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Abstract and Keywords

Sedentary behavior (SB) has been associated with chronic diseases, such as hypertension and obesity; the risk appears greater the longer one engages in SB. University students are a high-risk population for excessive SB due to academic responsibilities. Increasing frequency/length of breaks from sitting is an effective way to attenuate effects of SB. The Health Action Process Approach (HAPA) is a proven health behavior change model for behaviors like nutrition, but has yet to show effectiveness for increasing non-sedentary behaviors. Forty-five university students (12 Males, Mean age 23.3) were randomized into HAPA-intervention (sedentary behavior) or HAPA-control (nutrition) groups. Occupational Student and Non-Occupational Screen Time Break Frequency and Duration were assessed at eight time points (Baseline, Week 1-6 Treatment, Follow-up). Moderate to large non-significant effects ($\eta^2_p = 0.10 - 0.23$) were found favoring the intervention group for all measures. Findings suggest a HAPA-based intervention has potential to break up SB in university students.

Keywords: Sedentary Behavior, Break frequency, Break duration, Health Action Process Approach, Action Planning, Coping Planning, University Students
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Contents
Abstract and Keywords .......................................................................................................................... ii
Acknowledgements ............................................................................................................................. iii
List of Tables ........................................................................................................................................ vii
List of Figures ....................................................................................................................................... viii
List of Appendices ............................................................................................................................... ix
1. Introduction ........................................................................................................................................ 1
  1.1 Defining Sedentary behavior ........................................................................................................... 1
  1.2 How Much Sitting Do We Do? ...................................................................................................... 2
  1.3 Sedentary behavior as a disease .................................................................................................. 2
  1.4 Breaking up sedentary behavior ................................................................................................. 4
  1.5 Occupational Interventions ......................................................................................................... 6
  1.6 The Health Action Process Approach (HAPA) ........................................................................... 9
  1.7 HAPA model as a predictor of Health Behavior ......................................................................... 11
  1.8 HAPA model as an intervention for increasing Physical Activity .............................................. 11
  1.9 HAPA model as an intervention for reducing sedentary behavior ........................................... 12
Purpose ................................................................................................................................................ 14
Hypothesis .......................................................................................................................................... 14
2. The Current Study ............................................................................................................................. 15
  2.1 Methods ....................................................................................................................................... 15
    Participants ....................................................................................................................................... 15
    The modified SIT-Q 7d questionnaire .............................................................................................. 16
    Breaks from Sitting as a Student (Primary Outcome Measures) ...................................................... 17
    Breaks from Sitting while Engaged in Screen Time (Secondary Outcome Measures) .................. 17
    Other Measures .......................................................................................................................... 18
      Time Spent Sitting ..................................................................................................................... 18
    Treatment ........................................................................................................................................ 20
      Health Action Process Approach (HAPA) to Break Up Sitting as a Student ............................ 20
Behavioral Counseling Form ........................................................................................................... 88
Modified SIT-Q 7d Legend............................................................................................................ 89
Legend (continued)...................................................................................................................... 90
Appendix C ................................................................................................................................... 91
Modified SIT-Q 7d Poster............................................................................................................. 92
Curriculum Vitae .......................................................................................................................... 93
List of Tables

Table 1. Means, Standard Deviations, and 95% Confidence Intervals for Frequency of Breaks from Occupational (Student) Sitting at Each Time Point..........................................................28

Table 2. Means, Standard Deviations, and 95% Confidence Intervals for Duration of Breaks from Occupational (Student) Sitting at Each Time Point..........................................................30

Table 3. Means, Standard Deviations, and 95% Confidence Intervals for Frequency of Breaks from Screen Time Sitting at Each Time Point........................................................................32

Table 4. Means, Standard Deviations, and 95% Confidence Intervals for Duration of Breaks from Screen Time Sitting at Each Time Point........................................................................33
# List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Health Action Process Approach Model (HAPA; Schwarzer, 2008)</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Flow of participants through the study</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Average weekly baseline sitting profile for intervention group participants</td>
<td>26</td>
</tr>
<tr>
<td>4</td>
<td>Average weekly baseline sitting profile for control group participants</td>
<td>27</td>
</tr>
<tr>
<td>5</td>
<td>Occupational Break Frequency scores throughout the study</td>
<td>29</td>
</tr>
<tr>
<td>6</td>
<td>Occupational Break Duration scores throughout the study</td>
<td>31</td>
</tr>
</tbody>
</table>
List of Appendices

Appendix A: Recruitment Poster, Ethics Approval, and Letter of Information........................................55

Appendix B: Demographic questionnaire, Dietary Recall survey, modified SIT-Q 7d, Behavioral Counseling form, and modified SIT-Q 7d Legend..............................................................64

Appendix C: Modified SIT-Q 7d Pilot Study Poster..................................................................................91
1. Introduction

1.1 Defining Sedentary behavior

The field of Sedentary Behavior (SB) research has been gaining significant attention over the past decade, and it’s clear why: sedentary behaviors are pervasive in nearly every aspect of daily living. Recent estimates of television use and driving personal vehicles are higher than ever before, at 4 hours and 1 hour per day, respectively (Owen, 2010). Occupational sedentary behavior is also prevalent; in 2003, close to 6 in 10 working adults use a computer on the job (Owen, 2010). Sedentary behavior is defined as: “any waking behavior that is less than/equal to 1.5 METs, and is in a seated, lying, or reclining position.” (Healy et al., 2011). A MET is a Metabolic Equivalent Task, a multiple of the basin metabolic rate (Owen, 2012), defined in terms of oxygen uptake; one MET is equal to 3.5 mL·kg⁻¹·min⁻¹ (Pate, O’Neill & Lobello, 2008). Sedentary Behaviors require ≤1.5 METs, Light or Incidental Physical Activity requiring >1.5 and <3.0 METs, and Physical Activity requiring ≥3.0 METs (Pate et al., 2008; Tremblay et al., 2010). It is important to note that standing, which could be considered sedentary from a MET viewpoint, is not considered a sedentary behavior (Owen et al., 2010). It is also important to make the distinction between sedentary behavior and physical inactivity. While many authors classify and measure sedentary behavior and physical inactivity as being the same, typically derived from a threshold of >100 counts per minute on an accelerometer (Carson et al., 2014; Healy et al., 2011) the behaviors are not necessarily the same; while sitting and lying can be categorized as both physically inactive and sedentary behaviors, standing is not a sedentary behavior – despite being physically inactive (Owen, 2011). As Saunders et al. suggests, “Sedentary behavior should not be viewed as simply the lack of physical activity but may instead represent an independent and distinct risk factor for chronic disease” (2011). Indeed, this “sedentary physiology” (Owen, 2010) associated with sedentary behavior introduces its own unique health risks and consequences, and as such should not simply be viewed as a lack of physical activity.
1.2 How Much Sitting Do We Do?

Guidelines for Physical Activity for most populations are, for the most part, well established. Health Canada recommends that adults (18-64) be active at least 2.5 hours a week to achieve health benefits, as well as focus on moderate to vigorous aerobic activity throughout each week (CSEP, 2012). However, guidelines for sedentary behavior are less developed, despite sedentary behaviors occupying a much larger portion of the average person’s waking day. The CSEP Canadian Physical Activity and Sedentary Behavior Guidelines do not include a section for sedentary behaviors for Adults 18-64 years, and only include one measurable recommendation for Youth 12-17 years: limiting recreational screen time to no more than 2 hours per day (CSEP, 2012). A 2014 study estimated that Canadians are sitting close to 10.8 hours a day (Carson et al.) and a 2010 study estimated Americans are sitting up to 10.2 hours a day (Owen, Sparling, Healy, Dunstan, & Matthews); time spent engaged in sedentary behaviors easily add up to over half the average adult’s waking day (Saunders, 2011).

1.3 Sedentary behavior as a disease

While excessive sedentary behaviors pose a health risk simply due to displacement of time available for higher MET activities, there are many distinct health risks associated with engaging in prolonged sedentary behaviors.

There have been numerous large-scale epidemiology studies that have assessed the effect of prolonged or excessive sedentary behavior on cardio-metabolic factors. A study with 861 sedentary Spanish workers, for instance, found that the most sedentary workers had a significantly worse lipid and metabolic profile than their less sedentary counterparts, with higher levels of triglycerides, lower levels of HDL Cholesterol, and more biomarkers indicating insulin resistance (glucose levels, insulin), and inflammation (leukocytes, C-Reactive Protein); all independent of physical activity level (Léon-Latre et al., 2014). Similarly, the detrimental effects of sedentary behavior on cardio-metabolic biomarkers were supported by Buman et al. in analyzing 2005-2006 NHANES data (n=2,185); sedentary behavior was seen to be detrimentally associated with insulin levels, insulin sensitivity, and triglycerides (2014). A study by Stephens et al. found that even one day of uninterrupted sitting can reduce whole body insulin action by
39% in healthy adults (2011). A review of 18 studies by Wilmot and colleagues (2012) found that there was a 112% increase in relative risk for diabetes, 147% increase in the risk for cardiovascular disease, and 90% increase in cardiovascular mortality associated with higher levels of sedentary behavior. Collectively, they also attributed a 49% increase in all-cause mortality from prolonged sedentary behavior.

Bed rest studies also offer insight into the deleterious effects of chronic sedentary behavior. Hamburg et al. observed a decreased insulin sensitivity, as well as increased blood pressure, dyslipidemia and impaired microvascular function in healthy volunteers after 5 days of bed rest (2007). A systematic review by Saunders et al. found evidence suggesting that uninterrupted bouts of sedentary behavior of 2 hours to 7 days results in “rapid and deleterious changes in triglyceride levels, insulin sensitivity, and glucose tolerance” (2011).

Excessive sedentary behavior has also been linked to greater cancer risk. A review by Schmid and Leitzmann (2014) found that, when comparing the highest to lowest levels of sedentary behavior, there was an increase in relative risk for colon cancer (RR=1.24, 95% confidence interval [CI] = 1.19 to 1.98) and endometrial cancer (RR=1.32, 95% CI = 1.08 to 1.61) for total sitting time, and a positive association between lung cancer and overall sitting time (RR = 1.21; 95% CI = 1.03 to 1.43).

A possible mechanism for the harmful effects of prolonged sitting comes from animal studies with mice. The work by Bey and Hamilton (2003) offer strong evidence supporting the notion that suppression of postural skeletal muscle lipoprotein lipase (LPL) activity associated with standing are what elicit these metabolic changes (e.g., insulin sensitivity, Triglyceride uptake, plasma HDL-C) during prolonged sedentary periods. Hamilton and colleagues also report that low levels of ambulatory activity can attenuate these dramatic losses in LPL activity (2004).

The risk associated with sedentary behaviors also appears to be dose dependent; the longer one remains sedentary, the greater their risk. Some evidence for this dose response pattern comes from the 1999/2000 AusDiab study, which compared self-reported TV viewing time and a number of biomarkers for cardio-metabolic risk; significant and detrimental, dose-response associations were observed in both men and women between TV viewing time and 2-h plasma glucose, waist circumference, and systolic
blood pressure.” (Healy et al., 2008). Interestingly, the study also found these effects persisted after adjusting for levels of moderate-to-vigorous physical activity (MVPA) during leisure time and waist circumference, suggesting that the health consequences associated with sedentary behavior are independent from levels of regular MVPA. The deleterious effects of sedentary behavior independent of MVPA are also supported by a number of studies (Léon-Latre et al., 2014; Dunstan et al., 2012; Thorp et al., 2011; Schmid & Leitzmann, 2014; Healy et al., 2008; Henson et al., 2008; Judice et al., 2015; Biswas et al., 2015) and reviews (Proper et al., 2011). In short, those individuals who meet the MVPA guidelines, but still engage primarily in sedentary behaviors, may be deemed ‘active’ – however, they are still at risk from their sedentary lifestyle; an “active couch potato” so to speak (Owen et al., 2010).

### 1.4 Breaking up sedentary behavior

Further evidence for the dose-dependent effects of sedentary behavior can be seen in the beneficial nature of breaking up sitting or taking breaks from sedentary behavior. As previously mentioned, there exist no measurable guidelines for reducing sedentary behavior for adults, or how often to break up existing sedentary behaviors. However, there are a number of studies that illustrate the benefit of breaking up prolonged sedentary behavior.

Dunstan and colleagues (2012), for instance, found that breaking up uninterrupted sitting with 2-minute bouts of light or moderate intensity walking both improved postprandial glucose metabolism through reductions in glucose iAUC (light: 5.2 [4.1-6.6]; moderate: 4.9 [3.8-6.1]; both P < 0.01) and insulin iAUC (light: 633.6 [552.4-727.1]; moderate: 637.6 [555.5-731.9], P < 0.0001), as compared to uninterrupted sitting (6.9 [5.5-8.7] & 828.6 [722.0-950.9], respectively) in overweight/obese adults. These results are supported by Bailey and Locke (2015) who found that interrupting postprandial sitting with light intensity walking for 2 minutes every 20 minutes improved markers for glucose metabolism; but interrupting postprandial sitting with standing for 2 minutes every 20 minutes did not. Another study involving overweight/obese men investigating the effect of interrupting postprandial sitting showed; those who interrupted their sitting by standing 1.5 minutes, 10 times every 30 minutes expended 20% more energy than those who did not interrupt their sitting over an 8 hour period, and 9% more energy.
than those who stood still for 15 minutes every 30 minutes over an 8 hour period (Hawari et al., 2016). A study in older Portuguese adults found that the “odds for abdominal obesity decreased 7 % for each additional hourly break in sedentary time in women (OR=0.93, 95 % CI: 0.87-1.00), but not in men, independent of total sedentary time and moderate-to-vigorous physical activity” (Judice et al., 2014). Consistent with these studies, Swartz and colleagues (2011) found that breaking up a 30 minute bout of sedentary behavior, with either a 1, 2, or 5 minute walking period at a self-selected pace, elicited a significant positive change in energy expenditure of 3.0, 7.4, and 16.5 kcal for each trial, respectively. The authors expand on their findings, inferring that a 5 minute interruption to 30 minutes of prolonged sitting over an 8 hour period could expend an additional 132 kilocalories per day.

