Sedentary behaviour: theory-based interventions and measurement considerations in high-risk populations

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High amounts of total and prolonged sedentary behaviour (SB) are detrimental to both short and long-term health. SB describes any waking behaviour performed in a seated, lying, or reclining posture at a low energy expenditure. While the average Canadian spends over 9.5 hours sedentary per day, high-risk populations such as university students and office workers report up to 14 hours per day. Interventions targeting these at-risk populations are needed. This dissertation aimed to build and contribute to the knowledge surrounding theory-based interventions and measurement amongst these high-risk populations. First, in a randomized controlled trial (study 1), we evaluated the effectiveness of a Health Action Process Approach (HAPA) based intervention, augmented with text messages to reduce student-related sitting, and showed a significant reduction in student-related sitting time for the intervention group compared to the controls. Next, in response to the COVID-19 pandemic, many office working adults were quickly transitioned from working in-office to working from home. Since this population has been shown to be at an even higher risk for more sedentary time, we took immediate action. Building from study 1, study 2 investigated whether augmenting the HAPA intervention with choice architecture principles grounded in behavior economics (i.e., the ability to choose or not) will affect SB break frequency (BF) in adults working from home. Interestingly, results measured with a device versus self-report were different. With the device, BF improved over the intervention period, but was no different between choice vs. nonchoice groups. With self-report, the group that was able to choose demonstrated more favourable BF patterns compared to the group that did not get to choose. Finally, since working from home has become a permanent switch for most, it is imperative to validate an appropriate self-report measure to assess sitting patterns in this setting. Thus, studies 3A and 3B are secondary analyses of the data in study 2 and aimed to validate the occupational sitting and physical activity questionnaire (OSPAQ-study 3A) and the modified 7-day Sit questionnaire (SITQ-7d-study 3B) against an activPAL4™ in full-time home-based ‘office’ workers, respectively. The findings suggest that the OSPAQ is an easily administered and valid questionnaire to measure group level total sitting while the SITQ-7d requires further validation before confidently recommending this self-report tool for assessing BF. Implications of these intervention and measurement studies are discussed.
Keywords

Sedentary behaviour, university students, office-workers, Health Action Process Approach, intervention, health behaviour change, validation, measurement, Bland-Altman
Summary for Lay Audience

Sitting for most of the day and for long periods at a time (i.e., 30+ minutes without getting up) has immediate and long-term negative health effects. The average Canadian spends over 9.5 hours of their day sitting and this number is even higher (~14 hours per day) in populations that tend to sit for their occupation (i.e., office workers, university students). Since these populations are at a higher risk, interventions are needed to try and reduce and break up sitting time. This dissertation aimed to build and add to the knowledge surrounding theory-based interventions and measurement amongst these high-risk populations. First, in a randomized controlled trial (study 1), we were able to reduce sitting time in university students with a counselling session (giving them the knowledge and tools to form plans to reduce their sitting time) followed by daily text messages. Next, in response to the COVID-19 pandemic, many office working adults were quickly transitioned from working at the office to working from home. Since this at-home office working population is even higher risk for more sitting time, we took immediate action. Building from study 1, study 2 condensed the counselling session into a 3-minute educational video and explored whether supplementing it with the ability to choose or not (instead of the text-messages) would impact breaks from sitting in adults working from home. Interestingly, our findings differed depending on whether sitting breaks were measured with a device or self-reported via questionnaire. With the device, sitting breaks improved, but was no different between groups that got to choose or not. With self-report, the group that got to choose resulted in a better sitting profile. Finally, since working from home has become a permanent switch for most, it is essential to validate an appropriate self-report measure to capture sitting patterns in this setting. Thus, study 3A and 3B aimed to validate the sitting questionnaires that were used in study 2. The first questionnaire focused on measuring total sitting, standing, and moving time. Results indicated that it is a valid questionnaire to capture sitting and standing time in home-based office workers. The second questionnaire focused on sitting breaks and sitting break duration. Results indicated that this questionnaire requires further validation before confidently recommending this self-report tool in this population.
Co-Authorship Statement

While the contents of this thesis are composed of my original work, major contributions were made by several co-authors. This thesis contains no material previously published or written by another person except where due reference has been made in the text.

Study 1: This study is published in *Psychology & Health* with co-authors: Scott Rollo & Harry Prapavessis. “A combined health action process approach and mHealth intervention to reduce sedentary behaviour in university students – a randomized controlled trial”

Study 2: Co-authors: Madison Hiemstra, Marc Mitchell, Nina Bartmann, Scott Rollo, & Harry Prapavessis (unpublished)

Study 3: This study is published in *Applied Ergonomics* with co-authors: Madison Hiemstra, Marc Mitchell, Nina Bartmann, Scott Rollo, Paul A. Gardiner, & Harry Prapavessis

Study 4: This study has been submitted for publication to the *Journal for the Measurement of Physical Behaviour* with co-authors: Madison Hiemstra, Nina Bartmann, Marc Mitchell, Wuyou Sui, Scott Rollo, Paul A. Gardiner, & Harry Prapavessis
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Harry, thank you for giving me the opportunity to pursue graduate studies, and making the experience such an enjoyable one. You have molded me into the passionate, curious, and lifelong learner I am today. You have provided me with countless opportunities that I am forever grateful for. Your wisdom and kindness always had a way for calming the storm. More importantly, thank you for putting up with me these past five years, time flies when you are having fun, right?

Paul, I can’t thank you enough for everything you have done for me these past three years. I am so glad I did that five-minute presentation in Prague, as I don’t think I would have pursued a PhD without your collaboration. Although my PhD didn’t go even the slightest as planned, I really appreciate everything I was able to learn from you. You always had my future in mind and the time I spent in Australia with you was an experience of a lifetime.

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Lastly, I would like to give a shout out to my sit-to-stand desk, for allowing me to break up my sedentary behaviour as I pieced together this dissertation.
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Chapter 1 – General Introduction and Dissertation

Objectives
1.1 Definitions - What is Sedentary Behaviour?

The Canadian Physical Activity Guidelines state that to receive health benefits, adults between the ages of 18-64 should partake in 150 minutes of moderate to vigorous physical activity per week (Ross et al., 2020). A large body of evidence has made it clear that you can meet the physical activity guidelines and still be at risk for many non-communicable diseases if you are spending increased amounts of time ‘sedentary’ (Bailey et al., 2019; Greer et al., 2015; Owen et al., 2012). The term ‘sedentary’ has come a long way since how it was portrayed in the 1980’s (Pate et al., 2008). In previous years, the term sedentary was not well defined and usually implied a low level of physical activity (Pate et al., 2008).

With sedentary behaviour research growing at an exponential rate, the Sedentary Behaviour Research Network (SBRN) came out with consensus definitions for several key terms including physical inactivity, sedentary behaviour, and stationary behaviour to name a few (Trembley et al., 2017). From this terminology consensus project, sedentary behaviour was defined as any waking behaviour in a seated, lying, or reclining posture while expending less than or equal to 1.5 metabolic equivalents (Tremblay et al., 2017). Thus, sedentary behaviour makes up a large portion of our everyday behaviour such as eating, watching television, sitting in class, working at your computer or scrolling through your phone, if you are seated or lying down. On the other hand, physical inactivity is defined as “an insufficient physical activity level to meet present physical activity recommendations” (Tremblay et al., 2017). Thus, being ‘sedentary’ and being ‘inactive’ are two separate constructs and are associated with their own health consequences. Although use of correct terminology around sedentary behaviour has improved since the publication of the consensus project in 2017, some research still equates sedentary behaviour with physical inactivity (Dillon & Gardiner 2021). Thus, using the proper definition and measurement tools are imperative to move this area of research forward.
1.2 Sedentary Behaviour- Impact on Health

Sedentary behaviour research has been growing at an exponential rate since the year 2000 (Leblanc et al., 2017). In the last decade alone, there have been numerous systematic reviews reporting on the detrimental association of sedentary behaviour with various health outcomes. The most prevalent health outcomes that have been identified are all-cause mortality, and chronic diseases such as fatal and non-fatal cardiovascular disease, type 2 diabetes, certain types of cancer (colon, endometrium and lung), and metabolic syndrome (de Rezende et al., 2014; Edwardson et al., 2012; Guo et al., 2020; Katzmarzyk et al., 2019; Marin et al., 2020; Taylor et al., 2020; Wilmot et al. 2012). It is important to note that these associations are even more pronounced in low-income and lower-middle-income countries (Li et al., 2022). High levels of sedentary behaviour have also been associated with lower levels of cognitive function, depression, function and disability, physical activity levels, physical health-related quality of life, weight gain, obesity, as well as mental health problems (e.g., anxiety) (Saunders et al., 2020; Teychenne et al., 2010; Teychenne et al., 2015; Thorp et al., 2011). In contrast, reducing and breaking up sedentary behaviour time has been shown to have beneficial effects on body composition and markers of cardiometabolic health (Saunders et al., 2020; Paterson et al., 2021; Quan et al., 2021).

Not only is overall daily sedentary time a health consideration, but prolonged sedentary bouts and infrequent breaks in sedentary time appear to compromise the cardiometabolic profile too (Carson et al., 2014; Canabrava et al., 2019; Healy et al., 2011; Saunders et al., 2012). One study concluded that uninterrupted sitting lasting more than just one hour may lead to a meaningful decrease in vascular function in lower limb arteries (Paterson et al., 2020). Furthermore, a meta-analysis of isotemporal studies provides evidence of the positive effects of breaking up prolonged time spent sitting on metabolic outcomes. In one study, reallocating sedentary time to light intensity physical activities such as walking or standing provided preventive benefits for cardiometabolic health (del Ponzo-Cruz et al., 2018). While there seems to be a dose-response relationship in that higher intensity physical activity will provide greater cardiometabolic benefits, it is uplifting to know that advocating for even the lightest of intensities can in turn provide health benefits (del Ponzo-Cruz et al., 2018).
There is also evidence to suggest that there is a benefit to taking multiple, short, physical activity breaks as opposed to one continuous bout of exercise for attenuating some cardiometabolic health outcomes (Loh et al., 2020). A recent review and meta-analysis concluded that breaking up prolonged sitting or reducing sitting time throughout the day generally leads to acute and chronic beneficial effects in cardiovascular parameters of adults (i.e., blood pressure) (DaSilva et al., 2021). After synthesizing 45 studies, bout lengths ranged from 1 minute 30 seconds to 30 minutes with varying intensities (light to vigorous) and frequencies (every 20 minutes to every 2 hours). The authors stated that resistance activities also seem to be useful, but the evidence is less clear for how much and how often it is needed to elicit beneficial effects on cardiovascular parameters (DaSilva et al., 2021).

Furthermore, it is important to note that many of these outcomes are still prevalent even after adjustment for physical activity levels (Bailey et al., 2019). Research has been able to provide notable developments for the interaction of sedentary behaviour and moderate to vigorous physical activity with respect to multiple health outcomes (Del Pozo-Cruz et al., 2018; Ekelund et al., 2019; Ekelund et al., 2016; Patterson et al., 2018). A large meta-analysis examined the joint and stratified associations of sedentary behaviour with physical activity and all-cause mortality to investigate if physical activity can attenuate or even eliminate the detrimental effects of prolonged sitting (Ekelund et al., 2016). The study concluded that high levels of moderate intensity physical activity (i.e., 60-75 minutes per day) seem to eliminate the increased risk of death associated with high sitting time. That said, the adherence rates to the physical activity guidelines are poor, with less than half of adults in society accumulating the recommended guidelines of 150 minutes of moderate-to-vigorous intensity physical activity per week (Clarke et al., 2021). Therefore, interventions aiming to reduce and interrupt sedentary time with light intensity physical activity could be promising, especially for improving cardiometabolic health (Powell et al., 2018).

1.3 24-Hour Movement Guidelines

*American College of Sports Medicine’s (ACSM) Guidelines for Exercise Testing and Prescription* was first published in 1975. Since then, there has been a revision made approximately every five years; illustrating the rapidly changing and growing body of
research that recognizes the importance of moderate-intensity physical activity. With sedentary behaviour research evolving to show its own distinct health repercussions, it is now also being recognized as an important 24-hour movement behaviour. In 2018, the World Health Organization (WHO) updated the Global Recommendations on Physical Activity for Health based on the latest available science, including that of sedentary behaviour (Dempsey et al., 2020). In 2020, the Canadian 24-Hour movement guidelines for adults aged 18-64 and adults aged 65 years or older were launched (Ross et al., 2020). These guidelines state that for health benefits, adults should be a) physically active each day, obtaining 150 minutes of moderate to vigorous physical activity per week while also participating in muscle strengthening activities using the major muscle groups at least twice per week; b) minimize sedentary behaviour, limiting sedentary time to eight hours or less with no more than three hours of recreational screen time and breaking up long periods of sitting as often as possible and c) achieve sufficient sleep, getting seven to nine hours of good quality sleep on a regular basis with consistent bed and wake-up times. A recent study investigating the health associations of meeting the 24-hour movement guidelines indicated that a total of 19.1% met none of the three recommendations, 43.9% met one of them, 29.8% met two of them, and 7.1% met all three (Rollo et al., 2022a). In another study using 3471 adults from the 2005-2006 U.S National Health and Nutrition Examination Survey reported that only 63.8%, 35.8% and 41.5% of participants met the recommendations for sleep, sedentary behaviour and physical activity respectively (Clarke et al., 2021). With sedentary behaviour showing the lowest adherence, it should be the top priority for future interventions, especially in populations more susceptible to high levels (i.e., office workers, university students, etc.).

1.4 Measurement

The measurement of sedentary behaviour is essential for monitoring population trends, understanding sub-populations and high-risk groups, assessing correlates and determinates, or testing intervention effects (Clark et al., 2011). Sedentary behaviour is most often measured with either a self-report questionnaire or with a device placed on the participant’s body. Each of these methods comes with advantages and disadvantages. While device-based measures of sitting time are reported to be more valid than self-reported sitting time, devices come at a high cost and are often burdensome to
participants and research staff (Dall et al., 2017). Self-report questionnaires can be susceptible to social desirability bias and problems with accuracy of recall and thus, tend to underestimate total sitting time (Copeland et al., 2017; Prince et al., 2020). However, they can capture the domain or individual type of sitting that is taking place (i.e., watching TV, reading, etc.) whereas a device cannot. This is an important issue given that some types of sedentary behaviour appear to be more prevalent with indicators of poor health than others. For example, studies have observed that watching television time could be detrimental to cognitive health whereas reading could be beneficial (Blasko et al., 2014; Olanrewaju et al., 2020). While the association of sedentary behaviour with many non-communicable diseases have been established, there are other health outcomes that have been found to vary depending on the method of measurement used, such as cognitive function (i.e., self-report versus device; Dillon et al., 2022). Therefore, the need for validated, high-quality, easily administered self-report questionnaires are imperative.

1.4.1 Device based measures – Inclinometers and accelerometers

Inclinometers (e.g., activPAL) are considered the gold standard for measuring sedentary behaviour given it has the highest sensitivity for distinguishing between sitting and standing (Aminian & Hickson, 2012; Aunger & Wagnild, 2022; Dowd et al., 2012). Another type of device that is commonly used is an accelerometer (e.g., Actigraph, Axivity, etc.). While accelerometry captures time spent sedentary, it lacks the ability to distinguish sitting from standing, which is a key component in the definition of sedentary behaviour (Aunger & Wagnild, 2022). Cross validation and direct observation of an Actigraph with an activPAL showed that the Actigraph underestimates sitting time (Kozey-Keadle et al., 2011). Furthermore, the objective measures of the inclinometers and accelerometers themselves can vary. For example, the definition of non-wear time, the minimum number of valid hours per day, number of valid days and the selection of cut points for sedentary behaviour are all determined by the individual authors and can thus differ from study to study, making it hard to directly compare findings (Hidding et al., 2017).

1.4.2 Self-report-based measures- Questionnaires

Many different questionnaires exist with the intention of measuring sedentary behaviour time. Each one varies regarding the number of questions it entails, the domain
or type of sedentary behaviour it assesses, the population it is designed for, and the recall
time (e.g., past day, week, weekend, weekday, etc.). Thus, when choosing a sedentary
behaviour questionnaire, it is important to consider such variables. For example, the
Marshall Sitting Questionnaire assesses time spent sitting on weekdays and weekend
days for 1) traveling to and from places, 2) at work, 3) watching television, 4) using a
computer at home, and 5) for leisure, not including television (Marshall et al., 2010). In
contrast, the Occupational Sitting and Physical Activity Questionnaire (OSPAQ) assesses
the percent of time spent sitting, standing, walking or heavy labour in the last seven days
during work hours (Chau et al., 2012). Just from these two questionnaires alone, you can
see the amount of variability in assessment. Furthermore, there are questionnaires
specific to children (i.e., Sedentary Behaviour and Sleep Scale; SBSS; Mellecker et al.,
2012), adolescents (i.e., The Adolescent Sedentary Activity Questionnaire; ASAQ; Hardy
et al., 2007), undergraduate students (i.e., NIGHTLY-WEEK-U; Moulin et al., 2020),
adults (i.e., Workforce Sitting Questionnaire; Chau et al., 2011) and older adults (i.e.,
Measure of Older Adults Sedentary Time; MOST; Gardiner et al., 2011) to name a few.

1.4.3 Questionnaire quality assessment

The psychometric properties of questionnaires used in the pediatric and adult
populations have been previously reviewed (Hidding et al., 2017; Lubans et al 2011;
Prince et al., 2017). Interestingly, out of the 46 studies included in the review by Hidding
et al. (2017), they were not able to identify one that was both valid and reliable for use in
children. With that in mind, it is important to note that accelerometers and/or
inclinometers are not able to provide validation for a question regarding a specific type or
domain of sedentary time (i.e., television viewing). Thus, questionnaires that can be both
valid and reliable against a device are typically ones that measure various domains of
sedentary behaviour and can then sum the time from each domain to also provide total
sedentary behaviour time (Prince et al., 2017). The review in 2017 by Prince and
colleagues intended to determine the most valid and reliable questions/questionnaires for
assessing total and individual modalities of sedentary behaviour. They did this by
reviewing sedentary behaviour questionnaires used in national and international surveys
as well as examining questionnaires that have undergone formal testing for
validity/reliability. The authors identified 16 pediatric and 18 adult national/international
surveys and large national epidemiological studies assessing at least one modality of 
sedentary behaviour. They also found 14 pediatric and 35 adult questionnaires with 
psychometric information included. They concluded that reliability was generally good to 
excellent for questions measuring key domains or type of sitting while validity was poor 
to moderate and reported much less frequently (Prince et al., 2017). Among adults, the 
questionnaires that looked at either a single item of sitting time or generated a composite 
score from several items to estimate total sitting time were the Past-day Adults Sedentary 
Time (PAST; Clark et al., 2013) and Past-Adults’ Sedentary Time- University (PAST-U; 
Clark et al., 2016). Notably, the International Physical Activity Questionnaire (IPAQ), 
which is one of the most frequently used tools for self-reported sedentary time related 
poorly to device-based measures (Prince et al., 2017). More specifically, it has been 
shown to underestimate total sitting time by 161.7 minutes per day when compared 
against a device (Prince et al., 2020).

More recently, Prince and colleagues (2020) undertook a systematic review to 
compare self-report versus device measures of sedentary behaviour in adults. The review 
included 185 unique studies with data from 55,199 participants. Consistent with previous 
literature, self-report measures underestimated sedentary time by ~1.74 hours/day 
compared to device-based measures. In contrast, self-reported time spent at work was 
~40 minutes higher than when assessed by devices. Another review in 2020 by Bakker 
and colleagues pooled criterion validity of all available single-item questionnaires and 
showed fair correlations (r = 0.34) with device-based measures of sedentary time. As 
previously stated, social desirability bias could be playing a role, however, estimating 
total sedentary time can be more challenging than estimating physical activity given that 
sedentary time is less structured. For example, it is much easier to recall a 30-minute run 
you did a couple days ago versus how long you sat in the waiting room for your doctor’s 
appointment on the same day. While many sedentary behaviours can be structured (i.e., 
watching a 30-minute show on television) many are unstructured and thus make it more 
challenging to accurately recall.

All things considered, a single item, easily administered self-report questionnaire that 
shows high reliability and validity when compared with the gold standard activPAL is 
still needed. Additionally, as was previously described, sedentary behaviour research has
highlighted that the way sedentary time is accumulated (i.e., prolonged uninterrupted bouts versus short, frequent bouts) is just as important as total sedentary time (Peddie et al., 2013). In the review by Prince and colleagues (2017), not one questionnaire was tailored towards measuring sedentary break frequency or duration of sedentary bouts. A previous study examined the validity of an interviewer-administered questionnaire to assess work place sitting time and breaks in sitting time and found promising results (Clark et al., 2011). However, given the recent release of the 24-hour movement guidelines highlighting that the population needs to break up sitting time as often as possible, it is essential to have a self-report questionnaire that can measure total sitting, break frequency as well as break duration. Validation of such sedentary behaviour measurement is urgent, as this is what can help to guide future policy, research and practice.

### 1.5 Prevalence of Sedentary Behaviour

Currently, most published population-based estimates of sedentary behaviour are limited to high-income countries, with limited data on global trends in adults (Dempsey et al., 2020; McLaughlin et al., 2020). One review derived accelerometer-based estimates from large or population-representative studies and indicated that adults spend approximately 8.2 h/day (range 4.9–11.9 h/day) sedentary (Bauman et al., 2018). Another study pooling accelerometer data from adults (aged between 20 and 75 years) of four different European countries revealed an average sedentary time of 8.83 h/day (Loyen et al., 2017). In US adults, data from the National Health and Nutrition Examination Surveys for 2007 to 2016 indicated that sedentary behaviour time has increased from 5.7 hours per day to 6.4 hours per day (Du et al., 2019). In Canada, it has been reported that the average person spends up to 9.8 hours per day in sedentary pursuits (Colley et al., 2011). Unfortunately, daily levels of sedentary behaviour are estimated to be even higher among populations where sitting is implied in their occupation, such as university students or office workers (Castro et al., 2020; Thorp et al., 2012).

#### 1.5.1 University Students as a Priority in Sedentary Behaviour Research

The age group of university students, specifically undergraduate students can be identified as ‘emerging adulthood’, typically defined as 18-25 years of age (Arnett,
Previous studies have indicated that the transitional period from high school to university or college comes with a decline in physical activity, dietary quality and sleep (Bray & Born, 2004; Deforche et al., 2015). This transitional period has also been associated with the abandonment of routines and habits and the adoption of a new lifestyle (Deforche et al., 2015). Thus, it is no surprise that research has established that university students are one of the most inactive populations (Guthold et al., 2018). On top of this, university students have been found to spend up to 14.35 hours/day sitting (Castro et al., 2020; Moulin et al., 2019). This is of concern as this period of emerging adulthood is typically overlooked, and habits made during this time can translate into lasting behaviour patterns (Nelson et al., 2008). Since university students remain inactive, even with access to resources aimed at increasing or maintaining physical activity throughout university (i.e., intramural sports leagues, campus recreation center, etc.), it may be more plausible to instead target the reduction of sitting behaviours. University is an inherently sedentary environment, with increased amounts of time spent sitting in class and studying compared to high school (Moulin & Irwin, 2017). Thus, this ‘emerging adulthood’ population represents a key period for establishing and intervening in long-term health behaviour patterns, specifically targeted at decreasing levels of sedentary behaviour.

1.5.2 Office Workers as a Priority in Sedentary Behaviour Research

In some places around the world, office workers have been reported to spend more than 11 hours a day sedentary (Kazi et al., 2014; Smith et al., 2015; Tudor-Locke et al., 2011). For workplace specific sedentary time, it has been reported that office workers spend almost 80% of their workday sedentary, and 42% of their work hours engaged in prolonged (≥ 30 minutes) sitting bouts (Hadgraft et al., 2016). Due to the high volume of sedentary behaviour accumulated in this population, the office is a key setting for interventions to be implemented in order to improve occupational and public health.

1.6 Using Theory in Health Behaviour Change Research

The global disease burden can be attributed to many behavioural risk factors such as smoking, alcohol misuse, physical inactivity, sedentary behaviour, and certain dietary behaviours (Bauer et al., 2014; Kontis et al., 2014; Lavie et al., 2019). Behaviour change
can play a key role in the prevention, management and treatment of many diseases and disabilities (Carey et al., 2018). Interventions based on theory typically produce larger effect sizes and have the potential of being easily implemented on a large-scale at a low-cost (Bartholomew & Mullen, 2001).

Schwarzer and Luszczynska (2008) define health behaviour change as the motivational, volitional, and actional processes of abandoning such health-compromising behaviours in favor of adopting and maintaining health-enhancing behaviours. Behaviour change techniques are defined as ‘a replicable component of an intervention designed to alter or redirect casual processes that regulate behaviour’ (Carey et al., 2018). Behaviour change techniques are designed to facilitate behaviour change and do this by either augmenting factors that facilitate behaviour change or by mitigating factors that inhibit behaviour change (Michie et al., 2013). While behavioural interventions are becoming increasingly popular, the links between the behaviour change techniques used and the theoretical constructs they are believed to modify are not always transparent in intervention studies (Carey et al., 2018). Interventions that are grounded in a well-established theoretical framework can support the understanding of processes through which behaviour change techniques have their effects (Hagger et al., 2020). In addition, the use of the behaviour change taxonomy can help in selecting the appropriate behaviour change techniques to facilitate in future evaluation, replication, and syntheses of an intervention (Michie et al., 2013).

Due to the high prevalence of sedentary behaviour alongside the high levels of physical inactivity, there are many behavioural theories that have been applied to the health promotion of these specific behaviours (Rhodes et al., 2019). For example, there are social cognitive approaches such as the Theory of Planned Behaviour (Ajzen, 1991; 1985), Protection Motivation Theory (Rogers, 1975), and Social Cognitive Theory (Bandura, 1996, 2004). There are stage models such as the Transtheoretical Model (TTM; Marcus & Simkin, 1994). There are Humanistic approaches such as the Self-determination theory (Deci and Ryan, 2000). There are dual process approaches such as the theory of energetic cost minimization (Cheval et al., 2018) and the affect and health behaviour framework (Williams and Evans, 2014). There are socioecological frameworks such as the ecological model of physical activity (Spence & Lee, 2003). Lastly, there are
action control models such as the Health Action Process Approach (HAPA; Schwarzer 2008) and the Multi-Process action control approach (M-PAC; Rhodes, 2017). These various conceptualizations of theories each come with their own pros and cons. Theories based on stages (i.e., TTM) allows people to be classified into various groups depending on the ‘stage’ they are in; and thus, reflect specific cognitive or behavioural characteristics (Schwarzer et al., 2011). This is helpful in intervention studies as it makes it easier to target homogenous groups for the design of stage-matched treatments (Schwarzer et al., 2011). On the other hand, continuum models have been found useful for explanation and prediction but are often too general because all variables involved need to be addressed, without the consideration of subgroups of participants. A recent critical narrative review on the maintenance of physical activity indicated that there are clear differences between physical activity initiation and maintenance, both epidemiologically and conceptually (Rhodes & Sui, 2021). This can also be applied to the reduction of sedentary behaviour in the sense that many behaviour change interventions grounded within theory puts in the effort of initiating the reduction of the unwanted behaviour, but once behaviour change is underway, there is a lack of focus on the maintenance of the behaviour. A theoretical model that addresses both the initiation and maintenance stage of behaviour change is the HAPA model. The model includes post-intention constructs such as action planning, coping planning, maintenance self-efficacy and recovery self-efficacy. Individuals that illustrate higher levels of these constructs are said to have a better chance of maintaining behaviour compared to those who only initiated the behaviour (Rhodes & Sui, 2021).

1.6.1 Health Action Process Approach (HAPA)

Traditional theories are often criticized for the intention-behaviour gap, or in other words, the failure of intention to predict behaviour. The HAPA model intends to bridge this gap, overcoming many limitations prevalent in other models/theories. The HAPA framework is distinct from other models for a number of reasons. First, it suggests that the behaviour change process be divided into both motivational and volitional phases. Second, there are two volitional phases to account for those who have not yet translated their intentions in action, and those who have. Third, it employs postintentional planning, for intenders in the volitional preactional stage that are motivated to change, but do not
act because they lack skills or knowledge. Fourth, there are two kinds of mental stimulation, action planning and coping planning. Fifth and lastly, phase specific self-efficacy (Schwarzer et al., 2011). The HAPA framework is illustrated in Figure 1.

![Figure 1. The Health Action Process Approach (Schwarzer, 2008)](image)

In the first phase of HAPA (i.e., the pre-intentional or motivational phase), risk perceptions, outcome expectancies and action/task-self-efficacy are all influential factors in the formation of intentions. In the latter part of the model (i.e., the volitional phase), action planning, action control/planning and maintenance/recovery self-efficacy are regarded as being influential. The first phase leads to forming intentions whereas the second phase leads to actual behaviour change. Risk perceptions (e.g., “I am at risk for cardiovascular disease”) are said to set the stage for the contemplation process. Similarly, positive outcome experiences (e.g., “If I interrupt my sedentary behaviour with 2 minutes of walking every 45 minutes, I will reduce my cardiovascular risk”) are important in the motivation phase, concerned with beliefs about the positive and negative outcomes of a specified behaviour. Task self-efficacy refers to the perceived capability of a person to implement a certain behaviour and facilitates goal setting (e.g., “I am confident that I can stand up and move around for 2 minutes every hour”) (Schwarzer et al., 2003). Action planning specifies in detail how and under what situational circumstances an intended action is to be implemented. In other words, it is the ‘when’, ‘where’ and ‘how’ to act for the purpose of the goal intention. Action planning/control is to aid in sustaining
behaviour change, and encompasses self-regulatory processes of self-monitoring, awareness of standards and effort (Schwarzer et al., 2008). Maintenance self-efficacy refers to optimistic beliefs about one’s capabilities to deal with barriers that may arise. Lastly, recovery self-efficacy refers to one’s conviction to get back on track after being derailed (Schwarzer et al., 2008).

The HAPA model has been utilized to predict and modify many health behaviours such as physical activity, dietary behaviours, breast self-examination, seat-belt use, smoking cessation and most recently, sedentary behaviour (Schwarzer, 2008; Schwarzer & Luszczynska, 2008; Rollo & Prapavessis, 2020; Sui & Prapavessis 2017). One study using the HAPA model examined if HAPA constructs were associated with sedentary behaviour levels in older adults and found that greater plans to reduce sedentary behaviour were related to lower levels of sedentary behaviour (Maher & Conroy, 2016). Sui and Prapavessis (2017) found that a HAPA-based intervention utilizing action planning and coping planning was able to significantly increase number of breaks from sitting in full-time university students. Rollo and Prapavessis investigated the effectiveness of a HAPA-based planning intervention augmented with tailored text-messages and were able to significantly reduce workplace sitting time. Taken together, the HAPA model seems to be effective for predicting and/or modifying sedentary behaviour in various populations.

1.7 Previous Interventions Targeting University Students

The number of interventions targeting the reduction of sedentary behaviour time in university students is limited but growing (Moulin et al., 2019). Previous interventions have targeted the university environment by implementing sit-to-stand desks and pedal machines (Butler et al., 2018; Jerome et al., 2017; Maeda et al., 2019). Jerome and colleagues (2017) tested the effectiveness of standing desks on the classrooms of university students in a six-week cross-over design. The study observed sitting and standing behaviours via direct observation (i.e., video cameras) and concluded that students stood significantly more when they had access to sit-stand desks compared to when they had access to seated desks (7.2 minutes/hour/student) (Jerome et al., 2017). Complimentary to these findings, Butler and colleagues (2018) noted that the
implementation of standing desks improved several cardio-metabolic health outcomes while also proving to be a widely accepted solution for reducing sitting time throughout a seven-week intervention in university students (Butler et al., 2018). Standing desks have also shown success when paired with the implementation of decisional cues (Mnich et al., 2019). More specifically, a three-week study was conducted providing access to sit-stand-desks and posters with decisional cues and reported a decrease in sitting from 92.9% to 84.5% (Mnich et al., 2019). A study by Maeda and colleagues (2019) using pedal machines observed a cumulative pedal time per day of 95.5 minutes, however, they only reported modest reductions in overall sedentary time. While these studies show potential for decreasing school-related sedentary behaviour, these are cost-dependent and may not be scalable for all institutions, classrooms, and study spaces. Additionally, since undergraduate studying occurs in multiple environments, both on and off campus, sit-to-stand desks placed throughout the university may not be enough (Mac Neela et al., 2012). In turn, behavioural interventions that can easily be administered large-scale at a lower cost, without institutional buy-in need to be explored.

Previous interventions in university students that do not involve the use of environmental alterations have been digital and/or theory-based interventions (Castro et al., 2021; Cotton & Prapavessis, 2016; Miragall et al., 2018; Sui & Prapavessis 2017).

Cotton and Prapavessis (2016) conducted a randomized control trial aimed at increasing non-sedentary behaviours and found small-to-moderate effects favouring the effectiveness of a text-message-based intervention. A later intervention by Sui and Prapavessis (2017) used a theory-based intervention (HAPA), specifically action and coping planning to target university students sedentary break frequency and duration. After a six-week intervention period, the intervention group significantly increased their break frequency, but not break duration, compared to the controls. In 2018, Miragall and colleagues examined the effect of an internet-based motivational intervention supported by pedometers on increasing daily steps in sedentary university students. They delivered a three-week intervention that included information to increase motivation and set individualized physical activity goals (Miragall et al., 2018). Their results were promising, showing that the intervention increased daily steps more than the non-intervention condition (Miragall et al., 2018). Castro and colleagues (2021) performed a
quasi-experimental (pre-post) pilot study including a one-on-one educational session paired with daily text-messages for six days. From pre-to post-intervention, they found a significant reduction in accelerometer-based total and prolonged sedentary time during weekend days, along with an increase in standing and stepping, although no significant changes were found for weekdays (Castro et al., 2021). Overall, these studies show encouraging results for reducing and breaking up sedentary behaviour in university students, but more work is needed in order to optimize effectiveness.

1.8 Previous Interventions Targeting Office Workers

The literature around changing sedentary behaviour in office workers is more advanced than university students. Hence, many more interventions have been conducted in office workers with the intent to reduce sedentary time. These various interventions tend to target the environment (i.e., physical workplace changes), workplace policies, use information and counselling (i.e., behavioural/individual) or some combination of these (i.e., multicomponent) (Carr et al., 2013; Danquah et al., 2017; Edwardson et al., 2018; Healy et al., 2013; Healy et al., 2016; Mackenzie et al., 2015; Neuhaus et al., 2014).

A review of behaviour change strategies used in sedentary behaviour reduction interventions among adults concluded interventions using environmental restructuring, persuasion or education were the most promising (Gardner et al., 2016). Specifically, self-monitoring, problem solving, and restructuring the social or physical environment. A later review done in 2018 by Shrestha et al. investigated the effects of interventions aimed at reducing sitting time at work. The review included 34 studies: 16 environmental, four regarding workplace policy, 10 information and counselling interventions and four multicomponent interventions. The review concluded that interventions using sit-to-stand desks (i.e., environmental) reduced workplace sitting time by an average of 84 to 116 minutes per workday. Interestingly, when combined with information and counselling, it didn’t seem to significantly increase sedentary behaviour reduction. Providing information, counselling, or feedback alone reduced sitting by an average of 5 to 51 minutes per day and when combined with computer prompts, an average of 14 to 96 minutes per day. Consistent with these findings, an umbrella review
including 40 systematic reviews found that interventions targeting the physical environment are the most effective in reducing sedentary behaviour in a number of settings, including the office (Lam et al., 2022). However, they indicate that the intervention costs can be up to €3587. Thus, similar to university students, while changing the environment has shown to be successful in reducing sedentary behaviour, many workplaces may not be able to afford such changes. Thus, it is important to examine the feasibility and effects of other intervention strategies that can be widely implemented at a low cost.

To ensure that behaviour change is sustained overtime, it is best practice to have social, environmental, and organizational support (Stokes et al., 2006; Taylor et al., 2018). Previous interventions that have successfully reduced sedentary behaviour in the office setting have implemented multi-level interventions (Edwardson et al., 2018; Pereira et al., 2020). For example, the SMArT Work and the Stand and Move at Work interventions combined height-adjustable desks with organizational, group, and individual strategies and observed significant reductions in sedentary behaviour at 12 months. However, organizational buy-in is limited, as one study in 2017 reviewed existing national and international occupational health and safety policies relating to occupational sedentary behaviour (Coenen et al., 2017). Interestingly, after review of over 100 documents from ten countries and six international/pan-European agencies, they were not able to find one policy focusing specifically on sedentary behaviour. That said, the risks associated with high levels of sedentary behaviour were acknowledged and control measures to eliminate or minimize the behaviour going forward were identified. Since this review, a study by Okely et al. (2018) published a chapter examining home, workplace, education, transportation, healthcare, and non-home-based leisure settings where reducing sedentary behaviour can be targeted at a policy level and the current evidence for such policies. They provide examples of relevant policy initiatives such as 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). It is mentioned that there needs to be a shift in societal norms and a focus beyond just health benefits (i.e., work
productivity, economic benefits, etc.) in order for such policies to be effective (Okely et al., 2018).

One study that was able to reduce sedentary behaviour in office-working adults that didn’t involve environmental changes or organizational buy-in was a combined theory and mHealth intervention (Rollo & Prapavessis, 2020). The study combined the use of the HAPA model along with tailored text messages to reduce workplace sitting time and found significant effects. This was the first study to implement this type of approach within the office setting (Rollo & Prapavessis, 2020). Although it illustrates potential, further research is still required in order to confirm that the changes can be maintained over longer periods of time.

### 1.9 How the COVID-19 Pandemic Changed the Workplace Setting

The COVID-19 pandemic disrupted work organizations across the globe (Kniffin et al., 2020). With the rapid shutdowns and mandates implemented across the world, it has created many challenges for both employers and employees with having to shift to virtual workspaces in order to increase employee safety (Kniffin et al., 2020). Some say that the lockdowns accelerated working trends that were already underway, shifting the typical ‘office worker’ to online or virtual environments permanently (Kniffin et al., 2020). For example, Twitter, in response to the pandemic, declared that their employees could work from home indefinitely (Kantrowitz, 2020). Another survey of 229 human resource leaders indicated that pre-pandemic, 30% of employees were working from home some of the time; during the pandemic, this number became 80% and almost half (41%) of participants surveyed were likely to work remotely at least some of the time post pandemic (Gartner, 2020).

While some professionals who don’t require in-person interaction for their specific role prefer and are more productive if they work from home; others, that were forced to make the transition, unprepared, may face the challenge of not having the proper environment or space in one’s home to attend to work. Working from home does come with benefits such as flexible hours, no daily commute time and increased autonomy, however, research has shown that the work from home environment makes it challenging to maintain boundaries between work and nonwork (Ramarajan & Reid, 2013) and can
also lead to feelings of isolation and loneliness (Xiao et al., 2021). Thus, since working from home has become more prevalent, and seems to be a permanent transition (Anderson et al., 2021), the diversity of work arrangements creates the need for future research to examine its impact on various outcomes (i.e., physical activity, sedentary behaviour, work productivity, etc.).

There is an increasing amount of research being done in this working from home population, since the pandemic, to explore a number of the aforementioned outcomes. A cross-sectional study compared physical activity and sedentary behaviour levels during work time between those who work from home and at workplaces (i.e., in-office) (Fukushina et al., 2021). They observed that sedentary behaviour time was longer in the group working from home (n = 494) compared to the in-office group (n = 745). Additionally, significantly shorter light physical activity and moderate to vigorous physical activity times were reported in the group working from home. Similarly, another study examined work style changes among company workers after COVID-19 and analyzed the effects on workers domain specific sedentary and active behaviours (Kooohsari et al., 2021). They showed that workers had more working from home days and fewer office-based working days after the outbreak of COVID-19. The increase in working from home was then associated with increases in work-related sitting time and total sitting time along with a decrease in work-related moderate physical activity (Kooohsari et al., 2021). Studies have also indicated that the occupational stressors of working from home have led to weight gain, musculoskeletal discomfort and decreased mental-well-being (i.e., mood disturbance and depression) (Barone Gibbs et al., 2021; Buomprisco et al., 2021; Xiao et al., 2021). Additionally, one study used an online survey (n = 7753) to collect information on dietary behaviours, physical activity and mental health since the onset of the pandemic (Flanagan et al., 2021). While they observed an increase in healthy eating (due to less eating out and increased cooking) they report an increase in sedentary leisure behaviours and a decline in physical activity (Flanagan et al., 2021). Consistent with the abovementioned findings, a systematic review including 64 studies reporting changes in sedentary behaviour from before to during the COVID-19 pandemic concluded that majority of studies do report an increase in sedentary behaviour alongside decreases in physical activity (Stockwell et al., 2021). Findings such as these
are what brought upon the ‘urgent need’ to address the higher levels of sitting and lower levels of physical activity that were brought on by the pandemic (Smirmaul & Arena, 2020). Sedentary behaviour has thus been identified as a feasible health behaviour to target for enhancing individuals physical and mental health during the COVID-19 pandemic (Zieff et al., 2021).

1.10 Dissertation Objectives

1.10.1 General Objectives

The overarching objectives of this dissertation are to 1) target populations at a high-risk for sedentary behaviour health consequences and implement theory-based health promotion strategies to reduce how much they sit and 2) bring awareness to measurement issues related to sedentary behaviour research.

1.10.2 Specific Objectives

Given the amount of time university students are reported to be sedentary, and the detrimental health effects of total and prolonged sitting time, the aim of study 1 (chapter 2) was to evaluate the effectiveness of a Health Action Process Approach (HAPA) based planning intervention augmented with text messages to reduce student-related sitting time. During the end stages of study 1, the onset of the COVID-19 global pandemic changed the office working world in the blink of an eye. With office workers already being an at-risk population and working from home leading to increasing levels of sedentary behaviour, there is a dearth of evidence regarding the effectiveness of reducing sedentary behaviour in this population working from home. Thus, study 2 (chapter 3) investigated whether augmenting the HAPA intervention with choice architecture principles grounded in behavior economics (i.e., the ability to choose or not) will affect sedentary behaviour patterns in a group of home-based office working adults.

