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Exploring the Relationship Between Sedentary Behavior and Subjective Well-Being

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Abstract

Sedentary behavior (SB) describes any waking behavior that is low energy and performed in a sitting, lying, or reclining posture. The average Canadian spends over 9.5 hours sedentary per day, with populations like university students reporting over 11 hours per day. Detrimental associations between excessive, long-term SB and chronic disease risk are well-established. However, relationships between SB and subjective well-being (SWB) are less clear. SWB is typically conceptualized as either (i) hedonic well-being, whereby ideal SWB is achieved through optimizing affect (i.e., mood) and life satisfaction; or (ii) eudaimonic well-being, whereby ideal SWB is achieved through self-actualization and purpose. Current literature surrounding the relationship between SB and SWB is conflicting. Hence, the objective of this dissertation was to explore the relationships between SB and SWB. To this end, three studies were conducted. Study 1 mapped the current literature that examined indices of SB (i.e., objectively-measured and self-reported SB and physical inactivity, and screen time) and outcomes of hedonic well-being (i.e., affect, life satisfaction) through a scoping review. Findings revealed a weak detrimental association between indices of SB and outcomes of SWB – however, little research actually examining SB exists. Study 2 built upon the dearth of research examining SB and SWB through a cross-sectional survey. Specifically, relationships between total, self-compared, and domain-specific SB and breaks from SB and outcomes of SWB were examined among a national sample of university students. Findings reflect the weak detrimental association in previous literature; however, self-compared SB, breaks from SB, and some domains of SB exhibited larger associations with outcomes of SWB than total SB. Study 3 aimed to evaluate the preliminary effectiveness of an acute SB-reducing intervention on outcomes of SWB among a sample of sedentary university students. Although the intervention provided only weak evidence for effectiveness, change correlations and its interplay with intervention effectiveness revealed objectively-measured, total, and self-compared SB as well as breaks from SB, to be salient targets for intervention. Findings from this work inform the effectiveness of future SB-reducing interventions, which help to elucidate the directionality and causality of relationships between SB and SWB.

Keywords

sedentary behavior, physical inactivity, subjective well-being, affect, life satisfaction, hedonic well-being, eudaimonic well-being, university students

Summary for Lay Audience

Sedentary behavior (SB) describes the majority of behaviors we perform, such as sitting, lying, and reclining. Between all the domains of sitting (e.g., transportation, screen time, occupation) the average Canadian sits for over 9.5 hours per day, with some groups, like office workers and university students, sitting for even longer. Excessive sitting is a health concern as prolonged SB has been associated with increased risk of chronic diseases (e.g., heart disease, type 2 diabetes, hypertension) and all-cause mortality. However, the relationship between SB and subjective well-being is less clear. Subjective well-being (SWB), generally, describes an individual's self-evaluation of their life, and can be split into hedonic well-being and eudaimonic well-being. Hedonic well-being proposes that SWB is optimized when one's affect (i.e., mood) and life satisfaction are optimized. While similar, eudaimonic well-being proposes that SWB is optimized through purpose, subjective vitality, and realizing oneself. Regardless of perspective, research surrounding relationships between SB and SWB is unclear. As such, the purpose of this dissertation was to explore the relationships between SB and SWB. Study 1 mapped relationships between indices of SB (e.g., SB, physical inactivity, screen time) and hedonic well-being within the current literature through a scoping review. Findings revealed weak detrimental associations between SB and outcomes of hedonic well-being, but the specific domain of sitting impacted this relationship. Study 2 more specifically examined relationships between total and domain-specific SB and outcomes of SWB through a survey. Findings reinforced relationships observed in study 1, as well as highlighted the importance of self-compared sitting time, breaks from sitting, and certain domains of SB (e.g., screen time). Study 3 determined the early effectiveness of a short-term SB-reducing intervention in a sample of university students through a randomized pilot trial. While the intervention was ineffective, analyses revealed that device-measured SB, total reported sitting, self-compared sitting, and breaks from sitting were all important components of interventions aimed at modifying SWB. Overall, SB appears to be weakly, detrimentally associated with outcomes of SWB; however, specific domains of SB, self-compared SB, breaks from sitting, and changes from one's typical SB demonstrated stronger relationships with outcomes of SWB.

Co-Authorship Statement

The author recognizes the contribution of Ms. Ana Rudkovska, who assisted with the scoping review (Study 1). Specifically, Ms. Rudkovska assisted in the initial screening of articles by title and abstract, the following screening of articles by full-text, and data charting.

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Chapter 1

1 Introduction

The benefits of physical activity (PA), specifically moderate-to-vigorous physical activity (MVPA), are well-established[1]. Consequently, global guidelines detailing the ideal volume, intensity, and forms of PA have been developed[2], as have specific guidelines for many countries (e.g., Canada[3], USA[4]). Physical activity guidelines for adults in Canada align with these global guidelines and recommend at least 150 minutes of MVPA accumulated in bouts of at least 10 minutes[3]. However, applying PA guidelines to an average day (i.e., 30 minutes of MVPA per day, 5 days per week) accounts for only 3% of waking time, assuming an average 8 hours of sleep. Put differently, 97% of one's waking day activity is spent engaging in behaviors other than PA, assuming individuals are meeting PA guidelines, which fewer than 1 in 5 Canadian adults are[5]. The remaining waking hours are predominantly spent in sedentary behaviors.

1.1 Sedentary Behavior

Sedentary behavior (SB) describes any behavior that is (i) waking, (ii) expends ≤ 1.5 Metabolic equivalents, and (iii) is performed in a seated, lying, or reclining posture[6]. The broad definition of SB implicates behaviors in nearly every domain of daily life: sitting during meals, occupations, screen time, and transportation, for example. The 9.8 hours per day spent sedentary for the average Canadian[7] is reflective of the pervasive and universal nature of SBs. Daily levels of SB are estimated to be even higher among populations where SB is implied in their occupation, such as office workers[8] and university students[9]. As such, considerable research has explored the link between excessive chronic SB and health outcomes. A systematic review of systematic reviews by de Rezende and colleagues detailed the detrimental health outcomes associated with chronic excessive SB, including an increased risk for all-cause mortality, heart disease, type 2 diabetes, and some cancers[10]. Additional systematic reviews have summarized the negative association between chronic SB and depression[11] and anxiety[12]. Importantly, the health consequences of chronic SB appear to be independent of levels of PA[10] – in other words, meeting PA guidelines does not completely attenuate the negative health effects of chronic sitting. Work by Ekelund and colleagues suggests that 60-75 minutes of MVPA are needed to completely eliminate the increased risk of death associated with higher SB[13]; the infeasibility of a population achieving these levels of MVPA cements SB as an outcome of interest, independent of PA.

1.2 Pathogenesis vs. Salutogenesis

Currently, research examining SB and health outcomes have primarily examined health through a pathogenic lens, whereby optimal health is achieved through the absence of disease/illness or disease markers[14]. Through a pathogenic lens, a healthy person would not have an impaired glucose response or would register a normal level of resting blood pressure, for instance. However, many medical sociologists and philosophers have refuted this narrow definition of health, arguing that health cannot be dichotomized and solely constructed through biological/physiological markers. Rather, definitions of health must also include the assets and factors that support health[15]. From this viewpoint stems the concept of salutogenesis, which in contrast to pathogenesis, examines health as a continuum and focuses on factors that actively promote health[14]. Importantly, individual evaluations of health and well-being are vital to a salutogenic orientation, as salutogenesis "must relate to all aspects of a person"[14]; hence, outcomes assessing individuals' own conceptions of their health, such as subjective well-being, are of particular interest.

1.3 Subjective Well-Being

Subjective well-being (SWB) broadly describes an individual's own conceptions of their life and functioning[16]. Under the umbrella of SWB, there are two distinct, but related, philosophies. The first, hedonic well-being, theorizes SWB as the fulfillment of happiness and pleasure with one's life. As such, measurement of SWB is constituted by positive and negative affect (i.e., feelings/emotions) and life satisfaction (i.e., a global cognitive measure of one's own life compared to an imagined ideal[16]). The interfacing operationalization of SWB to hedonic well-being is eudaimonic well-being. In contrast to the 'pleasure-centered' focus of hedonic well-being, eudaimonic well-being conceptualizes SWB as a self-evaluation of one's aliveness and is concerned with constructs of self-realization and subjective vitality[16], for instance. While these two philosophies conceptualize SWB differently, there are moderate interrelations between them (e.g., happiness and meaningfulness[17]). Hence, measurement of SWB through a complementary lens of hedonic and eudaimonic well-being may present the most holistic assessment of the phenomenon.

1.4 Subjective Well-Being and Sedentary Behavior

Compared to evidence surrounding SB and traditional health outcomes, there is relatively little evidence examining the relationship between SB and SWB. In general, there is evidence to suggest that greater SB is weakly, negatively associated with outcomes of SWB. For example, Hogan and colleagues found SB predicted less frequent positive emotions, independent of PA[18]. Further experimental work by Edwards and Loprinzi found life satisfaction was significantly lower among participants who increased their SB over a 1-week intervention[19]. However, other work has found no relationship between SB and outcomes of SWB. Puig-Ribera and colleagues noted no significant interactions between sitting time during traveling, sitting time during TV, and total sitting time and overall SWB over a 19-week period[20]. Findings by Maher and Conroy further complicate these relationships, as they found no difference in life satisfaction between more or less sedentary individuals, but did note that within-subject differences from one’s typical SB were predictive of changes in life satisfaction[21].

Several factors contribute to the incongruency of findings among studies exploring SB and SWB. Firstly, agreement upon which outcomes of SWB are measured is variable. For example, when considering hedonic well-being, some work only measured life satisfaction[21,22], while others only measured affect[18,23]. Further, some studies only examined one dimension of affect (i.e., positive[24] or negative[25]). Secondly, measurement of SB within previous work is also inconsistent. Given the relative nascency of a consensual definition of SB, a significant fraction of the literature exploring SB and SWB has not actually measured SB. Rather, studies have measured physical inactivity (PI) through use of an accelerometer[26], which cannot capture the postural component of SB, or through binary self-reported PA items[27]. Furthermore, several studies have measured a specific domain of SB as a proxy for total SB[25,28] (e.g., screen time).

Further compounding to the inconsistent assessment of SB is the variability among instruments used to measure SB. Specifically, studies typically measure either objective SB or self-reported SB. Objectively-measured SB is assessed through the use of an inclinometer, a device capable of measuring the activity and postural components of SB, owing to the device's placement on the thigh. In addition, an inclinometer can be worn continuously for upwards of 7 days and during aquatic activities, unlike an accelerometer. Overall, inclinometers offer the most valid and reliable means of capturing actual sitting behaviors[29]. However, measurement of SB through solely objective measurement does present caveats. While inclinometers capture *how much* sitting is being performed and *when* it is performed, they cannot distinguish between *what* an individual is doing while sedentary. In other words, objective measurements may capture 2 hours of SB in a given time period but will be unable to discern whether an individual was sitting during travel or at work or in class, for example. Similarly, sleeping is indistinguishable from simply laying down while awake to an inclinometer. Hence, pairing objective data with some measure of sleep, as well as self-reported measures of SB, is key for interpretation of results.

Self-report instruments for measuring SB are currently the most popular means of measuring SB within the SB and SWB literature. However, even among studies utilizing self-reported instruments, considerable variability among what kind of SB is measured exists. Namely, assessments of SB either focus on total sitting behavior or domain-specific SBs. Total sitting measures offer the advantage of a single global estimate of one's sitting behavior that can be compared to others. Further, a downfall of using total sitting measures is the failure to acknowledge the unique volumes and contexts of certain sitting behaviors. For example, while two individuals may report similar levels of total SB, the composition of those times may vary drastically – one individual may spend a significant portion of their time sedentary at work, while another may primarily spend that time in screen time or transportation, for example. Applied to the current research, certain domains of SB demonstrate positive associations with SWB in certain populations, contrary to associations with total sitting[22,30]. For example, O'Neill and Dogra found positive associations between computer use, playing instruments, and reading and life satisfaction among older adults[22]. Thus, the use of domain-specific measures of SB add richness to an individual's SB profile, albeit at a potential burden to the respondent. Another notable limitation to both total sitting and domain-specific measures is the tendency for individuals to underreport their actual SB, up to 2 hours by some estimates[31]. Hence, a conjoined measure of objective and self-reported SB instruments provides the most holistic picture of an individual's SB. To the author's knowledge, only one study examining the relationship between

SB and an outcome of SWB has measured both objective and self-reported SB[21]. In response to this gap in literature – and to further explicate the relationships between SB and SWB – three studies were effectuated: a scoping review, a cross-sectional survey, and a randomized pilot study. A brief overview and rational for conducting these three studies are highlighted below.

1.5 Study 1 – Scoping Review

The heterogeneity among indices of SB (i.e., SB, PI, screen time), as well as measurement of these indices (i.e., objectively-measured, self-reported), among studies examining the relationship between SB and outcomes of SWB conflates the interpretation of these relationships. These relationships are further confounded through selective measurement of SWB (e.g., only measuring affect). Hence, a scoping review was conducted to map the findings of the present literature.

Scoping reviews, unlike systematic reviews, are not typically conducted to evaluate and/or confirm a particular practice or to resolve discrepancies among conflicting evidence[32]. Rather, scoping reviews can clarify key concepts, identify knowledge gaps, and identify the types of available evidence, and as such, are often precursors to a systematic review[32]. Importantly, scoping reviews do not produce a synthesized result or answer to a question, but rather provide an overview of the evidence[32]. Owing to the broad search criteria and exploratory aim of the review, a scoping review was deemed the most appropriate methodology.

As such, a scoping review was conducted to answer the following research question: What is known from the literature regarding the relationships between indices of SB (i.e., objectively-measured and self-reported SB, PI, and screen time) and outcomes of hedonic well-being (i.e., affect, life satisfaction, overall hedonic well-being)? Hedonic well-being was selected as the focus for this review given that outcomes of hedonic well-being (i.e., affect, life satisfaction, overall hedonic well-being) currently represent most of the available literature.

1.6 Study 2 – Cross-Sectional Study

Existing literature assessing SB and SWB, specifically hedonic well-being, is lacking with respect to the inclusion of multiple outcomes of SWB and domain-specific SBs. Previous large-scale studies have examined only one outcome of hedonic well-being (e.g., life satisfaction[18,22]), only total sitting[18], and/or only limited domains of SB[33]. Additionally, populations of interest among these works have varied from adolescents[34,35] to adults[18] to older adults[22] and special populations[23]. Considering the individualized construction of SWB[16], determinants of SWB likely vary between populations. For example, O'Neill and Dogra found positive associations between time spent using a computer and life satisfaction among older adults[22]. Conversely, Hrafnkelsdottir and colleagues found life dissatisfaction to be correlated with higher screen time in adolescents[28]. These findings suggest that relationships between domains of SB and outcomes of SWB are affected by age, and potentially other demographics. Hence, a large-scale cross-sectional study aimed at exploring the relationships between outcomes of hedonic well-being and both total and domain-specific sitting time among a target population that spends a lot of time sitting (e.g., university students[9]) is warranted.

1.7 Study 3 – Randomized Pilot Trial

There unfortunately is limited experimental work pertaining to SB and its relationship(s) with SWB. Experimental work is an important predecessor to the existing cross-sectional work as experimental designs can elucidate the directionality and causality of the identified relationships. Applied to the current work, the directionality and causality of relationships between SB and SWB remain unclear. Namely, do changes in SB elicit changes in outcomes of SWB, or vice-versa? Experimental works by Edwards and Loprinzi[19], Endrighi et al.[36], and Duvivier et al.[37], have investigated this question, and overall have reported a weak-to-moderate detrimental effect of SB on outcomes of SWB. However, there are notable limitations with these works. Specifically, all three studies utilized an acute sedentary intervention, whereby participants were asked to maximize their time spent sedentary and refrain from any extraneous movement or activity for one week. However, work by Maher and Conroy suggests that changes from one's typical SB, not total SB, can predict changes in life satisfaction[21]. As such, interactions discovered by experimental designs that induce SB may not mirror those in designs that reduce SB. Furthermore, all three studies measured PI as a proxy for SB, which misconstrues the interpretation of their findings. Hence, experimental work designed to acutely decrease SB to illuminate the directionality and causality of relationships between SB and SWB is warranted. Importantly, the dearth of experimental work examining this specific paradigm precludes the estimation of sample size from effect sizes or inferential statistics. Thus, a randomized pilot trial was executed.

Randomized pilot trials, according to Eldridge and colleagues, are small-scale randomized trials that often mirror the design of a larger, future randomized controlled trial (RCT), and are conducted to ascertain whether a future study can be done[38]. Applied to the current work, a randomized pilot trial was executed with the purpose of determining the preliminary effectiveness of an acute SB reducing behavioral intervention for a future RCT. A secondary objective of the pilot was to explore whether any changes in SB outcomes were related to changes in outcomes of SWB.

1.8 Summary of Objectives

Overall, the nature of the relationship(s) between indices of SB (i.e., SB, PI, screen time) is unclear. Seminal evidence suggests there is a weak, detrimental association between increased SB and outcomes of SWB. However, these findings are confounded by inconsistencies in operationalization and measurement of SB, selective assessment of outcomes of SWB, and a dearth of valid experimental work. Hence, the aim of this dissertation was to investigate the relationships between SB and SWB. To this end, three studies were conducted. Firstly, a scoping review was conducted to map current relationships between indices of SB and hedonic well-being. A large-scale cross-sectional study was then undertaken to confirm these relationships in a university student population. Finally, a randomized pilot trial to reduce SB was executed to determine the preliminary effectiveness of a behavioral intervention to reduce SB, in order to inform a future RCT.

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Chapter 2

2 Study 1 – Relationships between indices of sedentary behavior and hedonic well-being: A scoping review

2.1 Rationale

Individuals' subjective evaluations of their own well-being (i.e., subjective well-being; SWB) have important implications for their objective[1] and self-reported health[2], as well as overall longevity[3]. SWB is typically conceptualized as either hedonic well-being or eudaimonic well-being[4]. Hedonic well-being describes optimal well-being as a product of maximizing both state and trait positive emotions or mood while minimizing negative emotions or mood (i.e., affect), while also experiencing a high satisfaction with life[5]. In contrast, eudaimonic well-being examines SWB as a subjective evaluation of one's aliveness and vitality[6], and is interested in outcomes such as self-actualization, vitality, and mental health[4].

The multifaceted nature of SWB implicates multiple influencers on SWB (e.g., variables that could impact one's affect). Hence, considerable research is devoted to understanding which behaviors – in particular, health behaviors – have a beneficial or detrimental effect on SWB[7]. Notably, the bulk of research examining health behaviors and SWB addresses 'purposeful' health behaviors, or health behaviors that are engaged in through conscious effort. These often include: engaging in MVPA, dietary behaviors, smoking, and sleep[7]. For example, greater levels of moderate-to-vigorous physical activity (MVPA) are associated with greater hedonic well-being[1], improved affect[8] and higher life satisfaction[9]. However, engagement in MVPA may make its effects more salient for individuals; the physiological effects of exercise, for instance, are proposed as a mechanism to explain associated improvements in SWB[1]. Conversely, the relationship between SWB and sedentary behavior (SB) is less understood and demonstrates equivocal findings[10,11]. These conflicting findings can be explained, in part, through issues in defining SB, heterogeneity among measures of SB, and a lack of delineation between hedonic and eudaimonic well-being.

Among studies that examine SB and SWB, few actually measure SB. Sedentary behavior is defined as any behavior that is: (i) waking, (ii) expends ≤1.5 Metabolic Equivalents, and (iii) is performed in a seated, lying, or reclining posture[12]. Importantly, consensus on the current definition of SB is relatively new, and as such, the bulk of existing literature does not operationalize SB in accordance with this definition. For example, several studies that assess 'sedentary time' are in fact measuring physical inactivity (i.e., failing to meet physical activity guidelines[13]) or inactivity (i.e., the lack of physical activity[14]). For the purposes of this review, we will refer to both physical inactivity and inactivity as physical inactivity (PI). Although SB and PI do not overlap precisely (e.g., standing and sleeping are PI, but not SB), they do describe many of the same behaviors (e.g., sitting, lying, reclining). Similarly, some studies use specific contexts of SB as a proxy for sedentary time, such as the measurement of time spent during screen-based activities (e.g., TV, computer use). Hence, it is important to delineate between SB and PI as well as identify salient SB contexts, like screen time, when examining relations between SB and SWB.

The instruments used to measure SB present as another issue, even among studies that examine SB as currently defined. Sedentary behavior can be assessed either objectively through inclinometers (i.e., activity trackers that can distinguish between postures), or as a self-reported measure through instruments that specifically assess sitting behaviors (e.g., total, domain-specific). Despite both of these methods assessing SB, there is limited overlap between the types of SB these instruments capture. Objective measures demonstrate validity and reliability in tracking free-living SB, such as total time spent sitting or standing, and number of sit-to-stand transitions[15]. However, objective measures are unable to distinguish between contexts or domains of sitting behavior (e.g., classifying screen time vs. occupational sitting). Conversely, some self-report instruments prompt respondents to divide their SB into different domains[16], in addition to assessing total SB. While self-reported instruments are subject to desirability bias (e.g., individuals tend to underreport their SB by approximately 2 hours/day[17]), the importance in identifying the context of sitting behavior is especially pronounced with respect to SWB, as several studies allude to the presence of a domain-specific effect of sitting on SWB[18]. Thus, examining both objective and self-reported measures of SB may provide a distinct yet complementary picture of the relationship(s) between SB and SWB.

Lastly, the lack of discernment between hedonic well-being or eudaimonic well-being among studies examining SB and SWB is a concern. While several principles of hedonic and eudaimonic well-being are correlated (e.g., positive affect and functioning), they represent distinctive concepts [4]. As such, findings from studies examining aspects of hedonic well-being cannot be interpreted interchangeably with eudaimonic well-being, and vice-versa, with the exception of instruments that assess both types of well-being (e.g., Warwick-Edinburgh Mental Well-Being Scale[19]; WEMWBS). Given that many studies examining SWB and SB examine outcomes of hedonic well-being (i.e., affect, life satisfaction) – particularly large-scale cross-sectional and longitudinal work[20] – hedonic well-being should be the focus when examining this relationship.

With these issues in mind, a scoping review was undertaken to synthesize, describe, and map an overall description of the existing evidence examining the relationship(s) between objective and subjective indices of SB (i.e., SB, PI, and screen time) and outcomes of hedonic well-being (i.e., affect, life satisfaction, and overall hedonic well-being). Owing to the broad scope of the search criteria and the aim of the present review, a scoping review was justified as the most appropriate methodology[21].

2.2 Methods

This study was guided by the PRISMA Extension for Scoping Reviews[22] (PRISMA-ScR). The PRISMA-ScR checklist can be found in *Appendix A*. No review protocol was created for the present review.

2.2.1 Eligibility Criteria

Eligible studies met the following criteria: (i) peer-reviewed journal article or thesis dissertation; (ii) published from earliest database entry year to May 29th, 2019; (iii) included a measure of SB or proxy of SB (i.e., PI, screen time); (iv) included a measure of hedonic well-being or outcome of hedonic well-being (i.e., affect, life satisfaction, hedonic well-being); (v) examined a relationship between some measure of SB and some measure of hedonic well-being; and (vi) written in English.

Quantitative, mixed-methods, and qualitative studies were included to place emphasis on the broad scope of the review. For this reason, multiple types of study design, data analyses, and outcome measures were accepted. Similarly, all age groups were included in order to examine potential age-related differences in types of SB and outcomes of hedonic well-being.

Papers were excluded (i) if the presence of a measure of hedonic well-being or SB could not be distinguished in the data analysis or results and (ii) they only examined quality of life/health-related quality of life, or other forms of well-being not directly hedonic well-being/outcome of hedonic well-being (e.g., physical well-being, social well-being). Importantly, for the purposes of this review, inclusion of a measure of physical activity was not the same as a measure of PI; physical activity as an outcome concerned with the level and intensity of movement behaviors (e.g., moderate exercise), whereas PI also encompasses a measure of the lack of physical activity, and/or the volume thereof. For instance, reporting 30 minutes of total daily physical activity is not equivalent to reporting 23.5 hours of daily PI, since sleep behaviors are unaccounted for.

2.2.2 Information Sources

The following databases were searched to identify potentially relevant documents: PubMed, SCOPUS, Web of Science, PsycINFO, Nursing and Allied Health Database, CINAHL, SPORTDISCUS, and Physical Education Index. All searches were run from the earliest possible entry date for that particular database to May 29th, 2019. Search strategies were co-developed with a librarian at the host institution and further refined through team discussion. The reference lists of pertinent reviews and articles were also scanned for relevant articles.

2.2.3 Search Strategy

Final search string queries for each database can be found in *Appendix B*. The search strategy for PubMed was as follows: (“sedentary behavior” OR "sedentary behaviour" OR inactivity) AND ("life satisfaction" OR "satisfaction with life" OR "well-being" OR affect OR "wellness" OR "quality of life").

2.2.4 Selection of Sources of Evidence

All searched articles were placed into a group folder in Mendeley (v1.19.4). To calibrate the screening process, the first and second author screened a random 10 sets of 10 consecutive articles within the list of searched articles (alphabetized, duplicates removed) together to determine screening calibration criteria. The screening calibration criteria were based upon agreement with two questions: “Did the study include a measure of hedonic well-being?” and “Did the study include a measure of sedentary behavior?”. Calibration criteria development revealed common permutations of hedonic well-being outcomes to be marked for closer examination, including: ‘mood(s)’, ‘happiness’, ‘well-being’, ‘feelings’, ‘emotion(s)’, and ‘sadness’. Similarly, common substitutes for sedentary behavior included: ‘inactivity’, ‘sedentary time’, ‘sitting’, ‘screen time’, ‘screen use’, ‘screen watching’, and ‘posture’.

Upon calibration, the first and second author each screened through half of the remaining searched records by title and abstract. Irrelevant articles were removed at the discretion of the reviewer. Articles that were deemed worthy of further examination or articles deemed unclear for inclusion were marked. Upon completing their designated half of articles, each reviewer then screened the marked articles of the other reviewer for inclusion. Inconsistencies between screened articles were resolved through discussion and consensus between the first and second author. Upon excluding the screened articles, the first author and second author examined each study together to determine inclusion for analysis. There were no disagreements regarding inclusion of eligible studies – however, if there were, the third author would have been consulted for consensus.

2.2.5 Data Charting Process

The data charting table was adapted from a previous review by author one and author three[23]. Author one independently charted the data, while iteratively updating the data charting process as unforeseen, but relevant, data emerged. Author two reviewed and confirmed data charting after author one had completed the process. Owing to the broad scope of the present review, no standardized data abstraction tool was developed or used. Rather, studies were parsed for relevant data regarding the primary outcomes and descriptive characteristics.

2.2.6 Data Items

For each study selected, the following data were extracted and tabulated: country of origin; sample representativeness (i.e., regional, national); sample size and inclusion criteria (where available); study design; outcome of SB and hedonic well-being examined; name and description of the instrument or item(s) used to evaluate sedentary/well-being outcome; how the instrument of SB/well-being was scored and/or analyzed; and main findings (i.e., relationship between sedentary outcome and well-being outcome). Correlations, effect sizes, regression means, confidence intervals, *p*-values, and other relevant statistics were included when provided.

2.2.7 Synthesis of Results

Results are described narratively and are grouped by the index of SB (i.e., objectively-measured SB, self-reported SB, objectively-measured PI, self-reported PI, and screen time). Findings are also presented in a pinwheel (see *Figure 2*), which was adapted from a previous review[24]. The pinwheel provides at-a-glance interpretation of the results of included studies. Green boxes represent a positive relationship between a sedentary outcome and well-being outcome; red boxes indicate a negative relationship between a sedentary outcome and well-being outcome; and yellow boxes indicate no observed relationship or a null relationship between a sedentary outcome and well-being outcome. Mixed associations were indicated with mixed color boxes. Finally, the bordering of the boxes indicates the design of the included study: a dashed line border represents a cross-sectional design; a thin solid border represents a longitudinal design; and a thick solid border represents an experimental design.

2.3 Results

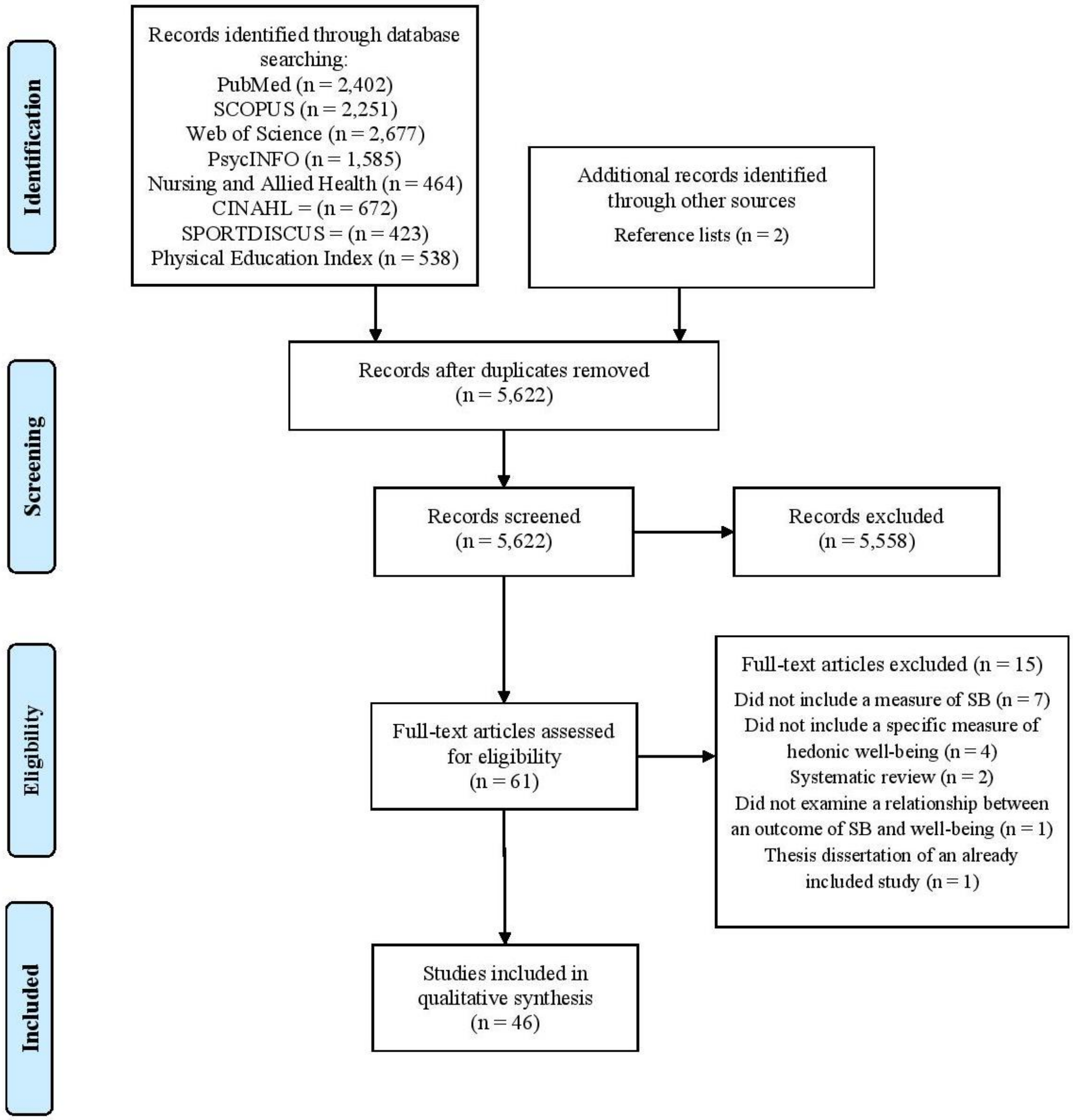

Figure 1: PRISMA flow diagram.

2.3.1 Selection of Sources of Evidence

The PRISMA Flow Diagram[25] of the present review can be found in *Figure 1*.

2.3.2 Characteristics of Sources of Evidence

Overall, 46 studies met eligibility criteria and are presented in this review[10,11,14,18,20,26–66]. Of these, 27 studies[10,18,39–41,45–47,50,51,53,54,20,55,56,58–60,62,64,26,33–38] (58.70%) utilized a cross-sectional design, 14[11,14,61,63,65,66,28,29,32,42,43,49,52,57] (30.43%) used a longitudinal design, and 5[27,30,31,44,48]

(10.87%) used an experimental design. All experimental study designs were randomized. The majority of these studies were from the US[18,26,49,53,60–62,65,66,28,29,31,33,35,42–44] (n = 17), followed by Canada[10,11,35–37,54–56] (n = 8), and the UK[14,30,32,46,50,57] (n = 6), with less than 5 studies coming from the Netherlands, Luxembourg, Spain, Finland, Poland, Australia, Korea, Iran, Brazil, China, and Iceland. Sample sizes ranged from 127[66] to 204,534[20] for cross-sectional studies; 82[49] to 2,038[32] for longitudinal studies; and 24[27] to 264[48] for experimental studies. Special populations examined included children and adolescents[18,20,45,49,52,58,59,34–41] (n = 15), older adults[32,42,47,55,57,65] (n = 6), and cancer survivors[11,54,56] (n = 3). In terms of sedentary outcomes, 3 studies (6.52%) measured SB objectively[27,42,46], 10 (21.74%) measured self-reported SB[10,11,31,33,39,42,43,48,55,64], 11 (23.91%) measured PI objectively[18,28,65,29,30,43,44,54,56,57,61], 6 (13.04%) measured self-reported PI[14,47,53,62,63,66], and 18 (39.13%) measured some form of screen time[20,26,45,49–52,58–60,32,34–38,40,41]. In terms of outcomes of hedonic well-being, 10 studies (21.74%) assessed both positive and negative affect[11,14,26,28,31,33,44,49,61,66], 4 (8.70%) assessed solely positive affect[18,27,39,41], 4 (8.70%) assessed solely negative affect[29,30,40,59], 24 (52.17%) assessed life satisfaction[10,20,45,47,51,53–59,26,62–65,34–38,42,43], and 5 (10.87%) assessed hedonic well-being[32,46,48,50,52]. Every study examined the relationship between SB and hedonic well-being quantitatively.

2.3.3 Results of Sources of Evidence

Results of sources of evidence can be found in *Table 1* and *Figure 2.*

Table 1: Table and summary of included evidence.

Pinwheel Number	Study	Country (National or Regional)	Sample (n=)	Design/Intervention	Sedentary Behavior Outcome	Hedonic Well-Being Outcome	Results
1[55]	Bampton, Johnson and Vallance, 2015	Canada (Regional)	Older adults ≥55 years of age free from chronic medical or orthopedic conditions that may preclude resistance training (n = 358)	**Cross-Sectional**: Participants completed a mailed questionnaire.	**Sedentary Behavior (Self-Reported)**: Assessed using the Total and Domain Specific Measure of Sitting (TDSMS; Marshall et al., 2014). Five items assessing time spent sitting (hours and minutes) on a typical day during the past week. Domains of: Transportation, occupation, TV, home computer use, and non-screen time leisure sitting. Sedentary scores dichotomized into low SED (<482 total min/day) and high SED (≥482 total min/day) group.	**Life Satisfaction**: Satisfaction with Life Scale (SWLS; Diener et al., 1985). Five items on a 7-point Likert scale assessing satisfaction with life, with scores ranging from 5 to 35, with lower values indicating lower life satisfaction.	Compared to a high SED/low RT (resistance training) group, higher scores were observed in both the low SED/low RT (Mdiff = 2.8, $p = 0.022$) and low SED/high RT (Mdiff = 4.3, $p < 0.001$) groups.

