.23 (15.77)	54.64 (18.75)

Significant interactions were found for perceived role limitations due to emotional health problems, $F(1, 58) = 4.90$, $p = .031$, $\eta_\rho^2 = .08$, and emotional well-being, $F(1, 58) = 6.47$, $p = .014$, $\eta_\rho^2 = .10$. The HAPA intervention group reported significantly greater improvements in these variables compared to the control group. There was a trend interaction effect for energy/fatigue, $F(1, 58) = 3.37$, $p = .072$, $\eta_\rho^2 = .06$. Significant time effects were found for role limitations due to physical health problems, $F(1, 58) = 15.02$, $p < .001$, $\eta_\rho^2 = .21$, energy/fatigue, $F(1, 58) = 6.69$, $p = .012$, $\eta_\rho^2 = .10$, and work performance, $F(1, 58) = 45.30$, $p < .001$, $\eta_\rho^2 = .44$.

Associations Between HAPA Volitional Constructs and Target Sedentary and Non-Sedentary Behaviours

Bivariate data for relationships between the HAPA volitional constructs (AP, CP, and AC) and the targeted sitting-related behavioural outcomes are presented in Tables 12-16. Significant correlations ($p < .05$) in the expected direction were found between AP, CP, AC, and sitting time, standing time, walking time, and break frequency at all time points.

Table 12. Correlations between HAPA volitional constructs and primary sitting-related behavioural outcomes at baseline.

	AP[a]	CP[b]	AC[c]	Sitting time	Standing time	Walking time	Stretching time	Break frequency	Break duration
Action Planning	-	.790**	.649**	-.107	.187	.248	.245	-.089	.248
Coping Planning	-	-	.670**	-.231	.017	.296*	.298*	-.072	.289*
Action Control	-	-	-	-.276*	.214	.203	.369**	-.081	.217

*$p < 0.05$
**$p < 0.01$
[a]AP: Action planning
[b]CP: Coping planning
[c]AC: Action control

Table 13. Correlations between HAPA volitional constructs and primary sitting-related behavioural outcomes at week 2.

	AP[a]	CP[b]	AC[c]	Sitting time	Standing time	Walking time	Stretching time	Break frequency	Break duration
Action Planning	-	.788**	.767**	-.353**	.289*	.217	.043	-.423**	.062
Coping Planning	-	-	.634**	-.378**	.396**	.367**	.134	-.348**	.216
Action Control	-	-	-	-.274*	.361**	.322*	.008	-.498**	.154

$^{*}p < 0.05$
$^{**}p < 0.01$
[a]AP: Action planning
[b]CP: Coping planning
[c]AC: Action control

Table 14. Correlations between HAPA volitional constructs and primary sitting-related behavioural outcomes at week 4.

	AP[a]	CP[b]	AC[c]	Sitting time	Standing time	Walking time	Stretching time	Break frequency	Break duration
Action Planning	-	.841**	.770**	-.386**	.389**	.389**	.139	-.409**	-.017
Coping Planning	-	-	.726**	-.373**	.375**	.426**	.236	-.445**	.084
Action Control	-	-	-	-.395**	.420**	.363**	.221	-.499**	.027

$^{*}p < 0.05$
$^{**}p < 0.01$
[a]AP: Action planning
[b]CP: Coping planning
[c]AC: Action control

Table 15. Correlations between HAPA volitional constructs and primary sitting-related behavioural outcomes at week 6.

	AP[a]	CP[b]	AC[c]	Sitting time	Standing time	Walking time	Stretching time	Break frequency	Break duration
Action Planning	-	.899**	.773**	-.186	.310*	.307*	.166	-.475**	-.188
Coping Planning	-	-	.796**	-.257*	.377**	.327*	.247	-.537**	-.221
Action Control	-	-	-	-.231	.344**	.342**	.163	-.621**	-.035

$^{*}p < 0.05$
$^{**}p < 0.01$
[a]AP: Action planning
[b]CP: Coping planning
[c]AC: Action control

Table 16. Correlations between HAPA volitional constructs and primary sitting-related behavioural outcomes at week 8.

	AP[a]	CP[b]	AC[c]	Sitting time	Standing time	Walking time	Stretching time	Break frequency	Break duration
Action Planning	-	.891**	.761**	-.324*	.253	.272*	.001	-.298*	.048
Coping Planning	-	-	.749**	-.381**	.310*	.313*	.214	-.268*	.108
Action Control	-	-	-	-.275*	.225	.299*	.028	-.348**	.101

$^{*}p < 0.05$
$^{**}p < 0.01$

[a]AP: Action planning
[b]CP: Coping planning
[c]AC: Action control

Associations Between Target Behaviours and Work and Health-related Outcomes

Bivariate data for relationships between the targeted sitting-related behavioural outcomes and subsequent work and health-related variables are presented in Table 17. Significant correlations ($p < .05$) in the expected direction were found between sitting time, standing time, walking time, break frequency and specific health-related outcomes at 6 weeks.

Table 17. Correlations between primary sitting-related behavioural outcomes and work and health-related variables at baseline and week 6.

	Sitting time	Standing time	Walking time	Stretching time	BF[a]	BD[b]	WP[c]	RL-PH[d]	RL-EH[e]	EW[f]	E/F[g]
Sitting time	-	-.579**	-.489**	-.479**	.311*	-.274*	-.138	-.412**	-.287*	-.328*	-.323*
Standing time	-.203	-	.483**	.281*	-.429**	.153	.192	.287*	.203	.270*	.366**
Walking time	-.392**	.470**	-	.488**	-.272*	.210	.195	.138	.136	.107	.331**
Stretching time	-.181	.241	.105	-	-.268*	.090	.103	.131	.030	.027	.050
BF[a]	.145	-.028	-.211	.224	-	.183	-.306*	-.210	-.376**	-.372**	-.356**
BD[b]	-.390**	.210	.258*	.189	-.018	-	.218	.054	-.042	.210	.244
WP[c]	.135	.066	-.192	.190	.083	-.194	-	.216	.281*	.204	.324*
RL-PH[d]	-.135	.089	.170	-.123	-.240	.054	.216	-	.703**	.383**	.391**
RL-EH[e]	-.131	-.127	.075	.097	-.072	.056	.359**	.444**	-	.507**	.423**
EW[f]	-.014	.070	-.046	.146	.019	.116	.459**	.421**	.541**	-	.641**
E/F[g]	-.305*	.160	.158	.174	-.131	.355**	.197	.391**	.529**	.610**	-

$^{*}p < 0.05$; $^{**}p < 0.01$

[a]BF: Frequency of breaks from sitting at work

[b]BD: Duration of breaks from sitting at work

[c]WP: Work performance

[d]RL-PH: Role limitations due to physical health problems

[e]RL-EH: Role limitations due to emotional health problems

[f]EW: Emotional well-being

[g]E/F: Energy/fatigue

Note: Values below the diagonal are from baseline, numbers above the diagonal are from week 6

Discussion

The results of the present study provide evidence that a HAPA-based action and coping planning intervention, supplemented with tailored text messages can promote reductions in workplace sitting time and greater time spent standing and stretching in office workers. Beyond this generalized conclusion, a number of theoretical and methodological issues should be discussed.

The group by time interaction effect for the primary outcome of workplace sitting time was statistically significant and the accompanying effect was medium in size. From baseline to follow-up, sitting time at work was reduced by an average of 87.54 min/day in the intervention group – a net difference of 70.64 min/day when compared to the control group. The reductions in sitting time achieved in this study were greater than those obtained in previous behavioural interventions targeting sedentary time among office workers (Evans et al., 2012; Kozey-Keadle et al., 2012; Mackenzie, Goyder, & Eves, 2015). These results are also comparable to those from previous multicomponent and environmental intervention studies that have been conducted and found reductions in sitting time at work ranging from 33 min/workday to 125 min/workday (Chau et al., 2014; Danquah et al., 2017; Graves et al., 2015; Healy et al., 2013; Neuhaus et al., 2014; Pronk, Katz, Lowry, & Payfer, 2012).

Significant interaction effects that were moderate in size were also found for the intervention on specific non-SBs that might explain reductions in workplace sitting time, including time spent standing and time spent stretching. From baseline to follow-up, standing time and stretching time among the intervention group were increased by an average of 32.56 min/day and 11.34 min/day, respectively. This translated into the intervention group increasing their standing and stretching time by 28.5 min/day and 8.18 min/day, respectively, compared to the control group. Compared to other studies that have evaluated the effects of multi-component (93 to 127 min/workday) and sit-to-stand workstation interventions (35 to 73 min/workday) to increase workplace standing time (Chau et al., 2014; Graves et al., 2015; Healy et al., 2013; Neuhaus et al., 2014), the magnitude of change in standing time at work achieved in this study was less. Nonetheless, these findings are encouraging and suggest that a brief planning intervention augmented with daily text messages may also produce substantial increases in standing time with accompanying increases in stretching time. No significant interaction effect was found for time spent walking, however, walking time was increased by an average of 14.33 min/day in the intervention group. The findings are in line with previous intervention trials targeting walking or stepping time in the occupational domain that have reported increases in walking time between 1.8 min/workday and 13 min/workday (Chau et al., 2014; Graves et al., 2015; Healy et al., 2013; Neuhaus et al., 2014).

As mentioned, the intervention objectives were for participants to achieve a break frequency of taking a break every 30-45 minutes with each break being 2-4 minutes in duration. Although no significant interaction effect emerged, frequency of breaks from sitting at work increased from breaks every 97.38 minutes at baseline to every 63.86 minutes at follow-up for the intervention group. With the exception of week 8 (follow-up), the break frequency remained relatively unchanged in the control group. At follow-up, those who received the intervention increased their break frequency by 34.4% (33.52 min) and took breaks almost 1.5 times more frequently than the control group. Similarly, a break duration between 2-4 minutes was achieved by those in the intervention group.

These findings are consistent with those of Sui and Prapavessis (2017) who found that a HAPA-based action and coping planning intervention increased occupational (student) break frequency from every 90.54 minutes to every 58.39 minutes over an 8-week period and Cotten and Prapavessis (2016) who found that a text message-based intervention increased overall break frequency from 81.95 minutes of sitting to every 58.90 minutes over a 6-week period.

To our knowledge, this study represents the first HAPA-based sedentary intervention for office workers. Taken together, our findings provide evidence that augmenting a brief planning intervention with daily text messages can reduce workplace sitting time by increasing time spent standing and stretching, as well as frequency of breaks from sitting at work. These findings may have important implications for health outcomes. A reduction in sitting time by 87 min/day, increases in time spent standing (+32.56 min/day), walking (+14.33 min/day), and stretching (+11.34 min/day), as well as more frequent interruptions may result in positive health effects and, if sustained over time, could be associated with reduced risk of cardiovascular disease, type 2 diabetes, and all-cause mortality (Stamatakis et al., 2015; Thorp et al., 2011; Wilmot et al., 2012). For example, a meta-analysis reported that every 1-hour increase in daily sitting time is associated with a 5% increase in all-cause mortality among adults sitting >7 h/day (Chau et al., 2013). Further, reallocating time spent sitting to standing and/or walking has been shown to be associated with improved cardiometabolic health (Healy et al., 2015). Additionally, even small changes in stretching or walking could be clinically meaningful. Evidence suggests that breaking up prolonged periods of sitting with short walking breaks (i.e., 2 min) can improve blood glucose and insulin levels in adults (Dunstan et al., 2012). Although the target break frequency (every 30-45 minutes) was not achieved, those in the intervention group still substantially increased how often they interrupted their sitting at work, which has been shown to be beneficially associated with a number of cardiometabolic biomarkers (Healy et al., 2008).

This study also examined the effects of the intervention on participants' AP, CP, and AC regarding reducing their workplace sitting time. Large and significant interaction effects for the HAPA volitional constructs were found, indicating that individuals who received the HAPA-based intervention demonstrated greater AP, CP, and AC than those who did not. These findings support the benefits of a theoretically integrated approach for promoting volitional elements of AP, CP, as well as AC towards reducing workplace sitting time among office working adults. Previous research has shown both planning components to be critical for bridging the intention-behaviour gap and important factors for successful behaviour change. In this study, the HAPA volitional constructs of AP, CP, and AC were significantly related to the targeted sitting-related outcomes of sitting, standing, walking, and break frequency. These findings are congruent with those of Maher and Conroy (2016) who found that plans to limit SB were a proximal predictor of SB, however, this intervention trial also achieved successful manipulation of these behaviour change constructs.

Several studies have also recommended the need for "mini-booster interventions" to support intention formation and planning processes to reduce SB (Conroy et al., 2013; Maher & Conroy, 2016; Sui & Prapavessis, 2017). This study supplemented the HAPA-based behavioural counselling session with text messages, which were intended as daily boosters and meant to reinforce target outcomes. By including sedentary-related facts, as well as tips, challenges, and reminders to reduce and break up SB at work, it is possible that the text messages promoted AC processes including self-monitoring, awareness of standards, and self-regulatory effort. Given that scores for the volitional HAPA constructs remained elevated over the 8-week period, it is also likely that text messages helped to sustain the action and coping plans that individuals formed over time. These findings are in line with previous HAPA-based intervention trials that have been successful in promoting AP and CP towards PA (Gaston & Prapavessis, 2014).

Although mechanisms remain to be further elucidated, this study demonstrated that reducing workplace sitting time may lead to improved emotional well-being and energy/fatigue, and contribute to fewer perceived role limitations due to emotional health problems. While numerous observational (and a few experimental) studies have demonstrated an association between SB and mental health outcomes among office workers (Gibson et al., 2017; Teychenne et al., 2010; Teychenne et al., 2015), this was one of the first studies to demonstrate that an intervention targeting reductions in workplace sitting time may produce concurrent mental health benefits. Importantly, time spent sitting, standing, walking, and break frequency were significantly related to specific health-related outcomes at 6-weeks.

The current study had numerous strengths, including a RCT and repeated measures design, the use of valid and reliable self-report measures for SB, non-SB, and theoretical outcomes, excellent participant compliance (93.3% completion rate), low attrition rate (n = 4), and inclusion of a post-intervention follow-up assessment. Another strength was using a well-established health behaviour change framework (i.e., HAPA) to guide the development and implementation of the intervention, which permitted the examination of intervention effects on theoretical behaviour change constructs (i.e., AP, CP, and AC). The assessment period for this RCT (i.e., 8 weeks) was also greater in duration than previous behavioural interventions (Evans et al., 2012; Kozey-Keadle et al., 2012) and comparable in duration to lengthier environmental and multi-component interventions (Carr et al., 2013; Danquah et al., 2017; Graves et al., 2015; Neuhaus et al., 2014) that have been conducted among office workers. The ease of implementation and pragmatic nature were both strengths of this intervention, as was its low cost (approx. $2.00 per intervention participant) and potential scalability to large and diverse populations. For instance, the intervention components could easily be adapted to specific groups such as those with high levels of sedentary time (e.g., older adults), at-risk populations (e.g., type 2 diabetes, overweight/obese), or individuals living in remote geographic locations (e.g., rural residents). While other sedentary interventions have explored effects on cardiometabolic outcomes (Alkhajah et al., 2012; Carr et al., 2013; Graves et al., 2015; Healy et al., 2013), musculoskeletal symptoms (Graves et al., 2015; Healy et al., 2013; Neuhaus et al., 2014), and work-related outcomes (Healy et al., 2013; Neuhaus et al., 2014), few have explored whether reductions in sitting time can have beneficial effects on novel health-related quality of life outcomes.

The main limitation of the study was the use of only a subjective self-report measure of sedentary (and non-sedentary) behavior, which have been shown to be susceptible to participant response bias and possible underestimation of sedentary time/overestimation of non-SBs. An objective measure (i.e., accelerometers / inclinometers) would have allowed for more accurate estimates of sitting time and accompanying non-SBs in the occupational domain. For instance, the use of an objective measurement tool would have enabled researchers to determine the exact amount of workplace sitting time that was displaced with bouts of standing, walking, or stretching, as well as specific sedentary patterns (e.g., number of sit-to-stand transitions, time spent in prolonged sitting bouts). It would have also allowed the researchers to examine if the participants were actually behaving in accordance with their action plans and/or adhering to the daily text-message based prompts and reminders that were sent. Nevertheless, both the OSPAQ and SIT-Q 7d questionnaires have been shown to be valid and reliable measures of domain-specific SB (and non-SBs) (Chau et al., 2012; Chau et al., 2014; Sui & Prapavessis, 2017; Wijndaele et al., 2014). Further, baseline sitting, standing, and walking time were comparable to previous trials using both self-report measures (Chau et al., 2014; Graves et al., 2015) and accelerometers (Healy et al., 2013; Neuhaus et al., 2014). Another limitation is that the current sample was predominantly made up of middle-aged, Caucasian women working in the public sector; hence, findings may not be generalizable to other office-working populations. The demographics of this sample are, however, similar to those of samples from other sedentary intervention trials among office workers.

Several implications for future research stem from the findings herein. First, the findings of this study need to be substantiated using objective measurement of SB. Comparing and contrasting results of the self-report measures used in this study with objective assessment from an accelerometer with a built in inclinometer (e.g., ActivPAL3) would allow for a more accurate insight into intervention effects on SB (and non-SB) outcomes. It is also important that future work conduct formal mediation analyses to elucidate whether changes in sedentary-related HAPA volitional constructs mediated the effects of the intervention on behaviour. Future trials should evaluate the effects of each intervention component; for example, a study design in which one condition receives both planning and daily text messages whereas another condition receives only the planning component. Similarly, the contribution of AP versus CP components needs to be explored.

This study utilized a message framing strategy guided by HAPA (Schwarzer, 2008). While the text-messages were individualized in terms of times sent, they were standardized (generic) in that all intervention participants received the same texts in the same order, which were intended to promote the key intervention objectives. To enhance the effectiveness of persuasive messaging in the health field, research has demonstrated the importance of framing messages in a way that emphasizes self-determined motives and intrinsic goals and tailoring messages to recipient's pre-existing psychological, demographic, or behavioural characteristics (Latimer, Brawley, & Bassett, 2010; Pope, Pelletier, & Guertin, 2017). Future studies could explore alternative ways of *framing* the text messages (e.g., reinforcing individuals' specific action and coping strategies) as well as whether there is added benefit to utilizing message *tailoring* strategies (e.g., tailoring the text messages to individuals' pre-existing sedentary patterns, lifestyle, or work habits and preferences). Although this study focused on SB and non-SBs in the occupational domain, exploring the effects of this intervention on leisure and/or total daily sitting, standing, walking, and stretching time would be advantageous and provide greater insight into the potential impact of the intervention. Future trials should also include a longer follow-up period (i.e., 6 months, 12 months) to examine whether or not the reductions in workplace sitting time are maintained in the long-term. Finally, it is possible that combining this theory-driven behavioural intervention with sit-to-stand desks in the workplace would produce greater reductions in sitting time.

Conclusion

This is the first study to demonstrate that a HAPA-based intervention, specifically action and coping planning, augmented with a tailored text messages can reduce workplace sitting time and increase time spent standing and stretching among office-working adults. The intervention was successful in enhancing AP, CP, and AC towards reducing workplace sitting time, which are associated with both sedentary and non-sedentary behaviours (e.g., time spent standing). A larger RCT that includes an objective assessment of sedentary and non-sedentary behaviours, and a longer follow-up period is warranted.

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Chapter 5 – Dissertation Conclusions and Implications

Dissertation Conclusions and Implications

The purpose of this research programme was to (a) contribute to our understanding of relationships that exist between cognitive and motivational factors and SB, and (b) develop effective theory-based motivational and behavioural interventions targeting SB among office working adults. While interventions aimed at displacing and disrupting SB are urgently needed, research to identify effective behavior change strategies cannot advance without a more complete understanding of the psychological factors underpinning behavior change. For the first of my dissertation studies (Chapter 2), a systematic review was conducted to evaluate the literature on the association between cognitive and motivational factors and SB. Although other reviews have been conducted to examine socio-demographic and behavioral correlates of SB, to our knowledge, this was the first to focus exclusively on psychological determinants from a cognitive and motivational perspective. In contrast to biological (e.g., genetic) or demographic determinants such as age, ethnicity, or socioeconomic status, cognition and motivation variables represent potentially modifiable factors. The findings of this review identified important cognitive and motivational correlates that should be targeted in theory-based interventions designed to reduce SB.

Health behavior change scientists from numerous fields, including physical activity, have underscored the superiority of using theory to guide the development and evaluation of interventions. As the systematic review of the literature in Chapter 2 demonstrated, theoretical behavior change models have been useful in identifying cognitive and motivational factors that are associated with SB, however, the manipulation of these variables for purposes of behavior change interventions to reduce SB has yet to be extensively examined.

Using the motivational phase of the HAPA model and a RCT design, study 2 (Chapter 3) examined whether SB and diabetes information is a meaningful source of motivation to increase intentions for reducing daily sedentary time among preintender adult office workers (n = 96). Findings demonstrated that a brief, online-delivered motivational intervention grounded in HAPA has the potential to manipulate office workers' goal intentions to increase both number and length of daily breaks from sitting at work, and goal intentions to reduce daily sitting time and to increase daily standing time outside of work, as well as outcome expectations regarding reducing daily sitting time and improved health. Findings also indicated that self-efficacy is the greatest predictor of intentions to reduce sitting time across both work and leisure domains. Hence, it is important that future interventions find ways to manipulate self-efficacy to a greater extent (i.e., enhance office workers' confidence to change their SB patterns) in order to generate greater effects on motivation.

A vast majority of interventions targeting SB in the occupational domain have utilized environmental manipulations (e.g., sit-to-stand desks) or have been multi-component in nature – where as, theory-based behavioural interventions targeting modifiable cognitive factors (i.e., what the person can do) are limited. Using a RCT design, the purpose of study 3 (Chapter 4) was to examine the effectiveness of a HAPA-based intervention, specifically action and coping planning, augmented with tailored text messages to reduce workplace sedentary time and increase time spent in specific non-SBs at work. As expected, results demonstrated that the intervention was successful in promoting action planning, coping planning, and action control towards reducing workplace sitting time among office workers. Importantly, these volitional constructs were associated with sitting, standing, and walking time, as well as frequency of breaks from sitting at work. Relative to the controls, participants who received the HAPA-based intervention reported significantly greater reductions in time spent sitting (87.54 min/workday) and accompanying increases in time spent standing (32.56 min/workday) and stretching (11.34 min/workday) at work over an 8-week period.

Recent evidence has suggested a relationship between greater SB and adverse mental health outcomes, including increased risk of anxiety and depression, and lower health-related quality of life. While other sedentary interventions have explored effects on cardiometabolic outcomes, musculoskeletal symptoms, and work-related outcomes, few have explored whether an intervention targeting reductions in sitting time can have beneficial effects on novel health-related quality of life outcomes. A secondary objective of study 3 (Chapter 4) was to explore effects of the 6-week intervention on office workers' self-rated work performance and perceived health-related quality of life. Results indicated that compared to their control counterparts, participants who received the HAPA-based intervention reported significant improvements in emotional well-being and fewer role limitations due to emotional health problems, as well as non-significant improvements in energy/fatigue.

To the best of our knowledge, this was the first research programme to provide evidence surrounding the utility of HAPA as a theoretical framework to guide interventions targeting reductions in SB. Effective SB interventions may prove to be novel options for the prevention of non-communicable diseases and in the development of new health promotion policies and strategies for preserving and enhancing population health.

In closing, the research contained within this dissertation has made several unique contributions to the knowledge base surrounding the use of HAPA to understand and change SB in office workers. First, the comprehensive systematic review of Chapter 2 revealed numerous cognitive and motivational correlates of SB that are similar to variables included in the HAPA model. Second, study 2 showed that HAPA is a useful model for manipulating sedentary-related cognitions and enhancing motivation to reduce domain-specific sedentary time among office workers. Third, study 3 demonstrated the effectiveness of a HAPA-based intervention targeting post-intentional volitional constructs for reducing sedentary time and increasing specific non-SBs in the occupational domain. Together, these randomized controlled trials were among the first to test the usefulness of the HAPA model in its entirety (both motivational and volitional phases) to promote health behaviour change with regards to SB. Fourth, study 3 also demonstrated that reductions in workplace sitting time achieved through a HAPA-based intervention has the potential to significantly improve specific health-related quality of life indicators (e.g., emotional well-being) over a 6-week period among full-time desk-based employees working in office settings. There are several avenues for future work that stem from the study findings presented in this dissertation. Future studies should be conducted to examine whether the HAPA model can be applied to predict and modify SB in other at-risk populations who demonstrate high sedentary time – both non-diseased (e.g., older adults, adolescents) and diseased (e.g., adults with type 2 diabetes, cardiac rehabilitation patients, overweight/obese individuals).