With respect to measurement issues related to sedentary behavior research, it has been shown that device-based measures are more precise than self-report. However, they come at a high-cost and burden to both the researcher and participants. Therefore, study 3A (chapter 4) aimed to validate the OSPAQ, a self-report questionnaire that can measure total levels of sitting time in home-based office workers. Finally, since pattern of sedentary behaviour accumulation is just as important as total time spent sedentary, study
3B (chapter 5) aimed to validate the modified SIT-Q 7d questionnaire, a self-report tool that can capture sedentary break frequency and break duration. Although chapters 2, 3, 4 and 5 represent distinct research studies, there is direct relevance and linkage between the studies that will become clearer as the reader moves through these chapters. This series of dissertation is presented in an integrated-article format. As such, it is expected that there will be some repetition regarding background and rationale.
1.11 References


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Chapter 2 – A Combined Health Action Process Approach and mHealth Intervention to Reduce Sedentary Behaviour in University Students- A Randomized Controlled Trial\(^1\) (Study 1)

\(^1\)A version of this chapter has been previously published (Dillon et al., 2021). Reprinted with permission (see Appendix A).
Abstract

This investigation evaluated the effectiveness of a Health Action Process Approach (HAPA) based planning intervention augmented with text messages to reduce student-related sitting time (primary outcome) and increase specific non-sedentary behaviours. Relationships between the HAPA volitional constructs and sedentary and non-sedentary behaviours were also explored. University students ($M_{age} = 21.13$ y; $SD = 4.81$) were randomized into either a HAPA intervention ($n = 28$) or control ($n = 33$) condition. School-related sitting time, time spent in specific non-sedentary behaviours and HAPA volitional constructs were assessed at baseline, weeks 2, 4, 6 (post-intervention) and 8 (follow-up). Significant group by time interaction effects favouring the intervention group were found for sitting time ($p = 0.004$, $\eta^2_p = 0.10$), walking time ($p = 0.021$, $\eta^2_p = 0.06$) and stretching time ($p = 0.023$, $\eta^2_p = 0.08$), as well as for action planning ($p < 0.001$, $\eta^2_p = 0.17$), coping planning ($p < 0.001$, $\eta^2_p = 0.20$) and action control ($p < 0.001$, $\eta^2_p = 0.20$). Significant correlations ($p < 0.05$) were also found between the HAPA constructs and sitting-related outcomes. Combining a HAPA-based planning intervention with text messages can reduce student-related sitting time in university students.

Keywords: sedentary behaviour, intervention, health action process approach, text-messages, university students
2.1 Introduction

It is now well established that high levels of sedentary behaviour (SB) (i.e. sitting) are associated with a higher risk of type 2 diabetes, cardiovascular disease (fatal and non-fatal), and all-cause mortality (Katzmarzyk et al., 2019). High levels of sitting have also been shown to have an impact on mental well-being, such as increased risk of anxiety and depression (Teychenne et al., 2015; Zhai et al., 2015). Acute bouts of uninterrupted SB have been shown to result in rapid and deleterious changes in triglyceride levels, insulin sensitivity, and glucose tolerance (Saunders et al., 2012).

Contrary to this, it has been shown that as little as 10 additional breaks/day (e.g., standing and/or walking for at least 1 minute) in SB may be beneficially associated with waist circumference, systolic blood pressure, HDL-cholesterol, blood lipid levels, blood glucose levels, and insulin levels (Carson et al., 2014), indicating that not only reducing but breaking up sedentary time is particularly important for cardiometabolic health. A recent systematic review and meta-analysis including 42 studies indicated that performing light activity (i.e. walking) during SB breaks was more effective than continuous exercise for attenuating glucose measures when protocols were energy matched (Loh et al., 2019). Thus, by simply standing up, moving more and moving more often, many of the deleterious health consequences associated with high levels of SB may be mitigated.

Despite the known health risks of too much sitting, many Canadian and American adults have been found to spend up to 10 hours per day engaged in sedentary pursuits (Carson et al., 2014). In particular, university students spend a large portion of their day in SB and is lacking intervention research. Two recent systematic reviews confirmed that university students are highly sedentary (up to 14.35 hours/day) and may be on an early path to disease, hence representing an important population for SB reductions strategies to target (Castro, Bonnie, Vergeer, Bosselut, & Biddle, 2020; Moulin, Truelove, Burke, & Irwin, 2019).

Previous interventions aimed at reducing SB in university students have used a wide array of methods including the use of library pedal machines (Maeda et al., 2014), standing desks (Jerome et al., 2017), and standing desks paired with decisional cues (Mnich et al., 2019). Although providing university students with environmental
resources (e.g., access to sit-stand desks or pedal machines) have shown potential to decrease school-related SB, these are cost-dependent and domain-specific strategies that may not be scalable for all institutions, classrooms, and study spaces. Further, their acquisition requires buy-in at the institutional level.

Behavioural interventions employ strategies that can be implemented on a large-scale at low-cost without requiring the same degree of institutional buy-in. One theoretical model that has shown to be effective in behaviour change interventions is the Health Action Process Approach (HAPA; Schwarzer, 2008). The HAPA model is a well-established theoretical framework that has demonstrated success for predicting and modifying both health-enhancing and health-comprising behaviours such as physical activity, dental flossing, seatbelt use, dietary behaviour, and more recently SB (Maher, Slowinski, & Conroy, 2017; Rollo & Prapavessis, 2020; Schwarzer et al., 2007). The HAPA model intends to bridge the intention-behaviour gap by including post-intentional volitional factors that have been shown to help translate intentions into action and predict health behaviour engagement (Schwarzer and Luszczynska, 2008). Action plans are formulated to specify the “when”, “where” and “how” the intended behaviour will be implemented. Coping planning is used to address any barriers that may arise during the implementation and allows the development of alternative strategies to overcome these barriers. Lastly, action control incorporates self-regulatory processes to promote the maintenance of the behaviour (Schwarzer, 2008). To our knowledge, only one study has used the HAPA model in university students. Sui and Prapavessis’ (2018) used the HAPA model in full-time university students and were successful in significantly increasing SB break frequency. Nonetheless, intervention effects on actual sitting time and other non-sedentary outcomes were not assessed. Furthermore, the authors recommended that future studies measure changes in HAPA behaviour change constructs and include the implementation of regular “boosters” to help strengthen and sustain the intervention effects on sedentary outcomes.

Another successful behavioural intervention approach for reducing SB in university students is the use of screen-based technology. Previous studies have indicated that almost all university students own a mobile phone (Fowler and Noyes, 2015). Therefore, not only is using text messages a time-efficient and low-cost alternative
approach to intervention delivery, but they also allow the researchers to reach a large population across diverse settings. Cotton and Prapavessis (2016) demonstrated small-to-moderate effects for increasing break frequency, break duration, standing, and both light- and moderate-intensity physical activity during a 6-week text message intervention among university students. However, this study was not grounded within a prominent health behaviour change framework, did not included a follow-up assessment, and subsequently reported a high number of dropouts.

To our knowledge, only one study has combined the use of the HAPA model with text-messages to reduce and break up SB, however, this was conducted among office working adults (Rollo & Prapavessis, 2020). Findings from this study were encouraging, with significant interaction effects for reducing sitting time while increasing both time spent standing and walking (Rollo & Prapavessis, 2020). Whether these effects can be replicated among other populations at-risk of high sedentary time (e.g., college and/or university students) warrants investigation.

Therefore, with the abovementioned limitations in mind, 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 school-related sitting time (primary outcome). Secondary objectives were to examine (i) the effects of the intervention on specific non-sedentary behaviours that might explain reductions in school-related sitting time (i.e. time spent standing, time spent walking, time spent stretching, frequency and duration of breaks from sitting) and (ii) relationships among all the variables of interest (i.e. HAPA volitional constructs, sedentary and non-sedentary behaviours).

2.2 Methods

2.2.1 Study Design

Data collection for this two-arm, repeated measure, single-blinded, randomized controlled trial occurred in two waves from January to April 2019 and January to April 2020. Data were analyzed in May 2020. The study was approved by the institutional research ethics board (see Appendix B) and registered on ClinicalTrials.gov: NCT03760393.
2.2.2 Participants

Participants were full-time students recruited from universities across Canada. Participants were primarily recruited through recruitment posters distributed via various faculty-specific student social media groups/pages. Participants were also recruited by contacting professors and course instructors at specific universities via email, requesting they post and advertise the study recruitment poster on their course online portal (See Appendix C). The recruitment poster included brief study details (i.e., objective, eligibility criteria, procedures) and instructed interested individuals to contact the researcher via email (see Appendix D) if they wished to participate or receive additional details prior to making a decision (see Appendix E). To meet the eligibility criteria, participants were required to (a) be 18 years of age or older, (b) be a full-time university and/or college student, (c) be fluent in English, (d) have access to a computer with Internet, and e) own a mobile phone with free unlimited incoming text messages. Participants were excluded if they had a self-declared medical condition or physical limitation that prevented them from being physically active. See Appendix F for full Letter of Information and Informed Consent.

2.2.3 Measures

2.2.3.1 Time spent sitting, standing walking and stretching

Time spent sitting (primary outcome), standing, walking and stretching during school-related activities 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 has high test-retest reliability (intra-class correlation coefficients = 0.73 – 0.90) with 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). Participants were asked to record the number of hours and days they performed school-related activities over the previous 14 days. Next, participants were asked to record the percentage of time spent sitting, standing, walking and stretching (sum to 100%) for school-related activities on a typical day in the last 14 days. Calculations were consistent with Rollo and Prapavessis (2020) and were performed for time (minutes/day) spent standing, walking and stretching during school-
related activities.

2.2.3.2 Frequency and duration of breaks from sitting

Both frequency and duration of breaks from sitting served as secondary outcomes. The current study utilized the same modified version of the SIT-Q 7d questionnaire as used by Rollo and Prapavessis (2020) to measure participants frequency and duration of breaks from sitting during school-related activities (Wijndaele et al., 2014). The original questionnaire was modified by Sui and Prapavessis (2018) to include domain-specific break frequency and duration scores, which were the two items used in the current study. These items have shown adequate test-retest reliability ($r = 0.564 – 0.740$, ICC = $0.562 – 0.740$, $p = 0.05$). The question used to assess frequency of breaks from sitting during school-related activities was: “In the last 14 days, on average, how often did you interrupt your sitting time during school-related work hours?” Participants could respond with one of the following: less than every 30 minutes, every 30–45 minutes, every 45 minutes–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 7 hours or no interruption. Consistent with previous studies, results were coded to correspond with the upper limit for break frequency (Rollo & Prapavessis 2020; Sui & Prapavessis 2018). The options “over 7 hours” and “no interruption” were represented by a break frequency of 8 hours (i.e. 480 minutes). Although previous research has suggested that students spend approximately 6 hours a day doing school-related activities (Gaston, De Jesus, Markland, & Prapavessis, 2016) a maximum break frequency of 8 hours was chosen to be consistent with a “typical” occupational workday (i.e. 8 hours). To measure the duration of breaks taken from sitting during school-related activities, the following question was asked: “In the last 14 days, on average, how long were your breaks from sitting during school-related work hours?” Response options for the question included: less than 30 sec, 30 sec–1 minute, 1–2 minutes, 2–3 minutes, 3–4 minutes, 4–5 minutes, 5–10 minutes, 10–15 minutes, 15–30 minutes and over 30 minutes. In contrast to break frequency, break duration was coded with the lower limit. This approach to coding accounts for the non-linear intervals between response options and keeps estimates of break frequency and duration conservative (Wijndaele et al., 2014).
2.2.3.3 Action planning, coping planning, and action control constructs

Action planning (AP), coping planning (CP) and action control (AC) were assessed using the same questionnaires as Rollo and Prapavessis (2020), which were tailored specifically towards reducing occupational (student-related) SB. These consisted of four-, five-, and six-item purpose-built constructs to measure AP, CP and AC, respectively. 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 during school-related activities”. 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 during school-related activities”. An example item for AC was: “During the last two weeks, I have constantly monitored myself whether I break up my sitting time during school-related activities often enough”. Responses were measured on a five-point Likert scale that ranged from 1 (completely disagree) to 5 (totally agree).

2.2.3.4 Demographics and other baseline characteristics

Participants were asked to report their age, gender, ethnicity, physical health status, height and weight for calculation of body mass index, level of education, student status (full-time or part-time), hours of class per week, hours of work for pay per week, and weekly leisure-time physical activity (times per week) (Godin, 2011). Baseline levels of total, leisure, and occupational SB were assessed with a 12-item modified Sedentary Behaviour Questionnaire (SBQ; Rosenberg et al., 2010), that has been used in previous studies (Prapavessis, Gaston, & DeJesus, 2015; Rollo & Prapavessis, 2020).

2.2.4 Intervention

Participants randomized into the HAPA intervention group received a single, one-on-one behavioural counselling session (See Appendix J for slides and Appendix K for script), an informational booklet, a planning sheet (i.e., table) and daily text messages. During the behavioural counselling session, participants were informed about SB as a health risk, the benefits of reducing and breaking up SB, helpful strategies and target behaviours. The informational booklet reiterated the sedentary information discussed and served as a reference guide for participants, if needed. The planning sheet was provided
to assist participants in developing their AP and CP strategies and included headings drawn from the FITT principle: Frequency, Intensity, Time and Type (see Appendix L). The planning component of the intervention was modelled after previous work (Rollo & Prapavessis, 2020). Using the information and resources provided to them, participants were then asked to form 3-4 actions plans to specify when, where, how and for how long they would reduce and break up their school-related sitting time over the next 6 weeks. For example, a participant may develop a strategy of setting a timer/alarm on their phone to get up every 45 minutes and go for a 2-minute walk while studying. The frequency of this strategy would be every 45 minutes, the intensity would be the duration of the break from sitting (2 minutes), the time would be during their study time, and the type would be walking. Participants were also asked to identify any potential barriers that may arise or disrupt their action plans within the “Coping Strategies” section of the table and establish ways they could be overcome. Strategies were to clearly align with 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 physical activity (i.e., walking or stretching), as a student (i.e., during school-related activities). The strategies formulated were discussed verbally with each participant and noted by the researcher. Participants were then encouraged to write the formulated AP and CP strategies on their planning sheet during/after the counselling session.

Lastly, SB-related text messages were sent to participants once per day for six weeks, at a specified time identified by each individual based on their preferences and schedule. The series of text messages were designed to reinforce the action and coping plans that were formed by the participants and promote elements of AC. The messages were consistent with those outlined by Rollo and Prapavessis (2020). More specifically, the messages included various sedentary-related facts, as well as tips, challenges, and reminders to reduce their student-related sitting time. Participants received two challenges each week, one regarding breaking up sedentary time and one regarding reducing sedentary time. The messages started out relatively easy and progressed in difficulty throughout the intervention period. Example tips and reminders included, “Just because you are studying does not mean you have to stay seated all day. Be sure to take a break between classes or work sessions to get up & move around” and “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!”. See Appendix M for the full list of text messages.

2.2.5 Control

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

2.2.6 Procedures

University students who demonstrated interest in this study received a second email with a link that directed them to the online Letter of Information, Informed Consent, and questionnaire for baseline assessment of demographics and all primary and secondary outcomes (see Appendix G for full baseline questionnaire). Upon completion of the baseline assessment, all participants were randomized, using an online research randomization program (randomizer.org) and 1:1 allocation ratio, into either a 6-week HAPA-treatment (SB-related planning + text messages intervention) or control (no treatment) group. Those assigned to the HAPA intervention group were sent an email requesting that they provide a day and time (within 3 days of completing the baseline assessment) during which they would be available to receive the behavioural counselling session (see Appendix H). Those in the control group were simply reminded via email that they would receive a link to a questionnaire every two weeks for an 8-week period, and to complete these upon receiving them (see Appendix I).

For those in the HAPA intervention group, the researcher delivered the one-on-one behavioural counselling session (AP and CP intervention) electronically via phone and an online presentation platform (www.zoho.com/show/). During the counselling 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 during school-related activities. 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, CP strategies were created alongside each AP strategy in order to bolster 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 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 behavioural counselling sessions took 20-30 minutes to complete. Participants were told to keep their planning sheet and display it somewhere prominent so that they would be reminded of the strategies they developed. The 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 intervention group were then entered into a contact list on the text-messaging website called “Oh Don’t Forget”, which 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. Each intervention participant received the same order of daily texts as every other participant in the group; however, the time of day they were received was individualized for each participant based on their schedule and preferences.

Regardless of group assignment, all participants completed the same primary and secondary outcome measures at week 2, week 4, week 6 and a 2-week follow-up (week 8), which were administered online through a survey website called SoSci (www.soscisurvey.de). Participants received an email with a link to access the online questionnaires every two weeks for an 8-week period. Upon study completion, all participants were entered into a draw for a chance to win a $100 Tim Hortons or Starbucks gift certificate.

A fidelity check was performed in numerous ways. All 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 counselling session, participants developed personal strategies for their target behaviours 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 participants’ planning cognitions had changed as a result of the intervention received.

### 2.2.7 Statistical Analysis

Based on previous behavioural interventions targeting SB (Cotten & Prapavessis, 2016; Sui & Prapavessis, 2018; Rollo & Prapavessis, 2020), an a priori power calculation was performed using G*Power software v.3.1.9.2 to determine the required sample size given α, power and effect size to conduct a series of 2x5 repeated measures analyses of variance (ANOVAs). In order to achieve 80% power in a test based on α = 0.05, using two treatment groups with five assessment points resulted in a total required sample size of n = 56, for differences in sedentary and non-SB outcomes between groups with a minimum effect size of f = 0.15 (small-medium; i.e., η_p^2 = 0.01-0.06) to be detected. This equated to a sample size of n = 28 required for each experimental condition.

A winsorization technique was used to replace any outliers in the data (i.e. points over the 95th percentile) with the value of the 95th percentile. A total of 142 data points out of 3,300 primary and secondary outcome data points were imputed this way (76 in the intervention group and 66 in the control group). This method has been shown to be a valid approach to treat outliers (Guttman and Smith, 1969).

Univariate ANOVAs and chi-square analyses were used to ensure that there were no systematic differences between groups on demographic characteristics, levels of baseline total, occupational, and leisure SB, leisure-time physical activity, or any of the primary and secondary outcomes at baseline. Variables where significant baseline group differences were found were treated as covariates in subsequent analyses. For AP, CP and AC variables, a series of 2 (groups: intervention, control) x 5 (time: baseline, weeks 2, 4, 6 and 8) 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, standing, walking, stretching, frequency and duration of breaks from sitting) to identify possible group by time interaction effects. A P value <
0.05 was regarded as significant for all statistical tests and a partial eta squared (η²) of 0.01, 0.06, and 0.14 represented small, medium and large effect sizes, respectively. Finally, bivariate correlations were conducted to examine relationships between AP, CP and AC constructs and sedentary and non-SBs. All analyses were conducted using IBM SPSS version 25.0 software.

2.3 Results

2.3.1 Missing Data

On any given variable at a single assessment point, the maximum percentage of missing data/responses was 16.4% (n = 3). 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. Two participants and three participants dropped out of the intervention and control group respectively, all lost to follow-up. Of the 305 total participant questionnaires that could have been completed, four assessments and seven assessments were unanswered or missing from the control and intervention group, respectively. Figure 2 shows the flow of participants and dropouts for each group. Independent sample t-tests revealed no significant differences (all p values > 0.05) 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 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 and Campbell, 1999).
Figure 2. Flow of participants through the study.

2.3.2 Group Equivalency

Sixty-one healthy university students (mean age = 21.13 ± 4.81 years, 80.3 % female) were recruited to participate in the study. Twenty-eight participants were randomized to the HAPA intervention group (mean age = 21.43 ± 6.48 years, 85.7 % female) and thirty-three participants were randomized to the control group (mean age = 20.88 ± 2.70 years, 75.8 % female). Descriptive statistics for the demographic variables, baseline levels of SB and leisure-time physical activity can be found in Table 1. No significant differences emerged, indicating groups were equivalent at baseline for all measures (all p-values > 0.05). 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 only found for sitting time during school-related activities, $F(1, 55) = 6.81, p = 0.012, \eta^2_p = 0.09$. Due to these differences, an ANCOVA controlling for baseline sitting time was also conducted and reported for this outcome.
Table 1. Baseline characteristics by group, presented as mean (SD) or count (%) of group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>HAPA Intervention (n = 28)</th>
<th>Control (n = 33)</th>
<th>Entire Sample (N = 61)</th>
<th>Statistic</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>21.43 (SD = 6.48)</td>
<td>20.88 (SD = 2.70)</td>
<td>21.13 (SD = 4.81)</td>
<td>F(1,59) = 0.195</td>
<td>0.660</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4 (14.3 %)</td>
<td>8 (24.2 %)</td>
<td>12 (19.7 %)</td>
<td>X² (1) = 0.950</td>
<td>0.330</td>
</tr>
<tr>
<td>Female</td>
<td>24 (85.7 %)</td>
<td>25 (75.8 %)</td>
<td>49 (80.3 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>11 (39.3 %)</td>
<td>15 (45.5 %)</td>
<td>26 (42.6 %)</td>
<td>X² (3) = 0.751</td>
<td>0.861</td>
</tr>
<tr>
<td>Asian</td>
<td>13 (46.4 %)</td>
<td>12 (36.4 %)</td>
<td>25 (41.0 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>1 (3.6 %)</td>
<td>1 (3.0 %)</td>
<td>2 (3.3 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>3 (10.7 %)</td>
<td>5 (15.2 %)</td>
<td>8 (13.1 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.51 (SD = 3.14)</td>
<td>23.85 (SD = 6.35)</td>
<td>23.69 (SD = 5.10)</td>
<td>F(1,59) = 0.067</td>
<td>0.797</td>
</tr>
<tr>
<td>Level of Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>22 (78.6 %)</td>
<td>30 (90.9 %)</td>
<td>52 (85.2 %)</td>
<td>X² (2) = 2.984</td>
<td>0.225</td>
</tr>
<tr>
<td>Masters</td>
<td>4 (14.3 %)</td>
<td>3 (9.1 %)</td>
<td>7 (11.5 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2 (7.1 %)</td>
<td>0 (0.0 %)</td>
<td>2 (3.3 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>28 (100 %)</td>
<td>33 (100 %)</td>
<td>60 (100 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part-time</td>
<td>0 (0 %)</td>
<td>0 (0 %)</td>
<td>0 (0 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours of class Per Week</td>
<td></td>
<td></td>
<td></td>
<td>X² (3) = 1.809</td>
<td>0.613</td>
</tr>
<tr>
<td>0</td>
<td>1 (3.6 %)</td>
<td>0 (0.0 %)</td>
<td>1 (1.6 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤10</td>
<td>3 (10.7 %)</td>
<td>6 (18.2 %)</td>
<td>9 (14.8 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-20</td>
<td>20 (71.4 %)</td>
<td>22 (66.7 %)</td>
<td>42 (68.9 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-30</td>
<td>4 (14.3 %)</td>
<td>5 (15.2 %)</td>
<td>9 (14.8 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours of work for pay Per Week</td>
<td></td>
<td></td>
<td></td>
<td>X² (4) = 6.418</td>
<td>0.170</td>
</tr>
<tr>
<td>0</td>
<td>17 (60.7 %)</td>
<td>12 (36.4 %)</td>
<td>29 (47.5 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤10</td>
<td>4 (14.3 %)</td>
<td>9 (27.3 %)</td>
<td>13 (21.3 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-20</td>
<td>5 (17.9 %)</td>
<td>7 (2.3 %)</td>
<td>12 (19.7 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-30</td>
<td>1 (3.6 %)</td>
<td>5 (1.5 %)</td>
<td>6 (9.8 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40+</td>
<td>1 (3.6 %)</td>
<td>0 (0 %)</td>
<td>1 (1.6 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedentary Behaviour (hours/day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13.78 (SD = 5.32)</td>
<td>14.89 (SD = 7.68)</td>
<td>14.38 (SD = 6.67)</td>
<td>F(1,59) = 0.420</td>
<td>0.519</td>
</tr>
<tr>
<td>Leisure</td>
<td>7.26 (SD = 4.13)</td>
<td>9.08 (SD = 7.76)</td>
<td>8.25 (SD = 6.37)</td>
<td>F(1,59) = 1.246</td>
<td>0.269</td>
</tr>
<tr>
<td>Work</td>
<td>6.52 (SD = 2.59)</td>
<td>5.81 (SD = 2.18)</td>
<td>6.14 (SD = 2.38)</td>
<td>F(1,59) = 1.340</td>
<td>0.252</td>
</tr>
<tr>
<td>Weekly Leisure-time physical activitya</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>5.33 (SD = 4.98)</td>
<td>4.71 (SD = 3.34)</td>
<td>4.98 (SD = 4.10)</td>
<td>F(1,54) = 0.561</td>
<td>0.457</td>
</tr>
<tr>
<td>Moderate</td>
<td>3.71 (SD = 3.20)</td>
<td>3.32 (SD = 2.52)</td>
<td>3.49 (SD = 2.81)</td>
<td>F(1,54) = 0.113</td>
<td>0.717</td>
</tr>
<tr>
<td>Strenuous</td>
<td>2.79 (SD = 2.57)</td>
<td>2.23 (SD = 2.24)</td>
<td>2.47 (SD = 2.24)</td>
<td>F(1,56) = 0.533</td>
<td>0.468</td>
</tr>
</tbody>
</table>

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)
2.3.3 Fidelity Check

Descriptive data for the HAPA volitional constructs are presented in Table 2. There were significant group by time interaction effects for AP, $F(2.66, 156.98) = 12.13$, $p < 0.001$, $\eta^2_p = 0.17$; CP, $F(3.25, 191.65) = 14.91$, $p < 0.001$, $\eta^2_p = 0.20$; and AC, $F(3.05, 179.70) = 14.56$, $p < 0.001$, $\eta^2_p = 0.20$, towards reducing student-related sitting time. The observed power for each effect was 1.00. Participants in the HAPA intervention group reported significantly higher AP, CP and AC at all time points compared to those in the control group.

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

<table>
<thead>
<tr>
<th></th>
<th>HAPA Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td></td>
<td>Baseline</td>
<td>Week 2</td>
</tr>
<tr>
<td>Action planning</td>
<td>2.14 (1.02)</td>
<td>3.82 (0.62)</td>
</tr>
<tr>
<td>Coping planning</td>
<td>1.77 (0.70)</td>
<td>2.91 (0.63)</td>
</tr>
<tr>
<td>Action control</td>
<td>2.57 (0.92)</td>
<td>3.82 (0.49)</td>
</tr>
</tbody>
</table>

2.3.4 Intervention Effects

Descriptive data for time spent sitting (primary outcome), standing, walking, and stretching, as well as frequency and duration of breaks from sitting during school-related activities at all time points can be found in
2.3.4.1 Sitting time

A significant group by time interaction effect was obtained for time spent sitting during school-related activities, \( F(3.21, 144.26) = 3.85, p = 0.009, \eta^2_p = 0.08 \). The observed power was 0.83. Within-subjects contrasts revealed that relative to baseline, decreases in sitting time were significantly greater at week 2 and 8 for the HAPA intervention group compared to those in the control group. Controlling for baseline time spent sitting, the interaction effect was strengthened, \( F(3, 132) = 4.66, p = 0.004, \eta^2_p = 0.10 \).

2.3.4.2 Standing time

No significant group by time interaction effect, \( F(4, 224) = 0.376, p = 0.862, \eta^2_p = 0.01 \) or time effect, \( F(4, 224) = 0.481, p = 0.750, \eta^2_p = 0.01 \) was observed for time spent standing during school-related activities.

2.3.4.3 Walking time

A significant group by time interaction effect was found for time spent walking during school-related activities, \( F(4, 180) = 2.548, p = 0.041, \eta^2_p = 0.05 \). The observed power was 0.71. Within-subjects contrasts revealed that relative to baseline, increases in walking time were significantly greater at week 6 and 8 for the HAPA intervention group compared to the control group.

2.3.4.4 Stretching time

A significant group by time interaction effect was obtained for time spent stretching during school-related activities, \( F(3.02, 120.96) = 3.30, p = 0.023, \eta^2_p = 0.08 \). The observed power was 0.76. Within-subjects contrasts revealed that relative to baseline, increases in stretching time were significantly greater at week 2 for the HAPA intervention group compared to those in the control group.

2.3.4.5 Break frequency

No significant group by time interaction effect, \( F(3.15, 176.43) = 0.81, p = 0.493, \eta^2_p = 0.01 \) or time effect, \( F(3.15, 176.43) = 1.17, p = 0.325, \eta^2_p = 0.02 \) was observed for frequency of breaks from sitting during school-related activities.
2.3.4.6 Break duration

No significant group by time interaction effect, $F(3.32, 189.17) = 0.96, p = 0.419, \eta^2_p = 0.02$ or time effect, $F(3.32, 189.17) = 0.75, p = 0.534, \eta^2_p = 0.01$ was observed for duration of breaks from sitting during school-related activities.
### Table 3. Descriptive data (M ± SD) for sitting-related behavioural outcomes at baseline, week 2, week 4, week 6 and week 8.

<table>
<thead>
<tr>
<th></th>
<th>HAPA Intervention</th>
<th></th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td></td>
<td>Baseline</td>
<td>Week 2</td>
<td>Week 6</td>
</tr>
<tr>
<td>Sitting time</td>
<td>296.62 (126.74)</td>
<td>217.63 (50.50)</td>
<td>197.24 (117.36)</td>
</tr>
<tr>
<td>(min/workday)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standing time</td>
<td>52.91 (19.24)</td>
<td>69.34 (38.14)</td>
<td>63.36 (39.90)</td>
</tr>
<tr>
<td>(min/workday)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking time</td>
<td>59.31 (39.87)</td>
<td>73.40 (63.08)</td>
<td>61.85 (40.21)</td>
</tr>
<tr>
<td>(min/workday)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stretching time</td>
<td>18.29 (15.22)</td>
<td>35.10 (18.40)</td>
<td>23.70 (13.56)</td>
</tr>
<tr>
<td>(min/workday)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Break frequency</td>
<td>106.60 (43.02)</td>
<td>87.32 (34.89)</td>
<td>78.21 (37.72)</td>
</tr>
<tr>
<td>(min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Break duration</td>
<td>7.39 (6.81)</td>
<td>4.00 (3.74)</td>
<td>4.43 (3.74)</td>
</tr>
<tr>
<td>(min)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.3.5 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 4-8. Significant correlations ($p < 0.05$) were found between all HAPA volitional constructs and break frequency (weeks 2, 4, 6, 8), break duration (weeks 4, 6, 8), and time spent stretching (week 2) and standing (week 8). CP and/or AC were also significantly associated with standing time (weeks 2 and 6) and stretching time (weeks 6 and 8). No significant correlations emerged between these constructs and time spent sitting or walking.
### Table 4. Correlations between HAPA volitional constructs and primary sitting-related behavioural outcomes at baseline.

<table>
<thead>
<tr>
<th></th>
<th>AP</th>
<th>CP</th>
<th>AC</th>
<th>Sitting time</th>
<th>Standing time</th>
<th>Walking time</th>
<th>Stretching time</th>
<th>Break frequency</th>
<th>Break duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP</td>
<td>-</td>
<td>0.560**</td>
<td>0.694**</td>
<td>0.057</td>
<td>0.115</td>
<td>-0.001</td>
<td>0.107</td>
<td>-0.212</td>
<td>0.102</td>
</tr>
<tr>
<td>CP</td>
<td>-</td>
<td>-</td>
<td>0.639**</td>
<td>-0.107</td>
<td>0.093</td>
<td>-0.027</td>
<td>0.122</td>
<td>-0.201</td>
<td>0.021</td>
</tr>
<tr>
<td>AC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.026</td>
<td>0.041</td>
<td>-0.018</td>
<td>0.149</td>
<td>-0.206</td>
<td>0.232</td>
</tr>
</tbody>
</table>

*p < 0.05  
**p < 0.01

*a*AP: Action planning  
*b*CP: Coping planning  
*c*AC: Action control

### Table 5. Correlations between HAPA volitional constructs and primary sitting-related behavioural outcomes at week 2.

<table>
<thead>
<tr>
<th></th>
<th>AP</th>
<th>CP</th>
<th>AC</th>
<th>Sitting time</th>
<th>Standing time</th>
<th>Walking time</th>
<th>Stretching time</th>
<th>Break frequency</th>
<th>Break duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP</td>
<td>-</td>
<td>0.739**</td>
<td>0.792**</td>
<td>0.163</td>
<td>0.199</td>
<td>0.179</td>
<td>0.288*</td>
<td>-0.349**</td>
<td>-0.135</td>
</tr>
<tr>
<td>CP</td>
<td>-</td>
<td>-</td>
<td>0.762**</td>
<td>0.052</td>
<td>0.268*</td>
<td>0.139</td>
<td>0.320*</td>
<td>-0.322*</td>
<td>-0.014</td>
</tr>
<tr>
<td>AC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.162</td>
<td>0.217</td>
<td>0.189</td>
<td>0.325*</td>
<td>-0.340**</td>
<td>-0.113</td>
</tr>
</tbody>
</table>

*p < 0.05  
**p < 0.01

*a*AP: Action planning  
*b*CP: Coping planning  
*c*AC: Action control

### Table 6. Correlations between HAPA volitional constructs and primary sitting-related behavioural outcomes at week 4.

<table>
<thead>
<tr>
<th></th>
<th>AP</th>
<th>CP</th>
<th>AC</th>
<th>Sitting time</th>
<th>Standing time</th>
<th>Walking time</th>
<th>Stretching time</th>
<th>Break frequency</th>
<th>Break duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP</td>
<td>-</td>
<td>0.782**</td>
<td>0.736**</td>
<td>-0.071</td>
<td>0.029</td>
<td>-0.150</td>
<td>-0.036</td>
<td>-0.381**</td>
<td>-0.500**</td>
</tr>
<tr>
<td>CP</td>
<td>-</td>
<td>-</td>
<td>0.827**</td>
<td>-0.257</td>
<td>0.104</td>
<td>-0.200</td>
<td>0.037</td>
<td>-0.388**</td>
<td>-0.420**</td>
</tr>
<tr>
<td>AC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.188</td>
<td>0.037</td>
<td>-0.258</td>
<td>-0.008</td>
<td>-0.282*</td>
<td>-0.376**</td>
</tr>
</tbody>
</table>

*p < 0.05  
**p < 0.01

*a*AP: Action planning  
*b*CP: Coping planning  
*c*AC: Action control

### Table 7. Correlations between HAPA volitional constructs and primary sitting-related behavioural outcomes at week 6.

<table>
<thead>
<tr>
<th></th>
<th>AP</th>
<th>CP</th>
<th>AC</th>
<th>Sitting time</th>
<th>Standing time</th>
<th>Walking time</th>
<th>Stretching time</th>
<th>Break frequency</th>
<th>Break duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP</td>
<td>-</td>
<td>0.828**</td>
<td>0.889**</td>
<td>0.047</td>
<td>0.252</td>
<td>0.199</td>
<td>0.231</td>
<td>-0.426**</td>
<td>-0.396**</td>
</tr>
<tr>
<td>CP</td>
<td>-</td>
<td>-</td>
<td>0.904**</td>
<td>-0.008</td>
<td>0.326*</td>
<td>0.152</td>
<td>0.238</td>
<td>-0.460**</td>
<td>-0.318*</td>
</tr>
<tr>
<td>AC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.063</td>
<td>0.303*</td>
<td>0.129</td>
<td>0.309*</td>
<td>-0.479**</td>
<td>-0.282*</td>
</tr>
</tbody>
</table>

*p < 0.05  
**p < 0.01

*a*AP: Action planning  
*b*CP: Coping planning  
*c*AC: Action control
57

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

<table>
<thead>
<tr>
<th></th>
<th>AP²</th>
<th>CP⁶</th>
<th>AC⁸</th>
<th>Sitting time</th>
<th>Standing time</th>
<th>Walking time</th>
<th>Stretching time</th>
<th>Break frequency</th>
<th>Break duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP</td>
<td>-</td>
<td>0.645**</td>
<td>0.777***</td>
<td>-0.091</td>
<td>0.295*</td>
<td>0.206</td>
<td>0.081</td>
<td>-0.251</td>
<td>-0.367**</td>
</tr>
<tr>
<td>CP</td>
<td>-</td>
<td>-</td>
<td>0.867***</td>
<td>-0.064</td>
<td>0.331*</td>
<td>0.176</td>
<td>0.391**</td>
<td>-0.348**</td>
<td>-0.339**</td>
</tr>
<tr>
<td>AC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.073</td>
<td>0.331*</td>
<td>0.210</td>
<td>0.305*</td>
<td>-0.325*</td>
<td>-0.394**</td>
</tr>
</tbody>
</table>

*p < 0.05
**p < 0.01

²AP: Action planning
⁶CP: Coping planning
⁸AC: Action control

2.4 Discussion

The findings of the present study provide preliminary evidence that a HAPA-based AP and CP intervention, combined with tailored text messages, can promote reductions in student-related sitting time, while increasing time spent walking and stretching among university students. Beyond these general findings, the following specific findings warrant commentary.

The group by time interaction effect for the primary outcome of student-related sitting time was statistically significant with an accompanying medium effect size after adjusting for baseline levels of sitting time. From baseline to follow-up, sitting time during school-related activities was reduced by an average of 120.07 minutes/day in the intervention group; while sitting time decreased by 10.5 minutes in the control group. These results are comparable to Mnich et al. (2019), who observed a significant interaction effect for a decrease in time spent sitting (-8.4%) among university students using decisional cues paired with sit-stand desks. Due to the lack of interventions targeted towards reducing SB in university students, changes in sitting time in the current study are constrained to being compared to interventions among office working adults which have reported reductions in sitting of 39.6 minutes per 8-hour workday, but only 15.5 minutes for those incorporating educational/behavioural components (Chu et al., 2016). These changes are also greater than those reported in a previous intervention combining a HAPA-based action and coping plans with daily text messages in office working adults which showed an average decrease in workplace sitting time of 87.54 minutes/day in the intervention group from baseline to follow-up (Rollo & Prapavessis, 2020). It is possible that interventions targeting self-regulatory skills (i.e., HAPA volitional constructs) may
have more of an impact among the university student population, as these behavioural interventions can focus on improving the individual’s psychological capability to reduce SB without the need for high-cost environmental changes. This is consistent with a previous review which demonstrated behaviour change strategies targeting SB reduction among adults have been shown to be effective, especially when combined with persuasion or educational components (Gardner et al., 2016). The greater reduction found in this population compared to the office workers in Rollo and Prapavessis (2020) could be due to the nature of the student versus office-worker environment. While office workers tend to work in the same environment on a daily basis, university students can employ an extensive array of environments for their “work” (e.g., lecture halls, libraries, coffee shops, at home study space). Therefore, the combination of targeting established behaviour change constructs based on the HAPA model and providing frequent reminders (i.e., text-messages) may be an appropriate and effective behaviour change technique for reducing SB among university students. However, as previous studies have suggested, the “mini-boosters” provided by the daily-text messages may have provided the ongoing support the participants needed in order to maintain their behavioural change over time (Maher & Conroy, 2016; Rollo & Prapavessis, 2020; Sui & Prapavessis, 2018). Nonetheless, future work is required to investigate what minimum threshold of text message frequency is needed in order to encourage maintenance of these HAPA constructs.

In addition to the significant reduction in sitting time, the intervention group also demonstrated significant increases in specific non-SBs during school-related activities, which may help to explain the reductions in sitting time shown. We observed overall increases in walking, standing and stretching time by 27.58 minutes/day, 14.58 minutes/day and 4.25 minutes/day, respectively. Significant interaction effects that were moderate in size emerged for both walking and stretching time. These results are in line with those of a previous HAPA and mHealth intervention conducted among office-working adults which also found significant interaction effects that were moderate in size (Rollo & Prapavessis, 2020). Results from the current study are consistent with previous university student interventions for light activity (i.e., walking). Cotten and Prapavessis (2016) observed a small to moderate effect size for light-intensity physical activity (i.e.
walking) (+50.07 minutes/day) and moderate-intensity physical activity (+13.03 minutes/day) at 6 weeks when using screen-based technology. Mnich et al. (2019) observed a significant interaction effect in university students for time spent being active (+3.0%) in their 3-week study using sit-to-stand desks. However, findings are mixed when compared to previous interventions for standing time. Like the current study, Cotton and Prapavessis (2016) report no significant effect for time spend standing (+18.25 minutes/day) during their 6-week screen-based intervention. On the other hand, Mnich et al. (2019) report a significant time effect for time spent standing (+5.3%). This could be due to nature of the intervention. In both the current study and the Cotton and Prapavessis (2016) study, students most likely did not have access to a proper environment that would allow work to be done while standing. However, Mnich et al. (2019) provided standing desks, thus, this increase in behaviour would be expected. To our knowledge, no previous interventions have investigated time spent stretching in university students.

These intervention effects could potentially have a clinically meaningful impact on the health of university students as a 30 minute per day reduction in sitting time has been shown to be an effective target when investigating long-term health benefits (Peachey, Richardson, Tang, Dal-Bello Haas, & Gravesande, 2020). It has been shown that reallocating 2-hours of sitting to stepping was significantly associated with reductions in body mass index, waist circumference, triglycerides and two-hour plasma glucose in adults aged 25 and over (Healy et al., 2015). Thus, the reduction in sitting time of 120 minutes, along with the subsequent increases in walking, standing and stretching time of 27.58, 14.58 and 4.25 minutes/day, respectively, during school-related activities could potentially result in beneficial health outcomes if sustained over a longer time period. Therefore, future studies are encouraged to investigate how reducing sedentary time in this population can affect various health indicators and outcomes.