2[62]	Barile, Mitchell, Thompson, Zack, Reeve, Cella, and Smith, 2015	US (National)	Adults (n = 4,184)	**Cross-Sectional**: Data were drawn from the summer wave of Porter Novelli's 2010 HealthStyles database. Participants were mailed a survey.	**Physical Inactivity (Self-Reported):** Assessed the number of days per week in a "usual week" and number of minutes per day that participants reported engaging in either vigorous or moderate physical activity, as well as days per week they performed muscle-strengthening activities. Sedentary time was categorized based on federal guidelines (i.e., sedentary = 0 min/week of physical activity).	**Life Satisfaction**: Satisfaction with Life Scale (SWLS). Four items* on a 7-point Likert scale assessing satisfaction with life, with scores ranging from 4 to 21, with lower values indicating lower life satisfaction. *The full SWLS uses 5 items.	Those in the physical and mental health conditions class (PMHCC) reported being more sedentary (31.4%) compared to the healthy class (HC; 12.8%), physical health conditions class (PHCC; 21.8%), and the mental health conditions class (MHCC; 15.7%). Those in the PMHCC reported significantly lower life satisfaction scores (*p* <0.05) than all other classes.
3[63]	Baumann, Tchicaya, Lorentz and Le Bihan, 2017	Luxembourg (National)	Patients admitted for a coronary angiography (n = 1,289)	**Longitudinal**: Data collected as part of the Monitoring and Dynamics of Health Status through Risk Factors for Cardiovascular Disease (MDYNRFC) project (2008/2009 cohort). Baseline (post-coronary angiography) and follow-up (5 years post-coronary angiography).	**Physical Inactivity (Self-Reported):** Assessed the average number of minutes per week of physical activity. Dichotomized to yes/no for meeting physical activity guidelines.	**Life Satisfaction:** Single-item self-reported question: 'All things considered, how satisfied would you say you are with your life these days? Please tell me on a scale of 1 to 10, where 1 means very dissatisfied and 10 means very satisfied'. Dichotomized to high life satisfaction (LS; ≥7) or low LS (<7).	Longitudinal changes in physical activity were significantly linked to low LS. The presence of low physical activity at both timepoints was associated with a lower LS, compared to adequate physical activity at both timepoints (OR = 0.469, *p* <0.001).

4[64]	Buck, Loyen, Foraita, Van Cauwenburg, De Craemer, Mac Donncha, Oppert, Burg, Lien, Cardon, Pigeot, Chastin and Consortium, 2019	Europe	EU Citizens aged 15 or older (n = 23,865)	**Cross-Sectional**: Data collected as part of the Eurobarometer survey, wave 80.2. Participants completed a questionnaire.	**Sedentary Behavior (Self-Reported):** International Physical Activity Questionnaire (IPAQ) - one item assessing sitting time on a typical weekday: "During the last 7 days, how much time did you spend sitting on a week day?" Responses categorized into: '1h or less up to 2h 30min'; '2h 31min up to 4h 30min'; '4h 31min up to 7h 30min'; '7h 31min up to 8h 30min or more'. Participants were considered 'inactive' for reporting 0 minutes per week of either moderate physical activity or vigorous physical activity.	**Life Satisfaction**: Single-item question derived from a 4-point Likert scale in the Eurobarometer questioning ("On the whole, how satisfied or not are you with the life you lead?"). Responses dichotomized to 'satisfied' (i.e., 'very' or 'fairly') or 'not satisfied' ('not very' or 'not at all').	Through Bayesian network analysis, life satisfaction was found to be indirectly associated with SB through occupation for young males (ages 15-25) and adult males (ages 26-44); life satisfaction was strongly associated with the type of occupation, while increased sedentary behavior was also associated with certain occupations (e.g.,. 'employed position working at a desk or traveling'). Life satisfaction was also indirectly associated with sedentary behavior through the availability of recreational facilities in older adult females (ages 65+); greater availability of recreational facilities leads to improved life satisfaction and lower sedentary behavior.

5[65]	Buman, Hekler, Haskell, Pruitt, Conway, Cain, Sallis, Saelens, Frank, and King, 2010	US (Regional)	Older adults aged 66 or older and able to walk ≥10 feet alone with or without assistive devices (n = 975)	**Longitudinal**: Data collected as part of the Senior Neighbourhood Quality of Life Study. Participants were mailed an accelerometer and survey at baseline. They wore the accelerometer for 7 days and then completed the survey at baseline and mailed the materials back. Six months later they were mailed the accelerometer and survey again, and wore the accelerometer for 7 days, followed by completing the survey before again mailing back the materials.	**Physical Inactivity (Objective):** Objective data derived from an Actigraph accelerometer. Sedentary time was operationalized as periods of time with <100 counts/minute.	**Life Satisfaction**: Single-item question on a 5-point Likert scale ("All things considered, how satisfied are you with your life as a whole?"; Andrews & Withey, 1976). Responses categorized from 1 ('very dissatisfied') to 5 ('very satisfied'). Life satisfaction measure grouped into a psychosocial well-being item for analysis.	Physical inactivity time was modestly, but negatively, associated with psycho-social well-being (β = -0.03, 95% CI: [-0.05, -0.01]).
6[66]	Dalton, 2018	US (Regional)	Undergraduate students (n = 127)	**Longitudinal**: Baseline assessment followed by online daily diary entries for the following 14 consecutive days	**Physical Inactivity (Self-Reported):** Daily exercise levels assessed through a single-question: 'Did you exercise today?'. If participants answered 'yes', they were prompted to respond to the question "What type of exercise did you engage in?", with options '1 = Mild/Gentle', '2 = Moderate', '3 = Vigorous' and 'For how	**Affect**: Daily negative and positive affect assessed using the brief version of the Positive and Negative Affect Scales (PANAS; Watson, Clark & Tellegan, 1988), a 20-item questionnaire where participants rate the extent they feel 20 different emotions and a 5-point Likert scale from 1 ('very slightly or not at all') to 5 ('extremely'). Affect scores can range from 10-50, with scores indicating more affect in that domain	Daily negative affect (b = 0.03, SE = 0.01, p <0.01) and daily positive affect (b = -0.02, SE = 0.01, p <0.01) were both weak predictors of daily maladaptive health behaviors. Changes to daily negative affect (b = 0.02, SE = 0.01, p = 0.01) and changes to daily positive affect (b = -0.02, SE =

					many minutes did you exercise?'. Sedentary time was classified as responding 'no' to the question. Sedentary time was grouped into a composite score of "maladaptive health behaviors" along with consumption of fats and sweets at or above recommended daily intake levels (per World Health Organization 2015 guidelines), alcohol and cigarette use, and inadequate (or too much) sleep.		0.01, $p < 0.01$) were also weak predictors of daily maladaptive health behaviors.

7[26]	Depp, Schkade, Thompson, and Jeste, 2010	US (National)	People aged >15 years (n = 3,968)	**Cross-Sectional**: Participants were recruited through random-digit dialing and were then interviewed. Participants were asked to detail their previous day and divide their day into 'episodes'.	**Screen Time**: Time spent engaged in TV watching was assessed as a percentage of sampled time. Percentage of sampled time was calculated as duration engaged in the activity divided by summed duration of all sampled activities within each age strata.	**Affect:** Respondents were asked the extent to which they experienced six different feelings (i.e., happy, interested, sad, stressed, in pain, and tired), on a Likert-type scale from 0 ('not at all') to 6 ('very strong'), in response to an activity from their previous day. Only the feelings of happy, sad, and stressed were analysed. **Life Satisfaction**: Overall life satisfaction was assessed with a single question ("In general, how satisfied are you with your life?") on a scale from 1 ('not at all satisfied') to 4 ('very satisfied'). Life satisfaction dichotomized to lower life satisfaction ('not at all satisfied', 'not satisfied', 'satisfied') and higher life satisfaction ('very satisfied').	There was a significant main effect of TV with greater experienced sadness (estimate = -0.121, SD = 0.04, p = 0.003). Generalized Estimate Equation analyses indicated TV watching was more common among participants with low life satisfaction.

8[27]	Duvivier, Schaper, Koster, van Kan, Peters, Adam, Giesbrecht, Kornips, Hulsbosch, Willems, Hesselink, Schrauwen and Savelberg, 2017	Netherlands (Regional)	Adults aged 40-80 with a BMI between 25 and 35 kg/m2 reporting <2.5h/week of MVPA (n = 24)	**Experimental:** Randomized cross-over design. Two groups of four day interventions with a ten-day washout period between conditions. Sit regimen intervention: Participants were instructed to restrict walking and standing to ≤1 h/day each, spending the remainder of the waking day sitting. Sitless regimen intervention: Participants were instructed to substitute at least 7 h/day of sitting with ≥4 h of self-perceived light walking and ≥3 h of standing; and to interrupt sitting preferably every 30 min with standing/walking bouts. Subjects were instructed to walk at a self-perceived light-intensity.	**Sedentary Behavior (Objective):** Physical activity and posture allocation were measured objectively for 24 h/day using an activPAL3 activity monitor.	**Affect (Positive)**: Mood was assessed with the Affect Grid test; which is a 19 × 19 single-item measure, assessing the self-reported degree of pleasantness and arousal of the participants (Russell et al., 1989).	After the activity regimens, measurements of mood were performed both before the Oral Glucose Tolerance Test (OGTT) in the fasted state, as well as after an OGTT. Before the OGTT, pleasantness was not different between the activity regimens for the total group, although a non-significant improvement (*p* = 0.059) was observed in women after SitLess vs. Sit (estimated change 2.20, 95% CI: [–0.08–4.48], n = 10). After the OGTT, pleasantness was significantly higher after SitLess vs. Sit (1.67, 95% CI: [0.09, –3.25], n = 21) in the total group; this could mainly be explained by a significant difference in pleasantness in the female subjects after SitLess vs. Sit (2.80, 95% CI: [0.52, –5.08], n = 10).

9[28]	Elavsky, Kishida and Mogle, 2016	US (Regional)	Community-dwelling perimenopausal and postmenopausal women age 40-60 who have not used hormone therapy in the last six months (n = 121)	**Longitudinal**: Participants completed daily diaries assessing momentary affect and objective sedentary behavior over 15-days.	**Physical Inactivity (Objective)**: Objectively-measured sedentary behavior was measured using the Actilife GT1M accelerometer. Sedentary minutes were operationalized as periods of 0 to 99 counts per minute.	**Affect:** 10-item Positive and Negative Affect Schedule (PANAS) with wording adopted for momentary assessment. Respondents indicated on their current feelings on a 0 to 100 scale ranging from 'not at all' to 'extremely'. Responses were averaged across the positive and negative affect items, respectively.	Momentary (-0.08, SE = 0.01, $p < 0.05$) and daily (-0.11, SE = 0.02, $p < 0.05$) physical inactivity were independently related to lower positive affect but not to negative affect. Greater momentary (-0.31, SE = 0.04, $p < 0.05$) and daily (-0.33, SE = 0.06, $p < 0.05$) positive affect predicted fewer inactive minutes. Higher levels of daily negative affect were significantly related to more minutes of physical inactivity (0.35, SE = 0.17, $p < 0.01$). Lagged momentary physical inactivity significantly predicted positive affect (-0.04, SE = 0.01, $p < 0.05$); greater physical inactivity at the previous was related to less positive affect at the next moment.

10[29]	Ellingson, Meyer, Shook, Dixon, Hand, Wirth, Paluch, Burgess, Hebert, and Blair, 2018	US (Regional)	Healthy adults aged 21-35 with a BMI between 20 and 35 kg/m2 with no history of depression, anxiety, or panic disorder (n = 271)	**Longitudinal**: Participants completed baseline demographics and then wore an accelerometer for 10-day activity monitoring. All measures repeated 1 year after baseline.	**Physical Inactivity (Objective)**: Physical inactivity time was objectively measured using the SenseWear Mini Armband (SWA; BodyMedia Inc. Pittsburgh, PA). Tri-axial accelerometer worn on the arm 24 hours a day for 10 consecutive days, except during water-based activities. Sedentary time calculated as total time spent ≤1.5 METs while awake. Sedentary time was divided into time accumulated in bouts of ≥30 minutes or <30 minutes. Groups were categorized by sedentary hours/day: <10.5, 10.5-12, and >12.	**Affect (Negative)**: Profile of Mood States (POMS) - A 65-item self-reported questionnaire assessing affect over the past week. All subscales were used (i.e., tension, depression, anger, vigor, fatigue, and confusion). A summary score of total mood disturbance (TMD) was calculated: TMD; tension + depression + anger + fatigue + confusion – vigor + 100.	Change in physically inactive time significantly predicted changes in TMD (Std. β = 0.23, p = 0.001) with more physical inactivity at time 2 leading to higher TMD. Change in physical inactivity time significantly predicted changes in the depression (Std. β = 0.19, p = 0.009), anger (Std. β = 0.18, p = 0.01), fatigue (Std. β = 0.19, p = 0.008), and confusion (Std. β = 0.21, p = 0.003) subscale, with more physical inactivity at time 2 leading to poorer subscale scores. Baseline physical inactivity time significantly predicted changes in the depression (Std. β = 0.14, p = 0.049) and anger (Std. β = 0.24, p = 0.001) subscales.

11[30]	Endrighi, Septoe and Hamer, 2016	UK (Regional)	Adults aged 18 to 35 years who are regularly active (≥3 1-hour sessions of MVPA per week), have a BMI between 19 and 25 kg/m2, not on any regular medication, and non-smoker (n = 43)	**Experimental:** Randomized cross-over design. Participants each completed two two-week conditions. Two conditions: Intervention (sedentary) - In the sedentary condition, participants were instructed to replace any daily structured or unstructured form of physical activity by being sedentary, and were encouraged to be sedentary as much as possible. Control (free-living): In the control condition, participants were instructed to maintain their habitual levels of daily activity.	**Physical Inactivity (Objective)**: Sedentary time was objectively measured using the ActiGraph GT1M. Tri-axial accelerometer was required to be worn around participants' waist as instructed every day after waking and until bedtime, and only remove it briefly when showering or swimming. A minimum of 10 hours of wear time per day was considered valid. Sedentary time was defined through the cutoff of <190 counts/minute. Sedentary time was computed as daily time minus daily total active time.	**Affect (Negative)**: Profile of Mood States Short Form (POMS-SF) - A 37-item self-reported questionnaire assessing affect over the past week. All subscales were used (i.e., tension, depression, anger, vigor, fatigue, and confusion). A negative mood mean score was computed by adding the five negative mood subscales and subtracting vigor/activity (range 0-100), with higher scores reflecting greater negative affective states.	Pairwise comparison revealed that sitting time increased by an average of 31.49 min/day (SE = 12.13, $p = 0.01$) during the sedentary condition. The sedentary intervention resulted in increases in negative mood across all subscales ($p \leq 0.05$). The increase in physical inactivity time was significantly associated with the POMS negative mood score (β = 0.32, $R^2 = 0.10$, $p = 0.03$), and this association persisted after controlling for changes in MVPA (β = 0.32, $p = 0.05$). MVPA was not associated with the POMS (β = –0.003, $p = 0.98$).

12[31]	Finch, Tomiyama, and Ward, 2017	US (Regional)	Adults aged 18 and older with no reported current major pathological disorder (n= 96)	**Experimental:** Randomized counterbalanced trial. Participants completed a single-visit, of one of 32 possible conditions (two postures x (two tests x two sections to each test). Two postures: Stand while completing tests (~30 min.) and Sit while completing tests (~30 min.).	**Sedentary Behavior (Self-Reported)**: Sedentary time was assessed using the International Physical Activity Questionnaire Short Form (IPAQ-SF); specifically "During the last 7 days, how much time did you spend sitting on a week day?". Sedentary time was divided into tertiles of low, moderate, and high sitting time (median = 7.00 h/day, IQR = 2.38). Distinctions between sedentary behavior and non-sedentary behavior (i.e., sitting and standing) are implied as part of the intervention.	**Affect:** Modified Positive and Negative Affect Schedule (PANAS) - included an abbreviated list of 16 emotions to minimize participant fatigue, as this instrument was delivered 4 times during the visit.. Omitted emotions (guilty, scared, strong, hostile, proud, irritable, ashamed, and afraid, excited, attentive, and active). Added the items “stressed,” “tired,” “comfortable,” “distracted,” and “focused,” which were expected to be more relevant to work-related tasks.	Participants reported feeling more interested (*M* = 3.09, SD= 1.37 vs. *M* = 2.81 , SD = 1.40, *p* = 0.008), enthusiastic (*M* = 2.05, SD = 1.19 vs. *M* = 1.90, SD = 1.18, *p* = 0.025), and alert (*M* = 3.66, SD = 1.47 vs. *M* = 3.40, SD = 1.58, *p* = 0.044) for the reading comprehension section that they stood for versus sat for. Participants reported feeling more comfortable while sitting rather than standing for both the reading comprehension (*M* = 3.88, SD = 1.40 vs. *M* = 3.41, SD = 1.34 , *p* = 0.001) and creativity tests (*M* = 4.25, SD = 1.33 vs. *M* = 3.83, SD = 1.33, *p* = 0.002). No other body position effects on mood were found for the reading comprehension or creativity tests for the remaining emotions: focused, inspired, motivated, determined, stressed, anxious, nervous,

							tired, jittery, distracted, distressed, and upset.
13[32]	Hamer, Yates, Sherar, Clemes, and Shankar, 2016	UK (National)	Participants who previously participated in "The 1970 British Cohort Study (BCS70)" (n = 2,038)	**Longitudinal**: Participants aged 16 were drawn from the 1970 British Cohort Study and were assessed again at age 42.	**Screen Time:** At the first timepoint (i.e., age 16), respondents were asked three separate questions about time spent in three types of screen based, sedentary activities (TV, Games, Films) "after school yesterday". Options were 'none at all', 'less than 1 h', '>1 h', '>2 h', '>3 h', '>4 h', and '>5'. Values were recoded to 0-6, and were summed across the three categories to estimate total screen time. At the second	**Hedonic Well-Being**: Warwick Edinburgh Mental Well-being Scale (WEMWBS). Fourteen-item scale comprising of positively worded items that assess mental well-being (i.e., hedonic and eudaimonic well-being), with scores ranging from 14 to 70. Higher scores indicates greater mental well-being. Mental Well-Being was assessed at the second timepoint (i.e., age 42) only.	Adjusting for covariates, adolescents reporting >3 h of after school screen time had -1.74 (95% CI: [-2.65,-0.83]) WEMWBS points at 42 years, compared with adolescents reporting <1 h screen time. Respondents that reported ≥3 hours/day of screen time at age 16 and ≥3 hours/day of TV viewing at age 42 demonstrated the lowest wellbeing scores (-2.91, 95% CI: [-4.12, -1.69]).

					timepoint (i.e., age 42), respondents indicated how many hours they spent watching TV per day. Options were 'none', '0≤1', 1<3', '3<5', and '≥5'.		
14[33]	Hogan, Catalino, Muta and Fredrickson, 2015	US (Regional)	Community-dwelling adults aged 19-65 years old (Study 1: n = 624; Study 2: n = 208)	**Study 1 - Cross-Sectional:** Participants completed an Internet-based survey. **Study 2* - Longitudinal:** A subset of participants from Study 1 were recruited; three months later, some of these participants completed a follow-up questionnaire (n = 142)**.** *****Study 2 did not examine an outcome of sedentary behavior and was not included.	**Sedentary Behavior (Self-Reported):** Sedentary time for Study 1 was assessed using the short version of the international physical activity questionnaire (IPAQ-SF); specifically "How much time per day do you spend sitting?". No sedentary behavior measure or operationalization was given for Study 2.	**Affect:** Differential Emotions Scale (mDES; Fredrickson, 2013). Nine positive emotions and ten negative emotions were rated on a five-point scale, with options of '1 - not at all' to '5 - most of the time'. Composite scores were calculated for positive and negative emotions by averaging across emotions in those two categories.	Results demonstrated sedentary behavior, controlling for physical activity, predicted less frequent positive emotions ($\beta = -.11$, $p = .008$, $R^2 = .10$) and fewer psychosocial resources ($\beta = -.11$, $p = .012$, $R^2 = .07$). Sedentary behavior, controlling for physical activity, did not predict negative emotions ($\beta = .001$, ns). Time spent sedentary, independent of physical activity, is associated with emotional experiences. A medium-sized ($K^2 = .1407$, 95% CI = [0.0687,

							0.2116]) significant indirect effect between sedentary minutes and psychosocial resources, controlling for physical activity, was observed. Authors suggest "that sedentary behavior had an indirect effect on psychosocial resources through positive emotions, controlling for physical activity...independent of a person's physical activity, the higher their sedentary behavior, the lower their levels of positive emotions.
15[34]	Hrafnkelsdottir, Brychta, Rognvaldsdottir, Gestsdottir, Chen, Johannsson, Guomundsdottir and Arngrimsson, 2018	Finland (Regional)	Students in tenth grade from six elementary schools in a metropolitan area (n = 315)	**Cross-Sectional:** Participants wore a wrist-worn accelerometer for 7 days, and completed self-administered questionnaires and body composition measures.	**Screen Time:** Screen time was assessed by asking participants to report "How many hours per day on average; separately for weekdays and weekend-days they played computer games, watched TV/DVD/internet material, used the internet for web-browsing/Facebook/e-mail and other computer use". Each item was scored on a seven-point Likert scale, with the following response	**Life Satisfaction:** Satisfaction with Life Scale (SWLS), a measure of global cognitive judgements of satisfaction with one's life. The scale contains 5 items rated on a 7-point Likert scale, with the following response options: 1 = "strongly disagree", 2 = "disagree", 3 = "somewhat disagree", 4 = "neither agree nor disagree", 5 = "somewhat agree", 6 = "agree", 7 = "strongly agree". A score of 20 represents a neutral point on the scale, with higher score indicating more satisfaction and lower score	After adjusting for covariates (i.e., sex, maternal education, % body fat), reporting less screen time was associated with a significantly lower life dissatisfaction (RR = 0.38, 95% CI [0.20, 0.72]).

					options: 1 = "none", 2 = "about 1/2 h", 3 = "1 up to 2 h", 4 = "2 up to 3 h", 5 = "3 up to 4 h", 6 = "4 to 5 h" and 7 = "more than 5 h". Average daily hours for each type of screen-based activity were computed, using the midpoints for scoring categories and weighted averaged for weekdays and weekend-days. All screen-based activities were then summed for a total daily screen time (h/day) and participants were sorted into high and low screen time groups based on their relation to the group median value.	indicating less satisfaction.	

16[20]	Iannotti, Janssen, Haug, Kololo, Annahiem and Borraccino, 2009	International (41 countries)	Adolescents aged 11, 13, and 15 (n = 204,534)	**Cross-Sectional**: Self-report questionnaires were administered in school classrooms in each participating country and region as part of the "Health Behavior in School-Aged Children (HSBC)".	**Screen Time**: Two two-part questions asking number of hours spent per day watching television and using a computer during free time, on both weekdays and weekends. Values ranged from: 'none', '1/2 hour', '1' hour', '2 hours', '3 hours', '4 hours', '5 hours', '6 hours', and '7 or more hours'. Values were calculated and summed to create a screen-based media score.	**Life Satisfaction:** The Cantril Ladder - Participants indicated where they stood on a 10-point ladder with 0 being 'worst possible life' and 10 being the 'best possible life'. Values range from 10 (top of ladder = 'best possible life') to 0 (bottom of ladder = 'worst possible life').ts indicated where they stood on a 10-point ladder with 0 being 'worst possible life' and 10 being the 'best possible life'.	More frequent screen-based media use was associated with poorer Life Satisfaction (Regression coefficient range: -0.09 to -0.03) in four regions (i.e., North America, Western Europe, Northern Europe, and Southern Europe).
17[35]	Iannotti, Kogan, Janssen and Boyce, 2009	North America (Canada & USA)	North American adolescents from grades 6 to 10 (n = 22,084)	**Cross-Sectional**: Self-report questionnaires were administered in school classrooms in each participating country and region as part of the "Health Behavior in School-Aged Children (HSBC)".	**Screen Time**: Two two-part questions asking average number of hours per day spent watching television and using a computer during free time, on both weekdays and weekends. Values ranged from: 'none', '1/2 hour', '1' hour', '2 hours', '3 hours', '4 hours', '5 hours', '6 hours', and '7 or more hours'. Values were calculated and summed to create a screen-based media score.	**Life Satisfaction:** The Cantril Ladder - Participants indicated where they stood on a 10-point ladder with 0 being 'worst possible life' and 10 being the 'best possible life'. Values range from 10 (top of ladder = 'best possible life') to 0 (bottom of ladder = 'worst possible life').	Screen-based media exhibited a small significant negative correlation with life satisfaction (r = -0.07, p <0.001). Screen-based media also significantly predicted life satisfaction (regression coefficient = -0.05, p < 0.001).

18[36]	Janssen, 2016	Canada (National)	School-aged students from grade 6-10 (n = 20,122)	**Cross-Sectional**: Self-report questionnaires were administered in school classrooms in each participating country and region as part of the "Health Behavior in School-Aged Children (HSBC)".	**Screen Time:** Time spent playing sedentary video games on an average day was assessed with the following question: "How many hours a day, in your free time, do you usually spend playing games on a computer, games console, tablet (like iPad), smartphone or other electronic device (not including moving or fitness games)?" Participants indicated how much time they spent in each activity during weekdays and the weekend with the following response options: "None at all," "About half an hour a day," "About 1 hour," "About 2 hours," "About 3 hours," "About 4 hours," "About 5 hours," "About 6 hours," About 7 or more hours a day." Average number of hours/day they engaged in each activity was calculated.	**Life Satisfaction**: The Cantril Ladder - Participants indicated where they stood on a 10-point ladder with 0 being 'worst possible life' and 10 being the 'best possible life'. Values range from 10 (top of ladder = 'best possible life') to 0 (bottom of ladder = 'worst possible life'). Scores of 8 or higher indicated a high life satisfaction.	Replacing 1 hour/day of sedentary video games with 1 hour/day of active video games would be associated with a 4% (95% CI: [2%-7%]) increased probability of having higher life satisfaction.

19[37]	Janssen, Roberts, and Thompson, 2017	Canada (National)	School-aged students from grade 6-10 (n = 21,821)	**Cross-Sectional**: Self-report questionnaires were administered in school classrooms in each participating country and region as part of the "Health Behavior in School-Aged Children (HSBC)".	**Screen Time**: Three two-part questions asking average number of hours per day spent watching television, playing sedentary video games, and using a computer during free time, on both weekdays and weekends. Values ranged from: 'none', '1/2 hour', '1' hour', '2 hours', '3 hours', '4 hours', '5 hours', '6 hours', and '7 or more hours'. Participants were grouped based on average daily screen time: those who did meet screen time recommendation (i.e., ≤2.0 hours per day) and those who did not (>2.0 hours per day).	**Life Satisfaction**: Measured using the Cantril Ladder, established tool with good psychometric properties that measures subjective well-being and overall happiness. Values range from 10 (top of ladder = Best possible life) to 0 (Bottom of ladder = Worst possible life).	Youth who met screen time guidelines demonstrated a *z*-score of 0.26 (SE = 0.04) for life satisfaction, compared to a *z*-score of -0.03 (SE = 0.02) for youth who did not meet screen time guidelines. After adjusting for covariates (including adherence to other guidelines), youth who met screen time guidelines demonstrated a *z*-score of -0.46 (SE=0.06) for life satisfaction, compared to a z-score of -0.62 (SE=0.05) for youth who did not meet screen time guidelines.

20[14]	Jones, O'Connor, Conner, McMillan, and Ferguson, 2007	UK (Regional)	Adults (n = 420)	**Longitudinal:** Participants completed an initial questionnaire, followed by a weekly 7-day diary for the following four week. A final questionnaire was completed after 4 weeks.	**Physical Inactivity (Self-Reported):** Participants were asked whether they had participated in any exercise that day, and if so, to describe the exercise. Daily physical activity options ranged from (Yes = 1, No = 0).	**Affect:** Daily mood measured using the shortened version of the Positive and Negative Affect Schedule. Participants assessed feelings of interest, distress, excitement, upset, inspired, determined, scared, jittery, enthusiastic and afraid. Values ranged from scale of 1 ('very slightly or not at all') to 5 ('extremely'). Means across the five positive and five negative items were separately calculated to give daily measures of PA and NA.	In men, but not women, likelihood to exercise was predicted by positive affect (regression coefficient = 0.10, SE = 0.05, $p = 0.05$) and negative affect (regression coefficient = -0.16, SE = 0.06, $p = 0.01$).
21[38]	Kleszczewska, Szkutnik, Siedlecka, and Mazur, 2019	Poland (National)	School-aged students aged 14-18.5 (n = 3,693)	**Cross-Sectional**: Self-report questionnaires were administered in school classrooms in each participating country and region as part of the "Health Behavior in School-Aged Children (HSBC)".	**Screen Time**: Three two-part questions asking average number of hours per day spent watching television, playing sedentary video games, and using a computer during free time, on both weekdays and weekends. Values ranged from: 'none', '1/2 hour', '1' hour', '2 hours', '3 hours', '4 hours', '5 hours', '6 hours', and '7 or more hours'. Weighted averages of school days and weekend days were calculated.	**Life Satisfaction**: Measured using the Cantril Ladder, established tool with good psychometric properties that measures subjective well-being and overall happiness. Values range from 10 (top of ladder = Best possible life) to 0 (Bottom of ladder = Worst possible life).	There was a significant difference between those who reported low, average, and high screen-time ($p < 0.001$), with those reporting lower screen time also reporting higher life satisfaction.

22[39]	Knowles, Gastin and Kremer, 2017	Australia (Regional)	Secondary school students attending a sport school (n = 233)	**Cross-Sectional:** Participants completed a 100-item online questionnaire.	**Sedentary Behavior (Self-Reported)**: Teenagers in Leisure Time (TILT) survey. TILT items ask participants to self-report on their usual time spent in leisure activities daily over a typical week (e.g., 'How long do you spend watching TV before and after school on a usual school day?'). Participants selected the number of hours and minutes in 15 minute gradations. Responses coded to four groups: low (<210 min), average (210-630 min), high (631-1050 min), and very high (>1050 min).	**Affect (Positive):** WHO-5 Wellbeing Index - contains five positively worded items concerning positive mood, vitality and general Interests. Values rated on a five-point Likert Scale of (1 = "at no time" to "5 = all of the time").	Student-athletes report significantly less total leisure SB than non-sport school students (d = 0.62, $p < 0.001$). No significant differences between student-athletes and non-sport school students was found for wellbeing (d = 0.25, p = 0.15).
23[40]	Kremer, Elshaug, Leslie, Toumbourou, Patton and Williams, 2014	Australia (National)	Adolescents (Year 6 and 8) (n = 8,256)	**Cross-Sectional:** Participants completed an online questionnaire as part of the "Healthy Neighbourhoods Study".	**Screen Time:** Screen time was assessed through an online self-report instrument that was adapted and expanded from the Communities That Care Youth Survey. Participants also reported on the time they spent watching television and on a computer or playing video games for leisure separately for week and weekend days (1 = 'none'; 6 = 'more than 6	**Affect (Negative):** Negative affect was assessed using the Short Mood and Feelings Questionnaire (SMFQ), which measures depressive mood and feelings, and other symptoms associated with depression such as negative affect. The instrument comprises 13 items (e.g., "I felt miserable or unhappy") rated using a three-point scale (0 = 'not true'; 1 = 'sometimes true'; 2 = 'true'). Sum total SMFQ scores dichotomized to moderate-high depressive symptoms	The asymptomatic group was more likely to meet screen time guidelines (<2 hours per day of screen time, X^2 = 18.4, $p < 0.001$). A significant age group × screen time effect indicated the effect of meeting screen time guidelines on depressive symptoms was moderated by the age of the participant.

					h'). The average number of hours for week and weekend days were summed and then recoded into 'meeting screen time guidelines ('<2 hours per day') or not (≥2 hours per day).	(≥8) or asymptomatic (<8).	
24[41]	Lee, Spence, Tremblay, and Carson, 2018	Korea (National)	Adolescents aged 12-17 (n = 65,528)	**Cross-Sectional:** Participants completed an online survey as part of the 2016 Korea Youth Risk Behavior Web-based survey.	**Screen Time:** Participants were asked to report hours and minutes per day spent in front of a screen for academic or recreational purposes during the past seven days, separately for weekdays and weekend days. Weekly weighted average time spent in front of a screen was calculated for academic purposes and recreational purposes separately. For the primary objective, screen time for recreational purposes, screen time was categorized into meeting guidelines (≤2 hours per day) or not meeting guidelines (>2	**Affect (Positive):** Measured using a single-item based on happiness. Participants were asked to rate how happy they are on regular days. Response options ranged from (1 = very happy) to (5 = very unhappy). Responses were then coded as happy (4 or 5) or not happy/neutral (1, 2, or 3).	Students who met the screen time recommendation was significantly associated with being happy (OR = 1.06, 95% CI: [1.02, 1.10]). There were no significant associations between screen time for academic or recreational purposes and psychological well-being (i.e., happiness and stress).

					hours per day). For the secondary objective, both academic and recreational screen time were categorized, separately, into three groups: 0 minutes per day, 1-120 minutes per day, and >120 minutes per day.		
25[42]	Maher and Conroy, 2017	US (Regional)	Older Adults aged 60 years and older, who self-reported sitting for ≥8 hours/day with no diagnosis of dementia/Alzheimer's or deficit in functional mobility (n = 101)	**Longitudinal:** Participants wore an ActivPAL3 inclinometer device for two weeks. Participants also completed daily questionnaires on a provided tablet computer for the duration of the study.	**Sedentary Behavior (Objective):** Assessed using an ActivPAL3 inclinometer. The ActivPAL3 is able to distinguish between posture and activity to classify time as sitting, standing, or stepping. **Sedentary Behavior (Self-Reported):** Assessed using a 9-item self-reported questionnaire regarding daily sedentary behavior. Participants were asked to report the amount of waking time they spent engaged in domain-specific sedentary activities (i.e.,	**Life Satisfaction:** Assessed using a single item from the Satisfaction With Life Scale (SWLS) which was modified for daily administration: "I was satisfied with my life today"). Responses ranged from 0 ('strongly disagree') to 100 ('strongly agree').	Life satisfaction was weakly, negatively correlated with self-reported (ICC = -0.06) and objectively measured sedentary behavior (ICC = -0.01). Predictive models revealed life satisfaction was lower on days when people were more sedentary than was typical for them; however, there was no difference in life satisfaction between more or less sedentary people. Life satisfaction did not differ between

					watching TV, using the computer, reading, socializing with friends, in transit, completing hobbies, doing paperwork, eating, or any other activities). Responses were summed to calculate a daily total sedentary behavior score.		people who reported being more or less sedentary in general or on days when people reported being more or less sedentary than was typical for them.
26[40]	Maher, Doerksen, Elavsky and Conroy, 2014	US (Regional)	University students (n = 128)	**Longitudinal:** Participants wore an accelerometer device for two weeks. Participants also completed daily questionnaires at the end of every day (7PM-4AM) for the duration of the study.	**Physical Inactivity (Objective):** Actigraph model GT3X - triaxial accelerometer worn on the participants' hip throughout the day during waking hours (minus aquatic activities). Sedentary behavior was estimated as the percentage of valid wear time spent in sedentary behavior (i.e., <100 counts per minute). **Sedentary Behavior (Self-Reported):** Daily sedentary behavior was assessed through the sitting time item from the International Physical Activity Questionnaire (IPAQ). Participants reported the total amount of	**Life Satisfaction:** Assessed using a single item from the Satisfaction With Life Scale (SWLS) which was modified for daily admistration: "I was satisfied with my life today"). Responses ranged from 0 ('strongly disagree') to 100 ('strongly agree').	Physical inactivity and life satisfaction tended to have a weak negative association (*r*s -0.05 to -0.13). Previous-day life satisfaction negatively influenced subsequent sedentary behavior at the within-person level; however, this association was not found when examining the objective measure of physical inactivity, independent of physical activity. The between-person influence of overall sedentary behavior or physical inactivity did not predict life satisfaction.

					time they spent engaged in sedentary behavior that day after prompted with examples of sedentary activities (i.e., “Think about the time you spent sitting today. This includes times spent at work, at home, while doing course work, and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting down to watch television.”)		

27[18]	Maher, Dzubur, Nordgren, Huh, Chou, Hedeker, and Dunton, 2019	US (National)	Children and adolescents, adults, and mother-child dyads (n = 617)	**Cross-Sectional:** Data was pooled from participants who previously took part in one of four studies: Mobile Healthy PLACES, Project MOBILE, AsthEMA, and MATCH. Participants in all studies received a mobile phone and waist-worn accelerometer. Participants wore the accelerometer for 4-7 days, and received ecological momentary assessment surveys at random times throughout the 4-7 days.	**Physical Inactivity (Objective):** Actigraph model GT3X - triaxial accelerometer worn on the participants' hip throughout the day during waking hours (minus aquatic activities). Sedentary behavior was operationalized as the average minutes of sedentary behavior (i.e., <100 counts per minute) per hour of wear time. This was done to account for different wear times across studies.	**Affect (Positive):** Participants' positive affect was measured differently in all EMA studies. Across all studies, participants were asked to report about the extent to which they felt various emotions right before the beep went off. Positive affect was assessed in children and adolescents using two items (i.e., HAPPY/ JOYFUL). Among adults, positive affect was assessed in MATCH using two items (i.e., HAPPY/CALM) and in Project MOBILE using three items (i.e., HAPPY/CHEERFUL/CALM). These items are derived from the Positive and Negative Affect Schedule (PANAS). Participants in Mobile Healthy PLACES, AsthEMA, and MATCH responded to items on a 1 (not at all) to 4 (extremely) scale. Participants in Project MOBILE responded to items on a 1 (not at all) to 5 (extremely) scale. Data from Mobile Healthy Places, AsthEMA, and MATCH were recoded so that 3 (quite a bit) and 4 (extremely) would correspond to 4 (quite a bit) and 5 (extremely), respectively, on the response scale used in Project MOBILE. Positive affect composite score	After controlling for sex and age, neither subject-level mean nor variability in positive affect were significantly associated with physical inactivity time per valid hour ($\beta = 0.33$, $p = 0.65$; $\beta = 0.16$, $p = 0.49$, respectively).

						values were rescaled for analyses to range from 10 to 50.	