Finally, anecdotal evidence in the form of positive feedback highlighted how helpful the office workers participating in study 3 found the intervention for reducing their workplace sitting time. The following are just a few of the written comments that were received from participants:

"Thanks for this study. I have found I now feel uncomfortable (low to the ground) when I sit for any substantial length of time. I now use my standing desk more than I sit." (Participant #22)

"I just wanted to say that I'm glad that I participated! I have set my Fitbit to remind me hourly to get up and move and although I am not always successful, it keeps me aware!" (Participant #12)

"I'm ***really*** *enjoying this study! … and greatly appreciate getting your text messages in the afternoon!" (Participant #50)*

"We have a staff development day in June, and I'm wondering if you would mind if I shared the information from this study, particularly the first slide [show] presentation that was shared with me. I know it would make a world of difference to staff members here at [institution]. […] Thank you as well for permission to share this wonderful information!!" (Participant #28)

"I have been doing this [in reference to text messages]. Thanks for reminders … I'm now always thinking about getting up …" (Participant #38)

"I am using the shredder upstairs when I need it now instead of stock piling it for 1 trip at the end of the day!" (Participant #5)

"The texts are awesome, btw! I am already definitely more mindful!" (Participant #5)

Appendix A: Reproduction License (Study 1)

pangshengjiao
Candidacy Exa.../Dissertation Defence July 1, 2019 at 3:08 AM
P
Reply: Inquiry regarding permission to reuse a published article in AIMS Public Health
To: Andrew Rollo

Dear Rollo,

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Appendix B: Studies Examining Cognitive and Motivational Determinants of Sedentary Behavior (Study 1)

Study	Sample	Design	Determinants examined	Sedentary behavior measure	Data collection timeline	Results: Correlates/predictors of sedentary behavior
Atkin, Corder, Goodyer, et al., 2015	Convenience sample - N = 738 - Large sample of early adolescents, aged 14 years; schools located in the counties of Cambridgeshire and Suffolk - United Kingdom (UK)	Cross-sectional	Non-theory driven Variables: - Adolescents perceived family functioning - Friendship quality	Direct: - Physical activity and sedentary time were assessed objectively using combined heart rate and movement sensing (Actiheart, CamNtech Ltd, Papworth, UK) - Participants asked to wear for remainder of the testing day and then for four consecutive days,	Single assessment	*Association of family functioning and friendship quality with sedentary time:* - Higher scores on the good friendship qualities subscale was associated with lower sedentary time on weekdays (−10.34; −17.03, -3.66). *Association of family functioning and friendship quality with self-reported sedentary behaviors:* - Boys from better functioning families were less likely to report playing video games at the weekend (OR; 95% confidence interval: 0.73; 0.57,0.93) or reading for pleasure (weekday: 0.73; 0.56,0.96 weekend: 0.75; 0.58,0.96). - Boys who attained higher scores on the good friendship qualities scale were less likely to play video games at the weekend (0.61; 0.44,0.86) or report high homework on weekdays (0.54; 0.31,0.94). - A higher score for good friendship qualities was associated with lower odds of

				including two weekend days Self-report: - Separately for week and weekend days, time spent per day in each of the following sedentary behaviors: watching TV (inc. video/ DVD), using the internet, playing video games, doing homework, and reading for pleasure.		girls playing video games during the week (0.76; 0.58,1.00) or reading for pleasure at the weekend (0.61; 0.42,0.88). Girls that reported fewer friendship difficulties had lower odds of high TV viewing (0.76; 0.62,0.93) or playing video games (0.71; 0.52,0.97) at the weekend, and lower odds of reading for pleasure (0.63; 0.49,0.81) or reporting high homework on weekdays (0.70; 0.52,0.95).
Bai, Chen, Vazou, et al., 2015	- N = 1,552 - Students in 3rd through 12th grade from 18 schools	Cross-sectional	Psychological, theory-driven: youth physical activity promotion (YPAP) model	Self-report: - The Youth Activity Profile (YAP): Based conceptually	Single Assessment	*Variables correlated with sedentary behavior:* - Psychosocial variables (i.e., attraction to PA and perceived competence) had low negative correlations with SB (r = –.19 to

	involved in PE4Life training programs (4 schools in Arkansas and 14 schools in Iowa) - 540, 318, and 694 youth from 8 elementary, 3 middle, and 7 high schools, respectively - Arkansas, USA; Iowa, USA		Variables: - Children’s attraction to PA - Perceived physical competence	on the widely used Physical Activity Questionnaire - Online survey tool designed to assess youth participation in PA (at school and at home) as well as their SB - The first five items assess the PA level at school (PAS) in various school time periods. The next five items measure PA level at home (PAH) in various time periods. The last five items		–.34, $p < .05$) - Elementary school: Attraction to PA (r = –.29); Perceived competence (r = –.19) - Middle school: Attraction to PA (r = –.34); Perceived competence (r = –.33) - High school: Attraction to PA (r = –.33); Perceived competence (r = –.23) *Variables predicting SB:* - Perceived Competence significantly predicted SB (β = –.28; 95% CI: –0.22, –0.14). Attraction to PA statistically significantly predicted SB in all age groups (β = –.49; 95% CI: –0.22, –0.14). Thus, the students who felt more competent in PA and attracted to PA were more likely to be active and less sedentary. The effect of Perceived competence on SB was reduced but remained statistically significant after controlling for the effects of attraction to PA. Bootstrapping mediation analysis confirmed that perceived competence had a statistically significant indirect effect on SB (IE = .13, $p < .05$).

				measure SB including time spent watching TV, playing video games, on the computer, on the phone/texting, and overall SB.		
Busschaert, De Bourdeaudhuij, Van Cauwenberg, et al., 2016	Random sample - N = 188 - Adult inhabitants of the city of Sint-Niklaas, aged 25-60 years - Sint-Niklaas, Belgium	Longitudinal prospective design	Non-theory driven: Intrapersonal, social-cognitive and physical environmental variables Variables: Intrapersonal: - BMI, occupational status, residential area, depressive symptoms, children living at home, family situation, occupational classification,	Self-report: Context-specific sitting time (i.e. TV-viewing, computer use, motorized transport and occupational sitting) - 11 items targeting sitting behavior in the past 7 days	One-year (April 2013-April 2014) Baseline: All variables One-year follow-up: All variables	*Social-cognitive correlates of TV-viewing, computer use, motorized transport and occupational sitting at baseline:* - A one-unit higher score for 'I enjoy watching TV for many hours' (attitude 3) and 'I find TV a way to relax' (attitude 4) was associated with respectively 19 and 12 % more sitting while watching TV. Also, a one-unit higher score for 'time partner spend watching TV' (modelling 1) was associated with 5 % more sitting while watching TV. - A one-unit higher score for 'I think using a computer is pleasant' (attitude 1), 'I enjoy using a computer for many hours' (attitude 3) and 'I think that I spend too much time on the computer' (norm) was associated

			educational level and sex Social-cognitive: - attitude, self-efficacy, norm, social norm, social support and modelling Physical environmental: - TV set, other TV viewing equipment - computer equipment, other equipment for computer use - number of operational motorized vehicles - occupational desks at work or not			with respectively 34, 17 and 24 % more sitting while using a computer. A one-unit higher score for 'I consider it possible that I do not use a computer for some days in the week' (self-efficacy 1) was associated with 13 % less sitting while using a computer. - A one-unit higher score for 'I think that I spend too much time using motorized transport' (norm) was associated with 14 % more sitting during motorized transport. A one-unit higher score for 'I consider it possible to take the bicycle or to go by foot spontaneously even if it is possible to use a car' (self-efficacy 3) was associated with 19 % less sitting during motorized transport. *Relationship between changes in social-cognitive predictors from baseline to follow-up and changes in TV-viewing, computer use, motorized transport and occupational sitting:* - An increase from baseline to follow-up with one unit on the five-point Likert scale for 'I enjoy watching TV for many hours at a time' (attitude 3) was associated with 7.96 min/day more sitting while watching TV at follow-up. An increase from

						baseline to follow-up with one unit on the eight-point Likert scale for 'time partner spend watching TV' (modelling 1) was associated with 9.91 min/day more sitting while watching TV at follow-up. - An increase from baseline to follow-up with one unit on the five-point Likert scale for 'I consider it possible to park the car somewhat further spontaneously and to walk the remaining distance' (self-efficacy 2) was associated with 8.48 min/day more sitting during motorized transport at follow-up. More active transport to go to work/school (modelling 1) from baseline to follow-up of the partner was associated with 16.47 min/day more sitting during motorized transport at follow-up of the respondent.
Chang & Sok (2015)	Convenience sample - N = 306 - Elderly persons with hypertension (HTN) who were registered at	Cross-sectional	Theory-driven: Empowerment theory Psychosocial variables: - Self-efficacy for PA - Social support for	Self-report: - International Physical Activity Questionnaire -Short Form (IPAQ-SF) - Single question	Single assessment	*Characteristics related to sedentary behavior:* - A higher number of minutes of sedentary behavior were associated with lower levels of empowerment ($r = -.498$, $p < .001$) and self-efficacy for PA ($r = -.297$, $p < .001$) *Predictors of sedentary behavior:* - Empowerment was found to be the

	three public health centers of three boroughs in Seoul, Korea - Seoul, Korea		PA - Empowerment - Depressive symptoms Other variables: - Demographic characteristics - Disease related characteristics (e.g., perceived health) - Behavioral characteristics (e.g., alcohol consumption, PA)	about sitting from the IPAQ-SF - Time in sedentary behavior was assessed in minutes over the previous 1 week, including time spent sitting at work, at home, in class, and during leisure activities as well as sitting or lying time spent at a desk, meeting friends, reading books, moving in a car, and watching TV.		strongest predictor of a high level of sedentary behavior ($\beta = -.394$, $p < .001$).

Conroy, Maher, Elavsky, et al., 2013	Convenience sample - N = 128 (53 men and 75 women with a mean age of 21.3 years (*SD* = 1.1)) - College students, recruited from advanced undergraduate courses - PA, USA	Prospective study	Psychological, theory-driven: Dual-process theory of motivation Variables: - Intentions to limit sedentary behavior - Sedentary behavior habits	Direct: - ActiGraph GT3X accelerometer (ActiGraph, Pensacola, FL) Self-report: - International Physical Activity Questionnaire (IPAQ) - Four-item measure included questions about the duration of time spent engaged in vigorous physical activity, moderate physical activity,	14-day ecological momentary assessment study; daily sampling schedule	*Variables correlated with sedentary behavior:* - Habit strength for sedentary behavior was positively associated with sedentary behavior (*r*s = .20, .36) and unassociated with physical activity (*r*s = -.03, -.06). People with stronger sedentary habits reported, on average, weaker intentions to limit their sedentary behavior (r = -.25). Intentions to limit sedentary behavior were associated with less sedentary behavior (*r*s ranged from –.23 to –.56) and more physical activity (*r*s ranged from .18 to .30). Sedentary behavior and physical activity exhibited moderate to strong negative correlations (*r*s ranged from –.22 to –.59). - Self-reported SB: Daily deviations in intentions were significantly associated with decreased self-reported sitting time (γ_{100} = –0.09, p < .001; i.e., people who reported stronger intentions to limit their sitting time subsequently reported sitting less) - Both the overall strength of intentions to limit sitting time (γ_{02} = –0.22, p < .001) and sedentary habit strength (γ_{03} = 2.13, p

				walking, and sitting that day - Sedentary behavior scores were expressed as the number of minutes that a participant spent sitting each day		< .001) were significantly associated with self-reported sitting time (in opposite directions as expected) - Directly-monitored SB: Daily deviations in intentions to limit sedentary behavior were associated with decreased sedentary behavior (γ_{100} = –1.40, *p* = .003) - Habit strength was associated with greater sedentary behavior (γ_{03} = 23.97, *p* = .04 - Sedentary behavior also varied within people as a function of concurrent physical activity, the day of week, and the day in the sequence of the monitoring period.
De Cocker, Duncan, Short, et al., 2014	Random sample - N = 993 - Employed Australian adults - Australia	Cross-sectional	Non-theory driven: Socio-demographic, health-related, work-related, and psychosocial factors Variables: - Socio-demographic (country of birth, gender, age,	Self-report: Occupational sitting time: - Workforce Sitting Questionnaire (WSQ) - Assesses time spent sitting on a	Single assessment	*Differences in occupational sitting-time between psychosocial categories:* - Participants with higher social norms and less control to reduce sitting, those finding it valuable, pleasant, healthy, relaxing (all p < 0.001) to sit less, those disagreeing that sitting less is not beneficial at all (p = 0.001), those disagreeing that sitting less is aggravating health problems (p = 0.041), and those intending to sit less (p < 0.001) reported higher occupational sitting-time compared to the respective comparison

			education, income) - Health-related (general health, weight, BMI, physical activity) - Work-related (employment status, occupational task, occupational classification) - Sedentary-specific psychosocial (Social norm towards sitting less at work; Social support to sit less at work; Self-efficacy: sit less the next month at work; Self-efficacy: certainty to sit less at work; Control to sit less; Advantages of sitting less at work; Disadvantages of sitting less at work; Intention to sit less	workday and a non-workday for the last seven days while (1) travelling to and from places; (2) at work; (3) watching TV; (4) using a computer at home; and (5) doing other leisure activities. - Time spent sitting at work was computed as follows: [(average daily sitting-time at work on workdays × number of workdays) + (average daily sitting-time at work on non-		categories *Associations of psychosocial correlates with occupational sitting-time:* - Univariate regressions: Social norm towards sitting less at work (β = 45.8), self-efficacy: certainty to sit less at work (β = 0.4), control to sit less (β = 14.6), advantages of sitting less at work (β = 46.5), disadvantages of sitting less at work (β = –34.6), intention to sit less at work (β = 71.8) - The full multiple regression model showed that, of the eight psychosocial factors, only higher awareness of advantages of sitting less at work was associated with more occupational sitting time (β = 0.673; 95% CI: 0.06–1.28; p = 0.030). - Employment status and occupational classification moderated the association between control to sit less and occupational sitting. A lack of control to sit less was associated with higher occupational sitting in part-time and full-time workers, but not in casual workers; and in white-collar and professional

			at work)	workdays × number of non-workdays) / 7] to get the average daily occupational sitting-time.		workers, but not in blue- collar workers.
Gaston, De Jesus, Markland, et al., 2016	Convenience sample - N = 571 individuals (416 females and 155 males; M_{age} = 23.93 years, SD = 6.18, Range = 18-54 years) - University students or staff - Ontario, Canada	Cross-sectional - An internal computer-generated randomization scheme (via Survey Monkey) directed participants to one of five groups: general, weekday work/school, weekday leisure/recreation, weekend work/school, and weekend leisure/recreati	Theoretical Model: organismic integration theory (OIT), a sub-theory of self-determination theory (SDT) Variables: - Motivation type(s): - External - Introjected - Identified - Intrinsic	Self-report: Sedentary Behavior Questionnaire (SBQ) - 12-item modified version - Completed twice: once referring to an average weekday and once referring to an average weekend. - The SBQ included both work/school	Single assessment	*Pearson correlations for sedentary behavior and regulation type:* - Weekend work/school: external regulation (r = .18, p < .05), intrinsic motivation (r = –.27, p < .001) - Weekday work/school: introjected regulation (r = .22, p < .05) - Weekday leisure/recreation: intrinsic motivation (r = .19, p < .05) - Weekend leisure/recreation: intrinsic motivation (r = .31, p < .001) - There were no significant relations between identified regulation and behavior. *Variables predicting sedentary behavior:* - Weekend work/school: external

		on. - Depending on group assignment, the sedentary-derived motivation items were preceded by a different introduction.		and leisure/recreation activities. - Five separate sedentary behavior time scores were computed, an overall score (i.e., average time spent per day in sedentary activity) as well as time spent in leisure/recreational and work/school activities on weekdays and weekends, separately.		regulation, intrinsic motivation - Weekday work/school: introjected regulation - Weekday leisure/recreation: intrinsic motivation - Weekend leisure/recreation: intrinsic motivation - The percent of variance explained ranged from 3% (weekday leisure/recreation) to 10% (weekend work/school).
Gebremariam, Totland, Andersen, et al., 2012	- N = 885 - Group of Norwegian children in	Longitudinal prospective study	Non-theory driven Variables: - Perceived parental	Self-report: - TV/DVD use, computer/elec	Baseline: September 2007 1st follow-up:	*Factors associated with an increase in TST between BL and T2:* - Among males, self-efficacy related to barriers to PA (B = -2.16 (-3.60, -0.73))

	the transition between childhood and adolescence. - Students from 25 control schools of an intervention study, the HEalth In Adolescents (HEIA) study. - Average age at baseline = 11.2, standard deviation ± 0.3) - Norway		regulation - Self-efficacy related to barriers for PA - BMI - Pubertal development category - Ethnicity - Living status of children (i.e., those living with married or cohabitating parents; those living with their father or mother alone, equally with their mother or father, grandparents or another adult) - Parental education	tronic game use and total screen time (TST; hours/week) - Four questions with pre-coded answer categories assessing screen-based sedentary behaviors on weekdays and weekends - The answer categories for TV/DVD use were: half hour [0.5], one hour [1], two hours [2], three hours [3], four hours [4], five hours or more [5].	May 2008 2nd follow-up: May 2009	was inversely related to an increase in TST, indicating a decrease of around 2.2 hours per week per unit increase in self-efficacy score. *Predictors of tracking of high TST:* - Results of the multinomial regression analysis show that, among girls, children with low self-efficacy related to barriers to PA were more likely to track high TST (OR = 2.30, C.I. = 1.13-4.69, $p < .05$) compared to children with high self-efficacy. - Among males, boys with low self-efficacy related to barriers to PA were also more likely to track high TST (OR = 6.83, CI = 3.22-14.45, $p < .001$) than the group with high self-efficacy.

				- The answer categories for computer/electronic game use were: no playing [0], half hour or less [0.5], one hour [1], two hours [2], three hours [3], four hours or more [4]. - TST computed		
Ham, Sung, & Kim, 2013	Convenience sample - N = 370 - School-age children - South Korea	Cross-sectional	Non-theory driven: sociodemographic, psychosocial, and behavioral characteristics Variables: - General and family characteristics - Sleep duration	Self-report: - Screen time - A single question was used for the determination of screen time, ''how many hours per day have you spent	Single assessment	*Differences in Psychosocial Characteristics According to Screen Time:* - Increased screen time showed a significant association with pros and cons of exercise and exercise self-efficacy ($p < .05$). Those with screen time of 3 or more hr/day had lower pros of exercise ($F = 3.537$, $p = .030$), higher cons of exercise ($F = 6.829$, $p = .001$), and lower exercise self-efficacy ($F = 3.354$, $p = .036$), compared to their counterparts.

			- Stress - Pros and cons of exercise - Exercise self-efficacy - Eating behaviors	viewing TV/video, using computers, and playing video games during the past month?’’ - Scored on a nominal scale (1 = less than 1 hr, 2 = 1–2.9 hr, 3 = 3 or more hr).		*Multinomial Logistic Regression Analysis of Factors Associated With Screen Time:* - Pros and cons of exercise, and self-efficacy did not show a significant association with screen time among subjects with screen time between 1 and 2.9 hr/day. - Among subjects with screen time of 3 or more hr/day, cons of exercise (OR = 2.844, 95% CI = [1.285, 6.298]) showed a significant association with screen time. Other variables including pros of exercise and self-efficacy did not show a significant association with a screen time among subjects with screen time of 3 or more hr/day.
He, Piché, Beynon, et al., 2010	Random sample - N = 508 student-parent pairs - Elementary school students and their parents (i.e., grades 5	Cross-sectional - Children were categorized into 2 groups: ‘‘low-screen users,’’ who met the CPS guidelines, and ‘‘high-screen users,’’ who	Psychological, theory-driven: Social-ecological model; Attitude-Social Influence-Self-efficacy Model (ASE) Variables: - Attitude (i.e., how they felt about	Self-report: Children’s screen-related behaviors - Brief self-administered questionnaire, The Child Sedentary Activity Questionnaire	Single assessment	*Differences in variables btw low- and high-screen users:* - A significantly smaller proportion of high-screen users held negative attitudes about screen use (P < .01) - Intentions: More than two thirds of children indicated that they would elect to spend more time engaged in physical activities if they were ‘‘given the choice’’; however, fewer high-screen users than

	and 6 students) - London, Ontario, Canada	exceeded Canadian Pediatrics Society (CPS) guidelines.	excessive screen use and what motivates them to use screens) - Social influence (i.e., perceptions of parental expectations and controls over screen use) - Intention	(CSAQ), - Designed to measure children's re-call of hours spent each day of the previous week watching television or videos and playing computer and video games outside of school hours. - Children's school screen time was estimated by asking grade 5 and 6 classroom teachers about the number of hours their students spent		low-screen users ($P < .01$) chose to do so. - Significantly fewer high-screen users had perceived parental limits on TV ($P < .05$), video games ($P < .01$), or the computer for nonhomework use ($P < .01$) on weekends.

				watching television and videos or using computers in the classroom each day. - Total screen time was the combined amount of screen-related activities during in-school and out-of-school hours.		
Hoyos Cillero, Jago, & Sebire, 2011	- n = 247 primary school-aged and n = 256 secondary school-aged children - Spanish school children	Cross-sectional	Psychological, theory-driven: Social cognitive theory Variables: - Individual factors (self-efficacy to reduce screen-viewing time, behavioral	Self-report: Screen-viewing - Self-administered questionnaire comprising six items assessing hours of TV viewing,	Single assessment	*Relationship between screen-viewing behaviours and variables:* - Stronger sedentary group norms (OR 1.26 [1.04–1.53], *p* = 0.017) and higher behavioural capability (OR 1.25 [1.01–1.54], *p* = 0.036) were associated with watching TV ≥2 h/day on weekdays and weekends respectively for primary school-aged females. - For younger males, having lower paternal