As mentioned, the intervention objective was for participants to achieve a break frequency of every 30-45 minutes with each break from sitting being 2-4 minutes in duration. Although no significant group by time interaction effect was observed for break frequency, the intervention group increased their break frequency from 106.60 minutes to 64.82 minutes, taking breaks 41.78 minutes more often than the control group (109.50
minutes) at week 6 (post-intervention). Break duration also did not show a significant interaction effect over the 8-week period. However, in line with the intervention objectives, the intervention group maintained fairly consistent break durations of 4 minutes at weeks 2, 4, and 6, whereas, the control group reported break durations of approximately 8 minutes during the same time period. The university students in Sui and Prapavessis’ (2018) study using the HAPA model went from breaks every 90.54 minutes to every 59.46 minutes post-intervention (week 6) (total change of 31.08 minutes). Cotton and Prapavessis (2016) used text messages in university students and increased break frequency from 81.95 minutes to every 58.90 minutes (total change of 23.05 minutes). Therefore, the greater increase in the current study versus the preceding two could be attributed to the combined application of the HAPA model with the daily text-messages. Future studies are required in order to explore if the behavioural change can be maintained over a longer time period (i.e. 6-12 months). The break frequency achieved in this study (every 64.82 minutes) was not quite at the level recommended by Dunstan et al. (2012) for beneficial cardiometabolic outcomes and was higher than the target intervention objective (i.e., every 30-45 minutes). However, it has been shown that taking a 5-minute walking break every hour has beneficial effects for weight control and/or weight loss (Swartz et al., 2011), which is consistent with the current findings.

This study also examined the effects of the intervention on HAPA post-intentional volitional constructs, including AP, CP and AC; and in turn, relationships between these constructs and sedentary and non-SBs during school-related activities. Significant group by time interaction effects were found for all of the HAPA volitional constructs, indicating that individuals who received the HAPA-based intervention increased their AP, CP and AC towards reducing school-related sitting time while simultaneously decreasing actual sitting time. These findings support using a theoretically integrated approach in the design and implementation of SB interventions, which allows for the exploration of specific behaviour change constructs, to better understand the intervention effects observed (Gardner et al., 2016). These findings are consistent with previous HAPA-based interventions that were also successful in promoting increases in these volitional constructs (Gaston & Prapavessis, 2014; Rollo & Prapavessis, 2020). The HAPA model utilizes planning constructs in order to bridge the intention-behaviour gap
commonly observed in health behaviour change literature. Together, these findings suggest that an intervention grounded in a prominent health behaviour change framework augmented with daily text messages may be a practical and promising approach to reduce SB in university students.

In this study, the HAPA volitional constructs of AP, CP, and/or AC were significantly related to the targeted sitting-related outcomes of break frequency and break duration from weeks 2-8 and to a lesser extent time spent standing and stretching. Based on the supplementary tables 2-6, the following observations can be made. First, as expected there were no significant correlations prior to treatment at baseline. Second, the most consistent correlations were observed for break frequency and break duration. Third, no consistent correlations were found for stretching or standing. Fourth and finally, there were no relationships found for sitting or walking. Overall, the relationships shown are promising as students were encouraged to form action and coping plans in line with the intervention objectives of increasing their frequency of breaks from sitting and time spent standing and in light movement during school-related activities. It is possible that university students may have identified 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). While beyond the scope of this investigation, future behavioural intervention trials should conduct formal mediation analyses to explore whether changes in sedentary-related HAPA volitional constructs mediate the effects of the intervention on behaviour.

2.4.1 Strengths and limitations

The current study had several strengths. First, the randomized controlled trial design allowed for any observed effects in the intervention group to be compared to a control group. Second, valid and reliable self-report measures that have been used in previous literature were utilized to capture SB, non-SBs and the theoretical behaviour change constructs. Third, the intervention was grounded in a prominent theoretical model, allowing for examination of intervention effects on established behaviour change constructs (i.e., AP, CP, AC). Fourth, this study demonstrated favourable participant compliance, with a completion rate of >90%. Fifth, the inclusion of a follow-up assessment was a strength that previous interventions in this population have lacked
(Cotton & Prapavessis, 2016; Jerome et al., 2017; Maeda et al., 2014; Mnich et al., 2019). Lastly, the ease of implementation, low cost, and potential scalability to large and diverse populations are also strengths.

With regards to study limitations, it is important to note that the findings herein must be considered within the context of the global COVID-19 pandemic, as many participants completed their follow-up assessment subsequent to the Canada-wide closure of university campuses. While sitting time and non-SBs remained relatively stable throughout, break frequency showed a substantial inconsistency from week 6 (post-intervention) to week 8 (follow-up) that was unfathomable. Additionally, the university student “occupation” can be quite inconsistent in workload on a day-to-day basis. All full-time students attending university experience mid-terms or other evaluations at different time points throughout each semester. This would typically involve more time spent studying outside of the classroom. Given that these periods fluctuate with every course and university, it was not within our capacity to determine when these periods would have occurred for each participant, especially due to the staggered recruitment approach utilized. While this intervention targeted school-related SB, future studies should explore intervention effects on both school-related and leisure sitting time to provide greater insight into the potential influence of theory-based behavioural interventions among university students. Next, although the RCT design is a strength, a limitation was the lack of a passive control group. Future studies should aim to include a placebo group that receives information in a different way (i.e., information pamphlets). Another limitation was the use of only a subjective (i.e., self-report) measure of both sedentary and non-SBs. Although this study employed valid and reliable measures of domain-specific SB (and non-SBs), self-report instruments have been shown to be susceptible to participant response bias (i.e., possible under- or over-estimation). Thus, future studies should utilize a device (i.e., accelerometers or inclinometers) to objectively capture sedentary time. Lastly, the current study sample consisted of predominantly Canadian, female, full-time undergraduate level students. Therefore, findings may not be generalizable to other student populations.
2.5 Conclusion

This was the first study undertaken in university students to demonstrate the effectiveness of a HAPA-based intervention augmented with tailored text-messages for reducing SB while increasing specific non-SBs during school-related activities. The intervention was successful in enhancing AP, CP and AC among university students with a short behavioural counselling session and subsequent daily “boosters”, and in turn, significantly reduced sitting time among this at-risk population. If the observed reductions in sitting can be sustained over time, valuable health benefits for this population may be obtained. A randomized controlled trial including a larger sample size, device-based measurement of SB, a longer follow-up period, assessment of health indices, and a more diverse sample is warranted.
2.6 References


2.7 Chapter 2 Summary and Implications

In study 2, we learned that combining a HAPA-based planning intervention with text messages can reduce student-related sitting time in university students. Unfortunately, the COVID-19 pandemic forced many universities to shut-down their campuses, forcing students to study from home while learning was transitioned to virtual platforms. While more research is clearly needed in university students, studying this population in a home-based, virtual environment would be impractical; as post-pandemic, students will likely transition back to face-to-face learning. Another population that was forced to abruptly switch to a home-based model are office workers. While students will eventually make their way back to in-person learning, many office workers forced to work from home will not make their way back to the office. Thus, this permanent switch highlights the need for research in this home-based office working population, especially since research is finding that they are sitting more and moving less in this home-based environment. Using what we learned from study 1, we can build an intervention that addresses some of the limitations. First, a device-based measure of sedentary behaviour was recommended, which will be implemented in study 2. Second, while the HAPA framework combined with text messages showed to be a more feasible, low-cost intervention compared to most; it still required a 20-to-30-minute one-on-one behavioural counselling session, which still limits its implementation on a large scale. Furthermore, the use of text-messages required many hours of pre-programming and timing from the researcher side. Thus, other new and novel strategies to supplement HAPA need to be investigated. Specifically, future research needs to examine whether the HAPA framework can be more easily implemented, without the need for individual counselling or individualized text-messages. Study 2 intends to build from study 1, addressing these concerns, using a home-based office working population.
Chapter 3 – The Power of Choice (or not) in Modifying Sedentary Behaviour Patterns in Home-Based Office Workers- A Randomized Comparison Trial (Study 2)
Abstract

In response to the global COVID-19 pandemic, many Canadian adults quickly transitioned from working in-office to working remotely from home. Evidence suggests this transition may have exacerbated harmful sedentary behaviour patterns. Our primary objective was to investigate whether the ability to choose (or not) enhances the effectiveness of a theory driven (Health Action Process Approach; HAPA) intervention for increasing SB break frequency (BF) in adults working from home. A two-by-two factorial repeated measure randomized comparison trial was conducted. SB variables were measured with a device (activPAL4™) and self-reported (modified SIT-Q 7d) at baseline and week 4 with a total of 148 participants (forced assignment group: n = 71, mean age 45.3 ± 11.8 years, 70% female; choice of assignment group: n = 77, mean age 44.5 ± 11.2 years, 74% female). Device measured BF did not show significant group by time interaction effects ($F_{1,91} = 0.997, p = 0.61, \eta^2_p = 0.003$, power = 0.08). However, there was a significant time effect ($F_{1,91} = 18.53, p < 0.001, \eta^2_p = 0.169$, power = 1.0), where both groups increased their BF over the intervention. Self-reported BF showed a significant group by time interaction effect ($F_{1,114} = 4.568, p = 0.035, \eta^2_p = 0.039$, power = 0.563), where those in the choice of assignment group increased BF to a greater extent than those in the forced assignment group. Overall, for device measured SB, group assignment did not result in significant changes for break frequency. For self-reported measures of SB, choice assignment favoured increases in sedentary BF. Overall, the behaviour modification strategies used may be useful for providing immediate beneficial changes to sedentary behaviour patterns in populations working from home.

Keywords: health action process approach, intervention, sedentary behaviour, office-workers
3.1 Introduction

Office-working adults represent an at-risk population burdened by high sedentary time (i.e., sitting, lying, or reclining behaviours at low energy expenditure), both at work and in their leisure time (Smith et al., 2015; Tremblay et al., 2017). Some may spend up to 77 per cent of their working day sitting, with most of this time accumulated in uninterrupted bouts (Thorp et al., 2012). High levels of sedentary behaviour in addition to prolonged bouts of sedentary time are a public health concern, increasing the risk of obesity, diabetes, cardiovascular disease, some cancers and mortality (de Rezende et al., 2014). This issue has been exacerbated by the COVID-19 pandemic with the transition to home-based office work (Fukushima et al., 2021; Koohsari et al., 2021). Not only do employees working from home spend more time sedentary than those working at offices, but they also engage in less physical activity (Flanagan et al., 2021; Stockwell et al., 2021). This is problematic, as most employees prefer to keep a hybrid or remote working style after the pandemic is over (Alexander et al., 2021); and many economists predict that a large percentage of the increase in remote work that came about during the pandemic will likely continue (Barrero et al., 2021). Given this trend, it is of paramount importance to reduce sedentary behavior in home-based office-workers.

One way to mitigate the health risks associated with high sitting time is to partake in 60-75 minutes of moderate to vigorous physical activity per day (Eklund et al., 2016). However, given the majority of the population does not even meet the global physical activity guidelines of 150 minutes of moderate-vigorous intensity physical activity per week (Bull et al., 2020), this seems unattainable for most. A more feasible way to reduce the detrimental effects of sitting may be to simply ‘sit less’. Emerging evidence suggests that the pattern of sedentary behaviour accumulation may be just as important as the total time spent sitting (Peddie et al., 2013). For example, an individual can sit for 8 hours in a day, accumulating all 8 hours with only one or two interruptions versus someone who breaks their sitting every 20 minutes (over the course of 8 hours). Breaking up long sitting periods with short, frequent bouts of non-sedentary behaviours like standing or slow walking (for one to three minutes) every 30 to 45 minutes has shown many positive health benefits (Dempsey et al., 2016; Dunstan et al., 2012; Healy et al., 2008; Loh et al., 2020). Therefore, a sedentary behaviour reduction intervention, focused on increasing
sedentary break frequency may be a feasible way to address this growing public health concern.

Previous office-worker studies focusing on sedentary behaviour reduction have shown substantial reductions in total and prolonged sitting time (Carr et al., 2013; Edwardson et al., 2017; Rollo & Prapavessis, 2020). These studies, and many other sedentary reduction interventions often involve professional coaching, ergonomic replacements, large workplace wellness programs, and purchased self-monitoring tools (Edwardson et al., 2017; Morris et al., 2019). These approaches are unfortunately resource and cost dependent, may require buy-in at the organizational level, and are less scalable from a public health promotion standpoint. Digital health interventions involving the use of information and communication technologies may be a low-cost alternative (Rollo & Prapavessis, 2020). Although high attrition leading to limited effectiveness continues to be a hallmark of digital health interventions (Eyesenbach, 2005), stronger application of behaviour change theories has been shown to boost digital health intervention engagement and effectiveness (Craig et al., 2008; Mitchell et al., 2017; 2020; Rollo & Prapavessis, 2020). For example, the combination of the Health Action Process Approach (HAPA) with an mHealth intervention was able to significantly reduce sitting time in a group of office workers by 87.54 minutes/day (Rollo & Prapavessis, 2020). A study by Schroe and colleagues (2020) investigated the efficacy of three behaviour change techniques (action planning, coping planning and self-monitoring) and their combinations on physical activity and sedentary behaviour against a background set of other behaviour change techniques. They found that the delivery of self-monitoring was able to reduce sedentary behaviour more so compared to no delivery of self-monitoring. More importantly, they found that the combination of action planning with self-monitoring was most effective for decreasing sedentary behaviour (Schroe et al., 2020). Thus, we propose that using the theoretical framework of the HAPA model, specifically focusing on the action planning component, combined with self-monitoring will result in an effective sedentary behaviour reduction intervention.

To optimize intervention efficacy, behavioural change models/theories can also be complimented via behavioural economics concepts (Mitchell et al., 2017). Behavioural economics is an offshoot of traditional economics and is complimented by insights from
psychology. Behavioural economics has shown promise for improving many health behaviours such as increased physical activity levels (Pearson et al., 2020; Bachireddy et al., 2019), smoking cessation (Giné et al., 2010), and increased healthy eating (Roberto & Kawachi, 2014). Additionally, behavioural economics leverages technology in efforts to maximize efficacy, cost effectiveness, and reach (Bickel et al., 2016). Since the application of many behavioural economic techniques do not require face-to-face counselling or professional coaching (as they are more subconscious tweaks to environmental structure), we propose that a digital health intervention, grounded within a health behaviour change theory (i.e., HAPA), strengthened with behavioural economic concepts may provide a feasible strategy for an effective, large-scale, low-cost intervention in home-based office workers.

Choice preference uncertainty (due to unfamiliarity with a topic, item, etc.) is well-documented in consumer scenarios (Chernev et al., 2015). Since many office workers lack knowledge around unhealthy sitting behaviours (i.e., don’t know it’s bad for them and therefore don’t know how or how often it should be broken up) (Hadgraft et al., 2018); it is possible that it may exist in choice scenarios like strategies to break or reduce sedentary behaviours due to lack of knowledge. In most cases, people do not like to be told what to do (i.e., psychological reactance) (Reynolds-Tylus, 2019). However, in the cases of lack of experience, it appears this may not always necessarily be the case (i.e., a person hiring a personal trainer). Choice options can be manipulated using behavioural economic concepts (Keller et al., 2011). In one eHealth office wellness study, participants reported barriers including the lack of choice and variety of “move more” strategy nudges, as well as inopportune timing of the nudges (Macdonald et al., 2020). Evidence suggests that providing office workers the opportunity to choose may result in increased autonomy and habit strength, thus, changing sitting behaviours in both the short and long term (Stephens et al., 2018; Landais et al., 2020). However, the effects of such intervention in home-based office workers remains unknown.

HAPA has been successful in reducing long bouts of sedentary behaviour in both in-office workers and university students in intensive interventions that have used one-on-one counselling and mHealth features (i.e., text messaging) (Dillon et al., 2021; Rollo & Prapavessis, 2020). However, these interventions are limited by its demand for individual
counselling sessions, and thus, are not scalable to a larger platform. Given the success of the HAPA model within these interventions, we propose an enhanced HAPA digital health intervention utilizing behavioural economic concepts that target choice preferences.

To our knowledge, no intervention has used a theoretical foundation and explored the added effectiveness of ‘choice’ for reducing and breaking up sedentary behaviour time in home-based office workers. Therefore, the primary objective of this study was to investigate whether the ability to choose (or not) enhances the effectiveness of a theory driven intervention, specifically targeting both objective and subjective sedentary behaviour break frequency in adult office workers who are working from home. Secondary, we examined the intervention’s effectiveness on device-based and self-reported measures of break duration, total sitting time and time spent in non-sedentary behaviours such as standing and moving (i.e., walking). Other secondary outcomes revolved around health knowledge about sedentary behaviour, adherence, engagement, and satisfaction.

3.1 Methods

3.1.1 Study Design

We conducted a four-week randomized comparison trial with a two-by-two factorial design. Office workers living in London, Ontario, Canada were recruited to participate in this study between September and November 2020. All study protocols were approved by the Health Sciences Research Ethics Board at Western University (see Appendix O) and registered at clinicaltrials.gov (NCT04488796). Results are reported in accordance with CONSORT guidelines.

3.1.2 Participants

Participants were full-time (i.e., employed ≥ 30 hours/week) office working adults (≥18 years old) currently working at least 50% of the time from home. Participants were excluded if they self-declared a medical condition or physical limitation that prevented them from being physically active, and/or were either planning on leaving their current employer or taking a leave of absence for more than three consecutive workdays during the study.
Office workers were recruited from large businesses, office spaces, and universities/colleges to participate using three recruitment strategies. First, contact was made with relevant liaisons and/or senior executives (e.g., Chief Executive Officer) at potential businesses of interest via email (see Appendix P). Those who were interested were asked to email all full-time employees within their respective office/business offering them the opportunity to participate (see Appendix Q). Second, recruitment emails were directly sent to office-working employees whose contact information is publicly listed and available on company and institution websites (e.g., employee directories) (see Appendix R). Third, recruitment posters were distributed via social media platforms (e.g., Facebook, LinkedIn, etc.) (see Appendix S).

### 3.1.3 Measures

**Break Frequency.** Sedentary break frequency (i.e., minutes/seconds between breaks) served as the primary outcome and was measured using both a device and self-report questionnaire. The device used was the activPAL4™ activity monitor (PAL Technologies Limited, Glasgow, UK; default settings). Data were collected for each participant during their self-reported working hours, start time (e.g., 8:30am) up to and including the last 15 seconds (4:29:45pm) before the self-reported end time (e.g., 4:30pm). The activPAL4™ is a small device worn on the midline anterior aspect of the thigh (right or left) that continuously records and differentiates the precise beginning and ending of each bout of sitting or lying, standing, and stepping at a variety of speeds, and the estimated MET-hours (a measure of energy expenditure) expended during those bouts using proprietary algorithms (Intelligent Activity Classification, PAL Technologies). The activPAL4™ monitor is currently considered the most accurate field-based measure of sedentary time and sit-to-stand transitions (Kozey-Keadle et al., 2011). A valid day was considered a minimum of 20 hours per day. Data were downloaded in custom duration epochs (15 seconds) via activPAL4 Professional Software (version 8.11.4.61) and transferred to Microsoft Excel (version 16.44). Participants must have accumulated three or more ‘valid’ workdays from Monday to Friday at baseline and Study Week 4 to be included in analyses (Edwardson et al., 2017).

The self-report questionnaire used to capture sedentary behaviour break frequency and was the modified version of the SIT-Q 7d (Sui & Prapavessis, 2017; Wijndaele et al.,
that has been previously used with an office workers population (Rollo & Prapavessis, 2020). Sui and Prapavessis (2017) modified the base questionnaire to include domain-specific (work-related) break frequency scores (which in addition to break duration, are the only items assessed for the purpose of this study) (See Appendix EE). These items have shown adequate test–retest reliability ($r = 0.564–0.740$, ICC = $0.562–0.740$, $p = .05$) and face validity (Sui & Prapavessis, 2017). The frequency of breaks taken from sitting at work were be measured with the following question: “In the last 7 days, on average, how often did you interrupt your sitting time during work hours?” Response options for the question will include: 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.

**Break Duration.** Break duration (i.e., minutes/seconds) served as a secondary outcome and was measured using both a device and self-report questionnaire. The device and device protocol are the same as previously stated for break frequency (primary outcome).

The self-report questionnaire used to capture sedentary behaviour break duration was also the modified SIT-Q 7d questionnaire (previously explained) (Sui & Prapavessis, 2017; Wijndaele et al., 2014). Again, Sui and Prapavessis (2017) modified the base questionnaire to include domain-specific (work-related) break duration scores. The duration of breaks taken from sitting at work were measured through the following question: “In the last 7 days, on average, how long were your breaks from sitting during work hours?” Response options for the question will include: 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 (see Appendix EE).

**Total time spent sedentary, standing, and moving.** Total sedentary time, standing time, and moving time were secondary outcomes and assessed with both a device and a self-report questionnaire. For the device-based measures, the activPAL4™ captured all variables and were expressed in minutes per day. Average daily sedentary time (minutes per day) were calculated [total amount of time/average number of days] using two different equations. The sum of ‘sedentary’ did not include ‘primary lying’,
‘secondary lying’ or ‘seated transportation’ time in calculations (as this was not a targeted behaviour of the intervention). Time spent standing was calculated from the ‘upright time’. Time spent moving was calculated only using ‘stepping time,’ not including ‘cycling time’. Each valid day of data was totaled and then averaged for the number of valid days to calculate average daily time (minutes) for the week. The percentage of time spent sedentary, standing, and walking from the activPAL4™ was calculated as follows: \[\text{average minutes spent in the behaviour (i.e., sitting, standing, or moving) per workday/total minutes of work time (i.e., 8:30 am to 4:30 pm = 8 hours*60)}\] \times [100].

In regard to the self-report measure, percentage of time spent sitting, standing and moving (i.e., walking) during work hours were measured with a previously used (Rollo & Prapavessis, 2020; Dillon et al., 2021) validated three-item modified Occupational Sitting and Physical activity questionnaire (OSPAQ; Chau et al., 2012) (see Appendix DD). 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). At each assessment period (baseline, week 1, week 2, week 3, week 4) participants were asked to record both the number of days they were at work and total number of hours they worked in the last 7 days. Participants were then be asked to record a percentage of time spent sitting, standing, and moving (i.e., walking) (cumulative total of 100%) during work hours on a typical workday in the last 7 days.

**Demographics and other baseline characteristics.** Participants were asked to report how many days they work from home, their hours of work (i.e., “when do you typically start and end work each day”), the sector in which they are employed (i.e., private, public, etc.), industry and role, age, gender, ethnicity, relationship status, level of education, self-reported height and weight and physical activity status. These questionnaires were only asked at baseline. See Appendix V for full baseline questionnaire.

**Intentions.** Intentions were measured as a fidelity check to examine whether the video delivered using the constructs from the motivational phase of the HAPA model was
able to change intentions for occupational sitting patterns. Intentions were measured at baseline and again after watching the video. Intentions were categorized into two behavioural subcategories, consistent with Rollo & Prapavessis (2020). The first was focused on increasing the number of breaks from sitting, while the second was focused on increasing daily time spent in activities of light movement (i.e., walking). Each category was measured with three items that were used as indicators for intentions. The stem for the questions was, “over the next four weeks...” which was followed by the recommended activities, for example, “My goal is to increase the number of breaks I take from sitting during work hours”.

**Knowledge of sedentary behaviour.** Knowledge of key intervention messages were assessed as a fidelity check with four true or false statements that were addressed in the educational video. For example, “True or False: 2-3 minutes of standing every 30 to 45 minutes is enough to reduce the risks associated with sitting too much?”. Knowledge was assessed at baseline and again after watching the video.

**Intervention adherence and engagement.** Intervention adherence was calculated by the percent of those who actively pre-committed to their strategies each Monday. Video engagement was measured by percent of video link clicks (from the Monday email) and percent of full video watches using Vimeo.com statistics, measured at week 1 and week 3.

**Participant strategy satisfaction.** Participant Strategy satisfaction was measured at the end of each intervention week with a 3-item Likert scale. The question read as, “In the last 7 days, how useful did you find your strategies?”. Participants could answer as “Not Useful, “Some Impact” or “Useful”.

**Exit survey.** The exit survey asked participants about their satisfaction and some of their experiences with the intervention (i.e., “what did you like/not like about this study?”, “I found that the change up of strategies each week was useful at keeping me engaged and continuing to complete the strategies”). See full list of questions in the follow-up questionnaire; Appendix AA.

### 3.1.4 Procedures

Participants provided informed consent via an individualized web-link sent by email and completed it via online through a survey website called Soci
(www.soscisurvey.de). Following consent, participants were randomized into either the ‘Forced Assignment’ or ‘Choice of Assignment group’. All randomizations were conducted using an online research randomization program (www.randomizer.org). Participants then completed one of two versions of the baseline questionnaire (through sosci) based on whether they were randomized into the ‘Forced Assignment’ or the ‘Choice of Assignment’ group. Those in the Forced Assignment group were again randomized into one of two strategy conditions: self-selected strategies or automated (expert recommended) strategies. Those in the Choice of Assignment group were not randomized again, instead, they had the option to choose whether they would like to receive automated (expert-recommended) or choose (self-select) their strategies each week. The participants randomized into the ‘Choice of Assignment ‘group were asked (at the end of their baseline questionnaire) whether they would: (a) “prefer to choose and manage their own sitting reduction strategies from a list of expert recommended strategies” or, (b) “prefer to be assigned with two strategies every week from a list of expert recommended strategies”. The ‘forced assignment’ group were not given this choice.

Upon completion of the baseline questionnaire, participants were asked to sign an additional consent form (either digitally or on paper) and submit it via email, along with their home address for mailing purposes. Participants were sent an activPAL4™ activity monitor via courier and an email with written and video device application instructions (i.e., device applied to mid-thigh using Tegaderm (3M)). Participants were instructed to apply the device on Sunday evening and wear it 24 hours/day for five working days (Monday to Friday). Participants returned the device using a pre-paid return package.

Regardless of group assignment, all participants completed the same outcome measures at baseline and week four. Additionally, all participants received the HAPA based intervention, receiving strategies every Monday and self-reporting sitting behaviours every Friday. Participants wore the activPAL4™ during the baseline period and again during week four of the intervention. All participants received a ‘reminder’ email every Wednesday, reminding them of their strategies for that week.
3.1.5 Intervention

On the first and third Monday of the four-week intervention period, a three-minute (Kim, 2019) whiteboard-style educational video (https://vimeo.com/468538690) was shared with study participants (MacDonald et al., 2020). The video was grounded within the motivational constructs of the HAPA framework, including messages framed towards risk perception (e.g., “Many large population health studies have linked high levels of total sitting time and long periods of sitting time to an increased likelihood of premature death”), outcome expectancies (e.g., “we want YOU to know that breaking up your sitting bouts, every 30 to 45 minutes, with at least 2 to 3 minutes of movement, WILL BOOST YOUR MOOD, work productivity and decrease back and joint pain INSTANTLY”), and action self-efficacy (e.g., “you don’t have to train for a triathlon to reap all those benefits”). Immediately after the video, participants were prompted to complete a short questionnaire reassessing sedentary behaviour knowledge and intentions for sedentary behaviour change (previously assessed in the baseline questionnaire). The educational video was circulated again at the beginning of week 3 to serve as a reminder.

Sedentary behaviour reduction strategies were sent to all participants via email every Monday during the intervention period (weeks 1 to 4). These emails differed depending on group allocation (see Forced Assignment and Choice of Assignment sections). Notably, in study weeks 1 and 3, participants were asked to first watch the educational video, complete the knowledge check questionnaire (only in week 1), and then receive/choose their two strategies. Table 9 shows the list of all strategies from which these were drawn. These strategies align with the “move more” concept (Healy et al., 2015) (originally coined in the Stand Up Australia program (Neuhaus et al., 2014)) and are based on those delivered and tested in previous studies (Hadgraft et al., 2018; Stephens et al., 2018). The strategies were re-defined to align with the current intervention goals of increasing break frequency (i.e., move more OFTEN). The strategies aligned with the action planning construct of the HAPA model. Specifically, the strategies promoted breaking up sitting bouts every 45 minutes with at least 1-2 minutes of movement (light-to-moderate intensity) (Dunstan et al., 2012; Edwardson et al., 2017; Healy et al., 2008; Healy et al., 2015; Loh et al., 2020).
Upon receiving or choosing their strategies, participants were asked to ‘Accept’ or ‘Reject’ their two strategies each week using an “Enhanced Active Choice” model proposed by Keller and colleagues (2011). In this model, participants must actively accept or reject options where the benefits or consequences of a given choice are highlighted (Carroll et al., 2009; Keller et al., 2011). For example, in the present study, weekly pre-commitments to sitting reduction strategies were sought in this way:

“As you now know, breaking-up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:”

I WILL break up my sitting throughout my work hours this week by: [X strategy], to reduce my risk of diabetes, mental health issues, and other detrimental health outcomes

I WILL NOT break up my sitting time during my work hours this week, [X strategy], EVEN if it means I increase my risk of developing diabetes, mental health issues and other detrimental health outcomes

Assigned or self-selected strategies (dependent upon group assignment) were sent in a reminder email on the Wednesday morning of each intervention week. On the Friday of each intervention week, participants were prompted to self-report their average sedentary behaviour break frequency and duration as well as the total time spent sitting, standing, and moving (i.e., walking) for that week. They were also asked to rate their satisfaction of the strategies. Participants were sent an activPAL4 again to wear during the final week of the intervention (week 4). See Figure 3 for flow of study details.

3.1.6 Forced Assignment

After initial randomization, the Forced Assignment group was again immediately randomized into either a) the automated (expert recommended) strategy condition in which they were randomly assigned two strategies (from the list of eight) or b) the self-selected strategy condition, in which they could choose their own two sedentary behaviour reduction strategies from a list of eight (presented in randomized order
(Blankenship, 1942)). The “self-selecting” participants were instructed that they could choose the same or different strategies from week to week (See Appendix Y for an example of a week 1 questionnaire)

3.1.7 Choice of Assignment

The choice of assignment group had an additional question in their baseline questionnaire asking them to decide whether they wanted a) the automated ‘expert’ strategies assigned to them, or b) to self-select their own strategies. The “self-selecting” participants were instructed that they could choose the same or different strategies from week to week.
Table 9. Strategies to 'Move More Often'

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Set a constant 45-minute timer/alarm on your phone to break for a 2-minute walk or march on the spot throughout your workday.</td>
</tr>
<tr>
<td>2.</td>
<td>Use text-messages as a prompt to get up and sit down 3 times. This will hopefully allow you to break up your sitting at least every 45 minutes.</td>
</tr>
<tr>
<td>3.</td>
<td>Drink lots of water throughout your workday. Filling up your water bottle and taking more washroom breaks will hopefully allow you to break up your sitting every 45 minutes.</td>
</tr>
<tr>
<td>4.</td>
<td>Leave your phone on the other side of the room and get up at least once every 45 minutes to go check it throughout your workday.</td>
</tr>
<tr>
<td>5.</td>
<td>Record how many steps you are getting with your smartphone or wearable device every 45 minutes; your goal is to get up to 200 steps.</td>
</tr>
<tr>
<td>6.</td>
<td>When you notice your body slacking, numbing, or getting uncomfortable- get up and do 1-2 minutes of light stretching. Your goal is to get into a habit of stretching for 1-2 minutes at least every 45 minutes throughout your workday.</td>
</tr>
<tr>
<td>7.</td>
<td>Keep a tally of how many times you get up and sit down each hour. Try to work up to 1-2 sitting “breaks” every 45 minutes of your workday.</td>
</tr>
<tr>
<td>8.</td>
<td>Set a constant 45-minute timer/alarm on your phone to break for a 2-minutes of gentle squatting or lunging, taking breaks when needed throughout your workday.</td>
</tr>
</tbody>
</table>

Note. This is the list of eight strategies that were either presented to participants in random order (in self-selected strategy condition) or used to randomly assign two strategies to participants (in the automated “expert recommended” strategy condition). Strategies were modified from previous studies (Hadgraft et al., 2018; Stephens et al., 2018).
Figure 3. Flow of study
3.1 Statistical Analyses

An a priori power analysis was conducted in G*Power (v.3.1.9.2) based on previous related studies (Cotten & Prapavessis, 2016; Sui & Prapavessis, 2017; Rollo & Prapavessis, 2020). It indicated that a total sample size of 111 participants (n=56 per study arm) would provide 80% power to detect main effect differences in the primary outcomes with minimum effect sizes of f = 0.15 (small-medium; i.e., $\eta^2 = 0.01–0.06$) given two assessment points and an $\alpha = .05$.

Outliers (i.e., data outside the 95th percentile range) in the data were addressed with a winsorization technique, (Guttman & Smith, 1969) by replacing extreme outliers with the value of the closest 95% percentile value. A total of six data points of the 356 valid (592 total) data points for break frequency and duration were replaced (all from the Forced Assignment group). A total of 11 data points from the 1296 valid (1776 total) data points for the minutes and percent of sitting, standing, and moving data were replaced. Nine points from the Forced Assignment group and two from the Choice of Assignment group. To ensure group baseline equivalency, univariate ANOVAs and chi-square analyses were used on demographic characteristics, baseline sedentary behaviour break frequency and duration, total time in sedentary behaviour, and levels of intention to change sitting behaviours.

Repeated measure ANOVAs were completed to assess group assignment effects on break frequency and duration, as well as minutes sitting, standing, and moving. Group by time repeated measure ANOVAs were completed to assess change in behavioural intentions in sedentary behaviour pre- and post- educational video. To ensure fidelity of the educational video watched at baseline (pre-intervention), knowledge of sedentary behaviour from pre- and post-educational video were analyzed using a paired samples t-test. Intervention adherence, video engagement (from Vimeo), and exit survey responses will be reported descriptively, including frequencies (using percentages). A p-value < .05 was regarded as significant for all statistical tests and a partial-eta squared ($\eta^2$) of 0.01, 0.06, and 0.14 represented small, medium, and large effect sizes, respectively. All statistical analyses were conducted using IBM SPSS version 25.0.
3.1.1 Manipulation check

We were not powered to detect significant primary outcome interaction effects between the two treatment conditions (forced vs choice) and the two groups nested within each condition (forced-self-selected vs automated; choice-self-selected vs automated preference). We performed a manipulation check to ensure the two groups in each of the two conditions were not influencing the findings on the primary outcome. Within the Forced Assignment condition, we used a one-way repeated measures ANOVA to explore whether those randomized into the automated strategies condition performed differently than those randomized into the self-selected strategies condition. Within the Choice of Assignment group, a one-way repeated measures ANOVA was used to explore whether automated strategies were chosen more than self-selected strategies, and if so, did one group affect the primary outcome more than the other.

3.2 Results

3.2.1.1 Missing Data

On any given variable at a single assessment point, the maximum percentage of missing data/responses was 28.4 percent. Participants were considered to have ‘dropped out’ if they did not pick their strategies (Monday questionnaire) two weeks in a row. Of the 2,368 total responses that could have been completed, 581 responses (25%) were either unanswered or missing. Of the 1,232 possible responses for the Choice of Assignment group, 325 (26%) were either unanswered or missing. Of the 1,136 possible responses for the Forced Assignment group, 256 (23%) were either unanswered or missing. There were 27 participants who dropped out (20% drop out rate), 15 in the Forced Assignment group and 12 in the Choice of Assignment group. Figure 4 shows the flow of dropouts for each group throughout the four weeks. There were 29 issues with collecting activPAL4™ data, 19 at baseline and 10 at follow-up. The baseline issues were related to device malfunction (n=14), a lost monitor (n=1), self-reported mild skin allergic reactions (n=2), leaving on vacation unexpectedly (n=1), and not wanting to wear it due to personal preferences (n=1). At follow up, issues were related to device malfunction (n=6), lost monitors (n=2), wear non-compliance (n=3), and personal emergency (n=1). There were seven participants who were a part of the study who were
only able to participate in non-wearable activity monitor related study activities (Forced Assignment, n=4; Choice of Assignment, n=3), due to location (outside of mailing radius for the activPAL4 monitor).

Analyses revealed no significant differences (all p-values > .05) in the demographic variables for those with complete data and those with missing data. There was also no differential loss (i.e., greater loss in one group) between groups for those that completed the study versus those that dropped out. Taken together, all missing data were missing at random (Pampaka et al., 2014). Due to the large percentage of data missing; missing data were imputed using the multiple imputation function in SPSS (for all main analysis). A multiple imputation of five runs was performed based on previously described recommendations (Graham et al., 2007). SPSS automatically selected the appropriate imputation method (monotone vs. MCMC) after scanning the data for a monotone pattern of missing values. A sensitivity analysis was performed using the complete data set (no missing values imputed).
Figure 4. Dropouts throughout the study
3.2.1.2 Participant Characteristics

A total of 148 participants were enrolled and randomized. There were 71 (mean age 45.3 ± 11.8 years; 70% female) participants in Forced Assignment group, with 36 (50.7%) again randomized to the ‘automated, expert recommended’ group and 35 to the ‘self-selection’ group (49.3%). There were 77 (mean age 44.5 ± 11.2 years; 74% female) randomized to the Choice of Assignment group; 50 (64.9%) chose to be in the ‘automated, expert recommended’ group and 27 (35.1%) in the ‘self-selection’ group. There were no statistical differences between the choice and assigned groups at baseline, including sedentary behaviour change intentions. Participant characteristics are summarized in Table 10. Most (79.7%) reported working from home five days a week. As well, most (77.1%) participants self-reported spending more time sitting since transitioning to at-home work (see Appendix BB).

3.2.2 Manipulation check

Within the Forced Assignment condition, there were no significant group by time interaction effects for those randomized into the automated strategies condition versus those randomized into the self-selected strategies condition (p > 0.05). Within the Choice of Assignment group, the option to have strategies ‘automated’ was chosen significantly more than the option to self-select their own strategies (p < 0.05; n = 50 and n = 27, respectively). However, there were no group by time differences for the primary outcome for choice selection (p > 0.05). Hence, the main analysis was performed after collapsing the groups within the two overarching treatment conditions.
Table 10. Participant characteristics presented as mean (SD) or count (%) of group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total sample (n = 148)</th>
<th>Assigned (n = 71)</th>
<th>Choice (n = 77)</th>
<th>Statistic</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>44.90 (SD = 11.41)</td>
<td>45.30 (SD = 11.74)</td>
<td>44.53 (SD = 11.17)</td>
<td>F(1,146) = 0.164</td>
<td>0.686</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td>X² (2) = 1.217</td>
<td>0.544</td>
</tr>
<tr>
<td>Male</td>
<td>40 (27.0 %)</td>
<td>20 (28.2 %)</td>
<td>20 (26.0 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>107 (72.3 %)</td>
<td>50 (70.4 %)</td>
<td>57 (74.0 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Binary</td>
<td>1 (0.7 %)</td>
<td>1 (1.4 %)</td>
<td>0 (0.0 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td>X² (4) = 2.822</td>
<td>0.578</td>
</tr>
<tr>
<td>White</td>
<td>126 (85.1 %)</td>
<td>59 (83.1 %)</td>
<td>67 (87.3 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black or African American</td>
<td>3 (2.0 %)</td>
<td>2 (2.8 %)</td>
<td>1 (1.3 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>4 (2.7 %)</td>
<td>2 (2.8 %)</td>
<td>2 (2.6 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4 (2.7 %)</td>
<td>1 (1.4 %)</td>
<td>3 (3.9 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>27.33 (SD = 5.74)</td>
<td>27.45 (SD = 5.32)</td>
<td>27.22 (SD = 6.13)</td>
<td>F(1,146) = 0.060</td>
<td>0.807</td>
</tr>
<tr>
<td><strong>Level of Education</strong></td>
<td></td>
<td></td>
<td></td>
<td>X² (4) = 3.956</td>
<td>0.412</td>
</tr>
<tr>
<td>Highschool Diploma</td>
<td>13 (8.8 %)</td>
<td>9 (12.7 %)</td>
<td>4 (5.2 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>College Degree</td>
<td>26 (17.6 %)</td>
<td>11 (15.5 %)</td>
<td>15 (19.5 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University Degree</td>
<td>57 (38.5 %)</td>
<td>28 (39.4 %)</td>
<td>29 (37.7 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masters</td>
<td>30 (20.3 %)</td>
<td>15 (21.1 %)</td>
<td>15 (19.5 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doctorate (i.e., MD, PhD)</td>
<td>22 (14.9 %)</td>
<td>8 (11.3 %)</td>
<td>14 (18.2 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
<td></td>
<td></td>
<td></td>
<td>X² (4) = 1.657</td>
<td>0.799</td>
</tr>
<tr>
<td>Single</td>
<td>26 (17.6 %)</td>
<td>14 (19.7 %)</td>
<td>12 (15.6 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married or equivalent</td>
<td>107 (72.3 %)</td>
<td>50 (70.4 %)</td>
<td>57 (74.0 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separated or equivalent</td>
<td>7 (4.7 %)</td>
<td>3 (4.2 %)</td>
<td>4 (5.2 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td>7 (4.7 %)</td>
<td>4 (5.6 %)</td>
<td>3 (3.9 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Widowed</td>
<td>1 (0.7 %)</td>
<td>0 (0.0 %)</td>
<td>1 (1.3 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Work Sector</strong></td>
<td></td>
<td></td>
<td></td>
<td>X² (3) = 6.646</td>
<td>0.084</td>
</tr>
<tr>
<td>Private</td>
<td>61 (41.2 %)</td>
<td>35 (49.3 %)</td>
<td>26 (33.8 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>77 (52.0 %)</td>
<td>32 (45.1 %)</td>
<td>45 (58.4 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charity</td>
<td>2 (1.4 %)</td>
<td>2 (2.8 %)</td>
<td>0 (0.0 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>7 (4.7 %)</td>
<td>2 (2.8 %)</td>
<td>5 (6.5 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Days worked from home</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Five</td>
<td>118 (79.7 %)</td>
<td>56 (78.9 %)</td>
<td>62 (80.5 %)</td>
<td>F(1,146) = 0.061</td>
<td>0.805</td>
</tr>
<tr>
<td>Four</td>
<td>19 (12.8 %)</td>
<td>7 (9.9 %)</td>
<td>12 (15.6 %)</td>
<td>F(1,146) = 1.075</td>
<td>0.301</td>
</tr>
<tr>
<td>Three</td>
<td>11 (7.4 %)</td>
<td>8 (11.3 %)</td>
<td>3 (3.9 %)</td>
<td>F(1,146) = 2.936</td>
<td>0.089</td>
</tr>
<tr>
<td><strong>Physical Activitya</strong></td>
<td></td>
<td></td>
<td></td>
<td>X² (2) = 0.244</td>
<td>0.622</td>
</tr>
<tr>
<td>Yes</td>
<td>85 (57.8 %)</td>
<td>39 (54.9 %)</td>
<td>46 (59.7 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>62 (42.2 %)</td>
<td>31 (43.7 %)</td>
<td>31 (40.3 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minutes Worked</strong></td>
<td>494.56 (SD = 62.55)</td>
<td>495.85 (SD = 55.48)</td>
<td>493.38 (SD = 68.76)</td>
<td>F(1,146) = 0.057</td>
<td>0.812</td>
</tr>
<tr>
<td><strong>Objectively Measured</strong></td>
<td>N=107</td>
<td>N=53</td>
<td>N=54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Break Frequency (minutes)</td>
<td>22.87±11.78</td>
<td>22.83±11.12</td>
<td>22.93±12.50</td>
<td>F(1,105) = 0.002</td>
<td>0.966</td>
</tr>
<tr>
<td>Break Duration (minutes)</td>
<td>6.60±4.43</td>
<td>7.15±4.04</td>
<td>6.06±2.65</td>
<td>F(1,104) = 2.709</td>
<td>0.103</td>
</tr>
<tr>
<td>Sitting (without transport) (minutes)</td>
<td>297.08±177.66</td>
<td>286.84±176.31</td>
<td>307.31±179.68</td>
<td>F(1,138) = 0.463</td>
<td>0.497</td>
</tr>
<tr>
<td>Moving (without cycling) (minutes)</td>
<td>25.63±23.99</td>
<td>26.49±25.82</td>
<td>24.78±22.12</td>
<td>F(1,138) = 0.177</td>
<td>0.675</td>
</tr>
<tr>
<td>Standing (minutes)</td>
<td>82.47±69.40</td>
<td>86.66±77.57</td>
<td>78.29±60.42</td>
<td>F(1,138) = 0.507</td>
<td>0.478</td>
</tr>
</tbody>
</table>

*a In the past 3 months, have you been active for a minimum of 30 minutes/day on at least 3 days of the week? (i.e., jogging, biking, swimming).
3.2.3 Main Analyses

3.2.3.1 Primary Outcomes

**Device measured break frequency.** Break frequency did not show significant group by time interaction effects ($F_{1,146} = 0.890, p = 0.347, \eta^2_p = 0.006$, power = 0.16). However, there was a significant time effect ($F_{1,92} = 18.068, p < 0.001, \eta^2_p = 0.110$, power = 0.99) where both groups increased their break frequency over the intervention period (see Figure 5). All other break frequency data can be found in Table 11.