28[44]	Mailey, Rosenkranz, Ablah, Swank, and Casey, 2017	US (Regional)	Premenopausal females aged 21 years or older, who worked at least 35 hours/week, self-reported sitting for at least 80% of work hours, and engaged in <60 minutes/week of moderate-vigorous physical activity (n = 49)	**Experimental:** Randomized Controlled Trial. Participants were assigned to one of two groups for an 8-week intervention: short break and long break. All participants were advised to accumulate 30 minutes of nonsitting time during each workday. Participants were asked to submit the activity logs, which documented all breaks from sitting during the workday, to the research team at the end of each week. Intervention 1 (Short-Break): Participants were instructed to stand/ move for 1 to 2 minutes every half hour. Intervention 2 (Long-Break): Participants were instructed to take two 15-minute breaks from sitting each workday.	**Physical Inactivity (Objective):** Assessed using an Actigraph GT3X accelerometer. Participant wore for 7 days at baseline and during the final week of intervention. Sedentary behavior was operationalized as periods during work when counts per minute were <100. Total minutes of sedentary behavior at work were averaged across the number of workdays the accelerometer was worn to yield average daily sedentary time at work.	**Affect:** Positive and Negative Affect Schedule (PANAS) - two 10-item scales were used to measure positive and negative affect. Responses were on a 5-point scale ranging from 1 ('very slightly or not at all') to 5 ('Extremely'). Responses are then summed to arrive at total positive and negative affect score, ranging from 10 to 50.	Participants in the short break group demonstrated a significant reduction in accelerometer-measured physical inactivity during the workday (-35.57 minutes; $d = 0.75$), but physical inactivity did not change in the long break group. Kruskal–Wallis tests revealed a significant difference in percentage change between groups for negative affect ($p = 0.045$), such that negative affect improved in the short break group but not in the long break group. There was no significant difference in percentage change between groups for positive affect, thought this was trending ($p = 0.069$), favoring higher positive affect in the short break group.

29[45]	Matin, Kelishadi, Heshmat, Motamed-Gorji, Djalalinia, Motlagh, Ardalan, Arefirad, Mohammadi, Safiri, Qorbani, 2017	Iran (National)	School students aged 6 to 18 (n = 13,486)	**Cross-Sectional:** Data collected as part of the fourth survey of Childhood and Adolescence Surveillance and Prevention of Adult Non-communicable Diseases, also known as CASPIAN-IV (2011– 2012).	**Screen Time:** Two-items assessed students' time spent watching TV and time spent on computer working. Students reported the hours per day they spent doing each activity. Screen time was categorized as prolonged screen time (>2 hours per day) or meeting guidelines (≤2 hours per day).	**Life Satisfaction:** Life satisfaction was assessed using a single-item. Students were asked to indicate their degree of life satisfaction. Values ranged on a scale of 1 ('very dissatisfied') to 10 ('very satisfied'). Responses were categorized as 'not satisfied' (i.e., score <6) or 'satisfied' (i.e., score ≥6).	Logistic regressions revealed prolonged screen time correlated inversely with good life satisfaction (OR = 0.84, 95% CI: [0.75, 0.94]). However, this association was not seen in multivariate analysis when adjusting for physical activity (OR = 0.94, 95% CI: [0.82, 1.07]).
30[46]	Okely, Cukic, Shaw, Chastin, Dall, Deary, Der, Dontje, Skelton, & Gale, 2019	UK (Regional)	Older adults part of the Seniors Understanding Patterns study (n = 698)	**Cross-Sectional:** Data were taken from the Seniors Understanding Sedentary Patterns (USP) study* (Cohort LBC1936, Twenty-07 1950s, and Twenty-07 1930s). Participants wore an ActivPAL3 inclinometer for at least 7 days. Participants also completed a questionnaire. *Only the LBC1936 cohort completed a measure of well-being.	**Sedentary Behavior (Objective):** Assessed using an ActivPAL3 inclinometer. The ActivPAL3 is able to distinguish between posture and activity to classify time as sitting, standing, or stepping. Average percentage of waking time spent sedentary (i.e., sedentary time) and average number of sit-to-stand transitions were taken as outcome measures.	**Hedonic Well-Being:** Warwick Edinburgh Mental Well-Being Scale (WEMWBS) - Fourteen-item scale comprising of positively worded items that assess mental well-being (i.e., hedonic and eudaimonic well-being) on a 5-point Likert scale. Responses ranged from 1 ('None') to 5 ('All of the time') and sum scores ranging from 14 to 70, with higher scores indicating greater well-being. The WEMWBS was only administered to the LBC1936 cohort.	In the LBC1936 cohort, wellbeing score, which was assessed concurrently with sedentary behavior, was not associated with sedentary time or number of sit-to-stand transitions (*p* > 0.258).

31[10]	O'Neil, and Dogra, 2016	Canada (National)	Adults aged 45 or older (n = 30,865)	**Cross-Sectional:** Data were taken from the Healthy Aging Cycle of the Canadian Community Health Survey (CCHS-HA; 2008-2009). Participants completed a questionnaire.	**Sedentary Behavior (Self-Reported):** Measured using a two-item questionnaire asking how often they had participated in sedentary activities in the past seven days. Then they were asked to identify those activities from a pre determined list. Sedentary activities on the list were bingo, cards, or other games; computer activities; crosswords, puzzles, etc.; handicrafts, listening to radio/music; playing musical instruments; reading; visiting with others; watching TV; and other. The 'other' category was not analysed.	**Life Satisfaction:** Measured using a single item. Participants self-reported their satisfaction in life in general. Options ranged from 'very satisfied', 'satisfied', 'somewhat satisfied', or 'not satisfied'. Responses were dichotomized to good ('very satisfied' and 'satisfied') and poor ('somewhat satisfied' and 'not satisfied') life satisfaction.	In middle-aged adults (i.e., aged 45-60), computer use (OR = 1.99, 95% CI: [1.66, 2.39], $p < 0.05$), reading (OR = 1.66, 95% CI: [1.37, 2.01], $p < 0.05$), playing musical instrument (OR = 2.2, 95% CI: [1.22, 3.96], $p < 0.05$), and visiting others (OR = 1.21, 95% CI: [1.00, 1.46], $p < 0.05$) were positively associated with good satisfaction with life. Listening to radio/music (OR = 0.82, 95% CI: [0.68, 0.99], $p < 0.05$) was negatively associated with good satisfaction with life. After adjustment of covariates, only associations between computer use (OR = 1.39, 95% CI: [1.14, 1.70], $p < 0.05$), reading (OR = 1.35, 95% CI: [1.10, 1.66], $p < 0.05$), and playing musical instrument (OR = 2.15, 95% CI: [1.18, 3.94], $p < 0.05$) remained. In older adults (i.e., aged >60), computer use (OR = 2.01, 95% CI: [1.59, 2.54], $p <$ 0.05), reading (OR =

							1.69, 95% CI: [1.32, 2.16], $p < 0.05$), doing crosswords (OR = 1.52, 95% CI: [1.15, 2.00], $p < 0.05$), and visiting others (OR = 1.21, 95% CI: [1.00, 1.46], $p < 0.05$). After adjustment of covariates, associations between computer use (OR = 1.42, 95% CI: [1.09, 1.84], $p < 0.05$), reading (OR = 1.40, 95% CI: [1.08, 1.82], $p < 0.05$), doing crosswords (OR = 1.62, 95% CI: [1.21, 2.16], $p < 0.05$), and visiting others (OR = 1.35, 95% CI: [1.06, 1.70], $p < 0.05$) persisted.
32[47]	Ormel, Kempen, Deeg, Brilman, Van Sonderen, and Relyveld, 1998	Netherlands (National)	Late middle aged and older adults who either live independently or in residential homes but not nursing homes (n = 5,279)	**Cross-Sectional:** Data collected as part of the Groningen Longitudinal Aging Study (GLAS). Participants completed an interview and mailed questionnaire.	**Physical Inactivity (Self-Reported):** Inactivity was operationalized as time spent sitting down without doing anything, resting, and sleeping. Subjects were asked the number of hours per day spent in each of these three activities. These three separate measures were then summed.	**Life Satisfaction:** Life satisfaction assessed with Cantril's Ladder. Participants were presented with a single-item: "Here is a picture of a ladder. Suppose that we say the top of the ladder represents the best possible life for you and the bottom represents the worst possible life for you. Where on the ladder do you feel you personally stand at the present time?". Values ranged from from (1-10).	Participants with no medical condition and no depression reported significantly lower inactivity ($p < 0.001$) and higher life satisfaction ($p < 0.001$), as compared to participants with no medical condition and depression. Similarly, participants with medical condition(s) and no depression reported significantly lower inactivity ($p < 0.001$) and higher life satisfaction ($p <$

							0.001), as compared to participants with medical condition(s) and depression.

33[48]	Puig-Ribera, Bort-Roig, Gine-Garriga, Gonzalez-Suarez, Martinez-Lemos, Fortuno, Martori, Munoz-Ortiz, Mila, Gilson, and McKenna, 2017	Spain (National)	Administrative and academic staff with low and moderate physical activity levels (0 to 3000 MET·min·week) (n = 264)	**Experimental:** Randomized controlled trial. Data were collected as part of the Walk@WorkSpain (W@WS) study. University campuses were cluster randomized to either a 19-week intervention or comparison group. Participants completed questionnaires at baseline, 8 weeks, 19 weeks, and two-month follow-up. Additionally, each group was given a pedometer and diary to track daily steps and self-reported sitting time, respectively. Intervention: Received the automated W@WS program which encouraged office workers to 'sit less and move more' during workdays. Participants recieved behavioral strategies for increasing steps and decreasing sitting time throughout the 19 weeks. Comparison: The	**Sedentary Behavior (Self-Reported):** Sitting time on weekdays and weekend days were separately evaluated in three questions: sitting time traveling, sitting time watching TV, and total sitting time. All responses were operationalized into minutes/day.	**Hedonic Well-Being:** Warwick Edinburgh Mental Well-Being Scale (WEMWBS) - Fourteen-item scale comprising of positively worded items that assess mental well-being (i.e., hedonic and eudaimonic well-being) on a 5-point Likert scale. Responses ranged from 1 ('None') to 5 ('All of the time') and sum scores ranging from 14 to 70, with higher scores indicating greater well-being**.**	No significant interactions were identified between group and program time points for mental well-being (p = 0.305).

				comparison group was asked to maintain habitual behavior.			

34[49]	Rusby, Westling, Crowley and Light, 2014	US (Regional)	Middle school students, grades 6-8, half of which were selected for higher risk behaviors (e.g., deviant peer affiliation, tobacco and substance use) (n = 82)	**Longitudinal:** Participants completed four ecological momentary assessment periods: fall, winter, and spring of 7th grade, and fall of 8th grade. Each period was a week long and prompted students randomly 27 times during non-school hours and weekends.	**Screen Time**:Students were asked whether they were engaging in small screen recreation (i.e., watching TV, playing video games, computer use, excluding time engaging in homework or reading) during a ecological momentary assessment. Responses were dichotomized to 0 = 'did not participate in the activity' and 1 = 'participated in the activity'.	**Affect:** Assessed using two items on a 9-point scale. Participants reported on their current mood states: 'How happy are you right now?' and 'How sad are you right now?', with 1 = 'not at all' to 9 = 'very much'.	No associations were detected for small screen recreation and sad mood ($\gamma 20 = -0.01$, $p = .782$) or happy mood ($\gamma 30 = 0.12$, $p = .317$).

35[50]	Shiue, 2015	Scotland (National)	Adults aged 16-99 (n = 9,709)	**Cross-Sectional:** Data were drawn from the two most recent waves of the Scottish Health Survey (2012, 2013). Participants completed a household interview.	**Screen Time:** Assessed daily TV and screen watching time. Responses were dichotomized to <*x* hours per day or ≥*x* hours per day, where *x* is equal to the number of hours where significant differences in OR are seen between groups for a specific item.	**Hedonic Well-Being:** Warwick Edinburgh Mental Well-Being Scale (WEMWBS) - Fourteen-item scale comprising of positively worded items that assess mental well-being (i.e., hedonic and eudaimonic well-being) on a 5-point Likert scale. Responses ranged from 1 ('None') to 5 ('All of the time') and sum scores ranging from 14 to 70, with higher scores indicating greater well-being**.**	Compared to those who spent <2 hours of daily screen time, participants who reported ≥2 hours of daily screen time had a greater likelihood of reporting 'Less than usual' on 'Feeling optimistic about the future' (OR = 1.28, 95% CI: [1.07, 1.54], p = 0.007). Compared to those who spent <3 hours of daily screen time, participants who reported ≥3 hours of daily screen time had a greater likelihood of reporting 'Less than usual' on 'Feeling confident' (OR = 1.29, 95% CI: [1.07, 1.54], p = 0.007). Compared to those who spent <4 hours of daily screen time, participants who reported ≥4 hours of daily screen time had a greater likelihood of reporting 'Less than usual' on 'Feeling relaxed' (OR = 1.18, 95% CI: [1.01, 1.39], p = 0.041) and 'Feeling cheerful (OR = 1.60, 95% CI: [1.29, 1.99], p < 0.001).

36[51]	Sirgy, Lee, Kosenko, Meadow, Rahtz, Cicic, Jin, Yarsuvat, Blenkhom and Wright (1998)	Global	Household respondants (n=1,226)	**Cross-Sectional:** Participants completed a questionnaire.	**Screen Time:** Hours of TV viewership assessed through four self-report frequency questions: '1. How much time did you spend watching television yesterday?', '2. How much time do you usually spend watching television every day?', '3. How many hours per week do you watch television?', and '4. On an average day, about how much time, if any, do you personally spend watching television?'.	**Life Satisfaction:** Assessed through the delighted- terrible (D-T) life satisfaction measure and the congruity life satisfaction measure. The D-T is a single-item 7-point self-report question: 'How do you feel about your life as a whole?' with responses of 'terrible' (1) to 'delighted' (7), with a neutral item of 'I've never thought about it' (4). The congruity life satisfaction measure is a 10-item, 6-point measure that theorizes that life satisfaction is a function of a comparison between perceived life accomplishments and a set of evoked standards.	No direct relationship between life satisfaction and TV viewership was observed ($p > 0.05$).

37[52]	Straatmann, Oliveira, Rostila, and Lopes, 2016	Brazil (Regional)	Middle school students, aged 10-15, who are not pregnant or lactating and no underlying physical and/or mental condition that would prevent them from completing questionnaires (n = 526)	**Longitudinal:** Data were collected as part of the Longitudinal Study of Adolescent Nutritional Assessment (ELANA). Adolescents in middle school completed questionnaires at baseline and two years after.	**Screen Time:** Two items assessed average time and days spent watching TV and using videogames/computers. The first question was: 'How many days do you watch TV and videogames/computers per week?', with response values of 1 = 'never or almost never', 2 = '1 to 2 times per week', 3 = '3 to 4 times per week', 4 = '5 to 6 hours per week', and 5 = 'every day'. The second question was: 'In general, how many hours do you usually spend watching TV and videogames/computers per day?'. Average daily time in minutes was calculated by multiplying 'hours per day' by 'days per week' for TV and videogames/computers applying this formula: [(days per week)*(hours per day)]*60/7, utilized as a continuous variable. Those who spent >4 hours per day of screen time were classified as 'exceeding recommended screen time'.	**Hedonic Well-Being:** Assessed through the psychological well-being sub-section of the KIDSCREEN self-report questionnaire. This sub-section included 7 questions which were related to positive or negative attributes regarding emotional symptoms, life satisfaction, as well as feelings of sadness and loneliness. The questionnaire posed questions regarding the last week and for each item five options were provided on a 5-point Likert scale from 1 = 'never' to 5 = 'always' or from 1 = 'not at all' to 5 = 'extremely'. Lower values reflect poorer pscyhological well-being. t values were calculated, with those scoring in the bottom 10th percentile classified as 'poor' and those above the 10th percentile as 'good'.	Significant inverse association between psychological well-being scores and screen minutes per day at T2 among girls (r^2 =0.049, β = -3.81, 95% CI: [-7.0, -0.9]). Significant association between the onset of exceeding screen time recommendations among girls and poor well-being (RR: 1.3, 95% CI: [1.0, 1.6]). No associations were demonstrated between persistence of screen time (T1-T2) and psychological well-being in boys and girls.

38[53]	Strine, Chapman, Balluz, Moriarty, and Mokdad, 2008	US (National)	Adults (n = 13,483)	**Cross-Sectional:** Data collected as part of the Behavioral Risk Factor Surveillance System (BRFSS) study (2005). Participants were called via random-digit dialing to answer a questionnaire.	**Physical Inactivity (Self-Reported):** Persons were considered to be physically inactive if they had reported not participating in any leisure-time physical activity or exercise during the past 30 days.	**Life Satisfaction:** Assessed through a single question: 'In general, how satisfied are you with your life?'. Possible responses were: 'very satisfied', 'satisfied', 'dissatisfied', and 'very dissatisfied'. These groups were categorized as: very satisfied, satisfied, or dissatisfied/very dissatisfied.	Persons who were dissatisfied with their lives were 2.2 (95% CI: [2.1, 2.4]) times more likely to be physically inactive than those who were very satisfied with their lives.
39[54]	Vallance, Bebb, Boyle, Johnson, Gardiner, and D'Silva, 2018	Canada (Regional)	Lung cancer survivors who (a) had a previous clinical and/or pathological diagnosis of NSCLC confirmed by chart review, (b) are not currently receiving any treatment for lung cancer or any other cancer, (c) are community dwelling (not living in a hospice or long term care), and (d) have ability to read and write English. (n = 127)	**Cross-Sectional:** Participants wore a hip-worn accelerometer for 7 days and completed a questionnaire.	**Physical Inactivity (Objective):** Assessed using an Actigraph GT3X+ accelerometer. Participant wore for the device for 7 days. Sedentary behavior was operationalized as periods when counts per minute were <100.	**Life Satisfaction**: Satisfaction with Life Scale (SWLS). Five items on a 7-point Likert scale assessing satisfaction with life, with scores ranging from 5 to 35, with lower values indicating lower life satisfaction.	Physical inactivity time was significantly associated with life satisfaction at the 25th percentile (β = -0.04, 95% CI: [-0.07, 0.0]) and 50th percentile (β = -0.03, 95% CI: [-0.05, -0.01]) of depression scores.

40[56]	Vallance, Boyle, Courneya, and Lynch, 2015	Canada & Australia (Regional)	Colon cancer survivors aged 18-80 who speak English, are not currently undergoing any adjuvant therapy, able to understand and provide written informed consent, and willing and able to wear an accelerometer for 7 days (n = 180)	**Cross-Sectional:** Participants wore a hip-worn accelerometer for 7 days and completed a questionnaire.	**Physical Inactivity (Objective):** Assessed using an Actigraph GT3X+ accelerometer. Participant wore for the device for 7 days. Sedentary behavior was operationalized as periods when counts per minute were <100. Cut points for sedentary time accrued in at least 30-min bouts (hours) were <1.31 (Q1), 1.31 to <2.18 (Q2), 2.18 to <3.41 (Q3), and ≥3.41 (Q4).	**Life Satisfaction**: Satisfaction with Life Scale (SWLS). Five items on a 7-point Likert scale assessing satisfaction with life, with scores ranging from 5 to 35, with lower values indicating lower life satisfaction.	For overall physical inactivity time, no significant differences emerged for life satisfaction across inactivity quartiles (p = 0.844).
41[57]	Withall, Stathi, Davis, Coulson, Thompson and Fox, 2014	UK (Regional)	Older adults without (a) a bereavement within the last two months, (b) terminal illness, (c) moderate to advanced dementia or other debilitating mental illness, (d) an illness that would put them at risk for participating, (e) a reason their GP would recommend exclusion and (e) are able to complete the questionnaire without assistance (n = 228)	**Longitudinal:** Data were drawn from the Older People and Active Living (OPAL) study, Participants wore a hip-worn accelerometer for 7 days and completed daily log documenting purposes of journeys, as well as completing an in-home interview at baseline and visit two.	**Physical Inactivity (Objective):** Assessed by 7-day accelerometry (Actigraph GT1Ms) using a 10-second epoch. Sedentary bouts were the mean number of minutes of sedentary time (0–99 CPM) per day. Bouts of more than 100 min of continuous zero count data were considered non wear time and excluded.	**Life Satisfaction**: Satisfaction with Life Scale (SWLS). Five items on a 7-point Likert scale assessing satisfaction with life, with scores ranging from 5 to 35, with lower values indicating lower life satisfaction.	No significant relationships emerged between volume of physical inactivity time and life satisfaction (r = -0.012, $p \geq 0.05$).

42[11]	Wrosch and Sabiston, 2013	Canada (Regional)	Female Breast Cancer survivors (a) aged 18 years or older, (b) with a first diagnosis of breast cancer within the past year, (c) ≤20 weeks post primary treatment, (d) who can read and write in French or English, and (e) report no health problems that would prevent them from engaging in physical activity (n = 176)	**Longitudinal:** Participants completed questionnaires at baseline and 3-month follow-up.	**Sedentary Behavior (Self-Reported):** Sedentary time assessed using an adapted version of the Leisure Time Exercise Questionnaire. Participants were asked to report the number of times per week they typically engage in different activities and the average duration of each activity bout. Sedentary activities included television/video watching and computer/video games. Weekly total minutes were calculated by multiplying the frequency of activity by the total minutes.	**Affect:** Assessed by administering 24 items from the Profile of Mood States (POMS). On three non-consecutive days following the main questionnaire, participants were asked to report the extend to which they had experience 9 positive emotions (e.g., happy, calm, energetic) and 15 negative emotions (e.g., angry, sad, afraid) during the day, using 5 point Likert-type scales 0 = 'not at all' to 4 = 'extremely'). A mean score across days for both positive and negative affect were calculated.	Sedentary activity, positive affect, and negative affect did not change significantly over 3 months in the entire sample (*p*s > 0.50). Sedentary time at baseline was not associated with baseline positive or negative affect (*p*s > 0.05). Sedentary time at follow-up was negatively associated with positive affect at follow-up (r = -0.18, $p \leq 0.05$), but not negative affect (p > 0.05).
43[58]	Yan, Zhang, Oniffrey, Chen, Wang, Wu, Zhang, Wang, Ma, Li and Moore, 2017	China (Regional)	Adolescents in grades 7-12 (n = 2,625)	**Cross-Sectional:** Participants completed a take-home questionnaire.	**Screen Time:** Students were asked how many hours a day they usually spent (1) watching television, (2) playing e-games, (3) receiving news or study materials from electronic devices, (4) using social media sites or apps, and (5) watching videos both on school days and on non-school days. Response options referred to daily use (i.e., '≤1 hour/day' , '2–3 hours/day', '3–4	**Life Satisfaction**: Satisfaction with Life Scale (SWLS). Five items on a 7-point Likert scale assessing satisfaction with life, with scores ranging from 5 to 35, with lower values indicating lower life satisfaction. Scores of 20 represented the midpoint, with scores of 5-19 indicating dissatisfaction and scores of 21-35 indicating satisfaction.	On school days, watching television for more than four hours ($\beta = -3.825$, p = 0.012) was negatively associated with life satisfaction. No other associations were observed between screen time activities on both school day and non-school days and life satisfaction.

					hours/day', and '>4 hours/day). Total hours per week of overall screen-based behaviors was calculated per type of screen-based behaviors. We collapsed 'use, but not daily' and 'do not use' into four categories: 'never', 'not every day', '<1 h, '2–4 h', and '>4 h daily'.		
44[59]	Yang, Helgason, Sigfusdottir, and Kristjansson, 2013	Iceland (National)	Children aged 10-12 in grades 5, 6, and 7 (n = 10,829)	**Cross-Sectional:** Data were drawn from the 2007 Youth in Iceland study. Students completed a questionnaire.	**Screen Time:** Screen use was assessed through five items about the average time respondents usually spent each day on the follow activities: watching TV/DVD/VCR, playing Internet computer games, playing computer games not on the Internet, using Internal communication or 'chatting' channels, and 'other' computer use. Response options were 1 = 'No time', 2 = '1/2-1 hour', 3 = 'about 1 hour', 4 = 'about 2 hours', 5 = 'about 3 hours' and 6 = '4 hours or more'. All variables were re-coded into three groups with 1 = '0–1 hour per day', 2 = '2–3 hours	**Affect (Negative):** Assessed as part of the Symptom Check List 90 (SCL-90), respondents were asked whether they had experienced any of the seven symptoms during the week before the study. The following questions were relevant to negative affect: 'How often felt sad or with little interest in doing things', 'How often felt lonely', 'How often cried easily or wanted to cry', 'How often felt sad or blue'. Response options were 1 = 'never', 2 = 'almost never', 3 = 'seldom', 4 = 'sometimes' and 5 = 'often'. For the purpose of this analysis, the responses were dichotomized into 0 = 'Never, almost never or seldom', and 1 = 'Sometimes or often'.	For all items of the SCL-90, screen use of '4 hours per day' or more is associated with a significant increase in odds of having experienced subsequent negative indicators 'sometimes or often' during past 7 days, for both boys and girls. A linear dose-response relationship is observed for both boys and girls in all categories of screen use and its relations to feeling sad or having little interest in doing things. Numerous screen time activities showed no significant differences for items on the SCL-90

					per day’ and 3 = ‘4 hours or more per day’.		between '0-1 hour per day' and '2-3 hours per day'.
45[60]	Yang and Oliver 2010	US (Regional)	Adults (n= 225)	**Cross-Sectional:** Participants completed a self-report questionnaire.	**Screen Time:** Participants reported on the number of hours spent watching television on weekdays within four parts of the weekday (i.e., 6 a.m. to noon, noon to 7 p.m., 7 p.m. to 10 p.m., and 10 p.m. to 6 a.m.) and on Saturdays and Sundays. Weekly television viewing was computed from these responses. Participants also reported on the number of hours per week they spent watching each type of television program (i.e., movies, dramas, comedies/sitcoms, soap operas, news, music/celebrity shows, and game shows.	**Life Satisfaction**: Satisfaction with Life Scale (SWLS). Five items on a 7-point Likert scale assessing satisfaction with life, with scores ranging from 5 to 35, with lower values indicating lower life satisfaction.	Television viewing did not significantly predict dissatisfaction with personal life.

46[61]	Zenk, Horoi, Jones, Finnegan, Corte, Riley and Wilbur, 2017	US (Regional)	African American women aged 25 to 65 who were not students (n = 97)	**Longitudinal:** Participants completed an initial interview where they received the baseline questionnaire, and received the accelerometer. They then wore the accelerometer for 7 days and completed ecological momentary assessments on the provided smartphones. Afterwards participants completed a final interview with a questionnaire.	**Physical Inactivity (Objective):** Sedentary time assessed using the MeterPlus accelerometer. Sedentary time was defined as the total number of minutes of sedentary time (0-99 activity counts per minute). A minimum of 60 consecutive minutes of zero activity intensity counts identified non-wear.	**Affect:** Assessed by the short-form Positive and Negative Affect Schedule (PANAS) measured positive and negative affect. Five items assessed positive affect (e.g., inspired, enthusiastic); five items assessed negative affect (e.g., upset, distressed). Participants reported (using a "mark all that apply" checklist) which of the ten emotions they had been feeling since the last signal. Dichotomized both positive affect and negative affect as having 'none' or 'one or more' endorsed emotions.	Positive affect at some time during the day was not significantly associated with daily inactivity. Based on regressed models of inactivity after 10 am on affect at the first daily signal, reporting negative affect, accounting for typical level, was associated with a 33.2-minute increase in subsequent daily inactivity (p = .007). Positive affect at the first daily signal was not associated with subsequent daily inactivity. Physical inactivity during the day (before 7 pm) was negatively associated with positive affect at the last daily signal (p = .002). This is the equivalent of a 34.1% lower likelihood of positive affect at the last daily signal for each one-hour increase in inactivity during the day.

2.3.4 Synthesis of Results

2.3.4.1 Objectively-Measured Sedentary Behavior

Of the 3 studies that assessed objectively-measured SB[27,42,46], 1 study was cross-sectional[46], 1 was longitudinal[42], and 1 was experimental[27]. With regards to well-being outcomes, 1 assessed solely positive affect[27], 1 assessed life satisfaction[42], and 1 study assessed hedonic well-being[46]. All 3 studies used an ActivPAL3 inclinometer. Similarly, all 3 studies used an established instrument to measure well-being: 1 study used the Affect Grid test[27]; 1 study assessed life satisfaction through a single item[42]; and 1 study used the WEMBWS to measure hedonic well-being[46]. Additional details can be found in *Table 1*.

In sum, objectively-measured SB demonstrated either a weak detrimental or null relationship with hedonic well-being outcomes. Objectively-measured SB was negatively associated with positive affect[27]. Similarly, 1 study found a weak correlation between objectively-measured sedentary time and life satisfaction[42]; notably, life satisfaction was lower on days when people were more sedentary than was typical for them, but not when compared to the SB of others. Finally, 1 study found no association between hedonic well-being and SB[46]. Notably, 2 of the 3 studies examining objectively-measured SB used an older adult population[42,46].

2.3.4.2 Self-Reported Sedentary Behavior

Of the 10 studies that assessed self-reported SB[10,11,31,33,39,42,43,48,55,64], 5 studies were cross-sectional[10,33,39,55,64], 3 were longitudinal[11,42,43], and 2 were experimental[31,48]. With regards to well-being outcomes, 3 studies assessed both positive and negative affect[11,31,33], 1 evaluated assessed solely positive affect[39], no studies assessed solely negative affect, 5 assessed life satisfaction[10,42,43,55,64], and 1 study assessed hedonic well-being[48]. There was considerable variability in the instruments used to assess self-reported SB: 4 studies utilized a single-item question from the International Physical Activity Questionnaire[31,33,43,64] (IPAQ), with the remaining 6 studies asking participants to self-report their sitting during several (≥3) domains of activity[10,11,39,42,48,55] (e.g., homework, TV, transportation). Similarly, the instruments used to measure well-being outcomes varied considerably: all 4 studies that measured affect[11,31,33,39] used different instruments; 4 studies assessed life satisfaction through a single-item question[10,42,43,64], while the other 1 utilized the SWLS[55]. Additional details can be found in *Table 1*.

In sum, self-reported SB demonstrated weak mixed associations with hedonic well-being outcomes. With respect to positive affect, 3 studies showed a negative association with self-reported SB[11,31,33], while 1 study did not observe any association[39]; notably, this study assessed positive affect as part of the WHO-5 Wellbeing instrument. In terms of negative affect, none of the 3 studies found any associations with self-reported sedentary behavior[11,31,33]. Conversely, all 5 studies examining life satisfaction found negative relationships with self-reported SB[10,42,43,55,64]; however, 2 studies also observed no relationship[10,42], and 2 studies also observed a positive relationship[10,64]. Notably, some studies examined SB differences between-subjects and within-subjects[42,43]. Finally, the study examining hedonic well-being and self-reported SB did not observe an association[48].

2.3.4.3 Objectively-Measured Physical Inactivity

Of the 11 studies that assessed objectively-measured PI[18,28–30,43,44,54,56,57,61,65], 3 were cross-sectional[18,54,56], 6 were longitudinal[28,29,43,57,61,65], and 2 were experimental[30,44]. With regards to well-being outcomes, 3 studies assessed both positive and negative affect[28,44,61], 1 study assessed solely positive affect[18], 2 studies assessed solely negative affect[29,30], and 5 studies assessed life satisfaction[43,54,56,57,65]. There was some variability in the instruments used to assess PI: 8 studies used a model of the ActiGraph hip-worn accelerometer[18,30,43,44,54,56,57,65], 1 used a MeterPlus accelerometer[61], 1 used a SenseWear Mini Armband[29], and 1 used an Actilife accelerometer[28]. Equally, there was some variance in how well-being was measured: all three studies assessing both positive and negative affect[28,44,61] used the PANAS; both studies assessing negative affect[29,30] only used a form of the POMS; and the study assessing solely positive affect[18] adapted two items from the PANAS. For life satisfaction, 3 studies used the SWLS[54,56,57], while the other two used single-item questions to assess life satisfaction[43,65], though notably 1 study adapted the single question from the SWLS[43]. Additional details can be found in *Table 1*.

In sum, objectively-measured PI demonstrated weak mixed associations with hedonic well-being outcomes. For positive affect, only 2 of the 4 studies observed a negative association[28,61], though 1 study did observe a comparable trending relationship[44] (p = 0.069) favoring lower positive affect among the long break intervention group[44]. Conversely, all 5 studies examining negative affect found a weak positive correlation with objectively-measured PI[28–30,44,61]. Mixed associations for life satisfaction were also observed, with 3 of the 5 studies reporting a weak negative association with objectively-measured PI[43,54,65].

2.3.4.4 Self-Reported Physical Inactivity

Of the 6 studies that assessed self-reported PI[14,47,53,62,63,66], 3 studies were cross-sectional[47,53,62] and 3 were longitudinal[14,63,66]. With regards to well-being outcomes, 2 studies assessed both positive and negative affect[14,66], and 4 assessed life satisfaction[47,53,62,63]. There was considerable variability in the instruments used to assess self-reported physical inactivity: 4 studies utilized a single-item question[14,53,63,66], dichotomizing their responses to 'yes/no', with respect to physical activity; one study assessed inactivity as responding 0 minutes/week of physical activity[62]; and one study assessed a sum of the hours per day spent sitting down without doing anything, resting, and sleeping as inactivity[47]. Instruments used to measure well-being outcomes were fairly consistent: Both studies that assessed affect used a form of the PANAS[14,66]; 3 studies used a single-item question to assess life satisfaction[47,53,63] (two used a 10-point scale[47,63]), while the remaining study utilized a shortened SWLS[62]. Additional details can be found in *Table 1*.

In sum, self-reported PI demonstrated weak detrimental relationships with hedonic well-being outcomes. With respect to positive affect, 1 study found negative changes to positive affect to weakly predict daily maladaptive health behaviors, including PI[66], while the other study found likelihood to exercise was predicted by positive affect in men[14]. Comparably, negative affect was a weak predictor of daily maladaptive health behaviors as well as likelihood to exercise in men[14,66]. A similar association was seen in all 4 studies examining life satisfaction and self-reported physical inactivity; higher physical inactivity was associated with poorer life satisfaction[47,53,62,63].

2.3.4.5 Screen Time

Of the 18 studies that assessed screen time[20,26,32,34–38,40,41,45,49–52,58–60], 15 studies were cross-sectional and 3 were longitudinal[32,49,52]. With regards to well-being outcomes, 2 studies assessed both positive and negative affect[26,49], 1 assessed solely positive affect[41], 2 assessed solely negative affect[40,59], 11 assessed life satisfaction[20,26,60,34–38,45,51,58], and 3 assessed hedonic well-being[32,50,52]. Heterogeneity among measures of screen time were greater than other indices of SB. Children and adolescents were the primary population among studies assessing screen time (n = 13). Screen-time behaviors included, but were not limited to: TV watching[20,26,50–52,58–60,32,34,35,37,38,40,45,49] (n = 16), using a computer[20,34,59,35,37,38,40,45,49,52,58] (n = 11), video games[32,34,36–38,40,49,52,58,59] (n = 10), internet chatting/social media[34,58,59] (n = 3), films/movies/videos[32,58] (n = 2), using tablet devices[37] (n =1), and using a smartphone or other electronic device[37] (n = 1). Studies ranged from including a single form of screen time to 5 types of screen-based activities. Screen time behaviors were often divided between weekdays and weekends focused on after school time, and in some studies excluded academic-based screen-time[41,49] (e.g., homework online). Additionally, only 3 studies collected screen-time as a continuous variable[36,51,60]. In terms of affect measurement, only the studies assessing solely negative affect used a previously established measure of affect[40,59]; the remaining studies assessed affect through purpose-built items[26,41,49]. Similar to the other indices of SB, studies that examined life satisfaction either utilized a single-item measure[20,26,35–38,45,51] (e.g., Cantril's Ladder) or used the SWLS[34,58,60]. As with other studies, 2 of the 3 studies that examined hedonic well-being used the WEMWBS[32,50], while the remaining study used a subsection of an adolescent-specific questionnaire[52] (i.e., KIDSCREEN). Additional details can be found in *Table 1*.