	- Spain		capability) - Social factors (sedentary group norms, social reasons for sedentary behaviors, perceived maternal rules for screen-viewing)	computer playing and console playing for an average weekday and weekend day. - Daily TV, computer and console games-playing times were summed to create an overall screen-viewing variable. - In addition, children were classified as not meeting TV and overall screen-viewing guidelines in accordance with AAP		rules (for weekdays OR 0.83 [0.75–0.90], $p < 0.001$; and for weekends OR 0.68 [0.50–0.93], $p = 0.016$) was a significant predictor for exceeding TV viewing guidelines. - For older females, having stronger sedentary group norms (OR 1.36 [1.17–1.58], $p < 0.001$) was associated with increased likelihood of exceeding TV viewing guidelines on weekdays and weekends respectively. - The significant predictors for younger females playing console games ≥2 h/day on weekdays were higher maternal rules (OR 1.88 [1.30–2.70], $p = 0.001$) and lower paternal rules (OR 0.49 [0.30–0.79], $p = 0.004$) on weekdays. On weekends, lower self-efficacy (OR 0.61 [0.37– 0.99], $p = 0.047$) was also a strong determinant for this subgroup. - For younger males, having stronger sedentary group norms (OR 1.28 [1.05–1.57], $p = 0.013$), stronger social reasons for engaging in screen-viewing (OR 1.24 [1.00–1.53], $p = 0.048$) and lower maternal rules (OR 0.57 [0.33–0.97], $p = 0.039$) were significant determinants for console games-playing ≥2 h/day on weekdays. On

				guidelines (≥2 h/day).		weekends, higher behavioural capability (OR 1.37 [1.09–1.72], *p* = 0.006) and lower maternal rules (OR 0.78 [0.64–0.94], *p* = 0.012) were also significant predictors for this subgroup. - Older females having lower paternal rules (OR 0.57 [0.45–0.70], *p* < 0.001) were more likely to engage ≥2 h/day in console games-playing on weekdays and on weekends respectively. - For older males, having stronger sedentary group-norms (OR 1.22 [1.00–1.50], *p* = 0.047) was associated with playing console games ≥2 h/day on weekends. - For younger females, stronger sedentary group norms (OR 1.19 [1.02–1.40], *p* = 0.027) and lower paternal rules (OR 0.70 [0.50–0.98], *p* = 0.043) were significant predictors for exceeding screen-viewing guidelines on weekdays. On weekends, higher behavioural capability (OR 1.30 [1.09–1.56], *p*= 0.003) was also a strong predictor for this subgroup. - Lower paternal rules (for weekdays OR 0.90 [0.82–0.99], *p* = 0.046 and for weekends OR 0.64 [0.45–0.90], *p* = 0.011)

						was a significant predictor for younger males exceeding screen-viewing guidelines. On weekends, higher behavioural capability (OR 1.37 [1.13–1.65], *p*= 0.001) was also a strong predictor for this subgroup. - Older females with strong sedentary group norms (OR 1.34 [1.01–1.77], *p* = 0.039) were more likely to spend ≥2 h/day engaged in overall screen-viewing time on weekdays. Lower self-efficacy (OR 0.10 [0.02–0.47], *p* = 0.003), higher maternal rules (OR 4.16 [1.50–11.5], *p* = 0.006) but lower paternal rules (OR 0.17 [0.07–0.44], *p* < 0.001) were also significant determinants for exceeding screen-viewing guidelines on weekends for this subgroup. - For older males, lower paternal rules (OR 0.76 [0.60–0.97], *p* = 0.027) was a significant predictor for exceeding screen-viewing guidelines on weekends.
Huang, Wong, & Salmon, 2013	Random sample - N = 303 - School children in	Cross-sectional	Non-theory driven: Demographic information, individual, social, environmental variables	Self-report: Physical activity and screen-based behaviors (SBBs; i.e., TV viewing,	Single assessment	- Less family support for PA (β = –0.73; 95% CI: –1.34, –0.13) was associated with higher TV viewing time in the crude model among boys (*p* < 0.05) - In the hierarchical model, family support for PA (β = –0.54; 95% CI: –1.10, 0.00)

	grades 4-6 recruited from 16 primary schools - Hong Kong, China		Variables: - Sex of child - Parent's education level - Children's BMI - Children's self-efficacy for PA - Child self-reported number of siblings at home - Child's perceived family and peer support - Perceived parental enjoyment of SBBs - Parental role modeling - Guidance/Rules on SBBs - The home environment	electronic games playing, and Internet use) - Children's Leisure Activities Study Survey questionnaire -Chinese version (CLASS-C) - Children reported the total time they spent in a checklist of 31 physical activities and SBBs during past week - Scored by calculating daily minutes spent in MVPA and SBBs		was negatively associated with boys' TV viewing time ($p < 0.05$) - Self-efficacy (β = –0.77; 95% CI: –1.69, 0.15; $p < 0.1$) and family support for PA (β = –1.03; 95% CI: –1.55, –0.51; $p < 0.01$) were associated with boys' internet use/e-games playing - Self-efficacy (β = 1.15; 95% CI: 0.24, 2.06; $p < 0.05$) and peer support for PA (β = 0.91; 95% CI: –0.10, 1.92; $p < 0.1$) were correlated with girls' internet use/e-games playing - In the full model for boys, family support for PA (β = –0.86; 95% CI: –1.41, –0.30) was negatively associated with Internet use and e-games playing ($p < 0.01$). - Interestingly, girls with higher self-efficacy for PA (β = 1.06; 95% CI: 0.02, 2.11) reported more time spent using the internet and playing e-games ($p < 0.05$)

			- Perceived neighborhood safety - Social environment in neighborhood - Sports facilities in neighborhood			
Janssen, Basterfield, Parkinson, et al., 2015	Representative sample - N = 365 - Children and adolescents; 9.3 (±0.4) years at baseline and 12.5 (±0.3) years at follow-up. - Northeast England, UK	Longitudinal prospective study	Theory-driven: Socio-ecological model - 20 measures of potential determinants of changes in both sedentary time and fragmentation between 9 y and 12 y Variables: - Demographic and biological domain (gender; age; BMI; socioeconomic status (SES); maternal age; maternal BMI;	Direct: Sedentary time and sedentary fragmentation: - ActiGraph accelerometry - In brief, participants were asked to wear the ActiGraph GT1M (ActiGraph Corporation; Pensacola USA) on a waist belt	Three-year follow-up Baseline: September 2008 to August 2009 Follow-up: January 2012 to November 2012 - Baseline measures were taken when children were 8–9 y of age (from here on referred to as 9 y) and when	*Univariate analyses of determinants associated with change in sitting time:* - Child interest in sedentary behavior (β = 1.12; 95% CI: – 0.20–2.41) - More interest was associated with greater increase in sedentary time.

			parent outside of family home) - Psychological domain (interest in sedentary behaviors) - Behavioral domain (time spent on electronic devices; change in time spent in objectively measured moderate-to-vigorous intensity physical activity (MVPA); attendance at sports clubs) - Socio-cultural environmental domain (parenting rules in relation to sedentary behavior/screen time; parental modelling of sedentary behavior/screen time; parent enjoyment of sedentary	during waking hours for 7 days - Sedentary time was expressed in absolute terms (minutes per day) when describing the magnitude of daily sedentary, but in the analyses was expressed as a % of wear time to minimize variation in sedentary time due to wear time. - Sedentary fragmentation was expressed using the	children were 11–12 y (from here on referred to as 12 y).	

			behavior/screen time; parent daily sedentary behavior/screen time) - Physical environmental domain (number of TVs in the home; TV in bedroom; computer at home; subscription-based television services available; seasonality)	fragmentation index - A greater fragmentation index indicates that time spent sedentary is more fragmented (interrupted).		
Kremers & Brug, 2008	- N = 383 - Adolescents (mean age = 13.5, *SD* = 0.6; range 12–17 y; 55.4% girls) at five schools in the region around the town of Nijmegen, The	Cross-sectional	Non-theory driven Variables: - Self-report habit index (SRHI; habit strength for watching TV and using a computer) - Pros of watching TV and using a computer	Self-report: television viewing and using a computer - Frequency measure with respect to these behaviors consisted of six items, assessing the	Single assessment	*Correlations Between Pros, Cons, Habit Strength and Behavioral Measure of Sedentary Behavior Among Adolescents:* - The SRHI score correlated positively with the behavioral measure ($r = 0.50$, $p <$ .001), intention ($r = 0.37$, $p < .001$), and the perceived pros ($r = 0.56$, $p < .001$) and correlated negatively with the cons ($r = –$ 0.21, $p < .001$) - Sedentary intentions correlated positively with sedentary behavior ($r = 0.29$, $p <$

	Netherlands - The Netherlands		- Cons of watching TV and using a computer - Intention for SB	number of minutes that the respondents spent on these behaviors. - Two items assessed the number of days they engaged in watching TV or video and using a computer (surfing the Internet, playing games, chatting) during a normal week. Four additional items assessed the amount of time that the adolescents engaged in		.001) - Perceived pros correlated with sedentary behavior (*r* = 0.37, *p* < .001) - Perceived cons correlated negatively with sedentary behavior (*r* = –0.29, *p* < .001) *Hierarchical Multiple Regressions to Test Moderating Influence of Habit on the Pros–Intention, Cons–Intention and Intention–Behavior Relationship:* - Hierarchical-regression analyses with intention as the dependent variable revealed main effects of habit and perceived pros, as well as a significant habit x pros interaction. Simple slope analyses indicated a significant relation between pros and intention in the weak-habit group (β = 0.34; *t*[379] = 4.80; *p* < .001) and a nonsignificant relation (β = 0.12; *t*[379] = 1.69) in the strong-habit group. The habit x cons interaction was not statistically significant. - Regarding the intention–behavior relationship, hierarchical regression revealed main effects for both intention and habit, as well as a significant habit x intention interaction. Simple slope

				each of these behaviors during a regular weekday (two items) and during a regular weekend day (two items). - A sum score was computed of the total number of minutes spent per day watching TV or using a computer.		analyses showed a significant relation between intention and behavior in the weak habit group (β = 0.30; *t*[379] = 4.26; *p* < .001) and a nonsignificant association in the strong-habit group (β = 0.08; *t*[379] = 1.21).
Lowe, Danielson, Beaumont, et al., 2015	Convenience sample - N = 31 - Advanced cancer patients diagnosed	Prospective study	Theoretical Model: Theory of Planned Behaviour (TPB) Variables: - Attitudes to perform regular physical activity:	Direct: - activPAL^{TM} accelerometer for 7 days (PAL Technologies Ltd, Glasgow,	Single assessment - TPB variables: cross-sectional survey via face-to-face	*TPB variables correlated with objectively measured sedentary behavior:* - Correlates of median time spent supine or sitting in hours per day were instrumental attitude (i.e., perceived benefits) of physical activity (*r* = –0.42; *p* = 0.030) and affective attitude (i.e., perceived enjoyment) of physical activity (*r* = –0.43;

	with brain metastases, aged 18 years or older, cognitively intact, and with palliative performance scale greater than 30%, were recruited from a Rapid Access Palliative Radiotherapy Program multidisciplinary brain metastases clinic. - Cross Cancer Institute, Edmonton, AB, Canada		affective and instrumental attitudes - Subjective norms (SN) - Perceived behavioral control (PBC) and self-efficacy for physical activity - Intention with respect to regularly being physically active	United Kingdom)	interviews to all participants - Participants asked to wear an activPAL™ accelerometer for up to 7 days	p = 0.024). - Correlation between intention and objectively measured sedentary behavior (r = –0.32, p = 0.10) was not statistically significant, but potentially meaningful. *Differences in TPB variables between participants based on the median of 20.7 h spent sitting or supine per day:* - Participants who sat or were supine for greater than 20.7 h per day reported significantly lower instrumental attitude (M = 0.7; 95% CI = 0.0–1.4; p = 0.051) and affective attitude (M = 0.7; 95% CI = 0.0–1.4; p = 0.041) *Differences in objectively measured sedentary levels based on medical and demographic factors:* - Participants who were <60 years of age (M = 19.4, 95% CI – 4.0–0.0, p = 0.055) recorded less time spent sit- ting or supine per day
Maher &	- N = 188 (89 female, 95	Prospective Experimental	Psychological, theory-driven: Dual-	Self-report: Daily	7-day	- Sedentary behavior had positive weak correlations with sedentary behavior habit

Conroy, 2015	male, three did not report) - Undergraduate students - USA	(7-day action planning intervention) - Before data collection, participants were assigned to one of four conditions in a 2 × 2 factorial design. The two experimental factors represented whether participants created or did not create a detailed plan describing when, where, and how participants would engage in physical activity the following day (Factor 1), or when, where,	process theories of health behavior motivation Variables: - Demographics - Habit strength (both PA and sedentary behavior habit strength) - Intentions to engage in PA - Intentions to reduce sedentary behavior	physical activity and sedentary behavior - International Physical Activity Questionnaire (IPAQ) - Adapted to focus on daily instead of weekly PA and SB - Asked to report the amount of time that they spent in physical activities for at least 10 min at a time that day as well as the total amount of time spent sitting that	protocol - Baseline + for the next 7 days, participants received an e-mail each night at 7:00 p.m. containing a link to access the questionnaire that included questions about their behavior that day and intentions for physical activity and sedentary behavior the following day and the planning intervention(s) corresponding to their	strength (r = .17) but a negative medium-sized correlation with SB intentions (between-person r = –.33, within-person r = –.36). - The daily planning intervention to limit sedentary behavior (γ_{01}, γ_{02}, γ_{03}) was not significantly associated with daily sedentary behavior. - Habit strength was a significant, positive predictor of sedentary behavior (γ_{03}), so that people with stronger habits for sedentary behavior engaged in more sedentary behavior. - The interaction between daily planning and sedentary behavior habit strength was not a significant predictor of daily sedentary behavior (γ_{05}). - Participants who had stronger usual intentions to limit or interrupt sedentary behavior had lower usual levels of physical activity (γ_{06}). - On days when participants intended to limit or interrupt sitting time more than was typical for them, they reported lower

		and how participants would limit or interrupt an extended period sitting the following day (Factor 2).		day	randomly assigned experimental condition.	levels of sedentary behavior (γ_{10}).
Maher & Conroy, 2016	- N = 100 (n=67 women, n=33 men) - Community-dwelling older adults - USA	Prospective study	Psychological, theory-driven: Dual-process theory of motivation; habit model; The Health Action Process Approach (HAPA) Variables: - Intentions to limit SB - Task self-efficacy to limit SB - Outcome expectations for light-intensity PA - Risk perceptions - Sedentary behavior	Self-report: Daily self-reported sedentary behavior - 9-item scale which featured domain-specific sedentary activities included in other validated measures of older adults' sedentary behavior (i.e., watching TV, using	14-day ecological momentary assessment study - Over the 14 days participants completed questionnaire s on their tablet at the beginning (measures included daily task self-efficacy, intentions, planning to limit sedentary	*Between- and within- person correlations between sedentary behavior (self-reported and objectively measured) and dual-process constructs:* - Self-reported and objectively measured sedentary behavior were moderately correlated (*r*s = .38, .28). - Sedentary behavior (self-reported and objectively measured) had weak-to-moderate positive correlations with habit strength (*r*s = .22, .18) and weak-to-moderate negative correlations with planning (*r*s = –.10, –.21). - Planning had moderate positive correlations with intentions (*r*s = .51, .58). - Intentions had strong positive correlations with task self-efficacy (*r*s =

			habit strength - Physical activity (i.e., IPAQ) - Physical symptoms - Temporal processes	computer, reading, socializing with friends, in transit, completing hobbies, etc.) Direct: - Objectively measured sedentary behavior - ActivPAL3 activity monitors used	behavior, sleep/wake times) and end of each day (measures included domain-specific sedentary time, physical activity, physical symptoms) and wore the activity monitor on their thigh during all sleeping and waking hours.	.83, .83). - Intentions also had weak-to-moderate positive correlations with sedentary behavior risk perceptions and light-intensity physical activity outcome expectations (*r*s = .20, .06, respectively) at the between-person level. - Intraclass correlation coefficients (ICC) were calculated to describe the proportion of variance in each variable attributable to between-person differences. ICCs indicated that approximately half of the variance in self-reported and objectively measured sedentary behavior and two thirds of the variance in task self-efficacy, intentions, and planning was the between-person variance, with the remainder driven by within-person factors and measurement error. *Multilevel model of daily sedentary behavior:* - Multilevel models predicting behavior revealed that sedentary behavior was (a) negatively associated with planning to reduce sedentary behavior at the within-person, and (b) positively associated with sedentary behavior habit strength

						(monitored behavior: γ_{02} = 19.97, *p* = .04). - There were no differences in objectively monitored sedentary behavior between participants who tended to form stronger or weaker plans (γ_{01} = –0.41, *p* = .24) but, as hypothesized, participants were less sedentary on days when they formed stronger-than- usual plans to limit sedentary behavior (γ_{10} = –0.51, *p* = .005). - As indicated by the pseudo-R^2, this model accounted for 14% of the variance in objectively measured sedentary behavior, with habit strength accounting for 9% and daily planning accounting for 5% of the explained variance. *Multilevel model of daily plans to limit SB:* - Plans to limit sedentary behavior were (a) positively associated with task self-efficacy at the within-person level (γ_{10} = 0.14, *p* = .001), but (b) negatively associated at the between-person level (γ_{01} = –0.59, *p* = .04), and (c) positively associated with intentions at the between- (γ_{02} = 1.17, *p* = .001) and within-person

						level (γ_{20} = 0.20, p = .004). - As indicated by the pseudo-R^2, this model accounted for approximately 20% of the variance in daily plans to limit sedentary behavior. Daily intentions accounted for 23%, daily task self-efficacy accounted for 10%, and usual intentions and task self-efficacy each accounted for 2% of the explained variance. *Multilevel model of intentions to limit SB:* - Intentions to limit sedentary behavior were (a) positively associated with task self-efficacy at the between (γ_{01} = 0.96, p = .001) and within-person level (γ_{10} = 0.61, p = .001), but (b) not associated with light-intensity physical activity outcome expectations, sedentary behavior risk perceptions, or sedentary behavior habit strength. - As indicated by the pseudo- R^2, this model accounted for approximately 44% of the variance in daily intentions to limit sedentary behavior, with daily task self-efficacy accounting for 80% and usual task self-efficacy accounting for 4% of the

						explained variance.
Norman, Schmid, Sallis, et al., 2005	Convenience sample - N = 878 - Ethnically diverse clinic-based sample of adolescents who were 11 to 15 years old - San Diego County, California, USA	Cross-sectional	Theory-driven: Psychosocial and environmental variables - Psychosocial constructs assessed based on social cognitive theory, the transtheoretical model - Environmental variables derived from ecological models. Variables: Psychosocial: - behavior change strategies - pros and cons of change - self-efficacy	Self-report: - Survey adapted from Robinson. - Participants were asked how much time they spent doing the following leisure-time sedentary behaviors: - watching TV (including videos on VCR/DVD); - playing computer or video games (such as Nintendo or Sega); - sitting and	Single assessment	*Associations between predictor variables and leisure-time sedentary behavior:* - Girls: Higher scores on change strategies (OR: 0.59; 95% CI: 0.45–0.76), pros (OR: 0.62; 95% CI: 0.51–0.77), and self-efficacy (OR: 0.45; 95% CI: 0.35–0.59) were related to decreased likelihood of being in the high-sedentary-behavior group. - Girls: High scores on cons (OR: 1.90; 95% CI: 1.50–2.40) and enjoyment of sedentary behaviors (OR: 1.41; 95% CI: 1.19–1.68) were related to increased likelihood of being in the high-sedentary-time group. - Boys: Higher scores on self-efficacy (OR: 0.56; 95% CI: 0.44–0.71) was associated with decreased likelihood of being in the high-sedentary-behavior group. - Boys: Higher scores on the cons (OR: 2.15; 95% CI: 1.69–2.73) and enjoyment of sedentary behaviors (OR: 1.49; 95% CI: 1.24–1.80) were associated with increased likelihood of being in the high-sedentary-

			- family support - enjoyment of sedentary behaviors - TV and video household rules - parent-reported support for PA Environmental: - home environment - neighborhood environment variables	listening to music on the radio, audiotapes, or CDs; - sitting and talking on the telephone. - Questions were asked first for "most recent day when you were not in school" and then for the "most recent school day." - An index of sedentary-behavior time was computed by summing the 4 items for non-school days.		behavior group. *Multivariate model for girls:* - Included all of the variables that were associated with the outcome from the unadjusted bivariate analyses. - The R^2 for the main-effects model was 0.25, and the inclusion of the interaction term increased the R^2 to 0.28. The Hosmer-Lemeshow test indicated that the fit of the model was good (P = .25). *Multivariate model for boys:* - Included age, BMI percentile, cons, and self-efficacy as significant correlates of sedentary time - The final model's R^2 was 0.22, and the fit of the model was good (P = .35).

Prapavessis, Gaston, & DeJesus, 2015	Convenience sample - N = 372 (283 females, 88 males, one undisclosed) - Adults, between 18 and 64 years of age - Ontario, Canada	Cross-sectional	Theoretical Model: Theory of Planned Behaviour (TPB) Variables: - Attitude - Subjective norms (SN) - Perceived behavioral control (PBC) - Intention with respect to time spent being sedentary	Self-report: Sedentary Behavior Questionnaire (SBQ) - 12-item modified version - Assessed participants' duration of time spent per day in various forms of sedentary pursuits for weekdays and weekends separately. The modified SBQ included both volitional and non-volitional activities.	Single assessment	*TPB variables correlated with sedentary behavior:* - Intention was correlated with attitude (0-4) in only one model, but was related to attitude (half) and attitude (12-16) in three models. Subjective norms were associated with intention in four of the five models and PBC showed an association only in one model. - For behavior, intention emerged as a significant correlate in all five models. Behavior was related with attitude (0-4) in one model, attitude (half) in three models, and attitude (12-16) in two models, SN in three models and PBC in a single model. *Variables predicting sedentary behavior:* - For intention, attitude (half) significantly predicted intention only in Model 5 (weekend leisure/recreation), SN was a significant contributor in three of the five models, and PBC was a significant predictor only in Model 2 (weekday work/school). The percent of variance explained ranged from 9% in Model 3 (weekday leisure/recreation) to 58% in Model 4 (weekend work/ school).

						- For behavior, intention alone significantly predicted behavior in all five models and explained between 2% (Model 3 - weekday leisure/recreation) and 36% (Model 2 - weekday work/school) of the variance. The addition of TPB variables in Step 2 explained an additional 3-11% of the variance in behavior. Attitudes significantly predicted behavior only in Model 2 (weekday work/school) and Model 3 (weekday leisure/recreation). SN significantly predicted behavior in Models 2 (weekday work/school) and 4 (weekend work/school); and PBC significantly predicted behavior only in Model 2 (weekday work/school). Overall, the models explained between 8 and 43% of the variance in behavior.
Quartiroli & Maeda, 2014	Covenience sample - N = 875 - US undergraduate college students - Wisconsin,	Cross-sectional	Theoretical Model: Self-determination theory Variables: - Basic psychological needs in exercise (i.e., perceived competence, autonomy, and	Self-report: physical activity and sedentary behavior - International Physical Activity Questionnaire - Self-	Single assessment	- Intrinsic regulation (r = –.111, p < .001), identified regulation (r = –.074, p < .05), autonomy (r = –.092, p < .01), competence (r = –.132, p < .001), and relatedness (r = –.110, p < .001) were all negatively related to sedentary behavior but the correlations were weak. - Although the SDT variables were able to predict some of the variance of sedentary behavior (ρ = -.074 to -.132), the correlations were consistently stronger for