![Graph showing device measured break frequency](image)

Figure 5. Device measured break frequency reported in minutes at baseline and week four.

**Self-reported measured break frequency.** Self-reported break frequency showed a significant group by time interaction effect ($F_{1,92} = 4.138, p = 0.044, \eta^2_p = 0.028$, power = 0.52), where those in the Choice of Assignment group increased break frequency to a greater extent than those in the Forced Assignment group (see Figure 6). All other break frequency data can be found in Table 11.
3.2.3.2 Secondary Outcomes

Device measured break duration. For break duration, there was a significant group by time interaction effect ($F_{1, 92} = 6.471, p = 0.012, \eta^2 = 0.042$, power = 0.72), with the Forced Assignment group increasing break duration compared to the Choice of Assignment group (see Figure 7). All other break duration data can be found in Table 11.
Self-reported measured break duration. Self-reported break duration found a group by time interaction effect trending towards significance \((F_{1,92} = 3.867, p = 0.051, \eta^2_p = 0.026, \text{power} = 0.50)\), where those in the Force Assignment group shortened their break duration more than those in the Choice Assignment group (see Figure 8). All other break duration data can be found in Table 11.

Device measured total sitting time, standing time and moving time. Sitting displayed a significant time effect \((F_{1,92} = 16.850, p < 0.001, \eta^2_p = 0.103, \text{power} = 0.98)\), where both groups decreased their sitting time over the four-week intervention period (see Figure 9). There was a significant group by time effect for standing, with the Forced Assignment group increasing their standing time more than the Choice of Assignment groups \((F_{1,92} = 6.248, p = 0.014, \eta^2_p = 0.041, \text{power} = 0.70)\) (see Figure 10). There was also a significant time effect for moving \((F_{1,92} = 5.777, p = 0.017, \eta^2_p = 0.038, \text{power} = 0.67)\) (see Figure 11). All other sitting, standing, and moving data can be found in Table 11.
Figure 9. Device measured sitting time reported in minutes at baseline and week four.

Figure 10. Device measured standing time reported in minutes at baseline and week four.
Self-reported measured total sitting time, standing time and moving time. Sitting displayed a significant time effect ($F_{1,92} = 95.529$, $p < 0.001$, $\eta^2_p = 0.396$, power = 1.0), where both groups decreased their sitting time over the four-week intervention period (see Figure 12). While sitting time went down, there was a significant time effect for an increase in standing (see Figure 13) and moving (see Figure 14) ($F_{1,92} = 37.421$, $p < 0.001$, $\eta^2_p = 0.204$, power = 1.0 and $F_{1,92} = 87.839$, $p < 0.001$, $\eta^2_p = 0.376$, power = 1.0), respectively. All other sitting, standing, and moving data can be found in Table 11.
Figure 12. Self-report measured sitting time reported in minutes at baseline and week four.

Figure 13. Self-report measured standing time reported in minutes at baseline and week four.
Figure 14. Self-report measured moving time reported in minutes at baseline and week four.
Table 11. Device and self-reported sedentary behaviour reported as mean (SD)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Baseline Assigned</th>
<th>Baseline Choice</th>
<th>Week 4 Assigned</th>
<th>Week 4 Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Break frequency (min)</td>
<td>22.65±12.67</td>
<td>23.02±12.67</td>
<td>18.31±8.49</td>
<td>20.26±10.57</td>
</tr>
<tr>
<td>Self-report Break Frequency (min)</td>
<td>126.72±63.50</td>
<td>142.60±79.28</td>
<td>68.58±28.75</td>
<td>60.24±28.91</td>
</tr>
<tr>
<td>Device Break Duration (min)</td>
<td>6.78±3.94</td>
<td>6.36±3.09</td>
<td>8.35±4.66</td>
<td>6.29±3.51</td>
</tr>
<tr>
<td>Self-report Break Duration (min)</td>
<td>6.75±7.25</td>
<td>4.74±4.47</td>
<td>3.18±4.09</td>
<td>2.93±2.02</td>
</tr>
<tr>
<td>Device Sitting (%)</td>
<td>78.73±8.98</td>
<td>79.37±9.28</td>
<td>71.61±13.04</td>
<td>77.48±10.05</td>
</tr>
<tr>
<td>Self-report Sitting (%)</td>
<td>85.07±17.73</td>
<td>87.62±13.51</td>
<td>73.34±18.39</td>
<td>71.75±16.77</td>
</tr>
<tr>
<td>Device Standing (%)</td>
<td>22.32±11.65</td>
<td>20.02±10.41</td>
<td>27.31±12.99</td>
<td>22.78±10.06</td>
</tr>
<tr>
<td>Self-report Standing (%)</td>
<td>8.04±13.91</td>
<td>5.68±8.12</td>
<td>13.31±13.65</td>
<td>13.11±9.41</td>
</tr>
<tr>
<td>Device Moving (%)</td>
<td>6.97±4.32</td>
<td>6.72±3.79</td>
<td>8.48±3.50</td>
<td>7.47±4.98</td>
</tr>
<tr>
<td>Self-report Moving (%)</td>
<td>6.87±7.73</td>
<td>6.19±7.53</td>
<td>13.48±10.44</td>
<td>15.23±10.04</td>
</tr>
</tbody>
</table>
3.2.4 Other Measures

**Intentions.** There was a significant group by time effect, with Forced Assignment increasing break frequency intentions \((F_{1,130}=8.541, \eta_p^2=0.062, p=0.004, \text{power}=0.827)\) and plans \((F_{1,130}=9.996, \eta_p^2=0.071, p=0.002, \text{power}=0.881)\). There was a time effect for break frequency goals for both Forced assignment and Choice of Assignment \((F_{1,130}=16.172, \eta_p^2=0.111, p<0.0001, \text{power}=0.979)\), with Forced Assignment trending towards a larger increase \((F_{1,130}=3.702, \eta_p^2=0.028, p=0.057, \text{power}=0.480)\). For walking (or moving) intentions, there was a significant group by time effect, with Forced assignment having a larger change in increase \((F_{1,130}=4.418, \eta_p^2=0.033, p=0.037, \text{power}=0.550)\). There were significant time effects for both walking plans \((F_{1,130}=27.542, \eta_p^2=0.175, p<0.0001, \text{power}=0.999)\) and goals \((F_{1,130}=6.910, \eta_p^2=0.050, p=0.01, \text{power}=0.742)\), where both groups increased in intentions. There was a trend towards a group by time effect for walking plans, with Forced Assignment having larger changes in intention from pre to post video \((F_{1,130}=3.834, \eta_p^2=0.029, p=0.052, \text{power}=0.484)\).

**Knowledge of sedentary behaviour.** Scores from pre- and post-educational video indicate that participants significantly increased their knowledge about sitting behaviours by 1.17 points (out of 4) \((95\% \text{ CI } 1.01 – 1.34), p<0.0001\) \((\text{pre-video: } 2.25 \pm 0.75/4; \text{post-video: } 3.42 \pm 0.71/4)\).

**Intervention adherence and engagement.** Intervention adherence and video statistics can be found in Table 12. Intervention adherence did not drop below 72% with no significant differences between the group assignments.

**Strategy satisfaction.** Strategy satisfaction results that were self-reported every Friday can be found in Figure 15. The Choice of Assignment group that chose to ‘self-select’ their strategies reported the highest satisfaction across the four-week intervention. The Forced Assignment group that was also randomized into the group to receive ‘automate, expert recommended’ strategies reported the least satisfaction over the four weeks.

**Exit survey.** Exit survey results can be found in Figure 16. Overall, most participants \((60\%)\) reported that the study helped them increase their knowledge about what sedentary behaviour is and how they can reduce it. Almost half of participants reported that pre-committing to their strategies at the beginning of the week and self-
reporting their sedentary behaviour patterns at the end of the week were great motivational tools (42.9% and 47% respectively). Lastly, more than half (53%) reported that the educational video was interesting to watch.

Table 12. Intervention adherence and engagement

<table>
<thead>
<tr>
<th>Video Type</th>
<th>Week 1 FA (n=66)</th>
<th>Week 1 COA (n=68)</th>
<th>Week 2 FA (n=66)</th>
<th>Week 2 COA (n=68)</th>
<th>Week 3 FA (n=66)</th>
<th>Week 3 COA (n=68)</th>
<th>Week 4 FA (n=66)</th>
<th>Week 4 COA (n=68)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Views</td>
<td>Unique Views</td>
<td>Finishes</td>
<td>% Average watched</td>
<td>Average time per view</td>
<td>Video Length</td>
<td>Desktop</td>
<td>Mobile</td>
</tr>
<tr>
<td>Week 1 Video</td>
<td>152</td>
<td>135</td>
<td>128</td>
<td>88</td>
<td>2:36</td>
<td>3:00</td>
<td>105</td>
<td>43</td>
</tr>
<tr>
<td>Week 3 Video</td>
<td>61</td>
<td>61</td>
<td>55</td>
<td>94</td>
<td>2:49</td>
<td>3:00</td>
<td>47</td>
<td>14</td>
</tr>
<tr>
<td>Tegaderm Application Video</td>
<td>318</td>
<td>237</td>
<td>272</td>
<td>86</td>
<td>2:58</td>
<td>3:31</td>
<td>180</td>
<td>128</td>
</tr>
</tbody>
</table>
Figure 15. Participant strategy satisfaction over the 4-week intervention period. FA Auto = Forced Assignment, Automated Strategies Group. FA SS = Forced Assignment, Self-Selected Strategies Group. COA Auto = Choice of Assignment, Automated Strategies Group. COA SS = Choice of Assignment, Self-Selected Strategies Group. Strategy usefulness is on the Y axis. Strategies were measured on a 3-item Likert scale. 1 = Not Useful, 2 = Some Impact and 3 = Useful. Time is on the X axis, each number representing that week.

Figure 16. Exit Survey Results

**EXIT SURVEY RESULTS**

- I would say this study helped me improve my knowledge about sedentary behaviour and how I can reduce it during work periods: 28.7% Strongly Agree, 60% Agree, 19.7% Neutral, 2.6% Disagree, 7% Strongly Disagree.
- Pre-committing to my strategies was a great motivational tool for helping me complete the strategies: 42.9% Strongly Agree, 30.4% Agree, 24.3% Neutral, 2.6% Disagree, 7% Strongly Disagree.
- I found that the self-report prompt at the end of the week to report my sitting habits was motivational in helping me commit to reducing my sitting time: 47% Strongly Agree, 47% Agree, 4.3% Neutral, 0.9% Disagree, 7% Strongly Disagree.
- I was honest when reporting my sitting habits for the self-report prompt at the end of the week: 21.7% Strongly Agree, 33% Agree, 18.3% Neutral, 7% Disagree, 7% Strongly Disagree.
- I found the educational video interesting to watch: 6.7% Strongly Agree, 7.8% Agree, 19.7% Neutral, 2.6% Disagree, 7% Strongly Disagree.
3.2.5 Sensitivity Analyses
The follow analyses were completed on the complete data set. All descriptive data can be found in Table 13.

3.2.5.1 Primary Outcomes

**Device measured break frequency.** Break frequency did not show significant group by time interaction effects ($F_{1,90} = 0.262, p = 0.61, \eta_p^2 = 0.003$, power = 0.08). However, there was a significant time effect ($F_{1,90} = 18.526, p < 0.001, \eta_p^2 = 0.169$, power = 0.989), where both groups increased their break frequency over the intervention.

**Self-reported measured break frequency.** Self-reported break frequency showed a significant group by time interaction effect ($F_{1,112} = 4.568, p = 0.035, \eta_p^2 = 0.039$, power = 0.563), where those in the Choice of Assignment group increased break frequency to a greater extent than those in the Forced Assignment group.

3.2.5.2 Secondary Outcomes

**Device measured break duration.** For break duration, there were no significant group by time interaction effects ($F_{1,90} = 2.361, p = 0.128, \eta_p^2 = 0.128$, power = 0.330), nor time effects ($F_{1,90} = 1.292, p = 0.259, \eta_p^2 = 0.014$, power = 0.203).

**Self-reported measured break duration.** Self-reported break duration found a group by time interaction effect trending towards significance ($F_{1,113} = 3.685, p = 0.057, \eta_p^2 = 0.032$, power = 0.477), where those in the Force Assignment group shortened their break duration more noticeably than those in the Choice Assignment group.

**Device measured total sitting time, standing time and moving time.** Sitting displayed a significant time effect ($F_{1,88}=12.559, \eta_p^2 = 0.125, p = 0.001$, power = 0.939), where both groups decreased their sitting time. There was a significant group by time effect for standing, with the Forced Assignment group increasing their standing time more than the Choice of Assignment groups ($F_{1,88}= 5.888, \eta_p^2 =0.063, p = 0.017$, power = 0.670). There were no time effects for moving ($F_{1,88}= 2.989, \eta_p^2 =0.033, p = 0.087$, power = 0.401).

**Self-reported measured total sitting time, standing time and moving time.** Sitting displayed a significant time effect ($F_{1,111}=16.054, \eta_p^2 = 0.127, p < 0.001$, power = 0.978), where both groups decreased their sitting time. While sitting time went down, there was a significant time effect for an increase in standing and moving ($F_{1,98}=4.552$, power = 0.087).
\[ \eta_\rho^2 = 0.045, \ p = 0.035, \ \text{power} = 0.561 \ \text{and} \ F_{1,106} = 13.074, \ \eta_\rho^2 = 0.111, \ p < 0.001, \ \text{power} = 0.948, \ \text{respectively}. \]
Table 13. Device and self-reported measured sedentary behaviour (complete data set) reported as mean (SD)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Baseline</th>
<th>Week 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assigned</td>
<td>Choice</td>
</tr>
<tr>
<td>Device Break frequency (minutes)</td>
<td>22.57±10.33</td>
<td>23.27±13.08</td>
</tr>
<tr>
<td>Self-report Break Frequency (minutes)</td>
<td>127.10±61.61</td>
<td>152.07±83.99</td>
</tr>
<tr>
<td>Device Measured Break Duration (minutes)</td>
<td>7.41±4.17</td>
<td>5.88±2.45</td>
</tr>
<tr>
<td>Self-report Measured Break Duration (minutes)</td>
<td>6.29±7.07</td>
<td>4.14±3.09</td>
</tr>
<tr>
<td>Device sitting (%)</td>
<td>78.23±9.38</td>
<td>80.04±9.17</td>
</tr>
<tr>
<td>Self-report sitting (%)</td>
<td>86.46±15.82</td>
<td>88.79±10.50</td>
</tr>
<tr>
<td>Device Standing (%)</td>
<td>22.35±11.04</td>
<td>20.37±9.31</td>
</tr>
<tr>
<td>Self-report Standing (%)</td>
<td>8.87±13.88</td>
<td>7.10±6.28</td>
</tr>
<tr>
<td>Device Moving (%)</td>
<td>7.09±4.70</td>
<td>6.48±3.95</td>
</tr>
<tr>
<td>Self-report Moving (%)</td>
<td>7.70±6.71</td>
<td>7.13±4.92</td>
</tr>
</tbody>
</table>
3.3 Discussion

This four-week intervention explored the effects of a theory-based intervention with the added feature of ‘choice’ on sedentary behaviour break frequency in office workers working from home. The intervention objective was to have participants break up their sedentary behaviour every 30 to 45-minutes with 1- to 2-minute breaks. Overall, the device-based results indicated that the theory-based intervention significantly increased break frequency for both groups. In other words, the implementation of ‘choice’ did not make a difference; both Forced Assignment and Choice of Assignment groups significantly increased their break frequency over the four weeks (4.34 minutes and 2.76 minutes, respectively), one did not significantly improve more than the other. In contrast, self-reported break-frequency did show a group by time interaction effect, with the Choice of Assignment group increasing break frequency to a greater extent that those in the Forced Assignment group (82.36-minute increase of frequency versus 58.14 minutes, respectively).

Regarding the secondary outcomes, for break duration, the device-based measure showed a significant group by time interaction effect, with the Forced Assignment group increasing the duration of their breaks (+ 1.57 minutes) and the Choice of Assignment group staying relatively stable (-0.07 minutes). When looking at self-reported break duration, we observed a group by time interaction effect trending towards significance, but in the opposite direction. More specifically, the Forced Assignment group shortened their break duration more so than the Choice of Assignment group (3.57-minute decrease versus 1.81-minute decrease).

For device-based sitting, standing, and moving time, we observed a significant time effect for sitting (i.e., both groups decreased sitting time, one didn’t improve more than the other). Forced Assignment decreased sitting time by 26-minutes and Choice of Assignment decreased by 13-minutes. The Forced Assignment group increased their standing time significantly more than the Choice of Assignment group (+29.58 minutes and +6.83 minutes, respectively). Both groups showed an increase in time spent moving over the four-week intervention period; Forced Assignment increased movement time by +6.57 minutes and Choice of Assignment increased movement time by +0.83 minutes. In contrast, the self-report measures showed that both groups decreased their percentage of
occupational time spent sitting (Forced Assignment decreased by 4.67% and Choice of Assignment decreased by 15.87%) while simultaneously increasing standing time (Forced Assignment increased by 5.27% and Choice of Assignment increased by 7.43%) and moving time (Forced Assignment increased by 6.61% and Choice of Assignment decreased by 9.04%), with no significant differences between the two groups.

Taken together, these findings suggest how sedentary behaviour is measured (self-report versus device) affects whether changes in behaviour can be detected. When measured with a device, it appears as though having the choice (or not), as defined by our two intervention groups, has no effect on sedentary break frequency or overall total sitting and moving time. However, placement in the Forced Assignment group resulted in an increase in break duration and overall time spent standing compared to the Choice of Assignment group. When measured with a self-report questionnaire, we observe no added benefit of ‘choice’ for overall sitting, standing, or moving time. However, there was an added benefit of being placed in the Choice of Assignment group for breaking sedentary time more often and keeping break durations shorter. Beyond these generalized findings, the following specific findings warrant commentary.

Overall, the sensitivity analysis supported the main analysis. There were two main differences. First, with the imputation analysis, we observed a group x time interaction effect for the device based measured break duration which was not illustrated with the complete data set. Second, device based moving time showed no time effect for the complete data set and once missing data was accounted for, a time effect was observed. These findings are likely due to the increase of power after filling in missing data using the multiple imputation method.

Looking at the device-based results, both groups significantly increased their break frequency to about 19 minutes. Although there are health benefits to increased break frequency (Diaz et al., 2017; Dunstan et al., 2012; Loh et al., 2020), the original objective of the intervention was to ensure break frequency times between 30- to 45-minutes in order to maximize both health benefits and work productivity. Interestingly, self-reported break frequency was more in line with the intervention objectives, with both groups reportedly taking breaks at around every 135 minutes (~2.25 hours) at baseline and increasing break frequency to around every 60 minutes (~1 hour) at week four. It is
possible that the participants were self-reporting “intentional” breaks. In other words, when they would purposely get up to take movement breaks as opposed to self-reporting every single break they took from sitting (i.e., getting up to throw something in the trash or grab something out of the printer). The device would have measured every single break the participant took, intentional or not, which could be a reason for the discrepancy in the findings (device measured break frequency ~23-minutes and self-report break frequency ~134-minutes at baseline). Another possibility for the discrepancy in findings would be self-report bias. The participants may have been self-reporting break frequency to align with the intervention objectives even though they were not following suit. However, the large discrepancy at baseline in addition to follow up suggests this might not be the only contributing factor.

Some of the participants’ exit survey feedback and other previous mixed methods studies have reported participants’ feedback on frequently interrupted work and inopportune break reminders are negatively impacting work levels (i.e., breaking concentration, ruining work “flow”) (Carter et al., 2020). When looking at the device measures from the current study, taking a break every ~20 minutes might have hindered work productivity. However, one systematic review by Sui et al. (2019) assessed the effects of various interventions on workplace sedentary behaviour. They concluded standing interventions appeared to have no negative impact to productivity and performance, however walking interventions had mixed null/negative associations. Many of the suggestions used in the current study either used timer-based prompts or breaks that were not planned (e.g., at 12:00pm I will get up and move). These strategy styles (and perhaps feelings of social desirability bias to follow the intervention goals) may have made participants feel more restricted or forced to get up at inopportune times (even when it was not ideal, such as feeling pressure to get up during a videoconference meeting). Luo and colleagues (2018) offered an intervention that allowed participants to specify their preferred duration and time of breaks throughout the day for prompts. Those who specified their intentional breaks compared to those who did not, had higher study habit strength over time. This may indicate that even more personalized methods of planning to break sedentary behaviour may be useful and more powerful in the long run. Additionally, future studies should stress the importance between balance of work
activity and breaking up sedentary behaviour, in order to maintain proper workflow and long-term behaviour change.

As previously mentioned, the intervention objective was to increase break frequency to every 30-45 minutes. A previous office workers study that used a HAPA-based intervention paired with text-messages was able to increase self-reported break frequency from 97.38 minutes to 63.86 minutes at follow-up (week 8) (Rollo & Prapavessis, 2020). This is comparable to the current study, with the home-based office workers self-reporting break frequency of ~135-minutes at baseline to ~60 minutes at week four. Interestingly, the office workers study by Rollo & Prapavessis (2020) saw a substantial increase in break frequency from baseline to week 4 (68.90 minutes) and it was maintained all the way to follow-up at week 8. This is encouraging for the current study as we saw the same pattern to the week four mark. Other studies that have used a HAPA-based intervention have also shown similar findings regarding increasing break frequency. For example, in university students, Sui and Prapavessis (2017) increased break frequency from every 90.54 minutes to every 58.39 minutes over an 8-week period. Similarly, Dillon and colleagues (2021) increased break frequency from every 106.60 minutes to every 64.82 minutes over a 6-week intervention period using the HAPA framework.

Compared to previous office working studies that have measured break duration, Rollo & Prapavessis observed a decrease in break duration similar to what we saw in our Choice of Assignment group. Rollo & Prapavessis (2020) reported a break duration of almost 6 minutes at baseline to just over 3-minutes at week four. In the current study, we saw self-reported break duration go down in both groups, with the Choice of Assignment reporting break durations of just under 3-minutes at week four while the Forced Assignment group reported break durations of just under 5-minutes at week four. While the current study’s self-report findings are in-line with this previous HAPA-based intervention, it is important to note how different the self-report and device based measured findings were. While self-reported break duration went down for both groups, when looking at the device-based findings, we observe that the Choice of Assignment group stayed relatively stable at ~6-minutes and the Forced Assignment group went up, increasing break duration from 6.78-minutes to 8.35-minutes. To our knowledge, this is
the first HAPA-based intervention that used a device in home-based office workers. Future work is needed to validate the self-report questionnaire used to measure break frequency and duration so that future research can easily implement an intervention on a large-scale and be confident in any observed findings.

Regarding other office-working interventions measuring sedentary behaviour, an eight-week parallel randomized trial by Mailey and colleagues (2016) investigated the effects of taking short 1- to 2-minute breaks every 30-minutes compared to two long (15-minute) breaks throughout the day, on device-measured (i.e., Actigraph) sitting time and cardiometabolic outcomes in female office workers (Mailey et al., 2016). Participants utilized three to four self-identified strategies throughout the intervention. They observed that the frequent short breaks were more beneficial than the two long breaks, as the short breaks group significantly decreased sitting time by -35.75 minutes ($d = -0.75, p = 0.03$), compared to the long breaks group ($d = 0.12, p = 0.68$). The short break group also demonstrated a significant decrease in fasting plasma glucose compared to the long break group. These findings support the idea of continuing to implement short, frequent breaks within this population. While Mailey and colleagues (2016) were able to decrease overall sitting time more so than the current study (35.75 minutes versus 26 minutes, respectively); they used a 30-minute individual orientation, completing a planning worksheet and self-identifying strategies, similar to the Rollo and Prapavessis (2020) intervention. Thus, it is not a surprise that a 30-minute individualized session resulted in a greater decrease in sitting time compared to a 3-minute educational video. However, our results are promising as the educational video grounded within the HAPA framework is much less time consuming and can be easily administered on a large-scale and showed it can still produce significant reductions in sitting time.

One meta-analysis investigating the effects of workplace interventions to reduce sedentary behaviour in white-collar office workers found that behavioural/educational interventions reported a pooled reduction of -15.5 minutes/8-hour workday ([95% CI] -22.9 minutes, -8.2 minutes), which is smaller than what we observed in our 4-week intervention period (21.05 minutes and 10.64 minutes for the forced assignment and choice of assignment group, respectively) (Chu et al., 2016). This is however, less than workplace interventions using activity-permissive workstations, as a review found a
mean reduction in sedentary time of 77-minutes per 8-hour workday across eight studies (Neuhaus et al., 2014). A later Cochrane review supported the potential effectiveness of sit-to-stand desks as opposed to information and counselling-based approaches but highlighted the need to investigate the long-term effectiveness (Shrestha et al., 2016). While sit-to-stand workstations show promising results, we need to create behaviour change without the need for institutional buy-in, and results from the current study are encouraging.

When looking at the device-based results for the current study, the decrease in sitting time (-7.12% and -1.89% for the Forced Assignment and Choice of Assignment groups, respectively) was replaced with an increase in standing time (+4.99% and +2.76% in the Forced Assignment and Choice of Assignment groups, respectively) and moving time (+1.51% and +0.75% in the Forced Assignment and Choice of Assignment groups, respectively). These device-based findings suggest that the Forced Assignment group performed better than the Choice of Assignment group for total sitting, standing and moving time. In contrast, when looking at the self-report-based results we observe the opposite, with the Choice of Assignment group showing better improvements for all three variables. For sitting, the Forced Assignment decreased by 11.73% whereas the Choice of Assignment group decreased by 15.87%. For standing time the Forced Assignment group increased by 5.27% whereas the Choice of Assignment groups increased by 7.43%. Similarly, for moving time the Forced Assignment group reported moving 6.61% more whereas the Choice of Assignment group reported increased moving time by 9.04%.

Office workers have shown to have limited knowledge on unhealthy sitting behaviours (i.e., how frequent sitting should be broken up) (Hadgraft et al., 2018). Choice preference uncertainty (due to unfamiliarity with a topic, item, etc.) is well-documented in consumer scenarios (Chernev et al., 2015); and it is possible that it may exist in choice scenarios; such as strategies to break or reduce sedentary behaviours due to lack of knowledge. In most cases, people do not like to be told what to do (i.e., psychological reactance) (Reynolds-Tylus, 2019). However, in the cases of lack of experience, it appears this may not always necessarily be the case (i.e., a person hiring a personal trainer). According to the device-based measures, home-based office workers perform the same in regard to reducing total sitting time and increasing total moving time whether they are: a) forced to
either choose or receive “expert recommended” strategies or b) have the option to choose their preferred method of receiving strategies. However, the Forced Assignment group did show an advantage for standing more compared to the Choice of Assignment group. It is possible that the Forced Assignment-self-selected group choose all standing-based strategies, and thus increased their standing time more than their moving time. In contrast, when looking at the self-report-based measures, there was no advantage for sitting, standing or moving time; both groups improved over the 4-week period. These results, taken together, indicate that assigning a person to a strategy condition (automated strategy or self-selected strategy) or providing a person the option to choose a strategy condition, does not matter, when measuring with a device; but there seems to be an advantage for being able to choose when sedentary behaviour patterns are measured via self-report. These findings again highlight the need for self-report measures to be validated against a gold-standard device in this population.

Intervention adherence shows promise for future similar interventions. Each Monday, participants received their strategies via an email link. Over the course of the four weeks, adherence to receiving the strategies and pre committing to the selected/assigned strategies started at ~98% and hovered around ~75-80% for the remaining weeks (with no significant differences between the groups). This is higher than Mailey and colleagues (2016), whose conservative adherence measures were 60.5% and 49.2% for short and long break groups, respectively (Mailey et al., 2016). This level of engagement/intervention adherence demonstrated that a simple intervention such as this one can be easily implemented and still have relatively high interest from participants. However, it is worth noting, this sample was subject to higher self-selection bias, as a lot of participants were at heightened concern for sitting levels and looking for change. This claim may be strengthened with the baseline data showing 77% of participants reporting feeling that they currently engaged in above average (or very much above average) sitting, compared to pre-pandemic levels. It would be interesting to see if this same level of engagement would hold in the case of less “heightened” urge to improve sitting levels (i.e., post-COVID-19 pandemic) or over the course of a longer intervention. The lack of group differences in intervention adherence, in addition to the lack of differences in sedentary behaviour break frequency, furthers the argument that the choice (or not) for
strategy conditions does not influence intervention engagement or behaviour change. As well, we did not have a control group available to compare to the intervention groups. Interestingly, the end of week self-report’ question investigating the “usefulness” of strategies showed the Choice of Assignment group, self-selection condition reporting the highest usefulness ratings (out of three) for their sedentary behaviour strategies each week, followed by the Forced Assignment, self-selection group. This trend suggests that perhaps the ability to choose individual strategies results in higher levels of perceived strategy “usefulness.” Higher levels of perceived usefulness are likely related to the ability to choose strategies that were most applicable to an individual’s work habits. Lastly, the findings from the exit survey illustrate that adding in small intervention features such as pre-committing to strategies and self-reporting sitting behaviours were perceived as motivational for behaviour change for more than half of participants and should be implemented into future interventions targeting this population.

This is one of the first studies to deliver a workplace sedentary behaviour intervention to an at-home office worker population. A key strength of this study is the large amount of device-based data (collected by the gold standard, activPAL4™), which is not seen in many larger office worker-related sedentary behaviour studies. This objective data depicted a fuller picture of the workday by providing break frequency and duration times. Often, sedentary behaviour studies report the change in total number of breaks and total sitting/standing time throughout the workday (Cukic et al., 2018). However, as indicated earlier, the health consequences of sedentary behaviour are related to not just total sitting time, but rather how the sitting time is accumulated. The large size and well-balanced (i.e., proportion of different education levels and private/public sectors jobs) sample indicate high levels of generalizability, which strengthen the current findings. As almost all (92.5%) participants reported working four or five days from home, these findings are most generalizable to those working almost exclusively at home. Overall, the intervention was easily implemented and displayed high participant adherence and engagement. This is promising for future interventions, as something as small as a 3-minute educational video, supplemented with committing to strategies and self-monitoring behaviour resulted in changes to sedentary behaviour patterns for the better.
Nevertheless, there are some limitations that should be considered when interpreting the results and considering future work. First, as previously mentioned, we did not have a control group. Future research should compare this HAPA-based intervention with a control group to further test its effectiveness. Second, although the strategies provided were sourced from other previous work and reviewed by sedentary behaviour experts, the efficacy of the utilized strategies are unknown. Third, the intervention effects were also limited by the short time frame of the study. A longer intervention and/or follow-up may have found different effects. Fourth, the findings may be limited by the lack of specificity of the times for an individual’s workday. For example, the current study collected work hours and days at baseline only, whereas other studies have had participants record work hours in a daily log (Stephenson et al., 2021). Thus, times may have slightly fluctuated due to work hour flexibility (i.e., family demands, COVID-19 restrictions at the time (influencing family dynamics at home), sleep times, etc.) (Ray & Pana-Cryan, 2021) or may have changed over the course of the intervention. Fifth, days worked from home and in-office were unspecified and results cannot be distinguished between the two. Future work should have participants log their location and times for their workdays daily in order to increase accuracy. Sixth, although all participants were working from home, types of at-home equipment, surroundings, and job demands may have varied, which may have affected the results. However, it also demonstrates stronger external validity for real-world implementation. Seventh and lastly, it was beyond the scope of this study to look at the influence of whether certain strategies (either provided or selected) ended up being more or less effective in changing sedentary behaviour. Thus, we did not investigate which strategies were more effective, nor the selection frequency (in the case of the self-selected strategy conditions). Future studies should compare effectiveness of specific behaviour change strategies.

3.4 Conclusion

An easily implemented version of the Health Action Process Approach (i.e., 3-minute educational video) is an effective way to reduce and break up sitting time in home-based office workers. Overall, the findings of this study suggest how sedentary behaviour is measured (i.e., self-report versus device) affects whether changes in behaviour can be detected between Forced Assignment and the Choice of Assignment groups. When
measured with the device, there was an advantage for the Forced Assignment group for break duration and standing whereas when measured with the self-report questionnaire, the Choice of Assignment group illustrated a better break frequency and duration profile. Regardless, the findings did suggest that a completely remote intervention utilizing an ‘enhanced’ HAPA model was both feasible and effective in at-home office workers. Future research is needed to validate the self-report questionnaires used in order to conduct more large-scale studies without the need of a device. While reducing sedentary behaviour is no substitution for meeting the physical activity guidelines, targeting sedentary behaviour may act as a “steppingstone” for those who do not engage in a physical activity. These results have potential implications for the development of public health messages for home-based office workers; as sedentary behaviour education, along with commitment to strategies and self-monitoring behaviour can reduce and break up sitting time. This is particularly relevant as more occupations continue to remain remote or take a hybrid (at-home and in-office) approach post COVID-19 pandemic.
3.5 References


3.6 Chapter 3 Summary and Implications

In study 2, we learned that using a more easily implemented version of the Health Action Process Approach introduced in study one (i.e., 3-minute educational video versus a 20-minute one-on-one behavioural counselling session) is an effective way to reduce and break up sitting time in home-based office workers. While devices are preferred for sedentary behaviour measurement, they come at a high-cost and a large burden to both the researcher and the participant, limiting overall use. This study was able to highlight some important implications for sedentary behaviour measurement in this population. For example, the difference in findings for break duration, where the Forced Assignment group self-reported a decrease in break duration whereas the device measured an increase in break duration. Self-report tools have yet to be validated in home-based office workers. Validated self-report measures of total sedentary behaviour time and pattern of sedentary behaviour accumulation would allow for large-scale surveillance and intervention research. The following two chapters (chapter 4-study 3A and chapter 5-study 3B) are secondary analyses of this data set and pertain to the validity of self-reported measures of sedentary behaviour, with the next chapter (chapter 4-study 3A) focusing on the occupational sitting and physical activity questionnaire (OSPAQ) within this home-based office worker population.
Chapter 4 – Validity of the Occupational Sitting and Physical Activity Questionnaire (OSPAQ) for Home-Based Office Workers During the COVID-19 global pandemic: A Secondary Analysis² (Study 3A)

²A version of this chapter has been previously published (Dillon et al., 2021). Reprinted with permission (See Appendix CC).
Abstract

High levels of occupational sitting is an emerging health concern. As working from home has become a common practice as a result of COVID-19, it is imperative to validate an appropriate self-report measure to assess sitting in this setting. This secondary analysis study aimed to validate the occupational sitting and physical activity questionnaire (OSPAQ) against an activPAL4™ in full-time home-based ‘office’ workers (n = 148; mean age = 44.90). Participants completed a modified version of the OSPAQ and wore an activPAL4™ for a full work week. The findings suggest that the modified OSPAQ has fair levels of validity in terms of correlation for sitting and standing (ρ = 0.35-0.43, all p < 0.05) and agreement (bias = 2-12%) at the group level; however, estimates were poor at an individual level, as suggested by wide limits of agreement (±22-30%). Overall, the OSPAQ showed to be an easily administered and valid questionnaire to measure group level sitting and standing in this sample of adults.

Keywords: OSPAQ, activPAL™, measurement-of-agreement
4.1 Introduction

Sedentary behaviour is defined as any waking behaviour in a seated, lying or reclining posture while expending less than or equal to 1.5 metabolic equivalents (Tremblay et al., 2017). Increased time spent sedentary has been associated with a higher risk of type 2 diabetes, cardiovascular disease and all-cause mortality (Katzmarzyk et al., 2019), independent from physical activity levels (Owen et al., 2010). Office-working adults have been shown to spend up to 77% of their workday sitting (Thorp et al., 2012), and therefore represent an at-risk population for high levels of sedentary time. The health concerns associated with high amounts of sedentary behaviour are increasingly being recognized with, for example, the recent launch of the Canadian 24-Hour Movement Guidelines for Adults, which provide time-specific recommendations for limiting daily sedentary time (Ross et al., 2020). Accordingly, it is not surprising that numerous interventions have targeted sedentary behaviour reduction in the workplace (Blackburn et al., 2020).

In response to the SARS-CoV-2 (COVID-19) global pandemic, many desk-based workers have pivoted from working at the office to working from home. For instance, findings from a survey targeting American full- or part-time office-workers (n = 5,858), found that only 20% reported working from home almost all the time or full-time pre-COVID; however, since the onset of COVID-19, these proportions have risen to 71% working from home most of the time or full-time (Pew Research Center, 2020). This rapid, unplanned and unequipped transition from office- to home-based settings for many office workers, in addition to social distancing and lockdown measures, has been linked to significant decreases in overall physical activity as well as significant increases in total daily sitting time (Ammar et al., 2020; FitBit, 2020; Tison et al., 2020). Evidence suggests that these decreases in physical activity may also be having a negative impact on mental health outcomes, including increased depression, loneliness, stress and decreased positive overall mental health (Meyers et al., 2020).

This work-from-home trend seems likely to outlive the global COVID-19 pandemic, as this pivotal transition seems to have already changed the environment of future office work. For instance, many workers have reported both preference and employer granted options for in-office/work-from-home flexibility indefinitely.
(Kantrowitz, 2020; Pew Research Center, 2020). Hence, it is important that interventions begin to target this new growing population’s sedentary behaviour patterns. Currently, evidence is sparse regarding interventions aimed at reducing sedentary behaviours in office workers who work from home. In addition to effective interventions, accurate measures to capture sedentary behaviour in this new “office environment” need to be tested and validated. Ideally, a measure that is less expensive and can be easily and quickly distributed, such as a self-report questionnaire, is urgently needed to advance sedentary research in this new segment of the working population.

While the preferred method of sedentary behaviour measurement is with a device that can differentiate sitting from standing (i.e., activPAL™), this type of device-based measurement is usually expensive (e.g., costs associated with purchasing each device, delivery to participants, dressings needed) and relatively invasive to ask participants to wear. Due to this cost barrier and added participant burden, there are a number of self-report questionnaires that have been developed and used in the literature. Questionnaires that have been previously used to assess sedentary behaviours in office working adults include, but are not limited to, the International Physical Activity Questionnaire (IPAQ; Eklund et al., 2006), the Workforce Sitting Questionnaire (Aittasalo et al., 2017), the Sedentary Behaviour Questionnaire (SBQ; Rosenberg et al., 2010) and the Occupational Sitting and Physical Activity Questionnaire (OSPAQ; Chau et al., 2012). Amongst these, the OSPAQ has been used in an array of populations such as university students (Dillon et al., 2021), university employees (Headley et al., 2018), sedentary obese individuals (Lohana & Yadav, 2020), health professionals (Zafiropoulos et al., 2019) and of relevance, office workers (Nelson-Wong et al., 2020; Rollo et al., 2020; Urda et al., 2017), to measure time spent sitting, standing, walking and performing heavy labour tasks during work hours. The OSPAQ measures sitting and standing as separate behaviours, thus, making it an ideal self-report tool to properly classify sedentary behaviour separate from physical inactivity. It is also very easy to implement as it only consists of three questions, minimizing participant burden. Validation studies using the OSPAQ have previously been conducted in various populations and demonstrated mixed levels of agreement and reliability depending on the occupation (i.e., sedentary versus non-sedentary) and device-based measure used (i.e., Actigraph versus activPAL™) (Chau et
al., 2012; Jancey et al., 2014; Maes et al., 2020; van Nassau et al., 2015). Whether these findings can be replicated among traditional office-workers now working from home warrants investigation. It is imperative to establish the ‘construct validity’ of this questionnaire in an at-home ‘office’ worker population to allow future research to confidently assess sedentary behaviour within this setting, without the need for costly device-based measures. It is also important to note that these previous validation studies carry several limitations and pose risk of bias due to inadequate sample size (van Nassau et al., 2015) or use a device that cannot accurately differentiate sedentary behaviour (i.e., sitting) from physical inactivity (i.e., standing) (Chau et al., 2012; Jancey et al., 2014). Validity evidence is lacking towards a questionnaire that can be administered to home-based office workers. Hence, a secondary analysis of data from an unpublished randomized comparison trial (NCT04488796) was undertaken to examine the measurement of agreement between the OSPAQ and the activPAL4™ inclinometer for estimating percentage of time spent sitting, standing and moving (i.e., walking) during work hours in office-working adults who had transitioned to working from home due to the COVID-19 pandemic.