In sum, screen time demonstrated weak detrimental or null relationships with hedonic well-being outcomes. Mixed associations between positive affect and screen time were observed: 3 studies did not identify a relationship[26,41,49], while 1 study did show a marginal improvement in odds ratio (OR = 1.06, 95% CI: [1.02, 1.10]) for being happy among adolescents who met screen time guidelines[41] (i.e., ≤2 hours per day). The opposite was true for negative affect, of which 3 studies identified a positive relationship[26,40,59] and 1 study did not[49]. Similarly, mixed findings between life satisfaction and screen time were observed: 2 studies found that TV watching, specifically, was not associated with life satisfaction[51,60]; however 1 study indicated TV watching was more common among those with low life satisfaction[38], and another found watching TV for >4 hours per day on school days (and no other screen behavior) was negatively associated with life satisfaction[58]. Other studies revealed significant negative associations between life satisfaction and increased screen time[20,34,35] or not meeting screen time guidelines[37]. Two studies examining hedonic well-being and screen time found a negative association between increased screen time/TV watching and well-being[32,50], however, 1 study did not find any relationship between screen time and well-being among boys and girls who consistently reported over screen time guidelines two years apart[52].

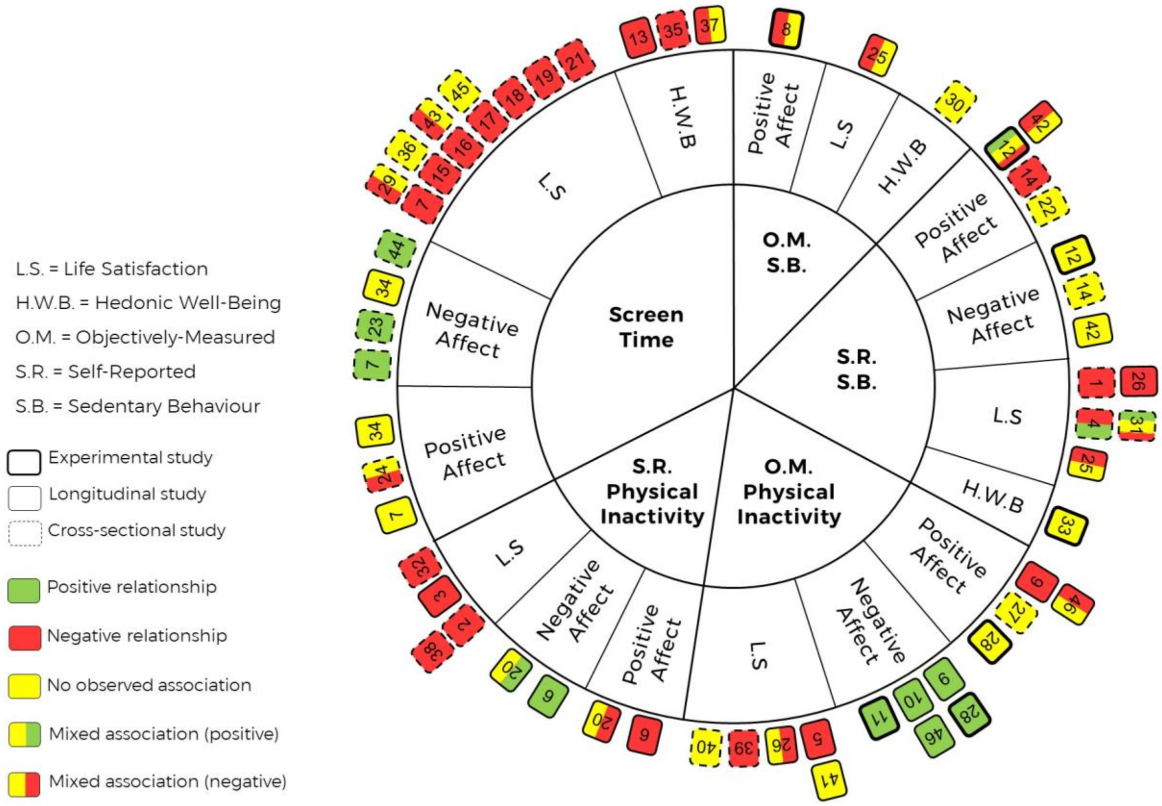

Figure 2: Pinwheel of associations between indices of sedentary behavior and outcomes of hedonic well-being.

2.4 Discussion

This scoping review examined literature relating indices of SB (i.e., objectively-measured and self-reported indices of SB, objectively-measured and self-reported PI, and screen time) and hedonic well-being outcomes (i.e., affect, life satisfaction, hedonic well-being). The broad inclusion criteria of this scoping review reflect the dearth of compiled literature examining these relationships, the variability among instruments assessing hedonic well-being, as well as the evolving operationalization and measurement of SB[12]. Consequently, this review presents unique trends among different definitions of SB and outcomes of hedonic well-being, revealing the contextual nature of these sitting behaviors. For ease of presentation and interpretation, the findings from this review are discussed based upon the differing operational definitions of SB: (a) objectively-measured SB, (b) self-reported SB, (c) objectively-measured PI, (d) self-reported PI, and (e) screen time.

2.4.1 Objectively-Measured Sedentary Behavior

Overall, objectively-measured SB was either weakly and negatively related or unrelated to hedonic well-being outcomes (see Table 1 and Figure 2). Each of the articles examining objectively-measured SB found, at least in part, a null association with their outcome of hedonic well-being. In the study examining positive affect, pleasantness between groups before an oral glucose tolerance test (OGTT) was not significantly different[27]. Significant differences favoring the Sitless group (vs. Sit group) were only present after administration of the OGTT, which the authors infer may be a product of the lingering improvements to insulin sensitivity from a reduced sedentary intervention. These findings coincide with some objectively-measured PI work, which support the predictive role of PI on positive affect; specifically, higher levels of PI during the day predict lower subsequent positive affect[28,61]. Importantly, no study examined negative affect and objectively-measured SB, necessitating future work explicating this relationship.

The study examining life satisfaction found a mixed weak negative/null correlation with objectively-measured SB[42]. Specifically, lower within-subject (i.e., self-compared) SB predicted lower life satisfaction, in contrast to the null associations found between-subject SB. Notably, this predictive relationship was absent when self-reported SB was examined, which may denote an effect of total actual sitting behavior on life satisfaction, unique from the perception of one's SB or specific sedentary activities.

With respect to hedonic well-being, no association was observed between total sitting time or number of sit-to-stand transitions[46]. However, this study utilized a cross-sectional design, which may have masked or been unable to capture the effect of any within-subject differences. Given the null between-subjects findings of the above studies examining affect and life satisfaction, the ability to assess hedonic well-being longitudinally may present unique relationships. For example, designs assessing hedonic well-being and objectively-measured SB at two or more time points during the day, similar to Elavsky and colleagues[28], and Zenk and colleagues[61], can determine the directionality and potential predictive capability of hedonic well-being on objectively-measured SB.

In sum, these results allude to the sensitive and fluctuating nature of positive affect, as well as the potential importance of within-individual changes in SB for hedonic well-being outcomes, which may explain the mixed/null results among observational studies with single or infrequent assessment points. By contrast, life satisfaction is a more stable construct than affect[67], and is likely less malleable to change, especially from habitual activities like sitting. Rather, changes in life satisfaction may be more sensitive to within-person changes in sitting (i.e., more or less sitting than is typical), rather than an objectively high or low level of sitting.

Objectively-measured SB represents the most valid and accurate means we currently have of observing total sitting behavior[15]. While these methods do have some weaknesses (e.g., distinguishing sleep and domain-specific sitting behaviors), use of these instruments are the most likely to shed light on whether actual sitting behaviors (e.g., total sitting, sit-to-stand transitions) have relationships with hedonic well-being outcomes. Hence, additional research utilizing inclinometers (e.g., ActivPAL) and longitudinal/experimental designs (e.g., ecological momentary assessment) is needed to further elucidate the causation and directionality of these relationships.

2.4.2 Self-Reported Sedentary Behavior

Overall, relationships between self-reported SB and outcomes of well-being are unclear. The two self-reported sedentary behavior studies that did not report a mixed association were confounded by some measure of physical activity; Bampton and colleagues assessed SB in combination with resistance training[55], while the indirect association observed by Buck and colleagues was through availability of recreational facilities[64]. Consistent associations were presented for affect. In all but one study – of which positive affect was measured as a single-item within a broader questionnaire[39] – positive affect was negatively associated with self-reported SB. In particular, work by Hogan and colleagues found SB predicted less frequent positive emotions, after controlling for physical activity[33], further supporting the findings of previously mentioned objectively-measured SB and physical inactivity studies[28,61]. Conversely, a null finding was consistently observed between negative affect and self-reported SB. Given that each study examining negative affect measured or analyzed sitting time as a total daily/weekly measure, these null findings could be indicative of the minimally negative affective contribution of sitting as a behavior, rather than the context in which it is performed. Since these null associations conflict with the positive relationships observed between negative affect and screen time, future work should explore whether these null associations are mirrored for other domain-specific sitting behaviors.

Generally, life satisfaction has weak negative or null associations with self-reported SB. However, when excluding studies that implied physical activity as part of their analyses[55,64], relationships between life satisfaction become more nuanced. Specifically, life satisfaction may be influenced primarily within-subject variance in SB, rather than between-subject variance. In other words, how sedentary an individual, compared to how sedentary they typically are, may influence their life satisfaction, or vice-versa – independent of how much sitting they actually do, compared to others. Additionally, the context of sitting behavior is likely associated with life satisfaction, as O'Neill and Dogra note significant variability among different sedentary activities and odds for reporting good life satisfaction[10]. For example, activities such as computer use and socializing with others were associated with greater odds of reporting good life satisfaction; though notably these odds did vary among age groups, supporting the notion that life satisfaction is an individualized construct[68].

Among the only study that examined overall hedonic well-being, no relationship was found; however, the experimental intervention was also unable to manipulate SB between the groups, which may explain the null findings[48]. Notably, while the authors collected domain-specific measures of SB, they analyzed the results as a total sitting time. More research examining this relationship using both total and domain-specific sitting measures is required.

Currently, certain self-reported measures of SB are likely the most feasible way to assess individuals' domain-specific sitting behaviors (e.g., SIT-Q 7d[16]) outside of direct observation. Given the malleable nature of some well-being outcomes, like affect, it is reasonable to hypothesize that the context/domain of a sitting behavior and perhaps demographic characteristics (e.g., age) have unique effects on these outcomes, independent of the actual sitting behavior itself. For example, increased time spent sitting in the transportation domain of sitting (e.g., commuting) has been linked to lower well-being[69]. Hence, further work relating a wider range of domains and sitting behaviors with hedonic well-being outcomes in diverse populations is warranted.

2.4.3 Objectively-Measured Physical Inactivity

Overall, objectively-measured PI showed a weak detrimental association with outcomes hedonic well-being (see Table 1 and Figure 2). Among studies examining positive affect, results are mixed[18,28,44,61]. However, the longitudinal studies revealed greater prior physical inactivity predicting lower positive affect during the next day or moment[28,61]. This "lagged momentary" effect of physical inactivity on positive affect may explain the null findings for some cross-sectional studies. Conversely, studies examining negative affect consistently reported weak, positive associations with objectively-reported SB[28–30,44,61]. Specifically, greater levels of daily negative affect are related to, and may predict, greater PI. However, none of these studies account for depression or anxiety when considering negative affect. Whether these effects are related uniquely to negative affect, or whether they can be accounted for through inclusion of these mental health measures has implications for interventions specifically aimed at improving well-being outcomes.

Relationships with life satisfaction and objectively-measured PI were also mixed and weak, similar to positive affect (see Table 1 and Figure 2). Most studies did not demonstrate an association. One study examined life satisfaction scores through quartiles of depression scores, which likely confounds its relationship with PI[54]. Of note, work by Maher and colleagues reported previous day life satisfaction negatively influencing subsequent day PI when self-reported[43]; however, this association was absent when examining the objective accelerometer data. These results lend themselves to the role of perception of SB as an influence on well-being outcomes, given the within-subjects (but not between-subjects) differences noted by several studies[28,43,61].

The operationalization of PI (i.e., "sedentary time") in these studies raises some limitations to how these data are interpreted. Sedentary behavior, as has been recently established, comprises of a waking qualifier, an activity level threshold, and a postural component[12]. Accelerometers, by design, are only able to distinguish the activity level threshold of SB through counts per minute (e.g., <100 counts per minute, typically). Additionally, given where most accelerometers are worn (e.g., hip or arm) and wear protocols (e.g., taken off during aquatic activities), there are forms of activity and SB that are not captured by these devices, like standing behaviors or seated exercises. While some research has found the differences in captured SB between the ActivPAL3 inclinometer and ActiGraph GT3X+ accelerometer to be non-significant, evidence still recommends use of an inclinometer to capture SB, as these methods are not necessarily interchangeable[70].

2.4.4 Self-Reported Physical Inactivity

Overall, self-reported PI appeared to have a weak detrimental effect on hedonic well-being outcomes, similar to objectively-measured PI (see Table 1 and Figure 2). Notably, two studies noted both positive and negative affect, as well as changes in positive and negative affect, as being weakly predictive of PI[14,66], contrary to objective evidence which only denotes negative affect as being predictive of PI[28,61]. Life satisfaction was also consistently negatively related to higher self-reported PI.

There are some considerations that must be taken into account when interpreting self-reported PI results as a proxy for SB. Physical inactivity inherently mirrors physical activity levels; time that is not spent being physically active – which is typically defined as moderate-to-vigorous in intensity – is considered PI. This distinction is reflected in how PI is measured and analyzed. For example, Strine and colleagues considered participants to be physically inactive if they reported not participating in *any* leisure-time physical activity during the past 30 days[53]. Similarly, Barile and colleagues classified 'sedentary' time as participants reporting 0 minutes/week of physical activity[62]. Other studies yet dichotomize PI as not meeting physical activity guidelines[63]. Ultimately, these categorizations of PI compare those individuals who are very physically inactive with those who are not. In essence, these findings likely represent relationships between hedonic well-being outcomes and the most sedentary percentiles of individuals.

However, many non-SB do not overlap with either physical activity or PI. For example, standing or light-intensity incidental movements, like walking, would be considered PI, just like sitting. Hence, using PI as a proxy measure for SB misrepresents how much/little sedentary an individual is. While the observed relationships between PI and hedonic well-being are reasonable, they are not necessarily representative of typical SB nor its relationship well-being outcomes.

2.4.5 Screen Time

Overall, screen time demonstrated a weak detrimental association with hedonic well-being outcomes (see Table 1 and Figure 2). Positive affect was the exception, with only one of the three studies finding a negative association with screen time[41]. Notably, this negative association with positive affect and screen time was only present when dichotomizing screen time by meeting/not meeting guidelines; the authors noted no relationship between happiness and recreational or academic screen time[41]. Conversely, weak positive associations between screen time and negative affect were consistent. However, the study that did not identify a positive association with negative affect amalgamated various screen time activities into a binary measure[49] (i.e., did/did not participate), which may have masked effects of individual screen behaviors.

Life satisfaction was negatively associated with screen time in most studies. Of the studies included, TV watching was the most common screen behavior to show a negative association with life satisfaction (see Table 1 and Figure 2). Results of some studies[37,38,45,58] suggest there may a threshold of screen time that, above which, life satisfaction is negatively impacted. This threshold may be similar to current screen time guidelines (e.g., <2 hours per day) or more excessive levels of screen behavior (≥4 hours per day). The presence of a threshold level of screen time is further supported by the results of included studies examining hedonic well-being[32] (e.g., ≥3 hours per day). These findings are in line with a recent review of reviews[71], which found screen time to be weakly correlated with poorer quality of life and well-being; however, one important distinction between the review by Stiglic and Viner, and the present work, is the definition of well-being. Our review focuses on hedonic well-being, which, while similar to health-related quality of life, is grounded in a salutogenic approach to health, rather than the pathogenic slant of the latter[72].

Relationships observed between screen time and outcomes of hedonic well-being are distinct from self-reported SB, which suggests that the effect of screen time is unique from overall sitting behavior. This notion is further evidence by the negative relationships that screen time has with perceived health status and quality of family relationships[35], as well as social media's negative role on well-being through social comparison and isolation[73]. Importantly, age may be a modifier when it comes to screen time. For instance, older adults are less likely than younger demographics to be using social media, which may reduce their risk for social comparison impacting their well-being. Contrary, findings from O'Neill and Dogra indicate that computer use is associated with the greatest likelihood of reporting good life satisfaction of any reported activity among older adults[10]. Thus, while it appears screen time is negatively associated with outcomes of hedonic well-being, further research is required to disentangle the contribution of the contextual effect of these screen-based activities as compared to the contribution of the sitting behavior itself, as well as exploring any demographic moderators. In other words, does watching TV, for example, have a unique effect on well-being, independent of sitting? And if so, for which populations?

Notably, the use of smartphone and handheld electronic devices was only assessed explicitly by one study. Given the rise in popularity of these devices, especially among younger adults and adolescents, coupled with their associations with detrimental mental health effects, such as smartphone-based anxiety and addiction (i.e., Nomophobia[74]), future research should include the use of these devices within screen time instruments.

2.4.6 Limitations

There are some limitations to note with the scoping review process. While our search strategy did uncover a large body of evidence related to our research question, the inclusion of some terms may have increased the reach of our searches. For example, the term "wellbeing" versus "well-being" has been adopted by some authors and groups as a means of delineating between well-being as the opposite of ill-being, and well-being as "what makes life go well for someone"[75]. Similarly, synonyms for affect, such as mood, emotion(s), and feelings may have revealed additional relevant literature. Finally, owing to the considerable number of articles screened and the limited team members for this review, our results are only up to date as of May 2019.

2.4.7 Conclusion

This review found weak, detrimental associations between some indices of SB and outcomes of hedonic well-being; specifically, these relationships appear to be more sensitive to within-person changes in indices of SB. In other words, greater levels of SB/PI/screen time than is typical for an individual may predict lower positive affect, greater negative affect, and lower life satisfaction, independent of physical activity. Unique detrimental relationships between screen time and other domains of sitting with outcomes of hedonic well-being, compared with total sitting, highlight the contextual nature of sitting behaviors and the potential moderating role of demographic characteristics (e.g., age, gender). Future work should look to assess sedentary time, as it is currently defined[12], through longitudinal and experimental designs, using both objective and self-reported instruments in diverse populations in order to capture the nature of relationships between total and domain-specific SB and outcomes of hedonic well-being.

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Chapter 3

3 Study 2 – Exploring the relationship between sedentary behavior and subjective well-being: A cross-sectional study

3.1 Rationale

Sedentary behaviors (SB) are any set of behaviors that are (1) waking, (2) expend ≤1.5 METs, and (3) are performed in a sitting, lying, or reclining posture[1] and encompass behaviors in a variety of different domains/settings (e.g., meals, transportation, occupation). Over the last decade, numerous systematic reviews have documented the link between excessive SB and higher rates of all-cause mortality, diabetes, heart disease, hypertension, and depression[2].

Notably, the bulk of SB research has examined this relationship through a pathogenic perspective of health that evaluates a person's health status through the presence or absence of disease markers/factors. Through a pathogenic lens, a person with symptoms of Type II Diabetes (e.g., elevated resting blood glucose, impaired glucose tolerance) would be considered unhealthy, as the presence of disease markers contraindicates health. By contrast, a salutogenic approach is concerned with the relationship between health, stress, and coping[3]. Through this lens, a person exhibiting symptoms of Type II Diabetes may yet be considered healthy if they report favorably on salutogenic outcomes, such as subjective well-being (SWB) or perceived wellness.

Despite being distinct from pathogenesis, salutogenic outcomes are often correlated with health[4], and hence, have important implications for traditional health and disease outcomes. For example, mental health markers, such as symptoms of depression and anxiety, are often correlated with negative affect – a salutogenic outcome. Salutogenic outcomes may illuminate factors that influence or inform a patient's health status, independent of markers/symptoms of disease (e.g., social determinants of health, satisfaction with life). Recent work has demonstrated correlations between perceived wellness and health-related quality of life in older adults[5]. Additionally, higher levels of SWB have been associated with longevity and may also be predictive of cardiovascular disease[6].

SWB falls under the salutogenic conceptualization of health, and generally encompasses one's own assessment of their lives and psychological functioning[4]. Specifically, SWB can be divided into two distinct philosophies: hedonic well-being and eudaimonic well-being. Hedonic well-being posits one's happiness and pleasure as the primary indicators of well-being and is constituted by positive and negative affect (i.e., mood) and life satisfaction (i.e., a global cognitive measure of one's own life compared to an imagined ideal[4]). Eudaimonic well-being posits that seeking pleasure and happiness do not always equate to improvements in well-being; rather, well-being arises from experiencing the actualization of one's true self and the values associated[4]. Because the two types of SWB capture similar, but unique, concepts, there is often value in including instruments that capture both hedonic and eudaimonic well-being when examining SWB; some instruments have been designed to capture both (e.g., Warwick-Edinburgh Mental Well-Being Scale[7], or WEMWBS).

Given the significant amount of time the average person spends engaged in SBs, determining the strength and direction of any potential relationship(s) between SB and SWB has implications for health outcomes and interventions. Work by Maher and colleagues found no predictive capability of subject-level variability in positive affect on levels of SB[8]. Conversely, work by Elavsky and colleagues found an inverse association between concurrent positive affect and SB[9]. Similarly, work by Edwards & Loprinzi demonstrated a detrimental effect on life satisfaction after experimentally increasing SB for 1 week[10]. Further research has suggested that there may be no relationship between SWB and SB[11] or that the relationship between SB and SWB may be attenuated by physical activity (PA)[12].

The abovementioned research underscores the tenet that relations between SB and outcomes of SWB are inconsistent at this time. A limitation of much of the previous research investigating this relationship lies in the measurement of both of these constructs. Measurement of SWB in relation to SB in prior work has generally focused on only one outcome of SWB[8,9].

Similarly, previous studies that have examined SB and SWB often examine either proxies of SB (e.g., screen time) or only total SB[11]. Evidence suggests that specific domains of SB may uniquely impact health outcomes, distinct from total accumulated sitting[8]. Levels of SB are often higher in populations with inherently sedentary occupations, such as university students[13]. Assessing SWB as a complete concept (i.e., affect, life satisfaction, *and* overall SWB) in relation to total *and* domain-specific SB may illuminate potential mechanisms for the SB and SWB relationship.

To the authors' knowledge, no prior work has examined the relationship between both total and domain-specific SB and salient concepts of SWB. Hence, the purpose of this study is to investigate the nature of these relationships within a university student population.

3.2 Methods

3.2.1 Design/Sample Size Calculation

A cross-sectional survey study was conducted. To the authors' knowledge, no prior study has examined domain-specific SB in relation to affect, life satisfaction, and overall SWB. Hence, a priori sample size calculation was performed assuming a small correlation (i.e., $r = 0.1$) between outcomes of interest. Based on a correlation size estimate of $r = 0.1$, two-tailed $\alpha = 0.05$, and $\beta = 0.80$, a sample size of 779 participants was acquired[14]. After accounting for attrition, a final sample size of 1000 participants was deemed appropriate.

3.2.2 Participants

University students from across Canada were invited to participate in this study. Inclusion criteria included (a) being a full-time university student attending a university, (b) being 18 years of age or older, (c) being able to read and write in English, and (d) having access to a computer/smartphone with internet. Exclusion criteria included only part-time enrollment or currently on a leave of absence from full-time studies at university.

3.2.3 Recruitment

University students were recruited through posters distributed around the host institution's university campus, verbal advertisement during lectures at the host institution, and through online university groups on Facebook.

3.2.4 Data Imputation

All datapoints within outcomes of interest that fell below the 5^{th} percentile or exceeded the 95^{th} percentile were deemed to be outliers. A Winsorisation technique was applied to any outliers in the data; data points under the 5^{th} percentile or over the 95^{th} percentile were replaced with the value of the 5^{th} percentile and 95^{th} percentile, respectively[15].

3.2.5 Measures

3.2.5.1 Sedentary Behavior

3.2.5.1.1 Past 7 days self-compared SB (i.e., total sitting, number of breaks, duration of breaks)

Assessed through three items on a 5-point Likert scale, with a score of 1 indicating ‘Much less than normal’, 3 indicating ‘About the same’, and 5 indicating ‘Much more than normal’.

3.2.5.1.2 Past 7 days domain-specific SB

Assessed using the modified SIT-Q 7d questionnaire[16]. The original SIT-Q 7d instrument[17] is a self-reported questionnaire that measures time spent sitting in various activities in a number of domains of activity over the past 7 days. Participants estimate their sitting time on both an average weekday (WY) and weekend day (WD) by selecting the option that best reflects how much time they spent sitting. The modified version of the SIT-Q 7d also assesses the number, frequency, and duration of breaks from sitting in specific domains. These modifications to the base questionnaire have shown adequate test–retest reliability (r = 0.564- 0.740, ICC = 0.562-0.740, p = .05, n = 21) and face validity among a university student population[16]. The full modified SIT-Q 7d can be found in *Appendix C*.

3.2.5.1.3 Past 7 days average weekday SB

Assessed through a single question on the IPAQ-S7S (i.e., ‘During the last 7 days, how much time did you spend sitting on a weekday?’). Participants were asked to specify both an hour(s) per day and minute(s) per day estimate.

3.2.5.2 Subjective Well-Being

3.2.5.2.1 Past 7 days positive and negative affect

Assessed through the Positive and Negative Affect Schedule[18] (PANAS). Participants were asked to indicate the extent to which they felt an emotion/feeling over the last 7 days on a 5-point Likert scale. Separate sum scores (range: 10-50) for positive and negative affect. The PANAS has been shown to be valid and reliable measure of affect in this population[18].

3.2.5.2.2 Life satisfaction

Assessed through the Satisfaction with Life Scale[19] (SWLS). The SWLS lists five statements concerning life satisfaction and asks participants to indicate the degree they agree/disagree with each statement on a 7-point Likert scale. A total sum score (range: 7-35) is attained, with higher scores representing higher life satisfaction.

3.2.5.2.3 Overall subjective well-being (SWB)

Warwick-Edinburgh Mental Well-Being Scale[7] (WEMWBS). The WEMWBS a 14-item questionnaire containing statements about feelings and thoughts encompassing both hedonic well-being (i.e., affect and life satisfaction) and eudaimonic well-being (e.g., self-actualization). Participants are asked to indicate the box (corresponding to a score of 1-5) that best describes their experience of the statement over the past two weeks. A total score (range: 14-70) is attained by summing the responses, with higher scores representing greater subjective well-being.

3.2.5.3 Covariates

3.2.5.3.1 Demographics

Assessed through a single question (e.g., "What is your…"). Age, preferred gender, current program of study, current year of study, degree pursuing, and ethnicity were collected.

3.2.5.3.2 Past 7 days depression

Centre for Epidemiological Studies Depression Scale[20] (CES-D). The CES-D contains 20 statements related to depression. Participants respond to each statement. A total score (range: 0-60) is attained by summing the responses, with higher scores representing greater depressive symptoms.

3.2.5.3.3 State anxiety

State-Trait Anxiety Inventory Form Y-1[21] (STAI Form Y-1). The STAI Form Y-1 contains 20 statements of feelings assessing state anxiety (i.e., anxiety "at this moment"). Participants are asked to self-report on the degree they agree with the statements. A total score (range: 20-80) is attained), with higher scores representing greater symptoms of anxiety.

3.2.5.3.4 Past 7 days physical activity

International Physical Activity Questionnaire – Short Form 7 Days[22] (IPAQ-S7S). Participants estimate how many days in the past week they performed vigorous physical activity, moderate physical activity, and walking, as well as the average time (i.e., hours/day and minutes/day) they spent engaged in these activities. A total weekly activity time for each physical activity intensity was attained.

3.2.6 Procedure

Interested participants followed the link to the online questionnaire, hosted through SoSci Survey[23], which presented the detailed letter of information and online consent. Participants then completed the online questionnaires, beginning with the demographics questionnaire, followed by the comparative sitting questions, modified SIT-Q 7d questionnaire, IPAQ-S7S, PANAS, the SWLS, the WEMBWS, the CES-D, and the STAI Form Y-1. Following the questionnaire participants could follow a link to a separate webpage to enter their email into a draw for one of twenty $30 gift cards.

3.2.7 Statistical Analysis

Analysis was computed using IBM SPSS software (version 25). Domain-specific SB question options were recoded to represent the upper limit (i.e., more sedentary) of that option, in order to signify the most conservative estimate of SB (e.g., '15-30 min' recoded to 0.5 hours), and to account for non-linear intervals between response options.

Bivariate correlations were calculated between SB (i.e., total, comparative, and domain-specific) and outcomes of SWB (i.e., positive/negative affect, life satisfaction, and overall SWB). Significant bivariate relations ($p<0.05$) were further examined using partial correlations controlling for the potential influence of demographic (i.e., age, current year of study), PA (i.e., vigorous, moderate, and light PA), and mental health (i.e., depression, anxiety) variables. Only variables that showed an association with both SB and SWB served as covariates in the partial correlation analyses. Given our large sample size ($n > 40$), tests of normality were not performed.

3.3 Results

3.3.1 Missing data

Of the 1006 total participants who completed the survey, 7 participants were excluded for not meeting inclusion criteria, and 70 participants had incomplete data for some outcome measure. Independent samples t-test revealed no significant differences in demographic characteristics between those who provided incomplete data and those who provided complete data ($p \geq 0.05$). Hence, data were deemed to be missing at random.

Descriptive characteristics of the study sample are shown in *Table 2*. A total sample size of 999 participants completed the survey.

Table 2: Demographic characteristics of the sample (*n* = 999).

	***M* (SD)**
Age	20.58 (2.92)
Year of Study	***n* (%)**
First Year	396 (39.6)
Second Year	271 (27.1)
Third Year	185 (18.5)
Fourth Year or Higher	147 (14.7)
Gender	***n* (%)**
Men	160 (16.3)
Women	821 (83.7)
Other	18 (0.8)
Current Degree Pursuing	***n* (%)**
Undergraduate	872 (87.3)
Masters	83 (8.3)
Doctorate or Professional degree	44 (4.4)
Current Program of Study	***n* (%)**
Arts & Humanities	150 (15.0)
Engineering	70 (7.0)
Health Sciences	254 (25.4)
Information and Media Studies	35 (3.5)
Science	250 (25.0)
Mathematics	13 (1.3)

Social Sciences	97 (9.7)
Business and Finance	94 (9.4)
Other	36 (3.6)
Ethnicity	***n* (%)**
European/Caucasian	499 (49.9)
Canadian	49 (4.9)
Jewish	9 (0.9)
Hispanic	14 (1.4)
Asian	333 (33.3)
Black	15 (1.5)
African	8 (0.8)
Middle Eastern	24 (2.4)
West Indian	3 (0.3)
Indigenous	7 (0.7)
Mixed	30 (3.0)
Missing	8

3.3.2 Bivariate Correlations between SB and Outcomes of SWB

Bivariate correlations between SB and outcomes of SWB are described in *Table 3*. With respect to positive affect (n = 999), small significant correlations were seen between 12 variables, ranging from r = -0.133 to 0.100. Positive correlations were observed in 7 variables: self-compared weekly break frequency (p = 0.005) and duration (p = 0.002), WY leisure reading (p = 0.026), number of screen time breaks (p = 0.025) and break duration (p = 0.014), WD socializing (p = 0.033), other activity break number (p = 0.003). Negative correlations were observed in 5 variables: self-compared weekly sitting levels (p < 0.001), WY napping (p = 0.001), WD TV (p = 0.038), screen time break frequency (p = 0.026), and average weekday hours of sitting (p < 0.001).

With respect to negative affect (n = 999), small significant correlations were seen between 24 variables, ranging from r = -0.096 to 0.177. Positive correlations were observed in 21 variables: self-compared weekly sitting levels (p < 0.001), WY (p = 0.010) and WD napping (p < 0.001), WD breakfast (p = 0.030), WY (p = 0.005) and WD TV (p = 0.005), WY (p < 0.001) and WD computer use (p < 0.001), WY (p = 0.012) and WD video gaming (p = 0.015), WY (p < 0.001) and WD leisure reading (p < 0.001), WY (p < 0.001) and WD chores (p < 0.001), WY (p < 0.001) and WD caregiving (p = 0.000), WY (p < 0.001) and WD hobbies (p < 0.001), WY social (p = 0.011), WY (p < 0.001) and WD music listening (p < 0.001). Negative correlations were observed in 3 variables: self-compared weekly break frequency (p = 0.002) and duration (p = 0.002), and WY sleep duration (p = 0.015).

With respect to life satisfaction (n = 999), small significant correlations were observed between 12 variables, ranging from r = -0.135 to 0.087. Positive correlations were observed in 2 variables: WY sleep duration (p = 0.012), and WD social (p = 0.010). Negative correlations were observed in 10 variables: total transportation (p = 0.005), WY (p = 0.032) and WD TV (p < 0.001), WY (p < 0.001) and WD computer use (p < 0.001), screen time break frequency (p = 0.025), WY (p = 0.005) and WD chores (p = 0.008), WY (p = 0.012) and WD music listening (p = 0.012).

With respect to overall subjective well-being (n = 999), small significant correlations were observed between 15 variables, ranging from r = -0.097 to 0.080. Positive correlations were observed in 7 variables: self-compared weekly break duration (p = 0.023), WY (p = 0.09) and WD sleep duration (p = 0.020), WD social (p = 0.012), screen break number (p = 0.004) and duration (p = 0.025), and other activity break number (p = 0.011). Negative correlations were observed in 8 variables: self-compared weekly sitting (p = 0.012), WD TV (p = 0.033), WY (p = 0.014) and WD computer use (p = 0.002), screen break frequency (p = 0.033), WY (p = 0.002) and WD music listening (p = 0.017), and average weekday hours of sitting (p = 0.012).

Table 3: Correlations between outcomes of subjective well-being, total weekday sitting, self-compared sitting time, and domain-specific sitting time.

Variable	Positive Affect	Negative Affect	LS	SWB
Weekday Hours of Sitting (*n*=775)	-.131**	.056	-.008	-.091*
Self-Compared Sitting Time (*n*=999)				
Weekly Self-Compared Sitting Time	-.133**	.177**	-.004	-.080*
Weekly Self-Compared Break Frequency from Sitting	.088**	-.096**	-.009	.046
Weekly Self-Compared Break Duration from Sitting	.100**	-.097**	-.017	.072*
WY/WD Sleeping and Napping (*n*=999)				

Sleep	.053 / .040	-.080*/ -.009	.087*/ .050	.082** / .074*
Napping	-.108**/ -.053	.082**/ .114**	-.037 / -.032	-.058 / -.045
WY/WD Meals (*n*=999)				
Breakfast	.028/ .056	.026 / .069*	.011 / .014	.025 / .040
Lunch	-.008 / .001	-.006 / .037	-.014 / -.011	.014 / .003
Dinner	-.001 / .038	.013 / .012	-.012 / -.011	.023 / .019
Transportation (*n*=580)				
Total Weekly Transportation	-.038	.030	-.116**	-.065
Occupation				
Total Weekly Student (Occupation) Sitting (*n*=815)	.010	.021	-.012	.019
Weekly Class Time (*n*=836)	-.018	.067	-.050	-.030
Student (Occupation) Break Frequency (*n*=829)	-.034	-.046	-.023	.023
Student (Occupation) Break Duration (*n*=826)	-.023	.068	-.045	-.012
Student (Occupation) Break Number (*n*=823)	.001	.038	.027	.038
Total Weekly Occupation 2 Sitting (*n*=350)	.004	.023	.006	.060
Occupation 2 Break Frequency (*n*=346)	.007	-.016	-.018	.040
Occupation 2 Break Duration (*n*=347)	-.034	.063	.059	.045
Occupation 2 Break Number (*n*=316)	-.084	.082	-.007	-.041
Total Weekly Occupation 3 Sitting (*n*=85)	-.153	.122	-.142	-.114
Occupation 3 Break Frequency	.022	.069	.008	.035

(*n*=83)				
Occupation 3 Break Duration (*n*=84)	.038	-.022	.025	.017
Occupation 3 Break Number (*n*=67)	-232	.223	.193	.086
WY/WD Screen Time (*n*=999)				
TV	-.038 / -.066*	.081*/ .088*	-.068*/ -.111**	-.046 / -.068*
Computer Use	-.037 / -.038	.142**/ .133**	-.118**/ -.135**	-.078*/ -.097**
Video Games	.052 / .026	.080*/ .077*	-.055 / -.053	.022 / .011
Screen Time Break Frequency	-.071*	.056	-.073*	-.067*
Screen Time Break Duration	.078*	-.029	.012	.071*
Screen Time Break Number	.076*	-.033	.007	.092**
WY/WD Other Activities (*n*=999)				
Reading	.071*/ .053	.130*/ .124**	.010 / .000	-.006 / -.024
Chores	.008 / .014	.147**/ .130**	-.089**/ -.084**	-.043 / -.039
Caregiving	.049 / .044	.119**/ .161**	-.020 / -.061	-.005 / -.035
Hobbies	.001 / .024	.125**/ .128**	-.043 / -.050	-.031 / -.036
Social	.055 / .067*	.081*/ .060	.011 / .082**	.031 / .080*
Music Listening	-.028 / -.015	.121**/ .142**	-.079*/ -.079**	-.097**/ -.075*
Miscellaneous	.045 / .039	.030 / .024	.000 / -.013	.037 / .019
Other Activities Break Frequency	-.027	.015	-.015	-.015
Other Activities Break Duration	.014	.015	.035	.016
Other Activities Break Number	.095**	-.007	.053	.080*

*$p<0.05$, **$p<0.01$ (2-tailed).