	USA		relatedness) - Behavioral regulation in exercise (i.e., intrinsic regulation, identified regulation, introjected regulation, external regulation, amotivation) - Relative autonomy index (i.e., degree of self-determination)	administered 7-day recall questionnaire - Includes seven items; six measures three levels of physical activity (light, moderate, and vigorous) and one item assesses average daily sitting time as a measure of sedentary behavior.		predicting MVPA (ρ = .114 to .305), MET min/wk (ρ = .095 to .250), guidelines met (ρ = .114 to .291), and PA guidelines (ρ = .111 to .288). - Psychological needs and behavioral regulation variables together were able to explain 2.8% of the variance of square root transformed sedentary behavior time, $F(8,866)=3.14$, $p = .002$, $R^2 = .028$, 90% CI[.006, .040].
Rhodes & Dean, 2009	Random sample - N = 380 - Two samples: Community adult sample (n = 206) and an	Cross-sectional (Community sample) Prospective design (Undergraduat e sample)	Theoretical Model: Theory of Planned Behaviour (TPB) Variables: - Attitude - Subjective norms (SN)	Self-report: - Four sedentary leisure behaviors (television viewing, reading/music , sedentary socializing,	Single assessment (Community sample) Two-week design (Undergradua te sample) - Baseline:	- Results were quite similar across community and undergraduate samples *TPB variables correlated with sedentary behavior:* - For television viewing and computer-use, attitude (r = .37 to .58) and intention (r = .25 to .61) correlated with behavior (p < .01), while perceived behavioral control did not across both samples. Subjective

	undergraduate student sample (n = 174) - Community sample (i.e., adults living in a metropolitan district) drawn from a random sample of residents 18–94 years old; Faculty of Education undergraduate students volunteered during their certified teacher preparation courses. - Victoria, BC, Canada		- Perceived behavioral control (PBC) - Intention with respect to sedentary leisure behavior	and computer use) measured by instrumentation validated by Salmon et al. (2003) - 1-week recall measure (i.e., time spent in each sedentary behaviors in the previous week and weekend) - Average frequency and average duration separated by weekday and weekend	TPB variables, self-reported sedentary behavior - Two weeks later: self-reported sedentary behavior	norm correlated with behavior for the community sample (r = .22 to .35; $p < .01$) but not the undergraduate sample. - Intention correlated with behavior for both reading/music (r = .28 to .25) and socializing (r = .31 to .30), but only attitude-reading/music (r = .25), attitude-socializing (r = .29), and subjective norm-socializing (r = .23) relationships were identified for the community sample ($p < .01$). *Variables predicting sedentary behavior:* TV viewing: - Community sample: attitude ($\beta = .55$) and subjective norm ($\beta = .18$) predicted intention, $F(3, 191) = 51.53$, $p < .01$, explaining 45% of its variance. Intention ($\beta = .41$) was associated with behavior, $F(1, 181) = 35.78$, $p < .01$, and shared 18% of its variance. - Undergraduates: attitude ($\beta = .48$) and perceived behavioral control ($\beta = .22$) predicted intention, $F(3, 169) = 38.16$; $p < .01$, explaining 40% of its variance. In turn, intention ($\beta = .41$) predicted behavior, $F(1, 164) = 33.29$, $p < .01$, and

						explained 18% of its variance. Computer use: - Attitude (community sample $\beta = .69$; undergraduate sample $\beta = .54$) predicted intention across both community, $F(3, 180) = 74.57$, $p < .01$, $R^2 = .55$ and undergraduate $F(3, 168) = 45.54$, $p < .01$, $R^2 = .45$, samples. - Intention predicted behavior for the community, $F(1, 170) = 96.15$, $p < .01$, $R^2 = .36$ and undergraduate, $F(1, 163) = 10.63$, $p < .01$, $R^2 = .06$, samples. - Attitude also added additional variance as an independent predictor of behavior across both community, $\Delta F(3, 167) = 4.07$, $p < .01$, R^2change = .04 and undergraduate, $\Delta F(3,160) = 6.04$, $p < .01$, R^2 change = .10, samples. Reading/music: - Attitude (community sample $\beta = .41$; undergraduate sample $\beta = .23$) predicted intention in the community, $F(3, 181) = 45.66$, $p < .01$, $R^2 = .42$ and undergraduate, $F(3, 169) = 8.59$, $p < .01$, $R^2 = .13$ samples, though perceived behavioral control ($\beta = .24$) was also a predictor in the

						community sample. - Intention predicted behavior for both community, *F*(1,178) = 15.56, $p < .01$, $R^2 = .08$ and undergraduate, *F*(1, 162) = 10.47, $p < .01$, $R^2 = .06$, samples. Socializing: - Attitude predicted intention across both models (community sample $\beta = .47$; undergraduate sample $\beta = .38$), while subjective norm ($\beta = .29$) was a predictor in the community sample and perceived behavioral control ($\beta = .43$) was a predictor in the undergraduate sample. Overall, both the community sample, *F*(3, 189) = 108.06, $p < .01$, $R^2 = .63$ and the undergraduate sample, *F*(3, 169) = 34.55, $p < .01$, $R^2 = .38$, were significant. - Intention also predicted behavior across both community, *F*(1, 177) = 17.56, $p < .01$, $R^2 = .09$ and undergraduate, *F*(1, 163) = 17.00, $p < .01$, $R^2 = .09$, samples.
Salmon, Owen, Crawford, et al., 2003	Random sample - N = 1,332 - Population-	Cross-sectional	Psychological, theory-driven: Behavioral choice theory (BCT)	Self-report: Leisure-time sedentary behavior:	Single assessment	*Associations of Barriers, Enjoyment, and Preferences with Sedentary Behavior:* - Multivariate logistic regression analyses were performed to predict the likelihood of

	based mail survey of Australian adults - Australia		- Incorporates both individual level and environmental influences Variables: - Barriers to physical activity (environmental, personal) - Enjoyment of physical activities - Enjoyment of sedentary behaviors - Preference for physical activity or sedentary behavior	- 1-week recall measure (time spent in nine sedentary behaviors in the previous Monday–Friday and weekend [Saturday and Sunday]) - Television viewing was dichotomized as low (< 14 hr/week) and high (> 14 hr/week); reading was dichotomized as low (< 5 hr/week) and high (> 5 hr/week); and sitting socializing was dichotomized as low (< 8		being a high television viewer (> 14 hr/ week), the likelihood of reading more than 5 hr/week, the likelihood of sitting and socializing more than 8 hr/week, and the likelihood of spending more than 36 hr/week in a total of nine leisure-time sedentary pursuits. *Variables predicting high participation in television viewing:* - Multiple linear regression explained 14.5% of the variance in television viewing, $F(22, 1251) = 11.0$, $p < .01$, with enjoyment of television viewing explaining the greatest proportion of variance ($R^2 = 10.2$, $\beta = 0.3$, $p < .01$); then physical activity barriers such as the weather ($R^2 = 1.1$, $\beta = 0.10$, $p < .01$), work commitments ($R^2 = 0.9$, $\beta = –0.11$, $p < .01$), feeling tired ($R^2 = 0.5$, $\beta = 0.06$, $p < .05$), and cost ($R^2 = 0.3$, $\beta = 0.06$, $p < .05$); and preference for vigorous physical activity ($R^2 = 0.3$, $\beta = –0.06$, $p < .05$). *Variables predicting reading more than 5 hr/week:* - Multiple linear regression explained 17.2% of the variance in reading, $F(22, 1251) = 13.1$, $p < .01$, with enjoyment of

				hr/week) and high (> 8 hr/week). Leisure-time physical activity: - 1-week leisure-time physical activity recall measure - Frequency and duration of participation in walking, moderate-intensity activity, vigorous activity, and total leisure-time activity.		reading explaining the greatest proportion of variance (R^2 = 11.1, β = 0.34, p < .01); physical activity barriers such as family commitments (R^2 = 1.2, β = –0.09, p < .01), the weather (R^2 = 0.6, β = 0.07, p < .01), work commitments (R^2 = 0.6, β = –0.09, p < .01), and lack of safety (R^2 = 0.3, β = 0.06, p < .05). *Variables predicting sitting and socializing more than 8 hr/week:* - Multiple linear regression explained 15.8% of the variance in sitting socializing, F(22, 1251) = 11.4, p < .01, with enjoyment of socializing explaining the greatest proportion of variance (R^2 = 9.1, β = 0.23, p < .01); then physical activity barriers such as family commitments (R^2 = 0.6, β = –0.08, p < .01), pollution (R^2 = 0.4, β = 0.07, p < .01), and work commitments (R^2 = 0.3, β = –0.07, p < .05); and preference for sedentary behavior (R^2 = 0.3, β = 0.06, p < .05). *Variables predicting high participation in leisure-time sedentary behavior:* - The amount of variance that was explained for total sedentary behavior was 13.3%, F(22, 1251) = 9.2, p < .01, with

						enjoyment of sedentary behavior explaining the greatest proportion of variance ($R^2 = 4.9$, $\beta = 0.20$, $p < .01$); then physical activity barriers such as the weather ($R^2 = 1.4$, $\beta = 0.10$, $p < .01$), family commitments ($R^2 = 1.5$, $\beta = –0.12$, $p < .01$), work commitments ($R^2 = 0.7$, $\beta = –0.14$, $p < .01$), feeling tired ($R^2 = 1.0$, $\beta = 0.09$, $p < .01$), and pollution ($R^2 = 0.5$, $\beta = 0.08$, $p < .01$); age ($R^2 = 0.5$, $\beta = –0.07$, $p < .05$); and preference for sedentary behavior ($R^2 = 0.4$, $\beta = 0.13$, $p < .01$), enjoyment of structured physical activity ($R^2 = 0.4$, $\beta = 0.09$, $p < .01$), and preference for moderate physical activity ($R^2 = 0.3$, $\beta = 0.08$, $p < .05$).
Van Dyck, Cardon, Deforche, et al., 2011	Random sample - N = 419 - Adults - Ghent, Belgium	Cross-sectional	Theory-driven: Ecological model Variables: - Socio-demographic (gender; age; educational attainment [primary, secondary, tertiary education]; employment status [employed, not	Self-report: Domestic screen time - Self-reported TV viewing time (min/day) and leisure-time internet use at home (min/day) - ‘Usual	Single assessment	*Bivariate correlations of psychosocial factors with TV viewing:* - Pros reducing TV viewing ($r = –0.31$, $p < .001$) - Cons reducing TV viewing ($r = 0.47$, $p < .001$) - Family social norm TV viewing ($r = 0.34$, $p < .001$) - Friends social norm TV viewing ($r =$

			employed/retired]; and body mass index) - Sedentary-specific home-environmental (number of TVs and computers in home, size of largest TV set) - Sedentary-specific psychosocial (Pros and cons of reducing screen time, self-efficacy about reducing screen time, and social norm from family and friends)	week' assessed		0.35, $p < .001$) - Self-efficacy reducing TV viewing ($r = -0.49$, $p < .001$) *Bivariate correlations of psychosocial factors with internet use:* - Pros reducing internet use ($r = -0.16$, $p < .01$) - Cons reducing internet use ($r = 0.31$, $p < .001$) - Family social norm internet use ($r = 0.40$, $p < .001$) - Friends social norm internet use ($r = 0.26$, $p < .001$) - Self-efficacy reducing internet use ($r = -0.47$, $p < .001$) *Associations of psychosocial variables with TV viewing time:* - For the psychosocial variables, perceiving more cons was associated with more TV viewing time ($\beta = 0.155$, $p = 0.014$) while more pros ($\beta = -0.177$, $p < 0.001$) and higher self-efficacy about reducing TV viewing time were related to

						less TV viewing time (β = –0.241, $p <$ 0.001). *Associations of psychosocial variables with leisure-time internet use:* - Concerning the psychosocial factors, perception of higher social norm from family towards Internet use (β = 0.161, $p =$ 0.011) and more cons (β = 0.187, $p =$ 0.002) were related to more leisure-time Internet use. Moreover, more pros (β = –0.116, $p = 0.009$) and higher self-efficacy about reducing leisure-time Internet use were associated with less Internet use (β = –0.285, $p < 0.001$).
Wallmann-Sperlich, Bucksch, Schneider, et al., 2014	Representative sample - N = 1515; 747 men; 43.5 ± 11.0 years - Working German adults - Germany	Cross-sectional	Non-theory driven: Socio-demographic, behavioural and cognitive correlates Variables: Socio-demographic: - age, education level, income level Behavioural: - work-related PA,	Self-report: Marshall Sitting Questionnaire - Five items were used to assess time spent in specific sitting pursuits (hours and	Single assessment	*Correlates of work-related sitting time:* - The only association with cognitive correlates was found in men for the belief ‘Sitting for long periods does not matter to me’ (β = .10) expressing a more positive attitude towards sitting with increasing sitting durations. *Variables predicting work-related sitting time:* - In model 4, for men, the belief ‘Sitting for long periods does not matter to me’

			travel-related PA, leisure-related PA as well as sitting time during transport, during TV watching, during leisure computer use and during leisure time Cognitive: - Health- related beliefs about sitting time	minutes) each day in five domains on weekdays and weekend days. - Dependent variable was sitting time during work on weekdays. All sitting time measures other than work-related on weekdays was considered independent variables. Global Physical Activity Questionnaire (GPAQ) - Used to		(recoded) (β = .10) was positively correlated with work-related sitting time, reflecting more positive attitudes towards sitting with increasing sitting durations. - For women, for the cognitive variables, no associations were found.

				assess PA		
Wong, Gaston, DeJesus, et al., 2016	Convenience sample - N = 596 - Undergraduate university students, aged 18-35 years - Ontario, Canada	Prospective study - After completing socio-demographics and the PMT items, participants randomized to complete general or leisure GI and II. Based on model assignment, they completed either the general or leisure SB questionnaire one week later.	Theoretical Model: Protection Motivation Theory (PMT) Sedentary-derived PMT variables: - Threat appraisals: perceived vulnerability (PV), perceived severity (PS) - Coping appraisals: response efficacy (RE), scheduling self-efficacy (SE) - SE subscales: three psychological (productive, focused, tired), and two situational (studying, leisure) - Intention: goal intention (GI), implementation	Self-report: Sedentary Behavior Questionnaire (SBQ) - 12-item modified version - Measured the quantity of time spent sitting on a typical day over the previous week - Seven items assessed leisure-specific, volitional sedentary activities Exercise	7-day period - Baseline: PV, PS, RE, SE, II, GI, LSI - One week later: modified SBQ - PMT cognitions were assessed prior to sedentary behavior	*PMT variables correlated with sedentary behavior:* - In the general model, scheduling SE productive/focused ($r = -.13$, $p < .05$) and scheduling SE studying in library/Wi-Fi area ($r = -.14$, $p < .05$) were significantly related to sedentary behavior. - In the leisure model, PV ($r = .12$, $p < .05$), scheduling SE TV/video games/computer ($r = -.13$, $p < .05$), scheduling SE studying in library/Wi-Fi ($r = -.11$, $p < .05$) and goal intention ($r = .20$, $p < .05$) were significantly related to sedentary behavior. *Variables predicting sedentary behavior:* - For goal intention, 5% and 1% of the variance was explained in the general and leisure model, respectively. RE and scheduling SE studying at home were significant contributors for the general model only. - For implementation intention, 10% and 16% of the variance was explained in the general and leisure model, respectively. In

			intention (II)	behavior: Leisure Score Index (LSI) of the Leisure Time Exercise Questionnaire - Four-item assessment that measures intensity and frequency of physical activity			the general model, PV, RE, and scheduling SE productive/focused were significant contributors. For the leisure model, PV, RE, and scheduling SE studying at home were significant contributors. - For sedentary behavior, 3% and 1% of the variance was explained in the general and leisure model, respectively. Goal intention was a significant contributor in the leisure model only.

Appendix C: Ethics Approval (Study 2)

Subject: 109151 Ethics Approval Notice

Ethics File #: 109151
Study Title: Sedentary Behaviour and Diabetes Information as a Source of Motivation to Reduce Daily Sitting Time in Adult Office Workers: An Experimental Study using the Health Action Process Approach
Prof. Harry Prapavessis

Hello,

The Approval Notice for the above mentioned study is now available in ROMEO.
**** **Please note**: The original will **not** be sent in the mail, it is available for download in Romeo ****

To access the Approval Notice:
1. Log in to ROMEO (https://grant3.vm.its.uwo.ca/Romeo.Researcher)
2. Click on 'Applications Submitted Post Review'.
3. Click on 'View' to open the file.
4. Under the 'Attachments' tab, you can download the Approval Notice.

Kind regards,

Office of Human Research Ethics

Western University
Support Services Building Room 5150

Appendix D: Recruitment Poster (Study 2)

Participants Needed for an Exercise Psychology Research Study

- We are conducting a research study examining **thoughts and beliefs related to both occupational and leisure time movement patterns**.
- We are interested in understanding factors that influence office-working adults' movement patterns during both work and leisure hours.
- **Looking for adult office workers:** Are you 18 years of age or older? Are you a full-time employee in an office setting?
- Participants will be asked to complete an online questionnaire on **one occasion**.
- Participants will be entered into a draw to win a **$100 Tim Hortons or Starbucks gift certificate.**

If interested please click the following link to access the letter of information and survey:
https://www.surveymonkey.com/r/QNH3SB6

****NOTE: Participation in the study is completely voluntary.***

[redacted]

Appendix E: Letter of Information and Informed Consent (Study 2)

EHPL Exercise & Health Psychology Laboratory

Study Title: The Health Action Process Approach and Movement Patterns in Adult Office Workers

Investigators: Harry Prapavessis, Ph.D. (Principal Investigator; [redacted]) & Scott Rollo, Ph.D. Candidate (Co-investigator; [redacted]), School of Kinesiology, Western University.

You are being invited to participate in a research study examining thoughts and beliefs related to both occupational and leisure time movement patterns. The purpose of this letter is to provide you with information required for you to make an informed decision regarding participation in this research.

Purpose of this Study

This is a research project being conducted by researchers in the School of Kinesiology at Western University. The purpose of the study is to determine whether the Health Action Process Approach can help us understand factors that influence office-working adults' movement patterns during both work and leisure hours.

Inclusion Criteria

To be eligible to participate, you must be 18 years of age or older, be a full-time worker/employee, be able to read and write in English, and have access to a computer with Internet.

Study Procedures

If you choose to take part in this study, you will be asked to complete an online questionnaire using SurveyMonkey. Survey Monkey is hosted on a US server and is subject to the United States Patriot Act. The online questionnaire includes demographic questions, as well as questions that will ask about your beliefs related to both occupational and leisure time movement patterns and should take approximately 15-20 minutes to complete. Approximately two thirds of participants will also view a series of slides about physical activity and health. Depending on group assignment, participation should take between 30 and 45 minutes in total. All responses are completely confidential.

Possible Risks and Harms

Anticipated risks or discomforts associated with participating in this study include boredom and disruption of your personal and/or work time. Additionally, there is a risk of privacy breach.

Possible Benefits

By participating in this study, you may learn more about the relationship between movement patterns and health as well as have a chance to reflect upon your own behaviour. You may also not receive any benefit from taking part in the study. In addition, the information gathered may provide benefits to society as a whole.

Voluntary Participation

Participation in this study is voluntary. You are free to discontinue and withdraw your participation from this study at any time. You also may choose to skip any questions that you do not wish to answer. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your future employment status. If you choose to withdraw from the study, any data collected from you prior to the point of withdrawal will still be used. No legal rights are waived by agreeing to participate.

Confidentiality and Publication

All data collected will remain confidential and accessible only to the investigators of this study and if required, Western University Health Sciences Research Ethics Board whom may access study data for monitoring or audit purposes. Your data will be retained for 5 years and will be stored on a password-protected University of Western Ontario computer located in the Exercise and Health Psychology Lab in the Arthur & Sonia Labatt Health Sciences Building Room 408. The information from this research project will be submitted, upon completion, for publication in a peer-reviewed academic journal as well as presented at relevant conferences.

Contacts for Further Information

If you require any further information regarding this research project or your participation in the study you may contact Scott Rollo [redacted] or Harry Prapavessis [redacted]. If you have any questions about your rights as a research participant or the conduct of this study, you may contact The Office of Research Ethics [redacted], email: [redacted].

Clicking on the "agree" button below indicates that you have read the above information, you voluntarily agree to participate and you are at least 18 years of age.

If you do not wish to participate in the research study, please decline participation by clicking on the "disagree" button.

- Agree
- Disagree

Appendix F: Health Action Process Approach Slide Show (Intervention – Sedentary behaviour and diabetes information) (Study 2)

SEDENTARY BEHAVIOUR

THE TRUTH ABOUT TOO MUCH SITTING

WHAT IS SEDENTARY BEHAVIOUR?

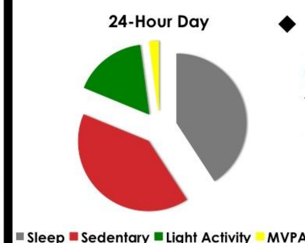
- Any waking activity characterized by an energy expenditure under 1.5 METs and a sitting or reclining posture (Sedentary Behaviour Research Network, 2012)

TYPES OF SEDENTARY BEHAVIOUR

- Work/occupational sedentary time
  - Sitting and using the computer
  - Sitting in a car to get to work
  - Sitting in meetings
  - Sitting and working at a desk

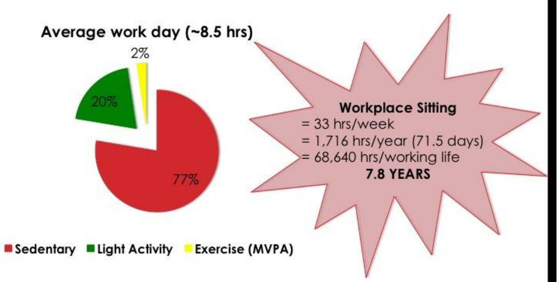
- Leisure/recreational sedentary time
  - Sitting and using a computer
  - Watching TV
  - Sitting and reading
  - Sitting and socializing

HOW SEDENTARY ARE CANADIANS?



- Canadian adults spend a whopping 9.7 hours of their daily waking hours being sedentary! (Colley et al., 2011)

SEDENTARY PATTERNS DURING WORK HOURS IN OFFICE WORKERS



(Thorp et al., 2012)

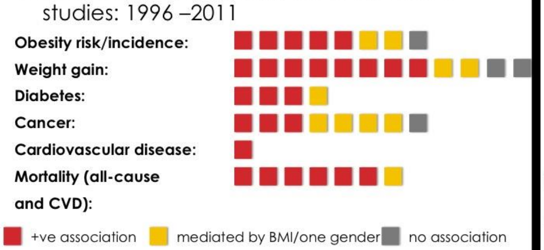
SEDENTARY BEHAVIOUR AND HEALTH

- An overview of 27 systematic reviews on sedentary behaviour (SB) and health outcomes showed that irrespective of physical activity, time spent in SB is *positively associated* with:
  - Death from any cause (i.e., all-cause mortality)
  - Numerous chronic diseases:
    - Fatal and non-fatal cardiovascular disease
    - Type 2 diabetes
    - Several types of cancers
    - Metabolic syndrome (problems with insulin, increases in fat around stomach, higher levels of fat and sugar in bloodstream)

(de Rezende et al., 2014)

SEDENTARY BEHAVIOUR AND HEALTH

- Associations reported from prospective studies: 1996 –2011



(Thorp et al., 2011)

HOW STRONG IS THE ASSOCIATION?

- Best evidence comes from systematic reviews which summarize findings of numerous studies
- **Systematic review:** Sedentary time in adults and the association with diabetes, cardiovascular disease and death (Wilmot et al., 2012)
  - 18 studies, 794,577 participants
  - Compared “greatest sedentary time” with “lowest”

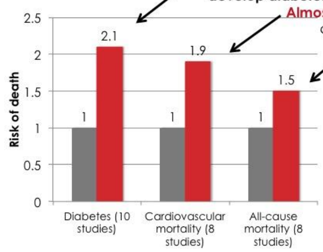
HOW STRONG IS THE ASSOCIATION?

- **Findings:**

Irrespective of physical activity level, those who spent the most time sitting were more than **two times** more likely to **have or develop diabetes**.

Almost twice as likely to die of cardiovascular disease

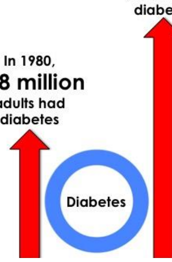
One and a half times more likely to die over the course of the study



DIABETES AS A GLOBAL HEALTH CONCERN

In 1980, **108 million** adults had diabetes

In 2014, **422 million** adults had diabetes



Global Prevalence (Adults 18+ years)

4.7% VS 8.5%

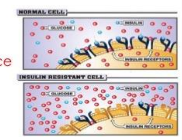
1980 2014

(WHO, 2016)

DIABETES AS A GLOBAL HEALTH CONCERN

- Type 2 diabetes is a chronic disease, caused by the body's ineffective use of insulin.
- This affects the way your body metabolizes sugar (glucose), the body's important source of fuel, which leads to an increased concentration of glucose in the blood.

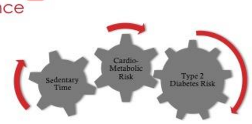
Elevated glucose in blood = poor glucose tolerance
Elevated insulin in blood = poor insulin sensitivity



(WHO, 2016)

SEDENTARY BEHAVIOUR AND DIABETES RISK

- **Systematic review** on the association of total sedentary time with cardiometabolic biomarkers in adults (Brocklebank et al., 2015)
  - **Consistent evidence:**
    - Sedentary time and ↓ insulin sensitivity
  - **Some evidence:**
    - Sedentary time and ↑ insulin, triglycerides, and insulin resistance



ACUTE EFFECTS AMONG ADULTS

- **Systematic review** on acute effects of sedentary behaviour (Saunders et al., 2012)
  - Uninterrupted sedentary behaviour ≤7 days results in moderate and deleterious changes in insulin sensitivity and glucose tolerance
  - Most participants were healthy young men

ACUTE EFFECTS AMONG ADULTS

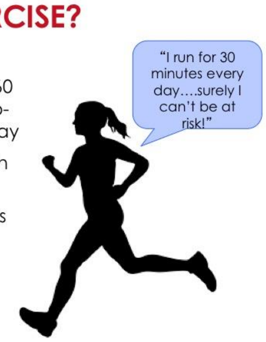
- Examples:
  - 2 hours of sitting = **~50%** reduced glucose tolerance (Nygaard et al., 2009)
  - 1 day of sitting = **39%** reduced insulin sensitivity (Stephens et al., 2011)

AGE AND SEDENTARY BEHAVIOUR

- Negative effects of sitting are seen among **ALL** age groups

WHAT ABOUT LEISURE-TIME EXERCISE?