Beyond these relatively acute bouts of interrupting sedentary behavior, there have been longitudinal studies to suggest that breaking up sitting more frequently has pronounced health benefits. A study done by Henson and Colleagues (2013) found that amongst a group of individuals with risk factors for diabetes mellitus (n=878), breaks in sedentary time were significantly inversely associated with 2h glucose (β=−0.111± 0.055, p=0.046), waist circumference (β=−0.215±0.051, p<0.001), and BMI (β=−0.151±0.049, p=0.003). Healy and Associates (2008) reported similar findings: a higher frequency of breaks from sitting was beneficially associated with adiposity measures, triglycerides, and 2h plasma glucose. In a study of 528 newly diagnosed type 2 diabetics, Cooper and colleagues (2012) found breaks in sedentary time were associated with lower waist circumference (B−0.15 cm [−0.24,− 0.05]; p= 0.003), and with more breaks associated with higher HDL-C.

There is ample evidence to support that simply reducing/displacing sedentary time with Light Intensity Physical Activity (LIPA) or MVPA is beneficial for health. A study by Baldwin et al. (2014) found allocating 30 minutes/day of sedentary time to either sleep, LIPA or MVPA was beneficially associated with a number of cardio-metabolic markers (e.g., insulin, HOMA-β, triglycerides). However, from an intervention perspective, it is arguably more effective to break up existing sedentary behavior in short bouts more frequently than it is to displace relatively large amounts of sedentary time to other behaviors like LIPA or MVPA. Therefore, it is important to account for not only the amount of sedentary time accumulated, but how it is accumulated (Healy et al., 2008); breaking up existing sedentary behavior more frequently has many positive health implications and applications.
1.5 Occupational Interventions

As previously mentioned, sitting is the most common sedentary behavior amongst adults, and can be the dominant daily behavior for people who have sedentary occupations. Owen and colleagues (2011) proposed an ecological model for mapping sedentary behavior determinants. In this ecological model, sedentary behavior is divided into domains (i.e., Leisure Time, Transport, Occupation, Household), with each domain encompassing unique determinants for sedentary behavior. Owen et al. also point to the importance of specificity in designing behavioral interventions to target sedentary behavior; they state: “it is expected that effective interventions will be tailored to the specific behavior, specific setting, and specific population subgroups” (2011). Thus, it can be reasonably expected that a behavioral intervention focused on occupational or household determinants would have the greatest impact/reduction for occupational or household sedentary time, respectively. It also stands to reason that those individuals or populations who spend considerable amounts of their waking time sitting are ideal candidates for behavioral interventions. To this end, many intervention studies have been conducted in an occupational setting – typically amongst office workers. The dose-dependent risk of sedentary behavior associates the most deleterious health effects with the longest bouts of unbroken sedentary behavior; office workers spend an estimated two-thirds of work hours sitting, with most of this time spent in unbroken bouts of at least 20 to 30 minutes (Evans et al., 2012; Ryan et al., 2011; Thorp et al., 2012), making them a high-risk population for sedentary behavior.

An early review paper by Chau and colleagues (2010) examined six intervention studies (3 Randomized Control Trials, 2 Randomized Trials, and 1 Pre Post design) which investigated workplace sedentary behavior, though as a secondary outcome. The authors found no significant findings in any of the studies with respect to the effectiveness of a workplace intervention to reduce occupational sitting time, but mention limitations such as the need for objective measurements, small number of studies, and shifting the focus of interventions away from increasing workplace MVPA, to increasing LIPA or frequency of breaks. A review of sedentary behavior and physical activity interventions by Prince et al. (2014) addresses these limitation: they found that interventions targeting sedentary behavior specifically, as
opposed to jointly with physical activity, produce less consistent results and report smaller reductions in sedentary behavior, than those interventions focused on sedentary behavior. These results allude to the advantage of specificity for future interventions; an intervention focused solely on sedentary behavior will likely have a greater impact on modifying said behavior, and thus a greater potential for producing clinically meaningful results.

Similarly, another review paper (19 field-based trials and 19 laboratory investigations) by Neuhaus et al. (2014) found a -77 min/8 hour change (95% CI = −120, −35 min) in occupational sedentary time with the use of sit-to-stand or activity permissive desks (e.g., treadmill desk, cycle ergometers). While the majority of health related outcomes showed no significant change, the authors note improvement for waist circumference and psychological well-being in 5/6 and 12/15 studies, respectively. These findings are supported in another review by MacEwen et al. (2015) which found a significant increase in HDL-C with the implementation of a traditional standing desk (Alkhajah et al., 2012), as well as treadmill desks (Koepp et al., 2013). Treadmill desks also showed improved total cholesterol and LDL levels over 9 months in a sample of overweight/obese office workers (Koepp et al., 2013), indicating that sedentary behavior interventions may also be effective for higher risk populations.

Another instance of sit-to-stand desk implementation was the Take-a-Stand Project (Pronk et al., 2011). Pronk and colleagues found that over 7 weeks, those in the intervention group (sit-stand device installed at their desk) reduced their occupational sitting time by 66 minutes per day over 7 weeks (p=0.03), as well as reducing upper back and neck pain by 54% (p=0.008). Interestingly, the observed effects all reverted to baseline levels within 2 weeks once the sit-stand desks were removed (p=0.027). Healy and colleagues (2013) sought to expand upon the aforementioned study by installing the same sit-stand devices, but supplementing three key messages for the intervention group: “Stand up, Sit less & Move more”. They showed a reduction of −125 min/8-h workday (95% CI: [−161, −89], p<0.001) in occupational sitting for the intervention group, which they found was replaced almost exclusively by standing. The authors mention that the “Move more” message was unheeded, though they attribute this to the lack of resources and/or opportunity for physical activity in the workplace.
As is evidenced by the findings of Healy et al. (2013), the benefit of a multi-component approach is also highlighted in a review paper by Gardner et al. (2016). The author’s critique the prevalence of interventions focused on the modification of the built environment (e.g., sit-stand stations, treadmill desks, etc.), and discuss the dearth of studies investigating constructs like motivation or information provision, as well as identifying intervention components that may contribute to effectiveness (Michie & Abraham, 2004).

Aside from the barriers of resources and/or opportunity for sedentary behavior interventions in the workplace, psychological variables may also impact occupational sedentary behavior. A qualitative study by Cole, Tully, and Cupples (2015) found that a major barrier to reducing occupational sedentary behavior was the perception of sitting; participants considered that standing may cause discomfort and ultimately, that the time they spent sitting reflected the volume of their work. Interviews also revealed that employee’s felt breaking up their sitting would adversely affect their work output; this was mirrored in the perceptions of the employer who felt that accomplished workers were those who sat at their computer. However, when introduced to a mobile phone app that allowed tracking of their sedentary behavior, researchers noted a mean decrease in occupational sitting time of close to – 80 min/day. These findings are encouraging, and serve to inform future interventions in addressing perceptions of sedentary behavior.

The potential of occupational interventions may extend beyond just the targeted workplace domain. Smith and colleagues (2015) found that of a sample of office employees (n=164), workers were sitting for over 10 hours a day on both weekdays and weekends; these results suggest that there is no compensatory physical activity or reduction in sedentary time during the weekend to offset the excessively sedentary weekdays. These results are echoed by Clemes, O’Connell, and Edwardson (2014), who suggest interventions should target both specific occupational domains, and leisure time domains. While many occupational interventions have shown success in reducing occupational sedentary time, there is a lack of research showing whether there is any carryover effect to other domains from a successful occupational intervention.
1.6 The Health Action Process Approach (HAPA)

Interventions grounded in well-established health behavior theories targeted at the individual level may aid in the development of robust experimental studies. Change or action theories provide frameworks that guide the development of interventions, translate concepts to messages and strategies, and form a basis for evaluation (Green, 2000). One of the challenges in conducting behavioral research is the apparent disconnect between a participant’s intention to perform a given behavior, and whether that intention elicits action, since strong intentions do not necessarily transform into behavior (Armitage, 2005); this divide between intention and action has been labeled by some researchers as “the intention-behavior gap” (Barg et al., 2012).

Although behavior change theories (Ajzen’s Theory of Planned Behavior, 1988; Roger’s Protection Motivation Theory, 1975) have been used to understand and predict sedentary behavior (e.g., Prapavessis et al., 2015; Wong et al., 2016) these theories lack post-intentional constructs that may explain this intention-behavior gap, they may not be ideal frameworks to develop a behavioral intervention around. The Health Action Process Approach, or HAPA, is a model of health behavior change that seeks to bridge the intention-behavior gap; the model does this by including post-intentional mediators of behavior (Schwarzer & Luszczynska, 2008).

The HAPA model (see Figure 1) is divided into two distinct stages (Heckhausen & Gollwitzer, 1987): a motivational stage which determines behavioral intention(s), and a volitional stage which leads to behavior. Within the motivational stage of the model are three constructs that contribute to forming intentions: risk perceptions, outcome expectancies, and task/perceived action self-efficacy (Schwarzer, 2008). Risk perceptions (e.g., I am at risk for diabetes) help to facilitate the contemplation process and act to develop thoughts about consequences and competencies. Positive outcome expectancies (e.g., if I sit an hour less a day, I will lower my risk for diabetes) are also important in developing intentions, as they contribute to tipping the scale towards performing a behavior. Finally, task/perceived action self-efficacy is the belief in one’s own capability to perform a desired action (e.g., I am capable of standing for an hour at work every day). Both outcome expectancies and task self-efficacy contribute heavily to forming intentions, especially for more difficult behaviors (Schwarzer, 2008).
The second stage of the HAPA model catalyzes the intention, formed in the motivational phase, into action – through use of the constructs of action planning and coping planning, which mediate phase specific self-efficacy (i.e., maintenance self-efficacy & recover self-efficacy) (Schwarzer, 2008).

Maintenance self-efficacy refers to the confidence in one’s capability to deal or cope with imminent barriers that arise during the maintenance period (e.g., I am confident I can stand at work even if no one else stands). Those individuals with higher maintenance self-efficacy are able to persist longer through complications, form better strategies and put forth more effort. Recovery self-efficacy refers to one’s confidence in being capable of resuming a difficult behavior after an interruption (Schwarzer, 2008), such as a relapse (e.g., I am confident I could start standing again at work, even after I have not stood for a week). In the event of a lapse or interruption to a behavior, individuals may experience “abstinence violation effect”, in which the magnitude of the lapse is exaggerated and the individual interprets the event as a complete failure (Marlatt et al., 1995). Those with higher recovery self-efficacy trust in their competence to regain control after a derailment (Schwarzer, 2008).

Action planning refers to the ‘when, where, and how’ of translating an intention into action. Schwarzer suggests that action planning is more effective than simply forming intentions since behavior is more likely to be elicited when relevant situational cues are encountered (2008). Coping planning is similar to action planning in that specific ‘when, where, and how’ details are made, however where action planning tends to be proactive –
coping planning tends to be reactive; individuals develop specific plans or alternate behaviors in anticipation of potential barriers (Sniehotta, Scholz et al., 2005). Coping planning and action planning act synergistically; after individuals develop when, where, and how they will perform an action or behavior, they imagine possible barriers and develop relevant coping strategies (Schwarzer, 2008).

1.7 HAPA model as a predictor of Health Behavior

The HAPA model has shown success in predicting a number of health behaviors, such as Breast Self-examination (Luszczynska & Schwarzer, 2003), seatbelt use in adolescents (Schwarzer, Schüz, Ziegelmann, Lippke, Luszczynska, & Scholz, 2007), dental flossing (Schüz, Sniehotta, Mallach, Wiedemann, & Schwarzer, 2009) and dietary behaviors (Schwarzer & Renner, 2000; Schwarzer et al., 2007; Renner, Kwon, Yang, Paik, Kim, Roh, Song, & Schwarzer, 2008). The HAPA model has also been used to predict physical activity. In a study with recently discharged cardiac rehabilitation patients, Sniehotta, Scholz, and Schwarzer found that 14% of physical activity variance was jointly explained by previous planning and recovery self-efficacy, 4 months after rehabilitation. A study by Lippke and colleagues (2005) amongst orthopaedic outpatients (n=423) found discontinuity patterns between patients who had intention but had not acted, actors, and those who did not have intention to exercise. The results of this study support the utility of the three stage HAPA model, and inform future behavioral predictions/interventions to consider and tailor to stage-specific differences. Barg and colleagues investigated whether the HAPA could predict physical activity in a sample of inactive middle-aged women (2012). They found that perceived action self-efficacy best predicted intention while maintenance self-efficacy was the best predictor of planning and behavior; interestingly, planning did not predict behavior, though the authors mention that no measure of coping planning was taken. Overall, the authors found that the HAPA model accounted for 15% of the variance in physical activity.

1.8 HAPA model as an intervention for increasing Physical Activity

In addition to the predictive utility of the HAPA model, research has shown the model to be an effective intervention for facilitating health behavior change. A study done by Lippke et al. (2004) in orthopaedic rehab patients (n=560) sought to determine whether an action planning intervention would be more
effective for those patients who had intention to exercise, but do not meet activity guidelines. They found that those patients who had intention to exercise, but were inactive, benefited more from the planning intervention than those inactive patients who had no intention to exercise, or those patients who were previously active. They also note that those patients who had formed intentions and action plans were more successful in adhering to the recommended level of exercise. A recent study showed similar findings in cardiac rehab outpatients (n=96) in Iran (Aliabad et al., 2014). Researchers found that, when those patients with intention to continue exercise after rehab developed an action plan and coping strategies, in addition to a HAPA booklet and HAPA based training, they significantly increased both their physical activity and maximal oxygen uptake, compared to the control group.