WY = Weekday, WD = Weekend day, LS = Life Satisfaction, SWB = Subjective Well-Being.

Data with a backslash (*x*/*y*) represent weekday and weekend values, respectively.

3.3.3 Partial Correlations between SB and SWB

Partial correlations between significant correlations SB and outcomes of SWB controlling for mental health and demographics are described in *Table 4*. With respect to positive affect, 3 significant partial correlations were observed, ranging from $r = -0.126$ to 0.120. Specifically, small positive correlations were observed when controlling for depression, anxiety, and total weekly hours of vigorous PA on the relationship between positive affect and: self-compared weekly break duration ($p = 0.027$) and WY leisure reading ($p = 0.001$). A small negative correlation was observed when controlling for vigorous PA and moderate PA on the relationship between positive affect and average weekday sitting ($p = 0.001$).

With respect to negative affect, 8 significant partial correlations were observed, ranging from $r = -0.068$ to 0.108. Specifically, small positive correlations were observed when controlling for depression and anxiety on the relationship between negative affect and: self-compared weekly sitting time ($p = 0.001$), WY computer use ($p = 0.009$), WY leisure reading ($p = 0.006$), WY chores ($p = 0.045$), and WD chores ($p = 0.038$). A small negative and positive correlation was also observed when controlling for just depression on the relationship between negative affect and weekly self-compared break frequency ($p = 0.037$) and WY socializing ($p = 0.017$), respectively.

With respect to life satisfaction, 2 significant partial correlations were observed, ranging from $r = -0.087$ to -0.072. Specifically, small negative correlations were observed when controlling for depression and anxiety on the relationship between life satisfaction and: WY computer use ($p = 0.044$), and WD computer use ($p = 0.013$).

With respect to overall SWB, only 1 significant partial correlation was observed. Specifically, a small positive correlation was observed when controlling for age on the relationship between SWB and screen time break frequency ($p = 0.002$).

Table 4: Partial correlations between outcomes of subjective well-being and time spent sitting in sedentary activities, controlling for mental health, physical activity, and demographics.

Variable	Positive Affect [d, ax, v, m, w]	Negative Affect [d, ax, v, a]	LS [d, ax, v]	SWB [d, ax, v, a]
Self-Compared Weekly Sitting				
Weekly Self-Compared Sitting Time [d, ax, m, w]	-.030 [d, ax, m, w] ($n = 564$, $p = .475$)	.108** [d, ax] ($n = 924$, $p = .001$)		-.057[d, ax] ($n = 924$, $p = .082$)
Weekly Self-Compared Break Frequency from Sitting [d, w]	.006[d, w] ($n = 633$, $p = .872$)	-.068*[d] ($n = 948$, $p = .037$)		
Weekly Self-Compared Break Duration from Sitting [d, ax]	.073*[d, ax] ($n = 924$, $p = .027$)	-.044[d, ax] ($n = 924$, $p = .177$)		.023[d, ax] ($n = 924$, $p = .484$)
Sleeping and Napping				
Sleep WY [d, ax]		-.026[d, ax] ($n = 924$, $p = .421$)	.040[d, ax] ($n = 924$, $p = .218$)	.006[d, ax] ($n = 924$, $p = .847$)
Sleep WD [d, ax]				.035[d, ax] ($n = 924$, $p = .288$)
Napping WY [d, a]	-.060[d] ($n = 948$, $p = .066$)	-.002[d, a] ($n = 924$, $p = .957$)		
Napping WD [d]		.049[d] ($n = 948$, $p = .135$)		
Screen Time				
TV WY [d, v]	.015[d, v] ($n = 845$, $p = .653$)	.001[d, v] ($n = 845$, $p = .980$)	.006[d, v] ($n = 845$, $p = .864$)	
TV WD [d, ax, v]	-.009[d, ax, v] ($n = 822$, $p = .796$)	.022[d, ax, v] ($n = 822$, $p = .525$)	-.062[d, ax, v] ($n = 822$, $p = .079$)	.036[d, ax, v] ($n = 822$, $p = .296$)
Computer Use WY [d, ax, v, m]		.091**[d, ax, v]	-.070*[d, ax, v]	.020[d, ax, v]

		(*n* = 822, *p* = .009)	(*n* = 822, *p* = .044)	(*n* = 822, *p* = .569)
Computer Use WD [d, ax, v]		.063[d, ax, v] (*n* = 822, *p* = .069)	-.087* [d, ax, v] (*n* = 822, *p* = .013)	-.011 [d, ax, v] (*n* = 822, *p* = .745)
Screen Time Break Frequency [d, v, m, w] (D, V, M, W)	-.019[d,v,m,w] (*n* = 563, *p* = .654)		-.032[d, v] (*n* = 845, *p* = .350)	.002[d, v] (*n* = 845, *p* = .943)
Screen Time Break Number (A, G, DT, M, W)				.099**[a] (*n* = 996, *p* = .002)
Other Activities				
Reading WY [d, ax, m]	.120**[d, ax, m] (*n* = 822, *p* = .001)	.090**[d, ax] (*n* = 924, *p* = .006)		
Reading WD [d, ax, m, a]		.074*[d, ax, a] (*n* = 924, *p* = .024)		
Chores WY [d, ax]		.066*[d, ax] (*n* = 924, *p* = .045)	-.035[d, ax] (*n* = 924, *p* = .282)	
Chores WD [d, ax, m]		.068*[d, ax] (*n* = 924, *p* = .038)	-.038[d, ax] (*n* = 924, *p* = .245)	
Caregiving WY [d, a]		.043[d, a] (*n* = 947, *p* = .188)		
Caregiving WD [d, a]		.059[d, a] (*n* = 947, *p* = .070)		
Hobbies WY [d, a]		.048[d, a] (*n* = 947, *p* = .140)		
Hobbies WD [d]		.042[d] (*n* = 948, *p* = .191)		
Social WY [d]		.077*[d] (*n* = 948, *p* = .017)		
Music Listening WY [d, ax, v, a, ys]		.028[d, ax, v, a] (*n* = 821, *p* = .417)	-.004[d, ax, v] (*n* = 822, *p* = 0.916)	.028[d, ax, v, a] (*n* = 821, *p* = 0.421)

Music Listening WD [d, ax, v, a, ys]		.046[d, ax, v, a] (*n* = 821, *p* = .183)	.004[d, ax, v] (*n* = 822, *p* = .902)	.054[d, ax, v, a] (*n* = 821, *p* = .120)
Total Weekly Sitting [v, m]	-.126**[v, m] (*n* = 651, *p* = .001)			-.064[v] (*n* = 716, *p* = .087)

*$p<0.05$, **$p<0.01$ (2-tailed).

Covariates: [d] = Depression, [ax] = Anxiety, [v] = Weekly Vigorous PA, [m] = Weekly Moderate PA, [w] = Weekly Walking, [a] = Age, [ys] = Year of Study.

WY = Weekday, WD = Weekend day, LS = Life Satisfaction, SWB = Subjective Well-Being.

3.4 Discussion

This study explored the presence and nature of relationships that exist between SB outcomes (i.e., self-compared, domain-specific, average weekday) and outcomes of SWB (i.e., affect, life satisfaction, overall SWB). Given that outcomes of SWB can be influenced by virtually all behaviors, it was hypothesized that certain domains of sitting and/or sitting behaviors may uniquely impact these outcomes. Our results indicate the presence of several relationships between domains of SB outcomes and outcomes of SWB. Furthermore, many of these relationships remained significant after accounting for mental health (i.e., anxiety, depression), PA, and demographics. These results expand upon our understanding of the relationship between SB and outcomes of SWB.

Many of the small significant correlations between positive affect and SB outcomes can be explained relatively intuitively. Positive relationships observed between WY leisure reading and WD socializing and positive affect likely reflect the positive affectual nature of these activities. Conversely, negative correlations between WY napping, WD TV, and positive affect suggests that these activities are less affectively rewarding, which is supported by the similarly sized positive correlations between these variables and negative affect. Our observed correlation with average weekday hours of sitting and positive affect is line with the bulk of previous research examining affect and SB, which denotes poorer affective responses predicted by greater sitting time[9,24]. Notably, half of the significant relationships among positive affect encompassed elements of breaks from sitting, suggesting that more frequent and longer breaks from sitting during screen time and other activities may influence positive affect, which is supported by previous acute paradigms[25], and occupational interventions[26].

While some of the relationships with negative affect mirror those found with positive affect, many are unique to negative affect. For example, WY and WD computer use, videogaming, chores, caregiving, hobbies, and music listening were all positively associated with negative affect. All forms of screen time (i.e., TV, computer use, videogaming) were positively associated with negative affect. Associations with computer use (and mobile phone use) may be explained, in part, to device-related anxiety. Being unable to access or engage with a smartphone is linked to feelings of anxiety and distress among university students[27]. Another explanation is that, as university students, engaging in these leisure activities may elicit feelings of guilt, nervousness, or distress when recalled, despite eliciting potential positive affectual responses (e.g., WY/WD videogaming).

Taken together, our work supports the presence of a relationship between affect and SB outcomes. Specifically, there appears to be relationships between positive affect, negative affect, and certain domains of SB, supporting the proposed contextual nature of this relationship[8]. Additionally, our work provides further evidence for the importance of breaks from sitting for positive and negative affect, as compared to previous research primarily examining breaks from sitting from a physiological perspective[28] or productivity viewpoint[29].

Life satisfaction, of all the outcomes of SWB, had fewest small significant associations with outcomes of SB. This is not surprising, since life satisfaction is described as “global cognitive judgements of satisfaction with one’s life”[19] it is reasonably less likely to be influenced by individual behaviors or as frequently as week-to-week (particularly by habitual behaviors like SBs). Only WY sleep duration and WD socializing were positively associated with life satisfaction, further supporting the notion that life satisfaction is a more stable construct than affect, only being associated with largely established influences on SWB[30]. There was no observed relationship between both self-compared sitting and average weekday sitting and life satisfaction. Recent research supports our finding of no association between sedentary time and satisfaction with life[31]. Work by Maher and colleagues offer an explanation for these null findings, suggesting that within-subject differences of daily SB, but not between-subject differences, influence life satisfaction in both university students[31]. This theory is further supported by experimental pilot work by Edwards and Loprinzi; the authors experimentally increased SB for 1-week among university students, after which participants reported a significant decrease in self-reported life satisfaction[10]. Of the negative relationships we observed, most can be explained by the context of the activity. Total time spent sitting in transportation, for instance, is supported by research linking duration of commuting to lower life satisfaction, especially among sedentary modes of commuting[32]. In terms of screen time, negative associations between life satisfaction, computer use and TV mirror previous research examining screen time and life satisfaction. Yan et al., found that only leisure-based screen activities (i.e., TV, social networking sites, and videos) were negatively associated with life satisfaction among Chinese adolescents, but not ‘receiving news’ or ‘study materials’[33]; the authors propose the use of screen-based devices for studying may neutralize their negative effects. Our work supports this hypothesis, since we did not observe any negative (or otherwise) relationships between outcomes of SWB and any occupational SB (e.g., studying, class, etc.), which included screen-based SBs related to their occupation.

The modest relationships between overall SWB and SB outcomes generally followed the trends previously observed for positive affect and life satisfaction. Namely, greater WY/WD sleep duration were positively correlated with overall SWB, while TV, computer use, and average weekday sitting were negatively correlated. Screen watching has been previously explored and results coincide with our findings, in that greater time spent watching screens is associated with lower overall SWB[34]. Further parallels exist with regard to breaks from sitting and overall SWB, reinforcing the potential importance of breaking up sitting time, particularly during leisure activities, for SWB. The similarities in observations between hedonic measures of well-being (i.e., affect and life satisfaction) and overall SWB is not surprising; the WEMWBS instrument is designed to capture both hedonic well-being and eudaimonic well-being[7]. Our observed relationship between average weekday sitting and overall SWB does not align with recent work by Okely and colleagues, which did not find any association between overall SWB and SB[35]. Notably, the authors examined a geriatric population; given overall SWB is considered a measure of societal progress[7], these two distinct age groups should reasonably differ in the activities and behaviors that influence their overall SWB.

With respect to partial correlations, each outcome of SWB exhibited a modest, significant correlation with depression, anxiety, and total weekly vigorous PA. Given how elements of outcomes of SWB and mental health often intersect (e.g., depression and negative affect), the observed associations are expected. Likewise, vigorous PA has demonstrated relationships with life satisfaction and affect[36]. As such, partial correlations between SB outcomes and outcomes of SWB, accounting for mental health and vigorous PA, were attenuated. Nearly 80% of previously significant correlations between SB outcomes and outcomes of SWB were no longer significant, with the majority of these accounting for both depression and anxiety. Of the partial correlations that remained significant, nearly all of them (i.e., 11/14) were related to affect, particularly negative affect. Specifically, correlations with average weekday sitting, self-compared SB measures, computer use, and other activities generally persisted, suggesting that relationships between these SBs and affect cannot be entirely explained by mental health and/or vigorous PA. The persistence of a significant partial correlation between positive affect and average weekday sitting, accounting for vigorous PA, supports work by Elavsky et al.[9], and Zenk et al.[24], which suggests that greater SB may predict lower future positive affect. In addition, the positive partial correlation between negative affect and self-compared weekly sitting, accounting for depression and anxiety, further support the potential role of within-individual differences in SB on negative affect. The lack of partial correlations between more global measures of SWB (i.e., life satisfaction, overall SWB), when accounting for depression and anxiety, may represent the overlap between the salutogenic and pathogenic models of health. As life satisfaction and overall SWB are likely less malleable to change in the short-term – similar to feelings of depression and anxiety – it may be that mental health or life satisfaction/overall SWB mirror the other; improvement(s) in life satisfaction may be more likely to improve symptoms of depression/anxiety than improvements in affect.

Overall, our work holds important implications for future work. The modest partial correlations between outcomes of SWB and SB, accounting for mental health and PA, confirm the related, but distinct models of salutogenic and pathogenic health. Furthermore, the presence of multiple relationships between outcomes of SWB and SB outcomes adds support for the complex, contextual nature of these associations[37]. Intervention work looking to reduce SB should consider which domains of SB they are looking to modify, as specific domains may contribute more positively to outcomes of SWB (e.g., socializing) than others (e.g., screen-time).

Additionally, SB interventions that can leverage the potential boon to SWB that breaks from sitting may provide should be considered[38]. Finally, the presence of unique correlations between WY and WD within the same activities highlights the importance of considering the temporal context of these relationships, in addition to behavioral context.

Our work is not without limitations. Owing to our cross-sectional design, we are unable to determine causal relationships between our outcomes of interest. For example, does engaging in more screen time result in poorer feelings of SWB, or do worsen outcomes of SWB elicit greater screen time? Experimental work manipulating SB, akin to the pilot work by Edwards and Loprinzi[10], is warranted to explicate this relationship further. Likewise the self-report nature of our survey is limited in accurately capturing SB, given adults typically self-report about 2 hours less SB than they capture objectively[39], and university students may report a larger discrepancy[13]. While there is currently no objective instruments (to our knowledge) that can distinguish between domains of SBs, there are devices – such as the ActivPAL4 – which can accurately and reliably capture overall SB[40]. Finally, while our work is the first to examine the relationships between outcomes of SWB and SB while accounting for mental health, PA, and demographics, there are additional measures that may account for variance among these relationships. For example, daily and chronic stress has been shown to be linked to maladaptive health behaviors like physical inactivity[41]. A dedicated measure of eudaimonic well-being (e.g., Subjective Vitality Scale[42]) would also be a valuable to include. Inclusion of these variables can contribute further to our understanding of SB and outcomes of SWB.

In sum, small, significant relationships between SB outcomes and outcomes of SWB are unique, contextual to time and type of activity, and some are distinct from mental health and PA. Self-compared sitting, breaks from sitting, screen time, and other activities are associated with both emotional aspects of SWB (i.e., positive and negative affect) as well as more global, cognitive measures of SWB (i.e., life satisfaction and overall SWB). Some significant partial correlations in average weekday sitting, self-compared sitting, screen-time, and other activities remained after accounting for mental health and PA. Research exploring the causal nature of these relationships experimentally is warranted.

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Chapter 4

4 Study 3 – Assessing the preliminary effectiveness of an acute sedentary behavior reducing intervention on outcomes of subjective well-being – A randomized pilot trial

4.1 Rationale

Sedentary behavior (SB) describes any behavior that is (i) waking, (ii) expends ≤1.5 Metabolic Equivalents (METs), and (iii) is performed in a sitting, lying, or reclining posture. Sedentary behaviors encompass the vast majority of behaviors performed in nearly every domain of daily life; from meals, to commuting, to occupations, and screen time, for instance. Daily levels of SB for Canadian adults average over 9.5 hours per day[1] which conservatively account for nearly 97% of waking time when assuming 8 hours of sleep and 30 minutes of daily physical activity (PA). Time spent sedentary is even higher among populations whose occupation obligates them to sit; university students, for instance, report upwards of 11 hours of SB a day[2].

Given that most individuals spend the bulk of their waking time engaged in SBs, particular focus has been devoted to studies investigating the health consequences of excessive SB. For example, multiple systematic reviews demonstrate a link between chronic excessive SB and heart disease, type 2 diabetes, hypertension, some cancers, and all-cause mortality[3]. Similarly, experimental studies examining the acute effects of prolonged SB demonstrate improved postprandial metabolic outcomes among participants who broke up their sitting with standing or light-intensity walking[4]. Notably, the majority of studies examining SB have examined health through a pathogenic lens, whereby health is defined as the absence of disease/markers of disease[5]. Conversely, relatively fewer studies have examined SB and health through a salutogenic lens, whereby health encompasses "positive health conceptions, such as quality of life, flourishing, and well-being"[6], particularly subjective well-being (SWB).

Subjective well-being, as defined by Diener et al., is "a broad category of phenomena that includes people's emotional responses, domain satisfactions, and global judgements of life satisfaction", which is assessed through outcomes of affect (positive and negative) and life satisfaction[7]. This operationalization of SWB by Diener et al.[7], is considered hedonic well-being, whereby optimal SWB is attained through maximizing happiness[8]. An interfacing conceptualization of SWB is eudaimonic well-being, whereby optimal SWB is attained through fulfillment of purpose and self-realization[8]. While constructs of both hedonic well-being and eudaimonic well-being are correlated, they represent distinct philosophies regarding SWB. As such, holistic conceptualization and assessment of SWB should include outcomes of both hedonic and eudaimonic well-being[8]. While a distinct concept from traditional health outcomes, outcomes of SWB demonstrate medium-to-large sized correlations with objective and subjective health outcomes[9]. With respect to SB specifically, capturing SWB is particularly useful among younger populations for whom the distal health consequences associated with long-term excessive sitting (e.g., chronic disease risk) are less relevant.

Previous works examining the relationship between SWB and SB demonstrate mixed results. Among studies examining affect and SB, some work has found no association[10] while other work suggests greater SB can predict lower positive affect[11]. Similarly, relationships between life satisfaction and SB demonstrate either null[12,13] or weak negative relationships, whereby previous day life satisfaction negatively predicted subsequent self-reported SB[14,15]. Some experimental work has been conducted to explicate the SB and SWB relationship[16–19].

Overall, results from experimental studies suggest that greater SB results in lower positive affect[19], greater negative affect[17,18], and lower life satisfaction[20]. However, all of these studies experimentally increased SB, in that participants in the treatment group were encouraged to sit more and move as little as possible for a period of four days[19] to two weeks[18]. Previous work suggests that within-person changes from one's typical SB (not between-person) are predictive of changes in outcomes of SWB[14,21,22]. Thus, the effect of experimentally decreasing SB on outcomes of SWB may not necessarily mirror the effects of experimentally increasing SB; hence, experimental work aimed at decreasing SB is needed.

Additionally, experimental works examining SB and SWB have not consistently measured SB as is currently defined[23]. For example, Endrighi and colleagues used an ActiGraph accelerometer in order to capture 'sedentary time'[18]; however, since ActiGraph is hip-worn and cannot distinguish between postures, it more accurately captures inactivity than sedentary time.

Similarly, work by Edwards and Loprinzi used a pedometer to capture step count as a proxy measure of inactivity[16,17]. Only Duvivier and colleagues used an inclinometer (e.g., ActivPAL3) in order to objectively capture SB[19]; however, their intervention period was only 4 days, which may not have been long enough to capture changes in as habitual a behavior as SBs. Previous evidence alludes to differences between weekday and weekend SBs among especially sedentary individuals[24], highlighting the need to capture SB for at least a 7-day period.

Issues with previous works are further confounded when considering their lack of measurement of domain-specific SB. Domain-specific SB, or the SB accumulated in different contexts of sitting (e.g., sitting during meals, occupation, screen time, etc.), demonstrate stronger, and often opposite, associations with outcomes of SWB than total SB[25,26]. These domain-specific effects also vary based on certain demographic characteristics, which may not be captured through aggregate data. For example, among older adults, TV watching is positively associated with life satisfaction[25,26]; conversely, these behaviors either demonstrate a negative association[27] or null relationship[28] among adults. Thus, measurement of domain-specific sitting may reveal unique relationships with outcomes of SWB, independent of total sitting.

Overall, previous work has been limited by either cross-sectional design[11,13,28] or solely SB-increasing manipulation, invalid measurement of SB, and lack of delineation between total and domain-specific sitting behaviors. Hence, there is the need for a study that experimentally decreases SB and assesses SB, including objective and domain-specific SB, to evaluate the effect of SB on outcomes of SWB.

Notably, the use of explicit behavioral theory is absent among SB-inducing studies. Work by Glanz and Bishop suggests that interventions that are developed around a theoretical foundation are more effective than atheoretical interventions[29]. With respect to SB, the Health Action Process Approach[30] (HAPA) model for behavior change has shown suitability. Specifically, the HAPA postulates that intentions to perform behaviors do not always elicit said behavior – dubbed the ‘intention-behavior gap’. However, targeting constructs of action planning and coping planning can facilitate the relationship from intention to behavior[30], thus improving the effectiveness of an intervention. The HAPA model has already been successfully applied to a SB-reducing context in university students[31] and office workers[29].

Therefore, a randomized pilot study was conducted to experimentally explore whether an intervention designed to decrease SB will lead to improvements in SWB. Randomized pilot trials, according to the conceptual framework developed by Eldridge and colleagues, are small-scale studies that reflect the design of a future RCT and are conducted to assess whether a larger trial can be done[32]. The main objective of this randomized controlled pilot trial was to determine the preliminary effectiveness of a HAPA-based behavioral intervention to decrease SB among sedentary university students, in order to inform a future randomized controlled trial (RCT). A secondary objective of this pilot study was to explore whether any changes in SB outcomes were related to changes in outcomes of SWB.

4.2 Methods

Trial reporting is guided by the CONSORT 2010 Statement for reporting randomized control trials[33]. A completed CONSORT checklist can be found in *Appendix D.*

4.2.1 Trial Design

A three-week (baseline, intervention, follow-up), single-blinded, parallel-group (equal allocation ratio [1:1]), randomized-controlled trial (RCT) was conducted. No changes to trial protocol, eligibility criteria, or planned statistical analyses were made after trial commencement.

4.2.2 Participants

A convenience sample of university students from the host institution were recruited to participate in this study through posters distributed around university campus, verbal advertisement during lectures, and through online university groups on Facebook. Eligible participants were (a) full-time university students attending the host institution, (b) aged 18 years of age or older, (c) who were able to read and write in English, (d) had access to a computer/smartphone with internet, and (e) objectively reported ≥7 hours of sedentary time per day over the baseline week, via ActivPAL4 inclinometer. Exclusion criteria were (a) part-time enrollment or currently on a leave of absence from full-time studies at university, (b) individuals self-reporting a mental illness, and (c) individuals currently reporting a physical disability that would prevent them from walking.

4.2.3 Setting

The study took place at a mid-sized (~30,000 students) post-secondary institution in Ontario, Canada during the 2019-2020 academic year.

4.2.4 Intervention

4.2.4.1 Treatment

Participants randomly allocated to the intervention group were told they would receive theory-driven behavioral counseling, with the goal of co-developing strategies aimed at (1) decreasing their weekly SB by 1-2 hours (based upon their current SB and how realistic they thought a 1 or 2 hour reduction was), as well as (2) increasing their daily step count to ≥10,000 steps/day, over the next week only. Behavioral counseling was guided by the HAPA[30], which postulates the relationship between intention to perform a behavior and the performance of the behavior/action (i.e., the intention-behavior gap) is mediated by the creation of a specific 'when, where, and how' plan (i.e., action planning) and the planned anticipation of barriers that may arise when enacting said plan (i.e., coping planning). Application of the HAPA model to manipulate SB in this population has been described in previous work[31] .

Upon being told their activity goals, participants were prompted to think about strategies to reduce their SB and increase steps/day, followed by the researcher stating: "strategies that we come up with should be two things: 1. they should be specific, so that you're not thinking about when, where, or how you're going to do them, or who you're going to do them with; and 2. strategies should be realistic *for you,* because if *you* don't find them realistic, you're probably not going to do them". Participants were then asked if they had any strategies that they could immediately think of. Prompts for behavioral strategies were used if the participant could not think of any strategy, and generally revolved around reducing SB in a particular domain of SB (e.g., transportation, occupation, etc.).

Creation of behavioral strategies was guided by the FITT principle[34], adapted to a SB context; where F represented the frequency per week that a strategy would be enacted (e.g., 3-4 times per week [Monday, Wednesday, Friday], every hour of sitting); I represented the intensity/length of time that a strategy be performed for (e.g., 20 minutes, 5 minute break from sitting, 3000 steps); the first T represented the time of day that the behavior will be performed (e.g., 6PM, mornings [8-11], during studying); and the second T represented the type (i.e., modality) of behavior performed (e.g., standing, walking, weightlifting).

Finally, upon creation of a strategy and its FITT specifics, an accompanying coping strategy (or strategies) was prompted via the researcher stating: “With any new strategy that we may try and implement, there are inevitably barriers that would prevent us from enacting the strategy. Can you think of any barriers or reasons that you might not perform this strategy? What could you do or plan for so that you could still perform the strategy, despite these barriers?”. Coping strategies often focused on practical steps, like setting an alarm or reminding a friend to work out together.

Proceeding creation of a complete strategy, participants were asked if they thought the strategy was specific and realistic enough, as a fidelity check. Upon agreement, participants were prompted to think about any other strategies that could help them achieve the SB and step count goals for the next week.

As an example, if a participant suggested that they could break up their sitting while studying, then the researcher would prompt the participant by asking, for instance: “How many days a week do you think you could realistically break up your sitting while studying? Which days specifically?” to assess frequency; “Realistically, how long would a break from studying be?” to assess intensity; “When do you usually study?” to assess time; and “What do you want to be doing during these breaks? Standing? Moving?” to assess type. When prompted for barriers, the participant might mention that they might be too engaged with studying that they would forget to stand/move every hour. Hence, a coping strategy might be to set an alarm at the beginning of a study session to go off every hour. Additionally, if taking a break from studying may be too distracting, then a coping strategy may also involve continuing to study but in a non-sedentary posture, like standing.

Strategies also often included using the native step counter app on their smartphone (e.g., Health on iOS, Google Fit on Google devices) to self-monitor their daily step count. At the end of the session, participants were encouraged to try each strategy at least once, and to try to adjust strategies if unperceived barriers arise. Additionally, participants were advised to place the completed counseling form somewhere where they would regularly see it. On average, participants co-developed 3-4 strategies. Behavioral counseling session typically took 30-45 minutes, and took place face-to-face in the researcher's lab.

4.2.4.2 Control

Participants randomly allocated to the control group received no specific instructions to modify their behavior. If prompted for further instruction, the researcher would encourage the participant to continue their normal behavior.

4.2.5 Outcomes

No changes to trial outcomes were made after the trial commenced.

4.2.5.1 Objectively measured SB/PA.

The ActivPAL4 inclinometer[35] was used to track the objective PA and SB of participants. Recent consensus work surrounding the definition of SB[23] has highlighted the importance of the postural distinction (e.g., standing vs. sitting) and activity threshold of SB (i.e., ≤1.5 METs), as compared to non-SBs (e.g., PA). The ActivPAL devices have demonstrated accuracy in distinguishing and tracking sitting/lying, standing, and movement behaviors[36]; classifying activity intensity categories in healthy adults[37]; and exhibits equivalent or improved performance to previously validated accelerometers[38,39].

A 7-day 24-hour continuous wear protocol was used. The ActivPAL4 was attached to the center of the right thigh, halfway between the superior iliac spine of the hip and the patella. Participants did not take off the device during bathing or water-based activities. Days were based upon start and end wear times of the device, according to the device. A minimum of 6 valid days (i.e., 144 hours) of wear time was required to be included in analysis, based upon weeklong protocols of other activity tracking studies[40,41]. Once data was collected off the device, data were visualized through graphs and scanned for abnormalities (e.g., excessively large volumes or high intensities of activity).

4.2.5.1.1 Average daily steps.

Measured as steps per day.

4.2.5.1.2 Average daily standing time.

Measured as standing minutes per day.

4.2.5.1.3 Average daily stepping time.

Measured as stepping minutes per day. Weighted average daily sleep time was subtracted from the raw stepping time from the inclinometer.

4.2.5.1.4 Average daily sitting time.

Measured as sitting minutes per day. Daily sitting time was calculated as: (((average daily weekday sedentary time*5) + (average weekend sedentary time*2)) / 7) – (((average weekday sleep*5) + (average weekend sleep*2)) / 7).

4.2.5.1.5 Average daily sit-to-stand transitions.

Measured as number of sit-to-stand transitions per day.

4.2.5.2 Self-reported SB.

4.2.5.2.1 Past 7 days self-compared SB.

Assessed through three items on a 5-point Likert scale, with a score of 1 indicating ‘Much less than normal’, 3 indicating ‘About the same’, and 5 indicating ‘Much more than normal’. Self-compared weekly sitting, self-compared weekly break number, and self-compared weekly break duration were assessed through the questions “In the last 7 days, my amount of sitting was…”, “In the last 7 days, my number of breaks from sitting were…”, and “In the last 7 days, my duration of breaks from sitting were…”, respectively.

4.2.5.2.2 Past 7 days domain-specific SB.

Assessed using the modified SIT-Q 7d questionnaire[42]. The original SIT-Q 7d instrument[43] is a self-reported questionnaire that measures time spent sitting in various activities in a number of domains of activity over the past 7 days (i.e., sleep and naps, meals, transportation, screen time, occupation(s), and other activities). Participants estimate their sitting time on either a weekday (WY) or a weekend day (WD). Domain-specific SB question options were recoded to represent the upper limit (i.e., more sedentary) of that option, in order to signify the most conservative estimate of SB (e.g., '15-30 min recoded to 0.5 hours).

For the domain of sleep, participants input, over the past week, what time they went to sleep and what time they woke up, on an average WY and WD, as well as how long they napped on an average WY and WD, with options of 'No daily napping', '1-15 min', '15-30 min', '30-45 min', '45 min – 1 hour' and 'More than 1 hour a day'. An average WY sleep time and WD sleep time was calculated using respective sleep and wake times differences.

For the domain of meals, participants indicated, over the past week, how long they sat for each meal (i.e., breakfast, lunch, dinner) on an average WY and WD, with options of 'None', '1-10 min', '10-20 min', '20-30 min', '30-45 min', '45 min – 1 hour', and 'More than 1 hour a day'.

For the domain of transportation, participants indicated, over the past week, how many days and how much time per day they spent sitting while traveling: to and from occupation(s), as part of occupation(s), and apart from occupation(s). Options for time spent sitting during transportation included: 'None', '1-15 min', '30-45 min', '45 min – 1 hour', '1-1.5 hours', '1.5-2 hours', '2-2.5 hours', '2.5-3 hours', '3-4 hours', '4-5 hours', '5-6 hours', '6-7 hours', and 'More than 7 hours'. A total weekly transportation measure was calculated by summing the products of days and time spent sitting during transportation in each of the questions.

For the domain of occupation, participants indicated, over the past week, whether they had any occupation(s), and if so, how many days and the average time they spent sitting while engaged in that occupation. Options for time spent sitting in an occupation included: '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', and 'More than 8 hours'. If the occupation selected was 'Study', then an additional question asked participants how many hours of class they attended in the last 7 days. A total weekly sitting time for each occupation was calculated by summing the products of days and time spent sitting during said occupation.

For the domain of screen time, participants indicated, over the past week, how long they spent sitting while engaged in each screen time (i.e., watching TV, leisure computer/phone use, videogaming) on an average WY and WD, with options of ‘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’, and ‘More than 7 hours’.

For the domain of other activities, participants indicated, over the past week, how long the spent sitting while engaged in each other activity (i.e., music listening, leisure reading, caregiving, hobbies, socializing, chores, and miscellaneous activities) on an average WY and WD, with options of ‘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’, and ‘More than 7 hours’.

The modified version of the SIT-Q 7d also assesses the number of breaks (e.g., ‘In the last 7 days, on average’, how many times did you interrupt your sitting time while engaged in screen time?’) and break frequency and duration from sitting in the domains of occupation, screen time, and other activities (e.g., ‘In the last 7 days, on average’, how often did you interrupt your sitting time while engaged in screen time?’). Participants estimate break frequency and duration by selecting a range of time that best reflects how frequent/long their breaks during that particular activity, with options of ‘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’, and ‘No interruption’ for break frequency; and options of ‘N/A – no breaks taken’, ‘Less than 30 sec’, ‘30 sec – 1 minute’, ‘1-2 min’, ‘2-3 min’, ‘3-4 min’, ‘4-5 min’, ‘5-10 min’, ‘10-15 min’, ‘15-30 min’, and ‘More than 30 min’.

4.2.5.2.3 Past 7 days total weekday SB

Assessed through a single question on the International Physical Activity Questionnaire – Short Form 7 days[44] (IPAQ-S7S) (i.e., ‘During the last 7 days, how much time did you spend sitting on a weekday?’). Participants were asked to specify both an hour(s) per day and minute(s) per day estimate. A total weekly sitting estimate was calculated by multiplying responses by seven.

4.2.5.3 Outcomes of SWB.

4.2.5.3.1 Past 7 days positive and negative affect

Assessed through the Positive and Negative Affect Schedule[45] (PANAS). The PANAS lists 20 words that describe different emotions and feelings. Participants were asked to indicate the extent to which they felt each emotion/feeling over the last 7 days on a 5-point Likert scale, with 1 indicating ‘very slightly or not at all’ and 5 indicating ‘extremely’. Separate scores (range: 10-50) for positive and negative affect are attained by summing items assessing positive and negative affect, respectively. The PANAS has been shown to be valid and reliable measure of affect in this population[45].

4.2.5.3.2 Life satisfaction

Assessed through the Satisfaction with Life Scale[46] (SWLS). The SWLS lists five statements concerning life satisfaction and asks participants to indicate the degree they agree/disagree with each statement on a 7-point Likert scale, with 1 indicating ‘Strongly disagree’, 4 indicating ‘Neither agree nor disagree’, and 7 indicating ‘Strongly agree’. A total score (range: 7-35) is attained by summing the responses, with higher scores representing higher life satisfaction.