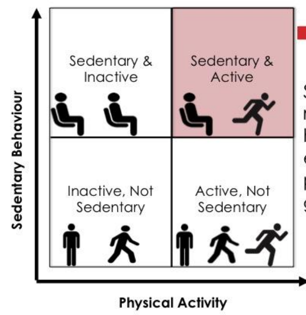
- **Physical activity recommendations:** 30-60 minutes of moderate-to-vigorous exercise per day
- That's only 2-4% of a 24h day!
- Remaining 23-23.5 hours sure matter



THE "ACTIVE COUCH POTATO"

◆ An individual who meets physical activity guidelines but spends most of the day being sedentary

THE "ACTIVE COUCH POTATO"



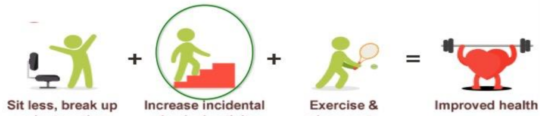
Sedentary time still related with adverse health outcomes, even if meeting physical activity guidelines

HOW TO REDUCE YOUR RISK

① Stand up

② Sit less

③ Move more, More often



THE EFFECTIVENESS OF REDUCING SEDENTARY BEHAVIOUR

◆ In a large sample of Canadian adults (~5000), it was shown that each additional 10 breaks/day is *beneficially* associated with:

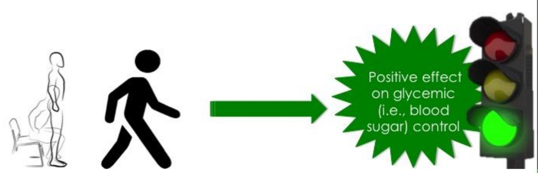
- ⬇ Waist circumference
- ⬇ Systolic blood pressure
- ⬆ HDL- "good" cholesterol
- ⬇ Blood lipid "fat" levels
- ⬇ Blood glucose "sugar" levels
- ⬇ Insulin levels

(Carson et al., 2014)

THE EFFECTIVENESS OF BREAKING UP SEDENTARY BEHAVIOUR

◆ **Systematic Review:** Relationship between breaks in SB and cardiometabolic health in adults (Chastin et al., 2015)

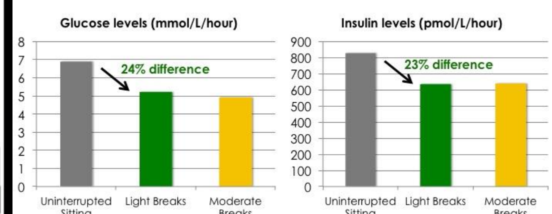
- Light-intensity physical activity breaks in sedentary periods result in significant reductions in glucose (-17%) and insulin levels (-15%)



THE EFFECTIVENESS OF BREAKING UP SEDENTARY BEHAVIOUR

◆ Dunstan et al. (2012)

- Breaking up prolonged sitting improves glucose and insulin levels



EASY WAYS TO REDUCE AND BREAK UP WORK SEDENTARY TIME

DRINK WATER and **get up** for refills

WALK OVER to speak with co-workers **instead** of phoning or e-mailing them

STAND UP when you're on the **phone**

Take REGULAR BREAKS from sitting by standing up every **30 min.**

LEAVE your desk FOR LUNCH

TAKE the STAIRS **instead** of the elevator

MOVE your TRASH BIN AWAY from your desk

Make **frequent** SIT-TO-STAND TRANSITIONS while **working at desk**

EASY WAYS TO REDUCE AND BREAK UP WORK SEDENTARY TIME

Get yourself an ACTIVE WORKSTATION (e.g., height-adjustable desk) to increase **movement** at work

Use PROMPTS or REMINDERS to determine certain **'standing times'** throughout the day

'WALKING' meetings

Use a HEADSET or SPEAKERPHONE during teleconferences to enable more **standing** during the meeting

AT-DESK EXERCISES at **scheduled** times

EASY WAYS TO REDUCE AND BREAK UP LEISURE SEDENTARY TIME

DRINK WATER and **get up** for refills	WALK or RIDE your bicycle **instead** of driving to get places	STAND UP when you're on the **phone**
GET UP every **20-30 min.** while sitting at the computer	Go for WALKS with friends **instead** of sitting and socializing	STAND UP and STRETCH **during** TV commercials
BE ACTIVE with your **kids**, **spouse**, and/or **partner**	**. . . in addition to your routine exercise, sport, and/ or gym session**	LIMIT SCREEN TIME to stay **active**

TAKE HOME MESSAGE

- Irrespective of age, sitting is associated with chronic disease risk
- Prolonged, unbroken sitting is detrimentally associated with blood sugar levels and insulin sensitivity
- Being a regular exerciser is good, but does not compensate for the negative effects of sitting
- Stand up, sit less, move more, more often to reduce your risk
- Getting up 2-3x per hour can really improve your risk profile!

SIT LESS MOVE MORE

THANK YOU!

Appendix G: Health Action Process Approach Slide Show (Attention-control – Moderate-to-vigorous physical activity and health information) (Study 2)

PHYSICAL ACTIVITY

EVERYTHING YOU NEED TO KNOW ABOUT PHYSICAL ACTIVITY AND HEALTH

MEASURING PHYSICAL ACTIVITY

- Researchers must be able to **quantify** activity. To do so, the following acronym is **very useful**:

F
- Frequency
- (How often?)

I
- Intensity
- (Light, moderate, or vigorous)

T
- Time
- (Duration spent in activity)

T
- Type
- (Cardio, Strength, Flexibility)

WHAT IS MODERATE-VIGOROUS PHYSICAL ACTIVITY?

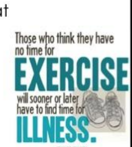
- Guidelines focus on "moderate-vigorous" intensity physical activity (MVPA) because research has shown that this intensity is associated with the greatest health benefit.

Moderate-intensity Physical Activity (Approximately 3-6 METs) Requires a moderate amount of effort and noticeably accelerates the heart rate.	Vigorous-intensity Physical Activity (Approximately >6 METs) Requires a large amount of effort and causes rapid breathing and a substantial increase in heart rate.
Examples of moderate-intensity exercise include:	Examples of vigorous-intensity exercise include:
• Brisk walking	• Running
• Dancing	• Walking / climbing briskly up a hill
• Gardening	• Fast cycling
• Housework and domestic chores	• Aerobics
• Traditional hunting and gathering	• Fast swimming
• Active involvement in games and sports with children / walking domestic animals	• Competitive sports and games (e.g. Traditional Games, Football, Volleyball, Hockey, Basketball)
• General building tasks (e.g. roofing, thatching, painting)	• Heavy shovelling or digging ditches
• Carrying / moving moderate loads (<20kg)	• Carrying / moving heavy loads (>20kg)

From the World Health Organization: http://www.who.int/dietphysicalactivity/physical_activity_intensity/en/

PHYSICAL ACTIVITY AND CHRONIC DISEASE

- What is chronic disease? Numerous conditions at least somewhat associated with lifestyle behaviours:
  - Fatal and non-fatal cardiovascular disease
  - Type 2 diabetes
  - Several types of cancers
  - Metabolic syndrome (i.e., increases in fat around the stomach region, higher levels of fat in bloodstream)



(WHO, 2014)

WHAT IS PHYSICAL ACTIVITY AND EXERCISE?

- Physical Activity
  - Any body movement produced by skeletal muscles that results in energy expenditure above resting level
- Exercise
  - Planned, structured, and repetitive physical activity focused on improving or maintaining a particular level of physical fitness (Caspersen, Powell, & Christenson, 1985)

CANADIAN PHYSICAL ACTIVITY GUIDELINES

Canadian Physical Activity Guidelines

FOR ADULTS - 18 – 64 YEARS

Guidelines

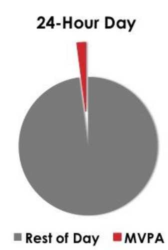
To achieve health benefits, adults aged 18-64 years should accumulate at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week, in bouts of 10 minutes or more.

It is also beneficial to add muscle and bone strengthening activities using major muscle groups, at least 2 days per week.

More physical activity provides greater health benefits.

From the Canadian Society for Exercise Physiology: www.csep.ca/CMFiles/Guidelines/CSEP_PAGuidelines_adults_en.pdf

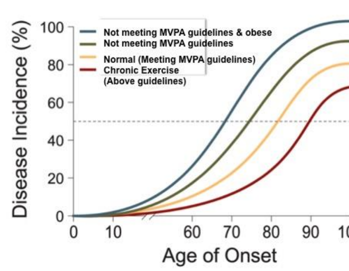
HOW ACTIVE ARE CANADIANS?



- Canadian adults accumulate an average of only 27 minutes of MVPA per day!
- 15% of adults accumulate a total of 150 minutes of MVPA per week!
- 5% of adults accumulate 150 min in 30+min bouts ≥5 days/week

Conclusion: Very few Canadians are sufficiently active! (Colley et al., 2011)

PHYSICAL ACTIVITY, AGE, & CHRONIC DISEASE INCIDENCE



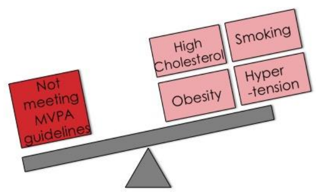
Take-home message: A lack of physical activity increases the risk for chronic disease incidence and reduces age of onset

(Handschin & Spiegelman, 2008)

PHYSICAL ACTIVITY AND HEALTH CONSEQUENCES

◆ Not meeting MVPA guidelines exposes an individual to a greater risk of dying than does smoking, obesity, hypertension, or high cholesterol

Risk Factors for All-cause Death



(Blair, 2009)

PHYSICAL ACTIVITY AND HEALTH

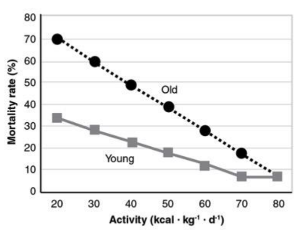
Summary of estimates of the prevalence of physical inactivity;* relative risks (RR); and population attributable fractions (PAF) for CHD, type 2 diabetes, breast cancer, colon cancer, and all-cause mortality associated with physical inactivity

	CHD	Type 2 diabetes	Breast cancer	Colon cancer	All-cause mortality
Prevalence of inactivity in population*	35.2 (22.3–40.5)	35.2 (22.3–40.5)	38.8 (23.3–44.3)	35.2 (22.3–40.5)	35.2 (22.3–40.5)
Prevalence of inactivity among persons eventually developing the outcome*	42.2 (23.0–56.2)	43.2 (23.6–57.6)	40.7 (22.5–56.7)	42.9 (23.4–57.1)	42.9 (23.4–57.1)
RR (95% confidence interval), unadjusted†	1.33 (1.18–1.49)	1.63 (1.27–2.11)	1.34 (1.25–1.43)	1.38 (1.31–1.45)	1.47 (1.38–1.57)
RR (95% confidence interval), adjusted†	1.16 (1.04–1.30)	1.20 (1.10–1.33)	1.33 (1.26–1.42)	1.32 (1.23–1.39)	1.28 (1.21–1.36)
PAF, using unadjusted RR‡	10.4 (7.2–13.4)	18.1 (10.8–22.8)	11.6 (6.8–15.5)	11.8 (6.8–15.1)	14.2 (8.3–18.0)
PAF, using adjusted RR‡	5.8 (3.2–7.8)	7.2 (3.9–9.6)	10.1 (5.6–14.1)	10.4 (5.7–13.8)	9.4 (5.1–12.5)

(Lee et al., 2012)

AGE AND PHYSICAL ACTIVITY

◆ Beneficial effects of physical activity are seen among **ALL** age groups



Mortality risk decreases as physical activity increases among both "young" and "old" individuals.

Take-home message: Physical activity is important for all ages!

(Dishman, Heath, & Lee, 2012)

MAKING PHYSICAL ACTIVITY GOALS

◆ If you are currently **not** meeting physical activity guidelines, you should **aim** to accumulate at least 150 minutes of MVPA physical activity per week, in bouts of 10 minutes or more.

From the Canadian Society for Exercise Physiology: http://www.csep.ca/CMFiles/Guidelines/CSEP_PAGuidelines_adults_en.pdf

TYPES OF PHYSICAL ACTIVITIES

Moderate-intensity activities will cause adults to sweat a little and to breathe harder.

Vigorous-intensity activities will cause adults to sweat and be 'out of breath'.

- Brisk walking
- Bike riding
- Jogging
- Cross-country skiing

From the Canadian Society for Exercise Physiology: http://www.csep.ca/CMFiles/Guidelines/CSEP_PAGuidelines_adults_en.pdf

PHYSICAL ACTIVITY AND HEALTH

◆ A major review published in the Canadian Medical Association Journal concluded that "regular physical activity contributes to the primary and secondary prevention of several chronic diseases and is associated with a reduced risk of premature death"

(Warburton, Nicol & Bredin, 2006)

PHYSICAL ACTIVITY AND PREMATURE DEATH

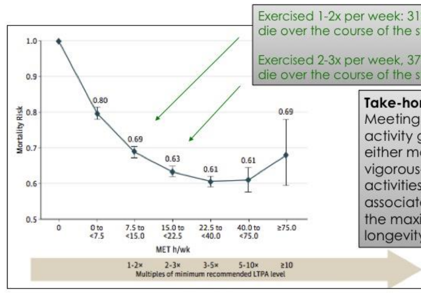
◆ In 2015, a large study in the Journal of the American Medical Association examined association between MVPA and mortality
- 661, 137 men and women (1993-2014)
- Median follow-up time was 14.2 years
- 116, 686 deaths occurred
- Exposure: Leisure time MVPA

(Arem et al., 2015)

PHYSICAL ACTIVITY AND PREMATURE DEATH

Exercised 1-2x per week: 31% less likely to die over the course of the study

Exercised 2-3x per week, 37% less likely to die over the course of the study



Take-home message: Meeting physical activity guidelines by either moderate- or vigorous-intensity activities was associated with nearly the maximum longevity benefit

(Arem et al., 2015)

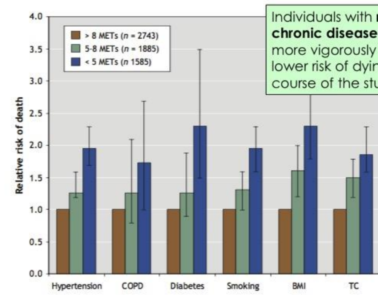
PHYSICAL ACTIVITY AND CHRONIC DISEASES

Regular exercise can:

- Lower the risk of colon cancer by 60%
- Reduce the risk of developing Alzheimer's disease by ~40%
- Reduce the incidence of heart disease & high blood pressure by ~40%
- Lower the risk of stroke by 27%
- Lower the risk of developing type II diabetes by 58%
- Can decrease depression as effectively as Prozac or behavioral therapy

Source: http://exerciseismedicine.org/assets/page_documents/EIMFactSheet_2014.pdf

PHYSICAL ACTIVITY AND HEALTH



Individuals with **risk factors or chronic diseases** who exercised more vigorously (>8 METS) had a lower risk of dying during the course of the study

(Warburton et al., 2006)

HOW TO INCORPORATE MVPA INTO YOUR DAY

BIKE OR WALK to work every day

Go to exercise at the GYM

Go for a BRISK WALK around the block after dinner

Take a DANCE CLASS after work

Join a weekday community RUNNING OR WALKING GROUP

HOW TO INCORPORATE MVPA INTO YOUR DAY

Be ACTIVE with the FAMILY on the weekend

Take up a FAVOURITE SPORT again or try a NEW SPORT

Do HOUSEHOLD CHORES or offer to help a neighbour rake the lawn

Train for and participate in a RUN or WALK for charity

Sign up for a GROUP EXERCISE CLASS

From the Canadian Society for Exercise Physiology: http://www.csep.ca/CMFiles/Guidelines/CSEP_PAGuidelines_adults_en.pdf

TAKE HOME MESSAGE

- Irrespective of age, not meeting MVPA guidelines is associated with chronic disease risk
- Getting 150 minutes of MVPA per week in 10-minute bouts or longer can really reduce your risk of developing a chronic disease

THANK YOU!

Appendix H: Complete Participant Questionnaire (Study 2)

Exercise & Health Psychology Laboratory

EHPL

The Health Action Process Approach and Movement Patterns in Adult Office Workers

2.

2. With which gender do you identify?

3. What is your age (in years)?

4. What is your ethnicity?

5. Are you a full time or part time employee?

- Full time
- Part time

6. Do you suffer from any medical condition which prohibits you from standing or doing light physical activity (e.g., spinal cord injury; confined to a wheelchair, etc.)?

- No
- Yes

7. How much do you weigh? (Answer ONE of the following):

How many pounds (lb.) do you weigh?

If you prefer, you can report your weight in kilograms (kg) here:

8. How tall are you? (Answer ONE of the following):

Enter your height in feet and inches (e.g., 6'2") [ ]

If you do not know your height in feet and inches, enter it in meters and centimeters here (e.g., 1.56m or 188cm) [ ]

9. Recently, have you given any thought to how much you sit?

Not at all	A little	Somewhat	Quite a bit	A lot
○	○	○	○	○

10. If you chose "Not at all" on the above question, please proceed to question 11. If you did not circle "Not at all" to the above question, please answer the following question.

Recently, have you monitored how much you sit?

Not at all	A little	Somewhat	Quite a bit	A lot
○	○	○	○	○

11. How many hours a week do you work for pay?

- ○ 0 hours
- ○ 10 or fewer hours per week
- ○ 11-20 hours per week
- ○ 21-30 hours per week
- ○ 31-40 hours per week
- ○ 40 or more hours per week

12. What sector are you employed in?

- ○ Private sector
- ○ Public sector
- ○ Charity
- ○ Other

4

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The Health Action Process Approach and Movement Patterns in Adult Office Workers

5.

The following questions ask about your thoughts and beliefs related to both occupational and leisure sitting time.

There are no right or wrong answers, so please answer honestly. The information you provide will be treated in the strictest confidence.

21. If I reduce my daily sitting time (i.e., at work and outside of work) over the next four weeks, then I would **expect to** . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Improve my blood sugar profile	○	○	○	○	○
Improve how effective my body is at using insulin to reduce high blood sugar levels	○	○	○	○	○
Improve my body's ability to maintain normal blood sugar levels	○	○	○	○	○
Improve my insulin profile	○	○	○	○	○

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22. If I spend too much time sitting (i.e., at work and outside of work) over the next four weeks, I will be at greater **risk for** . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Having high blood sugar	◯	◯	◯	◯	◯
Having poor insulin sensitivity (i.e., how effective the body is at using insulin to reduce high blood sugar levels)	◯	◯	◯	◯	◯
Having poor glucose tolerance (i.e., body's ability to maintain normal blood sugar levels)	◯	◯	◯	◯	◯
Developing diabetes	◯	◯	◯	◯	◯

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The Health Action Process Approach and Movement Patterns in Adult Office Workers

7.

25. Over the next four weeks, how confident are you that you can **reduce your daily sitting time at work** by ____?

	0% No Confidence	10%	20%	30%	40%	50%	60%	70%	80%	90%	100% Complete Confidence
15 minutes	○	○	○	○	○	○	○	○	○	○	○
30 minutes	○	○	○	○	○	○	○	○	○	○	○
45 minutes	○	○	○	○	○	○	○	○	○	○	○
1 hour	○	○	○	○	○	○	○	○	○	○	○
1 hour 30 minutes	○	○	○	○	○	○	○	○	○	○	○
2 hours	○	○	○	○	○	○	○	○	○	○	○
2 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
3 hours	○	○	○	○	○	○	○	○	○	○	○
3 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
4 hours	○	○	○	○	○	○	○	○	○	○	○
4 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
5+ hours	○	○	○	○	○	○	○	○	○	○	○

26. Over the next four weeks, how confident are you that you can increase the **NUMBER of breaks** you take in the course of a day from sitting **at work**?

	0% No Confidence	10%	20%	30%	40%	50%	60%	70%	80%	90%	100% Complete Confidence
1 additional break per day	○	○	○	○	○	○	○	○	○	○	○
2 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
3 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
4 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
5 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
6 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
7 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
8 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
9 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
10+ additional breaks per day	○	○	○	○	○	○	○	○	○	○	○

27. Over the next four weeks, how confident are you that you can increase the **LENGTH of your breaks** from sitting **at work** by ____?

	0% No Confidence	10%	20%	30%	40%	50%	60%	70%	80%	90%	100% Complete Confidence
30 seconds	○	○	○	○	○	○	○	○	○	○	○
1 minute	○	○	○	○	○	○	○	○	○	○	○
2 minutes	○	○	○	○	○	○	○	○	○	○	○
3 minutes	○	○	○	○	○	○	○	○	○	○	○
4 minutes	○	○	○	○	○	○	○	○	○	○	○
5 minutes	○	○	○	○	○	○	○	○	○	○	○
6-10 minutes	○	○	○	○	○	○	○	○	○	○	○
11-15 minutes	○	○	○	○	○	○	○	○	○	○	○
more than 15 minutes	○	○	○	○	○	○	○	○	○	○	○

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28. Over the next four weeks, how confident are you that you can **increase your daily time spent standing at work** by ____?

	0% No Confidence	10%	20%	30%	40%	50%	60%	70%	80%	90%	100% Complete Confidence
15 minutes	○	○	○	○	○	○	○	○	○	○	○
30 minutes	○	○	○	○	○	○	○	○	○	○	○
45 minutes	○	○	○	○	○	○	○	○	○	○	○
1 hour	○	○	○	○	○	○	○	○	○	○	○
1 hour 30 minutes	○	○	○	○	○	○	○	○	○	○	○
2 hours	○	○	○	○	○	○	○	○	○	○	○
2 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
3 hours	○	○	○	○	○	○	○	○	○	○	○
3 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
4 hours	○	○	○	○	○	○	○	○	○	○	○
4 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
5+ hours	○	○	○	○	○	○	○	○	○	○	○

29. Over the next four weeks, how confident are you that you can **increase your daily time spent in activities of light movement (i.e., stepping, walking) at work** by ____?

	0% No Confidence	10%	20%	30%	40%	50%	60%	70%	80%	90%	100% Complete Confidence
15 minutes	○	○	○	○	○	○	○	○	○	○	○
30 minutes	○	○	○	○	○	○	○	○	○	○	○
45 minutes	○	○	○	○	○	○	○	○	○	○	○
1 hour	○	○	○	○	○	○	○	○	○	○	○
1 hour 30 minutes	○	○	○	○	○	○	○	○	○	○	○
2 hours	○	○	○	○	○	○	○	○	○	○	○
2 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
3 hours	○	○	○	○	○	○	○	○	○	○	○
3 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
4 hours	○	○	○	○	○	○	○	○	○	○	○
4 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
5+ hours	○	○	○	○	○	○	○	○	○	○	○

The Health Action Process Approach and Movement Patterns in Adult Office Workers

8.

30. Over the next four weeks, how confident are you that you can **reduce your daily sitting time outside of work** by ____?

	0% No Confidence	10%	20%	30%	40%	50%	60%	70%	80%	90%	100% Complete Confidence
15 minutes	○	○	○	○	○	○	○	○	○	○	○
30 minutes	○	○	○	○	○	○	○	○	○	○	○
45 minutes	○	○	○	○	○	○	○	○	○	○	○
1 hour	○	○	○	○	○	○	○	○	○	○	○
1 hour 30 minutes	○	○	○	○	○	○	○	○	○	○	○
2 hours	○	○	○	○	○	○	○	○	○	○	○
2 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
3 hours	○	○	○	○	○	○	○	○	○	○	○
3 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
4 hours	○	○	○	○	○	○	○	○	○	○	○
4 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
5+ hours	○	○	○	○	○	○	○	○	○	○	○

31. Over the next four weeks, how confident are you that you can increase the **NUMBER of breaks** you take in the course of a day from sitting **outside of work**?

	0% No Confidence	10%	20%	30%	40%	50%	60%	70%	80%	90%	100% Complete Confidence
1 additional break per day	○	○	○	○	○	○	○	○	○	○	○
2 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
3 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
4 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
5 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
6 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
7 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
8 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
9 additional breaks per day	○	○	○	○	○	○	○	○	○	○	○
10+ additional breaks per day	○	○	○	○	○	○	○	○	○	○	○

32. Over the next four weeks, how confident are you that you can increase the **LENGTH of your breaks** from sitting **outside of work** by ____?

	0% No Confidence	10%	20%	30%	40%	50%	60%	70%	80%	90%	100% Complete Confidence
30 seconds	○	○	○	○	○	○	○	○	○	○	○
1 minute	○	○	○	○	○	○	○	○	○	○	○
2 minutes	○	○	○	○	○	○	○	○	○	○	○
3 minutes	○	○	○	○	○	○	○	○	○	○	○
4 minutes	○	○	○	○	○	○	○	○	○	○	○
5 minutes	○	○	○	○	○	○	○	○	○	○	○
6-10 minutes	○	○	○	○	○	○	○	○	○	○	○
11-15 minutes	○	○	○	○	○	○	○	○	○	○	○
more than 15 minutes	○	○	○	○	○	○	○	○	○	○	○

33. Over the next four weeks, how confident are you that you can**increase your daily time spent standing outside of work** by ____?