Further evidence of the efficacy of action plans for physical activity comes from a UK study (Milne et al., 2002) involving undergraduate students (n=248) which saw an intervention group creating “implementation strategies” (which are analogous to action planning) for when, where, and how they would increase their physical activity over the next week. The researchers found that the students who received the implementation intervention were more likely to perform exercise than either the controls who received no intervention, or the controls who were just as motivated to act, but did not create an action plan.

1.9 HAPA model as an intervention for reducing sedentary behavior

Based on the existing research, the HAPA model appears to be an effective means of predicting and changing health behaviors. To the author’s knowledge, there is limited evidence in using the HAPA as a framework to better understand sedentary behavior. Maher and Conroy (2015), for example, tested a dual-process theory that emphasized habit strength with the HAPA model constructs. In a sample of community-dwelling older adults (n=114), the authors measured sedentary-related task self-efficacy, planning (composite of action & coping), intentions, etc. In addition, self-report and objective measures of sedentary behavior were measured over a 14 day period. They found intra-model agreement of HAPA constructs. Specifically (a) intentions to limit sedentary behavior were stronger among those with greater usual task self-efficacy (b) plans to limit sedentary behavior were stronger among those with stronger usual intentions, and (c) participants were less sedentary on days they formed stronger-than-
usual plans to limit sedentary behavior. These results are promising, as they support the validity and utility of the HAPA model in a sedentary behavior context.

With respect to interventions, a feasibility study by Kozey-Keadle et al. (2012) explored the use of a behavioral intervention on reducing objectively-measured sedentary time in a free-living, non-exercising office worker sample (n=20) over 7 days. The intervention used by the authors was primarily information based but, while not grounded in any particular behavioral theory, did include questions pertinent to HAPA-specific constructs, such as: risk perceptions, outcome expectancies, as well as rudimentary action and coping planning. The researchers found participants significantly reduced their sitting time by 5% (p<0.01); equivalent to a 48 minute reduction in sitting time over a 16 hour waking day. In regards to number of breaks, the authors note that participants actually significantly reduced the number of breaks taken from sitting, however, they attribute these findings to the reduced sitting time yielding fewer opportunities for sit-to-stand transitions. Overall, the significance of these results support the efficacy of a behavioral intervention for reducing sedentary behavior.

Another feasibility study, by Gardiner and colleagues (2011), investigated the effectiveness of a face-to-face interview intervention in reducing sedentary time in a sample of older adults (n=59), over six days. The intervention’s key message was to stand up and move after 30 minutes of uninterrupted sitting. The authors used a composite of many behavioral constructs; HAPA related constructs that informed the intervention included: self-efficacy, outcome expectancies, action planning analog (goal setting), and a coping planning analog (barriers). Results from the study show a significant reduction in sedentary time (–3.2%, 95% CI: [– 4.18, –2.14], p<0.001), and increase in breaks during sedentary time per day (4.0, 95% CI: [1.48, 6.58], p=0.003). Although this study lacked a control group for comparison, these findings are also encouraging, and allude to the potential impact of a HAPA guided intervention for changing sedentary behavior.
Purpose

The primary purpose of this study was to determine if a HAPA based action and coping planning intervention, would increase occupational (student) break frequency and occupation (student) break duration.

A secondary purpose of this study was to determine if a HAPA based action and coping planning intervention tailored to occupation (student) break frequency and duration would affect screen time break frequency and screen time break duration, via carryover.

Hypothesis

H1: It is hypothesized that the HAPA based intervention group will report increased occupational (student) break frequency to 1 break/ 30 minutes of sitting, and increased occupational (student) break duration to 2-3 minutes/ break.

H2: It is hypothesized that the HAPA based intervention will increase screen time break frequency and screen time break duration for the intervention group, via carryover.
2. The Current Study

Ethical approval was granted from Western University’s Health Sciences Research Ethics Board (#107528; Appendix A). All participants were given the Letter of Information and gave written consent before filling out the first questionnaire.

2.1 Methods

Participants
Eligible participants were full-time university students attending Western University during the Winter 2016 school term. Inclusion criteria were as follows: (1) must be 18 years of age or older, (2) are a student attending Western University full-time, and (3) are in good mental and physical health. Exclusion criteria included being pregnant and/or being unable to read/write in English. Forty-five participants (Mean age 23.30 years, SD 4.11, Males = 12) who satisfied all the criteria completed the baseline measurements, and were randomized into one of two conditions: the intervention arm (HAPA based sedentary behavior counseling), or the control arm (HAPA based nutrition counseling). Figure 2 is a flow diagram illustrating how many participants were recruited and remained in this study at targeted primary endpoints.
The modified SIT-Q 7d questionnaire

The [base] SIT-Q 7d questionnaire is a domain-specific sedentary behavior questionnaire and has been shown to be both valid and reliable against objective measures (Wijndaele et al., 2014). However, the base questionnaire does not include measures for domain-specific break frequency or duration. To address this, Sui and Prapavessis (2015) modified the base questionnaire to include domain-specific break frequency & duration scores and provide test-retest reliability and face validity data, through a pilot study (Appendix B). The full questionnaire and legend can be found in Appendix B. The specificity of the outcomes for the current study (e.g., occupational break frequency & duration) necessitated the
need for a domain-specific, self-report sedentary behavior questionnaire. This need is in line with previous research recommendations, which advise that: “...[self-report measures] should extend beyond measures of overall sitting to include the various domains” (Healy et al., 2011).

### Breaks from Sitting as a Student (Primary Outcome Measures)

Below are the questions participants answered from the modified version of the SIT-Q 7d questionnaire.

**Frequency of breaks taken from sitting as a Student** – The frequency of breaks taken from sitting as a student was measured through the following question, in the occupation section of the questionnaire: “In the last 7 days, on average, how often did you interrupt your sitting time during Occupation [Student]?” 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, Over every 5 hours, No interruption. These results correspond with a score of 1-10, respectively.

**Duration of breaks taken from sitting as a Student** – The duration of breaks taken from sitting as a student was measured through the following question, in the occupation section of the questionnaire: “In the last 7 days, on average, how long were your breaks from sitting during Occupation [Student]?” 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. These results correspond with a score of 1-10, respectively.

### Breaks from Sitting while Engaged in Screen Time (Secondary Outcome Measures)

Below are the questions participants answered from the modified version of the SIT-Q 7d questionnaire.

**Frequency of breaks taken from sitting while engaged in Screen Time** – The frequency of breaks taken from sitting during screen time was measured through the following question, in the Screen Time section of the questionnaire: “In the last 7 days, on average, how often did you interrupt your sitting time while engaged in Screen Time?” Options for the question included: Less than every 30
Duration of breaks taken from sitting while engaged in Screen Time – The duration of breaks taken from sitting during screen time was measured through the following question, in the Screen Time section of the questionnaire: “In the last 7 days, on average, how long were your breaks from sitting while engaged in Screen Time?” 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, More than 30 min.

Other Measures

Demographics – The following demographic information was obtained: name, age, phone number, gender. Ethnicity, level of education, program of study, and year of study were also asked in a follow-up survey, but was optional to answer.

Dietary Recall – Participants first filled out a dietary recall questionnaire (Appendix B), which asked for the number of servings of each food group (i.e., grains, fruits & vegetables, dairy, meat & alternatives, and fats & oils) that the participant consumed over the 7 days, divided into breakfast, lunch and dinner. Servings were compared with those recommended by Canada’s Food Guide.

Time Spent Sitting

The modified version of the SIT-Q questionnaire was also used to obtain a baseline sitting profile of participants who enrolled in the present study (Figure 3 & 4). Below are the questions participants answered.

Time spent sitting in Occupation 1 (Student) – The time spent sitting in Occupation 1 (student) was measured through the following question: “How much time per day did you spend sitting doing occupation 1?” This score was used to inform an overall average baseline sitting profile (Figure 3 & 4).

Time spent sitting in Occupation 2 – The time spent sitting in Occupation 2 (i.e., work or volunteering) was measured through the following question: “How much time per day did you spend
sitting doing occupation 2?”. This score was used to inform an overall average baseline sitting profile (Figure 3 & 4).

**Time spent sitting in Occupation 3** – The time spent sitting in Occupation 3 (i.e., work or volunteering) was measured through the following question: “How much time per day did you spend sitting doing occupation 3?” This score was used to inform an overall average baseline sitting profile (Figure 3 & 4).

**Weekday/Weekend time spent sitting while watching TV** – The Weekday/Weekend time spent sitting while watching TV was measured through the following question(s): “How long did you spend sitting while watching TV/DVD/Netflix on a [weekday or weekend day]?” These scores were used to inform an overall average baseline sitting profile (Figure 3 & 4).

**Weekday/Weekend time spent sitting using the computer** – The Weekday/Weekend time spent sitting while using the computer was measured through the following question(s): “How long did you spend sitting while using computer (apart from occ.) on a [weekday or weekend day]?” These scores were used to inform an overall average baseline sitting profile (Figure 3 & 4).

**Weekday/Weekend time spent sitting while playing video games** - The Weekday/Weekend time spent sitting while playing video games was measured through the following question(s): “How long did you spend sitting while playing video games on a [weekday or weekend day]?” These scores were used to inform an overall average baseline sitting profile (Figure 3 & 4).

**Time spent sitting while engaged in Other Activities** – The time spent sitting while engaged in Other Activities was measured through questions such as: “How long did you spend sitting while [reading, doing chores, caring for others, doing hobbies, socializing, listening to music, or doing other activities] on a [weekday or weekend day]?” The sum of these scores was used to inform an overall average baseline sitting profile (Figure 3 & 4).
Treatment

Health Action Process Approach (HAPA) to Break Up Sitting as a Student

Participants randomized into the Health Action Process Approach (HAPA) intervention arm of the study were given a behavioral counseling table as reference for developing strategies as part of their Action Plan (Appendix B). The table included headings drawn from the FITT principle (Appendix B): Frequency, Intensity, Time and Type. Frequency is how often a strategy should be used; Intensity is either the duration of breaks from sitting or the servings of food group, depending on the intervention; Time is when the strategy should be enacted; and Type is either the activity done during the break from sitting, or the food group, depending on the arm of the study. Additionally, in line with the HAPA model there was a section titled ‘Coping Strategy’. The researcher first discussed what the goals of the behavior were; specifically, the goal was to break up sitting as a student every 30-45 minutes with a 2-3 minute break. The researcher then asked the participant “What are some strategies that might work for you in achieving this goal?”; additionally, participants were told that strategies should be specific and realistic. If participants could not think of a strategy, the researcher would guide them into creating one; suggesting a strategy and then asking the participant if they felt it was realistic for them to utilize. Once a strategy was identified, the researcher guided the participant through the behavioral counseling form, writing down what the participant. As an example, a participant in the intervention arm of the study may develop a strategy of setting an alarm for every 30 minutes, and stand for 2-3 minutes when the alarm goes off. The Frequency of this strategy would be every 30 minutes, the Intensity would be the duration of the break from sitting (i.e., 2-3 minutes), the Time would be during studying/being student, and Type would be either standing or walking; these strategies focused on the objective of increasing break frequency to every 30-45 minutes and achieving a break duration of 2-3 minutes, in the occupational domain of study (i.e., as a student) for the intervention group. After a strategy was specified through the FITT principles, participants were asked about coping strategies: “There are often barriers to performing strategies like these – coping strategies help us to overcome these barriers. What do you see as being a barrier that would prevent you from doing this strategy?”, followed by “What do you think is a realistic strategy that might help to overcome this/these barrier(s)?”. This process was repeated for 2-5 strategies, as deemed by the participant for feasibility and manageability. Participants
were then told to keep the sheet somewhere visible and trafficked, so they would be reminded of their plan. The second booster session followed a similar format to the first counseling session, except for the initial questions. Questions posed by the researcher during this second session were: “what worked from the strategies we previously discussed?”, “what didn’t work? Why?”, and “do you foresee any unique challenges to [behavioral objective] in the next three weeks?”. The number of strategies during this second session were personalized based upon the participant’s progress towards the behavioral objective, and whether they foresaw any additional challenges in the next three weeks. Coping strategies were again developed in conjunction with each new strategy. Participants were again given this behavioral counseling form with the revised action plan and coping strategies for the next three weeks and told to display it somewhere prominent so they would be reminded of the strategies.

All counseling sessions were kept as consistent as possible, with respect to the tone, demeanor and setting of the session.

Control
Health Action Process Approach (HAPA) following Canada’s Food Guide

For those randomized into the control arm of the study, strategies focused on the objective of having participants achieve weekly food group servings in line with the age-respective recommendations of Canada’s Food Guide. Counselling session specifics (i.e., action and coping planning) for the control group were identical to the treatment group as mentioned above, except for the goals for the control group, which were to meet the weekly recommended servings for the four food groups, as outlined by Canada’s Food Guide (Health Canada, 2007).

SoSci Survey

The modified SIT-Q 7d was adapted from a paper form into an electronic copy through SoSci Survey. All the sedentary behavior questionnaires (i.e., modified SIT-Q 7d) were also delivered electronically through the SoSci Survey service. SoSci creates a unique and secure email that only the intended recipient can use to access the questionnaire. Participant information is also secured through the SoSci
Survey website, ensuring protection of participant information. Questionnaires are also date-specific; regardless if a participant misses or does not complete a weekly questionnaire, an entirely new questionnaire will be sent for their next respective time point in the study. SoSci survey is able to track if/when a participant has started their questionnaire, and if/when they have completed a particular questionnaire.