4.2.5.3.3 Eudaimonic well-being

Assessed through the Subjective Vitality Scale[47] (SVS). The SVS consists of 7 statements on a 7-point Likert scale that evaluate subjective vitality (i.e., state of feeling alive and alert). Participants indicate how true they find each statement, ranging from ‘1 - Not at all true’ to ‘7 – Very true’. A shorter, more validated, 6 question version of the SVS[48] developed by Bostic, Rubio, & Hood was used in the present work.

4.2.5.3.4 Overall SWB

Assessed through the Warwick-Edinburgh Mental Well-Being Scale[49] (WEMWBS). The WEMWBS is a 14-item questionnaire containing statements about feelings and thoughts encompassing both hedonic well-being (i.e., affect and life satisfaction) and eudaimonic well-being (e.g,. meaning and self-actualization). Participants are asked to indicate the box (corresponding to a score of 1-5) that best describes their experience of the statement over the past two weeks, with a score of 1 indicating ‘None of the time’ and 5 indicating ‘All of the time’. A total score (range: 14-70) is attained by summing the responses, with higher scores representing greater subjective well-being.

4.2.5.4 Secondary Outcomes

4.2.5.4.1 Demographics

Assessed through a single question (e.g., “What is your…”). Age, preferred gender, current program of study, current year of study, degree pursuing, and ethnicity were collected. Past 7 days physical activity was also assessed using the IPAQ-S7S[44]. The IPAQ-S7S is a self-reported questionnaire that measures the volume and intensity of physical activity a participant has done in the last 7 days. Participants estimate how many days they performed vigorous physical activity, moderate physical activity, and walking, as well as the average time (i.e., hours/day and minutes/day) they spent engaged in these activities. A total weekly activity score for each physical activity intensity was attained through the product of how many days that exercise was performed, and average hours spent in performing said intensity of exercise.

4.2.6 Procedure

Interested participants met with the researcher, who presented the detailed and blinded letter of information and online consent. Participants were aware of a potential behavioural counseling session but were not told at which visit it would be occurring. Eligible and consenting participants then completed the demographics questionnaire and then were fitted with the ActivPAL4 inclinometer. Participants then scheduled their second visit for seven days after the initial meeting. At the beginning of the second visit, the ActivPAL4 was removed and SB levels for inclusion were verified. Participants were asked if they had any issues with the ActivPAL4 device (e.g., wear issues, skin irritation, etc.) when the device was removed during this session (and each subsequent visit). Upon confirmation of eligibility, participants were assigned to either the treatment or control group. Participants then completed the online questionnaires, beginning with the self-compared sitting questions, and followed by the modified SIT-Q 7d questionnaire, IPAQ-S7S, PANAS, the SWLS, the SVS, and the WEMBWS. After the questionnaires, participants in the treatment group received the single behavioral counseling session, while those in the control group received no behavioral instructions. Participants in both groups were then refitted with a new ActivPAL4 device and scheduled their third visit for a week later. During the third visit, the ActivPAL4 device was removed and both groups completed the questionnaires for the second time. Afterwards, a new ActivPAL4 device was refit and participants were given no specific behavioral instructions (treatment group participants were told to “do whatever you want” if the researcher was asked for instructions), and the fourth visit was scheduled for a week in the future. During the fourth visit, ActivPAL4 devices were removed from participants, and all participants completed the questionnaires for the third time. A researcher then debriefed all participants. Participants received a $30 gift card for their participation.

4.2.7 Sample Size Calculation

Due to the pilot nature of the present trial, no formal sample size calculation was used. Rather, the sample size of previous acute length SB studies was used as a guideline for sample size. Hence, a sample size of 30 was deemed appropriate for an initial pilot.

4.2.8 Randomization

Block randomization was used to allocate participants to either intervention or control groups in a 1:1 ratio with a fixed block size of 36 participants (i.e., 18 intervention and 18 control, accounting for a 20% attrition rate). The random number sequence was generated through the list randomizer on RANDOM.org[50]. Allocation was not concealed to the researchers. The same researcher generated the random allocation sequence, enrolled participants, and assigned participants to groups.

4.2.9 Blinding

Participants were blinded to the intervention content and assignment. The study was advertised as a “behavior change study” in recruitment materials, in the letter of information/consent, and in participant correspondence.

4.2.10 Statistical Analysis

Independent-samples *t*-tests were used to compare baseline demographic characteristics and primary outcome variables between groups to determine adequate group randomization.

A series of 2 (treatment vs. control) × 3 (time: visit 2, visit 3, visit 4) repeated measures ANOVAs were used to identify any time by group interaction effects and was accompanied by partial eta squared (η_p^2) and observed power values.

Bivariate correlations were computed for intervention-baseline differences (i.e., visit 3 – visit 2) between SB outcomes and outcomes of SWB to affirm relationships between these outcomes. Specifically, correlations were computed for both residual change and absolute change.

Analysis was computed using IBM SPSS software (version 23). Statistical significance was set at .05.

4.2.11 Data Imputation

A Winsorization technique was applied to the data; data points over the 95th percentile and underneath the 5th percentile in each group were replaced with the value of the 95th percentile and 5th percentile, respectively. Winsorization has demonstrated validity as a method for dealing with outliers[51]. A total of 63 data points (1.00% of possible data points) were imputed this way.

4.3 Results

4.3.1 Missing Data

Two participants who were assessed for eligibility were excluded. One participant was excluded for not meeting the SB inclusion threshold (i.e., reported <7 hours/day of SB), while the other participant chose not to participate citing the time commitment. Participants were considered to have “dropped out” if they did not complete the second or third visit of the study. Only one participant dropped out from the study, from the control arm, citing that they did not want to wear the device as it was becoming itchy and uncomfortable. Hence a total of 31 participants were included in data analysis; all 31 participants were included in primary and post-hoc analyses. Flow of participants and dropouts is shown in *Figure 3*.

CONSORT
TRANSPARENT REPORTING of TRIALS

CONSORT 2010 Flow Diagram

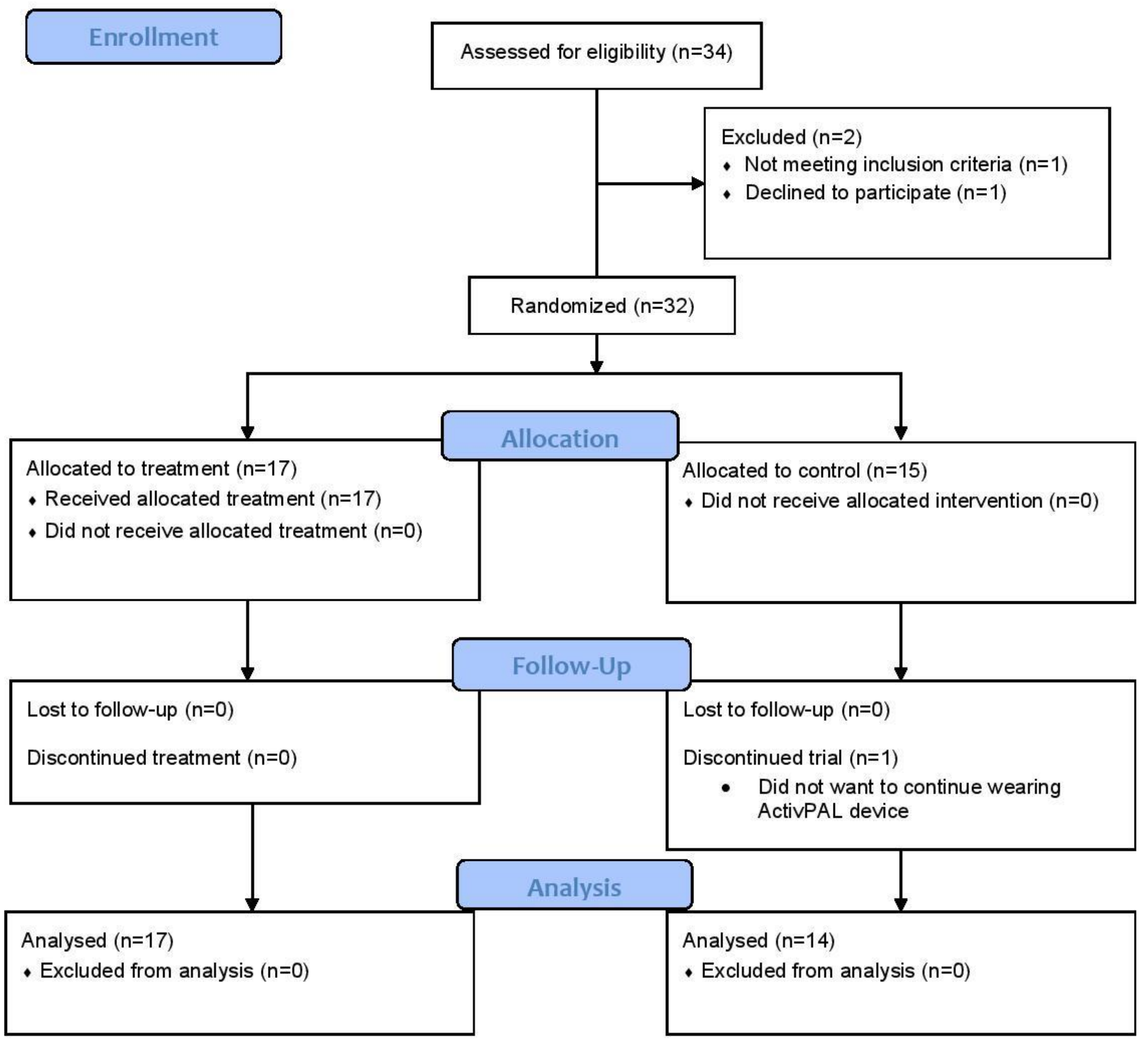

Figure 3: CONSORT flow of participants diagram.

4.3.2 Recruitment

Participants were recruited during the Fall 2019 and Winter 2020 academic terms at the host institution (i.e., September 2019 to February 2020). The study was stopped after planned sample size of completed participants was reached (i.e., 30). Notably the final two participants finished the study on the same day; hence, 31 participants included for analysis.

4.3.3 Group Equivalency

Sample characteristics are presented in *Table 5.* Significant group differences at baseline were observed for average daily steps, average daily stepping time, WY sleep time, and WY napping, whereby the treatment group reported significantly higher in all outcomes (*p*s > 0.05). No other significant differences between groups at baseline were found.

Table 5: Demographic characteristics. (n=31)

	M (SD)
Age	19.45 (2.68)
Gender	*n* (%)
Men	12 (38.7)
Women	19 (61.3)
Year of Study	*n* (%)
First Year	13 (41.9)
Second Year	11 (35.5)
Third Year	2 (6.5)
Fourth Year or Higher	4 (12.9)
Missing	1 (3.2)
Current Degree Pursuing	*n* (%)
Undergraduate	30 (96.8)
Doctorate or Professional degree	1 (3.2)
Current Program of Study	*n* (%)
Engineering	2 (6.5)
Health Sciences	19 (61.3)
Information and Media Studies	2 (6.5)

Science	5 (16.1)
Social Sciences	2 (6.5)
Business and Finance	1 (3.2)
Ethnicity	*n* (%)
European/Caucasian	7 (22.6)
Canadian	2 (6.5)
Hispanic	1 (3.2)
Asian	14 (45.2)
Black	3 (9.7)
Physical Activity (hours per week)	*M* (SD)
Walking (*n* = 26)	4.93 (4.12)
Moderate intensity (*n* = 30)	0.90 (1.33)
Vigorous intensity	2.35 (2.79)

4.3.4 Descriptive Data

Descriptive data for objectively-measured SB outcomes is presented in *Table 6*. Descriptive data for self-compared SB, average weekday sitting, and domain-specific SB are presented in *Table 7*. Descriptive data for outcomes of SWB are presented in *Table 8*.

Table 6: Means, standard deviations, and 95% confidence intervals for objectively-measured sedentary behaviors throughout the study.

	Treatment (*n* = 17)			Control (*n* = 14)		
Time	*Mean*	*SD*	*95% CI*	*Mean*	*SD*	*95% CI*
Average Daily Steps (steps/day)						
Baseline	9252.54	1925.78	[8262.40, 10242.78]	7328.67	2325.12	[5986.18, 8671.15]
Intervention	11028.20	2836.38	[9569.87, 12486.53]	8485.20	3020.25	[6741.36, 10229.05]
Follow-up	9689.50	2714.05	[8294.06, 11084.93]	7478.33	2969.84	[5763.59, 9193.06]
Average Daily Standing Time (minutes/day)						
Baseline	188.74	47.03	[164.56, 212.92]	189.06	62.63	[152.90, 225.22]
Intervention	192.32	41.25	[171.12, 213.53]	190.55	60.23	[155.77, 225.32]

Follow-up	189.81	53.64	[162.23, 217.39]	216.70	72.45	[174.87, 258.53]
Average Daily Stepping Time (minutes/day)						
Baseline	108.75	24.42	[96.20, 121.31]	85.53	22.48	[72.55, 98.51]
Intervention	125.31	33.79	[107.93, 142.68]	96.50	30.70	[78.78, 114.23]
Follow-up	112.54	31.35	[96.42, 128.66]	89.00	31.91	[70.58, 107.42]
Average Daily Sitting Time (minutes/day)						
Baseline	660.11	80.26	[618.84, 701.37]	731.20	92.96	[677.52, 784.87]
Intervention	655.57	83.80	[612.48, 698.66]	722.96	105.47	[662.06, 783.86]
Follow-up	651.36	81.78	[609.31, 693.41]	707.85	71.69	[666.46, 749.24]
Average Daily Sit-to-Stand Transitions (number/day)						
Baseline	50.31	14.20	[43.01, 57.61]	44.79	13.87	[36.78, 52.80]
Intervention	48.84	11.99	[42.67, 55.00]	43.22	12.56	[35.97, 50.48]
Follow-up	49.43	11.99	[43.26, 55.59]	45.04	13.80	[37.07, 53.01]

Bold text indicates significant differences between groups at baseline ($p < 0.05$)

Table 7: Means, standard deviations, and 95% confidence intervals for self-compared, average weekday, and domain-specific self-reported sedentary behaviors throughout the study.

	Treatment (n = 17)			Control (n = 14)		
Time	*Mean*	*SD*	*95% CI*	*Mean*	*SD*	*95% CI*
Self-Compared Weekly Sitting						
Baseline	3.47	0.62	[3.15, 3.79]	3.29	0.91	[2.76, 3.81]
Intervention	2.82	1.13	[2.24, 3.41]	3.50	0.76	[3.06, 3.94]
Follow-up	3.18	0.81	[2.76, 3.59]	3.21	1.12	[2.57, 3.86]
Self-Compared Weekly Break Frequency						
Baseline	2.94	0.83	[2.52, 3.37]	2.79	0.70	[2.38, 3.19]

Intervention		3.89	0.34	[3.72, 4.07]	2.86	1.03	[2.26, 3.45]
Follow-up		3.29	0.77	[2.90, 3.69]	2.64	0.63	[2.28, 3.01]
Self-Compared Break Duration							
Baseline		3.08	0.60	[2.77, 3.39]	2.93	0.47	[2.67, 3.20]
Intervention		3.71	0.59	[3.40, 4.01]	2.71	0.91	[2.19, 3.24]
Follow-up		3.29	0.59	[2.99, 3.60]	2.93	0.47	[2.66, 3.20]
Average Weekday Sitting Time (hours/day)							
Baseline† ¶		8.39	2.97	[6.81, 9.97]	7.42	1.79	[6.28, 8.56]
Intervention‡ ¶		7.83	2.54	[6.42, 9.24]	8.46	2.44	[6.91, 10.01]
Follow-up‡ ¶		7.25	2.30	[5.97, 8.53]	8.17	2.68	[6.46, 9.87]
Average WY/WD Sleep (hours/day)							
Baseline	***WY***	7.77	0.82	[7.35, 8.20]	7.05	1.10	[6.42, 7.67]
	WD	8.50	1.16	[7.90, 9.10]	7.46	1.25	[6.74, 8.18]
Intervention	*WY*	7.71	1.00	[7.20, 8.23]	6.15	1.33	[6.15, 7.69]
	WD	8.35	0.91	[7.88, 8.82]	7.86	0.91	[7.33, 8.38]
Follow-up	*WY*	7.85	1.05	[7.31, 8.39]	6.85	1.00	[6.27, 7.43]
	WD	8.63	0.94	[8.15, 9.12]	7.82	1.35	[7.04, 8.60]
Average WY/WD Napping (hours/day)							
Baseline	***WY***	0.25	0.35	[0.07, 0.43]	0.64	0.52	[0.34, 0.94]
	WD	0.19	0.35	[0.02, 0.38]	0.05	0.14	[-0.03, 0.14]
Intervention	*WY*	0.32	0.49	[0.07, 0.58]	0.46	0.57	[0.13, 0.79]
	WD	0.25	0.45	[0.02, 0.48]	0.38	0.59	[0.03, 0.72]
Follow-up	*WY*	0.18	0.28	[0.03, 0.32]	0.30	0.46	[0.04, 0.57]
	WD	0.26	.42	[0.04, 0.47]	0.32	0.51	[0.02, 0.62]
Meals: Average WY/WD Time Spent Sitting During Breakfast (hours/day)							
Baseline	*WY*	0.21	0.17	[0.12, 0.29]	0.27	0.17	[0.17, 0.37]
	WD	0.34	0.12	[0.28, 0.41]	0.34	0.27	[0.18, 0.49]

Intervention	*WY*	0.17	0.12	[0.11, 0.23]	0.27	0.25	[0.13, 0.42]
	WD	0.25	0.14	[0.17, 0.32]	0.29	0.20	[0.17, 0.40]
Follow-up	*WY*	0.21	0.16	[0.12, 0.29]	0.26	0.30	[0.08, 0.43]
	WD	0.25	0.17	[0.17, 0.34]	0.31	0.26	[0.16, 0.46]
Meals: Average WY/WD Time Spent Sitting During Lunch (hours/day)							
Baseline	*WY*	0.43	0.17	[0.35, 0.52]	0.50	0.28	[0.34, 0.66]
	WD	0.48	0.23	[0.36, 0.59]	0.52	0.30	[0.34, 0.69]
Intervention	*WY*	0.36	0.17	[0.27, 0.44]	0.40	0.18	[0.30, 0.51]
	WD	0.45	0.18	[0.35, 0.54]	0.48	0.31	[0.29, 0.66]
Follow-up	*WY*	0.35	0.11	[0.30, 0.41]	0.44	0.25	[0.30, 0.58]
	WD	0.41	0.14	[0.34, 0.48]	0.45	0.34	[0.26, 0.65]
Meals: Average WY/WD Time Spent Sitting During Dinner (hours/day)							
Baseline	*WY*	0.47	0.22	[0.36, 0.59]	0.61	0.37	[0.39, 0.82]
	WD	0.50	0.22	[0.39, 0.62]	0.70	0.39	[0.47, 0.92]
Intervention	*WY*	0.41	0.23	[0.29, 0.52]	0.65	0.49	[0.36, 0.93]
	WD	0.53	0.25	[0.41, 0.66]	0.71	0.39	[0.48, 0.94]
Follow-up	*WY*	0.45	0.14	[0.38, 0.52]	0.57	0.44	[0.32, 0.83]
	WD	0.51	0.21	[0.34, 0.62]	0.64	0.43	[0.39, 0.89]
Transportation: Average Weekly Time Spent Sitting During Transportation (hours/week)							
Baseline		8.93	8.58	[4.51, 13.34]	5.30	3.66	[3.19, 7.42]
Intervention		4.94	6.62	[1.54, 8.35]	6.98	7.29	[2.77, 11.12]
Follow-up		4.43	5.51	[1.59, 7.26]	4.46	3.54	[2.42, 6.51]
Occupation: Average Weekly Time Spent Sitting During Class (hours/week)							
Baseline†		14.75	3.59	[12.84, 16.66]	12.00	5.28	[8.95, 15.05]
Intervention†		15.63	4.73	[13.10, 18.15]	12.00	4.93	[9.15, 14.85]
Follow-up‡		14.73	4.86	[12.04, 17.42]	11.29	6.71	[7.41, 15.16]
Occupation: Average Weekly Time Spent Sitting as a Student (hours/day)							

Baseline†		5.69	1.89	[4.68, 6.69]	4.79	2.22	[3.50, 6.07]
Intervention†		5.19	1.60	[4.33, 6.04]	4.86	2.14	[3.62, 6.09]
Follow-up†		5.00	2.03	[3.92, 6.08]	4.86	1.88	[3.77, 5.94]
Occupation: Average Number of Breaks from Sitting as a Student (number)							
Baseline†		7.63	5.98	[4.44, 10.81]	6.54	7.07	[2.45, 10.62]
Intervention‡		5.27	3.63	[3.25, 7.28]	4.50	3.52	[2.47, 6.54]
Follow-up†		6.13	4.00	[4.00, 8.26]	5.86	5.65	[2.59, 9.12]
Occupation: Average Break Frequency from Sitting as a Student (every *x* hours)							
Baseline†		0.92	0.37	[0.72, 1.12]	0.98	0.42	[0.74, 1.22]
Intervention†		1.44	1.80	[0.48, 2.40]	1.48	1.08	[0.86, 2.10]
Follow-up† ◊		0.94	0.58	[0.63, 1.25]	1.72	1.64	[0.73, 2.71]
Occupation: Average Break Duration from Sitting as a Student (minutes)							
Baseline†		10.31	6.61	[6.79, 13.84]	9.21	7.47	[4.90, 13.53]
Intervention†		8.19	5.59	[5.21, 11.17]	8.86	9.97	[3.10, 14.61]
Follow-up†		5.94	3.96	[3.83, 8.05]	5.96	5.98	[2.51, 9.42]
Screen Time: Average WY/WD Time Spent Sitting While Watching TV (hours/day)							
Baseline	*WY*	2.12	1.43	[1.38, 2.85]	3.04	2.06	[1.85, 4.23]
	WD	2.38	1.41	[1.66, 3.11]	3.29	1.86	[2.21, 4.36]
Intervention	*WY*	1.75	1.04	[1.22, 2.28]	2.32	1.73	[1.32, 3.32]
	WD	2.25	1.28	[1.56, 2.91]	2.50	2.30	[1.17, 3.83]
Follow-up	*WY*	1.69	0.99	[1.18, 2.20]	1.61	1.11	[0.97, 2.25]
	WD	2.31	1.29	[1.65, 2.97]	1.89	1.24	[1.18, 2.61]
Screen Time: Average WY/WD Time Spent Sitting While Using A Computer/Smartphone (hours/day)							
Baseline	*WY*	2.50	1.32	[1.82, 3.18]	3.07	1.49	[2.21, 3.93]
	WD	3.06	1.68	[2.12, 3.92]	3.21	1.97	[2.08, 4.35]
Intervention	*WY*	2.07	1.40	[1.35, 2.80]	2.32	1.32	[1.56, 3.09]
	WD	2.41	1.45	[1.67, 3.16]	2.75	1.97	[1.62, 3.89]

Follow-up	*WY*	1.91	1.00	[1.40, 2.43]	2.68	1.32	[1.91, 3.44]
	WD	2.12	1.31	[1.45, 2.79]	2.46	1.39	[1.66, 3.27]
Screen Time: Average WY/WD Time Spent Sitting While Playing Video Games (hours/day)							
Baseline	*WY*	0.26	0.73	[-0.12, 0.62]	0.12	0.29	[-0.60, 0.27]
	WD	0.40	1.14	[-0.19, 0.99]	0.04	0.13	[-0.04, 0.11]
Intervention	*WY*	0.00	0.00	[0.00, 0.00]	0.05	0.12	[-0.02, 0.11]
	WD	0.04	0.11	[-0.02, 0.96]	0.05	0.17	[-0.05, 0.14]
Follow-up	*WY*	0.00	0.00	[0.00, 0.00]	0.18	0.54	[-0.13, 0.49]
	WD	0.00	0.00	[0.00, 0.00]	0.07	0.27	[-0.08, 0.23]
Screen Time: Average Number of Breaks from Sitting During Screen Time (number)							
Baseline		7.18	6.98	[3.59, 10.76]	6.00	7.41	[1.72, 10.28]
Intervention		4.97	2.90	[3.47, 6.46]	5.79	4.84	[2.99, 8.58]
Follow-up		6.00	3.37	[4.27, 7.73]	5.43	5.36	[2.33, 8.52]
Screen Time: Average Break Frequency from Sitting During Screen Time (every *x* hours)							
Baseline		1.41	0.59	[1.12, 1.72]	1.36	1.01	[0.78, 1.94]
Intervention†		1.03	0.50	[0.77, 1.30]	1.50	1.30	[0.75, 2.25]
Follow-up		1.00	0.31	[0.84, 1.16]	1.12	0.86	[0.61, 1.60]
Screen Time: Average Break Duration from Sitting During Screen Time (minutes)							
Baseline		8.41	8.57	[4.00, 12.82]	9.71	11.83	[2.88, 16.55]
Intervention		5.35	3.79	[3.40, 7.30]	12.64	20.29	[0.93, 24.36]
Follow-up		4.41	2.90	[2.92, 5.90]	6.57	7.88	[2.02, 11.12]
Other Activities: Average WY/WD Time Spent Sitting While Leisure Reading (hours/day)							
Baseline	*WY*	0.53	0.98	[0.02, 1.04]	0.46	0.59	[0.13, 0.80]
	WD	0.45	0.72	[0.08, 0.82]	0.32	0.41	[0.09, 0.56]
Intervention	*WY*	0.87	1.38	[0.16, 1.58]	0.63	1.05	[0.02, 1.23]
	WD	0.78	1.16	[0.18, 1.38]	0.63	1.14	[-0.03, 1.28]
Follow-up	*WY*	0.53	1.02	[0.00, 1.05]	0.68	1.27	[-0.05, 1.41]

	WD	0.41	0.75	[0.02, 0.79]	0.98	1.61	[0.05, 1.91]
Other Activities: Average WY/WD Time Spent Sitting While Doing Chores (hours/day)							
Baseline	*WY*	0.22	0.49	[-0.03, 0.47]	0.48	0.79	[0.02, 0.93]
	WD	0.35	0.72	[-0.02, 0.72]	0.34	0.59	[-0.03, 0.68]
Intervention	*WY*	0.13	0.18	[0.04, 0.23]	0.25	0.57	[-0.08, 0.58]
	WD	0.12	0.18	[0.03, 0.21]	0.23	0.46	[-0.04, 0.50]
Follow-up	*WY*	0.13	0.27	[-0.01, 0.27]	0.06	0.18	[-0.04, 0.16]
	WD	0.17	0.37	[-0.02, 0.37]	0.08	0.18	[-0.02, 0.19]
Other Activities: Average WY/WD Time Spent Sitting While Caregiving (hours/day)							
Baseline	*WY*	0.00	0.00	[0.00, 0.00]	0.04	0.09	[-0.02, 0.09]
	WD	0.00	0.00	[0.00, 0.00]	0.06	0.16	[-0.03, 0.15]
Intervention	*WY*	0.00	0.00	[0.00, 0.00]	0.00	0.00	[0.00, 0.00]
	WD	0.00	0.00	[0.00, 0.00]	0.12	0.40	[-0.12, 0.34]
Follow-up	*WY*	0.00	0.00	[0.00, 0.00]	0.05	0.12	[-0.02, 0.11]
	WD	0.00	0.00	[0.00, 0.00]	0.07	0.27	[-0.08, 0.23]
Other Activities: Average WY/WD Time Spent Sitting During Hobbies (hours/day)							
Baseline	*WY*	0.66	0.64	[0.33, 0.99]	0.50	0.58	[0.17, 0.84]
	WD	0.96	0.85	[0.52, 1.39]	0.48	0.71	[0.07, 0.89]
Intervention	*WY*	0.66	0.68	[0.31, 1.01]	0.23	0.46	[-0.04, 0.50]
	WD	0.77	0.85	[0.33, 1.20]	0.16	0.36	[-0.05, 0.37]
Follow-up	*WY*	0.37	0.54	[0.09, 0.65]	0.32	0.61	[-0.03, 0.67]
	WD	0.53	0.78	[0.13, 0.93]	0.39	0.74	[-0.03, 0.82]
Other Activities: Average WY/WD Time Spent Sitting While Socializing (hours/day)							
Baseline	*WY*	1.44	1.07	[0.89, 1.99]	1.66	1.62	[0.73, 2.59]
	WD	1.91	1.23	[1.28, 2.54]	2.52	2.15	[1.27, 3.76]
Intervention	*WY*	1.35	0.77	[0.96, 1.75]	1.04	0.99	[0.46, 1.61]
	WD	1.94	1.14	[1.35, 2.53]	1.71	1.90	[0.62, 2.81]
Follow-up	*WY*	1.29	0.64	[0.97, 1.62]	1.73	1.18	[1.05, 2.41]

	WD	1.52	1.22	[0.89, 2.14]	1.64	1.55	[0.75, 2.54]
Other Activities: Average WY/WD Time Spent Sitting While Listening to Music (hours/day)							
Baseline	*WY*	0.89	1.31	[0.22, 1.57]	0.88	1.38	[0.08, 1.67]
	WD	0.79	1.04	[0.26, 1.33]	0.75	1.23	[0.04, 1.46]
Intervention	*WY*	0.52	0.68	[0.17, 0.86]	0.52	0.79	[0.06, 0.98]
	WD	0.59	0.75	[0.20, 0.98]	0.64	0.98	[0.08, 1.21]
Follow-up	*WY*	0.44	0.53	[0.17, 0.71]	0.43	0.82	[-0.05, 0.90]
	WD	0.50	0.75	[0.11, 0.87]	0.45	0.82	[-0.02, 0.92]
Other Activities: Average WY/WD Time Spent Sitting During Other Activities (hours/day)							
Baseline	*WY*	0.19	0.35	[0.01, 0.37]	0.04	0.13	[-0.04, 0.11]
	WD	0.13	0.33	[-0.04, 0.30]	0.10	0.37	[-0.12, 0.32]
Intervention	*WY*	0.02	0.06	[-0.02, 0.05]	0.30	0.72	[-0.11, 0.72]
	WD	0.02	0.06	[-0.02, 0.05]	0.07	0.27	[-0.08, 0.23]
Follow-up	*WY*	0.23	0.48	[-0.02, 0.48]	0.12	0.30	[-0.06, 0.29]
	WD	0.30	0.55	[0.02, 0.58]	0.21	0.70	[-0.20, 0.61]
Other Activities: Average Number of Breaks from Sitting During Other Activities (number)							
Baseline		4.24	5.67	[1.32, 7.15]	4.43	7.73	[-0.04, 8.89]
Intervention		2.24	5.06	[-0.36, 4.84]	3.21	3.21	[1.36, 5.07]
Follow-up		3.49	7.33	[-0.28, 7.26]	1.21	2.46	[-0.20, 2.63]
Other Activities: Average Break Frequency from Sitting During Other Activities (every *x* hours)							
Baseline[‡ ¤]		0.77	0.73	[0.36, 1.17]	1.54	2.16	[0.17, 2.91]
Intervention[¶ ◊]		0.96	1.12	[0.20, 1.72]	2.04	1.94	[0.87, 3.21]
Follow-up[§ ≠]		1.23	0.61	[0.82, 1.64]	2.69	2.33	[0.74, 4.64]
Other Activities: Average Break Duration from Sitting During Other Activities (minutes)							
Baseline		8.32	14.24	[1.00, 15.65]	2.93	3.50	[0.91, 4.95]
Intervention		3.21	4.06	[1.12, 5.29]	8.29	16.70	[-1.36, 17.93]
Follow-up		5.47	14.17	[-1.82, 12.77]	2.71	4.53	[0.10, 5.33]

Bold text indicates significant differences between groups at baseline ($p < 0.05$)

† = Treatment group (n = 16), ‡ = Treatment group (n = 15), ¶ = Treatment group (n = 12), § = Treatment group (n = 11), ◊ = Control group (n = 13), ¤ = Control group (n = 12), ≁ = Control group (n = 8)

Table 8: Means, standard deviations, and 95% confidence intervals for outcomes of subjective well-being throughout the study.

	Treatment (n = 17)			Control (n = 14)		
Time	*Mean*	*SD*	*95% CI*	*Mean*	*SD*	*95% CI*
			Positive Affect			
Baseline	31.29	6.33	[28.04, 34.55]	30.86	7.48	[26.54, 35.18]
Intervention	32.47	6.25	[29.26, 35.68]	27.93	8.48	[23.03, 32.83]
Follow-up	32.06	7.08	[28.42, 35.70]	30.86	8.151	[26.15, 35.56]
			Negative Affect			
Baseline	20.76	8.36	[16.47, 25.06]	23.00	7.17	[18.86, 27.14]
Intervention	19.76	5.99	[16.69, 22.84]	20.79	6.85	[16.83, 24.74]
Follow-up	18.29	8.53	[13.91, 22.68]	19.79	7.08	[15.70, 23.88]
			Life Satisfaction			
Baseline	23.88	6.78	[20.40, 27.37]	22.36	6.88	[18.39, 26.33]
Intervention	24.76	6.95	[21.19, 28.34]	21.21	7.45	[16.91, 25.52]
Follow-up	24.59	7.91	[20.52, 28.66]	21.36	7.21	[17.20, 25.52]
			Subjective Vitality			
Baseline	26.18	7.70	[22.22, 30.14]	24.14	5.46	[20.99, 27.30]
Intervention	27.24	6.24	[24.03, 30.44]	22.93	8.67	[17.92, 27.93]
Follow-up	27.71	6.76	[24.23, 31.18]	25.50	6.81	[21.57, 29.43]
			Overall Subjective Well-Being			
Baseline	48.47	8.02	[44.34, 52.60]	48.00	8.49	[43.10, 52.90]

Intervention	50.76	7.60	[46.86, 54.67]	44.29	13.46	[36.51, 52.06]
Follow-up	50.82	7.73	[46.85, 54.80]	47.21	10.45	[41.18, 53.25]

Bold text indicates significant differences between groups at baseline ($p < 0.05$)

4.3.5 Interaction Effects and Main Effects

4.3.5.1 Objectively-Measured Sedentary Behavior

Interaction effects and main effects for objectively-measured SB outcomes are presented in *Table 9*.

4.3.5.1.1 Average daily steps.

No significant interaction effect was observed for average daily steps ($p > 0.05$). A significant main effect of time was observed ($p \leq 0.05$), indicating both groups increased their step count from baseline to intervention and then decreased their step count to baseline levels at follow-up. A secondary repeated-measures ANOVA accounting for baseline differences as a covariate indicated similar results.

4.3.5.1.2 Average daily standing time.

No significant interaction effect or main effect of time was observed for average daily standing time ($p > 0.05$). However, a medium-sized interaction effect was trending in favor of the treatment group ($\eta_p^2 = 0.161$, $p = 0.085$), whereby the treatment group stood for more minutes/week.

4.3.5.1.3 Average daily stepping time.

No significant interaction effect was observed for average daily stepping time ($p > 0.05$). A significant main effect of time was observed ($p \leq 0.05$), indicating both groups increased their stepping time from baseline to intervention and then decreased their stepping time to baseline levels at follow-up. A secondary repeated-measures ANOVA accounting for baseline differences as a covariate indicated similar results.

4.3.5.1.4 Average daily sitting time

No significant interaction effect or main effect of time was observed for average daily sitting time ($p \leq 0.05$).

4.3.5.1.5 Average daily sit-to-stand transitions

No significant interaction effect or main effect of time was observed for average daily sit-to-stand transitions ($p \leq 0.05$).

4.3.5.1.6 Self-Compared Sedentary Behavior

Interaction effects and main effects for self-compared SB outcomes are presented in *Table 10*.

4.3.5.1.7 Self-compared weekly sitting

No significant interaction effect or main effect of time was observed for self-compared weekly sitting ($p > 0.05$).

4.3.5.1.8 Self-compared weekly break frequency

No significant interaction effect was observed for self-compared weekly break frequency. However, a medium-sized interaction effect was trending in favor of the treatment group ($\eta_p^2 = 0.166$, $p = 0.083$), whereby the treatment group perceived themselves taking more breaks than typical, as compared to the control group. A significant main effect of time was observed ($p \leq 0.05$), indicating both groups perceived themselves taking more breaks from sitting than typical from baseline to intervention and then perceived a decrease in their breaks from sitting at follow-up.