4.2 Material and Methods

4.2.1 Study design & population

We performed a secondary analysis on data from an unpublished pre-registered randomized comparison trial (NCT04488796) that aimed to decrease and break up time spent sedentary among home-based office workers. Data were collected from September to December 2020. Participants were full-time, home-based office workers living in London, Ontario or the surrounding area. Individuals were eligible to participate if they were 18 years or older, self-declared working full-time (i.e., employed 30+ hours/week) 5 days per week (i.e., Monday to Friday), self-declared working at least 3 days per week from their home, were able to read and write in English and had access to a computer with Internet and email. Participants were ineligible if they were planning on leaving their current employer or taking a leave of absence/vacation for more than 3 consecutive workdays for the duration of the study. They were also ineligible if they self-declared
having a medical condition or physical limitation that prevented them from being physically active.

Participants were recruited using a number of strategies. First, contact was made via email with relevant liaisons and/or senior executives of potential businesses of interest (i.e., offices/businesses that were known to be working from home due to COVID-19). If interested, they were asked to email all full-time employees within their respective office/business inviting them to participate. Second, recruitment emails were sent directly to home-based office-working employees whose contact information was publicly available on company or institution websites (e.g., employee directories). Third, home-based office workers were recruited via recruitment posters distributed on various social media platforms (i.e., Facebook, Instagram, Twitter, LinkedIn). The recruitment emails included relevant study details (i.e., objective, eligibility criteria, brief procedures) and instructed interested individuals to contact the researcher via email if they wished to participate or wanted to receive additional details prior to making a decision. The study was approved by the institutional research ethics board.

4.2.2 Procedure & measures

After receiving a study invitation email, interested participants were sent a link with a unique authorization code and asked to complete an online questionnaire through a survey website called SoSci (www.soscisurvey.de). The online questionnaire consisted of a Letter of Information, informed consent and a baseline questionnaire assessing relevant demographic characteristics and outcomes of interest (i.e., primary and secondary measures including the OSPAQ). Upon completion of the first questionnaire, participants were emailed a PDF version of the Letter of Information/Informed Consent and were asked to sign the form (digitally) and send it back to research personnel, along with their address for activity monitor delivery. Participants received the activPAL4™ device via courier and were instructed to apply the device on Sunday evening and to wear the device all day for a period of 5 working days (Monday through Friday). Upon receiving the activPAL4™, participants also received a link (via email) to a detailed video outlining the proper procedures on how to apply the device. If there was any confusion, they were asked to either email or call one of the researchers. Upon finishing, they were instructed to place the device into the return envelope that was provided, and it was picked up via
courier the following Saturday. Participants then underwent a 4-week intervention period, filling out the OSPAQ at the end of each workweek (i.e., Friday). During the fourth week, they again wore the activPAL™ device and this was the period used for this secondary analysis validation study.

4.2.3 OSPAQ-revised

The percentage of time spent sitting, standing and moving (i.e., walking) during work hours was measured using a modified version of the OSPAQ (Chau et al., 2012) (See Appendix DD). Due to the sedentary ‘office’ setting, “heavy labour or physically demanding tasks” was removed from the questionnaire. This decision was made based off previous work done in the field that have reported low or zero prevalence of this behaviour in the workplace (Chau et al., 2012; Jancey et al., 2012; Nassau et al., 2015). Participants were asked to record both the total number of days and hours they worked in the last 7 days. Participants were then asked to record the percentage of time spent sitting, standing, and moving (i.e., walking) on a typical workday in the last 7 days (i.e., “How would you describe your typical workday for the last 7 days? This involves only time spent in work-related activities and does not include what you did in your leisure time.”). The sum of all percentages were to equal a total of 100% (e.g., 80% occupational sitting, 10% occupational standing and 10% walking). Time spent in each behaviour (minutes) was calculated as follows: [Minutes worked in the last 7 days/Days at work in the last 7 days] × [Percentage of the behaviour reported (i.e., sitting/standing/moving)/100].

4.2.4 activPAL™

The activPAL™ is currently considered the most accurate field-based measure of sitting time and sit-to-stand transitions (Kozey-Keadle et al., 2011). The activPAL4™ was the model used in the present study and is a small device worn on the midline anterior aspect of the thigh (right or left) that can differentiate between sedentary, standing and free moving activity using proprietary algorithms (Intelligent Activity Classification, PAL Technologies). Participants were instructed to wear the device for a full work week (i.e., Monday-Friday) at baseline as well as during the last intervention week. The activPAL™ monitor has been shown to be highly accurate as direct observation has shown a perfect correlation for time spent sitting/lying, standing and walking in primary school
aged children (Aminian & Hinckson, 2012) and has been used in many previous validation studies involving adults (Clark et al. 2013; Judice et al. 2015). The activPAL™ default settings were used, the validation wear time protocol was set to the ‘24-hour protocol’ (allowing 4 hours of non-wear) per day, and data were downloaded in custom duration epochs (15 seconds) via activPAL™ Professional Software (version 8.11.4.61) and transferred to Microsoft Excel (version 16.44). Participants were required to have at least three valid workdays from Monday-Friday to be used in data analysis, which is consistent with previous studies (Edwardson et al., 2017). In the baseline questionnaire, participants were asked to report the start and end time of their workday (i.e., What are the hours you work in-between?). The data analyzed for each participant’s workday included the data between the self-declared start time (i.e., 9:30am) up to (and including) the last 15 seconds (5:29:45pm) before the official end time (i.e., 5:30pm). Average daily sedentary time (minutes per day) was calculated [total amount of time/average number of days] using two different equations. First, as the sum of ‘sedentary’, ‘primary lying’ and ‘secondary lying’ time. Second, all the behaviours included in the first approach plus time spent in ‘seated transportation’. Time spent standing was calculated from the ‘upright time’. Time spent moving was done as two separate calculations, the first consisting solely of ‘stepping time’ and the second combining ‘stepping time’ with ‘cycling time’. Each valid day of data was totaled and then averaged for the number of valid days to calculate average daily time (minutes) for the week. The percentage of time spent sitting, standing and walking from the activPAL4™ was calculated as follows: [average minutes spent in the behaviour (i.e., sitting, standing or moving) per workday/total minutes of work time (i.e., 9:30 am to 5:30 pm = 8 hours*60)] × [100].

4.2.5 Statistical analysis

Statistical procedures were conducted in SPSS Statistics, Version 27 (SPSS Inc., Chicago, Illinois), GraphPad Prism version 9.0.2 (GraphPad Software Inc., San Diego, CA) and Stata Statistical Software Release 11.0 (StataCorp LP, College Station, TX) software programs. The level of significance was set at $p < 0.05$. Descriptive statistics were calculated for all demographic variables collected at baseline and are shown as mean (standard deviation (SD)) or number (percentage) of the sample. Univariate ANOVAs (continuous variables) and chi-square tests (categorical variables) were
conducted to ensure that there were no systematic differences between participants with valid and invalid data (all $p$-values > 0.05). Bland and Altman (1999) do not recommend excluding outliers; however, they do suggest assessing the influence of outliers on the results. Therefore, we ran the analysis both before and after removing extreme outliers with a winsorization technique (Guttman & Smith, 1969). A total of 11 data points were imputed this way. The removal of extreme outliers did not impact the results and were therefore left in the analysis.

Spearman correlation coefficients were calculated to assess the degree of association between the activPAL4™ and modified OSPAQ. The strength of the correlation was interpreted as poor (< 0.30), fair (0.30-0.50), moderately strong (0.60-0.80), or very strong (> 0.80) (Chan 2003). Limits of agreement between the activPAL4™ and the modified OSPAQ were determined according to the recommendations by Bland and Altman (Bland & Altman, 1986). The difference $[\text{OSPAQ} - \text{activPAL4™}]$ of the two paired measurements (as a percentage) was plotted against the average $[(\text{OSPAQ} + \text{activPAL4™})/2]$ of the two measurements (as a percentage). Percentage was deemed the most appropriate way to express the data because the OSPAQ is asked and interpreted as a percentage, but the Bland-Altman plots expressed in minutes are also reported. The mean difference, or bias, between the methods and the 95% limits of agreement intervals were calculated. Linear regression was used to determine linear bias. Significant linear bias indicates that the variability remained constant across average values while the mean difference increased significantly as average values increased. Therefore, where linear regression showed to be significant, the Bland–Altman plot presents the trend line for mean difference obtained from the regression and limits of agreement (±1.96 SD).

### 4.2.6 Missing data

On any given variable at a single assessment point, the maximum percentage of missing data was 28% ($n = 41$). Of the 148 participants that filled out the baseline questionnaire, 108 of them had valid activPAL4™ data and of those, 95 had valid self-report data. Independent samples $t$-tests revealed that those who had valid activPAL4™ data were not different from those who did not have valid data on all demographic
variables ($p$-values > 0.05). Taken together, all missing data were considered random. Hence, we decided to exclude missing data from the analysis.

4.3 Results

Descriptive statistics for the demographic variables, days worked from home and minutes worked per week are shown in Table 14. Percentages and minutes of device based (activPAL4™) and self-reported (OSPAQ) behaviour characteristics during work hours are illustrated in Table 15. The spearman rank correlation coefficient data between the activPAL4™ device and modified OSPAQ are displayed in Table 16. All the spearman correlations were found to be significant ($p < 0.05$). The correlation of the activPAL4™ device with sitting and standing were fair ($\rho = 0.35 - 0.43$) and the correlation with moving was poor ($\rho = 0.21 - 0.22$).

The Bland-Altman plots for percentage of time spent sitting, standing and moving are displayed in Figures 17-21.

For total time spent sitting (Figure 17), linear regression showed a significant positive association between the difference in the two measures (self-reported minus activPAL4™ derived sitting time) and the average of these two measures ($B = 0.42$, $SE = 0.12$, $p = 0.001$). Thus, the mean difference is estimated at $-37.97\% + 0.42 \times \text{average of the two measures}$. At mean levels of average self-reported/activPAL4™-derived sitting time (76.29%), the mean difference indicated self-reported sitting time was $-5.63\%$ lower than activPAL4™-derived sitting time with wide limits of agreement ($\pm 29.87\%$). When excluding transportation time from the device based sitting time (Figure 18), the linear regression again showed a significant positive association between the difference in the two measures and the average of these two measures ($B = 0.55$, $SE = 0.11$, $p = < 0.001$). Thus, the mean difference is estimated at $-42.63\% + 0.55 \times \text{average of the two measures}$. At mean levels of average self-reported/activPAL4™-derived sitting time (74.26%), the mean difference indicated self-reported sitting time was $-1.58\%$ lower than activPAL4™-derived sitting time with wide limits of agreement ($\pm 28.31\%$).

For percentage of time spent standing during the workday (Figure 19), linear regression was not significant and log transformation did not appear to limit the spreading of the data points. Thus, the original Bland-Altman methods were used (Bland-
Examination of the Bland-Altman plot showed a systematic underestimation of time spent standing with a mean difference of -11.71 percent (SD = 11.21) and wide 95% limits of agreement (±22.34%).

For percentage of time spent moving including device measured cycling time (Figure 20), linear regression showed a significant positive association between the difference in the two measures (self-reported minus activPAL4™ derived moving time) and the average of these two measures ($B = 1.18$, $SE = 0.14$, $p < 0.001$). Thus, the mean difference is estimated at $-7.04\% + 1.18 \times$ average of the two measures. At mean levels of average self-reported/activPAL4™-derived moving time (11.44%), the mean difference indicated self-reported moving time was 6.44% higher than activPAL4™-derived moving time with wide limits of agreement (±15.36%). After excluding device measured cycling time for percentage of time spent moving (Figure 21), linear regression was still significant ($B = 1.21$, $SE = 0.14$, $p < 0.001$). Thus, the mean difference is estimated at $-7.10\% + 1.21 \times$ average of the two measures. At mean levels of average self-reported/activPAL4™-derived moving time (11.36%), the mean difference indicated self-reported moving time was 6.60% higher than activPAL4™-derived moving time with wide limits of agreement (±14.93%).

The Bland-Altman plot for minutes of time spent sitting, standing and moving can be found in Figures 22-26.
Table 14. Participant characteristics presented as mean (SD) or count (%) of group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total sample</th>
<th>Valid data</th>
<th>Statistic</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 148)</td>
<td>(n = 108)</td>
<td>(valid vs invalid)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>44.90 (SD = 11.41)</td>
<td>45.52 (SD = 11.38)</td>
<td>F(1,147) = 1.181</td>
<td>0.279</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>40 (27.0%)</td>
<td>30 (27.8%)</td>
<td>X² (2) = 2.784</td>
<td>0.249</td>
</tr>
<tr>
<td>Female</td>
<td>107 (72.3%)</td>
<td>78 (72.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Binary</td>
<td>1 (0.7%)</td>
<td>0 (0.0%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>126 (85.1%)</td>
<td>91 (84.3%)</td>
<td>X² (4) = 0.688</td>
<td>0.953</td>
</tr>
<tr>
<td>Asian</td>
<td>7 (4.7%)</td>
<td>6 (5.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black or African American</td>
<td>3 (2.0%)</td>
<td>2 (1.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>4 (2.7%)</td>
<td>3 (2.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4 (2.7%)</td>
<td>3 (2.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>27.33 (SD = 5.74)</td>
<td>27.42 (SD = 5.94)</td>
<td>F(1,147) = 0.105</td>
<td>0.747</td>
</tr>
<tr>
<td>Level of Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highschool Diploma</td>
<td>13 (8.8%)</td>
<td>9 (8.3%)</td>
<td>X² (4) = 1.741</td>
<td>0.783</td>
</tr>
<tr>
<td>College Degree</td>
<td>26 (17.6%)</td>
<td>17 (15.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University Degree Masters</td>
<td>57 (38.5%)</td>
<td>42 (38.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doctorate (i.e., MD, PhD)</td>
<td>30 (20.3%)</td>
<td>22 (20.4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>26 (17.6%)</td>
<td>22 (20.4%)</td>
<td>X² (4) = 4.533</td>
<td>0.339</td>
</tr>
<tr>
<td>Married or equivalent</td>
<td>107 (72.3%)</td>
<td>73 (67.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separated or equivalent</td>
<td>7 (4.7%)</td>
<td>6 (5.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td>7 (4.7%)</td>
<td>6 (5.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Widowed</td>
<td>1 (0.7%)</td>
<td>1 (0.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>61 (41.2%)</td>
<td>41 (38.0%)</td>
<td>X² (3) = 2.546</td>
<td>0.467</td>
</tr>
<tr>
<td>Public</td>
<td>77 (52.0%)</td>
<td>58 (53.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charity</td>
<td>2 (1.4%)</td>
<td>2 (1.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>7 (4.7%)</td>
<td>6 (5.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days worked from home</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Five</td>
<td>118 (79.7%)</td>
<td>83 (76.9%)</td>
<td>X² (1) = 2.048</td>
<td>0.175</td>
</tr>
<tr>
<td>Four</td>
<td>19 (12.8%)</td>
<td>15 (13.9%)</td>
<td>X² (1) = 0.395</td>
<td>0.782</td>
</tr>
<tr>
<td>Three</td>
<td>11 (7.4%)</td>
<td>10 (9.3%)</td>
<td>X² (1) = 1.938</td>
<td>0.289</td>
</tr>
<tr>
<td>Physical Activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>85 (57.4%)</td>
<td>61 (56.5%)</td>
<td>X² (1) = 0.107</td>
<td>0.852</td>
</tr>
<tr>
<td>No</td>
<td>62 (42.6%)</td>
<td>46 (42.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minutes Worked</td>
<td>494.56 (SD = 62.55)</td>
<td>493.71 (SD = 65.82)</td>
<td>F(1,147) = 0.074</td>
<td>0.785</td>
</tr>
</tbody>
</table>

*aIn the past 3 months, have you been active for a minimum of 30 minutes/day on at least 3 days of the week? (i.e., jogging, biking, swimming).
Table 15. Percentages and minutes of device-based (activPAL™) and self-reported (OSPAQ) behaviours during work hours

<table>
<thead>
<tr>
<th>Variable</th>
<th>(activPAL™: n = 108, OSPAQ: n = 95)</th>
<th>(n = 108)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD), Median (Range)</td>
<td>Mean (SD), Median (Range)</td>
</tr>
<tr>
<td>% Sitting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>activPAL™</td>
<td>75.00 (12.48), 74.96 (27.22 - 94.32)</td>
<td>78.82 (13.34), 79.57 (27.96 – 130.41)</td>
</tr>
<tr>
<td>OSPAQ</td>
<td>71.82 (18.82), 75.00 (20.00 – 97.00)</td>
<td></td>
</tr>
<tr>
<td>Minutes Sitting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>activPAL™</td>
<td>365.85 (72.57), 369.61 (136.09 – 502.51)</td>
<td>384.50 (77.61), 386.72 (144.12 – 625.95)</td>
</tr>
<tr>
<td>OSPAQ</td>
<td>339.51 (108.28), 336.00 (68.57 – 612.00)</td>
<td></td>
</tr>
<tr>
<td>% Standing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>activPAL™</td>
<td>25.09 (12.46), 25.04 (5.68 – 72.78)</td>
<td></td>
</tr>
<tr>
<td>OSPAQ</td>
<td>13.46 (13.48), 10.00 (0.00 – 70.00)</td>
<td></td>
</tr>
<tr>
<td>Minutes Standing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>activPAL™</td>
<td>122.60 (64.26), 113.81 (27.24 – 393.01)</td>
<td></td>
</tr>
<tr>
<td>OSPAQ</td>
<td>61.36 (56.88), 45.00 (0.00 – 294.00)</td>
<td></td>
</tr>
<tr>
<td>% Moving (i.e., walking)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>activPAL™</td>
<td>8.06 (4.75), 6.96 (1.54 – 24.09)</td>
<td>8.23 (4.93), 7.17 (1.54 – 26.45)</td>
</tr>
<tr>
<td>OSPAQ</td>
<td>14.72 (10.86), 10.00 (0.00 – 50.00)</td>
<td></td>
</tr>
<tr>
<td>Minutes Moving (i.e., walking)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>activPAL™</td>
<td>39.64 (25.13), 33.40 (7.40 – 146.82)</td>
<td>40.51 (26.52), 34.89 (7.40 – 166.61)</td>
</tr>
<tr>
<td>OSPAQ</td>
<td>68.58 (51.04), 54.00 (0.00 – 240.00)</td>
<td></td>
</tr>
</tbody>
</table>

- Without transportation time included
- With transportation time included
- Without cycling time included
- With cycling time included
Table 16. Concurrent validity of the OSPAQ with the activPAL4™

<table>
<thead>
<tr>
<th>Variable</th>
<th>( (n = 95) )</th>
<th>( \rho )</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Sitting(^a)</td>
<td></td>
<td>0.406***</td>
</tr>
<tr>
<td>% Sitting(^b)</td>
<td></td>
<td>0.425***</td>
</tr>
<tr>
<td>% Standing</td>
<td></td>
<td>0.349**</td>
</tr>
<tr>
<td>% Moving(^c)</td>
<td></td>
<td>0.224*</td>
</tr>
<tr>
<td>% Moving(^d)</td>
<td></td>
<td>0.211*</td>
</tr>
</tbody>
</table>

\(^a\)Without transportation time included  
\(^b\)With transportation time included  
\(^c\)Without cycling time included  
\(^d\)With cycling time included  
*Significant at the 0.05 level  
** Significant at the 0.001 level  
*** Significant at the 0.0001 level
Figure 17. Bland–Altman plot of agreement of total self-report (OSPAQ) sitting time (including transportation time) with device-derived (activPAL™) sitting time ($n = 95$). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed as a percentage. The bolded dashed line shows the mean difference between the two measures (-5.63), with the dashed lines representing the limits of agreement ($\pm 29.87$).

Figure 18. Bland–Altman plot of agreement of self-report (OSPAQ) sitting time (excluding transport time) with device-derived (activPAL™) sitting time ($n = 95$). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed as a percentage. The bolded dashed line shows the mean difference between the two measures (-1.58), with the dashed lines representing the limits of agreement ($\pm 28.31$).
Figure 19. Bland–Altman plot of agreement of self-report (OSPAQ) standing time with device-derived (activPAL 4™) standing time ($n = 95$). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed as a percentage. The bolded dashed line shows the mean difference between the two measures (-11.71), with the dotted lines representing the limits of agreement ($\pm 22.34$).

Figure 20. Bland–Altman plot of agreement of self-report (OSPAQ) moving time (including cycling time) with device-derived (activPAL 4™) moving time ($n = 95$). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed as a percentage. The bolded dashed line shows the mean difference between the two measures (+6.44), with the dashed lines representing the limits of agreement ($\pm 15.36$).
Figure 21. Bland–Altman plot of agreement of self-report (OSPAQ) moving time (excluding cycling time) with device-derived (activPAL4™) moving time ($n = 95$). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed as a percentage. The *bolded dashed line* shows the mean difference between the two measures (+6.60), with the *dashed lines* representing the limits of agreement ($\pm$ 14.93).

Figure 22. Bland–Altman plot of agreement of total self-report (OSPAQ) sitting time (including transportation time) with device-derived (activPAL4™) sitting time. The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The *bolded dashed line* shows the mean difference between
the two measures (-20.21), with the dashed lines representing the limits of agreement (± 142.47).

![Figure 23](image1.png)

Figure 23. Bland–Altman plot of agreement of total self-report (OSPAQ) sitting time (including transportation time) with device-derived (activPAL4™) sitting time. The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The bolded dashed line shows the mean difference between the two measures (-40.47), with the dashed lines representing the limits of agreement (± 156.42).

![Figure 24](image2.png)

Figure 24. Bland–Altman plot of agreement of self-report (OSPAQ) standing time with device-derived (activPAL4™) standing time. The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The bolded dashed line shows the mean difference between the two measures (-65.59), with the dotted lines representing the limits of agreement (± 115.23).
Figure 25. Bland–Altman plot of agreement of total self-report (OSPAQ) moving time (including cycling time) with device-derived (activPAL4™) moving time. The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The bolded dashed line shows the mean difference between the two measures (+24.82), with the dashed lines representing the limits of agreement (±80.97).

Figure 26. Bland–Altman plot of agreement of total self-report (OSPAQ) moving time (excluding cycling time) with device-derived (activPAL4™) moving time. The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The bolded dashed line shows the mean difference between the two measures (+25.66), with the dashed lines representing the limits of agreement (±78.40).
4.4 Discussion

4.4.1 Main finding

The aim of the current study was to assess the criterion validity and absolute measurement of agreement of the OSPAQ against the activPAL4™ device for measuring occupational sitting, standing and moving in a sample of home-based office workers. Findings indicated fair levels of validity ($\rho = 0.35-0.43$, all $p < 0.05$) and acceptable agreement (mean difference = 2-12%) when comparing self-reported sedentary and standing with the device at the group level; however, estimates were poor at an individual level, as suggested by wide limits of agreement ($\pm22-30\%$). For moving time, we observed poor levels of validity ($\rho = 0.21-0.22$, all $p < 0.05$) and acceptable agreement (bias = 6-7%). Although the observed biases for moving time were reasonable the 95% limits of agreement were too large ($\pm15\%$) to have confidence in recommending the self-report measure for use at the individual level. Thus, the modified OSPAQ may be appropriate for use in large-scale studies examining group-level data rather than for studies requiring estimates of an individual’s sedentary behaviour profile. Beyond these general conclusions, there are some other observations that warrant commentary. When looking at the Bland-Altman plots for sitting time (Figures 17-18), it seems the more people sit, the more accurate they are at recalling their sitting time, which was confirmed after performing linear regression ($p < 0.001$). For example, at around the 80% mark, the individual data points cluster more around the midline compared to the 50% mark, indicating better agreement at a higher sitting percentage. For standing, it is suggested through the data that participants consistently underestimate the time in this behaviour (Figure 19). This is illustrated by the fact that most of the data points are below the midline. When looking at the moving time plots (Figures 20-21), we see patterns of inconsistent overestimation. That is, the less people move, the more accurate they were at recalling the behaviour, which again was confirmed by a linear regression ($p < 0.001$). Specifically, the individual data points of these plots are more clustered around the midline when people moved for 10% or less of their workday.
4.4.2 Relevant literature

With respect to previous work in this field, the first validation study conducted by Chau et al. (2012) used a convenience sample of office-workers (n = 99) and reported a moderate level of agreement between the OSPAQ and device (Actigraph) for estimating time sitting and standing. The authors reported the difference between the two measures as ‘small’, with the 95% limits of agreement for sitting ranging from -141.63 to 185.18 minutes (326.81-minute range). Although these large ranges could be attributed to the fact that the Actigraph accelerometer cannot differentiate between sedentary behaviour (i.e., sitting) and physical inactivity (i.e., standing), the findings were similar to what we observed in our study. Specifically, when examining our Bland-Altman plots in minutes as opposed to percentages, our 95% limits of agreement ranged from -162.69 to 122.26 minutes (284.95-minute range) for the measurement excluding transportation time and -196.89 to 115.95 minutes (312.84-minute range) when including transportation time. In sum, we observed similar results to the study by Chau et al. (2012) in regard to agreement for time spent sitting; however, the spearman correlations were stronger than the current study for sitting and standing time ($\rho = 0.65$ and 0.49 respectively) and similar for walking time ($\rho = 0.29$).

A later study also sought to validate the OSPAQ against a device-based measure using a sample of full-time university office workers (n = 41) (Jancey et al., 2014). Similar to Chau et al. (2012), the correlations reported were stronger than the current study for sitting standing and walking (i.e., moving) ($r = 0.58$, $r = 0.45$, $r = 0.45$ respectively). Contrary to Chau et al. (2012), Jancey et al. (2014) concluded a moderate level of agreement for standing and walking time, but systematic variation for sedentary time. It is important to note that the device used in this study was also an Actigraph, which makes the ability to measure posture impractical, as previously stated. These observations differ from the current study as we found systematic underestimation for standing time, while observing overall poor level of agreement for sitting and moving (i.e., walking). The 95% limits of agreement reported by Jancey et al. (2014) for sitting time were -784.7 to 733.9 minutes (1518.6-minute rage), which is much greater than both Chau et al. (2012) (326.81) and the present findings (312.84). For standing time, they reported 95% limits of agreement of -324.6 to 269.7 minutes (594.3-minute range).
compared to our findings of -180.80 to 49.64 minutes (230.44-minute range). For time spent walking, their 95% limits of agreement were -269.2 to 280.8 minutes (550-minute range), much larger than our findings of moving time with (-56.15 to 105.79 minutes; range of 161.94) and without (-52.74 to 104.06 minutes; range of 156.80) cycling time included.

The most recent validation study for the OSPAQ used a sample of both sedentary (n = 65) and non-sedentary (n = 331) workers (Maes et al., 2020). Consistent with the previous studies, the correlations reported were stronger than the current study for sitting, standing and walking (ρ = 0.53, ρ = 0.53, ρ = 0.49 respectively). The authors did not interpret the results of their Bland-Altman plots, but we examined the supplementary data file in order to make comparisons to the current study. For the purpose of relevance, we only further discuss results obtained from the sedentary worker data. The 95% limits of agreement for sitting appeared to range from approximately -45% to 50% (95% range), compared to our ~60% range. For time spent standing, 95% limits of agreement appeared to be around -45% to 30% (75% range) compared to our ~45%. This is the biggest discrepancy as we found systematic underestimation for standing time whereas their plot appeared randomly scattered. For time spent walking, it appears that the 95% limits of agreement ranged from about -20% to 45% (65% range), larger than our ~30%. While the Maes et al. study is an improvement in terms of the device used to measure sedentary behaviour time compared to the previously mentioned studies, it still poses the risk of misinterpretation as it is not stated how the Axivity AX3 accelerometer compares to the activPAL4™.

The only other validation study that has used an activPAL™ was conducted by van Nassau et al. (2015), using staff from a non-government health agency (n = 42) to compare the two device measures across a number of time points. In terms of correlations, they report similar findings to the present study for sitting (ρ = 0.37) and a weaker correlation for standing (ρ = 0.20). Correlations for walking or moving time were not reported. Unfortunately, this study also did not formally interpret their Bland-Altman plots, so in order to make comparisons we had to approximate numbers from the figure in their paper. Overall, the 95% limits of agreement appeared similar to those of Chau et al.
144

(2012) and the present study. For sitting, values ranged from -120 to 210 minutes (~330-minute). For standing, values ranged from around -75 to 75 minutes (~150-minute).

4.4.3 Implications and future directions

Overall, the above-mentioned findings, along with the present findings, are consistent in demonstrating acceptable validity for measuring sitting and standing with the modified OSPAQ at a group level. However, the large 95% limits of agreement between the modified OSPAQ and activPAL™ or other related devices limits its use at the individual level, particularly with respect to intervention work. Previous studies targeting sedentary behaviour have only resulted in reductions of ~40 minutes or less (Brakenridge et al., 2018; Chu et al., 2016; Jancey et al., 2016). This reduction in sedentary behaviour unfortunately falls well within the 95% limits of agreement shown in our study and the other research discussed. Put another way, based on the lack of OSPAQ sensitivity (accuracy) evidence at the individual level, intervention studies are likely not powerful enough to show sedentary behaviour change outside the limits of agreement to be statistically significant.

There are a number of reasons as to why the questionnaire may not be performing adequately at the individual level. First, it could be the case that a one-week recall is too long. Future studies should look to validate the questionnaire when occupational behaviours are recalled at the end of each day as opposed to each week. Previous work has shown increased levels of agreement when implementing self-reported questionnaires in this fashion (Moulin et al., 2019). Second, there may be an educational piece necessary when administering this questionnaire. People may misinterpret or misunderstand the questions, unaware of whether to include certain aspects of their workday in the recall (i.e., lunch break). Thus, future studies should investigate as to whether educating or providing a quick tutorial or example beforehand would improve agreement. Third, Bland-Altman advises authors to reproduce their results (Bland & Altman, 1999). In other words, under the same circumstances, when re-administered a month or two later is the agreement level the same? Although van Nassau et al. (2015) touched upon this in their paper, their lack of interpretation of Bland-Altman plots highlights the need for future work to incorporate this kind of paradigm. Lastly, as the OSPAQ only assesses total sitting time, it is important to note that break frequency and duration also are key
behaviours related to health outcomes that should be targeted. Therefore, while research continues to assess the OSPAQ and other similar questionnaires, questionnaires such as the revised SITQ-7d (Sui & Prapavessis 2016) that assesses break frequency and duration also need to be assessed and validated in this population.

4.4.4 Strengths and limitations

The main strength of this study was the use of the activPAL4™ device, which is the gold standard for measuring sedentary time. We were also the first to investigate the validity of the OSPAQ in a sedentary occupation working from home. While working from home was first intended to be temporary due to the COVID-19 pandemic, it seems as though this shift in work environment from the office to home could persist into the foreseeable future and beyond. Because of this shift in how office work is being conducted, it is important to evaluate how this may affect the validity of self-report sedentary questionnaires. A further strength is that the average number of valid days that were required to be included in the analysis was higher than previous studies. Lastly, our sample size and the variability of the sample is a strength, as it makes our study more generalizable given the wide array of sedentary workers that were recruited, compared to previous studies that only recruited office workers from a single company or office space.

This study also had limitations that should be taken into account when interpreting the findings. First, participants were not asked to record their start and end time of each working day while wearing the device. Therefore, participants’ self-reported start and end times might not be exact to their actual workday and thus, could be why the observed findings were not strong at the individual level. Additionally, our inclusion criteria only required a 50% or more work-from-home status; as participants did not record their workdays, we have no way of controlling for, or separating the work in office or at home days collected during the valid days. Lastly, practice effects could have impacted the results, as participants filled out the questionnaire four times prior to the assessment included in this secondary analysis. Thus, they may have improved their ability to recall their behaviour over the 4-week intervention period, leading to better levels of agreement at week 4 than what we might have seen at baseline. Alternatively, without feedback from previously self-reported sedentary behaviour, participants may have not optimally learned how to self-evaluate and thus improve the assessment of the
targeted behaviour. We were unable to shed light on this issue as the sequence of measuring activPAL4™ device data and OSAPQ data was not harmonized at baseline (i.e., OSAPQ was assessed before activPAL4™).

4.5 Conclusion

The modified OSPAQ shows acceptable criterion validity for accurate estimates of overall sitting and standing time but not moving time in the context of at-home office working adults. The 95% limits of agreement for percentage of time spent sitting, standing and moving (i.e., walking) were large (±15-30%) indicating that the OSAPQ may not be appropriate for measuring occupational sedentary and active behaviours at the individual level in this workplace setting. With home-based office work predicted to be a permanent feature for desk-based workers (Kantrowitz, 2020) and the cost and burden associated with administering devices to large populations, it is imperative to have a validated self-report measure to allow for accurate assessment of movement patterns during work hours. Although further validation is required (i.e., responsiveness to change), the modified OSPAQ is an easily administered and acceptable self-report method for measuring at-home sitting and standing time at a group level.
4.6 References


4.7 Chapter 4 Summary and Implications

In this chapter, we showed that the OSPAQ is a valid questionnaire for measuring sitting and standing time at a group level in home-based office workers. While total sedentary behaviour time is important in the overall picture of sedentary behaviour and health, we also need to be able to see how that sedentary behaviour time is accumulated. Thus, in this next chapter (chapter 5), we investigate the validity of the modified SIT-Q 7d in order to explore a self-report measure of sedentary behaviour break frequency and break duration in home-based office workers.
Chapter 5 – **Validity of the Modified SIT-Q 7d for Estimating Break Frequency and Duration in Home-Based Office Workers During the COVID-19 Pandemic: A Secondary Analysis (Study 3B)**
Abstract

Office workers spend a high percentage of their workday sitting and this is an emerging health concern. With many office workers continuing to work from home since the onset of the COVID-19 pandemic, it is imperative to have a validated self-report questionnaire to assess sedentary behaviour and reduce the cost and burden of using device-based assessment. This secondary analysis study aimed to validate the modified SIT-Q 7d questionnaire against an activPAL4™ device in full-time home-based ‘office’ workers (n = 148; mean age = 44.90). Participants completed the modified SIT-Q 7d and wore an activPAL4™ for a full work week. The findings showed that the modified SIT-Q 7d had fair (ρ = 0.35 – 0.37) and poor (ρ = 0.27 – 0.28) criterion validity for accurate estimates of break frequency and break duration, respectively. The 95% limits of agreement were large for break frequency (26.85 – 29.01) and medium for break duration (5.81 – 8.47), indicating that the modified SIT-Q 7d may not be appropriate for measuring occupational sedentary behaviour patterns at the individual level. Further validation is still required before confidently recommending this self-report questionnaire to be used amongst this population to assess breaks in sedentary time.

Keywords: measurement-of-agreement, bland-altman, activPAL™
5.1 Introduction

The SARS-CoV-2 (COVID-19) global pandemic has fundamentally changed the daily operations of many office workplaces (BBC, 2020). Over the last two years, many employees who traditionally completed occupational desk-based work in office spaces are now completing work in an at-home ‘office’ setting. One survey targeting office-working adults (n = 5,858) reported a significant rise in the proportion of office workers working remotely (~51%) in response to the COVID-19 social distancing measures (Pew Research Center, 2020). Evidence suggests that this transition to a work from home environment may be resulting in increased sedentary behaviours and decreased physical activity (Flanagan et al., 2021; Stockwell et al., 2021) which has previously been shown to be detrimental to both short- and long-term health outcomes (Saunders et al., 2020). Given office-working adults are estimated to spend up to 77% of their workday engaged in sedentary behaviours (Katzmarzyk et al., 2019; Thorp et al., 2012), they are at an increased risk for developing several non-communicable diseases associated with high levels of sedentary behaviour (e.g., diabetes, cardiovascular disease) (de Rezende et al., 2014). It should be noted that this transition, while sudden, is likely to persist for many large companies (Kantrowitz, 2020; Pew Research Center, 2020), while others may adopt a hybrid model going forward (BBC, 2020).

Sedentary behaviour is defined as any waking behaviour with a low energy expenditure (≤1.5 metabolic equivalents) performed in a seated, lying or reclining posture (Tremblay et al., 2017). Sedentary behaviours comprise the majority of behaviours we engage in on a regular basis such as eating meals, driving, screen time, etc. In contrast to physical activity, which is typically purposeful and performed in specific contexts, sedentary behaviour can vary in both the duration and domain of performance. For example, an 8-hour profile of sedentary behaviour can be comprised of six hours of television viewing and two hours of reading, or seven hours of occupational sitting and one hour of television viewing. Given that sedentary time across different domains and behaviours demonstrate variable associations with indicators of mental health (Stefan et al., 2019) and subjective well-being (Sui et al., 2021), measurement of sedentary behaviour warrants the assessment of multiple domains/contexts.
Many self-report measures exist that assess either total sitting time (e.g., SBQ; Rosenberg et al., 2010), total occupational sitting time (e.g., the Occupational Sitting and Physical Activity Questionnaire [OSPAQ] (Chau et al., 2012) or proxies of total sitting time, like screen time (e.g., Marshall Sitting Questionnaire; Marshall et al., 2010). While the OSPAQ has been previously validated in a group of home-based office working adults (Dillon et al., 2021), validity of instruments that assess domain-specific patterns of sedentary behaviour are lacking in this home-based office working population. One questionnaire that does measure domain-specific sedentary time in adults is the SIT-Q 7d (Wijndaele et al., 2014). The SIT-Q 7d is a modified version of the SIT-Q using a 7-day reference frame (Wijndaele et al., 2014) instead of the original “past year” recall (Lynch et al., 2014). In this questionnaire, sitting time is assessed across five different domains for weekdays and weekend days including, 1) meals; 2) transportation; 3) occupation; 4) leisure screen time and 5) time spent sedentary in other activities. The number of interruptions in sedentary time (standing up or walking somewhere) in occupational and TV viewing sedentary time are also assessed. The SIT-Q 7d questionnaire has been shown to be valid and reliable against device-based measures for sedentary time (Wijndaele et al., 2014) and has been used previously in adults (Luijkx et al., 2019).

A limitation with the SIT-Q 7d questionnaire is that it does not assess the specific frequency (e.g., every 30 minutes) or duration (e.g., 2 minutes) of breaks taken from the five different domains of sedentary behaviour. Breaks from sedentary behaviour, independent from total sitting time, can positively impact body composition and markers of cardiometabolic risk (Saunders et al., 2020). For example, eight hours of sedentary behaviour that is broken up every 30 minutes represents a different profile of movement compared to an individual that sits for eight hours straight. Specifically, acute bouts of uninterrupted sitting have been shown to negatively impact triglyceride levels, insulin sensitivity and glucose tolerance (Saunders et al., 2012). In contrast to this, adding as little as ten ‘breaks’ or ‘interruptions’ per day (i.e., standing and/or walking for at least one minute) has been associated with positive health outcomes (i.e., blood lipid levels, blood glucose levels and insulin levels) (Carson et al., 2014). Recent updates to Canada’s 24-hour movement guidelines for adults are congruent with this research, suggesting sedentary time be broken up as often as possible, in addition to limiting daily sedentary
time to eight hours or less per day (Ross et al., 2020). As such, the composition of sedentary time (and breaks therein) may be an important factor in modulating various health outcomes and should be measured in interventions aiming to reduce sedentary behaviour.

Accordingly, Sui and Prapavessis (2016) modified the SIT-Q 7d to include a measure of break frequency and duration within the relevant domains assessed in the SIT-Q 7d (i.e., occupation, screen time, other activities). This modified instrument has demonstrated face validity and acceptable test-retest reliability and has been used with university students (Dillon et al., 2021; Sui & Prapavessis, 2021; Sui & Prapavessis, 2018) and office-working adults (Rollo & Prapavessis, 2020); populations that traditionally demonstrate high levels of sedentary behaviour (Moulin et al., 2021). Notably, the additions made by Sui and Prapavessis (2016) have not yet been validated against a device-based measure of sedentary behaviour. Although utilizing a device-based measure may provide more accurate measures of sedentary behaviours, collecting large amounts of data via such devices is costly and burdensome. Thus, the validation of an easily administered self-report questionnaire that can measure sedentary break duration and frequency would make future research in this office-based working population more feasible. Moreover, given that the modified SIT-Q 7d utilizes a range of responses for respondents, determining which method of response coding (i.e., using the low, middle or high lower/upper bound/limit) most closely aligns with such a device-based measure can more accurately inform future research. This response coding is described below in section 2.2 (the modified SIT-Q 7d). Therefore, the purpose of this study was to assess the criterion validity and absolute level of agreement of the break duration and frequency items from the modified SIT-Q 7d questionnaire (Sui & Prapavessis, 2016) against an activPAL4™ (device-based measure) in a sample of full-time home-based ‘office’ workers.

5.2 Materials and Methods

5.2.1 Study Design & Population

This study was a secondary analysis of an unpublished pre-registered randomized comparison trial (NCT04488796). The intervention aimed to break up long periods of -
and decrease total time spent in - sedentary behaviours in a sample of full-time, home-based office workers living in a mid-size Southwestern Ontario city (and surrounding area). Participants were required to (a) be ≥18 years old, (b) self-declare to work full time (i.e., 30+ hours per week) five days per week (i.e., Monday to Friday) with a minimum of three days working from home, (c) able to read and write in English, and (d) have access to the Internet and email. Participants were excluded if they were planning on leaving their employer or taking a leave of absence/vacation for more than 3 consecutive workdays during the study period or had a physical limitation or medical condition that would limit their physical activity.

Several methods of recruitment were used. First, senior executives or relevant liaisons of local businesses/offices (known to be working from home due to COVID-19) were contacted via email. If they indicated interest, they were asked to send a recruitment email to all full-time employees within their division or business. Second, recruitment emails were sent to potential participants using publicly available contact information from company or institutional websites (e.g., employee directories). Lastly, social media campaigns (i.e., Facebook, Instagram, Twitter, LinkedIn) using recruitment posters were used to recruit the target population. Recruitment emails contained relevant study details and how to contact researchers for more information or to agree to participate. Overall, 148 employees consented to participate, and 108 participants had valid activPAL4™ data and complete modified SIT-Q 7d data. Ethics approval was granted by the institutional research ethics board.