Procedure
Approval for the study was obtained through the Research Ethics Board of Western University (see Appendix A). Recruitment posters were distributed by the Western University Poster Patrol around the Western University campus and participants were recruited via on campus posters, emails to participants in previous studies conducted by the EHPL, and through referrals from other participants. Interested persons contacted the researcher to arrange the initial meeting at the EHPL. Letter of Information/Consent (LOI/LOC) was emailed to potential participants; additionally, the LOI/LOC was reviewed again by participants at the initial meeting, and informed consent was obtained. After obtaining consent participants filled out a paper copy dietary recall questionnaire. The researcher left the room after explaining the survey to the participant, and returned upon completion of the survey. Participants were then emailed their first modified SIT-Q questionnaire, through SoSci, and directed to complete it online. Similar instructions were given to each participant, such as: “the questionnaire is a 7 day average, so unless the question states otherwise, average your weekly sitting time”, “some questions are very similar, such as time spent sitting while travelling to/from work, as part of work, and apart from work, so read the question carefully”, and “if you have any questions or need clarification on a question, just let me [the researcher] know.” While the participant was completing the online questionnaire, the researcher randomized the participant to either the intervention (break up student related sitting) or control (nutrition) condition with the Research Randomizer computer software (Urbaniak & Plous, 2013). For those in the intervention group, the study objective was to increase occupational (student) break frequency to a break every 30 minutes, with each break having a duration of 2-3 minutes. For those in the control group, the study objective was to comply with Canada’s Food Guide in respect to weekly recommended food group servings.
Upon completing the questionnaire, the researcher returned to the room and implemented the appropriate behavioral counseling intervention, detailed in the treatment and control sections above. After the initial meeting, participants were told they would receive the modified SIT-Q 7d questionnaire in their email weekly, for the next two weeks, and to complete the questionnaire the day they receive it. Participants were also asked to return to the EHPL approximately 3 weeks after the initial meeting. During this meeting, participants filled out the dietary recall survey and modified SIT-Q 7d questionnaire under the same conditions as the initial meeting. After the questionnaires were completed, the researcher conducted the second behavioral counseling intervention session, similar to the first counseling session. Participants were again given the behavioral counseling form with the revised action plan and coping strategies for the next three weeks and told to display it somewhere prominent so they would be reminded of the strategies.

After the second meeting, participants were told they would receive the modified SIT-Q 7d in their email weekly for the next three weeks, and to complete the questionnaire the day they receive it. Participants were also told that two weeks after the last questionnaire, there would be a follow-up modified SIT-Q 7d questionnaire. Participants then received a follow-up questionnaire two weeks after their week 6 questionnaire. Figure 2 is a flow diagram illustrating the design, procedure and measures used in the present study. All questionnaires can be found in Appendix B.

**Statistical Analysis**

**Sample size calculation**

Initial power calculations were based upon a previous sedentary behavior intervention study by Cotten and Prapavessis (2016), which employed a similar repeated measures design as the present study (2x4 and 2x8, respectively). The researchers reported a non-significant group by time interaction for break frequency, with a reported effect size of $\eta_p^2 = .05$, and a sample size of 56. Cotten and Prapavessis employed a text message based intervention for increasing break frequency and duration; by contrast, the present study utilized a specific, face-to-face HAPA based intervention, with an additional intermittent face-to-face session. Additionally, the researchers investigated and targeted more variables
with their intervention than the present study: 5 outcome measures vs. 2 outcome measures, respectively.

Due to the increased researcher contact and face time, and the more focused nature of our intervention, a larger effect was anticipated. Hence, G*Power software calculated a sample size of 56 participants for a medium effect size (\(\eta_p^2 = .08\)) with an alpha of .05 and power of .80.

**Primary and secondary outcome analyses**

IBM SPSS Statistics 24 software was used to analyze the collected data. A series of 2 (intervention vs. controls) x 8 (time – baseline, 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, and follow-up) repeated measures ANOVA were used to identify possible time by group interaction effects. P-value was set at 0.05 (Tabachnick & Fidell, 1996) and partial eta squared values (\(\eta_p^2\)) are reported along with corresponding P values.

### 2.2 Results

**Missing Data**

Of the 360 total possible questionnaires that could have been completed, 70 questionnaires (19.40%) were either unanswered, missing, or incomplete. Of the 208 possible questionnaires for the intervention group, 37 (17.80%) were either unanswered, missing, or incomplete. 4 participants dropped out of the intervention group during the study. Of the 152 possible questionnaires for the control group, 34 (23.40%) were either unanswered, missing, or incomplete. 3 participants dropped out of the control group during the study. Applying Fisher’s exact test, a Chi-square analysis of these data indicate a non-significant difference between groups for missing data (**p=0.23, two-sided**).

Additionally, an independent samples t-test revealed no significant differences (**all p values > 0.05**) in the demographic variables (i.e., age & gender) for those that completed the study vs those who dropped out. In addition, there was no differential loss between treatment groups for those that completed the
study vs those that dropped out (all \textit{p} values > 0.05). Taken together, all missing data were considered random. Hence, an intent-to-treat last observation carried forward was used to handle missing data.

**Data Exclusion**

A Winsorization technique was applied to any outliers in the data; data points over the 95\textsuperscript{th} percentile were replaced with the value of the 95\textsuperscript{th} percentile. A total of 25 data points out of 1424 outcome data points were imputed this way (13 in the intervention group and 12 in the control). This method has been shown as a valid way to treat outliers by several authors (Dixon & Tukey, 1968; Tukey & McLaughlin, 1963; Guttman & Smith, 1969; Hawkins, 1980; Duan, 1998).

**Fidelity check**

All sedentary behavior questionnaires sent to participants could be tracked for: if/when it was sent, if/when the participant had started, and if/when the participant completed the questionnaire. All dietary recall questionnaires were completed in the EHPL lab after researcher explanation and administration of Canada’s Food Guide pamphlet. During the face-to-face counseling session, participants developed personal strategies for their specific behavior on their own, with guidance from the researcher. Upon inception of each strategy, participants were asked if they thought the strategy was ‘realistic and specific’, implying aspects of task self-efficacy and action & coping planning.
Figure 3: Average weekly baseline sitting profile for intervention group participants.
Figure 4: Average weekly baseline sitting profile for control group participants.
Primary Outcomes – Occupational (Student) Break Frequency and Duration

Table 1: Means, Standard Deviations, and 95% Confidence Intervals for Frequency of Breaks from Occupational (Student) Sitting at Each Time Point.

<table>
<thead>
<tr>
<th>Time</th>
<th>Intervention Group (n=26)</th>
<th>Control Group (n=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Baseline</td>
<td>3.50</td>
<td>1.42</td>
</tr>
<tr>
<td>1 Week</td>
<td>3.27</td>
<td>1.54</td>
</tr>
<tr>
<td>2 Weeks</td>
<td>3.19</td>
<td>1.23</td>
</tr>
<tr>
<td>3 Weeks</td>
<td>3.08</td>
<td>1.50</td>
</tr>
<tr>
<td>4 Weeks</td>
<td>2.58</td>
<td>0.99</td>
</tr>
<tr>
<td>5 Weeks</td>
<td>2.92</td>
<td>1.96</td>
</tr>
<tr>
<td>6 Weeks</td>
<td>2.88</td>
<td>1.818</td>
</tr>
</tbody>
</table>

Scores correspond as follows: 1.00 - Less than every 30 min.; 2.00 - every 30-45 min.; 3.00 - every 45-60 min.; 4.00 - every 1-1.5 hours; 5.00 - every 1.5-2 hours; 6.00 - every 2-3 hours; 7.00 - every 3-4 hours; 8.00 - every 4-5 hours; 9.00 - over every 5 hours; 10.00 - no interruption
Figure 5. Occupational Break Frequency scores throughout the study.
Table 2: Means, Standard Deviations, and 95% Confidence Intervals for Duration of Breaks from Occupational (Student) Sitting at Each Time Point.

<table>
<thead>
<tr>
<th>Time</th>
<th>Intervention Group (n=26)</th>
<th>Control Group (n=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Baseline</td>
<td>6.62</td>
<td>2.53</td>
</tr>
<tr>
<td>1 Week</td>
<td>6.00</td>
<td>2.10</td>
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<tr>
<td>2 Weeks</td>
<td>6.08</td>
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<tr>
<td>3 Weeks</td>
<td>6.23</td>
<td>1.73</td>
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<tr>
<td>4 Weeks</td>
<td>6.19</td>
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<td>5 Weeks</td>
<td>5.58</td>
<td>2.04</td>
</tr>
<tr>
<td>6 Weeks</td>
<td>5.85</td>
<td>1.95</td>
</tr>
<tr>
<td>Follow-up</td>
<td>5.54</td>
<td>2.23</td>
</tr>
</tbody>
</table>

Scores correspond as follows: 1.00 - less than 30 sec.; 2.00 – 30 sec-1 min.; 3.00 – 1-2 min.; 4.00 – 2-3 min; 5.00 – 3-4 min; 6.00 – 4-5 min; 7.00 – 5-10 min; 8.00 – 10-15 min; 9.00 – 15-30 min; 10.00 – more than 30 min.
Descriptive data for the primary outcomes are presented in Tables 1 and 2. There was a large non-significant interaction effect for occupational (student) break frequency: $F(7, 36) = 1.53$, $P = 0.19$, Wilks’ $\Lambda = 0.77$, $\eta^2_p = .23$. During the intervention period Occupational (Student) Break Frequency scores for the intervention group decreased by 21.50% and increased by 3.94% for the control group; these changes roughly translate into an increased frequency of breaks from every 1-1.5 hours to every 45-60 minutes for the intervention group, and no change for the control group (every 1-1.5 hours).
There was a moderate non-significant group by time interaction effect for occupational (student) break duration: $F(7,36) = 0.59$, $P = 0.76$, Wilks' $\Lambda = 0.90$, $\eta^2_{p} = .10$. During the intervention period, Occupational (Student) Break Duration scores for the intervention group decreased by 13.16% and increased by 7.69% for the control group; these changes roughly translate into a decreased duration of breaks from 10-15 minutes to 5-10 minutes for the intervention group, with no change in the control group.

**Secondary Outcomes – Screen Time Break Frequency and Duration**

**Table 3: Means, Standard Deviations, and 95% Confidence Intervals for Frequency of Breaks from Screen Time Sitting at Each Time Point.**

<table>
<thead>
<tr>
<th>Time</th>
<th>Intervention Group (n=26)</th>
<th>Control Group (n=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Baseline</td>
<td>3.38</td>
<td>2.33</td>
</tr>
<tr>
<td>1 Week</td>
<td>3.96</td>
<td>3.19</td>
</tr>
<tr>
<td>2 Weeks</td>
<td>3.54</td>
<td>1.92</td>
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<tr>
<td>3 Weeks</td>
<td>3.58</td>
<td>2.14</td>
</tr>
<tr>
<td>4 Weeks</td>
<td>2.54</td>
<td>1.24</td>
</tr>
<tr>
<td>5 Weeks</td>
<td>2.50</td>
<td>1.18</td>
</tr>
<tr>
<td>6 Weeks</td>
<td>2.85</td>
<td>1.43</td>
</tr>
<tr>
<td>Follow-up</td>
<td>3.46</td>
<td>2.27</td>
</tr>
</tbody>
</table>

Scores correspond as follows: 1.00 - Less than every 30 min.; 2.00 - every 30-45 min.; 3.00 - every 45-60 min.; 4.00 - every 1-1.5 hours; 5.00 - every 1.5-2 hours; 6.00 - every 2-3 hours; 7.00 - every 3-4 hours; 8.00 - every 4-5 hours; 9.00 - over every 5 hours; 10.00 - no interruption.
Table 4: Means, Standard Deviations, and 95% Confidence Intervals for Duration of Breaks from Screen Time Sitting at Each Time Point.

<table>
<thead>
<tr>
<th>Time</th>
<th>Intervention Group (n=26)</th>
<th>Control Group (n=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Baseline</td>
<td>6.46</td>
<td>2.85</td>
</tr>
<tr>
<td>1 Week</td>
<td>5.08</td>
<td>2.65</td>
</tr>
<tr>
<td>2 Weeks</td>
<td>5.62</td>
<td>2.41</td>
</tr>
<tr>
<td>3 Weeks</td>
<td>5.50</td>
<td>2.44</td>
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<tr>
<td>4 Weeks</td>
<td>5.46</td>
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<td>5 Weeks</td>
<td>4.50</td>
<td>2.16</td>
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<tr>
<td>6 Weeks</td>
<td>5.12</td>
<td>2.32</td>
</tr>
<tr>
<td>Follow-up</td>
<td>4.85</td>
<td>2.48</td>
</tr>
</tbody>
</table>

Scores correspond as follows: 1.00 - less than 30 sec.; 2.00 – 30 sec-1 min.; 3.00 – 1-2 min.; 4.00 – 2-3 min; 5.00 – 3-4 min; 6.00 – 4-5 min; 7.00 – 5-10 min; 8.00 – 10-15 min; 9.00 – 15-30 min; 10.00 – more than 30 min.

Descriptive data for the secondary outcomes are presented in Tables 3 and 4. There was a large non-significant group by time interaction effect for Screen Time Break Frequency: F(7,37) = 1.39, P = 0.24, Wilks’ Λ = 0.79, ηp² = .21. During the intervention period Screen Time Break Frequency scores for the intervention group increased by 18.6% and increased by 9.36% for the control group; these changes roughly translate into an increased frequency of breaks from every 1-1.5 hours to every 45 min-1 hour for the intervention group, and no change for the control group.