4.3.5.1.9 Self-compared weekly break duration

No significant interaction effect or main effect of time was observed for self-compared weekly sitting ($p > 0.05$). However, a medium-sized interaction effect was trending in favor of the treatment group ($\eta_p^2 = 0.183$, $p = 0.059$), whereby the treatment group perceived themselves taking longer breaks than typical, as compared to the control group.

4.3.5.2 Average Weekday Sitting

Interaction effects and main effects for average weekday sitting are presented in *Table 10*. No significant interaction effect or main effect of time was observed for average weekday sitting ($p > 0.05$).

4.3.5.3 Domain-Specific Sedentary Behavior

Interaction effects and main effects for domain-specific SB are presented in *Table 9*.

4.3.5.3.1 WY/WD sleep

No significant interaction effect or main effect of time was observed for WY sleep or WD sleep time (ps > 0.05). A secondary repeated-measures ANOVA accounting for baseline differences for WY sleep revealed a significant interaction effect ($F(1,28) = 5.125$, $p = 0.031$, Wilk's $\Lambda = 0.85$, $\eta_p^2 = 0.155$, $1 - \beta = 0.590$), indicating a significant difference between groups whereby the treatment group increased their sleep time from intervention to follow-up. No interaction effect was seen for WD sleep when accounting for baseline differences.

4.3.5.3.2 WY/WD napping

No significant interaction effect was observed for WY or WD napping (ps > 0.05). However, a medium-sized interaction effect for WY napping was trending in favor of the control group ($\eta_p^2 = 0.183$, $p = 0.059$), whereby the control group reported more WY napping than the treatment group. A significant main effect of time was also observed for both WY and WD napping (ps ≤ 0.05), indicating both groups reported higher WY napping and less WD napping at baseline, then reported a decrease in their WY napping and higher WD napping at follow-up. A secondary repeated-measures ANOVA accounting for baseline differences in WY napping as a covariate indicated similar results.

4.3.5.3.3 WY/WD breakfast

No significant interaction effect or main effect of time was observed for WY breakfast or WD breakfast (ps > 0.05).

4.3.5.3.4 WY/WD lunch

No significant interaction effect was observed for WY lunch or WD lunch (*p*s > 0.05). A significant main effect of time was observed for WY lunch ($p \leq 0.05$), indicating both groups decreased the time sitting while eating lunch from baseline to intervention.

4.3.5.3.5 WY/WD dinner

No significant interaction effect or main effect of time was observed for WY dinner or WD dinner (*p*s > 0.05).

4.3.5.3.6 Total transportation

No significant interaction effect was observed for WY lunch or WD lunch ($p > 0.05$). A significant main effect of time was observed for total transportation ($p \leq 0.05$), indicating both groups decreased the time sitting during transportation from intervention to follow-up.

4.3.5.3.7 Total weekly class

No significant interaction effect or main effect of time was observed for total weekly class ($p > 0.05$).

4.3.5.3.8 Average daily time spent sitting as a student

No significant interaction effect or main effect of time was observed for average weekly time spent sitting as a student ($p > 0.05$).

4.3.5.3.9 Average number of breaks from sitting as a student

No significant interaction effect or main effect of time was observed for average number of breaks from sitting as a student ($p > 0.05$).

4.3.5.3.10 Average frequency of breaks from sitting as a student

No significant interaction effect or main effect of time was observed for average frequency of breaks from sitting as a student ($p > 0.05$).

4.3.5.3.11 Average duration of breaks from sitting as a student

No significant interaction effect was observed for average number of breaks from sitting as a student ($p > 0.05$). A significant main effect of time was observed for average duration of breaks from sitting as a student ($p \leq 0.05$), indicating both groups decreased the duration of their breaks from sitting as a student from baseline to intervention to follow-up.

4.3.5.3.12 WY/WD TV

No significant interaction effect was observed for WY TV or WD TV (*p*s > 0.05). However, a medium-sized interaction effect for WD TV was trending in favor of the control group (η_p^2 = 0.163, $p = 0.083$), whereby the control group perceived themselves taking longer breaks than typical, as compared to the control group. A significant main effect of time was also observed for both WY and WD TV (*p*s ≤ 0.05), indicating both groups reported a decrease in WY and WD TV time from baseline to intervention to follow-up.

4.3.5.3.13 WY/WD computer/smartphone use

No significant interaction effect was observed for WY or WD computer/smartphone use (*p*s > 0.05). A significant main effect of time was observed for WD computer/smartphone use ($p \leq 0.05$), indicating both groups reported less time sitting while using a computer or smartphone from baseline to intervention to follow-up.

4.3.5.3.14 WY/WD video gaming

No significant interaction effect or main effect of time was observed for total weekly class (*p*s > 0.05).

4.3.5.3.15 Average number of breaks from sitting during screen time

No significant interaction effect or main effect of time was observed for average number of breaks from sitting during screen time ($p > 0.05$).

4.3.5.3.16 Average frequency of breaks from sitting during screen time

No significant interaction effect was observed for average frequency of breaks from sitting during screen time ($p > 0.05$). A significant main effect of time was observed for average frequency of breaks from sitting during screen time ($p \leq 0.05$), indicating both groups decreased the frequency of their breaks from sitting during screen time from baseline to follow-up.

4.3.5.3.17 Average duration of breaks from sitting during screen time

No significant interaction effect was observed for average duration of breaks from sitting during screen time ($p > 0.05$). A significant main effect of time was observed for average duration of breaks from sitting during screen time ($p \leq 0.05$), indicating both groups decreased the duration of their breaks from sitting during screen time from baseline to follow-up.

4.3.5.3.18 WY/WD leisure reading

No significant interaction effect or main effect of time was observed for WY or WD leisure reading (ps > 0.05).

4.3.5.3.19 WY/WD chores

No significant interaction effect or main effect of time was observed for WY or WD sitting during chores (ps > 0.05).

4.3.5.3.20 WY/WD caregiving

No significant interaction effect or main effect of time was observed for WY or WD caregiving (ps > 0.05).

4.3.5.3.21 WY/WD hobbies

No significant interaction effect or main effect of time was observed for WY or WD hobbies (ps > 0.05).

4.3.5.3.22 WY/WD socializing

No significant interaction effect or main effect of time was observed for WY or WD socializing (ps > 0.05).

4.3.5.3.23 WY/WD music listening

No significant interaction effect or main effect of time was observed for WY or WD music listening (ps > 0.05).

4.3.5.3.24 WY/WD other activities

No significant interaction effect or main effect of time was observed for WY or WD other activities (ps > 0.05).

4.3.5.3.25 Average number of breaks from sitting during other activities

A significant large interaction effect was observed for average number of breaks from sitting during other activities ($\eta_p^2 = 0.253$, $p = 0.017$). Post-hoc analyses did not reveal any significant differences between groups at any time points (ps > 0.008). No significant main effect of time was observed ($p > 0.05$).

4.3.5.3.26 Average frequency of breaks from sitting during other activities

No significant interaction effect was observed for average frequency of breaks from sitting during other activities ($p > 0.05$). A significant main effect of time was observed for average frequency of breaks from sitting during other activities ($p \leq 0.05$), indicating both groups decreased the frequency of their breaks from sitting during other activities from baseline to follow-up.

4.3.5.3.27 Average duration of breaks from sitting during other activities

No significant interaction effect or main effect of time was observed for average duration of breaks from sitting during other activities ($p > 0.05$).

Table 9: Repeated-measures interaction effects and main effects of time for sedentary behavior outcomes and outcomes of subjective well-being.

		F	Hyp. df	Err. df	p	Λ	η_p^2	1 - β
		Objectively-Measured Sedentary Behavior						
Average daily steps	*Interaction*	0.428	2	28	0.656	0.97	0.030	0.113
	Main effect	**10.572**	**2**	**28**	**<0.001**	**0.57**	**0.430**	**0.980**
Average daily standing time	*Interaction*	2.693	2	28	0.085	0.84	0.161	0.490
	Main effect	10.572	2	28	0.141	0.57	0.131	0.395

Average daily stepping time	*Interaction*	0.369	2	28	0.695	0.97	0.026	0.103
	Main effect	**7.492**	**2**	**28**	**0.002**	**0.65**	**0.349**	**0.917**
Average daily sitting time	*Interaction*	0.155	2	28	0.857	0.99	0.011	0.072
	Main effect	0.624	2	28	0.543	0.96	0.043	0.144
Average daily sit-to-stand transitions	*Interaction*	0.144	2	28	0.893	0.94	0.061	0.192
	Main effect	1.184	2	28	0.321	0.92	0.078	0.238
Self-Compared Sedentary Behavior								
Self-compared weekly sitting	*Interaction*	2.286	2	28	0.120	0.86	0.140	0.425
	Main effect	0.490	2	28	0.618	0.97	0.034	0.122
Self-compared weekly break frequency	*Interaction*	2.780	2	28	0.079	0.83	0.166	0.503
	Main effect	**3.783**	**2**	**28**	**0.035**	**0.79**	**0.213**	**0.641**
Self-compared weekly break duration	*Interaction*	3.131	2	28	0.059	0.82	0.183	0.555
	Main effect	1.067	2	28	0.358	0.93	0.071	0.218
Average Weekday Sitting Time								
Average Weekday Sitting Time	*Interaction*	1.725	2	24	0.199	0.87	0.126	0.326
	Main effect	0.504	2	28	0.610	0.96	0.040	0.123
Domain-Specific Sedentary Behavior – Sleeping and Napping								
WY Sleep	*Interaction*	0.136	2	28	0.873	0.99	0.010	0.069
	Main effect	1.218	2	28	0.311	0.92	0.080	0.244
WD Sleep	*Interaction*	0.201	2	28	0.819	0.99	0.014	0.078
	Main effect	0.471	2	28	0.629	0.97	0.033	0.119
WY Napping	*Interaction*	2.572	2	28	0.094	0.85	0.155	0.471
	Main effect	**5.175**	**2**	**28**	**0.012**	**0.73**	**0.270**	**0.784**
WD Napping	*Interaction*	1.691	2	28	0.203	0.89	0.108	0.325
	Main effect	**3.606**	**2**	**28**	**0.040**	**0.80**	**0.205**	**0.619**
Domain-Specific Sedentary Behavior – Meals								
WY breakfast	*Interaction*	0.706	2	28	0.502	0.95	0.048	0.157

	Main effect	0.185	2	28	0.832	0.99	0.013	0.076
WD breakfast	*Interaction*	0.370	2	28	0.694	0.97	0.026	0.103
	Main effect	2.290	2	28	0.120	0.86	0.120	0.426
WY lunch	*Interaction*	0.276	2	28	0.761	0.98	0.019	0.089
	Main effect	**3.763**	**2**	**28**	**0.036**	**0.79**	**0.212**	**0.639**
WD lunch	*Interaction*	0.013	2	28	0.987	1.00	0.001	0.052
	Main effect	0.858	2	28	0.435	0.94	0.058	0.182
WY dinner	*Interaction*	1.797	2	28	0.184	0.89	0.114	0.343
	Main effect	0.266	2	28	0.768	0.98	0.019	0.088
WD dinner	*Interaction*	0.211	2	28	0.811	0.99	0.015	0.080
	Main effect	0.664	2	28	0.523	0.96	0.045	0.150
Domain-Specific Sedentary Behavior – Transportation								
Total weekly transportation	*Interaction*	2.432	2	28	0.106	0.85	0.148	0.449
	Main effect	**3.960**	**2**	**28**	**0.031**	**0.78**	**0.220**	**0.662**
Domain-Specific Sedentary Behavior – Occupation								
Total weekly class	*Interaction*	0.139	2	26	0.871	0.99	0.011	0.069
	Main effect	0.825	2	26	0.450	0.94	0.060	0.176
Average daily time spent sitting as a student	*Interaction*	0.592	2	27	0.560	0.96	0.042	0.138
	Main effect	0.362	2	27	0.700	0.97	0.026	0.102
Average number of breaks from sitting as a student	*Interaction*	0.137	2	26	0.873	0.99	0.010	0.069
	Main effect	1.630	2	26	0.215	0.89	0.111	0.312
Average frequency of breaks from sitting as a student	*Interaction*	1.083	2	26	0.353	0.92	0.077	0.219
	Main effect	2.177	2	26	0.134	0.86	0.143	0.404
Average duration of breaks from sitting as a student	*Interaction*	0.359	2	27	0.702	0.97	0.026	0.102
	Main effect	**6.483**	**2**	**27**	**0.005**	**0.68**	**0.324**	**0.871**
Domain-Specific Sedentary Behavior – Screen Time								
WY TV	*Interaction*	1.835	2	28	0.178	0.88	0.116	0.350

	Main effect	**4.345**	**2**	**28**	**0.023**	**0.76**	**0.237**	**0.706**
WD TV	*Interaction*	2.722	2	28	0.083	0.84	0.163	0.494
	Main effect	**3.400**	**2**	**28**	**0.048**	**0.80**	**0.195**	**0.592**
WY computer/smartphone use	*Interaction*	0.978	2	28	0.388	0.94	0.065	0.203
	Main effect	3.212	2	28	0.055	0.81	0.187	0.566
WD computer use/smartphone use	*Interaction*	0.062	2	28	0.940	1.00	0.004	0.058
	Main effect	**3.706**	**2**	**28**	**0.037**	**0.79**	**0.209**	**0.632**
WY video gaming	*Interaction*	1.523	2	28	0.236	0.90	0.098	0.296
	Main effect	1.554	2	28	0.229	0.90	0.100	0.302
WD video gaming	*Interaction*	2.231	2	28	0.126	0.86	0.137	0.416
	Main effect	0.681	2	28	0.514	0.95	0.046	0.153
Average number of breaks from sitting during screen time	*Interaction*	2.270	2	28	0.122	0.86	0.140	0.422
	Main effect	1.317	2	28	0.284	0.91	0.086	0.261
Average break frequency from sitting during screen time	*Interaction*	2.484	2	27	0.102	0.85	0.155	0.455
	Main effect	**4.055**	**2**	**27**	**0.029**	**0.77**	**0.231**	**0.672**
Average break duration from sitting during screen time	*Interaction*	0.767	2	28	0.474	0.95	0.052	0.167
	Main effect	**4.248**	**2**	**28**	**0.024**	**0.77**	**0.233**	**0.695**
Domain-Specific Sedentary Behavior – Other Activities								
WY leisure reading	*Interaction*	0.351	2	28	0.707	0.98	0.024	0.101
	Main effect	1.00	2	28	0.381	0.92	0.067	0.206
WD leisure reading	*Interaction*	1.561	2	28	0.228	0.90	0.100	0.303
	Main effect	2.137	2	28	0.137	0.87	0.132	0.401
WY chores	*Interaction*	1.757	2	28	0.191	0.89	0.111	0.337
	Main effect	3.266	2	28	0.053	0.81	0.189	0.574
WD chores	*Interaction*	1.396	2	28	0.264	0.91	0.091	0.274
	Main effect	1.862	2	28	0.174	0.88	0.117	0.354
WY caregiving	*Interaction*	1.645	2	28	0.211	0.90	0.105	0.317
	Main effect	1.645	2	28	0.211	0.90	0.105	0.317

WD caregiving	*Interaction*	1.880	2	28	0.171	0.88	0.118	0.357
	Main effect	1.880	2	28	0.171	0.88	0.118	0.357
WY hobbies	*Interaction*	1.146	2	28	0.332	0.92	0.076	0.231
	Main effect	1.593	2	28	0.221	0.90	.102	0.308
WD hobbies	*Interaction*	1.827	2	28	0.179	0.89	0.115	0.349
	Main effect	1.581	2	28	0.224	0.90	0.101	0.306
WY socializing	*Interaction*	1.097	2	28	0.348	0.93	0.073	0.223
	Main effect	1.062	2	28	0.359	0.93	0.071	0.221
WD socializing	*Interaction*	0.809	2	28	0.455	0.95	0.055	0.174
	Main effect	2.689	2	28	0.085	0.84	0.161	0.489
WY music listening	*Interaction*	0.003	2	28	0.997	1.00	0.000	0.050
	Main effect	2.534	2	28	0.097	0.85	0.153	0.465
WD music listening	*Interaction*	0.114	2	28	0.893	0.99	0.008	0.066
	Main effect	1.219	2	28	0.311	0.92	0.080	0.244
WY other activities	*Interaction*	2.361	2	28	0.113	0.86	0.144	0.437
	Main effect	0.317	2	28	0.731	0.98	0.022	0.095
WD other activities	*Interaction*	0.536	2	28	0.591	0.96	0.037	0.130
	Main effect	2.244	2	28	0.125	0.86	0.138	0.418
Average number of breaks from sitting during other activities	***Interaction***	**4.737**	**2**	**28**	**0.017**	**0.75**	**0.253**	**0.745**
	Main effect	1.369	2	28	0.271	0.91	0.089	0.270
Average break frequency from sitting during other activities	*Interaction*	0.375	2	13	0.695	0.95	0.055	0.098
	Main effect	**3.937**	**2**	**13**	**0.046**	**0.62**	**0.377**	**0.601**
Average break frequency from sitting during other activities	*Interaction*	2.481	2	28	0.102	0.85	0.151	0.457
	Main effect	0.311	2	28	0.735	0.98	0.022	0.095
Outcomes of Subjective Well-Being								
Positive affect	*Interaction*	1.524	2	28	0.235	0.90	0.098	0.296
	Main effect	0.679	2	28	0.515	0.95	0.046	0.153
Negative affect	*Interaction*	0.109	2	28	0.897	0.99	0.008	0.065

	Main effect	**3.887**	**2**	**28**	**0.032**	**0.78**	**0.217**	**0.654**
Life satisfaction	*Interaction*	2.293	2	28	0.120	0.86	0.141	0.426
	Main effect	0.049	2	28	0.952	1.00	0.003	0.057
Subjective vitality	*Interaction*	1.205	2	28	0.315	0.92	0.079	0.241
	Main effect	3.068	2	28	0.062	0.82	0.180	0.546
Overall subjective well-being	*Interaction*	3.209	2	28	0.064	0.82	0.178	0.540
	Main effect	0.927	2	28	0.408	0.94	0.062	0.194

Bold text indicates a significant effect ($p < 0.05$).

Λ = Wilks' Lambda, η_p^2 = partial eta squared, $1 - \beta$ = observed power.

4.3.6 Residual Change and Absolute Differences Correlations

4.3.6.1 Objectively-Measured Sedentary Behavior

Correlations between changes in objectively-measured SB outcomes and change in outcomes of SWB are presented in *Table 10*.

Change in average daily standing time was not significantly correlated with change in any outcome of SWB, but demonstrated a trending positive correlation with residual change in positive affect and subjective vitality and with absolute change for subjective vitality and overall SWB (0.10 > *p*s > 0.05).

Change in average daily sitting time was significantly negatively correlated absolute change in subjective vitality and both residual change and absolute change in overall SWB (*p*s ≤ 0.05). Additionally, change in average daily sitting time demonstrated a trending negative correlation with residual change in subjective vitality ($0.10 > p > 0.05$).

No significant correlations were observed between changes in any other objectively-measured SB outcomes and outcomes of SWB.

Table 10: Pearson correlation matrix between residuals and absolute differences* of objective SB outcomes and outcomes of SWB. (n = 31)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Average daily steps		***.512***	***.973***	***-.555***	-.075	-.056	.109	-.059	.082	.025
2. Average daily standing time	***.528***		***.527***	***-.857***	.322[†]	.239	-.130	.005	.316[†]	.341[†]
3. Average daily stepping time	***.974***	***.555***		***-.623***	.002	-.036	.088	-.023	.093	.052
4. Average daily sitting time	***-.601***	***-.800***	***-.675***		-.265	-.192	.108	-.067	**-.357**	**-.380**
5. Average daily sit-to-stand transitions	.063	.252	.147	-.293		.297	-.078	.074	.131	.048
6. Positive affect	.028	.302[†]	.027	-.222	.150		-.346[†]	**.390**	***.557***	***.561***
7. Negative affect	.237	-.116	.227	.008	.120	**-.455**		-.315[†]	-.330[†]	**-.384**
8. Life satisfaction	-.097	.002	-.064	-.123	.069	**.406**	***-.483***		***.613***	***.701***
9. Subjective vitality	.095	.348[†]	.095	-.349[†]	.131	***.586***	***-.494***	***.629***		***.792***
10. Overall subjective well-being	.000	.287	.030	**-.397**	.056	***.597***	***-.549***	***.701***	***.790***	

*Correlations between residuals are presented below the line; correlations between absolute differences are presented above the line.

Bold text indicates a significant correlation ($p < 0.05$); bold, italicized text indicates a significant correlation ($p < 0.01$).

[†] = trending correlation ($0.10 > p > 0.05$)

4.3.6.2 Self-Compared Sedentary Behavior

Correlations between changes in self-compared SB outcomes and change in outcomes of SWB are presented in *Table 11*.

Change in self-compared weekly sitting time was not significantly correlated with change in any outcome of SWB but demonstrated a trending negative correlation with residual change and absolute change in overall SWB ($0.10 > p$s > 0.05).

Residual change in self-compared weekly break frequency was significantly positively correlated with life satisfaction and overall SWB (*p*s $\leq$ 0.05). Additionally, self-compared weekly break frequency demonstrated a trending correlation with residual change in positive affect and absolute change in life satisfaction.

Change in self-compared weekly break duration was significantly positively correlated with residual change in life satisfaction, as well as absolute change in positive affect, life satisfaction, subjective vitality, and overall SWB (*p*s $\leq$ 0.05). Additionally, self-compared weekly break duration demonstrated a trending correlation with residual change in positive affect, subjective vitality, and overall SWB (0.10 > *p*s > 0.05).

Average Weekday Sitting

Correlations between changes in average weekday sitting and change in outcomes of SWB are presented in *Table 11*.

Significant negative correlations were observed between changes in average weekday sitting and both residual change and absolute change in life satisfaction (*p*s $\leq$ 0.05). Additionally, change in average weekday sitting demonstrated a trending negative correlation with residual change in overall SWB and absolute change in subjective vitality (0.10 > *p*s > 0.05).

Table 11: Pearson correlation matrix between residuals and absolute differences* of self-compared and average weekday SB and outcomes of SWB. (n = 31)

	1	*2*	*3*	*4*‡	*5*	*6*	*7*	*8*	*9*
1. Self-compared weekly sitting		**-.440**	***-.473***	**.393**	-.286	.017	-.298	-.238	-.319†
2. Self-compared weekly break frequency	-.251		***.600***	**-.428**	.277	-.089	.323†	.144	.206
3. Self-compared weekly break duration	-.326†	***.768***		-.349†	**.450**	-.125	***.486***	**.402**	**.392**
4. Average weekday sitting‡	.317	-.263	-.061		-.236	-.008	**-.531**	-.376†	-.320
5. Positive affect	-.036	.307†	.353†	-.203		-.346†	**.390**	***.557***	***.561***
6. Negative affect	-.050	-.298	-.194	.110	**-.455**		-.315†	-.330†	**-.384**
7. Life satisfaction	-.297	**.360**	**.419**	**-.475**	**.406**	***-.483***		***.613***	***.701***
8. Subjective vitality	-.164	.279	.331†	-.312	***.586***	***-.494***	***.629***		***.792***
9. Overall subjective well-being	-.330†	**.360**	.328†	-.377†	***.597***	***-.549***	***.701***	***.790***	

*Correlations between residuals are presented below the line; correlations between absolute differences are presented above the line.

Bold text indicates a significant correlation ($p < 0.05$); bold, italicized text indicates a significant correlation ($p < 0.01$).

† = trending correlation ($0.10 > p > 0.05$), ‡ = ($n = 27$)

4.3.6.3 Domain-Specific Sedentary Behavior

Correlations between changes in domain-specific SB and change in outcomes of SWB are presented in *Table 12.*

With respect to sleep, change in WY sleep time was significantly correlated residual change in subjective vitality and overall SWB, as well as absolute change in subjective vitality ($p \leq 0.05$). Change in WD sleep time was not significantly correlated with change in any SWB outcomes. Change in WY napping was significantly positively correlated with absolute change in positive affect ($p \leq 0.05$). Additionally, change in WY sleep time demonstrated a trending positive correlation with subjective vitality ($0.10 > p > 0.05$). Change in WD napping was significantly negatively correlated with residual change and absolute change in negative affect (ps ≤ 0.05).

With respect to meals, change in WY lunch was significantly negatively correlated with residual change in overall SWB ($p \leq 0.05$). Additionally, change in WY lunch demonstrated a trending negative correlation with absolute change in overall SWB ($0.10 > p > 0.05$). No significant correlations were observed among change in other meal-related sitting behavior.

With respect to transportation, no significant correlations were observed between change in total transportation and change in any outcome of SWB.

With respect to occupational sitting, change in total class time demonstrated a trending positive correlation with absolute change in subjective vitality ($0.10 > p > 0.05$). Change in average duration of breaks from sitting as a student was significantly positively correlated with both residual change and absolute change in positive affect (ps ≤ 0.05). No significant correlations were observed between change in any other occupational SB outcome or any outcome of SWB.

With respect to screen time, change in WY TV was significantly negatively correlated with residual change in subjective vitality, as well as absolute change in positive affect and subjective vitality (ps ≤ 0.05). Additionally, a trending negative correlation was observed between change in WY TV and change in overall SWB ($0.10 > p > 0.05$). Change in WY computer was significantly negatively correlated with both residual change and absolute change in negative affect (ps ≤ 0.05). Change in average number of breaks during screen time was significantly negatively correlated with residual change in life satisfaction ($p \leq 0.05$). Change in average duration of breaks from sitting during screen time was significantly positively correlated with residual change in negative affect, as well as significantly negatively correlated with residual change in overall SWB and absolute change in subjective vitality and overall SWB (ps $\leq$ 0.05). Additionally, change in average duration of breaks from sitting during screen time demonstrated a trending negative correlation with residual change in life satisfaction and subjective vitality, as well as absolute change in positive affect and life satisfaction (0.10 > *p*s > 0.05).

With respect to other activities, change in WY chores was significantly positively correlated with absolute change in positive affect and significantly negatively correlated with change in negative affect (*p*s ≤ 0.05). Additionally, change in WY chores demonstrated a trending negative correlation with absolute change in negative affect and trending positive correlations with residual change in subjective vitality and absolute change in life satisfaction (0.10 > *p*s > 0.05). Change in WY caregiving demonstrated a trending positive correlation with absolute change in overall SWB (0.10 > *p* > 0.05). Change in WD caregiving was significantly positively correlated with absolute change in overall SWB (*p* ≤ 0.05). Change in WD socializing was significantly positively correlated with absolute change in positive affect (*p* ≤ 0.05). Change in WY music listening was significantly positively associated with absolute change in life satisfaction (*p* ≤ 0.05). Additionally, change in WY music listening demonstrated a trending negative correlation with absolute change in negative affect and trending positive correlations with absolute change in life satisfaction and overall SWB (0.10 > *p*s > 0.05). Change in WY other activities was significantly negatively correlated with absolute change in positive affect (*p* ≤ 0.05). Additionally, change in WY other activities demonstrated a trending negative correlation with residual change in overall SWB (0.10 > *p* > 0.05). Change in average number of breaks from sitting during other activities was significantly positively correlated with absolute change in subjective vitality (*p* ≤ 0.05). Additionally, change in average number of breaks from sitting during other activities demonstrated a trending positive relationship with both residual and absolute change in positive affect, as well as a trending negative relationship with residual change in negative affect (0.10 > *p*s > 0.05). Change in average duration of breaks from sitting during other activities was significantly positively correlated with both residual change and absolute change in positive affect (*p*s ≤ 0.05).

Table 12: Pearson correlations between residuals and absolute differences of domain-specific SBs and outcomes of SWB. (n = 31)

	Positive affect		*Negative affect*		*Life satisfaction*		*Subjective vitality*		*Overall SWB*	
Sedentary behavior	*R.C.*	*A.C.*	*R.C.*	*A.C.*	*R.C.*	*A.C.*	*R.C.*	*A.C.*	*R.C.*	*A.C.*
Domain-Specific Sedentary Behavior – Sleeping and Napping										
WY sleep	.005	.075	-.046	-.066	.263	.267	.349†	**.415**	***.485***	***.473***
WD sleep	-.083	-.037	.030	-.136	.049	-.118	-.093	-.112	-.021	-.072
WY napping	.202	**.394**	-.096	-.078	-.052	-.024	-.014	.014	.031	.051
WD napping	-.068	-.067	**-.377**	**-.395**	-.015	-.011	.016	.031	.204	.184
Domain-Specific Sedentary Behavior – Meals										
WY breakfast	-.023	-.065	.001	.125	.090	.157	.271	.318†	.132	.230
WD breakfast	-.278	-.033	.057	-.083	-.110	-.100	-.005	.069	-.155	-.015
WY lunch	-.200	-.180	.235	.291	-.290	-.267	-.110	-.020	**-.436**	-.304†
WD lunch	.038	.061	.141	.191	.176	.173	.138	.179	-.083	-.022
WY dinner	-.079	-.069	.008	.002	.079	.079	.205	.223	-.034	-.020
WD dinner	-.004	.073	-.070	.029	.132	.179	.050	.140	-.142	-.012
Domain-Specific Sedentary Behavior – Transportation										
Total transportation	.025	.044	-.183	-.204	.105	.032	.137	.159	.162	.113
Domain-Specific Sedentary Behavior – Occupation										
Total class time	.142	.207	-.075	-.151	.086	.057	.255	.330†	.150	.153
Average weekly time spent sitting as a student	-.118	-.190	-.058	-.086	-.072	-.086	-.182	-.167	-.211	-.244

Average number of breaks from sitting as a student (*n* = 29)	.070	.171	.199	-.173	-.157	.030	-.240	.141	-.149	.130
Average frequency of breaks from sitting as a student (*n* = 30)	-.073	-.260	.086	.182	-.040	-.048	.056	-.038	-.021	-.018
Average duration of breaks from sitting as a student (*n* = 30)	***.397***	**.432**	-.184	-.208	.079	.082	.049	.065	-.002	-.029
Domain-Specific Sedentary Behavior – Screen Time										
WY TV	-.207	**-.436**	.081	.092	-.074	-.096	***-.507***	***-.615***	-.227	-.313†
WD TV	.138	-.092	-.224	.009	.192	.139	-.160	-.269	.049	-.050
WY computer/smartphone use	.182	.272	**-.396**	**-.395**	.149	.267	-.107	-.113	.078	.110
WD computer/smartphone use	.228	.116	-.245	-.140	.017	.074	-.162	-.174	.012	-.014
WY videogaming	-.264	.089	-.005	-.211	.048	.127	-.065	.234	-.147	.091
WD videogaming	-.140	.026	.099	-.139	.004	.110	-.119	.200	-.050	.078
Average number of breaks from sitting during screen time	-.220	.021	.203	-.165	***-.541***	-.221	-.193	.072	-.263	.036
Average frequency of breaks from sitting during screen time (*n* = 30)	-.157	-.181	-.202	-.272	.191	.165	-.056	-.088	-.033	-.026
Average duration of breaks from sitting during screen time	-.184	-.305†	**.411**	.156	-.355†	-.349†	-.352†	**-.431**	**-.364**	**-.446**
Domain-Specific Sedentary Behavior – Other Activities										
WY leisure reading	-.034	.004	.097	-.190	-.214	-.205	-.202	-.200	-.103	-.135
WD leisure reading	.038	.045	.103	-.276	-.220	-.202	-.149	-.125	-.072	-.101
WY chores	.174	**.415**	-.353†	***-.489***	.258	.303†	.333†	.268	.223	.218
WD chores	.290	.203	-.299	-.298	.188	.125	.241	-.018	.069	-.014

WY caregiving	-	.050	-	-.154	-	.277	-	.244	-	.332†
WD caregiving	.110	.115	-.271	-.274	-.077	.066	.042	.183	.220	**.399**
WY hobbies	-.013	.076	-.042	-.112	-.008	.056	-.175	-.168	.038	.007
WD hobbies	.009	-.122	.163	.105	-.013	.013	-.205	-.128	-.058	-.045
WY socializing	.091	.260	-.144	-.240	-.042	.129	-.054	.236	-.060	.101
WD socializing	.093	**.403**	.123	.042	-.069	.156	.050	.279	.006	.195
WY music listening	.148	.232	-.012	-.307†	.091	.339†	.105	**.425**	.008	.304†
WD music listening	.024	.107	.198	-.177	.004	.179	.041	.261	-.013	.206
WY other activities	-.251	**-.366**	.254	.105	-.272	-.216	-.112	-.074	-.302†	-.288
WD other activities	-.129	-.211	-.167	.035	-.241	-.131	-.216	-.077	-.260	.003
Average number of breaks from sitting during other activities	.336†	.337†	-.352†	-.205	.099	.166	.297	***.473***	.128	.235
Average frequency of breaks from sitting during other activities (n = 21)	-.248	.066	-.163	-.074	.012	.177	-.007	.152	.216	.350
Average duration of breaks from sitting during other activities	**.455**	**.373**	-.206	-.228	.004	-.074	.291	.206	.202	.119

Bold text indicates a significant correlation ($p < 0.05$); bold, italicized text indicates a significant correlation ($p < 0.01$).

SWB = subjective well-being, R.C. = residual correlation, A.C. = absolute difference correlation, † = trending correlation ($0.10 \geq p \geq 0.05$).

4.3.7 Adverse events

Given the minimal risk associated with the intervention and subsequent behaviors, data regarding adverse events/harms were not formally collected. However, anecdotally, no participants noted any adverse events or harms.

4.4 Discussion

This randomized pilot trial assessed the preliminary effectiveness of an acute behavioral intervention to reduce the SB and in turn improve the SWB of sedentary university students. This trial also examined relationships between changes in SB outcomes and outcomes of SWB from baseline to intervention.

4.4.1 Intervention effectiveness – Reducing sedentary behavior

Overall, the intervention was unable to significantly decrease objectively-measured SB, relative to the control group. Specifically, no significant interaction effects were demonstrated for average daily steps or average daily stepping time, average daily standing time, average daily sitting time, or average daily sit-to-stand transitions. However, a trending medium-sized interaction effect of average daily standing time favored the treatment group – the expected direction of change. Low observed power statistics provide evidence that the trial was underpowered to observe changes in these objectively-measured SB outcomes. An informal sample size calculation suggests that a sample size of 64 participants would be necessary to see significant changes in objectively-measured average standing time. Generally, from baseline to intervention to follow-up, both groups decreased their sitting time and increased their standing time. Notably, significant main effects of time were observed for average number of steps and stepping time, indicating both groups increased their number of steps/stepping time from baseline to intervention and then returned to baseline levels at follow-up.

Interaction effects for self-reported SB resembled objectively-measured SB, in that no significant interaction effects were demonstrated, including average weekday sitting; the exception was average number of breaks from other activities, which favored the treatment group. However, trending associations among multiple self-reported variables (i.e., self-compared break frequency and duration, transportation) favoring the treatment group indicate the potential influence of the intervention.

The (lack of) effectiveness of the current SB-reducing intervention presents a stark contrast to the effectiveness of previous SB-inducing studies. Endrighi and colleagues reported a significant 31.48 min/day (95% CI: [-57.64, -5.32]) increase in ‘sedentary time’ over a 2-week period as measured by accelerometer[18]. Duvivier and colleagues noted an even higher reduction

(5.9 hours/day, 95% CI: [5.75, 6.05]) in daily sitting time with a 4-day intervention as measured by accelerometer[19]. Most recently, Edwards & Loprinzi reported a significant -2826.53 steps/day (95% CI: [1835.33, 3817.73]) change from baseline over a 1-week intervention[16]. Conversely, the present work observed a 6.21 min/day (95% CI: [-23.19, 35.61]) decrease in sitting time for the treatment group over a 1-week intervention.

Despite the disparity among intervention effectiveness between our work and previous studies, comparisons between the two are misleading and inappropriate. Firstly, the present study used inclinometry to measure SB, compared to the use of accelerometers in the previously mentioned work to measure 'sedentary time' (i.e., PI). Using PI (via accelerometers) as a proxy for SB is inaccurate; accelerometry cannot distinguish between sitting and standing. Moreover, standard accelerometer activity cut-offs for sedentary time (i.e., <100 counts per minute) are not sensitive enough to capture postural changes[52], and vary drastically based on customized cut-offs and analysis algorithm[53]. Hence, inclinometry remains the gold standard for valid and reliable measurement of SB[54]. Secondly, inducing SB likely warrants a different approach to intervention than reducing SB. Specifically, previous experimental studies reported participants were simply 'instructed' to modify their behaviour (i.e., restrict PA, replace standing and movement with sitting). The ease of the intended behavior change among these studies may be attributed to the habitual nature of SB. Behavior modification through rewarding/reinforcing the habit behavior are less likely to encounter traditional barriers to behavior change (e.g., motivation, self-efficacy). Inversely, given the difficulty in changing habits, like SB, behavioral interventions aimed to counter habits require a consequent complexity to achieve success (e.g., reduce SB[55]). Furthermore, the current work recruited already sedentary individuals (i.e., ≥7 hours/day of sitting time) – a sample likely with a strengthened SB habit. Hence, it is reasonable to expect the drastic contrast in effectiveness between these types of interventions that we observed.