	0% No Confidence	10%	20%	30%	40%	50%	60%	70%	80%	90%	100% Complete Confidence
15 minutes	○	○	○	○	○	○	○	○	○	○	○
30 minutes	○	○	○	○	○	○	○	○	○	○	○
45 minutes	○	○	○	○	○	○	○	○	○	○	○
1 hour	○	○	○	○	○	○	○	○	○	○	○
1 hour 30 minutes	○	○	○	○	○	○	○	○	○	○	○
2 hours	○	○	○	○	○	○	○	○	○	○	○
2 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
3 hours	○	○	○	○	○	○	○	○	○	○	○
3 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
4 hours	○	○	○	○	○	○	○	○	○	○	○
4 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
5+ hours	○	○	○	○	○	○	○	○	○	○	○

34. Over the next four weeks, how confident are you that you can**increase your daily time spent in activities of light movement (i.e., stepping, walking) outside of work** by ____?

	0% No Confidence	10%	20%	30%	40%	50%	60%	70%	80%	90%	100% Complete Confidence
15 minutes	○	○	○	○	○	○	○	○	○	○	○
30 minutes	○	○	○	○	○	○	○	○	○	○	○
45 minutes	○	○	○	○	○	○	○	○	○	○	○
1 hour	○	○	○	○	○	○	○	○	○	○	○
1 hour 30 minutes	○	○	○	○	○	○	○	○	○	○	○
2 hours	○	○	○	○	○	○	○	○	○	○	○
2 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
3 hours	○	○	○	○	○	○	○	○	○	○	○
3 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
4 hours	○	○	○	○	○	○	○	○	○	○	○
4 hours 30 minutes	○	○	○	○	○	○	○	○	○	○	○
5+ hours	○	○	○	○	○	○	○	○	○	○	○

Exercise & Health Psychology Laboratory

The Health Action Process Approach and Movement Patterns in Adult Office Workers

9.

The following questions ask about your intentions regarding **the time you spend sitting at work:**

35. Over the next four weeks . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I INTEND to reduce the amount of time that I spend sitting at work.	○	○	○	○	○
I PLAN to reduce the amount of time that I spend sitting at work.	○	○	○	○	○
My GOAL is to reduce the amount of time that I spend sitting at work.	○	○	○	○	○

36. Over the next four weeks . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I INTEND to increase the number of breaks that I take per day from sitting at work.	○	○	○	○	○
I PLAN to increase the number of breaks that I take per day from sitting at work.	○	○	○	○	○
My GOAL is to increase the number of breaks that I take per day from sitting at work.	○	○	○	○	○

37. Over the next four weeks . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I INTEND to increase the length of breaks that I take from sitting at work.	○	○	○	○	○
I PLAN to increase the length of breaks that I take from sitting at work.	○	○	○	○	○
My GOAL is to increase the length of breaks that I take from sitting at work.	○	○	○	○	○

38. Over the next four weeks . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I INTEND to increase the amount of time that I spend standing at work.	○	○	○	○	○
I PLAN to increase the amount of time that I spend standing at work.	○	○	○	○	○
My GOAL is to increase the amount of time that I spend standing at work.	○	○	○	○	○

39. Over the next four weeks . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I INTEND to increase the amount of time that I spend in light movement at work.	○	○	○	○	○
I PLAN to increase the amount of time that I spend in light movement at work.	○	○	○	○	○
My GOAL is to increase the amount of time that I spend in light movement at work.	○	○	○	○	○

Exercise & Health Psychology Laboratory

The Health Action Process Approach and Movement Patterns in Adult Office Workers

10.

The following questions ask about your intentions regarding**the time you spend sitting outside of work:**

40. Over the next four weeks . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I INTEND to reduce the amount of time that I spend sitting outside of work.	○	○	○	○	○
I PLAN to reduce the amount of time that I spend sitting outside of work.	○	○	○	○	○
My GOAL is to reduce the amount of time that I spend sitting outside of work.	○	○	○	○	○

41. Over the next four weeks . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I INTEND to increase the number of breaks that I take per day from sitting outside of work.	○	○	○	○	○
I PLAN to increase the number of breaks that I take per day from sitting outside of work.	○	○	○	○	○
My GOAL is to increase the number of breaks that I take per day from sitting outside of work.	○	○	○	○	○

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42. Over the next four weeks . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I INTEND to increase the length of breaks that I take from sitting outside of work.	○	○	○	○	○
I PLAN to increase the length of breaks that I take from sitting outside of work.	○	○	○	○	○
My GOAL is to increase the length of breaks that I take from sitting outside of work.	○	○	○	○	○

43. Over the next four weeks . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I INTEND to increase the amount of time that I spend standing outside of work.	○	○	○	○	○
I PLAN to increase the amount of time that I spend standing outside of work.	○	○	○	○	○
My GOAL is to increase the amount of time that I spend standing outside of work.	○	○	○	○	○

44. Over the next four weeks . . .

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I INTEND to increase the amount of time that I spend in light movement outside of work.	○	○	○	○	○
I PLAN to increase the amount of time that I spend in light movement outside of work.	○	○	○	○	○
My GOAL is to increase the amount of time that I spend in light movement outside of work.	○	○	○	○	○

Exercise & Health
Psychology Laboratory

The Health Action Process Approach and Movement Patterns in Adult Office Workers

11.

45. During a typical 7-day period (a week), how many times on average do you do the following kinds of exercise for more than 15 minutes during your free time?

(Write on each line the appropriate number for times per week):

Strenuous exercise (Heart beats rapidly) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling) __________

Moderate exercise (Not exhausting) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing) __________

Mild/Light exercise (Minimal effort) (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snowmobiling, easy walking) __________

Over the past **7 days**, on average, how much time did you spend (from when you woke up until you went to bed) doing the following?

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46. Sitting and watching TV

- None
- 15 min or less per day
- 30 min per day
- 1 hour per day
- 2 hours per day
- 3 hours per day
- 4 hours per day
- 5 hours per day
- 6 hours per day
- 7 hours per day
- 8 hours per day
- 9+ hours per day

47. Sitting and using the computer for recreational purposes (i.e., games, Facebook, Youtube, movies, music, Skype, social media websites, etc.)

- None
- 15 min or less per day
- 30 min per day
- 1 hour per day
- 2 hours per day
- 3 hours per day
- 4 hours per day
- 5 hours per day
- 6 hours per day
- 7 hours per day
- 8 hours per day
- 9+ hours per day

48. Sitting for work (working at the computer, talking on the phone, office work, studying, reading, sitting in meetings, teleconferences, etc.)

- None
- 15 min or less per day
- 30 min per day
- 1 hour per day
- 2 hours per day
- 3 hours per day
- 4 hours per day
- 5 hours per day
- 6 hours per day
- 7 hours per day
- 8 hours per day
- 9+ hours per day

49. Sitting reading for pleasure

- None
- 15 min or less per day
- 30 min per day
- 1 hour per day
- 2 hours per day
- 3 hours per day
- 4 hours per day
- 5 hours per day
- 6 hours per day
- 7 hours per day
- 8 hours per day
- 9+ hours per day

50. Sitting and listening to music

- None
- 15 min or less per day
- 30 min per day
- 1 hour per day
- 2 hours per day
- 3 hours per day
- 4 hours per day
- 5 hours per day
- 6 hours per day
- 7 hours per day
- 8 hours per day
- 9+ hours per day

51. Sitting and playing a music instrument

- None
- 15 min or less per day
- 30 min per day
- 1 hour per day
- 2 hours per day
- 3 hours per day
- 4 hours per day
- 5 hours per day
- 6 hours per day
- 7 hours per day
- 8 hours per day
- 9+ hours per day

52. Sitting and doing arts and crafts (e.g., scrapbooking, cardmaking, painting, drawing)

- None
- 15 min or less per day
- 30 min per day
- 1 hour per day
- 2 hours per day
- 3 hours per day
- 4 hours per day
- 5 hours per day
- 6 hours per day
- 7 hours per day
- 8 hours per day
- 9+ hours per day

53. Sitting in a motor vehicle in order to get to work (i.e., commuting in a car or sitting in a bus or train).

- None
- 15 min or less per day
- 30 min per day
- 1 hour per day
- 2 hours per day
- 3 hours per day
- 4 hours per day
- 5 hours per day
- 6 hours per day
- 7 hours per day
- 8 hours per day
- 9+ hours per day

54. Sitting in a motor vehicle for leisure-related transportation purposes (i.e., sitting in a car, bus, or train to get to and from recreational activities, visiting friends or family, going out, etc.)

- ◯ None
- ◯ 15 min or less per day
- ◯ 30 min per day
- ◯ 1 hour per day
- ◯ 2 hours per day
- ◯ 3 hours per day
- ◯ 4 hours per day
- ◯ 5 hours per day
- ◯ 6 hours per day
- ◯ 7 hours per day
- ◯ 8 hours per day
- ◯ 9+ hours per day

55. Sitting and eating

- ◯ None
- ◯ 15 min or less per day
- ◯ 30 min per day
- ◯ 1 hour per day
- ◯ 2 hours per day
- ◯ 3 hours per day
- ◯ 4 hours per day
- ◯ 5 hours per day
- ◯ 6 hours per day
- ◯ 7 hours per day
- ◯ 8 hours per day
- ◯ 9+ hours per day

56. Sitting and socializing/visiting or non-work related phone conversations (e.g., talking with a friend, family member, etc.)

- ◯ None
- ◯ 15 min or less per day
- ◯ 30 min per day
- ◯ 1 hour per day
- ◯ 2 hours per day
- ◯ 3 hours per day
- ◯ 4 hours per day
- ◯ 5 hours per day
- ◯ 6 hours per day
- ◯ 7 hours per day
- ◯ 8 hours per day
- ◯ 9+ hours per day

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57. Sitting for religious or spiritual pursuits (e.g., meditation, prayer, sitting in church or other religious/spiritual meetings)

- ◯ None
- ◯ 15 min or less per day
- ◯ 30 min per day
- ◯ 1 hour per day
- ◯ 2 hours per day
- ◯ 3 hours per day
- ◯ 4 hours per day
- ◯ 5 hours per day
- ◯ 6 hours per day
- ◯ 7 hours per day
- ◯ 8 hours per day
- ◯ 9+ hours per day

Thank you for participating in this survey!

All participants have the chance to win a $100 Tim Hortons or Starbucks gift certificate.

If you wish to be entered into the draw to win a $100 Tim Hortons or Starbucks gift certificate, please enter your email below. Please click 'DONE' when you are finished.

If you do not wish to provide your email, please skip this question by leaving the textbox below blank and clicking DONE.

58. What is your email?

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Appendix I: Ethics Approval (Study 3)

Western Research

Date: 12 April 2018

To: Prof. Harry Prapavessis

Project ID: 111472

Study Title: Using a combined Health Action Process Approach and Mobile Health Intervention to Increase Non-Sedentary Behaviours in Office-Working Adults – A Randomized Controlled Trial

Application Type: HSREB Initial Application

Review Type: Full Board

Meeting Date : 20/Mar/2018 13:00

Date Approval Issued: 12/Apr/2018 14:44

REB Approval Expiry Date: 12/Apr/2019

Dear Prof. Harry Prapavessis

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

Documents Approved:

Document Name	Document Type	Document Date
Debriefing Form - April 4th, 2018	Debriefing Letter	04/Apr/2018
Email Script - Engagement of Key Contacts - Apr 4th, 2018	Recruitment Materials	04/Apr/2018
Email Script - Engagement of Key Contacts - Email Response - Apr 4th, 2018	Recruitment Materials	04/Apr/2018
Email Script - Initial Contact Email - Apr 9th, 2018	Email Script	09/Apr/2018
Email Script - Post-baseline Email - Control Participants -Apr 9th, 2018	Email Script	09/Apr/2018
Email Script - Post-baseline Email - Intervention Participants -Apr 9th, 2018	Email Script	09/Apr/2018
Email Script - Recruitment of Participants - Apr 4th, 2018	Recruitment Materials	04/Apr/2018
HAPA Intervention - Planning Sheet - Feb 26th, 2018	Other Participant Material(s)	26/Feb/2018
HAPA Intervention Behavioural Counseling Slides - Feb 26th, 2018	Other Participant Material(s)	26/Feb/2018
HAPA Intervention Group - Example Text-Messages - Feb 27th, 2018	Other Participant Material(s)	27/Feb/2018

LOI - Participants - Apr 11th, 2018	Written Consent/Assent	11/Apr/2018
Recruitment Poster - Apr 4th, 2018	Recruitment Materials	04/Apr/2018
Recruitment Poster - Participants Initial Contact - Apr 4th, 2018	Recruitment Materials	04/Apr/2018
Social Media Post - Recruitment of Participants via Social Media - Apr 11th, 2018	Recruitment Materials	11/Apr/2018
Study 3 - Baseline Questionnaire - Apr 4th, 2018	Online Survey	04/Apr/2018
Study 3 - Week 2 Questionnaire - Apr 4th, 2018	Online Survey	04/Apr/2018
Study 3 - Week 4 Questionnaire - Apr 4th, 2018	Online Survey	04/Apr/2018
Study 3 - Week 6 Questionnaire - Apr 4th, 2018	Online Survey	04/Apr/2018
Study 3 - Week 8 Follow-up Questionnaire - Apr 4th, 2018	Online Survey	04/Apr/2018

No deviations from, or changes to, the protocol or WREM application should be initiated without prior written approval of an appropriate amendment from Western HSREB , except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriCouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Nicola Geoghegan-Morphet, Ethics Officer on behalf of Dr. Joseph Gilbert, HSREB Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix J: Recruitment Poster (Study 3)

EHPL

Participants Needed for a Health Psychology Research Study

Western

- We are conducting a research study examining relationships between occupational activity levels, work habits, and perceived health and work-related outcomes in office-working adults.
- **Looking for adult office workers:** Are you 18 years of age or older? Are you a full-time employee in an office setting?
- Participants will be asked to complete a brief **online questionnaire** on **five occasions** over an 8 week period.
- Approximately ½ of participants will receive a single one-on-one behavioural counselling session regarding work-related activity patterns, as well as **daily** health-related text messages for **6-weeks**.

If you would like more information on this study, please contact the researcher, Scott Rollo, by email at arollo@uwo.ca.

****NOTE: Participation in the study is completely voluntary.***

[redacted]

EHPL Exercise & Health Psychology Laboratory

Appendix K: Email Script – Recruitment of Participants (Study 3)

Email Script for Recruitment

Subject Line: Invitation to Participate in a Health Psychology Research Study

Hello,

You are being invited to participate in a research study examining relationships between occupational activity levels, work habits, and perceived health and work-related outcomes in office-working adults. This is a research project being conducted by researchers in the School of Kinesiology at The University of Western Ontario.

If you choose to take part in this study, you will be ***asked*** to complete a brief online questionnaire on five occasions (i.e., once every two weeks) over an 8-week period. Each questionnaire will be administered using SoSci Survey (online survey service) and a link will be sent to your email on each occasion. The online questionnaires will include demographic questions, as well as questions that will ask about your work-related activity patterns and habits, as well as your perceived health and work performance, and each should take less than 10 minutes to complete. All responses are completely confidential. Approximately one half of participants will ***receive*** a single one-on-one behavioural counselling session regarding work-related activity patterns, as well as daily health-related text messages. The counselling session will be delivered by the researcher either in person or electronically after completion of the first online questionnaire, according to your schedule, and should take 20-30 minutes.

A recruitment poster with brief study information and participant details has been attached to this email.

If you would like more information on this study please contact the researcher, Scott Rollo, by email at [redacted].

Thank you,

Scott Rollo, MSc, BA
PhD Candidate, Kinesiology
Exercise and Health Psychology Laboratory
School of Kinesiology
The University of Western Ontario Canada
[redacted]

Harry Prapavessis PhD
Professor
Director Exercise and Health Psychology Lab
School of Kinesiology
The University of Western Ontario
[redacted]

Appendix L: Email Script – Initial Contact Email (Study 3)

Email Script for Recruitment

Subject Line: Invitation to Participate in an Exercise and Health Psychology Research Study

Hello,

Thank you for your interest in participating in a research study examining relationships between occupational activity levels, work habits, and perceived health and work-related outcomes in office-working adults. This is a research project being conducted by researchers in the School of Kinesiology at The University of Western Ontario.

A recruitment poster with brief study information and participant details has been attached to this email.

To be eligible to participate, you are required to: (a) be 18+ years of age, (b) be a full-time worker/employee in an office setting, (c) be in self-reported good mental and physical health, (d) be able to read and write in English, (e) have access to a computer with Internet, and (f) own a mobile phone with free unlimited incoming text messages.

If you meet these eligibility criteria and would like to participate, please click on the link below to access the letter of information, informed consent, and first questionnaire:

[redacted]

Please complete this at your earliest convenience.

All participants will have the chance to win a $100 Tim Hortons or Starbucks gift certificate.

I look forward to hearing back from you!

Much Appreciated,

Scott Rollo, MSc, BA
PhD Candidate, Kinesiology
Exercise and Health Psychology Laboratory
School of Kinesiology
The University of Western Ontario Canada

Harry Prapavessis PhD
Professor
Director Exercise and Health Psychology Lab
School of Kinesiology
The University of Western Ontario

Appendix M: Letter of Information and Informed Consent (Study 3)

Exercise & Health Psychology Laboratory

Study Title: The Relationship between Work-related Activity Patterns, Habits, and Perceived Health in Office-Working Adults

Investigators: Scott Rollo, Ph.D. Candidate (Co-investigator; [redacted]) & Harry Prapavessis, Ph.D. (Principal investigator; [redacted]), School of Kinesiology, Western University.

You are being invited to participate in a research study examining the relationships between work-related activity patterns and perceived health and work-related outcomes in office-working adults because you work in an office setting. The purpose of this letter is to provide you with information required for you to make an informed decision regarding participation in this research.

Purpose of this Study

This is a research project being conducted by researchers in the School of Kinesiology at Western University. The purpose of the study is to examine if relationships exist between occupational activity levels, work habits, and perceived health and work-related outcomes in adult office workers.

Inclusion Criteria

To be eligible to participate, individuals must: (a) be 18+ years of age, (b) be a full-time worker/employee in an office setting, (c) be able to read and write in English, (d) have access to a computer with Internet, and (e) own a mobile phone with free unlimited incoming text messages.

Study Procedures

If you choose to take part in this study, you will be asked to complete a brief online questionnaire on five occasions (i.e., once every two weeks) over an 8-week period. All questionnaires were created with SoSci Survey (Leiner, 2014), and will be made available to participants on www.soscisurvey.com. SoSci Survey is hosted on a European server, secure against unauthorized access according to common international standards, and is subject to the German data protection law. The online questionnaires will include demographic questions, as well as questions that will ask about your work-related activity patterns and habits, as well as your perceived health and work performance, and each should take less than 10 minutes to complete. All responses are completely confidential. Approximately one half of participants will receive a single one-on-one behavioural counselling session regarding work-related activity patterns, as well as daily health-related text messages. The counselling session will be delivered by the researcher either in person or electronically after completion of the first online questionnaire, according to your schedule, and should take 20-30 minutes. Upon study completion, all participants who did not receive the counselling session initially will be offered this session. It will be entirely up to you as to whether you would like to accept our offer, should this be the case. All participants will be entered into a draw for a chance to win a $100 Tim Hortons or Starbucks gift certificate at study completion.

Possible Risks and Harms

Anticipated risks or discomforts associated with participating in this study include disruption of your personal and/or work time to complete study surveys. Additionally, there is a risk of privacy breach.

Possible Benefits

By participating in this study, you may learn more about the relationship between work-related movement patterns and health, as well as have a chance to reflect upon and modify your own behaviour. You may also learn helpful strategies to modify your work-related activity patterns. You may also not receive any benefit from taking part in the study. In addition, the information gathered may provide benefits to society as a whole.

Voluntary Participation

Participation in this study is voluntary. You are free to discontinue and withdraw your participation from this study at any time. You also may choose to skip any questions that you do not wish to answer. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your future employment status. If you choose to withdraw from the study, you will be asked if any data collected from you prior to the point of withdrawal can still be used or if you would like it to be discarded and destroyed. No legal rights are waived by agreeing to participate.

Confidentiality and Publication

All data collected will remain confidential and accessible only to the investigators of this study and if required, Western University Health Sciences Research Ethics Board whom may access study data for monitoring or audit purposes. By agreeing to participate in this study, you will be asked to provide your phone number which will be entered into a web-based application and text-message website (http://ohdontforget.com) for purposes of sending you text message reminders over the course of the study. Your phone number will not be distributed, will only be used by the researchers of this study, and will be deleted from http://ohdontforget.com upon study completion. You will also be sent an individualized web-link to access and complete an online questionnaire through https://www.soscisurvey.de on five occasions. This will be sent to you via your private email and only you will be able to access the survey; no identifying information will be required. Please be advised that email is not a secure method of communication. Your data will be retained for 7 years and will be stored on a password-protected University of Western Ontario computer located in the Exercise and Health Psychology Lab in the Arthur & Sonia Labatt Health Sciences Building Room 408. The information from this research project will be submitted, upon completion, for publication in a peer-reviewed academic journal as well as presented at relevant conferences.

Contacts for Further Information

If you require any further information regarding this research project or your participation in the study you may contact Scott Rollo ([redacted]) or Harry Prapavessis ([redacted]). If you have any questions about your rights as a research participant or the conduct of this study, you may contact The Office of Research Ethics [redacted], email: [redacted].

Informed Consent:
I have read the Letter of Information, have had the nature of the study explained to me and I agree to partake. All questions have been answered to my satisfaction.

_______________________ ___________________ __________________

Print Name of Participant Signature *Date (DD-MMM-YYYY)*

My signature means that I have explained the study to the participant named above. I have answered all questions.

____________________ ___________________ __________________

Print Name of Person Signature *Date (DD-MMM-YYYY)*

Obtaining Consent

Appendix N: Participant Questionnaire – Primary and Secondary Outcomes (Study 3)

1. Clicking on the "agree" button below indicates that you have read the above information, you voluntarily agree to participate and you are at least 18 years of age.

If you do not wish to participate in the research study, please decline participation by clicking on the "disagree" button.

Agree

Disagree

Page 02

2. With which gender do you identify?

3. What is your age (in years)?

4. What is your ethnicity?

People living in Canada come from many different cultural and racial backgrounds. Are you:

[Please choose]

5. Do you suffer from any medical condition, which prohibits you from standing or doing light physical activity (e.g., spinal cord injury; confined to a wheelchair, etc.), or have you ever been told by your doctor to avoid physical activity?

No

Yes

6. How much do you weigh?

Please answer ONE of the following:

How many pounds (lb) do you weigh?	
If you prefer, you can report your weight in kilograms (kg) here:	

7. How tall are you?

Please answer ONE of the following:

Enter your height in feet and inches (e.g., 6'2")	
If you do not know your height in feet and inches, enter it in meters or centimeters here (e.g., 1.56m or 188cm)	

8. Are you a full time or part time employee?

Full time

Part time

9. How many hours a week do you work for pay?

0 hours

10 or fewer hours per week

11-20 hours per week

21-30 hours per week

31-40 hours per week

40 or more hours per week

10. What sector are you employed in?

Private sector

Public sector

Charity

Other

11. Recently, have you given any thought to how much you sit?

Not at all	A little	Somewhat	Quite a bit	A lot

12. Recently, have you monitored how much you sit?

Not at all	A little	Somewhat	Quite a bit	A lot

15. During a typical 7-day period (a week), how many times on average do you do the following kinds of exercise for more than 15 minutes during your free time?

Write on each line the appropriate number for times per week:

Strenuous exercise (Heart beats rapidly) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)	
Moderate exercise (Not exhausting) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)	
Mild/Light exercise (Minimal effort) (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snowmobiling, easy walking)	

On a typical weekday, how much time do you spend (from when you wake up until you go to bed) doing the following?

16. Sitting and watching TV

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

17. Sitting and using the computer for recreational purposes (i.e., games, Facebook, Youtube, movies, music, Skype, social media websites, etc.)

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

18. Sitting for work (working at the computer, talking on the phone, office work, studying, reading, sitting in meetings, teleconferences, etc.)