There was a larger non-significant group by time interaction effect for Screen Time Break Duration: F(7,37) = 1.48, P = 0.20, Wilks’ Λ = 0.78, ηp² = .22. During the intervention period, Screen Time Break Duration scores for the intervention group decreased by 26.17% and decreased by 9.93% for the control group; these changes roughly translate into a decreased duration of breaks from 5-10 minutes to 4-5 minutes, with no change in the control group.
2.3 Discussion

The primary aim of the current study was to investigate whether a HAPA based intervention would increase occupational (student) break frequency to 1 break/30 minutes and increase occupational (student) break duration to 2-3 minutes. A secondary aim was to examine for potential carryover effects of the intervention that would be seen through increase non-occupational screen time break frequency and screen time break duration. Using a two arm randomized control trial, the intervention group received a face-to-face HAPA based intervention that focused on creating a personalized action plan (when, where, how) and coping strategies (overcoming barriers) for increasing break frequency and duration from sitting as a student. The control group received a face-to-face HAPA based intervention and focused on meeting Canada Food Guide recommendations. Both groups completed breaks from sitting questionnaires at baseline, at weeks one through six, and a two week follow-up. Overall, moderate to large non-significant effects that favoured the intervention group were consistently found for both occupation (student) and screen time breaks. Detailed analysis and critique of these general observations merit further discussion.

Occupational (Student) break frequency & duration

From baseline to week six, the occupational (student) break frequency score decreased from 3.50 to 2.88 for the intervention group, and decreased from 4.22 to 4.06 for the control group. This translates into an increased break frequency of approximately every 1-1.5 hours to every 45-60 minutes for the intervention group, and no change for the control group (every 1-1.5 hours). Although the group by time interaction was not statistically significant, the accompanying effect size was large ($\eta^2 = .23$) (Richardson, 2011; Cohen, 1969), suggesting the intervention did positively affect this outcome measure. These findings, taken together, indicate that the present study was underpowered. Inputting this effect size for an a priori sample size calculation in G*Power indicated an additional 6 participants were needed to express significance. To further illustrate this point, an ancillary post-hoc analysis of the time point with the greatest difference between treatments groups (i.e., Week 6) approached significance ($p=0.06$) with a moderate-to-large effect size ($\eta^2 = .08$). These findings are potentially clinically meaningful. While the
average break frequency score for the intervention group at the end of the intervention period (2.88; every 45-60 minutes) was higher than the intended score (2.00 – every 30-45 minutes), those in the intervention group still increased their break frequency in accordance with break frequency research (Dunstan et al., 2012).

The findings must be considered within the context of how sedentary behavior fluctuates in a university student population. All full-time students attending Western University experience some form of final assessment in each of their courses, as well as additional midterms or evaluations depending on the course. These periods of assessments are typically accompanied with more time spent studying outside of the classroom for most students. Due to the staggered nature of recruitment for both groups, we cannot determine when these periods occurred; however, the consistent increase in break frequency over time seen in the intervention group, as compared to the control group, suggests that even during periods of greater occupational (student) sitting, the intervention can attenuate a decrease in occupational (student) break frequency.

Another relationship of note within this outcome occurred between baseline and week 3 time points, between both groups. Both intervention and control groups have comparable average baseline scores for occupational (student) break frequency; however, after the initial face-to-face meeting, both groups show an increase in break frequency. This trend persists until week 3, when the control group scores begin to revert back towards their baseline level for the remaining intervention period; by contrast, the intervention group scores continue to decrease towards their intended score for the remainder of the intervention period. A possible explanation for these data may be rooted in self-selection bias. The present study was advertised as a sedentary behavior change study. Therefore, it is reasonable to expect that those who consented to participate in this study had some intention to change their sedentary behavior, which could be reflected by the initial increase in both groups occupational (student) break frequency score. Additionally, participants received the same weekly break frequency questionnaires that acted as a reminder, reinforcing existing intentions enough to elicit action. In combination, these two forces likely contributed to what the author has coined as the ‘honeymoon’ effect. However, this ‘honeymoon’ effect could not persist indefinitely; from a HAPA standpoint it is plausible that, without the development of a detailed action plan and coping strategies for this outcome, participants in the control
group were unable to continue to translate their intentions to increase their occupational (student) break frequency into action. The disparity between groups becomes most evident from week 3 onwards, after both groups received their second/booster session for their behavior. The rebound in the control group from week 3 forwards may represent the most distal moment – when pre-existing intentions can no longer facilitate action (possibly due to barriers), and the intended behavior reverts back to baseline levels.

These findings also highlight the importance of the booster session for the intervention group. From week 3 to week 6, the intervention group continues its trend of increasing occupational (student) break frequency, while the control group begins the aforementioned rebound back to baseline levels. Considering that the sole difference between groups was the nature of the face-to-face sessions (sedentary behavior or nutrition), we hypothesize that the booster session (i.e., action and coping planning) was the key facilitator in maintaining behavior change for this outcome. This explanation is in line with a study by Conroy et al. (2013), which measured the daily variations in intention for reducing sedentary behavior in a group of college students. They conclude “…intentions formed at the outset of a behavior change program may not remain as consistent as one might expect over the days and weeks that follow initial intervention delivery”, and that “future interventions that involve setting a goal for limiting sedentary behavior may benefit from the inclusion of daily booster interventions [to maintain intention]”.

While the present study only included one booster session (i.e., second counseling session) at Week 3, the potentially attenuating effect of the session, for the intervention group, is evidenced by the disparity between groups at Week 3 onwards.

From week six to follow-up in week 8, the occupational (student) break frequency score decreased from 2.88 to 2.77 for the intervention group, and decreased from 4.06 to 3.28 for the control group. This translates into no change in break frequency for the intervention group (every 45-60 minutes), and an increased frequency from every 1-1.5 hours to every 45-60 minutes for the control group. These somewhat counterintuitive findings are likely the result of a reduced workload from a summer schedule. Given the total length of the study (8 weeks), the majority of follow-up questionnaires were administered during the transitionary period between winter and spring semester. This can be seen in the overall
average weekly hours of class attended between baseline and follow-up; 9.62 and 4.25, respectively. Despite the decrease in break frequency scores for the control group from week 6 to follow-up, the lower and continued decrease in break frequency scores for the intervention group indicate some positive lingering effect from the intervention for this outcome.

With respect to break duration, from baseline to week six, the occupational (student) break duration score decreased from 6.62 to 5.85 for the intervention group, and decreased from 7.00 to 6.50 for the control group. This roughly translates into a decreased break duration from approximately 5-10 minutes to 4-5 minutes for the intervention group and no change for the control group (5-10 minutes). Although the group by time interaction effect was not statistically significant, the effect size is moderate-to-large ($\eta^2_p = .10$) (Richardson, 2011; Cohen, 1969), suggesting that the intervention had a positive effect on this outcome measure. Similar to the occupational (student) break frequency outcome findings, this effect size suggests the present study was underpowered for duration as well.

Also similar to break frequency outcome findings, these break duration findings are potentially clinically meaningful. Recommendations for break duration vary, due to its dependence on break frequency; a shorter duration break of 2 minutes can still elicit beneficial effects if paired with frequent breaks every 30 minutes of sitting (Bailey et al., 2015; Hawari et al., 2016). Our findings of 4-5 minutes/hour of sitting are in agreement with Swartz and colleagues (2011), who recommend: “...making small changes, such as taking a five minute walking break every hour [from sitting] could yield beneficial weight control or weight loss results”. This decrease in occupational (student) break duration could be attributed to the intervention group creating an action plan and coping strategies focused on achieving an occupational (student) break duration of 2-3 minutes, or a score of 4.00. By comparison, the control group’s score remained fairly stable, decreasing only slightly over the intervention period.

Absence of the aforementioned ‘honeymoon’ effect in the control group for occupational (student) break duration indicates that this outcome was not as affected, if affected at all, by any pre-existing intentions. We hypothesize that this absence may occur due to the pre-existing knowledge or information concerning sedentary behavior that participants had, prior to participation in the study, likely focused on ‘reducing sedentary behavior’ and would likely have been very general. Given that participants in the control group
presumably had intentions to change their sedentary behavior (self-selection bias), they modified their behavior by taking breaks more frequently – however, the length of their breaks remained unchanged on account of unfamiliarity with sedentary behavior break recommendations.

From week six to follow-up in week 8, the occupational (student) break duration score decreased from 5.85 to 5.54 for the intervention group, and decreased from 6.50 to 6.44 for the control group. This roughly translates into no change in break duration for the intervention group (4-5 minutes), and a decreased duration from 5-10 minutes to 4-5 minutes for the control group. The results show both groups maintaining relatively similar occupational (student) break duration, as compared to the end of the intervention period. For the intervention group, this combination of a maintained follow-up occupational (student) break frequency and duration score suggests that the intervention has some enduring effect for at least two weeks.

Overall, the results from our primary outcomes are in line with the literature. Participants in the intervention group achieved an occupational (student) break frequency score of 2.88 (every 45-60 minutes) and an occupational (student) break duration score of 5.85 (4-5 minutes). Through a text-message based intervention, Cotten and Prapavessis (2016) were able to increase overall break frequency in a sample of university student from taking breaks every 81.95 minutes of sitting to every 58.90 minutes of sitting. The researchers were also able to increase break duration from 6.71 minutes to 7.49 minutes. Similar to the present study, one of the main goals of the Cotten and Prapavessis study was to increase break frequency and duration to a 5 minute break every 30 minutes of sitting. The operationalization of our primary outcomes makes it difficult to draw direct comparisons to studies that use accelerometer data; however, based upon the literature, our findings are in line with current recommendations for break frequency (every 30-60 minutes) and duration (2-5 minutes) from sitting (Swartz et al., 2011; Owen et al., 2011).

Non-occupational Screen time break frequency & duration
From baseline to week six, the screen time break frequency score decreased from 3.38 to 2.85 for the intervention group, and increased from 3.74 to 4.26 for the control group. This roughly translates into no
change for the intervention group (every 45-60 minutes), and a decreased break frequency from every 45-60 minutes to every 1-1.5 hours. Although the group by time interaction was not statistically significant, the accompanying effect size was large ($\eta^2_p = .24$) (Richardson, 2011; Cohen, 1969), suggesting the intervention did positively affect this outcome measure.

The relative stability in the screen time break frequency for the intervention group suggests that the intervention did have some carryover or protective effect, as the intervention group appears to have attenuated for the decrease in break frequency that the control group experienced, from week 3 to week 6. The aforementioned ‘honeymoon’ effect may offer some explanation for these findings. From baseline to week 3, the screen time break frequency scores for both groups are within recommended levels. From a HAPA perspective this may be reflective of participants’ initial intentions to reduce their sedentary behavior; these intentions, and consequent action, would not be unique to just the occupational domain, as was previously observed. However, these intentions likely could not evolve into action indefinitely; the decrease in screen time break frequency for the control group from week 3 onwards represents this diminished strength of intention, and subsequent reduction in behavior.

From week six to follow-up in week 8, the screen time break frequency score increased from 2.85 to 3.46 for the intervention group, and increased from 3.74 to 4.26 for the control group. This roughly translates into no change in screen time break frequency for the intervention group (45-60 minutes), or the control group (1-1.5 hours). The results show both groups maintaining relatively similar screen time break frequency; this suggests that potential beneficial carryover effect from the intervention can persist for at least two weeks post-study.

From baseline to week six, the screen time break duration score decreased from 6.46 to 5.12 for the intervention group, and decreased from 6.42 to 5.84 for the control group. These equate to an approximate decrease in screen time break duration from 4-5 minutes to 3-4 minutes for the intervention group, and no change for the control group (4-5 minutes). Although the group by time interaction was not statistically significant, the accompanying effect size was large ($\eta^2_p = .22$) (Richardson, 2011; Cohen, 1969), suggesting the intervention did affect this outcome measure.
From week six to follow-up in week 8, the screen time break duration score decreased from 5.12 to 4.85 for the intervention group, and decreased from 5.84 to 5.05 for the control group. These values convert into relatively no change in screen time break duration for the intervention group (3-4 minutes), and an approximate decrease from 4-5 minutes to 3-4 minutes for the control group (3-4 minutes). The results show both groups maintaining relatively similar screen time break frequency; this suggests that potential beneficial carryover effect from the intervention can persist for at least two weeks post-study.

Since break duration and frequency must be taken into account together to illustrate sedentary behavior, the decrease in screen time break duration in the intervention group is mitigated by the respective increased screen time break frequency; taken together, these values (every 45-60 minutes & 3-4 minutes, respectively) are in line with recommendations for break frequency and duration (Swartz et al., 2011; Owen et al., 2011), indicating the intervention had an overall positive carryover effect for screen time breaks over the intervention period and 2 week follow-up.

**Baseline sitting profiles**

At baseline, participants in the intervention group averaged 9.79 hours of class and 49.08 hours of sitting as a student, per week; similarly, participants in the control group averaged 7.89 hours of class and 42.28 hours of sitting as a student, per week. These values represent school-related sedentary behavior occupying approximately 35.0% and 29.9% of the week for the average intervention and control participant, respectively. For our sample, this translates to, on average, one-third of time spent in a week due to time spent sedentary as a student. These percentages would increase even further if sleep time were taken into account.

While time spent sedentary in class is arguably difficult to modify, possibly due to perceptions of sitting and a restrictive environment for sitting alternatives, modifiable student sedentary time (i.e., time spent sitting outside of class as a student) still accounts for a considerable amount of time in the week of an average full-time student (27.20%). These findings reaffirm that full-time university students are sitting for prolonged periods of time due to their occupation as a student, placing them at high-risk for the
deleterious health outcomes of excessive sedentary behavior. These findings also underscore targeting this population for intervention studies.