The ineffectiveness of the present intervention to reduce SB can be explained by several reasons. One reason is the intervention was not strong enough to elicit change in SB. The current intervention was theory-driven; specifically, intervention development was informed by the HAPA model for behavior change. As such, the intervention was aimed at improving the action planning and coping planning associated with the SB change so as to facilitate intentions to behavior. Further, the action plan itself was coached by the FITT principle[34], allowing for further specificity to encourage effectiveness and adherence. The action planning was built off the specified goal of reducing daily SB by 1-2 hours/day, as well as achieving a daily step goal of ≥10000 steps/day. According to the taxonomy of behavior change techniques by Michie and colleagues[56], the present intervention utilized (i) goal setting (behavior), (ii) action planning, (iii) problem solving, (iv) review of behavioral goals, and (v) mental rehearsal of successful performance. Additionally, participants were encouraged to self-monitor their step count through a smartphone app, if applicable – a form of (vi) self-monitoring (behavior). These specific strategies have shown success in previous SB interventions[57], while HAPA-based SB interventions, specifically, have shown success[31,58].

However, these strategies alone may not have been sufficient to elicit change in behavior. Inclusion of components of previously successful SB interventions, such as prompts and cues, are likely to improve the present intervention's strength. Complementing traditional behavior change strategies with prompts and feedback helps to address the lack of cognitive awareness associated with habitual behaviors, like SB[59]. Similarly, tailoring said prompts to the participant's action plan act as an additional strategy to facilitate behavior change[56]. Previous work utilizing SMS-delivered prompts and cues has shown success in reducing SB among university students[60] and office workers[58].

Another potential reason for the infirmity of the present intervention is the length of the intervention. While SB-inducing studies have demonstrated that 4 days to 2 weeks is sufficient time to significantly increase SB, this acute an intervention period may not be sufficiently long enough to see reductions in SB. Previous work utilizing this intervention in a university student population did not observe differences in SB outcomes between groups until after the third week of intervention, following the follow-up behavioral session[31]. These findings allude to the value of longer intervention periods and follow-up behavioral sessions. Longer intervention periods may be necessary to observe changes in habitual changes in SB. Longer intervention periods can also help capture trends in sitting within our particular population, as university students anecdotally report more SB during exam and assignment periods. Additionally, follow-up behavioral sessions can promote the use of feedback, review of previous behavior, and habit formation as behavioral strategies. Given the weekly collection protocol for the ActivPAL4 device, a follow-up behavioral session could be implemented the week proceeding the first behavioral session.

A final proposed reason for the ineffectiveness of the current intervention is how often SB was assessed. The present work assessed self-reported SB through a 7-day recall questionnaire[42]. However, previous work suggests that daily changes in SB have impacts on outcomes of SWB[14,15]. Additionally, given the ‘invisible’ nature of SB[61], recalling average weekly behaviors can be difficult, particularly when considering multiple domains of SB. Short-term recalls of SB, such as previous day recalls, demonstrate strong correlations with inclinometry[62]. Hence, adapting present instruments into previous-day recall questionnaires can provide a more accurate depiction of SB and help to capture relationships between daily changes in SB and outcomes of SWB. Alternatively, the use of ecological momentary assessments (EMA) have also shown potential for measuring SB since they provide context about the SB being performed at the time of assessment, and can be more easily corroborated with objectively-measured SB data[63].

In sum, the effectiveness of the present intervention to reduce SB may have been hindered, owing to the habitual nature of SB, combined with the lack of prompts or cues, short intervention period, and 7-day recall period. Future iterations of this intervention should seek to integrate prompts/cues, adopt longer intervention periods with follow-up sessions for feedback, and capture SB through daily diaries or EMA.

4.4.2 Intervention effectiveness – Improving subjective well-being

Trends among SB outcomes were also mirrored by life satisfaction and overall SWB; both of these outcomes demonstrated trending medium-sized interaction effects favoring the treatment group. Similar to objectively-measured SB, low observed power statistics provide evidence that the trial was underpowered to observe changes in these outcomes of SWB. An informal sample size calculation suggests that a sample size of 54 participants would be necessary to see significant changes in overall SWB. By contrast, positive affect, negative affect, and subjective vitality were not significantly different between groups, indicating the intervention was ineffective in modifying these outcomes of SWB. The lack of change observed in affect may be explained by its measurement. Specifically, state affect was collected in the current study, as it was hypothesized to be more sensitive to changes in SB than trait affect. However, given the 7-day recall of the SB measures, changes in state affect elicited by changes in SB may not be captured through weekly recall; rather, daily recall measurements or EMA may be necessary to capture these relationships[14,15]. Conversely, weekly recall questionnaires may be adequate for capturing less fluctuant outcomes of SWB, like life satisfaction and overall SWB; however, this reasoning does not appear to extend to eudaimonic well-being (i.e., subjective vitality). The distinctive differences between hedonic and eudaimonic well-being may contribute to the ineffectiveness of the intervention to modify subjective vitality. Hedonic well-being may be more sensitive to acute behavior change in general due to most behaviors eliciting an affective response. By contrast, eudaimonic well-being is concerned with self-actualization and purpose[8], and as such, may be less sensitive to acute novel behavior change. Furthermore, some research suggests that eudaimonic well-being improves the likelihood of practicing preventive health behaviors[64], suggesting the current directionality of the intervention is inappropriate.

Overall, trending interaction effects for life satisfaction and overall SWB provide weak evidence for the effectiveness of the present intervention to modify outcomes of SWB. More frequent outcome assessment, through past-day recall and EMA, may provide a clarity regarding the effectiveness of the present intervention for modifying state affect.

4.4.3 Correlations between change in SB and SWB outcomes

The secondary objective of this randomized pilot trial was to examine whether changes in SB outcomes were related to changes in outcomes of SWB, with the aim of corroborating relationships between these variables with previous research. Correlations observed in the present study largely reflect previously established relationships. Notable comparisons include the null association between change in number of sit-to-stand transitions and change in overall SWB[65], a negative association between change in reported average weekday sitting time and change in life satisfaction[15], and a null association between change in self-reported average weekday sitting time and change in negative affect[10]. The trending relationship between change in reported average weekday sitting time and overall SWB also echoes findings of the previous cross-sectional study.

However, multiple correlations identified were not in line with previous findings. For example, objectively-measured change in daily sitting time was significantly negatively correlated with overall SWB, in contrast to the null findings by Okely and colleagues[65]. WY computer/smartphone use was also significantly negatively correlated with negative affect, contrary to evidence demonstrating positive relationships between negative affect and computer use[66,67], including the previous cross-sectional work. Notably, the previous research mentioned were cross-sectional, hence, the relationships identified in the present work highlight potential within-subject relationships between these outcomes. Significant and trending relationships between change in self-compared SB outcomes and multiple outcomes of SWB present further evidence supporting this point, as does some longitudinal work[15].

Some unique relationships were also observed. With respect to objectively-measured outcomes of SB, favorable relationships with changes in outcomes of SWB were observed with changes in daily standing time, but not sit-to-stand transitions. This evidence, combined with self-compared and domain-specific break data, suggest that break duration may be more meaningful for outcomes of SWB than break frequency or number of breaks. Similarly, significant and trending moderate-strength correlations between self-compared SB outcomes and outcomes of SWB in the previous cross-sectional study and existing literature[15,21,22] underscore the influence of within-subject differences and self-compared SB (i.e., compared to typical SB).

Given the relatively small sample size of this randomized pilot trial, significant and trending correlations were likely only observed for the largest correlations. Previous cross-sectional research indicates that many relationships between outcomes of SWB and domain-specific SB are small in size (i.e., $r \geq 0.1$). As such, the present work is also underpowered to observe these small potential relationships as statistically significant. However, current relationships between change in outcomes do underscore the role of within-subject changes in SB and their associations with outcomes of SWB, as is highlighted by the previous cross-sectional study and existing literature[14,15,21,22].

4.4.4 Interplay between intervention effectiveness and change correlations

Interplay between intervention effectiveness and change in outcome correlations provide insight into the variables of interest. Specifically, trending/significant interaction effects for SB and SWB, coupled with a trending/significant change correlation suggests that the intervention is successful (or approaching success) in changing the outcomes and that the two outcomes are related, which may be indicative of causation through one outcome. Inversely, non-significant interaction effects coupled with non-significant change correlations indicate that both outcomes are insufficiently affected by the intervention and are not related, which can signal the lack of a causal relationship between these outcomes or a lack of power. Additionally, non-significant interaction effects paired with significant change correlations infers a relationship between outcomes, but insufficient strength in the intervention to elicit change in one (or more) outcomes, confounding the interpretation of causality. Similarly, significant/trending interaction effects and non-significant change correlations indicate that both outcomes have been changed but exhibit no relationship with each other, suggesting that the outcomes are independent of each other. Ultimately, shedding light on which scenario is most likely can inform the outcomes of focus of future research experimental research.

Applied to the current trial, average daily standing time, self-compared weekly break frequency, and self-compared break duration all exhibited trending interaction effects and trending/significant change correlations with overall SWB, reinforcing these SB outcomes as targets for intervention. With respect to outcomes with non-significant interaction effects but trending/significant change correlations, average daily sitting time, self-compared weekly sitting, duration of breaks from sitting in multiple domains, and self-reported weekday sitting time all warrant investigation in a sufficiently powered intervention. Overall, interplay between interaction effects and change correlations further compound the importance of examining objectively-measured sitting and standing, self-compared SB, and breaks from sitting as salient outcomes to target and modify with future behavioral interventions.

4.4.5 Limitations

One limitation of the present work was the low sample size. Although sample size calculations are not typically part of pilot studies, the low observed power statistics and trending correlation *p* values indicate that the current work was underpowered, without accounting for Bonferroni corrections for repeated measures (an additional limitation). Drawing on previous studies that were successful in reducing SB using a similar HAPA-based intervention[31,58], future iterations of the present work should aim for a sample size of 50-60 participants (i.e., 25-30 participants per group). The lack of allocation blinding to the researcher presents as another limitation. Although efforts were made by the researcher to allocate randomly, the lack of concealment may have impacted the delivery of the study. Utilizing third-party sequence blinding and sealed envelopes can ensure sequence and allocation concealment.

4.4.6 Generalizability

Given the pilot nature of the present trial, the generalizability of these findings is limited. Future work is aimed at improving the preliminary effectiveness of the intervention. Interpretation regarding the generalizability of findings must be preceded by a full-scale RCT.

4.4.7 Interpretation

Overall, the present randomized pilot trial provides evidence that the current behavioral intervention was for the most part ineffective in reducing the SB of a sample of university students over a 1-week period. While previous research utilizing a HAPA-based SB intervention have shown success, those studies utilized longer intervention periods, follow-up sessions, and prompts/cues. The addition of these components into the current intervention may relay greater effectiveness in reducing SB in this population. Weak evidence exists that the current intervention enhanced SWB. Correlations observed between changes in SB outcomes and outcomes of SWB largely reflect previous evidence; notable outcomes of interest include self-compared SB outcomes, break frequency and duration, and objectively-measured SB.

4.4.8 Registration and protocol

The following trial and associated protocol are registered at ClinicalTrials.gov under ClinicalTrials.gov ID: NCT03694951 and Protocol ID: 112399, respectively.

4.4.9 Funding sources

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Chapter 5

5 Overall discussion

The present research program aimed to explore the relationships between indices of SB and outcomes of SWB; to this end, three studies were conducted. Study 1 mapped the current body of literature examining relationships between indices of SB (i.e., objectively-measured SB and PI, self-reported SB and PI, and screen time) and hedonic well-being (i.e., affect, life satisfaction, overall hedonic well-being) through a scoping review. Study 2 explored relationships between both domain-specific and total SB measures and outcomes of SWB among a national sample of university students through a large-scale cross-sectional study. Study 3 aimed to evaluate the preliminary effectiveness of a SB-reducing behavioral intervention among a sample of university students via a randomized pilot trial. Findings from these works add to the burgeoning body of literature examining SB and SWB through examining both total and domain-specific SBs, as well as capturing objective measurements of SB through experimental design. Pertinent findings and implications for each study are described herein.

Findings from the scoping review reveal distinct differences among indices of SB and outcomes of hedonic well-being. Specifically, SB demonstrates mixed associations with outcomes of hedonic well-being. Overall sitting appears to be weakly, detrimentally associated with life satisfaction and positive affect, but not with negative affect or overall hedonic well-being. However, certain domains of sitting demonstrate positive associations with SWB (e.g., socializing, computer use). Conversely, screen time, a domain of SB, demonstrates consistent detrimental associations with negative affect, life satisfaction, and overall hedonic well-being, which suggests that the context of SB may have an independent influence on outcomes of SWB, separate from the volume of sitting itself. Some relationships between PI and outcomes of SWB deviate from relationships observed with SB. In particular, PI is consistently related to poorer life satisfaction and negative affect, which may be attributed to PI instruments capturing the most sedentary of individuals. Overall, findings from the scoping review highlight the dearth of research actually measuring SB – particularly domain-specific SB – rather than an index of SB, like PI. As such, studies examining SB should seek to utilize instruments that capture SB according to current definitions[1] and in multiple domains and modes (e.g., objectively, self-reported).

Findings from the cross-sectional study illuminate relationships between total and domain-specific SB and outcomes of SWB. Of the relationships examined, several follow trends observed in previous works. For example, detrimental associations were observed between average weekday sitting and positive affect as well as negative affect, life satisfaction, and overall SWB and screen time (i.e., TV watching, computer/smartphone use). By contrast, beneficial relationships were observed between self-compared SB outcomes (i.e., average weekly sitting, break frequency, and break duration) and affect and overall SWB. Unique relationships between breaks from sitting (i.e., number, frequency, duration) and positive affect and overall SWB provide seminal evidence for the importance of breaks from sitting for SWB. Notably, partial correlations reveal many relationships between average weekday sitting, self-compared sitting, and breaks from sitting and outcomes of SWB remain significant, albeit attenuated, after accounting for depression and anxiety; these findings allude to the correlated, but independent, relationships between SWB and mental health measures, and their subsequent relationship(s) with SB. As such, future work should look to include measures of breaks from sitting and self-compared sitting, in addition to total and domain-specific measures of SB.

Results of the randomized pilot trial indicate weak evidence for the effectiveness of the intervention to reduce SB and improve SWB as delivered, among a sample of sedentary university students. Reasons for the inability of the current intervention to change SB include inadequate intervention strength, insufficient intervention length, and inappropriate measurement of self-reported outcomes. Hence, strategies to improve intervention effectiveness include prompts/cues to reinforce intervention goals; lengthening study design to allow for feedback and a follow-up behavioral session; and use of daily diaries, past-day recall, or ecological momentary assessment. Despite the ineffectiveness of the intervention, relationships were observed between changes in SB outcomes and changes in outcomes of SWB. In particular, changes in objectively-measured daily sitting and standing demonstrate significant negative and trending positive relationships with overall SWB, respectively. Similarly directed correlations between self-compared sitting outcomes and breaks from sitting further underscore the potential role of these variables in influencing SB and SWB relationships. Interplay between intervention effectiveness and change correlations for these variables also reinforce the value in targeting these outcomes for behavior modification in future interventions.

In sum, the present research program elucidated relationships between SB and SWB. These studies reinforce the weak, detrimental association between SB and outcomes of SWB, while also highlighting the contextual, individualized nature of these relationships through self-compared and domain-specific SB findings. Future research describing SB and SWB relationships should aim to build off the present work by incorporating measures of objectively-measured SB, self-reported domain-specific and self-compared SB, and breaks from SB.

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Appendix A: PRISMA-ScR Checklist

Appendix A: PRISMA-ScR Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	13
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	N/A
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	13-15
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	15
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	15
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	15-16
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	16
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	16
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	16-17
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	17
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	17-18
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N/A
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	18
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	19
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	19-20
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	20-56
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	57-61
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	61-68
Limitations	20	Discuss the limitations of the scoping review process.	68
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	69
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	69

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

Appendix B: Scoping Review Search Strategies

Appendix B: Scoping review search strategies

PubMed: (“sedentary behavior” OR "sedentary behaviour" OR inactivity) AND ("life satisfaction" OR "satisfaction with life" OR "well-being" OR affect OR "wellness" OR "quality of life")

SCOPUS: TITLE-ABS-KEY ("sedentary behavior" OR "sedentary behaviour" OR inactivity) AND TITLE-ABS-KEY ("life satisfaction" OR "satisfaction with life" OR "well-being" OR affect OR "wellness" OR "quality of life") AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "ip")) AND (LIMIT-TO (LANGUAGE , "English"))

Web of Science: ((TI=life AND TI=satisfaction) OR TS=“life satisfaction” OR TS=“well being” OR TS=wellbeing OR TS=wellness OR (TS=“quality of life” NOT TS=“health-related”)) AND (TS=sedentary OR TI=inactivity OR TI=inactive)

PsychINFO: noft((“sedentary behavior” OR "sedentary behaviour" OR inactivity) AND ("life satisfaction" OR "satisfaction with life" OR "well-being" OR affect OR "wellness" OR "quality of life"))

Nursing and Allied Health Database: noft((“sedentary behavior” OR "sedentary behaviour" OR inactivity) AND ("life satisfaction" OR "satisfaction with life" OR "well-being" OR affect OR "wellness" OR "quality of life"))

CINAHL: (“sedentary behavior” OR "sedentary behaviour" OR inactivity) AND ("life satisfaction" OR "satisfaction with life" OR "well-being" OR affect OR "wellness" OR "quality of life")

SPORTDISCUS: (“sedentary behavior” OR "sedentary behaviour" OR inactivity) AND ("life satisfaction" OR "satisfaction with life" OR "well-being" OR affect OR "wellness" OR "quality of life")

Physical Education Index: (“sedentary behavior” OR "sedentary behaviour" OR inactivity) AND ("life satisfaction" OR "satisfaction with life" OR "well-being" OR affect OR "wellness" OR "quality of life")"

Appendix C: Modified SIT-Q 7d Questionnaire

Appendix C: Modified SIT-Q 7d questionnaire

Page 01

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
○	○	○	○	○	○

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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.

5. WEEKDAY MEALS

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

	None	1 – 10 min	10 – 20 min	20 – 30 min	30 – 45 min	45 min – 1 hour	More than 1 hour a day
Breakfast	○	○	○	○	○	○	○
Lunch	○	○	○	○	○	○	○
Dinner	○	○	○	○	○	○	○

6. WEEKEND DAY MEALS

In the last 7 days, how long did you sit for each of these meals, on an average WEEKEND DAY?

	None	1 – 10 min	10 – 20 min	20 – 30 min	30 – 45 min	45 min – 1 hour	More than 1 hour a day
Breakfast	○	○	○	○	○	○	○
Lunch	○	○	○	○	○	○	○
Dinner	○	○	○	○	○	○	○

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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.

7. 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").

8. 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

9. 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)

Occupation 1

None	1 – 15 min	15 – 30 min	30 – 45 min	45 min – 1 hour	1 – 1.5 hours	1.5 – 2 hours	2 – 2.5 hours	2.5 – 3 hours	3 – 4 hours	4 – 5 hours	5 – 6 hours	6 – 7 hours	More than 7 hours
○	○	○	○	○	○	○	○	○	○	○	○	○	○

Occupation 2

None	1 – 15 min	15 – 30 min	30 – 45 min	45 min – 1 hour	1 – 1.5 hours	1.5 – 2 hours	2 – 2.5 hours	2.5 – 3 hours	3 – 4 hours	4 – 5 hours	5 – 6 hours	6 – 7 hours	More than 7 hours
○	○	○	○	○	○	○	○	○	○	○	○	○	○

Occupation 3

None	1 – 15 min	15 – 30 min	30 – 45 min	45 min – 1 hour	1 – 1.5 hours	1.5 – 2 hours	2 – 2.5 hours	2.5 – 3 hours	3 – 4 hours	4 – 5 hours	5 – 6 hours	6 – 7 hours	More than 7 hours
○	○	○	○	○	○	○	○	○	○	○	○	○	○

10. 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

11. 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)

	None	1 – 15 min	15 – 30 min	30 – 45 min	45 min – 1 hour	1 – 1.5 hours	1.5 – 2 hours	2 – 2.5 hours	2.5 – 3 hours	3 – 4 hours	4 – 5 hours	5 – 6 hours	6 – 7 hours	More than 7 hours
Occupation 1	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Occupation 2	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Occupation 3	○	○	○	○	○	○	○	○	○	○	○	○	○	○

12. 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)

________ days

13. 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)

None	1 – 15 min	15 – 30 min	30 – 45 min	45 min – 1 hour	1 – 1.5 hours	1.5 – 2 hours	2 – 2.5 hours	2.5 – 3 hours	3 – 4 hours	4 – 5 hours	5 – 6 hours	6 – 7 hours	More than 7 hours
○	○	○	○	○	○	○	○	○	○	○	○	○	○

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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.

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

- ◯ Yes
- ◯ No

15. Occupation 1

Type of Occupation 1

◯	◯	◯
Work	Study	Volunteer

16. Name of Occupation 1

E.g. receptionist, student, etc.

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

[Please choose] ▼

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

hours

19. 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 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

20. In the last 7 days, on a average, how many times per day did you interrupt your sitting time while doing Occupation 1?

E.g. By standing up, walking somewhere, or getting a coffee?

____ times

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

◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
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	N/A – did not sit

22. 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

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").

23. 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

24. Occupation 2

Type of Occupation 2

◯ Work ◯ Study ◯ Volunteer

25. Name of Occupation 2

E.g. receptionist, student, etc.

____

26. How many days did you spend doing Occupation 2 in the last 7 days?

[Please choose] ▼

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

hours

28. 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

29. In the last 7 days, on a average, how many times per day did you interrupt your sitting time while doing Occupation 2?

E.g. By standing up, walking somewhere, or getting a coffee?

times

30. 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 3 – 4 hours	Every 2 – 3 hours	Every 4 – 5 hours	Over every 5 hours	No Interruptior

31. 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

32. 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

33. Occupation 3

Type of Occupation 3

◯ Work ◯ Study ◯ Volunteer

34. Name of Occupation 3

E.g. receptionist, student, etc.

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

[Please choose] ▼

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

hours

37. 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

38. In the last 7 days, on a average, how many times per day did you interrupt your sitting time while doing Occupation 3?

E.g. By standing up, walking somewhere, or getting a coffee?

times

39. 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 – 1.5 hours	Every 1.5 – 2 hours	Every 3 – 4 hours	Every 2 – 3 hours	Every 4 – 5 hours	Over every 5 hours	No Interruption

40. 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

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.

41. 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.

○	○	○	○	○	○	○	○	○	○	○
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

42. 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.

○	○	○	○	○	○	○	○	○	○	○
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

43. 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.

○	○	○	○	○	○	○	○	○	○	○
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

44. 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

45. 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
○	○	○	○	○	○	○	○	○	○	○

46. 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
○	○	○	○	○	○	○	○	○	○	○

47. In the last 7 days, on average, how many times per day did you interrupt your sitting time while engaged in screen time?

E.g. By standing up, walking somewhere, or getting a drink?

______ times

48. 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 Interruptior
○	○	○	○	○	○	○	○	○	○	○

49. 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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SECTION 6 - OTHER ACTIVITIES

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 on e hour sitting on the sofa reading a book while you were listneing 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.

50. 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

51. 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

52. 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.

○	○	○	○	○	○	○	○	○	○	○
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

53. 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.

○	○	○	○	○	○	○	○	○	○	○
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

54. 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

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
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

55. 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

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
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

56. 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
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

57. 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
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

58. 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
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

59. 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
○	○	○	○	○	○	○	○	○	○	○

60. 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
○	○	○	○	○	○	○	○	○	○	○

61. 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
○	○	○	○	○	○	○	○	○	○	○

62. 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
○	○	○	○	○	○	○	○	○	○	○

63. 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
○	○	○	○	○	○	○	○	○	○	○

64. In the last 7 days, on average, how many times per day did you interrupt your sitting time while engaged in these other activities?

E.g. By standing up, walking somewhere, or getting a drink while socializing or doing a hobby.

_____ times

65. 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 – 1.5 hours	Every 1.5 – 2 hours	Every 3 – 4 hours	Every 2 – 3 hours	Every 4 – 5 hours	Over every 5 hours	No Interruption

66. 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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Appendix D: CONSORT Checklist for randomized controlled trials

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Appendix D: CONSORT Checklist for randomized controlled trials

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomized trial in the title	104
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	N/A
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	104-107
	2b	Specific objectives or hypotheses	107
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	107
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	107
Participants	4a	Eligibility criteria for participants	107
	4b	Settings and locations where the data were collected	108
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	108-110
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	110-115
	6b	Any changes to trial outcomes after the trial commenced, with reasons	107
Sample size	7a	How sample size was determined	116
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomization:			

Sequence generation	8a	Method used to generate the random allocation sequence	116
	8b	Type of randomization; details of any restriction (such as blocking and block size)	116
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	116
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	116
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	117
	11b	If relevant, description of the similarity of interventions	N/A
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	117
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	117
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analyzed for the primary outcome	119
	13b	For each group, losses and exclusions after randomization, together with reasons	119
Recruitment	14a	Dates defining the periods of recruitment and follow-up	120
	14b	Why the trial ended or was stopped	120
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	120-122
Numbers analyzed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	119
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	136-140, 142, 143, 147-148
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	N/A
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	N/A
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	149
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	157
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	157
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other	157

		relevant evidence	
Other information			
Registration	23	Registration number and name of trial registry	157
Protocol	24	Where the full trial protocol can be accessed, if available	157
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	158

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

Curriculum Vitae

Academic Curriculum Vitae of Wuyou (Yoah) Sui

EDUCATIONAL BACKGROUND

September 2010 – April 2014	University of Waterloo, Bachelor of Science, Honours Kinesiology
September 2014 – August 2016	Western University, Master of Arts, Psychological Basis of Kinesiology
September 2016 – August 2020	Western University, Doctorate of Philosophy, Psychological Basis of Kinesiology

RESEARCH INTERESTS

Health Behaviour Change, Sedentary Behaviour, Digital Health, Chronic Disease, Mental Health, Subjective Well-Being, Exercise Psychology, Health Psychology, Gamification

RESEARCH PUBLICATIONS

Submitted/In-Press

Rudkovska, A., Sui, W., & Irwin, J.D. (2020). *Assessing the prevalence and severity of smartphone addiction in post-secondary students: A brief report.* Manuscript re-submitted for publication (Manuscript ID: JACH-2020-04-0203).

Rudkovska, A., Sui, W., & Irwin, J.D. (2020). *Exploring the prevalence of nomophobia in a Canadian university: An environmental scan.* Manuscript submitted for publication (Manuscript ID: JACH-2020-03-0152).

Sui, W., & Facca, D. (in press). Digital health in a broadband land: The role of digital health literacy within rural environments. *Health Science Inquiry*.

2019

Sui, W. & Rudkovska, A. (2019). Quality and quantity: The future of machine learning for health research appraisal. *Health Science Inquiry*, 10(2019): 43-44.

Sui, W. & Morava, A. (2019). The Future of Beh"AI"viour Change. *Health Science Inquiry*, 10(2019): 45-46.

Morava, A. & Sui, W. (2019). Who's Monitoring the Health-Monitoring Applications? *Health Science Inquiry*, 10(2019): 57-58.

Sui, W., Rollo, A., Prapavessis, H. (2019). The acute effect of exercise on cravings and withdrawal symptoms. In V. Preedy (Ed.) *The neuroscience of nicotine: Mechanisms and treatment*. London, UK: Elsevier.

Rollo, A., Sui, W., Prapavessis, H. (2019). Exercise as a smoking cessation aid. In V. Preedy (Ed.) *The neuroscience of nicotine: Mechanisms and treatment*. London, UK: Elsevier.

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

Rollo, S., Crutchlow, L., Nagpal, T. S., Sui, W., & Prapavessis, H. (2019). The effects of classroom-based dynamic seating interventions on academic outcomes in youth: a systematic review. *Learning Environments Research*, 22(2): 153-171. https://doi.org/10.1007/s10984-018-9271-3

2018

Sui, Y. & Rudkovska, A. (2018). Stand up for your health: Excessive sedentary behaviour as a modifiable risk factor for chronic disease. *Health Science Inquiry*, 9(2018): 45-46.

Rudkovska, A., Sui, Y., & Kfrerer, M. (2018). Catheter re-use: Thrifty or threatening? A commentary on intermittent catheter re-use by individuals with spinal cord injury. *Health Science Inquiry*, 9(2018): 62-63.

Sui, W., & Prapavessis, H. (2018). Standing up for student health: An application of the health action process approach for reducing student sedentary behavior – a pilot study. *Applied Psychology: Health and Well-Being*, 10(1): 87-107. doi: 10.1111/aphw.12105.

2016

Sui, W., & Prapavessis, H. (2016). Testing the face validity and reliability of a modified SIT-Q 7-day recall questionnaire measuring sedentary time and break frequency & duration. *Journal of Sport & Exercise Psychology*, *38*, S262.

OTHER PUBLICATIONS

Sui, W., & Prapavessis, H. (2020). *COVID-19 has created more cyclists: How cities can keep them on their bikes.* The Conversation. https://theconversation.com/covid-19-has-created-more-cyclists-how-cities-can-keep-them-on-their-bikes-137545

Sui, W. (2020). *5 tips to get you off the sofa – because sitting more during COVID19 is hurting your health.* The Conversation. https://theconversation.com/5-tips-to-get-you-off-the-sofa-because-sitting-more-during-covid-19-is-hurting-your-health-139289

Rudkovska, A., & Sui, W. (2020). *Can Facetime replace face-to-face time?* The Conversation. https://theconversation.com/why-facetime-cant-replace-face-to-face-time-during-social-distancing-136206

Sui, W. (2019). *How can using a standing desk affect your productivity?* Sedentary Behaviour Research Network. Retrieved from: https://www.sedentarybehaviour.org/2019/07/03/how-can-using-a-standing-desk-affect-your-productivity/

TEACHING/ACADEMIC EXPERIENCE

February 2020 – April 2020	Learning module voiceover Graduate Student Assistantship – DesignEd, Faculty of Health Sciences, Western University
February 2020	Guest Lecture for KINESIOL 3388B: The Psychology of Sport
October 2019	Guest Lecture for KINESIOL 3476F: Exercise and Health Behaviour Change
June 2018 – Present	Teaching Assistant Training Program Instructor – Centre for Teaching and Learning, Western University
April 2019	Guest Lecture for KINESIOL 2032B: Research Design in Human Movement Science – Western University
February 2019	Guest Lecture for KINESIOL 2980B: Special Topic – Kin LIFE Movement Module – Western University
January 2019	Advanced Teaching Program Instructor – Centre for Teaching and Learning, Western University
September 2018 – December 2018	Sessional Instructor for KINESIOL 3476F: Exercise and Health Behaviour Change
October 2018	Guest Lecture for KINESIOL 2980A: Special Topic: Kin LIFE Movement Module – Western University

June 2018	Completed the Instructional Skills Workshop – Centre for Teaching and Learning
April 2018	Guest Lectures for KINESIOL 2032B: Critical Appraisal and Knowledge Translation – Western University
January 2018 – April 2018	Teaching Assistant for KINESIOL 2032B – Western University
September 2017 – December 2017	Teaching Assistant for KINESIOL 3476F – Western University
September 2017 – December 2017	Completed the Teaching Support Centre's Theory/Practice in University Teaching Course (GS9500) – Western University
October 2017	Guest Lectures for KINESIOL 3476F – Western University
January 2016 – April 2016	Teaching Assistant for KINESIOL 2032B – Western University
March 2016	Guest Lecture in KINESIOL 2000 course, Western University: Behaviour change for health
September 2015 – December 2015	Teaching Assistant for KINESIOL 1070A – Western University
November 2015	Attended a Teaching Master Class – Dr. Mike Atkinson.
November 2015	Guest Lecture for HS3071: Ecological Models for Health Behaviour Change – Western University
October 2015	Completed the Teaching Support Centre's Teaching Mentorship Program
September 2015	Fall Perspective on Teaching Conference – Western University
July 2015	Future Professor Workshops – Western University
March 2015	Future Professor Workshops – Western University
January 2015 – April 2015	Teaching Assistant for KINESIOL 2032B – Western University
October 2014 – December 2014	Completed the Teaching Support Centre's Advanced Teaching Program – Western University
September 2014	Completed the Teaching Support Centre's Teaching Assistant Training Program – Western University

PRESENTATIONS

January 2020 3-Minute Thesis Kick-off presentation: "Three minutes, three years in the making". Oral presentation.

October 2019 Department of Health and Rehabilitation Sciences Seminar: Presenting your research to diverse audiences. Oral presentation.

June 2019 Sui, W & Prapavessis, H. (2019). Less couch, less grouch? Exploring the relationship between sedentary behaviour and subjective well-being. Poster presented at the annual meeting of the International Society for Behavioral Nutrition and Physical Activity, Prague, Czechia.

April 2019 3-Minute Thesis Ontario Final – McMaster University

March 2019 3-Minute Thesis Western University: Top 20 – Western University

October 2018 Sui, W., Smith, S. T., Fagan, M. J., Rollo, S., & Prapavessis, H. (2018). The effects of sedentary behaviour interventions on work-related productivity and performance outcomes in real and simulated office work: A systematic review. Poster presentation at the annual meeting of the Canadian Society for Psychomotor Learning and Sport Psychology, Toronto, Canada.

May 2018 Faculty of Health Sciences Research Day 2018 – Less couch, less grouch: The relationship between sedentary behaviour and subjective well-being. Oral presentation.

June 2017 Sui, W., & Prapavessis, H. (2017). Standing up for student health: An application of the health action process approach for reducing student sedentary behavior – a pilot study. Oral presentation at the annual meeting of the International Society for Behavioral Nutrition and Physical Activity, Victoria, Canada.

May 2017 Let's Talk Cancer Western: Exercise Psychology and Cancer – Western University

March 2017 3-Minute Thesis Western University: Top 20 – Western University

March 2017 Standing up for student health: An application of the Health Action Process Approach (HAPA) for reducing student sedentary behaviour – A pilot study. Poster presentation at London Health Research Day 2017.

January 2017 "Standing up for student health - Using behavioral counseling to increase non-sedentary behavior" – Retiring with Strong Minds Presentation

June 2016 Sui, W., & Prapavessis, H. (2016). Testing the face validity and reliability of a modified SIT-Q 7-day recall questionnaire measuring sedentary time and break frequency & duration. Poster presented at the annual meeting of the North American Society for the Psychology of Sport and Physical Activity, Montreal, Canada.

May 2016 Standing up for student health: An application of the Health Action Process Approach (HAPA) for reducing student sedentary behaviour. Oral proposal presentation at the Exercise is Medicine Ontario Student Conference 2016.

May 2016 Let's Talk Cancer Western: Exercise Psychology and Cancer – Western University.

March 2016 3-Minute Thesis Western University: Top 20 – Western University

December 2015 "Sitting is the new smoking" – Retiring with Strong Minds Presentation

April 2015	"Sitting is the new smoking" – Ignite London Presentation

RESEARCH-SPECIFIC HONOURS, AWARDS, AND SCHOLARSHIPS

2020	Dr. Bert Carron Graduate Scholarship in Sport and Exercise Psychology
2019	Second Place – Ontario 3-Minute Thesis Final
2019	Competitors Choice – Ontario 3-Minute Thesis Final
2019-2020	Ontario Graduate Scholarship (OGS)
2018-2019	Ontario Graduate Scholarship (OGS)
2018	Western's Ideas for Sustainability and the Environment (WISE) competition – Finalist: Graduate Student category
2014-2019	Western Graduate Research Scholarship
2017	Canadian Obesity Network SNP Western Research Blitz – 1^{st} Place
2017	Canadian Obesity Network SNP Ontario Research Blitz – 1^{st} Place
2017	Canadian Cancer Society Middlesex-London Research Blitz – 3^{rd} Place
2016	Canadian Obesity Network SNP Western Research Blitz – 1^{st} Place
2016	Canadian Obesity Network SNP Ontario Research Blitz – 2^{nd} Place
2016-2017	Ontario Graduate Scholarship (OGS)
2014	Society of Graduate Students 125^{th} Anniversary Scholarship