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

19. Sitting reading for pleasure

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

20. Sitting and listening to music

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

21. Sitting and playing a music instrument

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

22. Sitting and doing arts and crafts (e.g., scrapbooking, cardmaking, painting, drawing)

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

23. Sitting in a motor vehicle in order to get to work (i.e., commuting in a car or sitting in a bus or train)

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

24. Sitting in a motor vehicle for leisure-related transportation purposes (i.e., sitting in a car, bus, or train to get to and from recreational activities, visiting friends or family, going out, etc.)

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

25. Sitting and eating

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

26. Sitting and socializing/visiting or non-work related phone conversations (e.g., talking with a friend, family member, etc.)

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

27. Sitting for religious or spiritual pursuits (e.g., meditation, prayer, sitting in church or other religious/spiritual meetings)

None

15 min or less per day

30 min per day

1 hour per day

2 hours per day

3 hours per day

4 hours per day

5 hours per day

6 hours per day

7 hours per day

8 hours per day

9+ hours per day

The following questions ask about your plans with regards to reducing your sitting time at work.

33. During the last two weeks, I had a detailed plan regarding . . .

	Completely Disagree	Disagree	Neutral	Agree	Totally Agree
... when to break up my sitting time at work					
... where to break up my sitting time at work					
... how to break up my sitting time at work					
... how often to break up my sitting time at work					

34. During the last two weeks, I had a detailed plan regarding . . .

	Completely Disagree	Disagree	Neutral	Agree	Totally Agree
... what to do if something interferes with my plans to break up my sitting time at work					
... how to cope with possible setbacks from breaking up my sitting time at work					
... what to do in difficult situations in order to act according to my intentions to break up my sitting time at work					
... which good opportunities for action to take in order to break up my sitting time at work					
... when I have to pay extra attention to prevent lapses from breaking up my sitting time at work					

35. During the last two weeks, I have . . .

	Completely Disagree	Disagree	Neutral	Agree	Totally Agree
... constantly monitored myself whether I break up my sitting time at work often enough					
... watched carefully that I break up my sitting time at work often enough					
... had my intention to regularly break up my sitting time at work often on my mind					
... always been aware of my action and coping plans to break up my sitting time at work					
... really tried to regularly break up my sitting time at work					
... tried my best to act in accordance to my break frequency and duration standards					

36. How would you rate your overall work performance?

0	1	2	3	4	5	6	7	8	9	10
Absolutely Unacceptable										Absolutely Ideal

37. During the past 6 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	Yes	No
Cut down the amount of time you spent on work or other activities		
Accomplished less than you would like		
Were limited in the kind of work or other activities		
Had difficulty performing the work or other activities (for example, it took extra effort)		

38. During the past 6 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	Yes	No
Cut down the amount of time you spent on work or other activities		
Accomplished less than you would like		
Didn't do work or other activities as carefully as usual		

39. These questions are about how you feel and how things have been with you during the past 6 weeks.

For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the past 6 weeks...	All of the time	Most of the time	Some of the time	A little of the time	None of the time
Did you feel full of pep?					
Have you been a very nervous person?					
Have you felt so down in the dumps that nothing could cheer you up?					
Have you felt calm and peaceful?					
Did you have a lot of energy?					
Have you felt downhearted and blue?					
Did you feel worn out?					
Have you been a happy person?					
Did you feel tired?					

Page 05

40. How many hours did you work in the last 14 days?

Please enter the number of HOURS (e.g., 40, 80, 105) you worked in total over the last two weeks.

_____ hours

41. During the last 14 days, how many days were you at work?

Please enter the number of DAYS (e.g., 1, 3, 5, 10) you worked in total over the last two weeks.

days

42. In the last 14 days, on average, how often did you interrupt your sitting time (i.e., take a break to get up and move around) during work hours?

Less than every 30 min

Every 30–45 min

Every 45 min–1 hour

Every 1–1.5 hours

Every 1.5–2 hours

Every 2–3 hours

Every 3–4 hours

Every 4–5 hours

Every 5-6 hours

Every 6-7 hours

Over every 7 hours

No interruption

43. In the last 14 days, on average, how long were your breaks from sitting during work hours?

Less than 30 sec

30 sec–1 min

1–2 min

2–3 min

3–4 min

4–5 min

5–10 min

10–15 min

15–30 min

Over 30 min

44. How would you describe your typical work day in the last 14 days?

This involves only your work day, and does not include travel to and from work, or what you did in your leisure time.

Please enter a percentage ranging from 0-100% for each item and make sure the TOTAL ADDS UP TO 100%.

Sitting (including driving)	%
Standing	%
Walking	%
Stretching	%
Sum	0 %

45. Please answer the following question so we are able to match your responses from all surveys. We ask that you record your response to the question below and keep this as your unique identifier code until study completion.

Please enter the first three letters of your mother's maiden name followed by YOUR year of birth (e.g., Smi1973).

Last Page

Thank you for completing this questionnaire!

You will be asked to complete a brief online questionnaire once every two weeks for the next 8-weeks. A link to the survey will be sent to your email at these times as a reminder.

Your answers were transmitted, you may close the browser window or tab now.

M.Sc. Scott Rollo, The University of Western Ontario – 2018

Appendix O: Email Script – Post Baseline Email (Intervention) (Study 3)

Email Script for Recruitment

Subject Line: Invitation to Participate in an Exercise and Health Psychology Research Study

Hello,

Thank you for agreeing to participate in this research study examining relationships between occupational activity levels, work habits, and perceived health and work-related outcomes in office-working adults.

We appreciate you taking the time to complete the first questionnaire!

You will be asked to complete a brief online questionnaire once every two weeks for the next 8-weeks. A link to the survey will be sent to your email at these times as a reminder.

You have been randomly selected to receive a single one-on-one behavioural counselling session regarding reducing your workplace sitting time, as well as daily sitting- and activity-related text messages. The counselling session will be delivered by the researcher either in person or electronically, according to the your preferences and schedule, and should take 20-30 minutes in total.

We would appreciate it if you could provide a few dates and times (over the next three days) in which you would be available, either in person or electronically (based on your preference), to connect for a brief behavioural counselling session pertaining to work-related activity patterns. At this time, you will also be asked to provide your written informed consent.

I look forward to hearing back from you!

Much Appreciated,

Scott Rollo, MSc, BA
PhD Candidate, Kinesiology
Exercise and Health Psychology Laboratory
School of Kinesiology
The University of Western Ontario Canada
[redacted]

Harry Prapavessis PhD
Professor
Director Exercise and Health Psychology Lab
School of Kinesiology
The University of Western Ontario
[redacted]

Appendix P: Email Script – Post Baseline Email (Control) (Study 3)

Email Script for Recruitment

Subject Line: Invitation to Participate in an Exercise and Health Psychology Research Study

Hello,

Thank you for agreeing to participate in this research study examining relationships between occupational activity levels, work habits, and perceived health and work-related outcomes in office-working adults.

We appreciate you taking the time to complete the first questionnaire!

You will be asked to complete a brief online questionnaire once every two weeks for the next 8-weeks. A link to the survey will be sent to your email at these times as a reminder.

We would appreciate it if you could take a moment of your time to read the attached letter of information and if you are willing, sign and return the attached informed consent via email at your earliest convenience. If you have any questions or concerns, please do not hesitate to send us an email.

Much Appreciated,

Scott Rollo, MSc, BA
PhD Candidate, Kinesiology
Exercise and Health Psychology Laboratory
School of Kinesiology
The University of Western Ontario Canada
[redacted]

Harry Prapavessis PhD
Professor
Director Exercise and Health Psychology Lab
School of Kinesiology
The University of Western Ontario
[redacted]

Appendix Q: Health Action Process Approach Intervention – Behavioural Counselling Slides (Study 3)

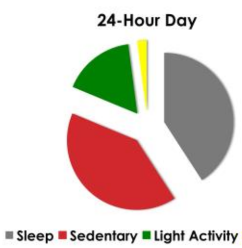
SEDENTARY BEHAVIOUR

THE TRUTH ABOUT TOO MUCH SITTING

WHAT IS SEDENTARY BEHAVIOUR?

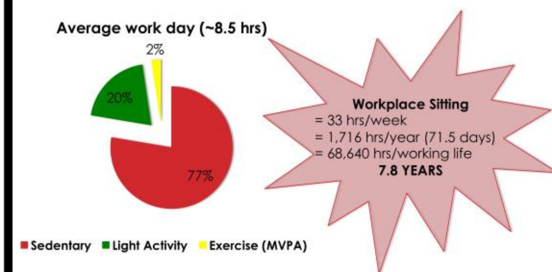
◆ Any waking activity characterized by an energy expenditure under 1.5 METs and a sitting or reclining posture (Sedentary Behaviour Research Network, 2012)

HOW SEDENTARY ARE CANADIANS?



◆ Canadian adults spend a whopping 9.7 hours of their daily waking hours being sedentary! (Colley et al., 2011)

SEDENTARY PATTERNS DURING WORK HOURS IN OFFICE WORKERS



(Thorp et al., 2012)

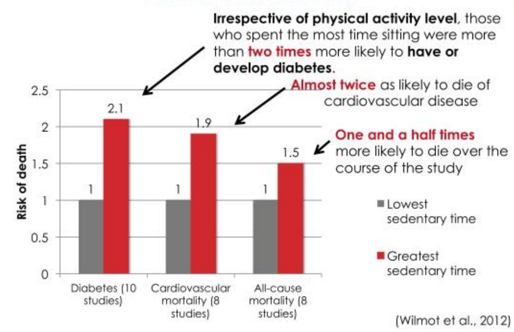
SEDENTARY BEHAVIOUR AND HEALTH

◆ An overview of 27 systematic reviews on sedentary behaviour (SB) and health outcomes showed that irrespective of physical activity, time spent in SB is *positively associated* with:

- Death from any cause (i.e., all-cause mortality)
- Numerous chronic diseases:
  - ◆ Fatal and non-fatal cardiovascular disease
  - ◆ Type 2 diabetes
  - ◆ Several types of cancers
  - ◆ Metabolic syndrome (problems with insulin, increases in fat around stomach, higher levels of fat and sugar in bloodstream)

(de Rezende et al., 2014)

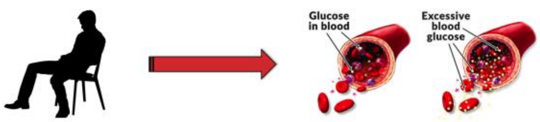
HOW STRONG IS THE ASSOCIATION?



(Wilmot et al., 2012)

ACUTE EFFECTS AMONG ADULTS

- **Systematic review** on acute effects of sedentary behaviour (Saunders et al., 2012)
  - Uninterrupted sedentary behaviour ≤7 days results in moderate and deleterious changes in insulin sensitivity and glucose tolerance
  - Most participants were healthy young men



ACUTE EFFECTS AMONG ADULTS

- Examples:
  - 2 hours of sitting = **~50%** reduced glucose tolerance (Nygaard et al., 2009)
  - 1 day of sitting = **39%** reduced insulin sensitivity (Stephens et al., 2011)

THE "ACTIVE COUCH POTATO"

- An individual who meets physical activity guidelines but spends most of the day being sedentary
- Sedentary time still related with adverse health outcomes, even if meeting physical activity guidelines

HOW TO REDUCE YOUR RISK

① **Stand up**

② **Sit less**

③ **Move more, More often**

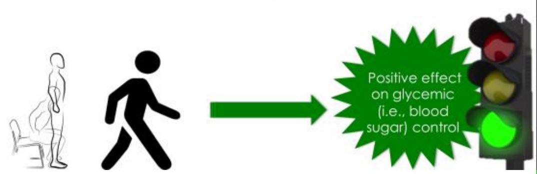
THE EFFECTIVENESS OF BREAKING UP SEDENTARY BEHAVIOUR

- In a large sample of Canadian adults (~5000), it was shown that each additional 10 breaks/day is *beneficially* associated with:
  - ⬇ Waist circumference
  - ⬇ Systolic blood pressure
  - ⬆ HDL- "good" cholesterol
  - ⬇ Blood lipid "fat" levels
  - ⬇ Blood glucose "sugar" levels
  - ⬇ Insulin levels

(Carson et al., 2014)

THE EFFECTIVENESS OF BREAKING UP SEDENTARY BEHAVIOUR

- **Systematic Review:** Relationship between breaks in SB and cardiometabolic health in adults (Chastin et al., 2015)
  - Light-intensity physical activity breaks in sedentary periods result in significant reductions in glucose (-17%) and insulin levels (-15%)



OBJECTIVES @ WORK

① Get up and break up your sitting every 30-45 minutes for at least 2-3 minutes

② Increase your time spent standing

③ Increase your time engaged in light-PA (walking)

EASY WAYS TO REDUCE AND BREAK UP WORK SEDENTARY TIME

DRINK WATER and **get up** for refills

WALK OVER to speak with co-workers **instead** of phoning or e-mailing them

STAND UP when you're on the **phone**

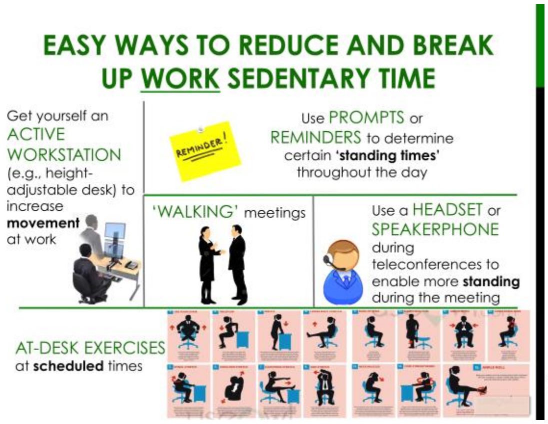
Take REGULAR BREAKS from sitting by standing up every **30 min.**

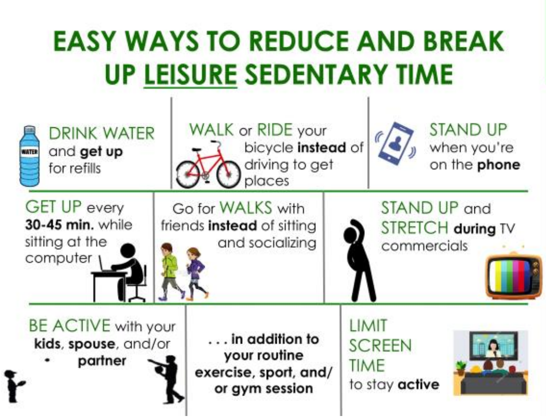
LEAVE your desk FOR LUNCH

TAKE the STAIRS **instead** of the elevator

MOVE your TRASH BIN AWAY from your desk

Make **frequent** SIT-TO-STAND TRANSITIONS while **working at desk**





FORMING A PLAN

- It is great to have good intentions, however, an action and coping plan on how to reduce your sitting time at work can really help!
- So let's translate those INTENTIONS into ACTION!

ACTION PLANNING

- "WHEN, WHERE, and HOW" will you break up your sitting time and increase time spent standing and in light movement at work?
- Frequency: how often a strategy should be used
- Intensity: duration of breaks from sitting
- Time: when the strategy should be enacted
- Type: type of activity done during break from sitting

COPING PLANNING

- "What are some challenges you foresee with executing this strategy?"
- "What do you think is something you can do in order to overcome this/these challenges?"

THANK YOU!

Appendix R: Health Action Process Approach Intervention – Planning Sheet (Study 3)

MY PLAN TO REDUCE MY SITTING TIME AT WORK

Objectives:
1) Increase break frequency to every 30–45 minutes and achieve a break duration of 2–4 minutes
2) Increase time spent standing at work
3) Increase time spent in light movement at work (i.e., walking)

Action Plans:
Please think about the time you spend at work during the week. When (how often), where, how, and for how long do you plan to break up your sitting time and increase time spent standing and in light movement at work over the next 6 weeks?

Coping Strategies:
What are some challenges you foresee with executing these strategies? What do you think is something you can do in order to successfully overcome these challenges?

Please write down your plans in the following table. The more precise, concrete and personal you formulate your plans, the more they can help you.

Reminder:
Frequency is how often a strategy should be used; **Intensity** is the duration of breaks from sitting; **Time** is when the strategy should be enacted; and **Type** is the activity done during the break from sitting.

Action Plans & Coping Strategies	Frequency	Intensity	Time	Type
Plan 1				
Strategy 1				
Plan 2				
Strategy 2				

Plan 3				
Strategy 3				
Plan 4				
Strategy 4				

Memorize your plans carefully. Visualize the situations and your planned actions and make a firm commitment to act as planned.

Appendix S: Health Action Process Approach Intervention – List of Text Messages

(Study 3)

List of Sedentary Behaviour-Related Text Messages sent to HAPA-intervention Group

1 (Study Start): Hi [redacted], welcome to the study! You will receive daily reminders with tips and strategies to help you reduce your workplace sitting time over the next 6-wks.

1 (Challenge): For the next week, your challenge is to get up at least once/hr while at work. To make it easier, try to stand up & move around every hour on the hour.

2 (Fact): Wondering why reducing sitting time is so important? By breaking up your sitting time, you can reduce your risk of heart disease.

2 (T/S): There are a number of easy ways to reduce & break up your sitting time at work! To name a few: Use prompts or reminders or try standing during phone calls.

3 (T/S): Remember - make sure to avoid sitting for more than an hour at a time. Try walking around or doing some light stretching while standing. You got this!

4 (T/S): Hey [redacted], is it time to take a break from sitting at that desk? Get up and stretch your legs.

4 (Challenge): On top of getting up every hour, your challenge for today is to replace 20 min of sitting with standing and/or walking. Walk to your colleague's desk instead of phoning/emailing them or take a brief walk outside during your lunch break!

5 (T/S): Just because you are at work does not mean you have to stay seated all day. Be sure to take a break between work episodes to get up and move around.

5 (Fact): By breaking up your sitting time at work you will reduce your risk of developing Type II diabetes!

6 (T/S): Tomorrow try to replace 30 minutes of sitting with standing or walking again. If it is easier, you can break it up into smaller amounts.

7 (T/S): Are you feeling sore or restless? Taking a quick stretch break is a great way to loosen up your muscles & joints, increase blood flow, and re-gain focus!

8 (Challenge): Your 7 day challenge is to get up for at least 3 min every hour while sitting at work. Start a timer, put on a 3min song or if you prefer, count to 180 slowly before sitting again. By end of day you will know what 3min feels like without a timer!

9 (T/S): Here is another reason to sit less: substituting sitting with standing or walking can help strengthen your bones.

10 (T/S): Good morning [redacted], make sure you are getting up every hour and staying up for 3 minutes while sitting at work today!

11 (Challenge): Today - try and aim to replace an hour of sitting time at work with standing or walking. Walk to your colleague's desk instead of phoning/emailing them or take a brief walk outside during your lunch break!

12 (Fact): You are going to want to stand up to read this one! Studies show we sit for an average of 9.7 hours/day, with some of us sitting for up to 15 hours in one day! Keep breaking up your sitting time at work to stay below that average & try to throw in some standing and/or stepping time when you can.

13 (T/S): Have you been spending a long time on the computer today? For every hour you spend working seated, try to stand up & work for 20 min or longer if you prefer.

14 (Fact): Those who sit for >3 hrs/day watching TV or sitting in front of computers are 64% more likely to die from heart disease. This includes desk-based computer work!

15 (Challenge): For the next 7 days aim to break up your sitting at work every 45 min and stay up for 4 min. Just because you are not seated does not mean work cant be done!

16 (T/S): Hey [redacted], hope you are able to make a lot of active choices today! Keep it up and soon they will become great healthy habits!

17 (T/S): Continue breaking up your sitting every 45 min or so with at least a 3 min break for the next few days. Squats, lunges and jumping jacks are all great ways to kill 3 min! Too much?!? Just take a standing break or a quick stroll around the office!

18 (Challenge): Tomorrow, try to replace as many sedentary work activities with active ones! Text or e-mail standing up, take the stairs instead of elevator, stand up on the bus, take a walk during lunch, have a 'walking' meeting - just keep moving!

19 (Fact): DID YOU KNOW? Replacing prolonged sitting at work with periods of light movement can have a positive effect on glycemic (blood sugar) control.

20 (T/S): Keep up with those 2-4 min breaks every 45 min and on top of that try to replace 60 min of sitting a day with standing. An hour workout would be a great replacement to sitting! Sit less and get fit? Sounds great!

20 (T/S): Keep up with those 2-4 min breaks every 45 min and on top of that try to replace 60 min of sitting a day with standing. Walk to your colleague's desk instead of phoning/emailing them or take a brief walk outside during your lunch break!

22 (T/S): As Bob Marley would say, "Get up, Stand up, Stand up for your health". Okay those aren't quite the lyrics, but you get it. Stand up!

23 (T/S): Next time you finish sending an email, or accomplishing a big day's task - take a break to stand up or walk around the office.

24 (T/S): Finding it hard to remember to take frequent breaks from sitting at work? Try using a prompt/reminder to determine certain 'standing times' throughout the day!

25 (Challenge): This week(end) try to get in 90 min of standing, walking or exercise each day during times that would normally be spent sitting. Go to the gym for an hour, break it up into 20 min chunks, do whatever you want to make it happen!

26 (Fact): Not sure why sitting too much is a problem? Even as little as 2 hrs of sitting can result in 50% reduced glucose tolerance and 39% reduced insulin sensitivity.

27 (T/S): Make a lot of phone calls, write a lot of emails, spend a lot of time in meetings - all the while being seated? Try doing some of these things standing! Who knows - you might find you prefer it!

28 (T/S): Remember: Stand up, Sit less, Move more, More often!

29 (Challenge): With only 2 weeks left of these texts it is time to make sure you are on track with the recommendations for sitting. From now on, try to get up every 30 min for at least 4 min. Do some work standing or take quick stretching breaks, anything that gets you up and moving!

30 (T/S): Got a break at work? Go for a walk around the office, or better yet, for a brief walk outside instead of spending it sitting down.

30 (Fact): Breaking up your sitting time can reduce your risk for certain types of cancer. You have more control over your health than you think!

31 (T/S): Pick 5 desk-based exercises (squats, lunges, jumping jacks, calf raises, push-ups, etc.) and do each one for a minute during one of your breaks. Do this each day for the remainder of the 6 wks and see how many you can do by the end! Practice makes perfect!

32 (Challenge): Your challenge this week: replace 100 min/day of time usually spent sitting at work (before these texts changed your life) with standing/light movement. If you were already doing this for 90 min, that only leaves 10 more min during the day to replace! Bonus points for working up a sweat!

33 (T/S): How has taking more frequent breaks from sitting at work been? Hopefully it makes you feel energized and less lazy!

34 (T/S): Here's a tip to decrease your sitting time: if you take public transportation to work try standing instead of sitting. If you live only a close distance away & drive, perhaps try walking or cycling one day a week!

36 (Challenge): For the last 7 days, your challenge is to take REGULAR BREAKS from sitting at work by standing up every **30 min**!

36 (Challenge): Is that 100min still feeling overwhelming? If you get up every 30min for 4 min during your work or free time, that counts for over 1/2 of the 100min in 7 hrs.

37 (T/S): Drink water and GET UP for refills! Have to pee? That's okay - not only is staying hydrated healthy, but making those trips to the washroom can be a great way to take a break from sitting.

38 (T/S): Be sure to make frequent sit-to-stand transitions while working at your desk today! Need help? There are a number of free apps available for your phone or desktop which can act as prompts or reminders to take regular breaks from sitting.

39 (Challenge): This week try to replace 2 hours a day of sitting at work with standing, walking or activity instead. This may seem like a lot, but if you have been keeping up it's only 20 more minutes a day than last week! That's nothing!

40 (T/S): Hey [redacted], are you watching carefully that you are breaking up your sitting time at work often enough?

40 (T/S): Another great way to create opportunities for yourself to take regular breaks from sitting is to move your trash bin away from your desk! Getting up to use it will increase your movement throughout the day! At very least, it will give you an opportunity to work on your 'paper toss' shooting game?!

41 (T/S): Looking for ways to increase your time spent moving while at work? Try walking to speak with co-workers instead of e-mailing. Take standing breaks every 30 min. Take stairs instead of the elevator! If you're still having trouble finding ways to reduce your sitting time, grab a colleague & go for a walk together at lunch!

42 (T/S): Enjoying taking regular breaks from sitting during work hours? Perhaps, look into getting yourself an ACTIVE WORKSTATION. There are a number of sit-to-stand desks designed to increase movement at work!