Though research is absent in regards to the effect of concurrent standing or LIPA on the comprehension of complex information, we hypothesize comprehension may be compromised with prescribing bouts of standing or LIPA long enough to significantly reduce overall sitting as a student. Taken together with the dose-dependent nature of sedentary behavior (Healy et al., 2008), we rationalized that changing break frequency and duration within this sitting time would be better adopted by participants (task self-efficacy), than the alternative behavior of taking much longer, extended breaks from sitting, and result in more meaningful change.

2.4 Strengths, Limitation, and Future Directions

The current study had several strengths, one of which was the use of a randomized control trial that allowed for any observed effects in the intervention group to be compared to a control group. Another strength was the use of an equal contact design in which both groups received a baseline counseling session and a 3 week booster session; this draws out the specific vs non-specific effects of treatment. The inclusion of a 2 week follow-up period to determine any residual effects of the intervention was also a strength. Incorporating the HAPA model – an evidence based theory of behavior change – into our intervention was another strength. The present study largely focused on action and coping planning as a means to shift intentions into actions, however future studies should seek to identify the effectiveness and contribution of the different constructs to the intervention (Michie & Abraham, 2004). Our findings allude to the importance of a booster session, as does previous research (Conroy et al., 2013). Integrating the text message-based work of Cotten and Prapavessis (2016) to the present study, future studies may investigate the efficacy of a HAPA-based behavioral intervention with the inclusion of personalized, regular ‘booster sessions’ delivered via text message.

Another strength was operationalizing break frequency by ‘every x minutes/hours’ rather than in numbers (i.e., 20/day). This allows for direct comparison of outcomes with current or prescribed
recommendations for break frequency and respective duration. Given that the optimal frequency/duration of breaks from sitting occur in relatively small amounts of time (e.g., every 30 minutes and 2-3 minutes, respectively (Dunstan et al., 2012; Swartz et al., 2011; Bailey & Locke, 2012)), it becomes important that any behavior change that results from an intervention be frequent and long enough to illicit health benefits.

A further strength of this study was the use of the modified SIT-Q 7d as a measure of sedentary behavior. The questionnaire is domain-specific, which is in line with a review on the subject of measurement in sedentary behavior research by Healy and colleagues (2011). Specifically, they recommend “For self-reported measures, monitoring should ex-tend beyond measures of overall sitting to include the various domains”. Additionally, the questionnaire is one of the only self-report measures of sedentary behavior to include domain-specific break frequency and duration questions. Both the base questionnaire and the modified version have associated reliability and validity studies (Wijndaele et al., 2014; Sui & Prapavessis, 2016), supporting the utility of the questionnaire.

There are nevertheless limitations with the present study that must be acknowledged. First, as previously stated in the discussion, the study was underpowered. Power analysis revealed six more participants were needed for significance for occupational (student) break frequency. These results should aid in informing future studies of appropriate estimates of sample size and expected effect sizes. Second, a self-report questionnaire was used as the sole measure of sedentary behavior. Being able to cross-reference the frequency/duration of breaks with objective data within certain domains would give researchers more accurate data (Healy et al., 2011), to which they can develop more specific and effective strategies for increasing non-sedentary behaviors. In addition, while the researcher encouraged questionnaires to be answered weekly, many participants forgot to answer the questionnaire, or answered within a few days of the targeted completion date, leaving open the possibility of overlap or poor recall of the intended time period. Due to the electronic nature of the weekly questionnaires, some were only partially completed, while some were initially blocked by the participant’s spam filter.

A previous pilot study by the author confirmed the face validity and reliability of the Modified SIT-Q 7d Questionnaire (Sui & Prapavessis, 2016), however some participants still had issues with the
questionnaire. For instance, some wording/interpretation issues likely occurred in the last section of the questionnaire, specifically the questions that read: “How often did you break up your sitting while doing other activities?” and “How long were your breaks from sitting while doing other activities”, where “other activities” could have been misinterpreted as activities other than the ones previously mentioned (i.e., reading, chores, etc.). This confusion is evident in the missing data or highly improbable answers to these questions. A proposed revision to the question could read: “How often did you break up your sitting while engaged in the previously mentioned activities?” and “How long were your breaks from sitting while engaged in the previously mentioned activities?. One participant also neglected to include her studies as an occupation, likely due to misinterpretation of how ‘occupation’ was defined (i.e., work, study or volunteering).

Another limitation of the study was the timing of the intervention delivery. University students have both midterm and final exams or projects in their courses; these evaluations typically take place over the course of a few weeks, given that professors typically do not coordinate their evaluations with other professors. Since not every participant started the study at the same time, it is difficult to determine instances where the sedentary behavior intervention may have had an attenuating effect on, an otherwise very sedentary period of study for most students. Had the timing of exams been accounted for, a larger or protective effect of the intervention could have been observed. In addition, the length of the intervention meant that recruitment for the study could only occur for a limited period of time; if the study ran past final exams, participants would no longer be “full-time students”, and thus be ineligible. For future studies, knowing a student’s exam schedule beforehand may be beneficial for tailoring interventions and/or for more detailed data analysis.

A further limitation was due to the lack of blinding in both the advertising and study procedure; participants were aware that this was a study targeting sedentary behavior. Subjects who participated in the study were likely highly motivated to change their sedentary behavior, which may account for why larger net differences were not observed between the control and intervention groups. A final limitation revolves around the issue of external validity. That is, the specificity of the sample used (i.e., university students) makes it difficult to generalize the findings to other populations. Future research should
replicate this study with other at-risk populations, such as office workers, where a HAPA based intervention could be applied (Gardner et al., 2016).

2.5 Conclusion

The current study presents evidence for the efficacious potential of a domain-specific HAPA-based intervention for increasing occupation break frequency and duration in full-time university students.
References


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Appendix A
Student volunteers needed for a 6 week Sedentary Behavior research study

Utilizing the Health Action Process Approach to reduce sedentary behavior in a university student population.

We are examining the efficacy of a behavioral model for reducing student sedentary behavior over a six week period. Participants will be asked to fill out weekly questionnaires, and attend two personalized counseling sessions.

Participants must be:
Students of UWO with no mental illness or pregnancy

Contact us if you would like to learn more about our study.

Email: [redacted] Phone: [redacted]

11/01/2016
Ethics Approval

Western University Health Science Research Ethics Board
HSREB Delegated Initial Approval Notice

Principal Investigator: Prof. Harry Prapavessis
Department & Institution: Health Sciences/Kinesiology, Western University

Review Type: Delegated
HSREB File Number: 107528
Study Title: Utilizing the Health Action Process Approach to reduce sedentary behavior in a university student population.

HSREB Initial Approval Date: January 29, 2016
HSREB Expiry Date: January 29, 2017

Documents Approved and/or Received for Information:

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<th>Comments</th>
<th>Version Date</th>
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<td>Behavioral Counseling Form</td>
<td>2015/11/30</td>
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<td>Demographic Questionnaire</td>
<td>2015/11/30</td>
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<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Weekly Diet Recall Survey</td>
<td>2015/12/03</td>
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The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above named study, as of the HSREB Initial Approval Date noted above.

HSREB approval for this study remains valid until the HSREB Expiry Date noted above, conditional to timely submission and acceptance of HSREB Continuing Ethics Review.

The Western University HSREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use Guideline for Good Clinical Practice Practices (ICH E6 R1), the Ontario Personal Health Information Protection Act (PHIPA, 2004), Part 4 of the Natural Health Product Regulations, Health Canada Medical Device Regulations and Part C, Division 5, of the Food and Drug Regulations of Health Canada.

Members of the HSREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB.

The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Ethics Officer, on behalf of Dr. Marcelo Kremenchutzky, HSREB Vice Chair
Study Title: Utilizing the Health Action Process Approach to reduce sedentary behaviour in a university student population.

Principal Study Investigator:
Harry Prapavessis, Ph.D. (School of Kinesiology, The University of Western Ontario)

Co-Investigators:
Wuyou Sui, M.A. (School of Kinesiology, The University of Western Ontario)

You are being invited to participate in a research study utilizing the Health Action Process Approach (HAPA) in a sedentary behaviour context. The HAPA is a model for health behavior change that uses Action Planning and Coping Strategies to assist in bridging intentions with behavior. The application of HAPA towards sedentary behaviour has not been fully explored. This study seeks to assess the effectiveness of the HAPA in reducing sedentary behavior, specifically in a university student population. University students tend to spend a large amount of time sedentary, typically due to studying/preparing for classes. It is this specific domain of university students’ sedentary profile that this study will be targeting.

The purpose of this letter is to provide you with the information you require to make an informed decision on participating in this research. This letter contains information to help you decide whether or not to participate in this research study. It is important for you to understand why the study is being conducted and what it will involve. Please take the time to read this carefully and feel free to ask questions if anything is unclear or there are words you do not understand. We are asking you to take part because you a Western University student in good physical and mental health.

Invitation to Participate in Research and Eligibility Criteria

You are being invited to take part in this research study because you:
- are 18 years of age or older
- are a student attending Western University full-time
- are in good mental and physical health
- are not pregnant
- are able to read and write in English

What is the purpose of this study?
The purpose of this study is to test the efficacy of the Health Action Process Approach for reducing occupation specific sedentary behavior, specifically in a university student population. In other words, does the HAPA adequately predict and reduce sedentary behavior in university students?

**WHAT ARE YOU ASKED TO DO IN THIS STUDY?**

If you choose to participate in this study, you will be asked to attend three laboratory sessions at the Exercise and Health Psychology Laboratory (EHPL) located at the Arthur & Sonia Labatt Health Sciences Building (HSB 408) in the University of Western Ontario. At the first meeting you will be asked to complete the modified SIT-Q 7d (2), weekly diet recall survey (4), as well as demographic surveys (1). Additionally, you will receive behavioral counseling (3) from an investigator. Each laboratory meeting will take approximately 1 hour and subsequent appointments will be arranged at your convenience with the second appointment approximately three weeks after the first. You will also be sent a follow-up email two weeks following the study containing the modified SIT-Q 7d (2).

After the first laboratory meeting, you will receive weekly emails containing the modified SIT-Q 7d questionnaire (2). In total, you will complete the modified SIT-Q 7d questionnaire (2) seven times throughout the study.

Following an outline for each laboratory session you will find detailed descriptions of each itemized task (1 & 2) that you will be asked to complete.

**During your first session at the laboratory you will be asked to complete:**

1) Demographic survey (item – 1)
2) Modified SIT-Q 7d (item – 2)
3) Behavioral counseling (item – 3)
4) Weekly diet recall survey (item – 4)

**During your second session at the laboratory you will be asked to complete:**

1) Modified SIT-Q 7d (item – 2)
2) Behavioral counseling (item – 3)
3) Weekly diet recall survey (item – 4)

The task descriptions are as follows:

1) **Provide demographic information**
   Time involvement = 5 minutes
The Demographic survey will ask for: Full name, phone number, email address, and partial date of birth.

2) Complete the modified SIT-Q 7d  
Time involvement = 30 minutes  
The modified SIT-Q will ask for information pertaining to sedentary time spent in many lifestyle domains (e.g. Occupation, Transportation, etc.), as well as the corresponding break frequency/duration.

3) Behavioral counseling  
Time involvement = 30 minutes  
The behavioral counseling will involve creating an action plan and coping strategies for behavior change that fit your lifestyle. Behavioral strategies will be tailored for either reducing sedentary behavior or improving nutrition. Strategies will be developed with you and will be tailored to be comfortable and realistic, following the FITT principle (i.e. Frequency, Intensity, Time, and Type).

4) Weekly diet recall survey  
Time involvement = 10 minutes  
The weekly diet recall survey will ask you to recall the number of servings of each food group (i.e. Grains, Fruits & vegetables, Dairy, Meat & alternatives, and Oils & fats) you consumed in the last week.

What are the risks associated with my involvement in this study?  
There are no perceived risks to this study.

Do I have to take part?  
Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your future care. If you decide to take part you will be given this Letter of Information to keep and be asked to sign the consent form. If you withdraw from the study, you maintain the right to request that any data collected from you not be used in the study. If you make such a request, all of the data collected from you will be destroyed. Please contact the study co-investigator Wuyou Sui if you wish to withdraw from the study.

Participation in other studies
If you are participating in another study at this time, please inform the study researchers right away to determine if it is appropriate for you to participate in this study.

**New findings**

If, during the course of this study, new information becomes available that may relate to your willingness to continue to participate, this information will be provided to you by the investigator.

**Are there any costs associated with participation?**

Your name will be entered into a draw for one of three $500 gift cards. Upon completion of all 7 questionnaires, you are also eligible for a follow-up questionnaire which you will receive a $10 gift certificate for completing. You will be provided with free parking for your visits to the laboratory if needed.

This study is covered by an insurance policy and if during the course of the study any injury should occur all medical expenses necessary to treat such injury will be paid provided: a) you comply at all times with the study researcher’s instructions b) you promptly report any such injury to the study researchers conducting the study, and c) the expenses are not otherwise covered by your provincial health care. Financial compensation for such things as lost wages, disability or discomfort due to this type of injury is not routinely available. You do not waive any legal rights by signing the consent form.

**Will information obtained in the study be confidential?**

All the information you provide to the researcher will be kept in the strictest confidence. You will be assigned an identification number and all data collected from you will be recorded and stored under this number only. Study researchers will not have any way of connecting your data to you. All data will be stored in coded form on computers accessible only to research staff in a secure office. You will not be identified in any documents relating to the research. No information obtained during the study will be discussed with anyone outside of the research team. If the results of the study are published, your name will not be used.

Representatives of the University of Western Ontario Health Sciences Research Ethics Board may contact you or require access to your study-related records to monitor the conduct of the research. If we find information we are required by law to disclose, we cannot guarantee confidentiality. We will strive to ensure the confidentiality of your research-related records. Absolute confidentiality cannot be guaranteed, as we may have to disclose certain information under certain laws.