5.2.2 Modified Sit-Q 7d

Participants’ frequency and duration of breaks from sitting at work were measured using a modified version of the SIT-Q 7d (Sui & Prapavessis, 2016; Wijndaele et al., 2014) (See Appendix EE). This questionnaire has been previously used to assess occupation-related sedentary time, as well as the number of breaks, break frequency and break duration from occupational sedentary time among office workers (Rollo & Prapavessis, 2020) and university students (Dillon et al., 2021; Sui & Prapavessis, 2018, 2021). Sui and Prapavessis (2016) modified the base questionnaire to include domain-specific (work-related) break frequency and break duration scores, which were the only items assessed for purposes of this study.
The frequency of breaks taken from sitting at work was measured with the following question: “In the last 7 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. All responses were first transformed into minutes, then results were coded and analyzed in four different ways. The first method was a conservative method, using the upper limit of each response. This approach accounts for the non-linear intervals between response options, thus, keeping estimates of break frequency conservative (Sui & Prapavessis, 2017; Sui & Prapavessis 2018). For example, the response of ‘Less than every 30 min’ was recoded to a value of ’30 minutes’, the response of ‘Every 30–45 min’ was recoded to a value of ’45 minutes’ and the response of ‘Every 45 min–1 hour’ was recoded to a value of ’60 minutes’ etc. This conservative method is what previous studies have utilized (Dillon et al., 2021; Rollo & Prapavessis, 2020; Sui & Prapavessis, 2018). Second, the midpoint value of each response was used. For example, the response of ‘Less than every 30 min’ was recoded to a value of ’15 minutes’, the response of ‘Every 30–45 min’ was recoded to a value of ’37.5 minutes’ and the response of ‘Every 45 min–1 hour’ was recoded to a value of ’52.5 minutes’ etc. Third, the lower limit of each response was used to represent the least conservative method. For example, the response of ‘Less than every 30 min’ was recoded to a value of ‘0 minutes’, the response of ‘Every 30–45 min’ was recoded to a value of ’30 minutes’ and the response of ‘Every 45 min–1 hour’ was recoded to a value of ’45 minutes’ etc. Fourth and lastly, we combined the midpoint and conservative method to account for the larger range responses at the top end of the scale. More specifically, the conservative method (previously explained) was used for the first five responses, and the midpoint method (previously explained) was used for the remaining responses. For example, the response of ‘Less than every 30 min’ was recoded to a value of ’30 minutes’, the response of ‘Every 30–45 min’ was recoded to a value of ’45 minutes’ and the response of ‘Every 45 min–1 hour’ was recoded to a value of ’60 minutes’ while the response of ‘Every 2–3 hours’ was recoded to a value of ’150 minutes’ and the response of ‘Every 3–4 hours’ was recoded to a response of ‘210 minutes’ etc. These multiple
methods of recoding were done since the modified version of the SIT-Q 7d has not been previously validated.

The duration of breaks taken from sitting at work was measured with the following question: “In the last 7 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. Consistent with break frequency, results were coded and analyzed in the same four ways described previously (conservative, midpoint, least conservative and midpoint/conservative). However, in contrast to break frequency that uses the upper limit for the conservative method, break duration utilizes the lower limit. For example, the response of ‘less than 30 sec’, ‘30 sec–1 min’ and ‘1–2 min’ were recoded to ‘0 minutes’, ‘0.5 minutes’ and ‘1 minute’ respectively. The midpoint method used the midpoint value of every response, and the least conservative method utilized the upper limit of each response. Lastly, the combined midpoint/conservative method used the conservative method for the first six responses and the midpoint method for the next three responses. Again, this combination was used since the bounds of the latter responses are wider than the first six. The option of “Over 30 min” was represented by a break duration of ’30 minutes’ in all four methods.

5.2.3 activPAL™

The activPAL™ is currently considered the gold standard of field-based measurement of sedentary time and sit-to-stand transitions (Kozey-Keadle et al., 2011). This monitor is highly accurate and has demonstrated perfect correlations for time spent sitting/lying, standing and walking with direct observation (Aminian & Hinckson, 2012). The present study utilized the activPAL4™ model, which is a small device worn on the midline anterior aspect of the thigh (right or left) that can differentiate between sedentary, standing, and free moving activity using proprietary algorithms (Intelligent Activity Classification, PAL Technologies). Participants wore the device (on either thigh) for a full work week (i.e., Monday-Friday) at baseline as well as during the last intervention week (i.e., week 4). The activPAL™ default settings were used; the validation wear time protocol was set to the ‘24-hour protocol’ (allowing 4 hours of non-wear) per day. Data were downloaded in custom duration epochs (15 seconds) via activPAL™ Professional.
Software (version 8.11.4.61) and exported to Microsoft Excel (version 16.44). At minimum, three valid workdays between Monday to Friday were required to be used in data analysis, which is consistent with previous studies (Edwardson et al., 2017). A baseline questionnaire collected information on start and end times of each participant’s workday (i.e., What are the hours you work in-between?). Data between the self-declared start time (e.g., 9:30:00am) up to (and including) the last 15 seconds (5:29:45pm) before the self-reported end time (i.e., 5:30pm) of each participant’s workday was used for analysis. Data was then coded in R (R Core Team, 2021) to extract the frequency and duration of sedentary ‘breaks’ (i.e., sitting to upright movements) for each participant. It was assumed that people started their day sitting (data that indicated otherwise was removed), and likewise assumed that people ended their day sitting. A break in sedentary time was defined as a transition from a sitting or lying posture to standing or stepping posture of at least 30 seconds (Paing et al., 2018). For each participant, data from each valid day of data was totaled and then averaged to calculate the average break frequency and duration for the week.

5.2.4 Procedure & measures

After receiving the initial recruitment email, interested participants were sent a link and a unique authorization code to complete a survey on SoSci (www.soscisurvey.de). This online questionnaire contained the Letter of Information, informed consent, and a baseline questionnaire assessing demographics, outcomes of interests (i.e., primary and secondary measures, including the modified SIT-Q 7 d). Upon completion of the baseline questionnaire, participants were emailed and asked to digitally sign a PDF version of the Letter of Information/informed consent. Participants emailed researchers the signed PDF as well as their home address for activity monitor delivery purposes. The activPAL4™ monitors, application materials and a return envelope were delivered via courier. Upon activPAL4™ delivery, participants were sent a link (via email) to a video outlining activity monitor application procedure. The email also contained instructions to apply the activity monitor on Sunday evening and wear continuously for the next five consecutive working days (Monday-Friday). At the end of the week, participants placed the activity monitors into the return envelopes, to be picked up the following Saturday via courier. Participants underwent a four-week intervention period; at the end of each work week
(i.e., Friday), participants filled out the modified SIT-Q 7d. During the baseline period and week 4 of the intervention, participants wore the activPAL4™. The data collected during the fourth week was used for this secondary analysis validation study, as the first week device data was not measured simultaneously with the self-report questionnaire.

5.2.5 Statistical analysis

Statistical procedures were conducted in SPSS Statistics, Version 27 (SPSS Inc., Chicago, Illinois) and GraphPad Prism version 9.0.2 (GraphPad Software Inc., San Diego, CA) software programs. The level of significance was set at $p \leq 0.05$. Descriptive statistics were calculated for all demographic variables collected at baseline and are shown as mean (standard deviation; SD) or frequency (percentage) of the sample. Univariate ANOVAs (continuous variables) and chi-square tests (categorical variables) were conducted to ensure that there were no systematic differences between participants with valid and invalid data (all $p$-values $> 0.05$).

Spearman correlation coefficients were calculated to assess the degree of association between the activPAL4™ and modified SIT-Q 7d. The strength of the correlation was interpreted as poor ($< 0.30$), fair ($0.30 - 0.50$), moderately strong ($0.60 - 0.80$), or very strong ($> 0.80$) (Chan, 2003).

Limits of agreement between the activPAL4™ and the modified SIT-Q 7d were determined according to the recommendations by Bland and Altman (1986). The difference [activPAL4™ − modified SIT-Q 7d] of the two paired measurements (minutes) was plotted against the average $[(\text{activPAL4™} + \text{modified SIT-Q 7d})/2]$ of the two measurements (minutes). The mean difference, or bias, between the methods and the 95% limits of agreement intervals were calculated.

5.2.6 Missing data

The percentage of missing data was 28% ($n = 41$). Of the 148 participants that filled out the baseline questionnaire, 107 of them had valid activPAL4™ data at follow-up, and 95 of those participants also had valid self-report data at week 4. Univariate ANOVAs and chi-square tests revealed that those who had valid activPAL4™ data were not different from those who did not have valid data on all demographic variables ($p$-
values > 0.05). Taken together, all missing data were considered to be missing at random. Hence, we decided to exclude missing data from the analysis.

5.3 Results

Descriptive statistics for the demographic variables, days worked from home and minutes worked per week are shown in Table 17. Device-based (activPAL4™) and self-reported (modified SIT-Q 7d) frequency and duration of breaks from sitting (minutes) during work hours are illustrated in Table 18. The spearman rank correlation coefficient data between the activPAL4™ device and modified SIT-Q 7d are displayed in Table 19. All spearman correlations were found to be significant (p < 0.05). Correlations of break frequency were fair (ρ = 0.35 – 0.37) while break durations were poor (ρ = 0.27 – 0.28), regardless of how self-reported frequency and duration were calculated.
Table 17. Participant Characteristics presented as mean (SD) or count (%) of group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total sample ( (n = 148) )</th>
<th>Valid data at week 4 ( (n = 95) )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>44.90 (SD = 11.41)</td>
<td>45.60 (SD = 11.67)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>40 (27.0 %)</td>
<td>20 (21.1 %)</td>
</tr>
<tr>
<td>Female</td>
<td>107 (72.3 %)</td>
<td>75 (78.9 %)</td>
</tr>
<tr>
<td>Non-Binary</td>
<td>1 (0.7 %)</td>
<td>0 (0.0 %)</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>126 (85.1 %)</td>
<td>83 (87.4 %)</td>
</tr>
<tr>
<td>Asian</td>
<td>7 (4.7 %)</td>
<td>5 (5.3 %)</td>
</tr>
<tr>
<td>Black or African American</td>
<td>3 (2.0 %)</td>
<td>1 (1.1 %)</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>4 (2.7 %)</td>
<td>2 (2.1 %)</td>
</tr>
<tr>
<td>Other</td>
<td>4 (2.7 %)</td>
<td>1 (1.1 %)</td>
</tr>
<tr>
<td><strong>BMI (kg/m(^2))</strong></td>
<td>27.33 (SD = 5.74)</td>
<td>27.17 (SD = 5.78)</td>
</tr>
<tr>
<td><strong>Level of Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highschool Diploma</td>
<td>13 (8.8 %)</td>
<td>8 (8.4 %)</td>
</tr>
<tr>
<td>College Degree</td>
<td>26 (17.6 %)</td>
<td>14 (14.7 %)</td>
</tr>
<tr>
<td>University Degree</td>
<td>57 (38.5 %)</td>
<td>37 (38.9 %)</td>
</tr>
<tr>
<td>Masters</td>
<td>30 (20.3 %)</td>
<td>19 (20.0 %)</td>
</tr>
<tr>
<td>Doctorate (i.e., MD, PhD)</td>
<td>22 (14.9 %)</td>
<td>17 (17.9 %)</td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>26 (17.6 %)</td>
<td>21 (22.1 %)</td>
</tr>
<tr>
<td>Married or equivalent</td>
<td>107 (72.3 %)</td>
<td>63 (66.3 %)</td>
</tr>
<tr>
<td>Separated or equivalent</td>
<td>7 (4.7 %)</td>
<td>5 (5.3 %)</td>
</tr>
<tr>
<td>Divorced</td>
<td>7 (4.7 %)</td>
<td>5 (5.3 %)</td>
</tr>
<tr>
<td>Widowed</td>
<td>1 (0.7 %)</td>
<td>1 (1.1 %)</td>
</tr>
<tr>
<td><strong>Work Sector</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>61 (41.2 %)</td>
<td>32 (33.7 %)</td>
</tr>
<tr>
<td>Public</td>
<td>77 (52.0 %)</td>
<td>54 (56.8 %)</td>
</tr>
<tr>
<td>Charity</td>
<td>2 (1.4 %)</td>
<td>2 (2.1 %)</td>
</tr>
<tr>
<td>Other</td>
<td>7 (4.7 %)</td>
<td>7 (7.4 %)</td>
</tr>
<tr>
<td><strong>Days worked from home</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Five</td>
<td>118 (79.7 %)</td>
<td>73 (15.7 %)</td>
</tr>
<tr>
<td>Four</td>
<td>19 (12.8 %)</td>
<td>13 (13.7 %)</td>
</tr>
<tr>
<td>Three</td>
<td>11 (7.4 %)</td>
<td>9 (9.5 %)</td>
</tr>
<tr>
<td><strong>Physical Activity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>85 (57.4 %)</td>
<td>54 (56.8 %)</td>
</tr>
<tr>
<td>No</td>
<td>62 (42.6 %)</td>
<td>40 (42.1 %)</td>
</tr>
<tr>
<td><strong>Minutes Worked</strong></td>
<td>494.56 (SD = 62.55)</td>
<td>468.50 (SD = 78.04)</td>
</tr>
</tbody>
</table>

\( a \) In the past 3 months, have you been active for a minimum of 30 min/day on at least 3 days of the week? (i.e., jogging, biking, swimming).
Table 18. Minutes break frequency and duration for the device (activPAL4™) and the four methods of assessment of the self-report questionnaire (SIT-Q 7d) (activPAL4™: n = 95, SIT-Q 7d: n = 95) Mean (SD), Median (25%–75% percentile)

<table>
<thead>
<tr>
<th>Break Frequency</th>
<th>activPAL4™</th>
<th>SIT-Q 7d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19.44 (8.79), 17.21 (12.82 – 24.18)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>68.80 (34.00), 60.00 (45.00 – 90.00)</td>
</tr>
<tr>
<td></td>
<td>57.68 (29.94), 52.80 (37.80 – 75.00)</td>
<td>60.00 (45.00 – 90.00)</td>
</tr>
<tr>
<td></td>
<td>47.39 (25.40), 45.00 (30.00 – 60.00)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>67.18 (29.24), 60.00 (45.00 – 90.00)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Break Duration</th>
<th>activPAL4™</th>
<th>SIT-Q 7d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.48 (2.95), 5.76 (4.29 – 8.41)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.59 (2.36), 3.00 (2.00 – 4.16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.57 (3.07), 3.50 (2.50 – 5.25)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.50 (6.23), 4.00 (3.00 – 10.00)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.20 (3.24), 3.00 (2.00 – 4.89)</td>
<td></td>
</tr>
</tbody>
</table>
Table 19. Concurrent validity of the SIT-Q 7d with the device (activPAL4™)

<table>
<thead>
<tr>
<th>Break Frequency</th>
<th>( \rho )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservative</td>
<td>0.369**</td>
</tr>
<tr>
<td>Midpoint</td>
<td>0.352**</td>
</tr>
<tr>
<td>Least Conservative</td>
<td>0.368**</td>
</tr>
<tr>
<td>Midpoint/Conservative</td>
<td>0.368**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Break Duration</th>
<th>( \rho )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservative</td>
<td>0.274*</td>
</tr>
<tr>
<td>Midpoint</td>
<td>0.274*</td>
</tr>
<tr>
<td>Least Conservative</td>
<td>0.282*</td>
</tr>
<tr>
<td>Midpoint/Conservative</td>
<td>0.274*</td>
</tr>
</tbody>
</table>

* \( p < 0.05 \), ** \( p < 0.001 \)

The Bland-Altman plots for frequency of breaks from sitting during the workday are displayed in Figures 27-30. For the conservative method plot (Figure 27), linear regression showed a significant positive association between the difference in the two measures (self-reported minus activPAL4™ derived break frequency time) and the average of these two measures (\( B = 1.59, SE = 0.08, p < 0.001 \)). Thus, the mean difference is estimated at \(-20.57 \text{ minutes} + 1.59 \times \text{average of the two measures}\). At mean levels of average self-reported/activPAL4™-derived break frequency time (44.67 minutes), the mean difference indicated self-reported break frequency was 50.59 minutes greater than activPAL4™-derived break frequency time with wide limits of agreement (\(\pm29.01 \text{ minutes}\)). For the midpoint method plot (Figure 28), linear regression showed a significant positive association between the difference in the two measures (self-reported minus activPAL4™ derived break frequency time) and the average of these two measures (\( B = 1.50, SE = 0.09, p < 0.001 \)). Thus, the mean difference is estimated at \(-19.41 \text{ minutes} + 1.50 \times \text{average of the two measures}\). At mean levels of average self-reported/activPAL4™-derived break frequency time (39.01 minutes), the mean difference indicated self-reported break frequency was 39.26 minutes greater than
activPAL4™-derived break frequency time with wide limits of agreement (±28.35 minutes). The least conservative method (Figure 29) also displayed a significant positive association between the difference in the two measures (self-reported minus activPAL4™ derived break frequency time) and the average of these two measures ($B = 1.35$, SE = 0.10, $p < 0.001$). Thus, the mean difference is estimated at $-16.94$ minutes + $1.35 \times$ average of the two measures. At mean levels of average self-reported/activPAL4™-derived break frequency time (33.76 minutes), the mean difference indicated self-reported break frequency was 28.79 minutes greater than activPAL4™-derived break frequency time with wide limits of agreement (±26.85 minutes). Lastly, the midpoint/conservative method (Figure 30) displayed a significant positive association between the difference in the two measures (self-reported minus activPAL4™ derived break frequency time) and the average of these two measures ($B = 1.46$, SE = 0.09, $p < 0.001$). Thus, the mean difference is estimated at $-15.04$ minutes + $1.46 \times$ average of the two measures. At mean levels of average self-reported/activPAL4™-derived break frequency time (43.71 minutes), the mean difference indicated self-reported break frequency was 48.69 minutes greater than activPAL4™-derived break frequency time with wide limits of agreement (±27.82 minutes).
Figure 27. Bland–Altman plot of agreement for frequency of breaks from sitting (minutes) during work hours using the conservative method with device-derived (activPAL4) frequency (n = 95). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The bolded dashed line shows the mean difference between the two measures (50.59), with the dotted lines representing the limits of agreement (± 29.01).
Figure 28. Bland–Altman plot of agreement for frequency of sedentary breaks (minutes) during work hours using the midpoint method with device-derived (activPAL4) frequency (n = 95). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The bolded dashed line shows the mean difference between the two measures (39.26), with the dotted lines representing the limits of agreement (± 28.35).

Figure 29. Bland–Altman plot of agreement for frequency of sedentary breaks (minutes) during work hours using the least conservative method with device-derived (activPAL4) frequency (n = 95). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The bolded dashed line shows the
mean difference between the two measures (28.79), with the dotted lines representing the limits of agreement (± 26.85).

Figure 30. Bland–Altman plot of agreement for frequency of sedentary breaks (minutes) during work hours using the midpoint/conservative method with device-derived (activPAL4) frequency (n = 95). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The bolded dashed line shows the mean difference between the two measures (48.69), with the dotted lines representing the limits of agreement (± 27.82).
The Bland-Altman plots for duration of breaks from sitting are displayed in Figures 31-34. For the conservative method plot (Figure 31), linear regression showed a significant positive association between the difference in the two measures (self-reported minus activPAL4™ derived break duration time) and the average of these two measures ($B = -0.35$, SE = 0.17, $p = 0.04$). Thus, the mean difference is estimated at $-1.14$ minutes $+ -0.35 \times$ average of the two measures. At mean levels of average self-reported/activPAL4™-derived break duration time (5.01 minutes), the mean difference indicated self-reported break duration was 2.91 minutes lower than activPAL4™-derived break duration time with moderate limits of agreement ($\pm 5.81$ minutes). When looking at the plot using the midpoint method (Figure 32), linear regression was not significant and log transformation did not appear to limit the spreading of the data points. Thus, the original Bland-Altman methods were used (Bland & Altman, 1999). Examination of the Bland-Altman plot showed an underestimation ($\sim 2$ minutes, SD = 3.80) for duration of breaks with slightly larger 95% limits of agreement ($\pm 7.44$ minutes). For the least conservative method (Figure 33), linear regression showed a significant positive association between the difference in the two measures (self-reported minus activPAL4™ derived break duration time) and the average of these two measures ($B = 1.11$, SE = 0.14, $p < 0.001$). Thus, the mean difference is estimated at $-7.17$ minutes $+ 1.11 \times$ average of the two measures. At mean levels of average self-reported/activPAL4™-derived break duration time (6.48 minutes), the mean difference indicated self-reported break duration was 0.03 minutes lower than activPAL4™-derived break duration time with wide limits of agreement ($\pm 8.47$ minutes). Lastly, the midpoint/conservative method (Figure 34) was similar to the midpoint method; using the original Bland-Altman methods (Bland & Altman, 1999) examination of the plot showed small bias (2 minutes, SD = 3.92) with wide 95% limits of agreement ($\pm 7.68$ minutes).
Figure 31. Bland–Altman plot of agreement for duration of breaks from sitting (minutes) during work hours using the conservative method with device-derived (activPAL4) sitting break duration (n = 95). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The bolded dashed line shows the mean difference between the two measures (− 2.91), with the dashed lines representing the limits of agreement (± 5.81).

Figure 32. Bland–Altman plot of agreement for duration of sedentary breaks (minutes) during work hours using the midpoint method with device-derived (activPAL4) sitting break duration (n = 95). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The dash dotted line shows the mean difference between the two measures (− 1.93), with the dotted lines representing the limits of agreement (± 7.44).
Figure 33. Bland–Altman plot of agreement for duration of sedentary breaks (minutes) during work hours using the least conservative method with device-derived (activPAL4) sitting break duration (n = 95). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The bolded dashed line shows the mean difference between the two measures (0.03), with dashed lines representing the limits of agreement (± 8.47).

Figure 34. Bland–Altman plot of agreement for duration of sedentary breaks (minutes) during work hours using the midpoint/conservative method with device-derived (activPAL4) sitting break duration (n = 95). The y axis is the difference between the two measures and the x axis is the average of the two, both expressed in minutes. The dash dotted line shows the mean difference between the two measures (-2.31), with the dotted lines representing the limits of agreement (± 7.68).
5.4 Discussion

The aim of the current study was to assess the criterion validity and absolute level of agreement of the modified SIT-Q 7d questionnaire against the activPAL4™ device for measuring frequency and duration of breaks from occupational sitting in a sample of full-time home-based ‘office’ workers. When comparing self-reported break frequency with the device, findings indicated fair levels of validity ($\rho = 0.35 – 0.37$, all $p < 0.05$), low levels of agreement (mean difference = 28.79 – 50.59) and wide limits of agreement (26.85 – 29.01). When comparing self-reported break duration with the device, findings indicated poor levels of validity ($\rho = 0.27 – 0.28$, all $p < 0.05$), acceptable levels of agreement (mean difference = -2.91 – 0.03) and medium limits of agreement (5.81 – 8.47). Thus, the current findings do not support the use of the modified SIT-Q 7d at the individual level; however, self-reported measurement may be used at the group level with caution, as break frequency shows moderate acceptability while break duration does not. No literature exists for us to compare our findings with. Besides these overall general observations, the following issues warrant commentary.

Regarding the four assessment methods used for the modified SIT-Q 7d questionnaire, for break frequency, the least conservative method showed the best agreement (Fig. 3) with a mean difference of 28.79 and wide limits of agreement (±26.85). The midpoint method (Fig. 2) was the next best, (mean difference = 39.26, 95% limits of agreement = ±28.35) followed by the combined midpoint/conservative method (Fig. 4; mean difference = 48.69, 95% limits of agreement = ±27.82) and lastly the conservative method (Fig.1; mean difference = 50.59, 95% limits of agreement = ±29.01). Findings followed the same pattern for break duration, with the least conservative method showing the best agreement (Fig. 7; mean difference = 0.03, 95% limits of agreement = ±8.47) followed by midpoint (Fig. 6; mean difference = -1.93, 95% limits of agreement = ±7.44), midpoint/conservative (Fig. 8; mean difference = -2.31, 95% limits of agreement ± 7.68) and conservative (Fig. 5; mean difference = -2.91, 95% limits of agreement = ±5.81). These are important findings as previous research has used the conservative approach for the assessment method (Dillon et al., 2021, Sui and Prapavessis, 2018).
There could be several reasons why the least conservative method of coding for the modified SIT-Q 7d showed the overall best agreement against the activPAL4™ device. For instance, the device captures all breaks while people might only be self-reporting ‘intentional’ or in other words, ‘conscious’ breaks. For example, if a person were to quickly stand up from their desk to reach for a stapler or take a printed item from the printer across the room, the device would capture that. While we were able to minimize this limitation by removing breaks that were less than 30 seconds, breaks that were between 30 seconds to one minute could have still influenced the data. That said, this type of sedentary behaviour break is not ‘intentional’ or ‘conscious’; a person would likely not remember taking a non-intentional break when asked to recall sedentary behaviour breaks days later. When examining the mean break frequency, we observed 19.44 minutes for the device and 47.39 minutes for the modified SIT-Q 7d, indicating that participants were taking breaks more often than they were self-reporting. Therefore, the discrepancy between the self-report and device-based measure could be because people were only self-reporting the ‘intentional’ breaks that they were taking (i.e., planning or intentionally getting up to go walk around the house for a two-minute activity break) as opposed to every single break (i.e., quickly grabbing the stapler).

Recall time might also be contributing to the inconsistency across measurement methods. We asked participants to recall their average break frequency and break duration at the end of each week, as opposed to the end of each workday. It is possible that more frequent recall (i.e., daily or previous day) would likely result in better validity and agreement between the two measures, as the breaks would be fresher in people’s minds (Marconcin et al., 2021; Matthews et al., 2013). When looking at the mean break duration, we observed 6.48 minutes for the device and 6.50 minutes for the modified SIT-Q 7d. This indicates that people might be more aware of how long their breaks are because the breaks are more memorable as opposed to the actual time the break is taken. For example, when people take a sedentary behaviour break, they might be doing the same things (i.e., grabbing water or coffee, going to the bathroom, taking a quick walk, etc.). This could make the duration of breaks easier to estimate or recall later. This might explain why the break duration was stronger in the individual analysis (i.e., 95% limits of agreement were smaller) whereas the break frequency was stronger in the group analysis.
(i.e., stronger spearman rank correlations). This has implications for future research in the sense that investigators need to properly educate participants about both intentional and incidental breaks to increase their self-awareness. One approach could involve getting participants to keep a logbook for a day or two, recording the time they take their breaks and how long each break was.

To our knowledge, this is the first study to explore how various assessment methods might lead to different levels of agreement. Hence, one study does not provide sufficient evidence on which method is most appropriate. Replication research is warranted in other populations to confirm the most appropriate assessment method(s). Future studies should also explore the assessment method of other combinations (e.g., combining least conservative with midpoint, etc.).

The main strength of this study was the use of the gold-standard device, the activPAL4™. While the COVID-19 pandemic forced many employees to quickly transition to an ‘at-home’ office setting, two years later, there are still many employees working from home with no intention to return to the traditional ‘office’ setting or are at least subject to hybrid work models (i.e., some work in-office, some work remote) (Malhotra, 2021; Pew Research Center, 2021, 2020). This shift in the occupational setting is new to the literature and requires further investigation. It is still unknown if home-based assessment of sitting might be different (harder to accurately report) than an office-based assessment of sitting as breaks in the office may be more structured than breaks at home. Workplace structures and environments have been shown to affect levels of sedentary behaviour and physical activity throughout the workday (Barone Gibbs et al., 2021; Jancey et al., 2016; MacDonald et al., 2020). Although the activPAL™ device provides great value in sedentary behaviour measurement, its main limitation is its inability to distinguish between types and contexts of sedentary behaviour. In contrast, one of the main strengths of the SIT-Q 7d is its sensitivity in measuring specific sedentary behaviour domains. However, being a self-reported instrument, the division and reporting of separate domains only works as well as they are separated. For example, before COVID, it is reasonable to assume that occupational sitting (and break frequency and duration) was easier to conceptualize, since work (typically) happened in a separate space and under a defined time (e.g., 9-5pm).
With working at home, the lines between occupational and leisure sitting have been blurred. Is it sitting for work if I eat breakfast at my desk in the morning? Furthermore, work done at home may not follow as rigid of time constraints as traditional office work (e.g., 9-5pm), and this questionnaire wasn’t originally designed to assess/convey what work from home is for respondents. Taken together, these issues raise concerns for why this questionnaire may not be appropriate for assessing sedentary behaviour in a work from home setting. Thus, future research is needed to expand on the findings herein and further validate the modified SIT-Q 7d in at-home office environments. Similarly, validation evidence is still required in the traditional office space, for the concerns previously mentioned. It is recommended that prior to collecting data, all study participants need to fully understand what a ‘sedentary behaviour break’ consists of, based on the objectives of the study (e.g., getting participants to take 1–2-minute intentional breaks every 30-45 minutes). Additionally, future validation is needed to investigate whether validity and agreement are stronger when recall is measured at different points in time (e.g., at the end of each day, previous day recall vs. the end of each week, previous week recall). Further, our sample size and variability (i.e., good proportions between different education levels and public/private sectors) of the sample is a strength, as this heightens the generalizability of the findings. Investigators should consider sample size, budget, and study objectives/outcomes as well as level of participant burden required to partake in measurement studies (Marconcin et al., 2021), particularly when accounting for reporting adherence, accuracy, and drop-out rates.

There are limitations that should be considered when interpreting the findings. First, participants self-reported their start and end time of their workday at baseline, so the times may not be exact to their workday hours during week four, nor did we have participants’ self-report start and work times in a diary. Working at home may have slightly variable start and end times, especially under potentially changing provincial wide-restrictions (e.g., school closures), increased work scheduling flexibility (Ray & Pana-Cryan, 2021), and/or family dynamics/demands. These factors could be a reason why the validation is not strong at the individual level. Second, to be included, participants had to work at least 50% or more from home. The study did not require participants to report which days were from home, and which may have been in-office,
and there were no ways of teasing the two apart. Future validation studies should ask participants to self-report their start and end time every day, in addition to the office setting (i.e., from home or in office). Third, since participants were self-reporting their behaviour at the end of each week, by week four, practice effects could have impacted the results as the questionnaire was filled out four times prior to the assessment included in the current analysis. Therefore, we may be seeing better agreement, or worse agreement at week four than we would see if we used week one data. For example, data could be better than week one as their ability to recall their behaviour may have improved over the four-week period or it is possible that because of repeated assessment, they paid less attention and got worse. Thus, these findings may not apply to people completing the questionnaire for the first time. Lastly, as this was a secondary analysis, we were unable to shed light on this issue as the sequence of measuring with the activPAL4™ device and modified SIT-Q 7d questionnaire was not harmonized at baseline (i.e., modified SIT-Q 7d was assessed before activPAL4™).

5.5 Conclusion

In conclusion, the modified SIT-Q 7d shows acceptable criterion validity for accurate estimates of break frequency but not break duration in the context of at-home office working adults. The 95% limits of agreement for break frequency were large (26.85 – 29.01) indicating that the modified SIT-Q 7d may not be appropriate for measuring occupational sedentary behaviour patterns at the individual level in at-home office workers. For break duration, the 95% limits of agreement were smaller (5.81 – 8.47), however, still too large to have confidence in recommending the use of this questionnaire at the individual level. The least conservative coding method for the modified SIT-Q 7d showed to be the best method of assessment. With many office-workers continuing to work from home since the onset of COVID-19, it is imperative to have a validated self-report questionnaire to reduce the cost and burden of using a device. Further validation is still required before confidently recommending this self-report questionnaire to be used as an easily administered and acceptable self-report method for measuring at-home sedentary behaviour patterns at a group level.
5.6 References


BBC. (2020, October 23). How will the pandemic change the way we work. ge the way we work. https://www.bbc.com/worklife/article/20201023-coronavirus-how-will-the-pandemic-change-the-way-we-work


Sui, W., Prapavessis, H., 2016. Testing the face validity and reliability of a modified SIT-Q 7 day recall questionnaire measuring sedentary time and break frequency and duration. J. Sport Exerc. Psychol. 38, S262–S262.


Chapter 6 – Summary, Implications, and Future Directions

This dissertation consisted of a series of interrelated research studies that addressed 1) reducing sedentary behavior in populations who sit too much and are at high risk of health consequences (study 1 and 2), and 2) bring awareness to measurement issues related to sedentary behaviour research (study 3A and 3B). Interventions targeting university students that are grounded in a theoretical framework are limited, as most have utilized either environmental manipulations (i.e., standing desks) or have been multi-component in nature. Thus, the first of my dissertation studies (chapter 2- study 1), was undertaken to evaluate the effectiveness of a Health Action Process Approach (HAPA) based planning intervention augmented with text messages to reduce student-related sitting time, while simultaneously increasing time spent in non-sedentary behaviours (i.e., standing, stretching, light movement). As expected, results showed that the constructs embedded within the HAPA model (i.e., action planning, coping planning and action control) were successful in reducing occupational (i.e., student) related sitting time and increasing time spent in other non-sedentary behaviours. While these findings have serious health implications for student related sitting, the one-on-one behavioural counselling session, along with the individualized text-messages limits its scalability.

Taking what we learned from study 1, we built a ‘modified’ HAPA-based intervention. More specifically, we condensed the one-on-one behavioural counselling session into a 3-minute educational video and supplemented it with pre-committing to sedentary behaviour strategies and self-monitoring behaviour instead of utilizing the text-messages. By taking this approach, we aimed to create a behaviour change intervention that if successful, could be easily implemented on a large-scale at a low-cost. Additionally, choice architecture is a behavioural economic concept becoming increasingly popular within the behaviour change literature and has yet to be tested in a home-based office-working populations in regard to reducing sitting time. Thus, for study 2 (chapter 3) we investigated whether an ‘enhanced’ HAPA based approach, augmenting HAPA with choice architecture can change sedentary behaviour patterns, specifically break frequency, in a group of home-based office working adults. From study 2, we were
able to show that the ‘enhanced’ HAPA-based intervention was in fact effective and feasible in this population for increasing sedentary behaviour break frequency and reducing overall sedentary time in home-based office workers. However, the ability to detect changes in behaviour based on the power of ‘choice’ was dependent upon the method of measurement. More specifically, when measured with the device, there was an advantage for the Forced Assignment group for break duration and standing time whereas when measured with the self-report questionnaire, the Choice of Assignment group illustrated a better break frequency and duration profile.

Due to the measurement issues that arose in study 2 and the importance of establishing precision in self-reported instruments, study 3A (chapter 4) aimed to validate the OSPAQ, the self-report questionnaire that assess total levels of sitting time. From this validation study, we showed that the OSPAQ is a valid measure of total sitting and standing time for groups of home-based office workers.

Finally, since pattern of sedentary behaviour accumulation is also important, study 3B (chapter 5) aimed to validate the modified SIT-Q 7d questionnaire that measures sedentary break frequency and break duration. From this validation study, we showed that the modified SIT-Q 7d questionnaire is valid for measuring break frequency but lacks validity for break duration.

Overall, these findings have implications for future intervention work. First, given the importance of theory in driving behaviour change, it is highly recommended that the HAPA model is continued to be used on its own or possibly in combination with other theories that were not explored in this dissertation (i.e., self-control or minimization effort). Investigating other theoretical perspectives or exploring complimentary theory-based combinations could allow for a more comprehensive intervention model. Second, other types of augmentation to a theory-driven approach should be considered. The current dissertation explored augmenting the HAPA model with text-messages and choice-architecture; other avenues such as decisional cues or prompts should be investigated. Third, the theory based interventions used within this dissertation should be studied in other high-risk populations where high levels of sitting take place, such as those with chronic disease. Fourth, while these interventions were shown to work at the university and home-based office level, their implementation on a larger scale needs to be
evaluated. This dissertation also has implications with respect to measurement. First, future studies should explore how more frequent assessments could affect the validity of the self-report measures used. For example, we used one-week recall, but daily recall or even multiple times within the same day such as an ecological momentary assessment (EMA) should be considered. More frequent recall would most likely improve the validity of the self-report measures (Clark et al., 2016). Second, the modified self-report questionnaires used within the current studies should be cross validated in other populations. Third, future studies should explore the responsiveness to change of the self-report questionnaires.

In closing, despite the limitations noted in each of the three studies, this dissertation has made notable contributions with respect to sedentary behaviour change and sedentary behaviour measurement in high-risk populations. While the first study showed to be effective, it lacked the ability to be implemented on a large-scale. Thus, study 2 tested the effectiveness of a more scalable behaviour change intervention, and the findings were encouraging. We also were able to validate self-report measures that can capture both total sedentary time and breaks in sedentary time in home-based office-workers, which is imperative for future intervention work.
References

Appendices
Appendix A: Reproduction License (Study 1)

From: GPHS-production@journals.tandf.co.uk
Subject: RE: Inquiry regarding permission to reuse a published article in Psychology and Health #TrackingId:11611694
Date: April 27, 2022 at 11:52:35 AM PDT

Dear Kirsten,

We are sorry for the delay in getting back to you.

You can use your article content as long as it is fully cited and referenced back to the original source and being cited with its DOI is necessary.

Best regards,

Sowmya

Work Timings: Monday to Friday 5:30am-2:30pm (GMT)

Psychology & Health
Appendix B: Ethics Approval (Study 1)

Date: 17 December 2018

To: Prof. Harry Papanekis

Project ID: 113197

Study Title: Using a Combined Health Action Process Approach and Mobile Health Intervention to Reduce Sedentary Behaviour in University Students – A Randomized Controlled Trial

Application Type: HSREB Initial Application

Review Type: Full Board

Meeting Date: 04/Dec/2018

Date Approval Issued: 17/Dec/2018

REB Approval Expiry Date: 17/Dec/2019

Dear Prof. Harry Papanekis

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:

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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,

Karen Gepaul, 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).
Email Script for Engagement of Key Contacts

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

Hello ______,

We appreciate your willingness to support our research efforts and to assist us with study recruitment by facilitating communications with your students.

We have included the study invitation (seen below) and accompanying attachment (i.e., recruitment poster) for you to share with your students, if possible on OWL.

------------------------

Hello,

You are being invited to participate in a research study examining relationships between occupational (student) activity levels, school-related work habits, and perceived health and work-related outcomes in university students. 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 student-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 occupational (student) 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 approximately 20 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, [RESEARCHER_EMAIL].

Thank you,
Appendix D: Email Script- Recruitment of Participants (Study 1)

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 the relationship between interrupting sedentary behaviour, glycemic variability and cognition. This is a research project being conducted by researchers in the School of Kinesiology at The University of Western Ontario.

To be eligible to participate, you are required to: (a) be 65+ years of age, (b) BMI >25 kg/m², (c) fasting glucose concentration 5.5 - 7.0 mmol/L (d) diagnosed with mild cognitive impairment by your physician (e) physical inactive (not doing 150 minutes of moderate-to-vigorous physical activity per week) (f) sit for >7 hours a day (g) able to walk without an assistive device (h) no contraindications for participation in exercise (i) own a smartphone (j) be able to read and write in English

If you would like more information on this study or would like to receive a letter of information about this study, please contact the researcher at the contact information given below.

I look forward to hearing back from you!

Much Appreciated,
Appendix E: Recruitment Poster (Study 1)

Participants Needed for a Health Psychology Research Study

- We are conducting a research study examining relationships between occupational (student) activity levels, school-related work habits, and perceived health and work-related outcomes in university students.

- **Looking for full-time university students:** Are you 18 years of age or older? Are you a student enrolled in full-time studies?

- 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, Kirsten Dillon, by email.

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

Kirsten Dillon
PhD Student
School of Kinesiology
Western University
London, ON N6A 5B9

Dr. Harry Prapavessis
Professor
School of Kinesiology
Western University

Exercise & Health Psychology Laboratory
Appendix F: Letter of Information and Informed Consent (Study 1)

Study Title: The Relationship between Student-related Activity Patterns, Work Habits, and Perceived Health among University Students

Investigators: Ph.D. (Principal investigator) School of Kinesiology, Western University.

You are being invited to participate in a research study examining the relationships between occupational (student-related) activity patterns and perceived health and work-related outcomes in university students. 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 student-led 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 (student) activity levels, school-related work habits, and perceived health and work-related outcomes among university students.

Inclusion Criteria

To be eligible to participate, individuals must: (a) be 18+ years of age, (b) be a full-time university and/or college student, (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.

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 student-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 occupational (student) 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 approximately 20 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.

**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 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 academic standing as a student. 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. There is a risk of privacy breach. 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 __________________________. 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 __________________________.
Informed Consent for Written 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 G: Participant Baseline Questionnaire (Study 1)

Online Questionnaire Template

Online Questionnaire Access Link (Pretest and Preview):
https://www.sosciSurvey.de/ehpl2018/?act=MYqg8dUrIrjbVUIl.kanMsW6N

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

2. What is your email?

3. With which gender do you identify?

4. What is your age (in years)?

5. What is your ethnicity?

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

[Please choose]

- White
- Chinese
- South Asian
- Black
- Filipino
- Latin American
- Southeast Asian
- Arab
- West Asian
- Japanese
- Korean
- Aboriginal peoples of Canada (e.g., First Nations, Metis, Inuit)
- Other

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.), or have you ever been told by your doctor to avoid physical activity?

No

Yes
7. **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:

8. **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)

9. **Are you a full time or part time student?**

Full time

Part time

10. **What best describes your current level of education?**

Undergraduate student  
Masters student  
Doctoral student  
Professional degree student (MD, DDS, JD)

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. **How many hours of class do you have per week?**

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

Not at all  
A little  
Somewhat  
Quite a bit  
A lot
14. Recently, have you monitored how much you sit?

Not at all  A little  Somewhat  Quite a bit  A lot
1  2  3  4  5

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)?