43 (Study End): Time to keep up these goals on your own. Hopefully they have become habits by now, & if not, just keep practicing them until they are automatic! Your health is worth the effort.

Questionnaire Completion Reminders (at Weeks 2, 4, and 6):

14: It has been 2 weeks! Check your e-mail for the next questionnaire, it should take less than 10 minutes. Why not do it standing up?

15 (if necessary): Reminder to complete the week 2 questionnaire if you have not yet done so!

28: Hope you have had a great, active break today. Please check your e-mail for the week 4 questionnaire!

29 (if necessary)**:** If you haven't completed the week 4 questionnaire yet please do so today!

42: Hey [redacted], it's been 6 weeks, please check your e-mail for the fourth questionnaire.

43 (if necessary)**:** If you haven't done the week 6 questionnaire yet please do it ASAP. Once you're done, why not stand up when you're on your next work phone call?

Planning Reminders (Weeks 3 and 5):

21: Remember the plans you set 3-weeks ago! Planning is an on-going process. Take a moment to look at the strategies you set for yourself & consider if they are helping you to achieve your goal of taking a break from sitting at work every 30-45 min for at least 2-4 min.

35: Its been 5-weeks! How have your plans worked so far? What has worked from the strategies we previously discussed to reduce & break up your sitting time? Formulate a new set of action & coping plans for this week to help you continue to reduce & regularly break up your sitting time at work.

Appendix T: Debriefing Letter (Study 3)

DEBRIEFING FORM

Project Title: Using a combined Health Action Process Approach and mHealth Intervention to Reduce Workplace Sitting Time in Office-Working Adults

Investigators: Scott Rollo, Ph.D. Candidate (Principal Investigator; [redacted]) & Harry Prapavessis, Ph.D. (Co-investigator; [redacted]), School of Kinesiology, Western University.

Thank you for your participation in this study. The purpose of the study was to determine whether a Health Action Process Approach-based planning and tailored text message intervention can reduce workplace sitting time by increasing frequency and length of breaks from sitting and non-sedentary behaviours (i.e., time spent standing and walking) among adult office workers.
We anticipated that participants who received the planning session and tailored text messages would report greater break frequency and break duration, time spent standing, and time spent in light-intensity physical activity, compared to participants who did not receive this information. In addition, it was hypothesized that participants in the intervention group would report greater action and coping planning and action control towards reducing workplace sitting time, as well as improved work- and health-related outcomes.

What you were told: All participants were asked to complete a brief online questionnaire on five occasions (i.e., once every two weeks) over an 8-week period. The online questionnaires included demographic questions, as well as questions that asked about health-related behaviours and outcomes; and your sitting patterns. All responses are completely confidential.

What you were not told: Approximately one half of participants received a single one-on-one behavioural counselling session regarding reducing workplace sitting time, as well as daily sitting- and activity-related text messages. We also did not disclose the true purpose of the study to you upon study initiation.

Why did we withhold certain information?

Due to this being a health behaviour change intervention targeting sedentary behaviour in office-workers and the fact that participants were randomized into either an intervention (treatment group) or control (no treatment group); it was deemed necessary to withhold particular key information that may influence a participant's performance or response. Further, this was done to assure scientific and methodological rigour. We believe it was necessary that we withhold the **true purpose** (stated above) of the study from all participants until study completion.

This is because we did not want you as a participant to be aware of: (a) the fact that this was an intervention, (b) the existence of experimental conditions, and (c) that the purpose was to target reductions in sedentary behaviour at work. This was done to prevent participation bias (i.e., individuals who may naturally be interested in this type of health promotion study) and response bias on behalf of participants (i.e., participants being motivated or influenced to respond in a certain manner because they were told the purpose was to 'reduce workplace sitting time'.

If you were randomized into the control group and did not receive the intervention, we are happy to now offer you the same intervention as those who were initially assigned to the treatment condition. It is entirely up to you as to whether you would like to accept our offer. If you are interested in learning more, please contact the researcher, Scott Rollo, by email at [redacted].

If you are uncomfortable with having been deceived, you are free to withdraw your data from the sample. If necessary, please notify the researcher, Scott Rollo, by email at [redacted].

Confidentiality and Publication

All data collected will remain confidential and accessible only to the investigators of this study and if required, Western University Health Sciences Research Ethics Board whom may access study data for monitoring or audit purposes. Your data will be retained for 7 years and will be stored on a password-protected University of Western Ontario computer located in the Exercise and Health Psychology Lab in the Arthur & Sonia Labatt Health Sciences Building Room 408. The information from this research project will be submitted, upon completion, for publication in a peer-reviewed academic journal as well as presented at relevant conferences.

Contacts for Further Information

If you require any further information regarding this research project or your participation in the study you may contact Scott Rollo ([redacted]) or Harry Prapavessis ([redacted]). If you have any questions about your rights as a research participant or the conduct of this study, you may contact The Office of Research Ethics [redacted], email: [redacted].

Thank you,

Scott Rollo, MSc, BA
PhD Candidate, Kinesiology
Exercise and Health Psychology Laboratory
School of Kinesiology
The University of Western Ontario Canada

Harry Prapavessis PhD
Professor
Director Exercise and Health Psychology Lab
School of Kinesiology
The University of Western Ontario

Appendix U: Means, Standard Deviations, and Test Statistics for HAPA Motivational Constructs and Goal Intentions Post-Intervention – Intent-to-treat sensitivity analyses following multiple imputation to handle missing data (Study 2)

Outcome	Group			Test Statistic
	Intervention M (SD)	Attention-Control M (SD)	Control M (SD)	
Outcome Expectancies	4.05 (.22)	3.76 (.42)	3.55 (.76)	$F(2,84) = 5.41$, $p = .006$, $\eta_\rho^2 = .11$
Risk Perceptions	3.77 (.68)	3.75 (.47)	3.63 (.75)	$F(2,93) = .451$, $p = .638$, $\eta_\rho^2 = .01$
Self-Efficacy (Work)				
Sitting Time	32.42 (22.01)	34.70 (25.11)	30.48 (18.66)	$F(2,91) = .300$, $p = .742$, $\eta_\rho^2 = .007$
Break Frequency	42.77 (26.95)	28.37 (21.47)	33.43 (27.45)	$F(2,93) = 2.64$, $p = .077$, $\eta_\rho^2 = .05$
Break Duration	61.61 (22.39)	60.05 (29.49)	57.45 (31.90)	$F(2,91) = .157$, $p = .855$, $\eta_\rho^2 = .003$
Standing Time	19.99 (16.97)	30.82 (24.85)	30.35 (23.51)	$F(2,90) = 2.03$, $p = .138$, $\eta_\rho^2 = .04$
Light Movement	25.36 (17.30)	25.33 (19.89)	25.04 (17.10)	$F(2,91) = .003$, $p = .997$, $\eta_\rho^2 = .00$
Self-Efficacy (Leisure)				
Sitting Time	36.73 (20.57)	43.23 (23.73)	30.85 (21.10)	$F(2,91) = 2.68$, $p = .074$, $\eta_\rho^2 = .06$
Break Frequency	44.06 (32.73)	41.77 (28.75)	40.95 (26.86)	$F(2,93) = .088$, $p = .916$, $\eta_\rho^2 = .002$
Break Duration	59.23 (32.71)	63.28 (30.45)	77.14 (17.01)	$F(2,91) = 3.33$, $p = .040$, $\eta_\rho^2 = .07$
Standing Time	35.87 (19.40)	37.03 (27.66)	30.70 (16.99)	$F(2,90) = .696$, $p = .501$, $\eta_\rho^2 = .02$
Light Movement	37.20 (23.93)	39.16 (23.32)	38.04 (23.86)	$F(2,93) = .056$, $p = .946$, $\eta_\rho^2 = .001$
Intention (Work)				
Sitting Time	3.92 (.86)	3.56 (.87)	3.81 (.92)	$F(2,91) = 1.48$, $p = .233$, $\eta_\rho^2 = .03$
Break Frequency	3.84 (.88)	3.52 (.66)	3.65 (.96)	$F(2,91) = 1.14$, $p = .324$, $\eta_\rho^2 = .02$
Break Duration	3.73 (.80)	3.17 (.97)	3.49 (.89)	$F(2,90) = 3.11$, $p = .049$, $\eta_\rho^2 = .07$
Standing Time	3.73 (.85)	3.14 (.88)	3.75 (1.02)	$F(2,93) = 4.86$, $p = .010$, $\eta_\rho^2 = .10$
Light Movement	3.54 (.85)	3.46 (.70)	3.52 (1.01)	$F(2,90) = .076$, $p = .927$, $\eta_\rho^2 = .002$
Intention (Leisure)				
Sitting Time	4.18 (.58)	3.83 (.55)	3.61 (1.18)	$F(2,89) = 3.36$, $p = .039$, $\eta_\rho^2 = .07$
Break Frequency	4.01 (.82)	3.61 (.75)	3.62 (1.11)	$F(2,91) = 1.84$, $p = .165$, $\eta_\rho^2 = .04$
Break Duration	3.73 (.98)	3.55 (.73)	3.68 (1.09)	$F(2,91) = .314$, $p = .731$, $\eta_\rho^2 = .007$
Standing Time	3.93 (.85)	3.42 (.71)	3.71 (.93)	$F(2,90) = 3.00$, $p = .055$, $\eta_\rho^2 = .06$
Light Movement	3.77 (.92)	4.07 (.58)	3.85 (1.17)	$F(2,89) = .859$, $p = .427$, $\eta_\rho^2 = .02$

Scott Rollo, PhD Candidate

CURRICULUM VITAE

Post-secondary Education:

Western University, London, Ontario, Canada (2015-)
Faculty of Health Sciences, School of Kinesiology
PhD in Kinesiology - Psychological Basis of Kinesiology
Currently Pursuing

Wilfrid Laurier University, Waterloo, Ontario, Canada (2012-2014)
Faculty of Science, Department of Kinesiology & Physical Education
Master of Science (MSc) in Kinesiology (Specialization: Sport and Rehabilitation Psychology)
Graduated 2014

Western University, London, Ontario, Canada (2008-2012)
Faculty of Health Sciences, School of Kinesiology
Bachelor of Arts, Honors Specialization in Kinesiology
Graduated 2012

Academic Accomplishments/Research Contributions:

Publications –

Rollo, S. & Prapavessis, H. Sedentary behaviour and diabetes information as a source of motivation to reduce daily sitting time in office workers: A randomized controlled trial using the motivational phase of the health action process approach. Article submitted to Applied Psychology: Health and Wellbeing. (Submitted)

Fagan, M.J., Guirguis, S., Smith, S., Sui, W., **Rollo, S.**, & Prapavessis, H. The acute effects of light-to-moderate intensity exercise and nicotine administration on working memory in non-smokers and smokers: A non-inferiority study. Article submitted to Nicotine & Tobacco Research. (Under Review, NTR-2019-093)

Maddison, R., **Rollo, S.**, Marchand, A., & Prapavessis, H. Chapter 4: Preventing Sports Injuries: A Case for Psychological Interventions. In A. Ivarsson & U. Johnson (Ed. 4), Psychological Bases of Sport Injuries. FiT Publishing. (In Press)

Sui, W., Smith, S., Fagan, M., **Rollo, S.**, & Prapavessis, H. (2019). The effects of sedentary behavior interventions on work-related productivity and performance outcomes in real and simulated office work: A systematic review. Applied Ergonomics. 75: 27-73. doi: https://doi.org/10.1016/j.apergo.2018.09.002

Rollo, S., Sui, Y., & Prapavessis, H (2019). *Exercise as a smoking cessation aid.* In V. R. Preedy (Ed), The Neuroscience of Nicotine - Mechanisms and Treatment. Chapter 55, pp. 459-465. Elsevier, Cambridge, UK. DOI.org/10.1016/B978-0-12-813035-3.00055-1

Sui, W., **Rollo, S.**, & Prapavessis, H (2019). *The acute effects of exercise on cravings and withdrawal symptoms.* In V. R. Preedy (Ed), The Neuroscience of Nicotine - Mechanisms and Treatment. Chapter 26, pp. 205-211. Elsevier, Cambridge, UK. DOI.org/10.1016/B978-0-12-813035-3.00055-1

Rollo, S., Crutchlow, L., Nagpal, T.S., Sui, W., & Prapavessis, H. (2018). The effects of classroom-based dynamic seating interventions on academic outcomes in youth: A systematic review. Learning Environments Research. 22(2): 153-171. doi: https://doi.org/10.1007/s10984-018-9271-3.

Prapavessis, H., De Jesus, S., Fitzgeorge, L., & **Rollo, S.** (2018). Anthropometric and body composition changes in smokers vs abstainers following an exercise-aided pharmacotherapy smoking cessation trial for women. Addictive Behaviors. 85: 125-130. doi: https://doi.org/10.1016/j.addbeh.2018.06.003.

Rollo, S., Tracey, J., & Prapavessis, H. (2017). Effects of a heart rate variability biofeedback intervention on athletes psychological responses following injury: A pilot study. International Journal of Sports and Exercise Medicine. 3: 081. doi. org/10.23937/2469-5718/1510081.

Rollo, S., Smith, S., & Prapavessis, H. (2017). Do you want your students to pay more attention in class? Try dynamic seating! Journal of Ergonomics. 7: 217. doi: 10.4172/2165-7556.1000217.

Rollo, S., Gaston, A., & Prapavessis, H. (2016). Cognitive and motivational factors associated with sedentary behavior: A systematic review. AIMS Public Health. 3(4): 956-984. doi: 10.3934/publichealth.2016.4.956.

Conference Presentations –

Rollo, S. & Prapavessis, H. (June 2019). Sedentary behaviour and diabetes information as a source of motivation to reduce occupational sitting time in office workers: A RCT using the health action process approach. Oral presentation at International Society of Behavioral Nutrition and Physical Activity (ISBNPA) Annual Meeting, Prague, Czech Republic. (International)

Sick, K., Rollo, S. & Prapavessis, H. (June 2019). The relationship between perceived sedentary behaviour and psychological health. Poster presentation at International Society of Behavioral Nutrition and Physical Activity (ISBNPA) Annual Meeting, Prague, Czech Republic. (International)

Rollo, S., Crutchlow, L., Nagpal, T.S., Sui, W., & Prapavessis, H. (October 2018). The effects of classroom-based dynamic seating interventions on academic outcomes in youth: A systematic review. Poster presentation at Canadian Society for Psychomotor Learning and Sport Psychology (SCAPPS) Annual Conference, Toronto, ON. (National)

Sui, W., Smith, S., Fagan, M., Rollo, S., & Prapavessis, H. (October 2018). The effects of sedentary behavior interventions on work-related productivity and performance outcomes in real and simulated office work: A systematic review. Poster presentation at Canadian Society for Psychomotor Learning and Sport Psychology (SCAPPS) Annual Conference, Toronto, ON. (National)

Rollo, S., & Prapavessis, H. (March 2018). Using a combined health action process approach and mHealth intervention to increase non-sedentary behaviours in office-working adults – A randomized controlled trial. Oral presentation at the Eastern Canada Sport and Exercise Psychology Symposium (ECSEPS) 2018, Montreal, QC. (National)

Fagan, M.J., Smith, S., Rollo, S., & Prapavessis, H. (February 2018). The acute effects of exercise and nicotine on cognition in non-deprived smokers. Poster presentation at Society of Research on Nicotine and Tobacco (SRNT) Annual Meeting, Baltimore, MD. (International)

Rollo, S., Gaston, A., & Prapavessis, H. (June 2017). Sedentary behavior and chronic disease information as a source of motivation to reduce school-related sitting time in university students: An experimental study using protection motivation theory. Oral presentation at Exercise is Medicine Canada National Student Conference, London, ON. (National)

Rollo, S., Gaston, A., & Prapavessis, H. (June 2017). Sedentary behavior and chronic disease information as a source of motivation to reduce prolonged, school-related sitting time in university students: An experimental study using protection motivation theory. Oral presentation at International Society of Behavioral Nutrition and Physical Activity (ISBNPA) Annual Meeting, Victoria, BC. (International)

Rollo, S., & Prapavessis, H. (March 2017). Sedentary behaviour and diabetes information as a source of motivation to reduce daily sitting time in adult office workers: An experimental study using the health action process approach. Oral presentation at the Eastern Canada Sport and Exercise Psychology Symposium (ECSEPS) 2017, Kingston, ON. (National)

Rollo, S., Gaston, A., & Prapavessis, H. (October 2016). Social-cognitive and motivational factors associated with sedentary behavior: A review. Poster presentation at Canadian Society for Psychomotor Learning and Sport Psychology (SCAPPS) Annual Conference, Waterloo, ON. (National)

Rollo, S., & Tracey, J. (October 2016). Effects of a heart rate variability biofeedback intervention on athletes' psychological responses following injury. Oral presentation at

Canadian Society for Psychomotor Learning and Sport Psychology (SCAPPS) Annual Conference, Waterloo, ON. (National)

Rollo, S. (June 2016). The use of a health action process approach intervention to reduce sedentary behaviour in adults. Oral presentation at Exercise is Medicine Ontario Student Research Conference, London, ON. (Provincial)

Rollo, S. (November 2014). Effects of a heart rate variability biofeedback intervention on athletes' psychological response following injury. Poster presentation at the Ontario Kinesiology Association (OKA) Annual Conference, Niagara Falls, ON. (Provincial)

Rollo, S. (March 2014). Effects of a heart rate variability biofeedback intervention on athletes' psychological response following injury. Oral presentation at the Eastern Canada Sport and Exercise Psychology Symposium (ECSEPS) 2014, Toronto, ON. (National)

Tracey, J., Rollo, S., & Riordan, A. (October 2013). Rock Solid: Implementing a mental skills training program for high performance curlers. Poster presentation at the Association for Applied Sport Psychology's (AASP) 2013 Annual Conference, New Orleans, LA. (International)

Rollo, S. (March 2013). Relationships between heart rate variability biofeedback, self-efficacy, coping, and pain management in injured athletes. Oral presentation at the Eastern Canada Sport and Exercise Psychology Symposium (ECSEPS) 2013, St. Catharines, ON. (National)

Interviews and Media Relations –

Rollo, S. Broadcast interview, Monday, July 23rd, 2018. Stop Smoking. *CTV News London.*

Academic Positions –

Lecturer, KIN 1070A (001): Psychology of Human Movement Science. The University of Western Ontario, Faculty of Health Sciences, School of Kinesiology. September 1st, 2018 – December 31st, 2018.

Teaching Assistantships –

Graduate Teaching Assistant, School of Kinesiology, Faculty of Health Sciences, Western University
- KIN 2000B: Physical Activity and Health, Jan 2016–Apr 2016
- KIN 3476F: Exercise and Health Behaviour Change, Sept 2015–Dec 2015

Graduate Teaching Assistant, Department of Kinesiology & Physical Education, Faculty of Science, Wilfrid Laurier University

- KP 413: Psychology of Injury Rehabilitation, Jan 2014–Apr 2014
- KP 412: Behaviour Modification, Jan 2014–Apr 2014
- KP 210: Sport Psychology, Sept 2013–Dec 2013
- KP 121: Sociocultural Aspects of Physical Activity, Sept 2013–Dec 2013
- KP 220: Human Physiology, Jan 2013–Apr 2013
- KP 210: Sport Psychology, Sept 2012–Dec 2012

Research Assistantship –

Physical Activity Coordinator, CO.21 Colon Health and Life-long Exercise Change trial, funded by NCICCTG, Western University, Dec 2015-ongoing

University Teaching & Learning Workshops/Certificates –

Western Certificate in University Teaching and Learning, Western Teaching Support Centre, January 2016 – In Progress.

Advanced Teaching Program (ATP) Certificate, Western Teaching Support Centre, ~30 hrs, May 10th-19th, 2016.

Teaching Mentor Program (TMP) Certificate, Western Teaching Support Centre, ~6-8 hrs, March 2016.

Scholarships, Awards and Other Accolades:

- Winter 2018 Travel Subsidy, Society of Graduate Students (SOGS), Western University, PhD in Kinesiology, May 2018, $500.00.
- **Dr. Bert Carron Graduate Scholarship in Sport and Exercise Psychology**, School of Kinesiology Graduate Internal Donor Award, Western University, PhD in Kinesiology, May 2018, $1,000.00.
- **SSHRC Doctoral Fellowship**, Social Sciences and Humanities Research Council of Canada (SSHRC), PhD in Kinesiology, May 2018-April 2020, $40,000.00.
- **Ontario Graduate Scholarship**, Western University, PhD in Kinesiology, May 2018-April 2019, $15,000.00. (**DECLINED)**
- Western Graduate Research Scholarship, School of Kinesiology, Faculty of Health Sciences, Western University, PhD in Kinesiology, September 2017-August 2018, $12,027.80.
- **Ontario Graduate Scholarship**, Western University, PhD in Kinesiology, May 2017-April 2018, $15,000.00.
- Western Graduate Research Scholarship, School of Kinesiology, Faculty of Health Sciences, Western University, PhD in Kinesiology, September 2016-August 2017, $12,027.80.
- **Ontario Graduate Scholarship**, Western University, PhD in Kinesiology, May 2016-April 2017, $15,000.00.

- Western Graduate Research Scholarship, School of Kinesiology, Faculty of Health Sciences, Western University, PhD in Kinesiology, September 2015-August 2016, $14,268.00.
- Graduate Teaching Assistantship, School of Kinesiology, Faculty of Health Sciences, Western University, PhD in Kinesiology, September 2015-April 2016, $6,165.00.
- Graduate Student Poster Presentation, 2nd Place Winner, Ontario Kinesiology Association, 2014 OKA Annual Conference, Niagara Falls, ON, November 2014, $300.00
- Medal for Academic Excellence at the Graduate Level (Gold Medal) Nomination, Faculty of Graduate and Postdoctoral Studies, Wilfrid Laurier University, MSc in Kinesiology, October 2014.
- Wilfrid Laurier Graduate Scholarship, Faculty of Graduate and Postdoctoral Studies, Wilfrid Laurier University, MSc in Kinesiology, September 2013-August 2014, $3,000.00.
- Graduate Teaching Assistantship, Department of Kinesiology & Physical Education, Wilfrid Laurier University, MSc in Kinesiology, September 2013-April 2014, approx. $10,250.00.
- Wilfrid Laurier Graduate Scholarship, Faculty of Graduate and Postdoctoral Studies, Wilfrid Laurier University, MSc in Kinesiology, September 2012-August 2013, $2,750.00.
- Graduate Teaching Assistantship, Department of Kinesiology & Physical Education, Wilfrid Laurier University, MSc in Kinesiology, September 2012-April 2013, approx. $10,250.00.
- Dean's Honor List, School of Kinesiology, Faculty of Health Sciences, Western University, BA Honors Specialization in Kinesiology, September 2011-April 2012.

<u>Volunteering, Committees, and Organizational Involvement:</u>

Elected Positions –

VP Education, Exercise is Medicine (EIM) Western Graduate Chapter, Western University, Oct 2015 – Sept 2018.

VP Finance, 2017/18 Kinesiology Graduate Students Association (KGSA), Western University, May 2017 – May 2018.

Board of Directors Member, Wilfrid Laurier University Graduate Student Association (GSA), Wilfrid Laurier University, Jan 2014 – Aug 2014.

Health & Wellness Coordinator, Kin & Physical Ed. Graduate Student Council, Wilfrid Laurier University, Sept 2012 – Aug 2014.

Volunteer Activities –

Lab Manager, Exercise and Health Psychology Laboratory (EHPL), Western University, Sept 2016 – ongoing

Conference/Meeting Organization –

Executive Planning Committee, KGSA Research Symposium/Annual General Meeting (AGM), hosted at Western University, April 25th, 2018.

Lead Organizer; Executive Planning Committee, Exercise is Medicine (EIM) On Campus Western, Health/Medical Sciences Career Panel, hosted at Western University, February 6th, 2018

Executive Planning Committee, EIM On Campus Western in partnership with Advanced Medical Group, EIM Symposium 2017, hosted at Advanced Medical Group (London), September 23rd, 2017

Executive Planning Committee, Exercise is Medicine (EIM) Canada National Student Research Conference, hosted at Western University, June 23-24, 2017

Lead Organizer; Executive Planning Committee, EIM On Campus Western in partnership with Advanced Medical Group, Lifestyle Medicine Day, hosted at Advanced Medical Group (London), April 1st, 2017

Executive Planning Committee, EIM Canada Ontario Student Research Conference, hosted at Western University, June 23-24, 2016