**Questions?**
If you have any questions about your rights as a research participant or the conduct of the study you may contact the Office of Research Ethics.

If you have any questions about the study, please contact the study co-investigator Wuyou Sui.

This letter is for you to keep. You will be given a copy of this letter of information and consent form once it has been signed. If you have any concerns, please feel free to contact one of the researchers below. You may request the general findings of this research study from the researchers after the study is complete.

Dr. Harry Prapavessis
Professor
School of Kinesiology, UWO

Wuyou Sui
M.A. Student
School of Kinesiology, UWO
Informed Consent

Study Title: Utilizing the Health Action Process Approach to reduce sedentary behaviour in a university student population.

I have read the Letter of Information, had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction. I will be given a copy of the Letter of Information and consent form once it has been signed.

Consenting Signature:

Participant: ______________________________________________________

Please Print Name

Participant: ______________________________________________________

Please Sign Name

Date: ________________

Please send me the overall conclusions from this trial:  Yes □ No □

Researcher Signature:

Person obtaining informed consent: __________________________________

Please Print Name

Person obtaining informed consent: __________________________________

Please Sign Name

Date: ________________
Appendix B
Demographics

Sociodemographic Questionnaire

YOUR CONTACT INFORMATION:

First Name:_______________________  Last Name:___________________________

Home Phone: _______- _______-________

Email Address: __________________________________________@_____________________

Date of Birth: _______/___________

            MM       YYYYY

Study ID: ___________________________
## Weekly Diet Recall Survey

**Participant ID:** _______  **Date:** _____________  □ First Meeting  □ Second Meeting

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</table>
Modified SIT-Q 7d

1. Participant details
   What is your study ID? (Initials may be used if Study ID is forgotten.)
   Today's Date (dd/mm/yyyy)

2. Study Week #
   Select which week of the study you are currently in (Leave blank if uncertain).
   [Please choose]

R Sc: Wiyou Sul, University of Western Ontario – 2016
Modified SIT-Q-7d Questionnaire

These questions are about the amount of time that you spent sitting or lying down and the frequency/length of breaks from sitting in the last 7 days. This questionnaire is organized into four sections, each asking about sitting or lying down and the number/duration of breaks in different settings.

If you have any questions or concerns with the questionnaire, please contact Yoah Sui

1. In the last 7 days, my amount of sitting was...
Compare your amount of sitting time over the last 7 days with a typical week for you.

   - Much less than normal
   - A little less than normal
   - About the same
   - A little more than normal
   - A lot more than normal

2. In the last 7 days, my number of breaks from sitting were...
Compare the number of breaks taken from sitting over the last 7 days with a typical week for you.

   - Much less than normal
   - A little less than normal
   - About the same
   - A little more than normal
   - A lot more than normal

3. In the last 7 days, my duration of my breaks from sitting were...
Compare the length of your breaks from sitting over the last 7 days with a typical week for you.

   - Much less than normal
   - A little less than normal
   - About the same
   - A little more than normal
   - A lot more than normal

R Sc, Wuyou Sui, University of Western Ontario – 2016
SECTION 1 – SLEEPING AND NAPPING
Think about what time you went to sleep and got up in the last 7 days. If you had variable sleeping patterns (e.g. you did shift work), please record the average time you went to bed and got up on weekdays and weekends.

Please answer the following questions in a 24hr format (e.g. Midnight = 0:00, Noon = 12:00).

1. WEEKDAY SLEEP
In the last 7 days, on an average WEEKDAY...
   at what time did you go to sleep? [ ] (e.g. 23:30)
   at what time did you wake up? [ ] (e.g. 06:00)

2. WEEKEND DAY SLEEP
In the last 7 days, on an average WEEKEND DAY...
   at what time did you fall asleep? [ ] (e.g. 23:30)
   at what time did you wake up? [ ] (e.g. 06:00)

NAPPING
A nap is a brief period of sleep, often during the day. A nap may be taken on a sofa as well as in a bed.

3. WEEKDAY NAPPING
In the last 7 days, on average, how long did you nap on a WEEKDAY?

   No daily napping  1 – 15 min  15 – 30 min  30 – 45 min  45 min – 1 hour  More than 1 hour a day

4. WEEKEND DAY NAPPING
In the last 7 days, on average, how long did you nap on a WEEKEND DAY?

   No daily napping  1 – 15 min  15 – 30 min  30 – 45 min  45 min – 1 hour  More than 1 hour a day

B.Sc. Wuyou Sui, University of Western Ontario – 2016
SECTION 2 – MEALS
Please think about the amount of time you spent sitting for breakfast, lunch, and dinner, on average in the last 7 days.
DO NOT include time spent eating while watching TV or using a computer. This is part of section 5.
DO include time spent sitting for breakfast, lunch, and dinner (at home, work, etc.), also when you were reading, chatting to other people or listening to the radio.
For example if you spent 30 minutes sitting for breakfast while reading the newspaper, or for lunch while working, then include this in this section.

1. WEEKDAY MEALS
In the last 7 days, how long did you sit for each of these meals, on an average WEEKDAY?

Breakfast

<table>
<thead>
<tr>
<th>None</th>
<th>1 – 10 min</th>
<th>10 – 20 min</th>
<th>20 – 30 min</th>
<th>30 – 45 min</th>
<th>45 min – 1 hour</th>
<th>More than 1 hour a day</th>
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Lunch

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<tr>
<th>None</th>
<th>1 – 10 min</th>
<th>10 – 20 min</th>
<th>20 – 30 min</th>
<th>30 – 45 min</th>
<th>45 min – 1 hour</th>
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Dinner

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<tr>
<th>None</th>
<th>1 – 10 min</th>
<th>10 – 20 min</th>
<th>20 – 30 min</th>
<th>30 – 45 min</th>
<th>45 min – 1 hour</th>
<th>More than 1 hour a day</th>
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2. WEEKEND DAY MEALS
In the last 7 days, how long did you sit for each of these meals, on an average WEEKEND DAY?

Breakfast

<table>
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<tr>
<th>None</th>
<th>1 – 10 min</th>
<th>10 – 20 min</th>
<th>20 – 30 min</th>
<th>30 – 45 min</th>
<th>45 min – 1 hour</th>
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<th>20 – 30 min</th>
<th>30 – 45 min</th>
<th>45 min – 1 hour</th>
<th>More than 1 hour a day</th>
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<th>1 – 10 min</th>
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SECTION 3 – TRANSPORTATION
This section refers to the time you spent sitting during transportation (travelling in a car, bus, train, on a motorbike, etc.) in the last 7 days. The questions are about travelling to and from your occupation, travelling as part of your occupation, and getting about apart from your occupation.

“Occupation” refers to three different types of activities: work, study, and volunteering. “Work” refers to all tasks done to earn money. “Study” refers to educational activities. “Volunteering” refers to work that you do for no pay, such as helping in a sports club. Please think about all three of these categories for the following questions.

DO NOT include cycling on a pedal bicycle.

1. Have you been working, studying, or volunteering (referred to as “occupation”) in the last 7 days?
If so, please list the occupations below.

☐ No

☐ Yes – Occupation 1

☐ Yes – Occupation 2

☐ Yes – Occupation 3

If you DID NOT have an occupation in the last 7 days, please skip to the “Getting about – apart from your occupation” section at the bottom of the page.

If you DID have an occupation, please answer the questions below. There is space for three different occupations (“Occupation 1”, “Occupation 2”, “Occupation 3”).

2. Travelling to and from your occupation
In the last 7 days, how many days a week did you sit while travelling to and from your occupation? (in a car, bus, train, on a motorbike, etc.; DO NOT include cycling on a pedal bicycle)

☐ Occupation 1 days

☐ Occupation 2 days

☐ Occupation 3 days

3. In the last 7 days, on average, how long did you sit while travelling to and from your occupation on such a day?
3. In the last 7 days, on average, how long did you sit while travelling to and from your occupation on such a day? (in a car, bus, train, on a motorbike, etc.; do not include cycling on a pedal bicycle)

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<thead>
<tr>
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<th>15 - 30 min</th>
<th>30 - 45 min</th>
<th>45 min - 1 hour</th>
<th>1 - 1.5 hours</th>
<th>1.5 - 2.5 hours</th>
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<th>Occupation 2</th>
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<th>15 - 30 min</th>
<th>30 - 45 min</th>
<th>45 min - 1 hour</th>
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<th>30 - 45 min</th>
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4. Travelling as a part of your occupation

In the last 7 days, how many days a week did you sit while travelling as a part of your occupation? (in a car, bus, train, on a motorbike, etc.; DO NOT include cycling on a pedal bicycle)

- Occupation 1: __________ days
- Occupation 2: __________ days
- Occupation 3: __________ days

5. In the last 7 days, on average, how long did you sit while travelling as a part of your occupation on such a day? (in a car, bus, train, on a motorbike, etc.; do not include cycling on a pedal bicycle)
6. Travelling apart from your occupation
In the last 7 days, how many days a week did you sit while travelling apart from your occupation? (in a car, bus, train, on a motorbike, etc.; DO NOT include cycling on a pedal bicycle)

[Input field for days]

7. In the last 7 days, on average, how long did you sit while travelling apart from your occupation on such a day?
(in a car, bus, train, on a motorbike, etc.; do not include cycling on a pedal bicycle)

[Input field for hours]
SECTION 4 - WORK, STUDY, AND VOLUNTEERING

This section is about the time you spent sitting and break frequency/duration during your occupation, which refers to work, study and volunteering. Please think about all three of these categories for the following questions.

1. Have you been working, studying, or volunteering (referred to as “occupation”) in the last 7 days?

   - Yes
   - No

If you did not have an occupation in the last 7 days, please skip to SECTION 5.
If you did have an occupation, please complete this section. There is space for three different occupations (“Occupation 1”, “Occupation 2”, “Occupation 3”).

2. Occupation 1
   Type of Occupation 1

   - Work
   - Study
   - Volunteer

3. Name of Occupation 1
   E.g. receptionist, student, etc.

4. How many days did you spend doing Occupation 1 in the last 7 days?

   [Please choose]
5. If the occupation was study, how many hours of class did you attend in the last 7 days?

6. In the last 7 days, on average, how much time per day did you spend sitting while doing Occupation 1?

DO NOT INCLUDE: time spent sitting for transportation (in a car, bus, train, on a motorbike, etc.) either for travelling to and from this occupation, or as part of this occupation. This was part of Section 3.

DO NOT INCLUDE: breakfast, lunch, or dinner. This was part of Section 2.

DO INCLUDE: time spent sitting in class. This was a previous question in this section.

Do include time spent sitting while studying outside of class.

None 1 – 15 min 15 – 30 min 30 min – 1 hour 1 – 2 hours 2 – 3 hours 3 – 4 hours 4 – 5 hours 5 – 6 hours 6 – 7 hours 7 – 8 hours More than 8 hours

7. In the last 7 days, on average, how often did you interrupt your sitting time during Occupation 1?

N/A – did not sit Less than every 30 min Every 30 – 45 min Every 45 – 60 min 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

8. In the last 7 days, on average, how long were your breaks from sitting from Occupation 1?

N/A – no breaks taken 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 More than 30 min

9. Did you have a second occupation in the last 7 days?

If you DID NOT have a second occupation in the last 7 days, please skip to Section 5.

If you DID have a second occupation in the last 7 days, please answer the questions below.

Yes No
10. Occupation 2
Type of Occupation 2
- Work
- Study
- Volunteer

11. Name of Occupation 2
E.g. receptionist, student, etc.

12. How many days did you spend doing Occupation 2 in the last 7 days?
[Please choose]

13. If the occupation was study, how many hours of class did you attend in the last 7 days?

14. In the last 7 days, on average, how much time per day did you spend sitting while doing Occupation 2?
DO NOT INCLUDE: time spent sitting for transportation (in a car, bus, train, on a motorbike, etc.) either for travelling to and from this occupation, or as part of this occupation. This was part of Section 3.
DO NOT INCLUDE: breakfast, lunch, or dinner. This was part of Section 2.
DO NOT INCLUDE: time spent sitting in class. This was a previous question in this section.
DO include time spent sitting while studying outside of class.
- None
- 1 - 15 min
- 15 - 30 min
- 30 min - 1 hour
- 1 - 2 hours
- 2 - 3 hours
- 3 - 4 hours
- 4 - 5 hours
- 5 - 6 hours
- 6 - 7 hours
- 7 - 8 hours
- More than 8 hours

15. In the last 7 days, on average, how often did you interrupt your sitting time during Occupation 2?
N/A – did not sit
Less than every 30 min
Every 30 - 45 min
Every 45 - 60 min
Every 1 - 1.5 hours
Every 1.5 - 2 hours
Every 2 - 3 hours
Every 3 - 4 hours
Every 4 - 5 hours
Every 5 hours
Over every 5 hours
No Interruption
16. In the last 7 days, on average, how long were your breaks from sitting from Occupation 2?

N/A - no breaks taken
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
More than 30 min

17. Did you have a third occupation in the last 7 days?
If you DID NOT have a third occupation in the last 7 days, please skip to Section 5.
If you DID have a third occupation in the last 7 days, please answer the questions below.

- Yes
- No

18. Occupation 3
Type of Occupation 3

- Work
- Study
- Volunteer

19. Name of Occupation 3
E.g. receptionist, student, etc.

20. How many days did you spend doing Occupation 3 in the last 7 days?

[Please choose]

21. If the occupation was study, how many hours of class did you attend in the last 7 days?

[ ] [ ] hours
22. In the last 7 days, on average, how much time per day did you spend sitting while doing Occupation 3?

DO NOT INCLUDE: time spent sitting for transportation (in a car, bus, train, on a motorbike, etc.) either for travelling to and from this occupation, or as part of this occupation. This was part of Section 3.