<table>
<thead>
<tr>
<th>Times Per Week</th>
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| a) 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) |
| b) Moderate exercise  
(Not exhausting)  
(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing) |
| c) Mild/Light exercise  
(Minimal effort)  
(e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, 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

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<tr>
<th>Min or less</th>
<th>15 min</th>
<th>30 min</th>
<th>1 hr</th>
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17. Sitting and using the computer for recreational purposes (i.e., games, Facebook, Youtube, movies, music, Skype, social media websites, etc.)

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<th>Min or less</th>
<th>15 min</th>
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18. Sitting for school or work (attending lectures, studying or doing schoolwork, school-related computer use, working on assignments, desk work, reading, sitting in meetings, teleconferences, paid work, etc.)

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None 15 min or less

15 min 30 min 1 hr 2 hrs 3 hrs 4 hrs 5 hrs 6 hrs 7 hrs 8 hrs 9 hours or more

19. Sitting reading for pleasure

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None 15 min or less

15 min 30 min 1 hr 2 hrs 3 hrs 4 hrs 5 hrs 6 hrs 7 hrs 8 hrs 9 hours or more

20. Sitting and listening to music

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None 15 min or less

15 min 30 min 1 hr 2 hrs 3 hrs 4 hrs 5 hrs 6 hrs 7 hrs 8 hrs 9 hours or more

21. Sitting and playing a music instrument

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None 15 min or less

15 min 30 min 1 hr 2 hrs 3 hrs 4 hrs 5 hrs 6 hrs 7 hrs 8 hrs 9 hours or more

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

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None 15 min or less

15 min 30 min 1 hr 2 hrs 3 hrs 4 hrs 5 hrs 6 hrs 7 hrs 8 hrs 9 hours or more

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

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None 15 min or less

15 min 30 min 1 hr 2 hrs 3 hrs 4 hrs 5 hrs 6 hrs 7 hrs 8 hrs 9 hours or more
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

15 min
30 min
1 hr
2 hrs
3 hrs
4 hrs
5 hrs
6 hrs
7 hrs
8 hrs
9 hours
or
more

25. Sitting and eating

None 15 min
or less

15 min
30 min
1 hr
2 hrs
3 hrs
4 hrs
5 hrs
6 hrs
7 hrs
8 hrs
9 hours
or
more

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

15 min
30 min
1 hr
2 hrs
3 hrs
4 hrs
5 hrs
6 hrs
7 hrs
8 hrs
9 hours
or
more

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

None 15 min
or less

15 min
30 min
1 hr
2 hrs
3 hrs
4 hrs
5 hrs
6 hrs
7 hrs
8 hrs
9 hours
or
more

The following questions ask about your plans with regards to reducing your sitting time as a student (i.e., during school-related activities). Examples of school-related activities include attending lectures, studying or doing schoolwork, school-related computer use, working on assignments, desk work, reading, sitting in meetings, teleconferences, etc.)

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

(a) … when to break up my sitting time as a student

Completely disagree     Disagree     Neutral     Agree     Totally agree
(b) … where to break up my sitting time as a student

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<th>Completely disagree</th>
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(c) … how to break up my sitting time as a student

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(d) … how often to break up my sitting time as a student

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

(a) … what to do if something interferes with my plans to break up my sitting time as a student

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(b) … how to cope with possible setbacks from breaking up my sitting time as a student

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(c) … what to do in difficult situations in order to act according to my intentions to break up my sitting time as a student

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(d) … which good opportunities for action to take in order to break up my sitting time as a student

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(e) … when I have to pay extra attention to prevent lapses from breaking up my sitting time as a student

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30. During the last two weeks, I have . . .
   (a) … constantly monitored myself whether I break up my sitting time as a student often
       enough

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<th>Completely disagree</th>
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   (b) … watched carefully that I break up my sitting time as a student often enough

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   (c) … had my intention to regularly break up my sitting time as a student often on my mind

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<th>Completely disagree</th>
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<th>Agree</th>
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   (d) … always been aware of my action and coping plans to break up my sitting time as a student

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   (e) … really tried to regularly break up my sitting time as a student

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<th>Completely disagree</th>
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   (f) … tried my best to act in accordance to my break frequency and duration standards

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</table>

31. How would you rate your overall work performance as a student?

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

32. During the past 6 weeks, have you had any of the following problems with your school, work or other regular daily activities as a result of your physical health? (Yes = 1, No = 2)
   a) Cut down the amount of time you spent on work or other activities
   b) Accomplished less than you would like
c) Were limited in the kind of work or other activities

d) Had difficulty performing the work or other activities (for example, it took extra effort)

33. During the past 6 weeks, have you had any of the following problems with your school, work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)? (Yes = 1, No = 2)

   a) Cut down the amount of time you spent on work or other activities
   b) Accomplished less than you would like
   c) Didn't do work or other activities as carefully as usual

34. 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...

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
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   a) Did you feel full of pep?
   b) Have you been a very nervous person?
   c) Have you felt so down in the dumps that nothing could cheer you up?
   d) Have you felt calm and peaceful?
   e) Did you have a lot of energy?
   f) Have you felt downhearted and blue?
   g) Did you feel worn out?
   h) Have you been a happy person?
   i) Did you feel tired?

Now think about the time you spend as a student involved in school-related activities.

Examples of school-related activities include attending lectures, studying or doing schoolwork, school-related computer use, working on assignments, desk work, reading, sitting in meetings, teleconferences, etc.)

35. How many hours did you spend being a student (i.e., in school-related activities) in the last 14 days?

Please enter the number of HOURS (e.g., 40, 80, 105) you spent in school-related activities in total over the last two weeks.

________________________ hours

36. During the last 14 days, how many days were you involved in school-related activities?

Please enter the number of DAYS (e.g., 1, 3, 5, 10) you were involved in school-related activities in total over the last two weeks.

________________________ days

37. 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) as a student during school-related activities?

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,
Over every 5 hours,
No interruption.

38. In the last 14 days, on average, how long were your breaks from sitting as a student during school-related activities?

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.

39. How would you describe your typical day as a student in the last 14 days? This involves only time spent in school-related activities, and does not include 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%.

a. Sitting (including driving) ________%
b. Standing ________%
c. Walking ________%
d. Stretching ________%
Total ________%

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

____________________________

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.
Appendix H: Email Script- Post Baseline (Intervention) (Study 1)

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 (student) activity levels, school-related work habits, and perceived health and work-related outcomes in university students.

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 student-related 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 approximately 20 minutes.

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 occupational (student) 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,
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 (student) activity levels, school-related work habits, and perceived health and work-related outcomes in university students.

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,
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 IN UNIVERSITY STUDENTS
University students spent an average of 11.65 hrs (SD = 3.35) sitting per day
Work/school-related sitting accounted for 6.18 hrs (SD = 2.43) of daily sitting time
The university and school-related activity as a key setting for prolonged sedentary time (Prapavessis, Gaston, & De Jesus, 2015)

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)

HOW STRONG IS THE ASSOCIATION?
Irrespective of physical activity level, those who spent the most time sitting were more than two times more likely to have or develop diabetes.
One and a half times more likely to die over the course of the study (de Rezende et al., 2014)
(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

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:
  1. Waist circumference
  2. Systolic blood pressure
  3. HDL “good” cholesterol
  4. Blood lipid “fat” levels
  5. Blood glucose “sugar” levels
  6. 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%)

Positive effect on glycemic (i.e., blood sugar control)
OBJECTIVES AS A STUDENT

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 friends/other students 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
- **TAKE the STAIRS** instead of the elevator

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 30-45 min. while sitting at the computer
- **Go for WALKS** with friends instead of sitting and socializing
- **STAND UP and STRETCH** during TV commercials
- **LIMIT SCREEN TIME** to stay active

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 as a student during school-related activities?
- **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?”

**REFERENCES**

Appendix K: Behavioural Counselling and Planning Session Script (Study 1)

**Behavioural Counselling and Planning Session Script**

Hi, how are you doing? Is now still a good time … still alright to have our chat right now?

General questions? Icebreakers? Get comfortable…

So you are a student @ ____________? Year? Program? What they study?

Alright, so before we begin, we got you interested in participating in this study? Did you just see the recruitment poster and want to get involved in a research study or do you have some underlying interest in this topic? sedentary behaviour?

Alright well let’s get started then …

So today as you may know, you are receiving what is formally known as a behavioural counselling session of sorts …
But really all this means, is were just going to have a very informal conversation, you and I, and I am going to speak to you a bit about SB or sitting too much, the health consequences associated with too much sitting, and hopefully show you not only the benefit, but also the ease with which you can reduce and break up your sitting time, especially as a student and in the school or occupational domain.

Okay, Did you by chance get the email I sent you a few minutes ago? Perfect.
[Overview with them what is in the email – link, and docs]

So before we get started, can you tell me what do you know about SB? Do you have any preconceived ideas or notions regarding it or thoughts?

**BEGIN PRESENTATION:**

**Slides 2-4:** (Notes in Slides)

After prevalence slide:
- Not only are we sitting too much, but it is BAD for our health.

**Slides 5-8:** (Notes in Slides)

**Slide 9 →** And this is a real problem as the majority of the public are not getting enough MVPA or health enhancing exercise, and then they are sitting all day (make reference to visual in slide – “and you can see this is quite easy to do in today’s day and age”), but even if you are, there is a new term that has been coined “THE ACTIVE COUCH POTATO”
Even if you are getting that 1-hr/day of recommended PA, if you are then spending extended periods of the day sitting, the health consequences are still there!

After health consequences:
Slide 10: So just as we exercise for health benefits, there is also benefits to concurrently reducing and breaking up SB
To reduce your risk is actually quite simple …Simply put, stand up, sit less, move more, more often!

Slides 11-12: And there is quite a bit of evidence to support this …
(Notes on slides)

Slide 13: So this brings us to the STUDY OBJECTIVES… the point of this study is to hopefully encourage you as a student to …
1st point
And reduce your total sitting time by ..2nd and 3rd point

Slides 14-16: In order to demonstrate to you that it is actually quite easy to do this …
(two slides on work/school domain [as a student] but also one slide for in their recreational/leisure time)

COUNSELLING AND PLANS:

Slide 17: In order to help, we are asking that you (and hopefully I will facilitate you in doing so) that you come up with a realistic and honest plan to reduce your daily sitting time over the next 6 weeks (and beyond)

By this I mean 3-4 strategies that you can actually see yourself using to both reduce your TOTAL sitting time as a student but also BREAK UP your sitting MORE REGULARLY

Slides 18-19 – (Just for them to get an idea of what we mean by forming an action plan and coping strategies)

DURING PLANNING SESSION:
Okay, so here is where I am done lecturing to you and I turn it over to you…
Do you have any strategies that you are already using and are effective? Or that you were already using without knowing but are now aware of after our chat? Or that you have in mind and think might be helpful? Or any you would like to try?

Prompt them if necessary? Ask questions to get them thinking about when they are most sedentary? Days of the week? Time of the day? What they are doing and where they are when they’re sedentary? Certain periods when it is possible to reduce and break up versus not so easy? Times when it may be easier than others?
- Perhaps suggest a strategy if you think a certain one may be effective or helpful…

Examples:
- Computer-based prompts (a number of free downloadable options now exist that can serve as reminders to take regular breaks by standing up; many options are customizable to times that work best for you and can easily be ignored/shut off if desired)
- Standing calls
- FitBit, Apple Watch, wearable technology
- Pedometer
- Using a standing desk
- Frequent sit-to-stand transitions while working
- Active workstations
- Stand during meetings
- Walking meetings
- Setting an alarm for certain times to get up and take a break from sitting to stretch or walk around
- Water bottle and refills?
- Taking stairs
- Walking to/from school and in-between classes

**END OF CALL:**
Alright …Do you have any questions or concerns?

Before we end, just a few housekeeping items:
- As you may know and assuming it is alright with you, you will be receiving daily text messages once a day for the next 6 weeks starting tomorrow. These will serve as reminders and will contain facts, strategies, tips and challenges to help you both reduce and break up your sitting time as a student over the next 6 weeks.

If this is okay with you, can I get your cell number? (If you already have it, just confirm with them)
Okay, and if you had to pick one time to receive these – a time that you think would be beneficial or helpful BUT ALSO not a disturbance or nuisance to you throughout the day – what time would you pick?

- In addition to this, every two weeks, they will receive a questionnaire via email to complete at their earliest convenience (make joke: and don’t worry…they are all much shorter than the first one they completed)

- Make a semi-joke about being obligated to remind them that the study is completely voluntary and if at any point, they are no longer interested or would like to withdraw, they are free to do so. However, with this in mind, you hope they don’t and hope they actually find some benefit to participating.

- And THAT’S IT! Thanks them, enjoy their day, and will be in touch soon.
Appendix L: Health Action Process Approach- Planning Sheet (Study 1)
MY PLAN TO REDUCE MY SITTING TIME AS A STUDENT DURING SCHOOL-RELATED ACTIVITIES

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

Action Plans:
Please think about the time you spend being a student and involved in school-related activities 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 as a student 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.

<table>
<thead>
<tr>
<th>Action Plans &amp; Coping Strategies</th>
<th>Frequency</th>
<th>Intensity</th>
<th>Time</th>
<th>Type</th>
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<tbody>
<tr>
<td>Plan 1</td>
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<td>Strategy 1</td>
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<td>Plan 2</td>
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<td>Plan 3</td>
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<td>Strategy 3</td>
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Memorize your plans carefully. Visualize the situations and your planned actions and make a firm commitment to act as planned.
Appendix M: Health Action Process Approach- List of Text Messages (Study 1)

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

1: Hi Jessica, welcome to the study! You will receive daily reminders with tips & strategies to help you reduce your sitting time as a student over the next 6-wks.
1: For the next week your challenge is to get up at least once/hr when studying or doing work. To make it easier, try to stand up & move around each hr on the hr.
2: Wondering why reducing sitting time is so important? By breaking up your sitting time, you can reduce your risk of heart disease.
2: There are a number of easy ways to reduce & break up your sitting time as a student! To name a few: Use prompts or reminders or try standing during phone calls.
3: 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: Hey Radha, is it time to take a break from sitting at that desk? Get up and stretch your legs.
4: On top of getting up every hour, your challenge for tomorrow is to replace 20 min of sitting with standing and/or walking. Walk to your next class, walk home instead of taking the bus or take a brief walk outside during your break!
5: Just because you are studying does not mean you have to stay seated all day. Be sure to take a break between classes or work sessions to get up & move around.
5: By breaking up your sitting time as a student you will reduce your risk of developing Type II diabetes!
6: Need a tip to sit less? Try walking to school or cycling if you live close enough, or if you drive, park further away from the building. It'll add some steps to your day and give you some nice fresh air!
6: 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: 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: Your 7 day challenge is to get up for at least 3 min every hour while studying or being a student. 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: Here is another reason to sit less: substituting sitting with standing or walking can help strengthen your bones.
10: Good afternoon Radha, make sure you are getting up every hour and staying up for 3 minutes while studying or being a student today!
11: Today - try and aim to replace an hour of occupational (student) sitting time with standing or walking.
12: 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 as a student to stay below that average & try to throw in some standing and/or stepping time when you can.
13: 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: 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?
14: 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: For the next 7 days aim to break up your sitting as a student every 45 min for at least 4 min. Just because you are not seated does not mean work can't be done!

16: Hey Radha, hope you are able to make a lot of active choices today! Keep it up and soon they will become great healthy habits!

17: 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!

18: Tomorrow, try to replace as many sedentary school-related 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, take a ‘walking’ meeting - just keep moving!

19: DID YOU KNOW? Replacing prolonged sitting during studying and being a student with periods of light movement can have a positive effect on blood sugar control.

20: 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!

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 as a student every 30-45 min for at least 2-4 min.

22: 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: Next time you finish sending an email, or accomplishing a big day’s task - take a break to stand up or walk around.

24: Finding it hard to remember to take frequent breaks from sitting as a student? Try using a prompt/reminder to determine certain ‘standing times’ during the day!

25: This weekend 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: 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: Make a lot of phone calls, write a lot of emails, spend a lot of time studying - all the while being seated? Try doing some of these things standing! Who knows - you might find you prefer it!

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

29: 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!

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

30: Got a break at school? Go for a walk around the building, or better yet, for a brief walk outside instead of spending it sitting down.

30: 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: 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: Your challenge this week: replace 100 min/day of time usually spent sitting as a student (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: How has taking more frequent breaks from sitting as a student been? Hopefully it makes you feel energized and less lazy!

34: Here’s a tip to decrease your sitting time: if you take public transportation to school try standing instead of sitting. If you live only a close distance away & drive, perhaps try walking or cycling one day a week!

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 as a student.

36: For the last 7 days, your challenge is to take REGULAR BREAKS from sitting as a student by standing up every 30 min!

36: Is that 100min still feeling overwhelming? If you get up every 30min for 4min during school-related activities, that counts for over 1/2 of the 100min in 7 hrs.

37: 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: 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: This week try to replace 2 hours a day of sitting in class or while studying 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: Hey Radha, are you watching carefully that you are breaking up your sitting time as a student often enough?

40: 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: Looking for a way to increase your time spent moving while at school? Try walking to/from school & to each class. Take standing breaks after 30 min of sitting. Take stairs instead of the elevator! If you are still having trouble finding ways to reduce your sitting time, grab a friend & go for a walk together at lunch!

42: Hey Radha, it's been 6 weeks, please check your e-mail for the final questionnaire.

42: Enjoying taking regular breaks from sitting as a student? Perhaps, look into getting yourself an ACTIVE WORKSTATION. There are a number of sit-to-stand desks designed to increase mvmt while working!

43: 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.

43 (if necessary): If you haven’t done the week 6 questionnaire yet please do it ASAP. Here’s a tip, why not stand up every time you receive a phone call during studying?
Appendix N: Debriefing Letter (Study 1)

DEBRIEFING FORM

Project Title: Using a combined Health Action Process Approach and mHealth Intervention to Reduce Sedentary Behaviour in University Students

Investigators: Scott Rollo, Ph.D. (Principal Investigator; srollo@uwo.ca), Harry Prapavessis, Ph.D. (Co-investigator; hprapave@uwo.ca) & Kirsten Dillon, Ph.D. Student (Co-investigator; kdillon9@uwo.ca) 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 student sitting time by increasing frequency and length of breaks from sitting and non-sedentary behaviours (i.e., time spent standing and walking) among university students.

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 occupational (student) 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 as a student. All responses were completely confidential.

What you were not told: Approximately one half of participants received a single one-on-one behavioural counselling session regarding reducing sitting time as a student, 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 university students 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 occupational sedentary behaviour (i.e., as a student). 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 student 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, [contact information removed].
If you are comfortable with the above information and the use of your study data, please provide your consent below and email this document back to the researcher, [Kirsten Dillon](kdillon9@uwo.ca).

**Informed Consent to Use of Collected Data:**

I have read the Debriefing Form, have had the nature of the study explained to me and I consent to the use of my study data. All questions have been answered to my satisfaction.

________________________  ____________________  __________
Print Name of Participant  Signature  Date (DD-MMM-YYYY)

**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 [Kirsten Dillon](kdillon9@uwo.ca) or [Harrington Prapavessis](hprapave@uwo.ca). 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 at [ethics@uwo.ca](mailto:ethics@uwo.ca).

Thank you,
Appendix O: Ethics Approval (Study 2)
Date: 3 September 2020

To: Professor Marc Mitchell

Project ID: 116127

Study Title: STAND UP to COVID: using behavioural economics to reduce sedentary behaviour in at-home office workers, a pilot randomized controlled trial

Application Type: HSREB Initial Application

Review Type: Full Board

Full Board Reporting Date: 21/Jul/2020 13:00

Date Approval Issued: 03/Sep/2020 15:26

REB Approval Expiry Date: 03/Sep/2021

Dear Professor Marc Mitchell

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:

<table>
<thead>
<tr>
<th>Document Name</th>
<th>Document Type</th>
<th>Document Date</th>
<th>Document Version</th>
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<td>Debriefing Script</td>
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<tr>
<td>STANDUP-poster</td>
<td>Recruitment Materials</td>
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<td>FRIDAY QUESTIONNAIRE-(week 1,2,3)</td>
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<td>10/Aug/2020</td>
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<td>FRIDAY WEEK 4 QUESTIONNAIRE-(Choice of assignment assigned)</td>
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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 P: Email Script - Engagement of Key Contacts (Study 2)

Engagement of Key Managerial Contacts

Subject Line: Recruiting Employees to Participate in a Sedentary Behaviour Reduction Study

Hello ________,

We have received your emailed address from [insert method of obtaining contact info]. We the researchers, Madison Hiemstra (co-investigator), Kirsten Dillon (co-investigator) and Marc Mitchell (Principle Investigator) would like to invite your employees to participate in a study we are conducting. Briefly, we want to see what the best strategies are to help you sit less using tips in weekly emails. A participant would participate in the study for a four-week intervention involving a follow-up 2 weeks later, which will all be completed online. An activity monitor would be worn by a participant for a total of 10 days: 5 days before the intervention and 5 days during the last week of the intervention (mailed to your home with pre-paid postage). We would also be asking your employees to watch a short educational video about health outcomes and sitting, commit weekly to a strategy to decrease their sitting throughout the day and complete a total of 7 questionnaires. In total, around 1 hour and 15 minutes will be required to take part over an 8-week period. There is no compensation for participation, although participants will have a chance to win an eGiftcard upon study completion.

As this is a research project being conducted by researchers in the School of Kinesiology at Western University, we ask that you please consider assisting us with study implementation by allowing us to share our study information with your employees at [insert name of company] through the means of email promotion from management, offering your employees the opportunity to participate.

Study participation is completely voluntary and study procedures will all take place online and electronically (including a wearable activity tracking device mailed to them) over the course of 8 weeks.

A letter of information and recruitment poster given to participants have been attached to this email for your viewing. If you are willing to assist us with the recruitment process or would simply like more information on this study, please contact [Kirsten Dillon or Madison Hiemstra] via this email or the phone number listed below. We will send one reminder email within two weeks if we do not hear back from you.

Kind regards,

Email Script for Engagement of Company Employees (from Management)

Appendix Q: Email Script - Management to Employee Recruitment (Study 2)

Subject Line: Recruiting Employees to Participate in a Sedentary Behaviour Reduction Study

Hello ________,

I am announcing that we have partnered with a few researchers at Western University that are looking to recruit employees working from home, like yourself. The researchers, Madison Hiemstra (co-investigator), Kirsten Dillon (co-investigator) and Marc Mitchell (Principle Investigator) would like to invite you to participate in their research study. Briefly, they want to
see what the best strategies are to help you sit less using tips in weekly emails. A participant would participate in the study for a four-week intervention involving a follow-up in 2 weeks later, which will be completed online. An activity monitor would be worn by a participant for a total of 10 days: 5 days before the intervention and 5 days during the last week of the intervention (mailed to your home with pre-paid postage). They will also be asking participants to watch a short educational video about health outcomes and sitting, commit weekly to a strategy to decrease their sitting throughout the day and complete a total of 7 questionnaires. In total, around 1 hour and 15 minutes will be required to take part over the course of 8 weeks. There is no compensation for participation, although participants will have a chance to win an eGiftcard upon study completion.

As this is a research project being conducted by researchers in the School of Kinesiology at Western University, they have asked us to share the study information with you by means of email. I have attached a recruitment poster file and a more detailed letter of information that will offer you more details about what the study exactly consists of and what to do if you are interested. Please note that deciding not to participate will not affect your employee status with the company.

The researchers have stated that study participation is completely voluntary and study procedures will all take place online and electronically (with exception to a wearable activity tracking device that will be delivered via pre-paid mail) over the course of 8 weeks.

If you would like more information about the study, you can contact one of the co-investigators listed on the letter of information that is attached or there is info on the recruitment poster (also attached). You can contact either by the phone number listed or via email.

Thanks everyone,

[Management]

Appendix R: Email Script- Public Recruitment (Study 2)

Subject Line: Recruiting Participant to Participate in a Sedentary Behaviour Reduction Study in Home-Based Office

Hello ________,

We have received your emailed address from [insert method of obtaining contact info] and identified you as a potential participant who may be a full-time, office worker (18+ years old) working from home only. We the researchers, Madison Hiemstra (co-investigator), Kirsten Dillon (co-investigator) and Marc Mitchell (Principal Investigator) at Western University would like to you to participate in a study we are conducting. Briefly, we want to see what the best strategies are to help you sit less using tips in weekly emails. A participant will participate in the study for a four-week intervention involving a follow-up 2 weeks later, which will all be completed online. An activity monitor would be worn by a participant on their thigh for a total of 10 days: 5 days before the intervention and 5 days during the last week of the intervention (delivered to you via pre-paid postage). We would also be asking your employees to watch a
short educational video about health outcomes and sitting, commit weekly to a strategy to decrease their sitting throughout the day and complete a total of 7 questionnaire. In total, around 1 hour and 15 minutes will be required to take part over an 8-week period. There is no compensation for participation, although you will have a chance to win an eGiftcard upon study completion. Study participation is completely voluntary and study procedures will all take place online and electronically (including a wearable activity tracking device) over the course of 8 weeks. A letter of information and recruitment poster have been attached to this email for your viewing for more detailed information. If you are willing to participate or want more information, please contact [Kirsten Dillon or Madison Hiemstra] via this email or the phone number listed below. We look forward to hearing from you!

Kind regards,
Appendix S: Recruitment Poster (Study 2)
STAND UP TO COVID: USING BEHAVIOURAL ECONOMICS TO REDUCE SEDENTARY BEHAVIOUR IN AT-HOME OFFICE WORKERS, A PILOT RANDOMIZED CONTROLLED TRIAL

Principle Investigator: Marc Mitchell, PhD. Western University

PARTICIPANTS NEEDED FOR RESEARCH IN FULL-TIME, HOME-BASED OFFICE WORKERS

We are looking for volunteers to take part in a study of changing sedentary behaviours in home-based office workers who meet the following criteria:

- 18 years or older,
- self-declare working 5 days per week (Monday to Friday),
- a full-time worker/employee (i.e. employed ≥ 30 hours/week),
- are a desk-based office worker currently only working from home,
- have access to a computer with Internet and email,
- and are able to read and write in English.

If you are interested and agree to participate you would be asked to:

watch a 3-minute educational video twice, wear an activity monitor on your thigh for a total of two work weeks, complete 3 medium and a few brief questionnaires. Additionally, we are asking you change up your sitting habits using provided strategies.

Your participation would involve participating in the study for a total of 5 weeks, with a brief follow-up 2 weeks later.

The average weekly time commitment will be 10 minutes, and there will be three longer surveys to complete which will take about maximum 15-20 minutes each. (Estimated total 1.25 hrs).

For more information about this study, or to volunteer for this study, please contact:
Kirsten Dillon, PhD Student
School of Kinesiology, Western University
Appendix T: Letter of Information and Informed Consent (Study 2)

LETTER OF INFORMATION AND INFORMED CONSENT

Study Title: STAND UP to COVID: using behavioural economics to reduce sedentary behaviour in at-home office workers, a pilot randomized controlled trial

Name of Principal Investigator

Dr. Marc Mitchell, PhD (Principal Investigator; marc.mitchell@uwo.ca), Kirsten Dillon, MA, PhD Student (kdillon9@uwo.ca; Co-investigator), & Madison Hiemstra, BSc, Master’s Student (mbrow368@uwo.ca), School of Kinesiology, Western University.

This study is being funded by:
The Center for Advanced Hindsight at Duke University, North Carolina, USA

Conflict of Interest
The investigators have none to declare.

Introduction and Invitation to Participate
You are being invited to participate in a study because you are a home-based office worker. We are looking for 145 home-based office workers to look at the relationship between work-related activity and various health outcomes. The purpose of this letter is to offer you with the information that is required for you to make an informed decision about participating in our study. We invite you to read this letter closely.

Purpose
The purpose of this study is to determine the most effective strategy of helping you sit less using tips in weekly emails.

Inclusion Criteria
To participate in this study, individuals must: a) be 18+ years of age, b) be an office, desk-based worker currently working at least 50% from your home, c) self-declare working 5 days per week AND >30 hours/week and d) have a job requires them to sit for the majority of their typical workday (i.e. majority of work is computer-based).

Background
Today, Canadian office workers spend up to 9.6 hours in sedentary behaviours. Sedentary behaviours are any sitting, lying or reclining position that requires little to no energy; we will refer to this behaviour as “sitting” for the rest of this document. Long periods and high daily levels of sitting are strongly linked with many poor long-term health outcomes like high risk of diabetes or death. There has not been many studies looking at home-based office workers and their sitting levels, nor any related studies that involve behaviour change in this group.

Study Design
This is a four-week study, in which you will be randomly placed into one of two conditions. Throughout the study, you will be participating only from your home, all questionnaires will be delivered online. We will deliver and pickup activity monitors (activPAL4) to and from your home by courier (FedEx).

**Procedures**

Once you read through this letter and understand what you will be doing for the study, *please sign page 6 electronically*. Once signed and filled out, please email the electronic copy back to the researchers, along with your home address (for activity monitor delivery). If you have any questions, feel free to call or email one of the researchers; as we can provide further details about the study or answer any questions before you decide to consent.

Once digital consent and home address is received, you will be mailed your activity monitor and receive an email with a link to video instructions on how to apply the activity monitor to your mid-thigh using a waterproof adhesive (Tegaderm, 3M). You will wear the activity monitor from **Sunday afternoon/evening until the next Friday evening** (this is your “baseline”). A pre-paid courier envelope will be sent along with the activity monitor and it will be picked up from your house once you have worn the monitor for the week.

Once you complete your “baseline” week, you will be put into one of two groups. Please do not discuss your assignment with other co-workers if they are also doing the study. The next Monday after “baseline” will be the first week of the intervention. During the intervention period (4-weeks), you will receive an email every Monday, Wednesday, and Friday and will be asked to fill out a total of 5 questionnaires. Once the 4-week intervention ends, two-weeks later, you will fill out one more questionnaire (as a follow-up). A total of 7 questionnaires (1 pre-intervention, 5 during intervention and 1 post-intervention) will be filled out for this study.

All participants will have a 1 in 3 chance to win an eGiftcard (Starbucks or Tim Hortons) at the end of the study based on the number of completed questionnaires. The draw will happen upon study completion and if deemed a winner, the eGiftcard will be sent to you from one of the co-investigators via email.

Participating in the intervention will require you to:

1) Fill out a baseline questionnaire (10-15 minutes)
2) Watch a 3-minute educational video on two different occasions
3) Fill out 4 short questionnaires (2-3 minutes each)
4) Fill out a post-intervention questionnaire (10-15 minutes)
5) Fill out a follow-up questionnaire (10-12 minutes)
6) Wear an activity monitor on your thigh for a total of 10 full days (mailed to your house)
7) Reduce your sitting time during work hours using various behavioural strategies (provided to you)

Here is a timeline to further illustrate the study procedures:
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. No legal rights are waived by agreeing to participate. 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 new information will be collected without your permission.

Risks, Harms, or Inconveniences
Expected risks or discomforts related with participating in this study include disruption of your personal time to complete the required needs of the study. We do not expect any severe risks, harms, or inconveniences, however there are a few you need to be aware of:

a) Inconveniences: As a part of the study requirements, we will be asking you to fill out surveys (described earlier with time commitments, total roughly 1-hour and 15 minutes). We will also be asking you to break up sitting/lying/reclining throughout your workday. Although this may seem interruptive, evidence suggests movement throughout your workday can increase your focus and productivity levels.

b) Skin Reactions: Part of the measurement tools used will consist of a small monitor that will be attached to your thigh skin with Tegaderm (from 3M). There always is a possibility for skin irritation. If you experience a skin irritation/reaction, you should remove the monitor from your thigh and wash with soap and water. If this occurs on the first week, you may still participate in the study; you will provide measurements through a self-report survey. In addition to the small device, there is a large covering of tegaderm tape that will cover a substantial portion of the thigh.

c) Privacy: With any study, there is always a possibility for privacy breaches. It is possible that information could be intercepted by unauthorized people (hacked) or otherwise shared by accident. This risk cannot be completely eliminated.

Benefits
You may not directly benefit from being in this study. However, you may benefit from this study in a few ways. First, by participating in this study:

a) learn about the relationship between work-related movement patterns
b) have a chance to reflect upon and modify your own behaviour
c) learn helpful strategies to modify your work-related activity patterns.

Overall, the information learned from this study may be used to improve workplace wellness programs for home-based office workers in the future, in turn, this may lead to improved health outcomes and quality of life for other office-workers.

Confidentiality
By agreeing to participate in this study, you are agreeing to providing the researchers with your email (for questionnaires), name, age, gender, home address (for activity monitor delivery purposes) and telephone number (to go over the letter of information and obtain verbal/written consent and to contact you if we cannot get a hold of you through email). Your employer will not be informed of who is participating nor will the decision to participate have any impact on employment. We will be storing any de-identified study data collected from you on Western
OneDrive. The Master list (containing your name and phone number) and home address list files will remain separate from your de-identified data and will password-protected and encrypted and 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. You will be sent an personalized web-link to access and complete an online questionnaire through https://www.soscisurvey.de on five occasions, and one questionnaire and strategy assignments through Western Qualtrics, a secure platform. This will be sent to you via your preferred email address 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 (as per Western University policy) on Western OneDrive. 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.

**Costs and Compensation**
You will not have to pay to participate in this study. You will not receive any compensation for participation in the study.

**Questions about the Study**
If you have any questions regarding your participation in the study, please contact one of our co-investigators, [Kirsten Dillon](mailto:kdillon9@uwo.ca) (PhD student at Western University) or [Madison Hiemstra](mailto:mbrow368@uwo.ca) (Master's Student at Western University); or you may contact [Dr. Marc Mitchell](519 661 -2111 x87936). 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 [ethics@uwo.ca].
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
Hi, I’m Dr. Marc Mitchell, and today I want to talk to you about the dangers of sitting. Our bodies were designed to move. Moving our bodies keeps our blood flowing, nerves thriving, and joints lubricated ... and has an unbelievable impact on our minds! Just a little bit of movement, like walking for a few minutes, can have a massive impact on our mood, productivity at work, and our happiness in general!! Like my PhD mentor Dr. Guy Faulkner always says, “Sweat is the best anti-depressant”.

People with desk-based jobs typically spend around 77% of their workday sitting. On top of our 8-hour workday, many of us find ourselves sitting during meals, sitting while driving to and from work, and at the end of the day, kicking back on ol’ couch to watch TV. Ultimately, the average Canadian spends 9.6 hours sitting in ONE 24-hr day!!! Yikes...That’s a road trip from Toronto to Quebec City.

Sound familiar? I know it does.

Unfortunately, these sitting behaviours add up over the weeks and years of our life; increasing the likelihood of serious health complications. Many large population health studies have linked high levels of total daily sitting time and long periods of sitting (like 60 minutes or longer at a time) to an increased likelihood of premature death. Early death!!! It’s also linked to an increased risk of obesity, diabetes, heart disease, several types of cancer.... and so on. THE BIG ONES are what’s going on in your melon. Sitting for long periods of time can INSTANTLY affect your mood. Like, right this second!!

Now, you may be thinking, “oh, I exercise at least 30 minutes a day, I’m good... this sitting disease stuff doesn’t apply to me.” WRONG!!! EVEN if you exercise, sitting for the rest of your day leads to short and long-term health consequences.

When you’re sitting or lying down, you’re burning around 1 calorie per minute. That’s like one-quarter of a sprinkle on a vanilla dip donut! When you stand up, you activate your muscles, your heart beats faster, and your caloric burn increases slightly to around 1.5 calories per minute. If you’re standing for 9.6 hours a day, standing burns an additional 288 calories... sweet)! PLUS, standing up has shown to instantly relieve lower back and joint pain too.

In short, sitting is bad for us, not just in 20 years, but today too, no matter how old you are.

But, we want YOU to know that breaking up your sitting bouts, every 30 to 45 minutes, with at least 2 to 3 minutes of movement, WILL BOOST YOUR MOOD, work productivity and decrease back and joint pain INSTANTLY. Everything gets better when you move, and you don’t have to train for a triathlon to reap all those benefits.

As we all continue to work through our 8-hour days at our desks, give yourself a fighting chance. It’s simple, just moving a bit more does the trick. So, STAND UP and move... to protect your health.
Appendix V: Baseline Questionnaire- Forced Assignment Group (Study 2)

Online Questionnaire Template

[LOI + BASELINE QUESTIONNAIRE can be accessed here:](https://www.soscisurvey.de/test215545/)

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 and simply exit the browser.

   Agree
   Disagree

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

   Full time (30+ hours/week)
   Part time (less than 30 hours/week)

3. Over the next 4 weeks, on average, how many days per week will you be working from home?

   a. 1 day per week will be at home
   b. 2 days per week will be at home
   c. 3 days per week will be at home
   d. 4 days per week will be at home
   e. All of my work is done from home

4. What are the hours you work in-between?

   Start time=
   End time=

5. What sector are you employed in?

   Private sector
   Public sector
   Charity
   Other

6. Briefly, describe the industry in which you work

7. What is your age (in years)?
8. **With which gender do you identify?**

9. **What is your ethnicity?**

   People living in Canada come from many different cultural and racial backgrounds. Are you: [Please choose]
   - White
   - Asian
   - Black or African American
   - Hispanic or Latino
   - Aboriginal peoples of Canada (e.g., First Nations, Metis, Inuit)
   - Other

10. **What is your marital/relationship status?**

    - Single
    - Married or equivalent (i.e. common law; same sex)
    - Separated or equivalent
    - Divorced
    - Widowed

11. **Please indicate the highest level of education you have received**

    - Less than high school
    - Highschool diploma
    - College degree
    - University degree
    - Masters
    - Doctorate (i.e. MD, PhD)

12. **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:

13. **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)
14. In the past 3 months, have you been active for a minimum of 30 minutes/day on at least 3 days of the week? (i.e. jogging, biking, swimming)?

☐ Yes
☐ No

15. How many hours did you spend as an employee (i.e., in work-related activities) in the last 7 days?

*Please enter the number of HOURS (e.g., 40, 80, 105) you spent as an employee in total over the last two weeks.*

_____ hours

16. During the last 7 days, how many days were you involved in work-related activities?

*Please enter the number of DAYS (e.g., 1, 3, 5, 10) you were involved in work-related activities in total over the last week*

___ days

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

Not at all 1  A little 2  Somewhat 3  Quite a bit 4  A lot 5

*Now think about the time you spend as an employee involved in work-related activities. Examples of work-related activities include attending work-related computer use, working on projects/tasks, desk work, reading, meetings, phone calls, teleconferences, etc.***

18. Do you feel that you sit more or less since working from home due to the COVID-19 pandemic?

*On a scale of 1-5, “0” being “very much below average and “5” being “very much above average”.***

19. How would you describe your typical workday for the last 7 days? [This involves only time spent in work-related activities and does not include 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 ___ %
Standing ___ %
Moving (i.e. walking) ___ %
Sum =
20. In the last 7 days, on average, how often did you interrupt your sitting time (i.e., take a break to get up and move around) during a work-related activity?

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  
Over every 5 hours  
No interruption

21. In the last 7 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.

The next 2 questions are scored on the following 5 item Likert scale:

<table>
<thead>
<tr>
<th>Completely disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Totally agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

22. Over the next four weeks...

I INTEND to increase the NUMBER of breaks I take from sitting during work hours  
I PLAN to increase the NUMBER of breaks I take from sitting during work hours  
My GOAL is to increase the NUMBER of breaks I take from sitting during work hours

23. Over the next four weeks...

I INTEND to increase the amount of time that I spend in light activities (i.e. walking) during work hours  
I PLAN to increase the amount of time that I spend in light activities (i.e. walking) during work hours
MY GOAL is to increase the amount of time that I spend in light activities (i.e. walking) during work hours

The following 4 questions are rated on a 10-point scale ranging from 1 “my worst ever” to 10 “my best ever”

24. How would you and the following people describe your EFFICIENCY this week?

   a) Self  
   b) Supervisor  
   c) Co-workers

25. How would you and the following people describe the OVERALL QUALITY of your work this week?

   a) Self  
   b) Supervisor  
   c) Co-workers

26. How would you and the following people describe the OVERALL AMOUNT of work you did this week?

   a) Self  
   b) Supervisor  
   c) Co-workers

Example: Let’s say that you feel that you were so efficient this week that it is close to being your best possible performance. In this case your answer would fall somewhere between 8 and 9.

27. Rate your _____ level of efficiency this week:

   a) Highest  
   b) Lowest

28. In the previous 7 days of work, how frequently did you...
   (on a 0-10-point scale with 1 being “never” and 10 being “almost always”)

   Become restless while at work?  
   Lose interest or become bored with your work?  
   Had difficulty concentrating at work?  
   Feel too exhausted to do your work?

29. During the past 4 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 = 1, No = 2)
e) Cut down the \textbf{amount of time} you spent on work or other activities
f) \textbf{Accomplished less} than you would like
g) Were limited in the \textbf{kind} of work or other activities
h) Had \textbf{difficulty} performing the work or other activities (for example, it took extra effort)

\textbf{30. These questions are about how you feel and how things have been with you during the past 4 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 4 weeks...?

The following are measured on a 5-point Likert scale from 1 “all of the time” to 5 “None of the time”:

j) Did you feel full of pep?
k) Have you been a very nervous person?
l) Have you felt so down in the dumps that nothing could cheer you up?
m) Have you felt calm and peaceful?
n) Did you have a lot of energy?
o) Have you felt downhearted and blue?
p) Did you feel worn out?
q) Have you been a happy person?
r) Did you feel tired?

\textbf{31. During the past 4 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 = 1, No = 2)

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

d) Cut down the \textbf{amount of time} you spent on work or other activities
e) \textbf{Accomplished less} than you would like
f) Didn't do work or other activities as \textbf{carefully} as usual

\textbf{Thank you for completing this questionnaire!}

\textbf{We would like to thank you very much for helping us.}
Your answers were transmitted, you may close the browser window or tab now.
Appendix W: Baseline Questionnaire- Choice of Assignment Group (Study 2)

Online Questionnaire Template

**LOI + BASELINE QUESTIONNAIRE** can be accessed here:
[https://www.soscisurvey.de/test215545/](https://www.soscisurvey.de/test215545/)

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 and simply exit the browser.

   Agree
   Disagree

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

   Full time (30+ hours/week)
   Part time (less than 30 hours/week)

3. Over the next 4 weeks, on average, how many days per week will you be working from home?

   a. 1 day per week will be at home
   b. 2 days per week will be at home
   c. 3 days per week will be at home
   d. 4 days per week will be at home
   e. All of my work is done from home

4. What are the hours you work in-between?

   Start time=
   End time=

5. What sector are you employed in?

   Private sector
   Public sector
   Charity
   Other

6. Briefly, describe the industry in which you work

7. What is your age (in years)?
8. With which gender do you identify?

9. What is your ethnicity?

   People living in Canada come from many different cultural and racial backgrounds. Are you:
   [Please choose]
   □ White
   □ Asian
   □ Black or African American
   □ Hispanic or Latino
   □ Aboriginal peoples of Canada (e.g., First Nations, Metis, Inuit)
   □ Other

10. What is your marital/relationship status?

    □ Single
    □ Married or equivalent (i.e. common law; same sex)
    □ Separated or equivalent
    □ Divorced
    □ Widowed

11. Please indicate the highest level of education you have received

    Less than high school
    Highschool diploma
    College degree
    University degree
    Masters
    Doctorate (i.e. MD, PhD)

12. 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:

13. 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)
14. In the past 3 months, have you been active for a minimum of 30 minutes/day on at least 3 days of the week? (i.e. jogging, biking, swimming)?

☐ Yes
☐ No

15. How many hours did you spend as an employee (i.e., in work-related activities) in the last 7 days?

*Please enter the number of HOURS (e.g., 40, 80, 105) you spent as an employee in total over the last two weeks.*

_____ hours

16. During the last 7 days, how many days were you involved in work-related activities?

*Please enter the number of DAYS (e.g., 1, 3, 5, 10) you were involved in work-related activities in total over the last week*

___ days

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

Not at all  1  A little  2  Somewhat  3  Quite a bit  4  A lot  5

*Now think about the time you spend as an employee involved in work-related activities. Examples of work-related activities include attending work-related computer use, working on projects/tasks, desk work, reading, meetings, phone calls, teleconferences, etc.)*

18. Do you feel that you sit more or less since working from home due to the COVID-19 pandemic?

*On a scale of 1-5, “0” being “very much below average and “5” being “very much above average”.*

19. How would you describe your typical workday for the last 7 days? [This involves only time spent in work-related activities and does not include 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 ___%
Standing ___%
Moving (i.e. walking) ___%
Sum =

20. In the last 7 days, on average, how often did you interrupt your sitting time (i.e., take a break to get up and move around) during a work-related activity?
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
Over every 5 hours
No interruption

21. In the last 7 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.

The next 2 questions are scored on the following 5 item Likert scale:

Complete disagree Disagree Neutral Agree Totally agree
1 2 3 4 5

22. Over the next four weeks...

I INTEND to increase the NUMBER of breaks I take from sitting during work hours
I PLAN to increase the NUMBER of breaks I take from sitting during work hours
My GOAL is to increase the NUMBER of breaks I take from sitting during work hours

23. Over the next four weeks...

I INTEND to increase the amount of time that I spend in light activities (i.e. walking) during work hours
I PLAN to increase the amount of time that I spend in light activities (i.e. walking) during work hours
MY GOAL is to increase the amount of time that I spend in light activities (i.e. walking) during work hours

24. Choose one of the following:
a) I prefer to choose and manage my own sitting reduction strategies from a list of expert recommended strategies
b) I prefer to be assigned two strategies every week from a list of expert recommended strategies.

The following 4 questions are rated on a 10-point scale ranging from 1 “my worst ever” to 10 “my best ever”

25. How would you and the following people describe your EFFICIENCY this week?
   d) Self
   e) Supervisor
   f) Co-workers

26. How would you and the following people describe the OVERALL QUALITY of your work this week?
   d) Self
   e) Supervisor
   f) Co-workers

27. How would you and the following people describe the OVERALL AMOUNT of work you did this week?
   d) Self
   e) Supervisor
   f) Co-workers

Example: Let’s say that you feel that you were so efficient this week that it is close to being your best possible performance. In this case your answer would fall somewhere between 8 and 9.

28. Rate your _____ level of efficiency this week:
   c) Highest
   d) Lowest

29. In the previous 7 days of work, how frequently did you...
   (on a 0-10-point scale with 1 being “never” and 10 being “almost always”)

   Become restless while at work?
   Lose interest or become bored with your work?
   Had difficulty concentrating at work?
   Feel too exhausted to do your work?

30. During the past 4 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 = 1, No = 2)

i)  Cut down the amount of time you spent on work or other activities
j)  Accomplished less than you would like
k)  Were limited in the kind of work or other activities
l)  Had difficulty performing the work or other activities (for example, it took extra effort)

31. These questions are about how you feel and how things have been with you during the past 4 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 4 weeks...?

The following are measured on a 5-point Likert scale from 1 “all of the time” to 5 “None of the time”:

s)  Did you feel full of pep?
t)  Have you been a very nervous person?
u)  Have you felt so down in the dumps that nothing could cheer you up?
v)  Have you felt calm and peaceful?
w)  Did you have a lot of energy?
x)  Have you felt downhearted and blue?
y)  Did you feel worn out?
z)  Have you been a happy person?
aa) Did you feel tired?

32. During the past 4 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 = 1, No = 2)

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

   g)  Cut down the amount of time you spent on work or other activities
   h)  Accomplished less than you would like
   i)  Didn't do work or other activities as carefully as usual

Thank you for completing this questionnaire!

We would like to thank you very much for helping us.
Your answers were transmitted, you may close the browser window or tab now.
Appendix X: activPAL Instruction Emails (Study 2)

Western

Subject Title: [Your Activity Monitor is on the Way!]
Hello,
You should be receiving your activity monitor, activPAL4, in the mail within the week! When you receive your packages from the mail, you will find a glove, Tegaderm (a clear band-aid sheet application), and the activPAL4. To apply the activPAL4 properly to your leg, follow the instructions in this link: https://www.youtube.com/watch?v=CHCCX2GW3DM.
If you have ANY questions on how to apply the actiPAL4 onto your leg, please do not hesitate to contact one of the co-investigators, Kirsten Dillon (604) 356-6359, or kdillon9@uwo.ca OR Madison Hiemstra (226) 236-3975, or mbrow368@uwo.ca.
Please apply this on the Sunday afternoon/evening before the baseline period week starts (Monday morning). You are always to wear this from time of application up until the end of your workday on Friday (5 FULL days total; Monday-Friday). It is waterproof-able, so that you can shower while wearing it. Please avoid swimming during your wear time.
If you notice at any point, you find that the application (Tegaderm) becomes itching, burning, tingling, or uncomfortable in any unbearable way, REMOVE the application immediately, and wash with warm water and soap until any residue is off your leg. If this occurs, please contact either co-investigator immediately for further instructions/recommendations. It is important to know when you remove the activPAL4 for our data collection and how to best assist you during the study.
After you remove the activPAL4 on Friday evening (anytime after your workday is completed), please place the activPAL4 in the pre-paid return envelope that the actiPAL4 originally came in and it will be picked up via courier (FedEx).

As always, contact us if you have any questions through email or phone.

#2 Activity Monitor Details Repeat

Subject Title: [Your Activity Monitor is on the Way!]
Hi again!
You should be receiving your activity monitor, activPAL4, in the mail within the week for the second time! When you receive your packages from the mail, you will find a glove, Tegaderm (a clear band-aid sheet application), and the activPAL4. To apply the activPAL4 properly to your leg, follow the instructions in this link: https://www.youtube.com/watch?v=CHCCX2GW3DM.
If you have ANY questions on how to apply the actiPAL4 onto your leg, please do not hesitate to contact one of the co-investigators, Kirsten Dillon (+1 (604) 356-6359, or kdillon9@uwo.ca) OR Madison Hiemstra (+1 (226) 236-3975, or mbrow368@uwo.ca).

Please apply this on the Sunday before the baseline week starts (Monday) (preferably by the latest, evening). You are always to wear this from time of application up until the end of your workday on Friday. It is waterproof-able, so that you can shower while wearing it. Please avoid swimming during your wear time.

If you notice at any point, you find that the application (Tegaderm) becomes itching, burning, tingling, or uncomfortable in any unbearable way, REMOVE the application immediately, and wash with warm water and soap until any residue is off your leg. If this occurs, please contact either co-investigator immediately for further instructions/recommendations. It is important to know when you remove the activPAL4 for our data collection and how to best assist you during the study.

After you remove the activPAL4 on Friday evening (when your workday is completed), please place the activPAL4 in the pre-paid return envelope that the actiPAL4 originally came in and it will be picked up via courier (FedEx).

As always, contact us if you have any questions through email or phone.
Appendix Y: Monday Week 1 Questionnaire- Self-Selection Group (Study 2)

Choice of Assignment, Self-Selection - W1 Monday

俑 M STAND UP Week 1 - Choice ACTIVE CHOICE

Hi $(e://Field/RecipientFirstName),

Welcome to week 1! 🎉
1. We first need you to watch this EDUCATIONAL VIDEO.
2. Then, click THIS LINK. We will be asking you a few short questions about the video AND you will get to pick your strategies for this week! We encourage you to save the strategies you selected in a pdf form offered at the end of the survey.

Look out 🚨 for that reminder email this week about your strategies
AND get moving 🏃‍♂️ to increase your chances at winning a $20 Amazon gift card! 🎉🎉

Follow this link to the Survey: ☑️
$[{.:SurveyLink?d=Take the Survey}]

Or copy and paste the URL below into your internet browser: $[{.:SurveyURL}]

Follow the link to opt out of future emails:
$[{.:OptOutLink?d=Click here to unsubscribe}]

Version date: August 12, 2020

Start of Block: Knowledge Checker
Q14 Sitting for periods longer than an hour and a half is linked with long term detrimental health outcomes

- True (1)
- False (2)

Q15 Exercising for at least 30 minutes a day will protect you from the dangers of sitting all day

- True (1)
- False (2)

Q16 The average Canadian sits for 8 hours a day

- True (1)
- False (2)

Q17 2 to 3 minutes of standing every 30-45 minutes is enough to reduce risks associated with sitting too much

- True (1)
- False (2)

End of Block: Knowledge Checker

Start of Block: Intentions
Q18 Recently, have you given any thought to how much you sit?

<table>
<thead>
<tr>
<th></th>
<th>Not at all (1)</th>
<th>A little (2)</th>
<th>Somewhat (3)</th>
<th>Quite a bit (4)</th>
<th>A lot (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recently, have you</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>given any thought to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>how much you sit?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q19 Over the next four weeks...(answer all 3)

<table>
<thead>
<tr>
<th></th>
<th>Completely Disagree (1)</th>
<th>Disagree (2)</th>
<th>Neutral (3)</th>
<th>Agree (4)</th>
<th>Totally Agree (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I INTEND to increase the NUMBER of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>breaks I take from sitting during</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>work hours (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I PLAN to increase the NUMBER of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>breaks I take from sitting during</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>work hours (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MY GOAL is to increase the NUMBER of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>breaks I take during work hours (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Q20 Over the next four weeks...(answer all 3)

<table>
<thead>
<tr>
<th>Completely Disagree (1)</th>
<th>Disagree (2)</th>
<th>Neutral (3)</th>
<th>Agree (4)</th>
<th>Totally Agree (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I INTEND to increase the amount of time that I spend in light activities (i.e. walking) during work hours (1)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I PLAN to increase the amount of time that I spend in light activities (i.e. walking during work hours (2)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>MY GOAL is to increase the amount of time that I spend in light activities (i.e. walking) during work hours (3)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

End of Block: Intentions

Start of Block: Move More Often
Q1 Please choose your **2 MOVE MORE** Strategies this week:

- Set a constant 45-minute timer/alarm on your phone to break for a 2-minute walk or march on your spot throughout your workday
- Use text messages as a prompt to get up and sit down 3 times. This will hopefully allow you to break up your sitting at least every 45 minutes.
- Drink lots of water throughout your workday. Filling up your water bottle and taking more washroom breaks will hopefully allow you to break up your sitting every 45 minutes.
- Leave your phone on the other side of the room, and get up at least once every 45 minutes to go check it throughout your workday.
- Record how many steps you are getting with your smartphone or wearable device every 45 minutes; your goal is to get up to 200 steps.
- When you notice your body slacking, numbing or getting uncomfortable- get up and do 1-2 minutes of light stretching. Your goal is to get into a habit of stretching for 1-2 minutes at least every 45 minutes throughout your workday.
- Keep a tally of how many times you get up and sit down each hour. Try to work up to 1-2 sitting “breaks” within every 45 minutes of your workday.
- Set a constant 45-minute timer/alarm on your phone to break for 2-minutes of gentle squatting lunging, taking breaks when needed throughout your workday.

- **End of Block: Move More Often**

Start of Block: Block 3

*Display This Question:*

If Please choose your **2 MOVE MORE** Strategies this week: = Set a constant 45-minute timer/alarm on your phone to break for a 2-minute walk or march on your spot throughout your workday
Q4 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- I WILL break up my sitting throughout my work hours this week by: setting a constant 45-minute timer/alarm on your phone to break for a 2-minute walk or march on the spot throughout my workday, in order to improve my work productivity, enhance my mood, decrease body pains. (1)

- I WILL NOT break up my sitting time during my work hours this week, by setting a constant 45-minute timer/alarm on your phone to break for a 2-minute walk or march on the spot throughout my workday, EVEN if it means I increase risks of body pains and decreased work productivity and mood. (2)
Q5 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- I WILL break up my sitting throughout my work hours this week by: using text-messages as a prompt to get up and sit down 3 times, with the goal of breaking my sitting at least once every 45 minutes, in order to reduce my risk of diabetes, mental health issues and other detrimental health outcomes. (1)

- I WILL NOT break up my sitting time during my work hours this week, by using text-messages as a prompt to get up and sit down 3 times, with the goal of breaking my sitting at least once every 45 minutes, EVEN if it means I increase risks of body pains and decreased work productivity and mood. (2)
Q6 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- **I WILL** break up my sitting throughout my work hours this week by: *drinking lots of water throughout my workday. Filling up my water bottle and taking more washroom breaks will hopefully allow me to break up my sitting every 45 minutes.* This will help me to improve my work productivity, enhance my mood, decrease body pains. (1)

- **I WILL NOT** break up my sitting time during my work hours this week, by *drinking lots of water throughout my workday. Filling up my water bottle and taking more washroom breaks will hopefully allow me to break up my sitting every 45 minutes.* I will *not do this EVEN if it means* I increase risks of body pains and decreased work productivity and mood. (2)
Display This Question:

If Please choose your 2 MOVE MORE Strategies this week: = Leave your phone on the other side of the room, and get up at least once every 45-minutes to go check it throughout your workday.

Q7 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

○ I WILL break up my sitting throughout my work hours this week by: leaving my phone on the other side of the room, with the goal to get up at least once every 45 minutes throughout your workday. This will help me to improve my work productivity, enhance my mood, decrease body pains. (1)

○ I WILL NOT break up my sitting time during my work hours this week, by leaving my phone on the other side of the room, with the goal to get up at least once every 45 minutes throughout your workday, EVEN if it means I increase my risks of body pains and decreased work productivity and mood. (2)
Display This Question:

If Please choose your 2 MOVE MORE Strategies this week: = Record how many steps you are getting with your smartphone or wearable device every 45 minutes; your goal is to get up to 200 steps.

Q8 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

○ I WILL break up my sitting throughout my work hours this week by: recording how many steps I am getting with my smartphone or wearable devices every 45 minutes (my goal is to get up to 200 steps), in order to improve my work productivity, enhance my mood, decrease body pains. (1)

○ I WILL NOT break up my sitting time during my work hours this week, by recording how many steps I am getting with my smartphone or wearable device every 45 minutes; (my goal is to get up to 200 steps), EVEN if it means I increase my risks of body pains and decreased work productivity and mood. (2)
Q9 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- I WILL break up my sitting throughout my work hours this week by using the strategy: when I notice my body slacking, numbing or getting uncomfortable - get up and do 1-2 minutes of light stretching (my goal is to get into a habit of stretching for 1-2 minutes at least every 45 minutes throughout my workday), in order to improve my work productivity, enhance my mood, decrease body pains.  (1)

- I WILL NOT break up my sitting time during my work hours this week by using the strategy: by when I notice my body slacking, numbing or getting uncomfortable - get up and do 1-2 minutes of light stretching (my goal is to get into a habit of stretching for 1-2 minutes at least every 45 minutes throughout my workday), EVEN if it means I increase risks of body pains and decreased work productivity and mood.  (2)
If you choose your 2 MOVE MORE Strategies this week, keep a tally of how many times you get up and sit down each hour. Try to work up to 1-2 sitting “breaks” within every 45 minutes of your workday.

Q10 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- I WILL break up my sitting throughout my work hours this week by: keeping a tally of how many times I get up and sit down each hour and trying to work up to 1-2 sitting “breaks” within every 45 minutes of my workday, in order to improve my work productivity, enhance my mood, decrease body pains. (1)

- I WILL NOT break up my sitting time during my work hours this week by, keeping a tally of how many times I get up and sit down each hour and trying to work up to 1-2 sitting “breaks” within every 45 minutes of my workday, EVEN if it means I increase risks of body pains and decreased work productivity and mood. (2)
Q11 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- I WILL break up my sitting throughout my work hours this week by: setting a constant 45-minute timer/alarm on my phone to break for 2-minutes of gentle squatting lunging, taking breaks when I need it throughout my workday in order to improve my work productivity, enhance my mood, decrease body pains. (1)

- I WILL NOT break up my sitting time during my work hours this week by, setting a constant 45-minute timer/alarm on my phone to break for 2-minutes of gentle squatting lunging, taking breaks when I need it throughout my workday, EVEN if it means I increase risks of body pains and decreased work productivity and mood. (2)
Appendix Z: Monday Week 1 Questionnaire- Automated Group (Study 2)

Choice of Assignment Automation - W1
Monday

M STAND UP Week 1 - No CHOICE ACTIVE CHOICE

Hi $[e://Field/RecipientFirstName],

Welcome to week 1! 🎉
1. We first need you to watch this [EDUCATIONAL VIDEO](#).
2. Then, click [THIS LINK](#). We will be asking you a few short questions about the video AND you will receive your MOVE MORE strategies for this week! We encourage you to save the strategies you selected in a pdf form offered at the end of the survey.

Look out 🌙 for that reminder email this week about your strategies.
AND get moving 🕺 to increase your chances at winning a $20 gift card! 🎉💰

Follow this link to the Survey: 🌐
$[e://SurveyLink?d=Take the Survey]

Or copy and paste the URL below into your internet browser: $[e://SurveyURL]

Follow the link to opt out of future emails:
$[e://OptOutLink?d=Click here to unsubscribe]

Version date: August 12, 2020

Start of Block: Knowledge Checker

Q14 Sitting for periods longer than an hour and a half is linked with long term detrimental health outcomes

- True (1)
- False (2)
Q15 Exercising for at least 30 minutes a day will protect you from the dangers of sitting all day

- True (1)
- False (2)

Q16 The average Canadian sits for 8 hours a day

- True (1)
- False (2)

Q17 2 to 3 minutes of standing every 30-45 minutes is enough to reduce risks associated with sitting too much

- True (1)
- False (2)

- End of Block: Knowledge Checker

Start of Block: Intentions

Q18 Recently, have you given any thought to how much you sit?

<table>
<thead>
<tr>
<th>Not at all (1)</th>
<th>A little (2)</th>
<th>Somewhat (3)</th>
<th>Quite a bit (4)</th>
<th>A lot (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Recently, have you given any thought to how much you sit? (1)
<table>
<thead>
<tr>
<th></th>
<th>Completely Disagree (1)</th>
<th>Disagree (2)</th>
<th>Neutral (3)</th>
<th>Agree (4)</th>
<th>Totally Agree (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I INTEND to increase the NUMBER of breaks I take from sitting during work hours (1)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>I PLAN to increase the NUMBER of breaks I take from sitting during work hours (2)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>MY GOAL is to increase the NUMBER of breaks I take during work hours (3)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Q20 Over the next four weeks...(answer all 3)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Completely Agree (1)</th>
<th>Disagree (2)</th>
<th>Neutral (3)</th>
<th>Agree (4)</th>
<th>Totally Agree (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I INTEND to increase the amount of time that I spend in light activities (i.e. walking) during work hours (1)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I PLAN to increase the amount of time that I spend in light activities (i.e. walking) during work hours (2)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>MY GOAL is to increase the amount of time that I spend in light activities (i.e. walking) during work hours (3)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

*End of Block: Intentions*

Start of Block: Move More Often

**Within this question, it was coded so that each participant would be randomly assigned two strategies. Only the two strategies would show up for the participant. These two strategies would be carried into the next enhanced active choice questions (i.e., I will/ I will not do X...”)**
Q1 These will be your **2 MOVE MORE** Strategies this week (click next to continue):

- Set a constant 45-minute timer/alarm on your phone to break for a 2-minute walk or march on your spot throughout your workday (1)

- Use text messages as a prompt to get up and sit down 3 times. This will hopefully allow you to break up your sitting at least every 45 minutes. (2)

- Drink lots of water throughout your workday. Filling up your water bottle and taking more washroom breaks will hopefully allow you to break up your sitting every 45 minutes. (3)

- Leave your phone on the other side of the room, and get up at least once every 45-minutes to go check it throughout your workday. (4)

- Record how many steps you are getting with your smartphone or wearable device every 45 minutes; your goal is to get up to 200 steps. (5)

- When you notice your body slacking, numbing or getting uncomfortable get up and do 1-2 minutes of light stretching. Your goal is to get into a habit of stretching for 1-2 minutes at least every 45 minutes throughout your workday. (6)

- Keep a tally of how many times you get up and sit down each hour. Try to work up to 1-2 sitting “breaks” within every 45 minutes of your workday. (7)

- Set a constant 45-minute timer/alarm on your phone to break for 2-minutes of gentle squatting lunging, taking breaks when needed throughout your workday. (8)

• **End of Block: Move More Often**

Start of Block: Block 3

DISPLAY THIS QUESTION:

*If These will be your 2 MOVE MORE Strategies this week (click next to continue):*, Set a constant 45-minute timer/alarm on your phone to break for a 2-minute walk or march on your spot throughout your workday is displayed
Q4 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- **I WILL** break up my sitting throughout my work hours this week by: *setting a constant 45-minute timer/alarm on your phone to break for a 2-minute walk or march on the spot throughout my workday*, in order to improve my work productivity, enhance my mood, decrease body pains. (1)

- **I WILL NOT** break up my sitting time during my work hours this week, *by setting a constant 45-minute timer/alarm on your phone to break for a 2-minute walk or march on the spot throughout my workday, EVEN if it means* I increase risks of body pains and decreased work productivity and mood. (2)
Q5 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- I **WILL** break up my sitting throughout my work hours this week by: **using text-messages as a prompt to get up and sit down 3 times, with the goal of breaking my sitting at least once every 45 minutes**, in order to reduce my risk of diabetes, mental health issues and other detrimental health outcomes. (1)

- I **WILL NOT** break up my sitting time during my work hours this week, **by using text-messages as a prompt to get up and sit down 3 times, with the goal of breaking my sitting at least once every 45 minutes, EVEN if it means** I increase risks of body pains and decreased work productivity and mood. (2)
Q6 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- I WILL break up my sitting throughout my work hours this week by: *drinking lots of water throughout my workday. Filling up my water bottle and taking more washroom breaks will hopefully allow me to break up my sitting every 45 minutes.* This will help me to improve my work productivity, enhance my mood, decrease body pains. (1)

- I WILL NOT break up my sitting time during my work hours this week, by *drinking lots of water throughout my workday. Filling up my water bottle and taking more washroom breaks will hopefully allow me to break up my sitting every 45 minutes.* I will not do this EVEN if it means I increase risks of body pains and decreased work productivity and mood. (2)
Q7 As you now know, breaking up your sitting **every 45 minutes** with **2-3 minutes of light activity** can **significantly reduce** negative health risks associated with prolonged sitting. Place a check in **ONE** box:

- **I WILL** break up my sitting throughout my work hours this week by: *leaving my phone on the other side of the room, with the goal to get up at least once every 45 minutes throughout your workday.* This will help me to improve my work productivity, enhance my mood, decrease body pains. (1)

- **I WILL NOT** break up my sitting time during my work hours this week, *by leaving my phone on the other side of the room, with the goal to get up at least once every 45 minutes throughout your workday*, **EVEN if it means** I increase my risks of body pains and decreased work productivity and mood. (2)
Display This Question:
If These will be your 2 MOVE MORE Strategies this week (click next to continue): Record how many steps you are getting with your smartphone or wearable device every 45 minutes; your goal is to get up to 200 steps. Is Displayed

Q8 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- I WILL break up my sitting throughout my work hours this week by: recording how many steps I am getting with my smartphone or wearable devices every 45 minutes (my goal is to get up to 200 steps), in order to improve my work productivity, enhance my mood, decrease body pains. (1)

- I WILL NOT break up my sitting time during my work hours this week, by recording how many steps I am getting with my smartphone or wearable device every 45 minute ;(my goal is to get up to 200 steps), EVEN if it means I increase my risks of body pains and decreased work productivity and mood. (2)
Display This Question:

If These will be your 2 MOVE MORE Strategies this week (click next to continue): , When you notice your body slacking, numbing or getting uncomfortable- get up and do 1-2 minutes of light stretching. Your goal is to get into a habit of stretching for 1-2 minutes at least every 45 minutes throughout your workday. Is Displayed

Q9 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

- I WILL break up my sitting throughout my work hours this week by using the strategy: when I notice my body slacking, numbing or getting uncomfortable- get up and do 1-2 minutes of light stretching (my goal is to get into a habit of stretching for 1-2 minutes at least every 45 minutes throughout my workday), in order to improve my work productivity, enhance my mood, decrease body pains. (1)

- I WILL NOT break up my sitting time during my work hours this week by using the strategy: by when I notice my body slacking, numbing or getting uncomfortable- get up and do 1-2 minutes of light stretching (my goal is to get into a habit of stretching for 1-2 minutes at least every 45 minutes throughout my workday), EVEN if it means I increase risks of body pains and decreased work productivity and mood. (2)
If These will be your 2 MOVE MORE Strategies this week (click next to continue): Keep a tally of how many times you get up and sit down each hour. Try to work up to 1-2 sitting “breaks” within every 45 minutes of your workday. Is Displayed

Q10 As you now know, breaking up your sitting every 45 minutes with 2-3 minutes of light activity can significantly reduce negative health risks associated with prolonged sitting. Place a check in ONE box:

○ I WILL break up my sitting throughout my work hours this week by: keeping a tally of how many times I get up and sit down each hour and trying to work up to 1-2 sitting “breaks” within every 45 minutes of my workday, in order to improve my work productivity, enhance my mood, decrease body pains. (1)

○ I WILL NOT break up my sitting time during my work hours this week by, keeping a tally of how many times I get up and sit down each hour and trying to work up to 1-2 sitting “breaks” within every 45 minutes of my workday, EVEN if it means I increase risks of body pains and decreased work productivity and mood. (2)
**Display This Question:**

If These will be your 2 MOVE MORE Strategies this week (click next to continue): , Set a constant 45-minute timer/alarm on your phone to break for 2-minutes of gentle squatting lunging, taking breaks when needed throughout your workday. Is Displayed

Q11 As you now know, breaking up your sitting **every 45 minutes** with **2-3 minutes of light activity** can **significantly reduce** negative health risks associated with prolonged sitting. Place a check in **ONE** box:

- I **WILL** break up my sitting throughout my work hours this week by: **setting a constant 45-minute timer/alarm on my phone to break for 2-minutes of gentle squatting lunging, taking breaks when I need it throughout my workday** in order to improve my work productivity, enhance my mood, decrease body. (1)

- I **WILL NOT** break up my sitting time during my work hours this week by, **setting a constant 45-minute timer/alarm on my phone to break for 2-minutes of gentle squatting lunging, taking breaks when I need it throughout my workday**, **EVEN if it means** I increase risks of body pains and decreased work productivity and mood. (2)

---

End of Block: Block 3

Start of Block: Block 2
Appendix AA- Friday Questionnaire- Week 4 - Forced Assignment Group (Study 2)

**FRIDAY WEEK 4 (POST-INTERVENTION) QUESTIONNAIRE** can be accessed here:  
https://www.soscisurvey.de/test215763/

1. **How many hours did you spend as an employee (i.e., in work-related activities) in the last 7 days?**  
*Please enter the number of HOURS (e.g., 40, 80, 105) you spent in school-related activities in total over the last two weeks.*  

_____ hours

2. **During the last 7 days, how many days were you involved in work-related activities?**  
*Please enter the number of DAYS (e.g., 1, 3, 5, 10) you were involved in work-related activities in total over the last week*  

___ days

*Now think about the time you spend as an employee involved in work-related activities. Examples of work-related activities include attending work-related computer use, working on projects/tasks, desk work, reading, meetings, phone calls, teleconferences, etc.)*

3. **How would you describe your typical workday for the last 7 days?** [This involves only time spent in work-related activities and does not include 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 ____ %  
- Standing ____ %  
- Moving (i.e. walking) ____ %  

Sum =

4. **In the last 7 days, on average, how often did you interrupt your sitting time (i.e., take a break to get up and move around) during a work-related activity?**

- 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  
- Over every 5 hours  
- No interruption
5. In the last 7 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.

6. In the last 7 days, how useful did you find your strategies?

Not useful Some impact Useful
1 2 3

The following 4 questions are rated on a 10-point scale ranging from 1 “my worst ever” to 10 “my best ever”

7. How would you and the following people describe your EFFICIENCY this week?

- g) Self
- h) Supervisor
- i) Co-workers

8. How would you and the following people describe the OVERALL QUALITY of your work this week?

- g) Self
- h) Supervisor
- i) Co-workers

9. How would you and the following people describe the OVERALL AMOUNT of work you did this week?

- g) Self
- h) Supervisor
- i) Co-workers

Example: Let’s say that you feel that you were so efficient this week that it is close to being your best possible performance. In this case your answer would fall somewhere between 8 and 9.
10. Rate your _____ level of efficiency this week:
   e) Highest
   f) Lowest

11. In the previous 7 days of work, how frequently did you...
   (on a 0-10-point scale with 1 being “never” and 10 being “almost always”)

   Become restless while at work?
   Lose interest or become bored with your work?
   Had difficulty concentrating at work?
   Feel too exhausted to do your work?

12. During the past 4 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 = 1, No = 2)

   m) Cut down the amount of time you spent on work or other activities
   n) Accomplished less than you would like
   o) Were limited in the kind of work or other activities
   p) Had difficulty performing the work or other activities (for example, it took extra effort)

13. These questions are about how you feel and how things have been with you during the past 4 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 4 weeks...

   The following are measured on a 5-point Likert scale from 1 “all of the time” to 5 “None of the time”:

   bb) Did you feel full of pep?
   cc) Have you been a very nervous person?
   dd) Have you felt so down in the dumps that nothing could cheer you up?
   ee) Have you felt calm and peaceful?
   ff) Did you have a lot of energy?
   gg) Have you felt downhearted and blue?
   hh) Did you feel worn out?
   ii) Have you been a happy person?
   jj) Did you feel tired?

14. During the past 4 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 = 1, No = 2)
For each question, please give the one answer that comes closest to the way you have been feeling.

j) Cut down the amount of time you spent on work or other activities  
k) Accomplished less than you would like  
l) Didn't do work or other activities as carefully as usual

Now, please complete our very short exit survey. This survey asks you about your feelings towards various aspects of the study – please complete it to help us improve the program in the future. Please remember that these answers are confidential, and the researchers will not directly link your name to your responses...so be honest! 😊

For each of the following questions, choose the answer that best describes how you feel.

15. Reason for participating – the main reason I signed up for the study was because

   • I would learn more about the health consequences of sitting and strategies to reduce them.  
   • A co-worker was doing the study, so I thought I would also participate.  
   • My manager suggested this would be a great study to participate in.  
   • I like participating in studies in general  
   • Other

16. The following pertain to the study overall…

   Choose the answer that best describes how you feel

   • Strongly disagree  
   • Disagree  
   • Neutral  
   • Agree  
   • Strongly agree

   a) I would say this study helped me increase my knowledge about what sedentary behaviour is and how I can reduce it during work periods.  
   b) Pre-committing to my strategies was a great motivational tool for helping me complete the strategies.  
   c) I found that the change up of strategies each week was useful at keeping me engaged and continuing to complete the strategies  
   d) I wish I had the option to choose my own strategies from a list  
   e) I found that the self-report prompt at the end of the week to report my sitting habits was motivation to keep me committed to reducing my sitting time.  
   f) I was honest when reporting my sitting habits for the self-report prompt at the end of the week.  
   g) I found the video(s) interesting to watch.  
   h) After I had new strategies for the week, I still found myself doing the other strategies from the weeks before.
17. What did you like about this work from home sedentary behaviour study?

18. What did you not like about this work from home sedentary behaviour study?

19. If you could change one thing about this study, it would be: ____

   Thank you for completing this questionnaire!

   We would like to thank you very much for helping us. Your answers were transmitted, you may close the browser window or tab now.
Appendix BB: Baseline question results of "Do you feel that you sit more or less than average since working from home due to the COVID-19 pandemic? (Study 2)"
Appendix CC: Reproduction Permission (Study 3A)

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From: Kirsten Dillon
Date: Monday, April 18, 2022 05:07 PM GMT

Thank you so much!

The Journal is Applied Ergonomics and the title of the article is, “Validity of the occupational sitting and physical activity questionnaire (OSPAQ) for home-based office workers during the COVID-19 global pandemic: A secondary analysis”

Kind regards,

Kirsten

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Modified OSPAQ Questionnaire

1. How many hours did you spend as an employee (i.e., in work-related activities) in the last 7 days?

   Please enter the number of HOURS (e.g., 40, 80, 105) you spent in school-related activities in total over the last two weeks.

   _____ hours

2. During the last 7 days, how many days were you involved in work-related activities?

   Please enter the number of DAYS (e.g., 1, 3, 5, 10) you were involved in work-related activities in total over the last week

   ____ days

   Now think about the time you spend as an employee involved in work-related activities. Examples of work-related activities include attending work-related computer use, working on projects/tasks, desk work, reading, meetings, phone calls, teleconferences, etc.)

3. How would you describe your typical workday for the last 7 days? [This involves only time spent in work-related activities and does not include 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 ____ %

   Standing ____ %

   Moving (i.e., walking) ____ %

   Sum =
Appendix EE: Modified Sit-Q 7d Questionnaire (Study 3B)

Modified Sit-Q 7d Questionnaire


1. In the last 7 days, on average, how often did you interrupt your sitting time (i.e., take a break to get up and move around) during a work-related activity?

   o Less than every 30 min
   o Every 30-45 min
   o Every 45 min - 1 hour
   o Every 1-1.5 hours
   o Every 1.5-2 hours
   o Every 2-3 hours
   o Every 3-4 hours
   o Every 4-5 hours
   o Over every 5 hours
   o No interruption

2. In the last 7 days, on average, how long were your breaks from sitting during work hours?

   o Less than 30 sec,
   o 30 sec – 1 min,
   o 1-2 min,
   o 2-3 min,
   o 3-4 min,
   o 4-5 min,
   o 5–10 min,
   o 10–15 min,
   o 15–30 min,
   o Over 30 min.
Curriculum Vitae

Name: Kirsten Dillon

Post-secondary Education:

Western University, London, Ontario, Canada (2019-)
Faculty of Health Sciences, School of Kinesiology
PhD in Kinesiology - Psychological Basis of Kinesiology
Supervisors: Dr. Harry Prapavessis & Dr. Paul Gardiner
Currently Pursuing

Western University, London, Ontario, Canada (2017-2019)
Faculty of Health Science, School of Kinesiology
Master of Arts (MA) in Kinesiology- Thesis Based
Supervisor: Dr. Harry Prapavessis
Graduated, 2019

York University, Toronto, Ontario, Canada (2012-2017)
Faculty of Health Sciences, School of Kinesiology
Bachelor of Science, Honors double Major/Minor in Kinesiology & Psychology
Graduated, 2017

Academic Accomplishments/Research Contributions

Publications-


Other Publications


Conference Presentations-


**Dillon, K.** REducing SEDENTary behaviour amongst mild to moderate cognitively impaired assisted living residents: a pilot randomized controlled trial (RESEDENT study). Poster Presentation at London Health Research Day (LHRD), Ontario, Canada (Provincial, April 2019)

**Dillon, K. & Prapavessis, H.** REducing SEDENTary behaviour amongst mild to moderate cognitively impaired assisted living residents: a pilot randomized controlled trial (RESEDENT study). Oral presentation at the Eastern Canada Sport and Exercise Psychology Symposium (ECSEPS), Montreal, QC. (National, March 2018)

*Interviews and Media Relations –*


**Dillon, K., & Hiemstra, M.** Radio Interview. STAND UP to COVID: using behavioural economics to reduce sedentary behaviour in at-home office workers, a pilot randomized controlled trial. iheartradio (94.5 Virgin Radio), Vancouver. October 2020


**Dillon, K.,** Published Interview. Work-from-homes can ‘stand up’ to COVID, A Western-led study aims to get more people moving as they work from home during COVID-19. Western News, London. September 2020.

*Teaching Assistantships-*
- KIN 4276G: Psychology of Body & Movement, Western University, Jan 2022-April 2022
- KIN 1070A: Psychology of Human Movement Science, Western University, Sept- Dec 2021
- KIN 3412B: Exercise for Special Populations: Chronic Disease, Western University Jan 2021-Apr 2021
- KIN 3402A: Introduction to Clinical Kinesiology, Western University, Sept 2020-Dec 2020
- KIN 3421B: Exercise and Chronic Disease: Special Populations, Western University, Jan 2019–Apr 2019
- KIN 3421A: Professional Kinesiology, Western University, Sept 2018–Dec 2018
- KIN 2000B: Physical Activity and Health, Western University, Jan 2018–Apr 2018
- KIN 3341: Biomechanical Analysis of Physical Activity, Western University, Sept 2017–Dec 2017

Scholarships, Award and Other Accolades:

- **Ontario Graduate Scholarship**, Western University, PhD in Kinesiology, September 2022-August 2023, $15,000.00 (Declined)
- **Ontario Graduate Scholarship**, Western University, PhD in Kinesiology, September 2021-August 2022, $15,000.00
- **Ontario Graduate Scholarship**, Western University, PhD in Kinesiology, September 2020-August 2021, $15,000.00
- Western Graduate Research Scholarship, School of Kinesiology, Faculty of Health Sciences, Western University, PhD in Kinesiology, September 2020- August 2021, $5,000.
- Graduate Teaching Assistantship, School of Kinesiology, Western University, PhD in Kinesiology, September 2020- April 2021, $6,672.84.
- **AER Global Opportunities Award**, Western International, Faculty of Health Sciences, Western University, PhD in Kinesiology, April 2020, $2,000.
- Graduate Conference Travel Award, Faculty of Health Sciences (FHS), Western University, PhD in Kinesiology, January 2020, $420.00.
- **Rapid Presentation Award Winner**, International Research Network on Dementia Prevention (IRNDP) Conference, PhD in Kinesiology, October 2019.
- Graduate Conference Travel Award, Faculty of Health Sciences (FHS), Western University, PhD in Kinesiology, September 2019, $362.00.
- Kinesiology Graduate Student Travel Award, School of Kinesiology, Western University, PhD in Kinesiology, September 2019, $501.00.
- Society of Graduate Students (SOGS), Western University, Masters in Kinesiology, September 2019, $400.00
- **Ontario Graduate Scholarship**, Western University, PhD in Kinesiology, September 2019- August 2020, $15,000.00.
- Western Graduate Research Scholarship, School of Kinesiology, Faculty of Health Sciences, Western University, PhD in Kinesiology, September 2019- August 2020, $10,000.
• Graduate Conference Travel Award, Faculty of Health Sciences (FHS), Western University, Masters in Kinesiology, May 2018, $250.00.
• Graduate Teaching Assistantship, School of Kinesiology, Western University, Masters in Kinesiology, September 2018- April 2019, $6537.84.
• Western Graduate Research Scholarship, School of Kinesiology, Faculty of Health Sciences, Western University, Masters in Kinesiology, September 2018- August 2019, $3,650.37.
• Graduate Teaching Assistantship, School of Kinesiology, Western University, MA in Kinesiology, September 2017- April 2018, $6537.84.
• Western Graduate Research Scholarship, School of Kinesiology, Faculty of Health Sciences, Western University, Masters in Kinesiology, September 2017- August 2018, $3,650.38.
• University Sports Academic All-Canadian, University Sports (U-Sports), York University, April 2017, Distinction.
• Most Valuable Player (MVP), York University Varsity Women’s Volleyball, April 2017, Distinction.
• Ontario University Athletics Team All-Star, Ontario University Athletics (OUA), York University, February 2017, Distinction.
• Dean's Honor List, Kinesiology & Health Sciences, York University, B.Sc. Honors double Major/Minor in Kinesiology & Psychology, September 2012-April 2017.
• Team Captain, York University Women’s Varsity Volleyball, September 2016- April 2017, Distinction.
• Athletic Financial Award (AFA), York University, B.Sc. in Kinesiology & Health Sciences, September 2016- April 2017, $4,000.00.
• Team Captain, York University Women’s Varsity Volleyball, September 2015- April 2016, Distinction.
• Athletic Financial Award (AFA), York University, B.Sc. in Kinesiology & Health Sciences, September 2015- April 2016, $4,000.00.
• Assistant Team Captain, York University Women’s Varsity Volleyball, September 2014- April 2015, Distinction.
• Athletic Financial Award (AFA), York University, B.Sc. in Kinesiology & Health Sciences, September 2014- April 2015, $4,000.00.
• Ontario University Athletics Athlete of the Week, Ontario University Athletics (OUA), February 2013, Distinction.
• York University Athlete of the Week, York University, January 2013, $50.00, Distinction.
• Athletic Financial Award (AFA), York University, B.Sc. in Kinesiology & Health Sciences, September 2013- April 2014, $4,000.00.
• Athletic Financial Award (AFA), York University, B.Sc. in Kinesiology & Health Sciences, September 2012 - April 2013, $4,000.00.