DO NOT INCLUDE: breakfast, lunch, or dinner. This was part of Section 2.

DO NOT INCLUDE: time spent sitting in class. This was a previous question in this section.

DO include time spent sitting while studying outside of class.

- None
- 1 – 15 min
- 15 – 30 min
- 30 min – 1 hour
- 1 – 2 hours
- 2 – 3 hours
- 3 – 4 hours
- 4 – 5 hours
- 5 – 6 hours
- 6 – 7 hours
- 7 – 8 hours
- More than 8 hours

23. In the last 7 days, on average, how often did you interrupt your sitting time during Occupation 3?

- N/A – did not sit
- Less than every 30 min
- Every 30 – 45 min
- Every 45 – 60 min
- Every 1.5 – 2 hours
- Every 2 – 3 hours
- Every 3 – 4 hours
- Every 4 – 5 hours
- Over every 5 hours
- No Interruption

24. In the last 7 days, on average, how long were your breaks from sitting from Occupation 3?

- N/A – no breaks taken
- 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
- More than 30 min

B.Sc. Wuyou Sui, University of Western Ontario – 2016
SECTION 5 – SCREEN TIME

This section refers to the time you spent sitting or lying down during screen time related activities in the last 7 days. Remember, each period of sitting down should only be entered once.

For example if you spent one hour sitting on the sofa surfing the internet while you were listening to music, count this time as one hour using computer apart from work, if this was your main focus. Do not count this as one hour of listening to music.

DO NOT include any screen time spent sitting/lying related to occupations.

1. In the last 7 days, on the average WEEKDAY, how long did you spend sitting or lying down while watching TV, DVD's/videos, Netflix?

DO include meals while sitting and watching TV.

<table>
<thead>
<tr>
<th>None</th>
<th>1 – 15 min</th>
<th>15 – 30 min</th>
<th>30 – 1 hour</th>
<th>1 – 2 hours</th>
<th>2 – 3 hours</th>
<th>3 – 4 hours</th>
<th>4 – 5 hours</th>
<th>5 – 6 hours</th>
<th>6 – 7 hours</th>
<th>More than 7 hours</th>
</tr>
</thead>
</table>

2. In the last 7 days, on the average WEEKEND DAY, how long did you spend sitting or lying down while watching TV, DVD's/videos, Netflix?

DO include meals while sitting and watching TV.

<table>
<thead>
<tr>
<th>None</th>
<th>1 – 15 min</th>
<th>15 – 30 min</th>
<th>30 – 1 hour</th>
<th>1 – 2 hours</th>
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<th>4 – 5 hours</th>
<th>5 – 6 hours</th>
<th>6 – 7 hours</th>
<th>More than 7 hours</th>
</tr>
</thead>
</table>

3. In the last 7 days, on the average WEEKDAY, how long did you spend sitting or lying down while using your computer/phone apart from occupation(s)?

E.g. Internet, email, chat, networking, Facebook, etc.

DO NOT include watching TV or movies online.
E.g. Internet, email, chat, networking, Facebook, etc.
DO NOT include watching TV or movies online.

None  1 – 15 min  15 – 30 min  30 – 1 hour  1 – 2 hours  2 – 3 hours  3 – 4 hours  4 – 5 hours  5 – 6 hours  6 – 7 hours  More than 7 hours

4. In the last 7 days, on the average WEEKEND DAY, how long did you spend sitting or lying down while using your computer/phone apart from occupation(s)?
E.g. Internet, email, chat, networking, Facebook, etc.
DO NOT include watching TV or movies online.

None  1 – 15 min  15 – 30 min  30 – 1 hour  1 – 2 hours  2 – 3 hours  3 – 4 hours  4 – 5 hours  5 – 6 hours  6 – 7 hours  More than 7 hours

5. In the last 7 days, on the average WEEKDAY, how long did you spend sitting or lying down while playing computer/video games?
E.g. Playstation, Xbox, PC...
DO NOT include non-sitting games.

None  1 – 15 min  15 – 30 min  30 – 1 hour  1 – 2 hours  2 – 3 hours  3 – 4 hours  4 – 5 hours  5 – 6 hours  6 – 7 hours  More than 7 hours

6. In the last 7 days, on the average WEEKEND DAY, how long did you spend sitting or lying down while playing computer/video games?
E.g. Playstation, Xbox, PC...
DO NOT include non-sitting games.

None  1 – 15 min  15 – 30 min  30 – 1 hour  1 – 2 hours  2 – 3 hours  3 – 4 hours  4 – 5 hours  5 – 6 hours  6 – 7 hours  More than 7 hours
7. In the last 7 days, on average, how often did you interrupt your sitting time while engaged in screen time?

- N/A - did not sit
- Less than every 30 min
- Every 30 - 45 min
- Every 45 - 60 min
- 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

8. In the last 7 days, on average, how long were your breaks from sitting while engaged in screen time?

- N/A - no breaks taken
- 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
- More than 30 min

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This section refers to the time you spent sitting or lying down during other activities in the last 7 days. Remember, each period of sitting down should be only entered once. For example, if you spent one hour sitting on the sofa reading a book while you were listening to music, count this time as one hour reading if this was your main focus.

DO NOT count this as one hour of listening to music.

DO NOT include any activities sitting/lying down related to occupation(s).

Please remember that each period of sitting should only be entered once.

1. In the last 7 days, on the average WEEKDAY, how long did you spend sitting or lying down while reading, per day?

E.g. Book, magazine, newspaper, etc.

None  1 – 15 min  15 – 30 min  30 min – 1 hour  1 – 2 hours  2 – 3 hours  3 – 4 hours  4 – 5 hours  5 – 6 hours  6 – 7 hours  More than 7 hours

2. In the last 7 days, on the average WEEKEND DAY, how long did you spend sitting or lying down while reading, per day?

E.g. Book, magazine, newspaper, etc.

None  1 – 15 min  15 – 30 min  30 min – 1 hour  1 – 2 hours  2 – 3 hours  3 – 4 hours  4 – 5 hours  5 – 6 hours  6 – 7 hours  More than 7 hours

3. In the last 7 days, on the average WEEKDAY, how long did you spend sitting or lying down while doing household tasks, per day?
E.g. cooking, ironing, etc.

<table>
<thead>
<tr>
<th>None</th>
<th>1–15 min</th>
<th>15–30 min</th>
<th>30 min–1 hour</th>
<th>1–2 hours</th>
<th>2–3 hours</th>
<th>3–4 hours</th>
<th>4–5 hours</th>
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4. In the last 7 days, on the average WEEKEND DAY, how long did you spend sitting or lying down while doing household tasks, per day?
E.g. cooking, ironing, etc.

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<th>5–6 hours</th>
<th>6–7 hours</th>
<th>More than 7 hours</th>
</tr>
</thead>
</table>

5. In the last 7 days, on the average WEEKDAY, how long did you spend sitting or lying down while caring, per day?
E.g. for children, grandchildren, elderly, or disabled relatives

<table>
<thead>
<tr>
<th>None</th>
<th>1–15 min</th>
<th>15–30 min</th>
<th>30 min–1 hour</th>
<th>1–2 hours</th>
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6. In the last 7 days, on the average WEEKEND DAY, how long did you spend sitting or lying down while caring, per day?
E.g. for children, grandchildren, elderly, or disabled relatives

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<th>4–5 hours</th>
<th>5–6 hours</th>
<th>6–7 hours</th>
<th>More than 7 hours</th>
</tr>
</thead>
</table>
7. In the last 7 days, on the average WEEKDAY, how long did you spend sitting or lying down for hobbies, per day?
E.g. playing piano, cards, doing crosswords, etc.

None 1–15 min 15–30 min 30 min – 1 hour 1–2 hours 2–3 hours 3–4 hours 4–5 hours 5–6 hours 6–7 hours More than 7 hours

8. In the last 7 days, on the average WEEKEND DAY, how long did you spend sitting or lying down for hobbies, per day?
E.g. playing piano, cards, doing crosswords, etc.

None 1–15 min 15–30 min 30 min – 1 hour 1–2 hours 2–3 hours 3–4 hours 4–5 hours 5–6 hours 6–7 hours More than 7 hours

9. In the last 7 days, on the average WEEKDAY, how long did you spend sitting or lying down for socializing, per day?
E.g. visiting friends, pub, cinema, sporting event, etc.

None 1–15 min 15–30 min 30 min – 1 hour 1–2 hours 2–3 hours 3–4 hours 4–5 hours 5–6 hours 6–7 hours More than 7 hours

10. In the last 7 days, on the average WEEKEND DAY, how long did you spend sitting or lying down for socializing, per day?
E.g. visiting friends, pub, cinema, sporting event, etc.

None 1–15 min 15–30 min 30 min – 1 hour 1–2 hours 2–3 hours 3–4 hours 4–5 hours 5–6 hours 6–7 hours More than 7 hours
11. In the last 7 days, on the average WEEKDAY, how long did you spend sitting or lying down while listening to music, per day?
   E.g. radio, CD, MP3, iPod, etc.
   | None | 1 – 15 min | 15 – 30 min | 30 min – 1 hour | 1 – 2 hours | 2 – 3 hours | 3 – 4 hours | 4 – 5 hours | 5 – 6 hours | 6 – 7 hours | More than 7 hours |

12. In the last 7 days, on the average WEEKEND DAY, how long did you spend sitting or lying down while listening to music, per day?
   E.g. radio, CD, MP3, iPod, etc.
   | None | 1 – 15 min | 15 – 30 min | 30 min – 1 hour | 1 – 2 hours | 2 – 3 hours | 3 – 4 hours | 4 – 5 hours | 5 – 6 hours | 6 – 7 hours | More than 7 hours |

13. In the last 7 days, on the average WEEKDAY, how long did you spend sitting or lying down for other activities, per day?
   E.g. activities not listed above. Please list the activity if there was one.
   | None | 1 – 15 min | 15 – 30 min | 30 min – 1 hour | 1 – 2 hours | 2 – 3 hours | 3 – 4 hours | 4 – 5 hours | 5 – 6 hours | 6 – 7 hours | More than 7 hours |

14. In the last 7 days, on the average WEEKEND DAY, how long did you spend sitting or lying down for other activities, per day?
   E.g. activities not listed above. Please list the activity if there was one.
   | None | 1 – 15 min | 15 – 30 min | 30 min – 1 hour | 1 – 2 hours | 2 – 3 hours | 3 – 4 hours | 4 – 5 hours | 5 – 6 hours | 6 – 7 hours | More than 7 hours |
15. In the last 7 days, on average, how often did you interrupt your sitting time while engaged in these other activities?
E.g. Socializing, listening to music, hobbies, etc.

N/A – did not sit
Less than every 30 min
Every 30 – 45 min
Every 45 – 60 min
Every 1.5 – 2 hours
Every 2 – 3 hours
Every 3 – 4 hours
Every 4 – 5 hours
Over every 5 hours
No Interruption

16. In the last 7 days, on average, how long were your breaks from sitting while engaged in these other activities?
E.g. Socializing, listening to music, hobbies, etc.

N/A – no breaks taken
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
More than 30 min

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Thank you for completing this questionnaire!

We would like to thank you very much for helping us.

If you are in week 1-5 of the study, please be sure to watch for next week’s questionnaire in your email.

If you have any questions, or would like to contact the study co-investigator, please email Yoah at

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

B.Sc. Wuyou Sui, University of Western Ontario – 2016
Behavioral Counseling Form

**Behavioral Counseling: Action Plan and Coping**

Participant ID: _______      Date: _____________      □ First Meeting      □ Second Meeting

Behavior change: ________________________________

<table>
<thead>
<tr>
<th>Behavioral strategy</th>
<th>Frequency</th>
<th>Intensity</th>
<th>Time</th>
<th>Type</th>
<th>Coping strategy</th>
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Next meeting: ____________________
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<tr>
<th>Date</th>
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<tr>
<td>1/1/2023</td>
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<td>Event B</td>
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<td>1/3/2023</td>
<td>Event C</td>
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<td>1/4/2023</td>
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<td>1/9/2023</td>
<td>Event I</td>
</tr>
<tr>
<td>1/10/2023</td>
<td>Event J</td>
</tr>
</tbody>
</table>

**Legend**
- No Activity
- Event 1
- Event 2
- Event 3
- Event 4
- Event 5
- Event 6
- Event 7
- Event 8
- Event 9
- Event 10

**Description**
- Event 1: Description
- Event 2: Description
- Event 3: Description
- Event 4: Description
- Event 5: Description
- Event 6: Description
- Event 7: Description
- Event 8: Description
- Event 9: Description
- Event 10: Description
Appendix C
**Background**

Recent research in sedentary behavior revealed a recall proportion of a small percentage of break frequency in determining the SIT-D 7-day measures of the physical activity intensity. However, the sedentary behavior intensity proportion of the measured frequency during the 7-day recall period is not consistent with the expected frequency.

**Purpose**

Testing the face validity and reliability of a modified SIT-D 7-day recall questionnaire measuring sedentary time and break frequency & duration.

**Methods**

A questionnaire with additional items was developed to assess the face validity of the modified SIT-D 7-day recall. The questionnaire was distributed to participants who completed the modified SIT-D 7-day recall.
Curriculum Vitae

Name: Wuyou (Yoah) Sui

Post-secondary: University of Waterloo

Education and University of Waterloo, Ontario, Canada

Degrees: 2010-2014 B.Sc.

The University of Western Ontario

2014-2016 M.A.

Honours and Province of Ontario Graduate Scholarship

Awards: 2016-2017

Society of Graduate Students (SOGS) 125th Anniversary Scholarship

2014-2015

Related Work Teaching Assistant

Experience Western University

2014-2016

CO.21 PAC Leader

Western University/University of Alberta

2014-2016